National Water Quality Monitoring Council
MONITORING NETWORKS
Connecting for Clean Water
2006 National Monitoring Conference

5th National Monitoring Conference

Monitoring Networks: Connecting for Clean Water

San José, California • May 7–11, 2006

Conference Themes

- Assessing methods & data comparability
- Applying new methods & innovative techniques
- Addressing different scales & multiple objectives
- Synthesizing & sharing data
- Improving communication among all stakeholders
- Integrating monitoring & prediction
- Large-scale programs: Results, lessons learned, & future directions

Conference Program and Presenter Information

CITY OF
SAN JOSE
CAPITAL OF SILICON VALLEY

Ron Gonzales
MAYOR

May 7, 2006

Dear Friends,

Welcome to the Fifth National Monitoring Conference in San José. This event is an excellent opportunity for exchanging information, developing skills and building effective networks to better understand, protect and restore our natural waters.

The City of San José is proud to host and co-chair this conference with the National Water Quality Monitoring Council. The theme "Monitoring Networks: Connecting for Clean Water" encourages broad and thoughtful discussion during keynote presentations and workshops that can open up new opportunities for advances that will benefit us all.

The San José region has earned a well-deserved reputation for environmental leadership and innovation with its award winning recycling, water conservation, water recycling and wastewater treatment programs. We also have a long history of tracking environmental progress and accumulating data that are the cornerstone of several major regional and innovative initiatives, including most recently, the State and Federal Salt Marsh Restoration Project in South San Francisco Bay.

I encourage you to make the most of your stay in San José by exploring all that our city has to offer visitors. Our wonderful and walkable downtown, our historical sites and landmarks, our beautiful parks, trails and open spaces, our museums and cultural events – and most important, our warm and hospitable community – welcome you to enjoy your time in San José.

Please accept my best wishes for a wonderful event and continued success in the future.

Best Wishes,

Ron Gonzales
Mayor

200 East Santa Clara Street, San José, CA 95113 *tel* (408) 535-4800 *fax* (408) 292-6422 www.sjmayor.org

NATIONAL WATER QUALITY MONITORING COUNCIL
Working Together for Clean Water
NWQMC

Welcome to the Fifth National Monitoring Conference in San José, California!

Dear Colleagues:

WELCOME TO THE CONFERENCE! We are delighted you could join us as we highlight the human, technological, and programmatic networks that connect all of us working for clean water. For this conference, we received over 500 abstracts from our colleagues in all sectors of the monitoring community in the United States as well as abroad. This year's program is rich in scope and content, including an unprecedented 335 platform presentations, over 130 technical posters, sixteen workshops and short courses, and 45 exhibits. Of special note, this year's agenda also features:

- Discussion sessions and presentations focused on large-scale collaborative monitoring networks, such as the proposed National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries,
- Presentations by our colleagues in California describing how they have implemented innovative monitoring networks across the state,
- Informal meetings and workshops encouraging volunteer monitoring program coordinators to exchange information, develop new skills, and build better networks, and
- Platform sessions showcasing the USGS National Water-Quality Assessment Program's new findings on the quality of the Nation's streams and ground water.

This Conference Program will provide you with a general overview of conference activities and contains:

- ✓ ***Collaborative Partnership for Water Quality Monitoring*** providing an introduction to the National Water Quality Monitoring Council, its mission, and membership
- ✓ A thank you to our ***Conference Sponsors***
- ✓ ***Elizabeth J. Fellows Award Announcement*** honoring this year's recipient of the EJF Award
- ✓ ***Acknowledgments*** recognizing the individuals, organizations, agencies, and businesses that planned this year's conference
- ✓ A list of ***Conference Exhibitors***
- ✓ A full ***Conference Agenda*** listing times and locations for all conference activities
- ✓ A list of **Poster Presentations** grouped by topic

Each attendee will also receive a CD that contains all of the information above plus the abstracts for all oral and poster presentations, workshops, and short courses.

We invite you to join us in making this conference an opportunity to share our experiences and explore the critical elements of building effective networks.

Sincerely yours,

Charles S. Spooner
Co-Chair, U.S. Environmental Protection Agency

Gail E. Mallard
Co-Chair, U.S. Geological Survey

"It is in the marriage of credible data use and increased stewardship behavior that the true potential and vitality of citizen monitoring begins to emerge." – Steven Hubbell

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Welcome friends, colleagues, and conference participants,

On behalf of the extensive volunteer monitoring community, we welcome you to this conference and invite you to experience presentations highlighting the broad spectrum of volunteer monitoring activities.

Across the country, and indeed throughout the world, volunteer monitors watch over watersheds, often where no one else is looking. They monitor the condition of streams, rivers, lakes, reservoirs, estuaries, coastal waters, wetlands, and wells. They do this because they want to help protect or restore a favorite water body near where they live, work, or play. They do this to ensure safe drinking water. They educate themselves, their community, and decision-makers. They recognize the importance of their role as watershed stewards. They make a difference.

Volunteers do physical, chemical and biological monitoring. They measure Secchi depth in lakes, identify stream benthic macroinvertebrates, and monitor bacteria levels. They make visual observations of habitat, land uses, and storm impacts, and assess the abundance and diversity of plants, fish, birds, and other wildlife. Some have undertaken more exotic activities, examining water samples for toxic phytoplankton or monitoring the health of coral reefs. Volunteers count and catalog beach debris, participate in restoring degraded habitats, and help monitor the success of restoration efforts.

When you talk to state agency staff about uses of volunteer monitoring data, they tend to focus on state-level uses like EPA's 305(b) report and 303(d) listing. And indeed volunteer data are increasingly finding their way into state reports and TMDL plans. But volunteer organizations are quick to point out that state-level uses are not the holy grail of volunteer data use. Volunteer monitoring is for the most part a local activity with local impacts. Watershed associations, lakefront homeowner associations, and other community groups use their monitoring data to guide their own restoration projects and management activities. They present their data to local planning committees or town councils to support proposals for protective ordinances and policies.

Volunteer monitoring of lakes and streams began in the 1970s and grew rapidly. Many volunteer monitoring programs have been going strong for more than 20 years, providing an unparalleled long-term record of water quality and the ability to assess whether water quality improvement and restoration projects are truly working. As volunteer monitoring has grown and matured, programs increasingly emphasize assuring data quality and documenting metadata so that the comparability of their data to that of others can be recognized. Credibility is key.

We invite all conference participants to take advantage of workshops, presentations, and informal exchanges, indeed to Connect for Clean Water with all members our vibrant monitoring community, especially those at this conference!

For our waters,

The Volunteer Monitoring Conference Planning Sub-Committee
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United States Department of the Interior

U. S. GEOLOGICAL SURVEY
Reston, VA 20192
Mail Stop 413

May 7, 2006

Colleagues and Conference Participants,

On behalf of the U.S. Geological Survey (USGS) and the National Water-Quality Assessment (NAWQA) Program, I am pleased to welcome you to the 5th National Monitoring Conference in San José, California. I am honored that the National Water Quality Monitoring Council offered the NAWQA Program an opportunity to play a major role in the conference.

In particular, we in NAWQA are excited to share with you our recent national-scale findings on pesticides and volatile organic contaminants from data collected in the first decade of the Program, 1992-2001. In addition, we bring to the conference our latest approaches and methods, for example, models that make the important step of moving us forward from monitoring to prediction of water quality conditions. Prediction of water quality conditions in unsampled waters is an important next step because water quality-assessment is something we need for all waters, not just those we can afford to monitor. We also bring to the conference early results on approaches to assessing and understanding the sources, fate, transport, and effects of contaminants in ground water and streams, and the effects of mercury and urbanization on aquatic ecosystems.

The quality of this conference is the reason we return each biennium. The quality is the result of the activities and contributions of a large number of individuals that make up the membership of the National Water Quality Monitoring Council. I want to thank all those who made this week possible and wish you a beneficial and productive time in San José.

Sincerely,

Donna N. Myers

Donna N. Myers, Chief
National Water-Quality Assessment Program

2006 National Monitoring Conference Program

Welcome to the City of San José
Welcome from the National Water Quality Monitoring Council
Welcome from the Volunteer Monitoring Conference Planning Sub-Committee
Welcome from the U.S. Geological Survey (USGS) and the National Water-Quality Assessment (NAWQA) Program

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National Water Quality Monitoring Council

NWQMC — National Water Quality Monitoring Council

Working Together for Clean Water

Collaborative Partnership for Water Quality Monitoring

Introduction

The National Water Quality Monitoring Council (Council) provides an opportunity for the monitoring community to develop consensus-based approaches and tools for monitoring and reporting on water quality. The Council promotes partnerships that foster collaboration, advance the science, and improve management of our water resources. The Council strives to represent the full range of the monitoring community.

Council Mission

Provide a national forum to coordinate consistent and scientifically defensible methods and strategies for improving water quality monitoring, assessment, and reporting.

The Challenge of Multi-Agency Monitoring

Each year government agencies, industry, academia and private organizations devote enormous amounts of time, energy, and money to monitor, protect, manage, and restore water resources and watersheds. Differences in project design, methods, data analysis, and data management have often made it difficult for monitoring information and results to be shared and used by all. The restoration and protection of water quality is dependent upon detailed, understandable, and easily accessible data and information.

Responding to the Challenge: The National Water Quality Monitoring Council

The Council provides guidance and technical support for voluntary implementation of actions that advance the science of monitoring. This is best accomplished in an arena of collaborative and coordinated efforts communicated to all interested parties. In sum these actions will ultimately improve water quality monitoring. The Council encourages use of metadata, lab accreditation, methods documentation, and other procedures that contribute to the broadest possible acceptance, sharing, and use of water quality data. The Council promotes effective communication of monitoring results and findings to decision-makers and the general public. In some cases, Council work groups develop tools and techniques. Examples of these are the National Environmental Methods Index and Water Quality Data Elements. In other cases, the Council provides a venue for wide-ranging discussion and dissemination of new methods and technologies developed by others through its Web site and at its National Monitoring Conferences.

Membership and Organization

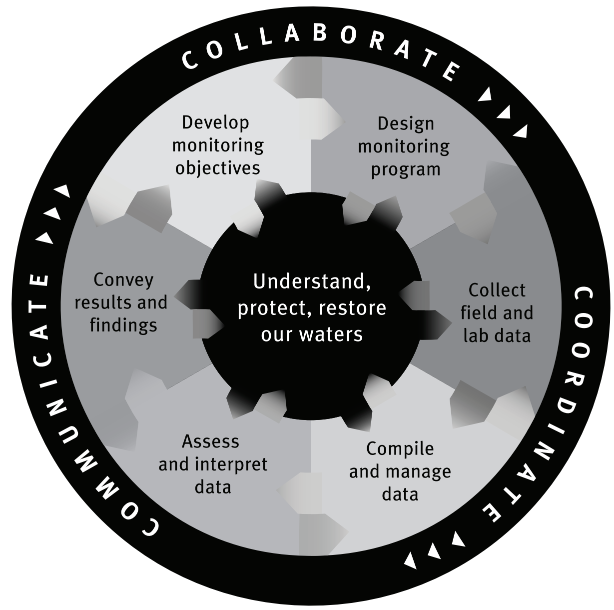
The Council was created in 1997 as a vehicle for bringing together the diverse expertise, skills, and talents needed to develop collaborative, comparable, and cost-effective approaches to water quality monitoring. The Council's 35 members represent the monitoring community: federal, tribal, state, interstate, local, and municipal governments; watershed and environmental groups; the volunteer monitoring community; academia; and the private sector including the regulated community. These are organizations that collect, analyze, interpret, disseminate, or use water quality monitoring information as well as those that develop monitoring technology, guidelines, and/or standards. The Council is co-chaired by the U.S. Geological Survey and the U.S. Environmental Protection Agency. The Council reports to the Advisory Committee on Water Information that operates under the Federal Advisory Committee Act.

Council Work Groups

- **Water Information Strategies** defines and promotes goal-oriented monitoring by proposing strategies for network design, data analysis and interpretation, and reporting results in support of the information needs of water quality management.
- **Methods and Data Comparability Board** provides a forum for exploring, evaluating, and promoting methods that facilitate collaboration and further comparability among water quality monitoring programs.
- **Watershed Components Interactions** provides an improved understanding of the factors affecting water quality within watersheds. The group assesses how these factors interact to develop effective monitoring strategies.
- **Collaboration and Outreach** works to build partnerships that foster collaboration among the many elements of the water monitoring community, particularly by supporting the development of state and regional monitoring councils, and promoting the importance of monitoring for decision-making.

A Framework for Monitoring

The Council, with broad and significant input from the monitoring community, has developed a pictorial framework for monitoring that shows the components of the monitoring process (as a series of interlinked cogs) needed to understand, protect, and restore our water resources. Incorporating the components of this framework into monitoring projects will improve monitoring efforts, results, and communication of information.



See Council Fact Sheet "A Framework for Water Quality Monitoring" and the American Water Resources Association (AWRA) IMPACT, September 2003 issue, Vol. 5, No. 5.

Council Activities and Products

The Council has taken a number of steps to encourage the water quality monitoring community to integrate the components of the monitoring framework into their efforts. The following examples of Council activities and products showcase efforts to improve data comparability and reliability as well as to foster institutional collaboration:

- Organizing and sponsoring biennial **National Monitoring Conferences** since 1998; each conference attended by more than 400 active participants representing a wide spectrum of the monitoring community. These conferences provide a national forum to present and explore methods and strategies for improving water quality monitoring, assessment, and reporting as well as presenting specific ways to foster collaboration and coordination.

To participate in the National Monitoring Conference, visit:
http://www.nwqmc.org

- Providing guidance and support for **State and Regional Water Quality Monitoring Councils** *(see Council Fact Sheet "Accomplishing More Together").* These councils bring members of the monitoring community together to share their expertise and knowledge and to promote strategic monitoring efforts at an appropriate scale.
- Sponsoring development and adoption of the **National Environmental Methods Index (NEMI)** that provides assistance in choosing appropriate field and laboratory methods to meet specified monitoring objectives. See www.nemi.gov for additional information.
- Sponsoring development and adoption of the **Water Quality Data Elements** — metadata that should be included with water quality results so that data comparability can be assessed.
- Publishing position papers on **Laboratory Accreditation** that describe a process that will give regulators and others in the monitoring community confidence that water quality data have been produced by qualified personnel using appropriate quality control and quality assurance procedures.

Member organizations of the Council

Federal:

U.S. Geological Survey
U.S. Environmental Protection Agency
Natural Resources Conservation Service
Tennessee Valley Authority
National Oceanic and Atmospheric Administration
National Park Service
U.S. Army Corps of Engineers

Tribal:

Inter Tribal Council of Arizona, Inc.

States representing Federal regions:

New Hampshire Department Environmental Services
New Jersey Department of Environmental Protection
Virginia Department of Environmental Quality
Alabama Department of Environmental Management
Indiana Department of Environmental Management
Texas Commission on Environmental Quality
California State Water Resources Control Board
Washington Department of Ecology
South Florida Water Management District
Oregon Department of Environmental Quality
West Virginia Department of Environmental Protection
Iowa Department of Natural Resources

Other:

Water Environment Federation
North American Lake Management Society
National Association of State Conservation Agencies
National Association of Conservation Districts
Association of Metropolitan Water Agencies
Association of American State Geologists
Ohio River Valley Water Sanitation Commission
American Society of Limnology and Oceanography
American Chemistry Council
University of Rhode Island, Watershed Watch
Colorado State University, Water Resources Research Institute
National Association of Clean Water Agencies
National Institutes of Water Resources

Additional information can be obtained through the
National Water Quality Monitoring Council's Web site at:

http://acwi.gov/monitoring/

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A National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries

The annual cost of water resource monitoring is hundreds of millions of dollars. Yet, numerous reports in recent years indicate that monitoring remains insufficient and lacks coordination to provide comprehensive information about U.S. water resources. The final report of the U.S. Commission on Ocean Policy recommended a National Monitoring Network (Network) to assure effective stewardship of ocean resources. The National Water Quality Monitoring Council of the Advisory Committee on Water Information was asked to design such a Network, in part because of its broad membership, including federal, tribal, state and local agencies, water associations, universities and the private sector. The proposed Network shares many attributes with ongoing monitoring efforts but is unique in that it uses an integrated, multi-disciplinary approach to address a broad range of resource components, from upland watersheds to offshore waters. Key design features include:

- Clear objectives linked to management questions
- Linkage to the Integrated Ocean Observing System (IOOS)
- Flexibility in design over time
- Importance of metadata, quality assurance, comparable methods and ready access

The Network provides critical information about the quality of coastal waters and their tributaries at regional and national scales, but does not incorporate or replace all ongoing water quality monitoring. State and local agencies must continue to meet many regulatory and local needs, (e.g., monitoring for drinking water) that will be outside the scope of the Network. However, many existing state and regional monitoring programs may well become “network compliant” and both contribute to and benefit from the National Network.

Table 3-2 in the Executive Summary (available at the NWQMC exhibit booth) provides an at-a-glance overview of the Network design by resource component, including estuaries, nearshore, offshore, Great Lakes, rivers, ground water, atmospheric deposition, beaches and wetlands. Constituents to be monitored include physical characteristics, inorganic and organic chemical concentrations, and biological conditions. Continuity of measurements among all resource components will provide a better understanding of the linkages among resources.

Full implementation of the Network will require the use of data collected by a number of federal, tribal, state, local, academic, and private sources. Data must be comparable to allow integration into a coherent assessment of the condition of and trends in the quality of the Nation’s coastal waters and their tributaries. The use of models to interpret environmental data will facilitate understanding of complex environmental issues.

Plenary talks, special sessions and exhibits throughout the conference will provide opportunities for you to learn more about the Network design, and to provide important feedback to the National Water Quality Monitoring Council.

THANK YOU

To our generous Conference Sponsors who have made the 2006 National Monitoring Conference a success!

Conference Co-Sponsors

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*** This denotes those organizations that generously provided travel support for volunteer monitoring and watershed program coordinators.**

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*** This denotes those organizations that generously provided travel support for volunteer monitoring and watershed program coordinators.**

National Water Quality Monitoring Council
MONITORING NETWORKS
Connecting for Clean Water
2006 National Monitoring Conference

ELIZABETH JESTER FELLOWS AWARD ANNOUNCEMENT

Elizabeth J. Fellows headed the Assessment and Watershed Protection Division in USEPA's Office of Water. She dedicated her career to natural resources management and environmental protection including envisioning the creation of the National Council. She was an effective advocate for developing a nationwide framework for coordinating, collecting, assessing, and communicating water quality monitoring information and results. In her memory, the National Water Quality Monitoring Council has established the Elizabeth Jester Fellows Award to recognize individuals for outstanding achievement, exemplary service, and distinguished leadership in the field of water quality monitoring.

In recognition of her contributions to water quality monitoring, the NWQMC is pleased to present the 2006 Elizabeth Jester Fellows Award to

Eleanor Ely
Editor
The Volunteer Monitor

In recognition of her contributions to water quality monitoring, the National Water Quality Monitoring Council is pleased to present the 2006 Elizabeth Jester Fellows Award to Eleanor Ely, editor of *The Volunteer Monitor* newsletter.

For sixteen years, Ellie has been the editor and driving force behind *The Volunteer Monitor*, the national newsletter for those who train and oversee the huge population of citizen volunteers across the country. Volunteer program coordinators all over the U.S. – and in many other countries – rely on the newsletter for technical advice on monitoring, sustaining programs, training volunteers, and many, many other topics. This newsletter is, in fact, *the* critical link connecting the thousands of diverse members of the volunteer monitoring community. Ellie's persistence, patience, and unique editorial insight ensure that her publication is timely *and* timeless, an invaluable resource for the entire monitoring community, from volunteer to professional.

Ellie devotes a tremendous amount of time, effort, and energy into writing, editing, and producing each issue of *The Volunteer Monitor* newsletter. She has a critical eye for details, and researches and thoroughly masters each newsletter topic – from data management to bacteria monitoring. Most remarkably, Ellie can translate the most arcane bureaucratic doublespeak or scientific technospeak into plain, clearly understandable English. She cares very much about the newsletter's technical and editorial quality, and is just as wholly dedicated to the volunteer monitoring movement itself; she knows more about individual volunteer monitoring programs and their leaders than any other person in the U.S. She is always eager to share her knowledge, experience, and connections with others, and to help forward the cause of volunteer environmental monitoring.

Ellie is a gifted writer, editor, and advocate of community-based environmental monitoring. Her selfless effort to enhance and advance the efforts of citizen volunteers has given them a greater voice in protecting and restoring the nation's water resources. Her colleagues in the volunteer monitoring community nominated her for this award as an expression of their admiration and gratitude.

Congratulations, Ellie!

ACKNOWLEDGMENTS

The Council offers its gratitude to those who served on the 2006 Conference Planning Committee. The Council also acknowledges the commitment and hard work of all those who served as abstract review team leaders and members, session moderators, workshop/short course facilitators and trainers, and speakers. Many thanks go to all of the environmental monitoring professionals who prepared presentations, posters, and exhibits for this conference. The numerous individuals who participated in organizing the 2006 conference are listed below:

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Jeff Schloss, University of NH
Chuck Spooner, USEPA (M)
David Tucker, City of San José

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Carol Winge, NALMS (S)
David Wunsch, NH DES (M)
Eric Vowinkel, USGS

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(M) Indicates Moderators and Workshop/Short Course Facilitators & Trainers
(V) Indicates Special Volunteer Monitoring Sub-committee
(S) Indicates Conference Staff

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Faith Zerbe, DE Riverkeeper
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*** This denotes those organizations that generously provided travel support for volunteer monitoring and watershed program coordinators.**

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http://www.ngwa.org/

National Water Quality Monitoring Council
http://water.usgs.gov/wicp/acwi/monitoring/

NOAA National Centers for Coastal Ocean Science
1305 East West Highway, Rm 8110
Silver Spring, MD 20910
301.713.3020
nccos.webmaster@noaa.gov
http://www.nccos.noaa.gov/welcome.html

ROM Communications, Inc.
12705 65th Street NW
Edmonton, A.B.
CANADA, T5A 0Z4
877.860.3762 or 250.860.3762
info@romcomm.com
http://www.romcomm.com/

RTI International
701 13th Street NW, Ste 750
Washington, DC 20005
202.728.2080
http://www.rti.org/

Schlumberger Water Services
460 Phillip Street, Suite 101
Waterloo, Ontario
Canada N2L 5J2
519.746.1798
http://www.slb.com/content/services/additional/water/index.asp

Solinst Canada, Ltd.
35 Todd Rd.
Georgetown, Ontario
Canada L7G 4R8
800.661.2023 or 905.873.2255
instruments@solinst.com
http://www.solinst.com/index2.html

Teledyne ISCO
4700 Superior Street
Lincoln, NE 68504
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iscoInfo@teledyne.com
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Teledyne RD Instruments
9855 Businesspark Avenue
San Diego, CA 92131-1101
858.693.1178
rdi@teledyne.com
http://www.rdinstruments.com/

Tennessee Valley Authority
1101 Market St.
Chattanooga, TN 37402-2801
423.751.0011
http://www.tva.gov/

Tetra Tech, Inc
http://www.tetratech.com/

US Environmental Protection Agency Environmental Technology Verification Program
http://www.epa.gov/etv/index.html

US Environmental Protection Agency Office of Environmental Information
.http://www.epa.gov/oei/

US Environmental Protection Agency Office of Water
http://www.epa.gov/OW/index.html

US Geological Survey
http://www.usgs.gov/

US Geological Survey National Water-Quality Assessment Program
http://water.usgs.gov/nawqa/

US Geological Survey NWISWeb
http://waterdata.usgs.gov/nwis

***USDA-CSREES Volunteer Water Quality Monitoring National Facilitation Project**
http://www.usawaterquality.org/volunteer/

Utility Systems Science & Software
2101 E. 4th Street, Suite 130A
Santa Ana, CA 92705
714.542.1004
mark.serres@uscubed.com
http://www.uscubed.com/usss/

Water Environment Federation
http://www.wef.org/Home

WET Labs
P.O. Box 518
Philomath, OR 97370
541.929.5650
sales@wetlabs.com
http://www.wetlabs.com/index.html

YSI, Inc.
1725 Brannum Lane
Yellow Springs, OH 45387
937.767.7241
environmental@ysi.com
http://www.ysi.com/index.html

*** This denotes those organizations that generously provided travel support for volunteer monitoring and watershed program coordinators.**

2006 NATIONAL MONITORING CONFERENCE AGENDA

Sunday, May 7

8:00 - 1:00; 12:00 - 5:00	Field Trip: USGS Polaris Research Vessel Cruises - morning and afternoon trips (Meet at main entrance to Convention Center on 1st floor)
9:00 - 4:00	Field Trip: Monterey Aquarium & "Walk 'n Talk" with the Monterey Bay National Marine Sanctuary (Meet at main entrance to Convention Center on 1st floor)
10:00 - 3:00	Field Trip: Roaring Camp Railroad (Meet at main entrance to Convention Center on 1st floor)
12:00 - 5:00	Registration in Ballroom Concourse
12:00 - 7:00	Exhibitor Set-Up (Exhibit Hall 1)

Monday, May 8

7:00 - 8:00	Breakfast in Exhibit Hall 1, Registration in Ballroom Concourse							
	Meeting Room C2	**Meeting Room A4**	**Meeting Room C1**	**Meeting Room A3**	**Meeting Room C3**	**Meeting Room C4**		
Concurrent Session A **8:00 - 10:30**	WORKSHOP: ***Words and Water Quality: Effective Communication Through Better Publications*** Facilitators: Eleanor Ely, *The Volunteer Monitor*; Abby Markowitz, Tetra Tech, Inc.	WORKSHOP: ***Critical Elements of a Bioassessment Program for State & Tribal Monitoring*** Facilitators: Michael Barbour, Tetra Tech, Inc.; Chris Yoder, Midwest Biodiversity Institute	WORKSHOP: ***Data to Action: Empowering Citizens through the Acquisition and Understanding of Monitoring Data*** Facilitators: Candie Wilderman and Lauren Imgrund, ALLARM; Faith Zerbe, Delaware Riverkeeper	SHORT COURSE: ***Assessing Ground Water Vulnerability through Statistical and Mechanistic Methods*** Trainers: Sandy Eberts, Leon Kauffman, Bernard Nolan, Matthew Landon, and Jeffrey Starn, USGS; Stephen Kraemer and Mike Muse, USEPA; Rob Malone, USDA	WORKSHOP: ***Using U.S. Geological Survey Spatial Data to Analyze Water Quality*** Facilitators: Curtis Price, Joseph Kerski, and Sandy Williamson, USGS	WORKSHOP: ***Probability Survey Design for Aquatic Resources using R Statistical Software*** Facilitator: Tony Olsen, USEPA		
10:30 - 11:00	Break - Refreshments in Exhibit Hall 1							
11:00 - 12:30	**Opening Plenary and EJF Award Presentation (Ballrooms A1, 2, 7, 8)** Welcome to the 2006 National Monitoring Conference, David Tucker, Conference Chair Welcome to San José: Capital of Silicon Valley, John Stufflebean, Director, Environmental Services, City of San Jose Introduction to the 2006 Conference, Linda Green, Conference Chair The National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries, Charles Spooner & Gail Mallard, NWQMC Co-Chairs **Keynote Speaker - Monitoring Networks: Connecting for Clean Water, Mr. Terry Tamminen, Special Assistant to the Governor of California** Presentation of the Elizabeth J. Fellows Award, Linda Green, Conference Chair Charge to Conference Participants, Jeffrey Schloss, Conference Chair							
12:30 - 1:30	Lunch in Exhibit Hall 1							

Monday, May 8

	Meeting Room A5	Meeting Room A6	Meeting Room A3	Meeting Room A4	Meeting Room C2	Meeting Room C4	Meeting Room C3	Meeting Room C1
Concurrent Session B **1:30 - 3:00**	***Measurement Performance I: Programwide Considerations*** Moderator: Karen Blocksom	***Perspectives on the Nation's Water Quality: Findings, Implications, & Future Directions I*** Moderator: Robin O'Malley	***Monitoring & Managing Ground Water Resources at Multiple Scales*** Moderator: David Wunsch	***Use of Ancillary Data and GIS Tools to Interpret Water Quality*** Moderator: Curtis Price	***Monitoring in the Shadow of the Golden Gate*** Moderator: Jessie Denver	***Pesticides in Midwestern Streams: Monitoring Strategies & Recent Results*** Moderator: Lyle Cowles	***Using & Developing WQ Indices*** Moderator: Curtis Cude	WORKSHOP: ***Getting Started in Volunteer Monitoring*** Facilitators: Linda Green, URI Watershed Watch; Danielle Donkersloot, NJ Watershed Watch Network
1:35 - 1:55	**Elements for a Successful Low-Level National Scale VOC Assessment**, David Bender, USGS	**Pesticides in the Nation's Streams and Ground Water, 1992-2001**, Robert Gilliom, USGS	**The Fall and Rise of an Aquifer—Stakeholders Unite to Conserve and Monitor the Sparta Aquifer in South Arkansas**, David Freiwald, USGS	**Characterizing the Landscape for Water-Quality Data Analysis: Methods and Implementation**, Curtis Price, USGS	**Sustaining a Regional Water Quality Monitoring Program: The Lessons from San Francisco Bay**, Michael Connor, San Francisco Estuary Institute	**Glyphosate concentrations in various hydrological compartments of a small watershed in east-central Indiana**, Nancy Baker, USGS	**Creative Outreach: Solving the Conundrum of Using Volunteer Water Quality Data as a Meaningful Source of Information**, Amanda Ross, Lower Colorado River Authority, Colorado River Watch Network	
1:55 - 2:15	**Lessons Learned in National Park Service Vital Signs Long Term Monitoring Program**, Roy Irwin, National Park Service	**Nutrients in the Nation's Streams and Groundwater, 1992-2001**, Neil Dubrovsky, USGS	**Proposed National Ground Water Monitoring Program**, Beverly Herzog, Illinois State Geological Survey	**Characterizing the Landscape for Water-Quality Assessment: Linking tabular county data on agricultural nutrient and pesticide applications to spatial land cover data to estimate nutrient and pesticide use in watersheds and ground water study areas**, Gail Thelin, USGS	**Monitoring metals in San Francisco Bay: Quantification of temporal variations from hours to decades**, Arthur Flegal, University of CA, Santa Cruz	**Monitoring Pesticides in Iowa's Waters**, Mary Skopec, IA Dept. of Natural Resources	**Anthropogenic Impacts to Fish Assemblages in Northern New Jersey Streams**, Leslie McGeorge, NJ Dept. of Environmental Protection	
2:15 - 2:35	**Meeting Programmatic Data Quality Objectives through a Standardized Verification and Validation System and Data Management**, Beverly van Buuren, San Jose State University Foundation, Moss Landing Marine Labs	**The National Coastal Assessment: Results, Lessons Learned and Future Directions**, Kevin Summers, USEPA	**The Need for Renewed Emphasis on State, Tribal and Federal Ground-Water Protection Programs**, Mike Wireman, USEPA Region 8	**The use of remotely-sensed and GIS-derived variables to characterize urbanization in the National Water-Quality Assessment program**, James Falcone, USGS	**Science, consensus and monitoring strategies: the art of revising a long-term benthic monitoring program**, Heather Peterson, CA Dept. of Water Resources	**Assessment of Nutrients and Selected Organic contaminants in Small Streams in the Midwestern United States**, 2004, James Stark, USGS	**Effects of hydrologic factors on ecological conditions of streams in the northeastern United States**, Jonathan Kennen, USGS	
2:35 - 2:55	**Challenges of Conducting Analytical Chemistry in Environmental Matrices or Why is my Blank not Blank?**, Meg Sedlak, San Francisco Estuary Institute	**Perspectives on the State of the Nation's Waters**, Robin O'Malley, The H. John Heinz III Center for Science, Economics and the Environment	**Developing a Ground Water Monitoring Strategy for Half the Cost - Literally**, David Wunsch, New Hampshire Geological Survey	**StreamStats: A Web-based application for estimating basin characteristics and streamflows**, Alan Rea, USGS	**Adapting an Ambient Monitoring Program to the Challenge of Managing Emerging Pollutants in the San Francisco Estuary**, Rainer Hoenicke, San Francisco Estuary Institute	**Trends in diazinon and other urban pesticides in stream samples from the northeastern United States**, 1993-2004, Patrick Phillips, USGS	**Assessment of Aquatic Biological Communities along a Gradient of Urbanization in the Willamette Valley Ecoregion and a Predictive Application to Unsampled Sites**, Ian Waite, USGS Oregon Water Science Center	
3:00 - 3:30	Break - Refreshments in Exhibit Hall 1							

Monday, May 8

	Meeting Room A5	Meeting Room A6	Meeting Room A3	Meeting Room A4	Meeting Room C2	Meeting Room C4	Meeting Room C3	Meeting Room C1
Concurrent Session C **3:30 - 5:00**	***Measurement Performance II: Field & Analytical Assessment*** Moderator: Tamim Younos	***Perspectives on the Nation's Water Quality: Findings, Implications, & Future Directions II*** Moderator: Donna Myers	***Monitoring Drinking Water & Sources of Supply*** Moderator: Gil Dichter	***Designing Watershed Assessments*** Moderator: LeAnne Astin	***Innovative Approaches for Developing Nutrient TMDLs*** Moderator: Jim Laine	***Making it Work: Designing Your Volunteer Monitoring Strategy*** Moderator: Bridget Hoover	***Seeing Your Way Through Turbidity Monitoring*** Moderator: Faith Zerbe	SHORT COURSE: ***Statistical Tools for Supporting the Development of a Multi Metric Index (MMI) for Macroinvertebrate Communities*** Trainer: John Stoddard, USEPA
3:35 - 3:55	**Uncertainty in Measured Streamflow and Water Quality Data for Small Watersheds**, Daren Harmel, USDA ARS	**A National Surveillance Study on Priority Pesticides in Canadian Aquatic Ecosystems**, Janine Murray, Environment Canada, National Water Research Institute	**Water quality monitoring of the Cambrian-Ordovician aquifer system in Iowa and Illinois**, Kimberlee Barnes, USGS	**Critical Evaluation of Waterbody Assessment Processes**, Lindsay Griffith, Brown and Caldwell	**The Northeast AVGWLF: A Watershed Scale Model to predict Sediment and Nutrient Transport**, Rebecca Weidman, New England Interstate Water Pollution Control Commission	**Designing Your Monitoring Plan: Linking Citizen Monitoring and Data Use**, Angie Becker Kudelka, Minnesota Waters	**Water Quality Impairment from Roadway Run-off: Characterizing Fine Particles**, Peter Green, University of California, Davis	
3:55 - 4:15	**Automated Validation and Grading of Aquatic Time Series Using a Probabilistic Parity Space Method**, Touraj Faramand, Aquatic Informatics Inc.	**Trends in Metals and Hydrophobic Organic Contaminants in Urban and Reference Lake Sediments Across the United States**, 1970 to 2001, Peter Van Metre, USGS	**Assessment of Shallow Ground-Water Quality in Agricultural and Urban Areas Within the Arid and Semi-arid Western United States**, Angela Paul, NV Water Science Center	**Whatever Happened to Pollution Surveys? The Case for Intensive River Segment Survey Designs**, Chris Yoder, Midwest Biodiversity Institute	**Modeling to Support the Development of Nutrient TMDLs in Baltimore Harbor**, Miao-Li Chang, MD Dept. of the Environment	**The Nuts and Bolts of a Volunteer Monitoring Day**, Diane Cross, South Yuba River Citizens League	**A Comparison of Ocular Turbidity Instruments for Shallow Waters**, Robert Carlson, Kent State University	
4:15 - 4:35	**Pre-mobilization Error Checks of Multi-parameter Field Instruments: One Way of Promoting Service-wide Consistency in a Water Quality Monitoring Program**, Peter Penoyer, National Park Service	**Volatile Organic Compounds in Ground Water and Drinking-Water Supply Wells**, John Zogorski, USGS	**Development of a Source Water Quality Monitoring Protocol for First Nations in Canada**, Rob Phillips, Environment Canada	**Combining Dynamic Assessments with Traditional Monitoring Approaches to Improve Understanding of NPS Pollution Impacts**, William Stringfellow, University of the Pacific	**Nutrient TMDLs for the Cahaba River Watershed**, Chris Johnson, AL Dept. of Environmental Management	**The Study Design - The Game Plan Behind Successful Monitoring Strategies and Effective Data Use**, Cheryl Snyder, PA Dept. of Environmental Protection	**Transparency tube as a surrogate for turbidity and suspend solids in rivers and reservoirs**, Nicole Reid, Michigan State University Extension	
4:35 - 4:55	**RPD Between Successive Measurement: A Simple But Neglected Tool for Assessing Monitoring Well Data Quality**, Bruce Castle, Erler & Kalinowski, Inc.	**Assessing the Ecological Conditions of the Great Rivers of the Central United States**, Brian Hill, USEPA	**Application of filtration-based luminescence method for rapid monitoring of microbial contamination in water**, Carmen Dumas, Ann Arbor Water Treatment Service Unit	**Introducing NHDPlus! – A Tool for Watershed Planning**, Richard Moore, USGS	**Supporting nutrient criteria development nationwide: Web application & Technical REQuest System (T-REQS)**, Jeroen Gerritsen, Tetra Tech, Inc.	**Monitoring - Just Do IT, Baywatchers: 14 years, QA data, Improved understanding, Being creative. The Coalition for Buzzards Bay Citizen's Water Quality Monitoring Program**, Tony Williams, The Coalition for Buzzards Bay	**Gaining Clarity on Transparency Measurements, Jeffrey Schloss**, University of New Hampshire Cooperative Extension	
5:00 - 7:00	Exhibit and Poster Reception (Exhibit Hall 1) This reception will kick off the networking with our long list of outstanding Exhibitors and Sponsors. This is also a prime opportunity to visit with our Poster Presenters.							

Tuesday, May 9

7:00 - 8:00	Breakfast in Exhibit Hall 1, Registration in Ballroom Concourse							
	Meeting Room A1	**Meeting Room A2**	**Meeting Room A3**	**Meeting Room A4**	**Meeting Room A5**	**Meeting Room A6**	**Meeting Room A7**	**Meeting Room C3**
Concurrent Session D **8:00 - 9:30**	***The National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries*** Session Topic: Integrating Atmospheric Deposition	***Tiered Aquatic Life Uses: Conceptual Models & Development Strategies*** Moderator: Susan Jackson	***Making the Connections Between Surface and Ground Water*** Moderator: Gil Dichter	***Monitoring to Meet Many Objectives*** Moderator: Joan Warren	***Evaluating the Effects of Agriculture on Water Quality I*** Moderator: Paul Capel	***Making it Work: Starting & Sustaining Volunteer Monitoring Programs*** Moderator: Erick Burres	***Monitoring BMPs: Baselines & Strategies to Assess Restoration Efforts*** Moderator: Lester McKee	SHORT COURSE: ***Uses of Real-Time Data: Capabilities, Limitations, Applications, Costs, & Benefits*** Trainers: Andy Ziegler, Trudy Bennett, and Teresa Rasmussen, USGS
8:05 - 8:25	**Connecting atmospheric deposition to coastal water quality**, Hans Paerl, UNC Chapel Hill	**The Biological Condition Gradient and Tiered Aquatic Life Uses**, Susan Davies, State of Maine	**Making the Connections Between Surface Water and Ground Water**, Pixie Hamilton, USGS	**South Carolina Surface Water Monitoring: Different Designs for Different Objectives**, David Chestnut, SC Dept. of Health and Environmental Control	**Transport of Agricultural Chemicals: Mass Budget Approach**, Kathleen McCarthy, USGS	**What the Heron Sees**, Jean-Ann Moon, Marshall County Retired and Senior Volunteer Program	**Effects of Multi-scale Environmental Characteristics on Agricultural Stream Biota in the Midwestern USA**, Julie Berkman, USGS	
8:25 - 8:45	**Strategy for linking the atmospheric deposition network to the proposed national water quality monitoring network**, Mark Nilles, USGS	**Rule-based models for uniform assessments on the Biological Condition Gradient**, Jeroen Gerritsen, Tetra Tech, Inc.	**Importance of ground-water flow and travel time on nitrogen loading from an agricultural basin in Connecticut**, John Mullaney, USGS	**Key Considerations in Monitoring Design**, Lyle Cowles, USEPA Region 7	**Transport of Agricultural Chemicals: Atmosphere to Land Surface**, Michael Majewski, USGS	**Communication is Key to Sustaining Long-Term Volunteer Water Quality Monitoring Programs**, Jacob Apodaca, Lower Colorado River Authority	**Protocols for the Evaluating the Effects of Land-use Patterns and Runoff Management on Urban Streams**, Christine Rohrer, Colorado State University	
8:45 - 9:05	**Atmospheric mercury monitoring: existing framework and technical challenges**, TBN	**ADEM's Monitoring Strategy for Streams and Rivers: Development and Testing of a Human Disturbance Gradient in the Alabama, Coosa, and Tallapoosa River Basins**, Lisa Huff, AL Dept. of Environmental Management	**Predicting the Occurrence of Nutrients and Pesticides during Base Flow in Nontidal Headwater Streams of the Mid-Atlantic Coastal Plain**, Anne Neale, USEPA ORD NERL	**Water quality monitoring designs for multiple objectives and spatial scales: an evaluation based on detection of expected and actual impairment**, John Hunt, University of California, Davis	**Transport of Agricultural Chemicals: Tile drains to surface water**, Wesley Stone, USGS Water Resources Division	**Involving Volunteers Beyond Water Monitoring**, Gayla Stock, Houston-Galveston Area Council	**Assessing Rain Garden Effectiveness**, Brooke Asleson, University of Minnesota	
9:05 - 9:25	**Open discussion** facilitated by David Whitall, NOAA	**Key Issues and Underlying Concepts in Use Attainability Analyses for Aquatic Life Designated Uses**, Chris Yoder, Midwest Biodiversity Institute	**Hydrologic controls on nutrient and pesticide transport through a small agricultural watershed, Morgan Creek, Maryland, USA**, Michael Brayton, USGS	**Essentials of specification of information needs**, Jos G. Timmerman, Institute for Inland Water Management and Waste Water Treatment (RIZA)	**Pesticide and nutrient behavior in a karst watershed located in southeastern Minnesota**, Paul Wotzka, MN Dept. of Agriculture	**Capture, care and feeding of volunteers**, Dwight Holford, Upper Putah Creek Stewardship	**Open discussion and Q&A**	
9:30 - 10:30	Quick Break (refreshments in Exhibit Hall 1) followed by Poster & Exhibit viewing							

Tuesday, May 9

	Meeting Room A1	Meeting Room A2	Meeting Room A3	Meeting Room A4	Meeting Room A5	Meeting Room A6	Meeting Room A7	Meeting Room C3
Concurrent Session E **10:30–12:00**	***Strength in Numbers: Monitoring Councils at Work*** Moderator: Charlie Peters	***An Overview of the National Wadeable Streams Assessment*** Moderator: Susan Holdsworth	***Assessing Ground Water Vulnerability Through Mechanistic Methods I*** Moderator: Wayne Lapham	***Remote Sensing & GIS-Enhanced Monitoring & Analysis*** Moderator: Jim Harrison	***Evaluating the Effects of Agriculture on Water Quality II*** Moderator: Paul Capel	***Assessing Coastal Watersheds*** Moderator: Mike Mc-Donald	***E. coli: Comparability of Methods & Rapid Detection*** Moderator: Eleanor Ely	WORKSHOP: ***Building Credibility: Quality Assurance & Quality Control for Volunteer Monitoring Programs*** Facilitators: Elizabeth Herron, URI Watershed Watch; Ingrid Harrald, Cook Inlet Keeper
10:35 - 10:55	**The Pacific Northwest Aquatic Monitoring Partnership: A Forum For Regional Coordination**, Jennifer Bayer, USGS	**National Stream and River Assessment Monitoring Design**, Anthony Olsen, USEPA NHEERL	**Proposed Tools and Approach for Ground-Water Vulnerability Assessment Using a Geographic Information System and Simulation Modeling**, Jack Barbash, USGS	**Using the National Hydrography Dataset Plus for drainage area delineation and site matching**, Kirsten Cassingham, USGS NC Water Science Center	**Transport of Agricultural Chemicals: Unsaturated Zone to Ground Water to Surface Water, San Joaquin Valley, California**, Joseph Domagalski, USGS	**Nitrogen and Phosphorus Loadings to the Neuse and Pamlico River Estuaries, North Carolina**, Jerad Bales, USGS	**Comparing E. coli Results Analyzed by Colilert® and Membrane Filtration Techniques**, Samuel Dinkins, Ohio River Valley Water Sanitation Commission	
10:55 - 11:15	**Interagency Monitoring Coordination: The Oregon Plan Monitoring Team**, Gregory Pettit, OR Dept. of Environmental Quality	**Defining Least-Impacted Reference Condition for the National Wadeable Streams Assessment**, Alan Herlihy, Oregon State University	**Basin-scale assessment of transport of water and agricultural chemicals through the unsaturated zone**, Richard Webb, USGS	**New NHD Tools for the Evaluation of Watershed Condition and Management Performance**, William Cooter, RTI International	**Linking Ground Water Age and Chemistry Data Along Flow Paths: Implications for Trends and Transformations of Nutrients and Pesticides**, Anthony Tesoriero, USGS	**Monitoring Wetlands in California**, Joshua Collins, San Francisco Estuary Institute	**Volunteer Monitoring of E. coli in Upper Midwest Streams: A Comparison of Methods and Preferences**, Kristine Stepenuck, University of WI-Extension, WI Dept. of Natural Resources	
11:15 - 11:35	**Development of the Florida Water Resource Monitoring Atlas**, Joe King, FL Dept. of Environmental Protection	**Process for developing a Macroinvertebrate Index of Biotic Integrity for the Wadeable Streams Assessment**, John Stoddard, USEPA	**Conceptual Framework for evaluating the impact of inactive wells on community water supplies**, Rick Johnson, Oregon Health & Science University	**GIS and Remote Sensing Applications In The Hydropolitics of Sub-Saharan Africa: The Case of Multinational Management of River Niger Basin of West Africa**, Edmund Merem, Jackson State University	**Transport of Agricultural Chemicals: Estimating Lag Times in Different Hydrologic Environments**, David Wolock, USGS	**Assessing the Health of National Park Service Southeast Coastal Waters Using the United States Environmental Protection Agency's National Coastal Assessment Protocols**, Joe DeVivo, National Park Service	**Development of Rapid QPCR Approaches for Measurement of E. coli and Enterococcus in Environmental Waters: The Future for Routine Monitoring?**, Rachel Noble, UNC Chapel Hill	
11:35 - 11:55	**Sustaining Long Term Regional Coordinated Monitoring Programs**, Todd Running, Houston-Galveston Area Council	**National Assessment of the Condition of Wadeable Streams in the Conterminous U.S.**, Steven Paulsen, USEPA	**Comparison of intrinsic susceptibility of public-supply wells to contamination among selected regional aquifer systems**, Leon Kauffman, USGS	**Incorporating remote sensing into an ambient monitoring strategy**, Mary Anne Nelson, ID Dept. of Environmental Quality	**Effective Policy Based on Sparse Data: TMDLs in the San Joaquin River Basin, California**, Leslie Grober, CA Regional Water Quality Control Board, Central Valley Region	**NOAA's National Estuarine Research Reserve's System Wide-Monitoring Program: Over 10 years of developing capabilities, applications, and expansions**, Susan White, NOAA National Estuarine Research Reserve	**IMS/ATP rapid method for the determination of E. coli concentrations in recreational waters**, Rebecca Bushon, USGS	
12:00 - 1:30	Lunch in Exhibit Hall 1							

Tuesday, May 9

	Meeting Room A1	Meeting Room A2	Meeting Room A3	Meeting Room A4	Meeting Room A5	Meeting Room A6	Meeting Room A7	Meeting Room C3
Concurrent Session F **1:30–3:00**	***The National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries*** Session Topic: **Estuaries—Water Quality Monitoring in San Francisco Bay**	***Evaluating the Effects of Urbanization on Water Quality I*** Moderator: Ian Waite	***Assessing Ground Water Vulnerability Through Mechanistic Methods II*** Moderator: Wayne Lapham	***Real-Time Monitoring I: Applications & Program Case Studies*** Moderator: Tamim Younos	***State Experiences in Probabilistic Monitoring*** Moderator: Art Garceau	***Assuring Credible Volunteer Data*** Moderator: Jim Harrington	***Stormwater Monitoring: When It Rains It Pours*** Moderator: Dan Radulescu	WORKSHOP: ***Bioassessment Method Performance and Comparability, Part 1*** Facilitators: Laura Gabanski, USEPA; Jerry Diamond, Tetra Tech, Inc.
1:35 - 1:55	**Estuaries component of the Network**, Jawed Hameedi, NOAA	**Effects of Urbanization on Stream Ecosystems: Overview and Study Design of the U.S. Geological Survey's Urban Stream Studies**, Cathy Tate, USGS	**Application of Ground Water Dating Techniques for Evaluating the Susceptibility of Aquifers and Public-Supply Wells to Contamination**, Sandra Eberts, USGS	**Integrating a Continuous Water Quality Monitoring Network into Texas' Surface Water Quality Monitoring Program**, Jill Csekitz, TX Commission on Environmental Quality	**Pennsylvania's Application of Probability-Based Sampling**, Tony Shaw, PA Dept. of Environmental Protection	**QA/QC and QAPP: How to get professional quality data from a volunteer program**, Ingrid Harrald, Cook Inlet Keeper	**First Flush Volunteers Do it in the Dark**, Bridget Hoover, Monterey Bay National Marine Sanctuary	
1:55 - 2:15	**Lessons from three decades of monitoring in San Francisco Bay**, James Cloern, USGS	**Ecological responses of streams to urbanization: A review of results from the U.S. Geological Survey's urban streams studies**, Thomas Cuffney, USGS	**Evaluating uncertainty in areas contributing recharge to wells for water-quality network design**, Jeffrey Starn, USGS	**Continuous in-stream monitoring to measure and estimate water-quality concentrations, densities, and loads**, Andrew Ziegler, USGS	**Probabilistic Monitoring in Virginia: Experiences from the First Five Years**, Lawrence Willis, VA Dept. of Environmental Quality	**What is Representativeness, and Why are We Confused?**, Revital Katznelson, CA State Water Resources Control Board	**Monitoring of priority toxic pollutants in Highway Stormwater Runoff**, Peter Green, University of California, Davis	
2:15 - 2:35	**San Francisco Bay Regional Monitoring Program**, Jay Davis, San Francisco Estuary Institute	**Identifying the changes to stream condition caused by urbanization, and how modeling the responses can be used to improve ecological risk characterizations**, James Coles, USGS	**Use of Multiple Tracers and Geochemical Modeling to Assess Vulnerability of a Public Supply Well in the Karstic Upper Floridan Aquifer**, Brian Katz, USGS	**A Real-Time Water Quality Monitoring Network for Investigating the Strengths and Weaknesses of Existing Monitoring Techniques**, David Stevens, Utah State University	**Idaho's experience with random design using NHD: intermittent streams and other considerations**, Mary Anne Nelson, ID Dept. of Environmental Quality	**Evaluation of the New York City Watershed Hudson Basin River Watch Volunteer Monitoring Pilot Project**, Heather Clark Dantzker, The Community Science Institute, Inc., Cornell University	**Monitoring and Analytical Issues For BMP Performance Evaluation**, Hong Lin, CDS Technologies	
2:35 - 2:55	**Open discussion** facilitated by TBN	**Modeling Urban Landscape Patterns and their Effects on Aquatic Ecosystems**, Marina Alberti, University of Washington	**Depth-Dependent Sampling to Determine Source Areas and Short-Circuit Pathways for Contaminants to Reach Public Supply Wells, High Plains Aquifer, York, Nebraska**, Matthew Landon, USGS	**Monitoring Surface-Water-Quality in the Tongue River Watershed of Montana and Wyoming**, Stacy Kinsey, USGS	**Utility Of Probability-Based Survey Design for Tracking Fish Species of Interest**, Matt Combes, MO Dept. of Conservation	**Experiences in monitoring**, Eric Russell, Surfrider Foundation	**Evaluation of water quality monitoring data at the local level, a reality check**, Jeff Hieronymus, Charlotte Storm Water Services	
3:00 - 3:30	Break - Refreshments in Exhibit Hall 1							

Tuesday, May 9

	Meeting Room A1	Meeting Room A2	Meeting Room A3	Meeting Room A4	Meeting Room A5	Meeting Room A6	Meeting Room A7	Meeting Room C3
Concurrent Session G **3:30–5:00**	***Monitoring for the Prevention & Cleanup of Toxics*** Moderator: Ed Santoro	***Evaluating the Effects of Urbanization on Water Quality II*** Moderator: Cathy Tate	***Assessing Ground Water Vulnerability through Mechanistic Methods III*** Moderator: Ryan Dupont	***Harnessing the Beast: Managing Complex Data Sets*** Moderator: Ellen Mc-Carron	**Monitoring for Trends** Moderator: Tony Olsen	**States & Volunteers: Partnerships that Work** Moderator: Alice Mayio	***Monitoring Algae: Tracking Trends, Toxins, & Food Web Dynamics*** Moderator: Fred Leslie	WORKSHOP: ***Bioassessment Method Performance and Comparability, Part 2*** Facilitators: Laura Gabanski, USEPA; Jerry Diamond, Tetra Tech, Inc.
3:35 - 3:55	**Monitoring mercury in biosentinel fish in San Francisco Bay**, Ben Greenfield, San Francisco Estuary Institute	**You're standing on it! Parking lot sealcoat and urban PAHs**, Barbara Mahler, USGS	**Groundwater Age as a Predictive Tool for Water Quality Monitoring**, Jean Moran, Lawrence Livermore National Laboratory	**Arkansas Monitoring Data Assessment Program (AMDAP) Using the Segment Evaluation Spreadsheet (SEGEVAL.XLS)**, Jessica Franks, USEPA Region 6	**The Regional Kendall Test for Trend**, Dennis Helsel, USGS	**The Vermont Lay Monitoring Program: Afloat For 26 Years!**, Amy Picotte, VT Agency of Natural Resources	**Spatial and temporal trends of algal biomass in small and large streams in Indiana, 2001-04**, Jeffrey Frey, USGS	
3:55 - 4:15	**Recovery and Monitoring Challenges with Water Quality Issues in New Orleans during Hurricane Katrina Recovery Operations**, William Roper, George Mason University	**City of Austin biological studies on the toxicity and effects of coal tar sealants on stream communities**, Mateo Scoggins, City of Austin	**Simulation of Short Circuit Flow Paths and Transient Conditions to Understand Vulnerability of Public Supply Wells to Contamination in the High Plains Aquifer, York, Nebraska**, Brian Clark, USGS	**Managing Monitoring Data from Many Sources: A New Hampshire Experience**, Deb Soule, NH Dept. of Environmental Services	**Water Quality Trends Along the Central Coast of California**, Marc Los Huertos, University of CA, Santa Cruz	**Using Citizen Monitoring Bioassessment and Water Quality Data to Obtain Impaired Watershed Status**, Joanne Hild, Friends of Deer Creek	**Influences of Stream Size in Determining Nutrient Criteria for Streams in the Eastern Corn Belt Plains Ecoregion**, Brian Caskey, USGS	
4:15 - 4:35	**The Regional Bypass WorkGroup—A Successful Application of Water Quality Prediction and Interagency Communication**, Charles Dujardin, Hydro-Qual, Inc.	**Assessing the Effects of Urban Land Use on Stream Ecosystems: Integrating Chemistry, Toxicity Test, and CYP1A1 Gene Activation Data from Extracts of Semipermeable Membrane Devices**, Wade Bryant, USGS	**GAMA Special Studies on Nitrate in California Groundwater**, Bradley Esser, Lawrence Livermore National Laboratory	**Expanding Water Quality Assessments beyond the Realm of 'Impairments' and into a Tool Useful to Watershed Managers at the Local Level**, Ken Edwardson, State of New Hampshire	**Lessons Learned from Monitoring Compliance with a Phosphorus Standard in the Florida Everglades and Assessing the Linkage between Phosphorus Control and Marsh Water Quality**, Garth Redfield, South FL Water Management District	**The Oregon DEQ Volunteer Monitoring Program: Managing and Applying Data Generated Within a Grassroots Framework**, Steve Hanson, OR Dept. of Environmental Quality	**Algal pigments in benthic organisms and fish: development of biomarkers to trace food-web relationships**, Katherine Alben, NY State Dept. of Health	
4:35 - 4:55	**Combining prediction and monitoring for reduction of toxics: the Lake Michigan Mass Balance Study**, Glenn Warren, USEPA	**Pesticides in urban settings—Use of a Pesticide Toxicity Index to evaluate potential toxicity of stream water samples to macroinvertebrates**, Karen Riva-Murray, USGS	**Understanding agriculture-related trends in ground-water quality in the Western Lake Michigan Drainages, Wisconsin**, David Saad, USGS	**Vital Signs Water Quality Data Management in the National Park Service**, Dean Tucker, National Park Service	**Wisconsin's Surface Water Quality Monitoring Program**, Kenneth Schreiber, WI Dept. of Natural Resources	**New Jersey's Answer to Multiple Volunteer Data Sources**, Danielle Donkersloot, NJ Dept. of Environmental Protection	**Screening for Algal Toxins in Volunteer-Monitored Lakes**, Gene Williams, Snohomish County Public Works Dept.	

Tuesday, May 9

5:15 - ?	**Special Session on National Ground Water Monitoring (Meeting Room A1)** The purpose of this brainstorming session is to discuss the formation of a work group to help develop a consistent, nationwide monitoring and assessment program leading to an accurate estimation of ground water stored volume, availability, and sustainability. We will focus on defining the need for coordinated national ground water monitoring and developing recommendations for the planning and initial implementation of such monitoring. See strawman document at http://water.usgs.gov/wicp/acwi/monitoring/workgroups/wci/
5:15 - 6:30	**Volunteer Monitoring Coordinators Meeting (Meeting Room C1)** Discussion leaders: Linda Green, USDA-CSREES National Facilitation of Volunteer Monitoring and Alice Mayio, U.S. EPA This informal meeting is to encourage discussion and networking among volunteer monitoring coordinators. What's working in the world of volunteer monitoring, what needs more work, and where are we headed? Share some examples of your program successes, challenges, needs and desires!
6:30 - ?	**Gathering of Volunteer Monitoring Coordinators -- location TBA**
7:00 - 9:00	**Panel Discussion: Effects of Urbanization on Streams (Meeting Room A8)** Facilitator: Cathy Tate, USGS National Water-Quality Assessment Program This panel discussion will build upon earlier technical sessions on "Evaluating the Effects of Urbanization on Water Quality I & II" and will include 5 to 6 panelists who will provide perspectives on urban water-quality studies that represent the diverse interests of conference attendees. A brief introductory discussion by panel members will be followed by a general Q&A period. We will focus on the following questions: 1) Urban designs...what's worked, what hasn't?; 2) What types of data are being collected, what data are most useful in assessing the effects of urbanization on stream quality?; 3) Which data or information are most useful to planners, regulators, and watershed groups, and how is data from urban water quality studies being used by stakeholders?

Wednesday, May 10

7:00 - 8:00	Breakfast in Exhibit Hall 1, Registration in Ballroom Concourse							
	Meeting Room A1	**Meeting Room A2**	**Meeting Room A3**	**Meeting Room A4**	**Meeting Room A5**	**Meeting Room A6**	**Meeting Room A7**	**Meeting Room C3**
Concurrent Session H **8:00–9:30**	***The National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries*** Session Topic: Large Rivers Monitoring Network	***Improving Data Management and Exchange*** Moderator: Rob Kent	***Cooperative Regional Monitoring in California*** Moderator: Ken Schiff	***Perspectives on the Nation's Water Quality: Findings, Implications, & Future Directions III*** Moderator: Ellen Tarquinio	***Effects of Urbanization on Water Quality: Case Studies*** Moderator: James Moring	***Making it Work: Effectively Training Volunteer Monitors*** Moderator: Paula Zevin	***Bioassessment Method Comparability & Performance*** Moderators: Jerry Diamond, Laura Gabanski	WORKSHOP: ***Statistical Analysis of Probability Survey Data Using R Statistical Software, Part 1*** Facilitator: Tony Olsen, USEPA
8:05 - 8:25	**Rivers Component of the Monitoring Network**, Jared Bales, USGS	**Water Quality Data Elements (WQDE): Enhancing comparability of monitoring information**, LeAnne Astin, Interstate Commission on the Potomac River Basin	**Inventory of Ocean Monitoring in the Southern California Bight**, Stephen Weisburg, Southern California Coastal Water Research Project	**Water quality monitoring and assessment of global change**, Richard Robarts, UNEP GEMS/Water Programme	**Comparing flow variability in urban streams across environmental settings**, Elise Giddings, USGS NC Water Science Center	**Georgia Adopt A Stream Coastal Region Training Center at Savannah State University**, Joseph Richardson, Savannah State University	**Comparable Biological Assessments From Different Methods and Analyses**, David Herbst, University of CA	
8:25 - 8:45	**Upper Mississippi River monitoring**, Mary Skopec, IA Dept. of Natural Resources	**Water Quality Exchange WQX: EPA's new look at Water Quality Data Management**, Kristen Gunthardt, USEPA Office of Water	**Southern California Bight Regional Marine Monitoring Program**, Kenneth Schiff, Southern California Coastal Water Research Project	**Evaluating the Potential Human-Health Relevance of Volatile Organic Compounds in Samples from Domestic and Public Wells in the United States**, Patricia Toccalino, USGS	**A tale of two streams: Chemical and physical characteristics of secondary tributaries in an arid urban watershed and potential impacts on a main stem river**, Philip Russell, Littleton Englewood Wastewater Treatment Plant	**The Importance of Professionally Training Citizen Monitors in Building, Promoting and Implementing a State-Wide Bioassessment Program in California**, James Harrington, CA Dept. of Fish and Game	**Pacific Northwest side-by-side protocol comparison test**, Steve Lanigan, USFS/BLM	
8:45 - 9:05	**Monitoring networks in Alabama**, Fred Leslie, AL Dept. of Environmental Management	**Compiling a baseline water quality database from heterogeneous data sources: lessons learned**, Nenad Iricanin, South FL Water Management District	**MARINe: A Long-term Monitoring Program for Detecting Change in Rocky Intertidal Environments**, Steve Murray, California State University, Fullerton	**Preliminary Findings of Anthropogenic Organic Compounds in Source and Finished Waters of Community Water Systems**, Gregory Delzer, USGS	**An evaluation of aquatic communities in urbanized Mediterranean climate streams: a guide to more effective stream restoration techniques in the Santa Clara Basin**, San Jose, California, Alison Purcell, University of CA, Berkeley	**Evaluation of Volunteer-based Water Quality Monitoring Training for SCORE (South Carolina Oyster Restoration and Enhancement)**, Steven O'Shields, I.M. Systems Group, Inc.	**National Wadeable Stream Survey Comparability Study**, Mark Southerland, Versar, Inc.	
9:05 - 9:25	**Open discussion** facilitated by Gail Mallard, USGS	**Data Comparability and Modernization of Environment Canada's Water Quality Information Holdings**, Chris Lochner, Environment Canada, National Water Research Institute	**The Value of Communication, Collaboration and Coordination for Statewide Decision Making: The Example of the Beach Water Quality Workgroup**, Robin McGraw, CA State Water Resources Control Board	**Are environmental contaminant concentrations in U.S. waters harmful to fish-eating wildlife?**, Jo Ellen Hinck, USGS Columbia Environmental Research Center	**Physical, chemical, and biological characteristics of streams in urbanizing areas near Denver, Colorado**, Lori Sprague, USGS	**A Participatory, Multi-Stakeholder Approach to Curbing Urban Sprawl**, Andrew Kett, Citizens' Environment Watch	**Determining the Comparability of Six Bioassessment Methodologies in New England**, Rebecca Weidman, New England Interstate Water Pollution Control Commission	
9:30 - 10:00	Break - Refreshments in Exhibit Hall 1							

Wednesday, May 10

	Meeting Room A1	Meeting Room A2	Meeting Room A3	Meeting Room A4	Meeting Room A5	Meeting Room A6	Meeting Room A7	Meeting Room C3
Concurrent Session I **10:00–11:30**	***Real-Time Monitoring II: Safeguarding Drinking Water & Public Health*** Moderator: Peter Tennant	***Collaborating for Improved Monitoring I*** Moderator: Toni Johnson	***Cooperative Regional Monitoring in California—Lessons Learned*** Moderator: Val Connor	***Evaluating Key Stressors to the Nation's Aquatic Resources*** Moderator: Katherine Alben	***Approaches to National Water Quality Monitoring & Assessment in Other Countries*** Moderator: Chuck Spooner	***Volunteer Monitoring: Raising the Bar*** Moderator: Jacob Apodaca	***Characterizing & Interpreting Habitat Data*** Moderator: Dan Sullivan	WORKSHOP: ***Statistical Analysis of Probability Survey Data Using R Statistical Software, Part 2*** Facilitator: Tony Olsen, USEPA
10:05 - 10:25	**BacteriALERT: A Cooperative Program for Water-quality Monitoring and Prediction of Escherichia coli Bacteria in the Chattahoochee River, Georgia**, Stephen Lawrence, USGS	**Monitoring Environmental Stressors and Evaluating the Existing and Potential Designated Uses of Hardies Creek, Galesville, Wisconsin**, Daniel Helsel, WI Dept. of Natural Resources	**Cooperative Agricultural Monitoring on California's Central Coast: An Integrated, Innovative Approach**, Karen Worcester, Central Coast Water Board	**Monitoring Implications of the Updated Ambient Water Quality Criteria for Copper and the Copper Biotic Ligand Model (BLM)**, Lauren Wisniewski, USEPA	**Europe-wide monitoring obligations under the EU Water Framework Directive**, Jos G. Timmerman, Institute for Inland Water Management and Waste Water Treatment (RIZA)	**Stream Waders and the Maryland Biological Stream Survey: Comparing Volunteer and Professional Stream Quality Data**, Chris Millard, MD Dept. of Natural Resources	**Watershed Stewardship Utilizing GPS Habitat and Bioassessment Surveys**, Aspen Madrone, Contra Costa County	
10:25 - 10:45	**AquaSentinel: An Advanced Real-Time Biosensor System for Source Water Protection**, Elias Greenbaum, Oak Ridge National Laboratory	**Water Quality Indicators and Monitoring Design to Support the Albemarle-Pamlico National Estuary Program: A Progress Report**, Dean Carpenter, Albemarle-Pamlico National Estuary Program	**A Regional Approach to Research/Monitoring in Southern California**, Chris Crompton, Orange County, California	**Characterizing and Interpreting Physical Habitat in the National Wadeable Stream Assessment**, Philip Kaufmann, USEPA	**Designing a National Water Quality Monitoring Network to support the Canadian Freshwater Quality Indicator**, Rob Kent, Environment Canada	**Evaluation of Volunteer Data—The Lakes of Missouri Volunteer Program Review**, Daniel Obrecht, University of Missouri, Lakes of Missouri Volunteer Program	**Great Lakes Aquatic Gap: A Regional Approach to Identifying Gaps in Species and Habitat Conservation for Great Lake Streams**, Jana Stewart, USGS	
10:45 - 11:05	**Variability in Responses of Multi-Parameter Sensors in a Prototype Real-Time Early Warning System to Monitor Water Quality**, Eric Vowinkel, USGS	**Development of a Collaborative Multi-Jurisdictional Stream-Monitoring Network to Support Restoration of the Chesapeake Bay**, Stephen Preston, USGS Chesapeake Bay Program Office	**Southern California Laboratory Intercalibration Exercises: A Demonstration Regarding the Comparability of Monitoring Programs Using Multiple Laboratories**, Rich Gossett, CRG Marine Laboratories, Inc.	**Nutrient and Acidity Status of Wadeable Streams in the Contiguous United States - Results from EPA's Wadeable Streams Assessment**, Ellen Tarquinio, USEPA	**Biological Assessment of Water Quality: Delivery of a National System in Australia**, Richard Norris, University of Canberra	**Volunteer Water Quality Monitoring Data Enhancing Lake Chatuge Watershed Study**, Callie Dobson, Hiwassee River Watershed Coalition, Inc.	**An Overview of the National Park Service's Vital Signs Water Quality Monitoring Program: A National Framework for Land Management Agencies**, Gary Rosenlieb, National Park Service	
11:05 - 11:25	**Real Time Monitoring—The Installation and Continuous Operation of Organic Carbon and Liquid Chromatography Analyzers at Remote Field Stations in the Sacramento-San Joaquin Delta**, David Gonzalez, CA Dept. of Water Resources	**Water Quality Monitoring Among Local Agencies in the Red River of the North Basin**, Robert Hearne, North Dakota State University	**Information management in a multi-agency cooperative monitoring program**, Larry Cooper, Southern California Coastal Water Research Project	**Evaluating the extent and relative risk of aquatic stressors in wadeable streams throughout the U.S.A.**, John Van Sickle, USEPA NHEERL	**Water monitoring and utilization: surveillance, struggle or symbol?**, Dennis Kool, Erasmus University Rotterdam (Centre for Public Governance)	**QA/QC Assessment of Volunteer Monitoring in Rhode Island**, Elizabeth Herron, URI Cooperative Extension	**Moving the National Water-Quality Assessment habitat data through time**, Jeffrey Steuer, USGS	
11:30 - 1:00	Lunch in Exhibit Hall 1							

Wednesday, May 10

	Meeting Room A1	Meeting Room A2	Meeting Room A3	Meeting Room A4	Meeting Room A5	Meeting Room A6	Meeting Room A7	Meeting Room C3
Concurrent Session J **1:00–2:30**	***The National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries*** Session Topic: Great Lakes Monitoring Networks	***Collaborating for Improved Monitoring II*** Moderator: Gayle Rominger	***Assessing Ground Water Vulnerability Through Statistical Methods I*** Moderator: Tom Nolan	***Challenges in the Development of Nutrient Criteria for Streams & Rivers I*** Moderator: Jeff Frey	***Mercury Contamination: Sources, Transport, & Fate I*** Moderator: Mark Brigham	***National Wadeable Streams Assessment: State Experiences*** Moderator: Leslie McGeorge	***New Technologies & Approaches*** Moderator: Bob Carlson	SHORT COURSE: ***Data Management and Databases: Capturing, Storing, and Managing Data for Success in Monitoring*** Trainers: Kristine Stepenuck, University of Wisconsin Extension and Wisconsin Department of Natural Resources; Lynette Seigley, Iowa Department of Natural Resources; Revital Katznelson, California State Water Resources Control Board
1:05 - 1:25	**The Great Lakes National Program's Multi-Media Monitoring Program**, Paul Horvatin, Great Lakes National Program Office	**Collaborative Monitoring in the Great Lakes: Revisiting the Lake Michigan Mass Balance Project**, John Hummer, Great Lakes Commission	**Regression model for national assessment of nitrate in ground water**, Bernard Nolan, USGS	**Overview of the National Nutrient Criteria Program**, Amy Parker, USEPA	**Statewide Monitoring of Mercury in Surface Water, Precipitation, and Fish in Indiana**, Martin Risch, USGS	**Texas' Contributions to the National Wadeable Streams Assessment and Future Direction of the State's Biological Monitoring Program**, Anne Rogers, TX Commission on Environmental Quality	**The SWAMP Advisor—a New Tool for Producing Consistent and Comprehensive Quality Assurance Project Plans (QAPPs)**, Lawrence Keith, Instant Reference Sources, Inc.	
1:25 - 1:45	**National Monitoring Network Design for the Great Lakes**, Jack Kelly, USEPA National Health and Environmental Effects Research Laboratory	**Collaboration on EMAP Stream Condition Assessments in EPA Region 8**, Thomas Johnson, USEPA Region 8	**Using Logistic Regression to Assess Regional Ground-Water Vulnerability: High Plains Aquifer**, Jason Gurdak, USGS Colorado Water Science Center	**Nutrient-Biota Interactions in Agriculturally Dominated Landscapes: Lessons from the U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program**, Mark Munn, USGS	**Mercury monitoring in California sport fish: Past, present, and future**, Jay Davis, San Francisco Estuary Institute	**Validation of a Multimetric Index Using Probabilistic Monitoring Data**, Jason Hill, VA Dept. of Environmental Quality	**Continuous nitrate concentration data from a small agricultural ditch in Indiana: Relationship to streamflow and inferences to biological processes affecting nitrogen cycling**, Timothy Lathrop, USGS	
1:45 - 2:05	Presenter TBD	**A Collaborative Approach to Assessing Watershed Conditions in Coastal National Parks**, Kristen Keteles, National Park Service	**Empirical modeling of nitrate loading and crop yield for corn-soybean rotations in Iowa**, Robert Malone, USDA ARS	**Response of benthic algal and invertebrate communities to nutrient enrichment in agricultural streams: Implications for establishing nutrient criteria**, Robert Black, USGS	**Mercury in northeastern North America: A synthesis of existing databases**, David Evers, BioDiversity Research Institute	**A comparison of biological methods for macroinvertebrate collection in Missouri streams**, Shane Dunnaway, MO Dept. of Conservation	**Use of Trace-Level Cyanide Method to Determine Attenuation of Discharged Cyanide in Lower South San Francisco Bay**, Peter Schafer, City of San Jose, CA	
2:05 - 2:25	**Open discussion** facilitated by Chuck Spooner, USEPA	**A Multi-scale Collaborative Approach For Linking Terrestrial and Aquatic Long-Term Monitoring: Lessons Learned in the Delaware River Basin and Proposed New Directions**, Peter Murdoch, USGS	**Using logistic regression to predict the probability of occurrence of volatile organic compounds in ground water**, Michael Moran, USGS	**The Use of Calculated Stream Metabolism in Understanding Nutrients in Agricultural Streams**, Jill Frankforter, USGS	**A Framework for Monitoring the Response to Changing Mercury Releases**, Michael Murray, National Wildlife Federation	**Comparability of Habitat and Macroinvertebrate Collection Methods in Oklahoma's Low Gradient Streams**, Monty Porter, OK Water Resources Board	**Identifying Greener Analytical Methods in NEMI for More Environmentally Friendly Monitoring**, Jennifer Young, ACS Green Chemistry Institute	
2:30 - 3:30	Quick Break (refreshments in Exhibit Hall 1) followed by Poster & Exhibit viewing							

Wednesday, May 10

	Meeting Room A1	Meeting Room A2	Meeting Room A3	Meeting Room A4	Meeting Room A5	Meeting Room A6	Meeting Room A7	Meeting Room C3
Concurrent Session K **3:30–5:00**	***Bits & Bytes in Cyberspace: Sharing Data Via the Internet*** Moderator: Linda Green	***State & Tribal Monitoring Approaches*** Moderator: Paul Currier	***Assessing Ground Water Vulnerability Through Statistical Methods II*** Moderator: Tom Nolan	***Challenges in the Development of Nutrient Criteria for Streams & Rivers II*** Moderator: Mark Munn	***Mercury Contamination: Sources, Transport, & Fate II*** Moderator: Jay Davis	***Volunteer Monitoring Databases*** Moderator: Kristine Stepenuck	***Predictive Bioassessment Models*** Moderator: Gretchen Hayslip	SHORT COURSE: ***Developing Habitat Condition Metrics*** Trainer: Phil Kaufmann, USEPA
3:35 - 3:55	**ACWA (Alaska Clean Water Action) Program and Web-based Tool for Managing Alaska's Waters**, Dianne Denson, State of Alaska	**Oklahoma's Beneficial Use Monitoring Program (BUMP) , Results, Lessons Learned, and Future Directions**, Julie Chambers, OK Water Resources Board	**Screening-Level Assessments of Public Water Supply Well Vulnerability to Natural Contaminants**, Stephen Hinkle, USGS	**Addressing California's Nutrient Issues**, Dena McCann, CA State Water Resources Control Board	**Mercury cycling and bioaccumulation in streams in Oregon, Wisconsin, and Florida**, Mark Brigham, USGS	**Development of an Internet Database for WV Save Our Streams Volunteer Monitors**, Timothy Craddock, WV Save Our Streams Program	**Assessing the biological quality of the Nation's streams with an indicator of taxonomic completeness**, Charles Hawkins, Utah State University	
3:55 - 4:15	**Integrating Historical and Real-Time Monitoring Data into an Internet-Based Watershed Information System for the Bear River Basin**, David Stevens, Utah State University	**Lock 'um in a Room, Hawaii's attempt to achieve comparability**, Linda Koch, Hawaii State Department of Health	**Probability of Detecting Atrazine/Desethylatrazine and Elevated Concentrations of Nitrate in Ground Water in Colorado**, Michael Rupert, USGS	**Algal Metric Approaches for Assessing Trophic Condition and Organic Enrichment in U.S. Streams and Rivers**, Stephen Porter, USGS	**EMMMA: A Web-based System for Environmental Mercury Mapping, Modeling, and Analysis**, Stephen Wente, USGS	**Westchester County Citizens' Volunteer Monitoring Program**, Susan Darling, Westchester County Department of Planning	**Comparability of Biological Assessments Derived from National-, Regional-, State-, and Provincial-Scale Predictive Models**, Peter Ode, CA Dept. of Fish and Game	
4:15 - 4:35	**Web-based Data Sharing for Small Watersheds**, Lisa Walling, Palo Alto Regional Water Quality Control Plant	**Data-Driven Decision-making: Enhanced use of Data Quality Objectives in New Hampshire's Comprehensive Water Monitoring Strategy**, Paul Currier, State of New Hampshire	**Development and Application of a regression model for estimating the occurrence of Altrazine in shallow ground water beneath agricultural areas of the United States**, Paul Stackelberg, USGS	**Impacts of Nutrients on the Biological Integrity of Wadeable Streams in Wisconsin**, Dale Robertson, USGS	**Reconnaissance survey of mercury in water, sediment, and fish from U.S. streams**, Barbara Scudder, USGS	**Open Source Citizen Volunteer Water Monitoring Database**, Andrew Alm, Environmental Alliance for Senior Involvement	**Using biomonitoring data to assess possible causes of biological impairment: Combining predictive models and taxon tolerance values**, Daren Carlisle, USGS	
4:35 - 4:55	**Displaying Water Quality Data on Internet Maps**, Sandy Williamson, USGS	**Navajo Nation EPA Water Quality Sampling Activities**, Eric Rich, Navajo Nation EPA	**Development of Spatial Probability Models to Estimate Ground-Water Vulnerability to Nitrate Contamination in the Mid-Atlantic Region**, Earl Greene, USGS	**Control of nitrogen cycling processes in the Upper Mississippi River (UMR)**, William Richardson, USGS Biological Resources Division	**Modeling Mercury in Stream Ecosystems**, Robert Ambrose, USEPA	**In-stream Monitoring Database**, Gretchen Peterson, PetersonGIS	**Biological Assessment of Water Quality: Delivery of a National System in Australia**, Richard Norris, University of Canberra	
6:00 - 9:00	**Evening Reception at The Tech Museum of Innovation (http://www.thetech.org/)** The Tech Museum of Innovation is located across the street from the Convention Center at 201 South Market Street. The Tech is a hands-on technology and science museum for people of all ages and backgrounds. Gallery themes include innovation, the internet, the human body, and exploration. Tickets for this reception must have been purchased during pre-conference registration.							

Thursday, May 11

7:00 - 8:00	Breakfast in Ballrooms A1, 2, 7, 8							
7:30 - 12:00	Exhibitor Break-Down (Exhibit Hall 1)							
	Meeting Room A3	**Meeting Room A4**	**Meeting Room A5**	**Meeting Room A6**	**Meeting Room C2**	**Meeting Room C4**	**Meeting Room C3**	**Meeting Room C1**
Concurrent Session L **8:00–9:30**	***Monitoring Across National Borders*** Moderator: James Stribling	***Monitoring for Compounds of Emerging Concern I*** Moderator: Akin Babatola	***Integrating Monitoring & Prediction: The Quality of the Nation's Streams I*** Moderator: Dave Wolock	***Evaluation of Trends in Ground Water Quality: Lessons Learned from Local to National-Scale Studies*** Moderator: Mary Ambrose	***Mercury Contamination: Sources, Transport, & Fate III*** Moderator: Don Dycus	***Volunteer Monitoring Gets Results*** Moderator: Danielle Donkersloot	***Determinants & Indicators of Stress in Aquatic Systems*** Moderator: Jerry Diamond	SHORT COURSE: ***Developing O/E (Observed-to-Expected) Models for Assessing Biological Condition*** Trainer: Chuck Hawkins, Utah State University
8:05 - 8:25	**Monitoring of transboundary waters in Europe: lessons learnt from the UNECE pilot projects**, John Chilton, British Geological Survey	**Occurrence of Anthropogenic Organic Compounds in Ground Water and Finished Water of Community Water Systems**, Jessica Hopple, USGS	**SPARROW: A Hybrid Statistical-Deterministic Approach to Modeling Surface-Water Quality**, Richard Smith, USGS	**Evaluation of Ground-Water-Quality Trends Design as Part of the USGS National Water Quality Assessment Program**, Michael Rosen, USGS	**Wet Deposition of Mercury In The U.S. and Canada, 1996-2004: Results from the NADP Mercury Deposition Network**, David Gay, Illinois State Water Survey	**Connection before Protection**, Cheryl Cheadle, OK Conservation Commission	**Integrated indicators of contaminant response in resident species: making a new generation of indicators feasible for management**, Susan Anderson, University of California, Davis	
8:25 - 8:45	**Global Water Watch, a Worldwide Network of Community-Based Water Monitoring Groups**, William Deutsch, Auburn University	**Monitoring Synthetic Musk compounds in Municipal Wastewater and Estimating Biota Exposure in the Receiving Waters**, Lantis Osemwengie, USEPA	**New England Sparrow Model and Example Applications of Model Results**, Richard Moore, USGS	**Trends in Pesticide Detections and Concentrations in Ground Water of the United States, 1993-2003**, Laura Bexfield, USGS	**Mercury concentrations in stream fish throughout 12 western states in the USA**, Alan Herlihy, Oregon State University	**How to get the Public Active in Water Quality Issues**, Ginger North, DE Nature Society	**Using simulation to evaluate the comparability of different bioassessment methods**, Yong Cao, Utah State University	
8:45 - 9:05	**Improving Binational Coordination of Monitoring in the Great Lakes**, Melanie Neilson, Environment Canada	**Chemical markers of human waste contamination in source waters: A simplified analytical approach**, Tammy Jones-Lepp, USEPA	**Regional scale point-source nutrient load estimation in support of SPARROW nutrient modeling**, Gerard McMahon, USGS	**Trends in shallow ground-water quality of the Delmarva Peninsula, Delaware, Maryland, and Virginia: Results from local-scale and regional study**, Linda Debrewer, USGS	**The roles of biogeochemistry and aquatic biota in mercury cycling in stream ecosystems**, Lia Chasar, USGS, Florida A&M University	**Breaking the Code: Training Volunteers to Convert Data to Information**, Candie Wilderman, ALLARM	**Quantifying tolerance indicator values for common stream fish species of the United States**, Michael Meador, USGS	
9:05 - 9:25	**The JA JAN Coalition a Binational Collaborative Network for Water Quality Monitoring in the U.S.-Mexico Border Region**, Hiram Sarabia-Ramirez, San Diego Baykeeper	**Occurrence of Radium-224, Radium-226, and Radium-228 in Aquifers Used Primarily for Drinking Water in the United States: Retrospective Survey of Results from 1987 to 2004**, Jeffrey Fischer, USGS	**Effect of Stream-Network Resolution on the Calibration of a Nutrient SPARROW Model for the Southeastern United States**, Anne Hoos, USGS	**Ground-water quality trends of the South Platte River alluvial aquifer, Colorado**, Suzanne Paschke, USGS	**Mercury in ground water. soils, and septage**, New Jersey Coastal Plain, Julia Barringer, USGS	**Data Tell Part of the Story, Actions Write the Rest**, Brian Soenen, IA Dept. of Natural Resources	**Relation between urbanization and relative toxicity of semipermeable membrane device extracts from the Lake Tahoe Basin and Truckee River watershed, Nevada and California, 2002-2004**, Timothy Rowe, USGS NV Water Science Center	
9:30 - 10:00	Break in Ballrooms A1, 2, 7, 8							

Thursday, May 11

	Meeting Room A3	Meeting Room A4	Meeting Room A5	Meeting Room A6	Meeting Room C2	Meeting Room C4	Meeting Room C3	Meeting Room C1
Concurrent Session M **10:00–11:30**	***Conveying Results: Translating Data into Understanding*** Moderator: Jessica Franks	***Monitoring for Compounds of Emerging Concern II*** Moderator: Akin Babatola	***Integrating Monitoring & Prediction: The Quality of the Nation's Streams II*** Moderator: Dave Wolock	***Bacteria Monitoring: From Source to Sea*** Moderator: Chris Coburn	***Mercury TMDLs: Lessons Learned from Local & Regional Studies*** Moderator: Ruth Chemerys	***Program Evaluation & Evolution*** Moderator: Ross Clark	***Taxonomic Data Quality, Comparability, & Performance*** Moderator: Andy Rehn	WORKSHOP: ***Wetlands Bioassessment*** Facilitators: Chris Faulkner, USEPA; John Mack, Ohio EPA
10:05 - 10:25	**A graphical presentation of water quality data in time and space**, Peter Stoks, Association of Rhine Water Works RIWA	**Monitoring perchlorate in shallow ground water in the Central United States**, Stephen Kalkhoff, USGS	**Biologically based urban response models for the South Atlantic gulf and Tennessee River basins**, Thomas Cuffney, USGS	**Skokomish River Fecal Coliform TMDL Attainment Monitoring in Washington State**, George Onwumere, Washington State Department of Ecology	**The Sacramento San Joaquin River Delta Mercury TMDL: Reducing Methylmercury in Fish and Water**, Michelle Wood, CA Regional Water Quality Control Board, Central Valley Region	**Water Quality Monitoring in Michigan, 1996-2006: A Decade of Program Evolution**, Gary Kohlhepp, MI Dept. of Environmental Quality	**Effect of taxonomic resolution on the performance characteristics of a new macroinvertebrate field sampling protocol for large rivers**, Karen Blocksom, USEPA	
10:25 - 10:45	**Designing a National Water Quality Monitoring Network to support the Canadian Freshwater Quality Indicator**, Rob Kent, Environment Canada, National Water Research Institute	**Perchlorate Monitoring in Llagas Groundwater Subbasin**, Michael Taraszki, MACTEC Engineering and Consulting, Inc.	**Estimating pesticide concentrations in U.S. streams from watershed characteristics and pesticide properties**, Charles Crawford, USGS	**Volunteer/State Partnerships Inspire Grassroots Action**, Cheryl Snyder, PA Dept. of Environmental Protection	**Guadalupe River Watershed Mercury TMDL**, Carrie Austin, SFBay Water Board	**A cooperative State and USGS statewide water quality monitoring network: accomplishments and lessons learned after 15 years**, Christopher Mebane, USGS	**A national autecology list for benthic macroinvertebrates**, Erik Leppo, Tetra Tech, Inc.	
10:45 - 11:05	**Watershed Assessment: A Template for Assessing Water Quality Conditions at Watershed Level**, Anitra Pawley, University of California, Davis	**Occurrence of Anthropogenic Organic Compounds in Surface Water and Finished Water of Community Water Systems**, James Kingsbury, USGS	**Regression models for explaining and predicting concentrations of organochlorine pesticides in whole fish from U.S. streams**, Lisa Nowell, USGS	**Volunteer Monitoring for Bacteria in San Francisco Bay Area Creeks**, Amy Wagner, USEPA	**Use of multi-media monitoring to develop a statewide mercury TMDL**, Bruce Monson, MN Pollution Control Agency	**Can you teach a long-term benthic monitoring program new tricks? Assessment and redesign to address different scales**, Marc Vayssières, CA Dept. of Water Resources	**Enhancing the Credibility of Taxonomic Data: the National Wadeable Streams Assessment**, James Stribling, Tetra Tech, Inc.	
11:05 - 11:25	**LakeSuperiorStreams.org: Making stormwater and stream data come alive for citizens, students, teachers, contractors, resource agencies, decision-makers and scientists**, Richard Axler, University of Minnesota - Duluth	**Concentrations of organic compounds in wastewater at five sites in New York State, 2003-04**, Patrick Phillips, USGS	**Use of WARP to Design a Monitoring Program to Identify Waters Potentially at Risk from Pesticides**, Nelson Thurman, USEPA	**Surfrider Foundation's Blue Water Task Force Program - Volunteer Monitoring that Leads to Change**, Rick Wilson, Surfrider Foundation	**Mercury Emission Trends and Biota Response in Florida: Case Study**, Thomas Atkeson, FL Dept. of Environmental Protection	**Optimization of a Large-scale Water Quality Monitoring Network in South Florida**, Patricia Burke, South FL Water Management District	**How often are we wrong? A Bayesian assessment of taxonomic identifications for the National Wadeable Streams Assessment**, Lester Yuan, USEPA	

Thursday, May 11

11:30 - 1:15	**Closing Plenary Luncheon (Ballrooms A1, 2, 7, 8)** Introduction to Closing Plenary, Charles Spooner, NWQMC Co-Chair **Keynote Speaker - The National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries, Dr. Robert Hirsch, Chair, Subcommittee on Water Quality and Availability** **Keynote Speaker - The Importance of a National Framework, Ms. Julie Packard, Executive Director, Monterey Bay Aquarium** Conference Closing, David Tucker, Conference Chair
1:30 - 3:30	Exhibitor Demonstrations at Guadalupe River Park & Gardens (Meet in Ballroom Concourse; participants will walk to demo site)
1:30 - 4:30	**From Paper to Action: Implementing State Water Monitoring Strategies -- State/EPA Meeting (Meeting Room A3)** In this interactive forum, State water quality managers and staff are invited to identify common challenges and share practical solutions to implementing their water quality monitoring strategies.
1:30 - 5:00	**USGS NAWQA Program Meetings (Meeting Rooms TBA)**
1:30 - 5:00	Field Trip: Wetlands Bioassessment (Part 2 of Workshop) (Meet at main entrance to Convention Center on 1st floor)
1:30 - 5:00	Field Trip: Salt Pond Restoration Tour (Meet at main entrance to Convention Center on 1st floor)

POSTER PRESENTATIONS

Poster presentations are listed below in thematic groups. All posters within the same thematic group will appear together in the Exhibit Hall.

Abstract#	Poster title, Author, Affiliation

ASSESSING AND EVALUATING GROUND WATER AND DRINKING WATER RESOURCES

001	*Effects of Organic Carbon Distribution on Redox Chemistry in a Glacial Aquifer*, *Woodbury, Connecticut*, **Craig Brown**, U.S. Geological Survey
002	*Optimizing a Monitoring Network Using Water Quality and Environmental Factors in the Glacial Aquifer System*, *United States*, **Terri Arnold**, U.S. Geological Survey
003	*Estimation of Stream-Valley Aquifer Withdrawals*, 2000, **Pierre Sargent**, USGS
004	*Comparison of the Vulnerability of Domestic Wells and Public Wells to Volatile Organic Compounds*, **Barbara Rowe**, U.S. Geological Survey
005	*Nutrients in ground water from private, public-supply, and monitoring wells open to the glacial aquifer system, United States*, **Kelly Warner**, U.S. Geological Survey
006	*Can we distinguish regional from local variations in trace-element concentration in the glacial aquifer system of the northern United States?*, **George Groschen**, U.S. Geological Survey
007	*Natural and human factors affecting shallow ground-water quality at local and regional scales in the North Atlantic Coastal Plain, New York through North Carolina*, **Scott Ator**, US Geological Survey
008	*Trends in ground-water withdrawals for irrigation and public-supply uses across the United States*, **Richard Marella**, U.S. Geological Survey
009	*Using a modified probability approach for determining the contributing area to a public supply well in karst terrain*, **Christy Crandall**, U.S. Geological Survey
010	*Spatial distribution of dissolved solids in major aquifers and rivers in the Southwestern United States*, **Nancy Bauch**, U.S. Geological Survey Colorado Water Science Center
011	*Reactive Transport of Nitrate in a Heterogeneous Alluvial Fan Aquifer, San Joaquin Valley, California*, **Christopher Green**, U.S. Geological Survey
012	*Framework of Possible Factors that Affect Water Quality in Basin-fill Aquifers of the Southwestern United States*, **Susan Thiros**, U.S. Geological Survey
013	*New Jersey's Ambient Ground-Water-Quality Monitoring Network: An Update,* **Michael Serfes,** New Jersey Geological Survey (NJGS)
014	*Design Considerations for Assessing Ground-Water Quality in Regional Aquifer Systems: The High Plains Aquifer*, **Bret Bruce**, U.S. Geological Survey

EVALUATING THE EFFECTS OF KEY STRESSORS AND EMERGING CONTAMINANTS

015 *Salt Marsh Ecosystem Heath at Ft. Pulaski National Monument near Savannah, Georgia*, **Joseph Richardson**, Savannah State University

016 *Relationships between species traits and trace element bioaccumulation in riverine fishes*, **Terry Short**, U.S. Geological Survey

017 *Uranium and 222radon in ground water from glacial and bedrock aquifers in the northern United States*, **Joseph Ayotte**, U.S. Geological Survey

018 *Agricultural Pesticides in Shallow Ground-water Flow Systems: A Contrast between Systems***,** **Gregory Steele**, U.S. Geological Survey

019 *The Occurrence of Volatile Organic Compounds in Aquifers of the United States*, **Wayne Lapham**, U.S. Geological Survey

020 *Real-Time Monitoring and Regression Analysis for Specific Conductance and Sodium-Adsorption Ratios in an Area of Coalbed Natural Gas Development in the Powder River Basin, Montana and Wyoming*, **Melanie Clark**, U.S. Geological Survey

021 *Small Scale Water Monitoring Networks for USACE Construction Projects*, **John Baum**, U.S. Army Corps of Engineers Sacramento District

022 *Using Long-Term Monitoring and Special Studies To Evaluate Trends and Address Problems at Twelve USACE Managed Reservoirs in California*, **John Baum**, U.S. Army Corps of Engineers Sacramento District

023 *Using a Spatially Balanced, Random Sampling Design to Assist Informed Management Decisions*, **Sarah Lowe**, San Francisco Estuary Institute

024 *Analysis of Pesticides, Antibiotics, and their Degradation Products Using State-of-the-Art Mass Spectrometry*, **Elisabeth Scribner**, U.S. Geological Survey, Kansas Water Science Center

025 *Herbicide transport and transformations in the unsaturated zone of two small agricultural basins with corn and soybean row crops*, **Tracy Hancock**, U.S. Geological Survey

026 *Dissolved Copper Trends in Lower South San Francisco Bay*, **Eric Dunlavey**, City of San José

027 *Legacy and Emerging Contaminants in San Francisco Bay Sport Fish*, 2003, **Ben Greenfield**, San Francisco Estuary Institute (SFEI)

028 *Comparison of Anthropogenic Organic Compounds in the Source Water and Finished Water for the City of Atlanta*, October 2002 - May 2005, **Melinda Dalton**, U.S. Geological Survey, Georgia Water Science Center

029 *A National Assessment of PBDEs in Lake Fish Tissue*, **Leanne Stahl**, U.S. Environmental Protection Agency

030 *Establishment of Baseline Water-Quality and Sediment-Chemistry Data at Sentinel Sampling Sites on Lake Powell for Future Monitoring of Organic and Inorganic Contaminants*, **Robert Hart**, U.S. Geological Survey

031 *The National Stream Quality Accounting Network (NASQAN II) Program: A Case Study of Water Quality in the Lower Rio Grande Basin*, **Rebecca Lambert**, U.S. Geological Survey

MERCURY

032 *Mercury Biomagnification from the Base of the Food Chain in Guadalupe River Watershed, San Jose, CA*, **Brent Topping**, U.S. Geological Survey

033 *Monitoring Mercury Contamination in the Carson River System, Nevada*, **Karen Thomas**, Nevada Water Science Center

034 *Mercury transport to San Francisco Bay through the Sacramento-San Joaquin River Delta*, **Nicole David**, San Francisco Estuary Institute

035 *Water and Air – Mercury in Idaho*, **Marti Bridges**, Idaho Department of Environmental Quality

036 *Monitoring Mercury Bioaccumulation in Fish during Everglades Restoration*, **David Evans**, NOAA Center for Coastal Fisheries and Habitat Research

037 *The Fish Mercury Project: Involving Stakeholders in Monitoring and Risk Communication in the Sacramento-San Joaquin Delta Watershed*, **Alyce Ujihara**, California Department of Health Services, Environmental Health Investigations Branch

038 *Caspian and Forster's Terns as Indicators of Mercury and Other Priority Pollutant Exposure in San Francisco Bay*, **Terrence Adelsbach**, U.S. Fish and Wildlife Service

039 *Time Series Study of Mercury in San Francisco Bay*, Christopher Conaway, UC-Santa Cruz

040 *Use of a National Descriptive Model of Mercury in Fish in Site-specific Applications*, Stephen Wente, U.S. Geological Survey

041 *Mercury in Stream Water, Streambed Sediment, and Fish of the Willamette Basin, Oregon, in Relation to Mercury Sources*, **Dennis Wentz**, U.S. Geological Survey

042 *Characterization of mercury concentrations in suspended sediment loads in Guadalupe River and Coyote Creek, San Jose, California: Can TMDL targets be met?*, **Lester McKee**, San Francisco Estuary Institute

043 *Mercury Monitoring in the San Jose/Santa Clara Water Pollution Control Plant*, **James Downing**, City of San José

NUTRIENTS

044 *Trends in Water Quality and Nutrient Sources and In-stream Nutrient Loads in the Southeastern United States*, **Douglas Harned**, U.S. Geological Survey

045 *Fate and transport of nutrients in the unsaturated zone in five agricultural areas of the United States*, **Lawrence Fisher**, U.S. Geological Survey

046 *Whole stream response to nitrate loading in three streams draining agricultural landscapes in Washington, Maryland, and Nebraska*, **John Duff**, U.S. Geological Survey

047 *Random nutrient concentration v. targeted nutrient concentration...is there a difference?,* **Mary Anne Nelson**, Idaho Department of Environmental Quality

048 *Supporting nutrient criteria development nationwide: Web application & Technical REQuest System (T-REQS*), **Jeroen Gerritsen**, Tetra Tech, Inc.

049 *Determination of Trends in Nutrient and Sediment Concentrations and Loads in Major River Basins, South-Central United States*, **Richard Rebich**, U.S. Geological Survey, Mississippi Water Science Center

EVALUATING THE EFFECTS OF LAND USE ON WATER QUALITY: URBANIZATION AND AGRICULTURE

050 *Causes of Increased Total Dissolved Solids and Conductivity Levels in Urban Streams in Georgia*, **Ted Mikalsen**, Georgia Environmental Protection Division

051 *Effects of Altered Storm Water Discharge on Water Quality in the Vernon River Estuary, Georgia*, **Joseph Richardson**, Coastal Environmental Analysis

052 *NAWQA Addresses Urban Water-Quality Issues through Multiple Studies*, **Cathy Tate**, U.S. Geological Survey

053 *Effects of Urbanization on Stream Stage and Temperature during Winter and Summer Storms within the Piedmont of North Carolina, 2002-2003*, **Robin Brightbill**, U.S. Geological Survey

054 *Nutrients and Biological Communities of Ozark Streams, 1993-2005,* **James Petersen**, U.S. Geological Survey

055 *Environmental Monitoring Network in the Cedar Creek Experimental Watershed*, **Gary Heathman,** USDA-ARS

056 *Occurrence of Volatile Organic Compounds in Selected Urban Streams in the United States, 1995-2003*, **David Bender**, U.S. Geological Survey

057 *Analysis of the effects of road salt on water quality in the northern United States*, **John Mullaney**, U.S. Geological Survey

058 *Estimating and Projecting Impervious Cover in the Southeastern United States*, **James Harrison**, U.S. Environmental Protection Agency, Region 4

059 *Response of fish communities to gradients of urbanization in southeastern streams near Atlanta, Georgia*, **M. Brian Gregory**, U.S. Geological Survey

060 *Urban Hydrology Monitoring Programs in the Atlanta Metropolitan Area, Georgia*, **William Hughes**, U.S. Geological Survey

061 *Development of an urban hydrological model linking denitrification potential to urban wetland restoration,* **Michael Mak**, Rutgers University

062 *National Water Quality Surveillance for Waterborne Pathogens and Related Indicators in Canadian Agricultural Waters*, **Rob Kent**, Environment Canada

063 *Anthropogenic Impacts to Fish Assemblages in Northern New Jersey Streams*, **Leslie McGeorge**, New Jersey Department of Environmental Protection

064 *Controlling Cumulative Impacts from Impervious Surfaces: Relationship between California State Law and NPDES Requirements*, **Brian Schmidt**, Committee for Green Foothills

MONITORING APPROACHES FOR WATERSHED ASSESSMENT AND IMPROVEMENT

065 *Diurnal Nutrient Fluctuations in the Lake Okeechobee Watershed, Florida*, **Robert Sheridan**, ETI Professionals, Inc. c/o U.S. Geological Survey

066 *Assessment of native stream biodiversity and the influence of invasive species in Tierra del Fuego, Chile,* **Michelle Moorman**, U.S. Geological Survey

067 *Using Environmental Monitoring and Assessment Program Data for Describing Condition of Inner Columbia River Basin Streams*, **Lillian Herger**, U.S. Environmental Protection Agency, Region 10

068 *The Water Quality Monitoring Programs of the Oklahoma Water Resources Board (OWRB)*, **Bill Cauthron**, Oklahoma Water Resources Board

069 *Coastal Watershed Assessment - Point Reyes National Seashore and Golden Gate National Recreation Area*, **Brannon Ketcham**, Point Reyes National Seashore

070 *San Francisco Area Network Water Quality Monitoring Protocol*, **Mary Cooprider**, National Park Service

071 *Water Quality Status and Issues in Nepal,* **Ms. Keshari Bajracharya**, His Majesty's Government, Ministry of Environment, Science and Technology

072 *New York City's Harbor Survey Program Water Quality Monitoring in an Urban Watershed*, **Beau Ranheim**, City of New York Dept. of Environmental Protection

073 *An Overview of the California Monitoring and Assessment Program (CMAP) for Perennial Streams*, **Melenee Emanuel**, California State Water Resources Control Board

074 *Sediment Quality Indicators for the Delaware Estuary*, **Edward Santoro**, Delaware River Basin Commission

075 *EPA's National Study of Chemical Residues in Lake Fish Tissue*, **Leanne Stahl**, U.S. Environmental Protection Agency

VOLUNTEER MONITORING AND STAKEHOLDER PARTNERSHIPS AND COLLABORATIONS

076 *Working together to determine the status of Maryland's Coastal Bays*, **Carol Cain**, Maryland Coastal Bays Program

077 *BioSITE: Students Investigating Their Environment*, **Sandra Derby**, Children's Discovery Museum

078 *Resources Available for Volunteer Monitoring Programs*, **Elizabeth Herron**, Cooperative Extension

079 *The Nuts and Bolts of a Volunteer Monitoring Day*, **Janet Cohen**, Community Action Partners

DATA MANAGEMENT, ANALYSIS, SHARING, AND INTERPRETATION

080 *Introducing NHDPlus!*, **Kristen Gunthardt**, U.S. Environmental Protection Agency, Office of Water

081 *Geographic Targeting for Watershed Restoration*, **Donald Malone**, Tennessee Valley Authority

082 *New NHD Tools for the Evaluation of Watershed Condition and Management Performance*, **William Cooter**, RTI International

083 *Evaluating Watershed Condition and Management Performance with the NHDPlus Toolkit,* **Mellony Hoskinson**, RTI International

084 *Arkansas Monitoring Data Assessment Program (AMDAP) Using the Segment Evaluation Spreadsheet (SEGEVAL.XLS),* **Jessica Franks**, U.S. Environmental Protection Agency,Region 6

085 *Spatial Scale and the Proximity Factor for Water Quality-Landscape Correlations*, **Ronald Zelt**, U.S. Geological Survey

086 *An American/Canadian Partnership - Sharing Data for the Gulf of Maine*, **Deb Soule**, New Hampshire Department of Environmental Services

087 *RésEau: Building Canadian Water Connections,* **Chris Lochner**, National Water Research Institute, National Water Quality Monitoring Office

088 *Facilitating the Exchange and Reporting of Monitoring Data*, **Cristina Grosso**, San Francisco Estuary Institute

089 *New Tools for Importing, Sharing, and Visualizing Biological Monitoring Data Using the Ecological Data Analysis System (EDAS)*, **Jeffrey White**, Tetra Tech, Inc.

090 *Flood-Tracking Chart for the Chattahoochee River near Metropolitan Atlanta, Georgia*, **Jacob LaFontaine**, U.S. Geological Survey

091 *Proactive Water Quality Monitoring with Actionable Data in Drinking Water Distribution Systems*, **Uwe Michalak**, Sensicore, Inc.

DATA QUALITY, COMPARABILITY, AND MEASUREMENT PERFORMANCE

092 *Use of Colilert, Colilert-18 and Enterolert for the Determination of E.coli, fecal coliforms and enterococci in Waste Waters*, Gil Dichter, IDEXX laboratories

093 *A Case Study for Comparison of NAWQA and EMAP Protocols for Benthic Macroinvertebrates and Habitat*, **David Peterson**, U.S. Geological Survey

094 *A Comparison of Stream Biological Assessment Results Obtained Using Different Sampling Protocols in Midwestern Agricultural Streams*, **Thomas Wilton**, Iowa Department of Natural Resources

095 *A Comparison of Benthic Macroinvertebrate Assemblages Collected in New Mexico and Texas Reference Streams Using Selected Methods from State and Federal Agencies*, **James Moring**, U.S. Geological Survey

096 *Components of Variability in Long Term Regional Monitoring Program Data*, **Donald Yee**, San Francisco Estuary Institute

097 *Discrete versus continuous: A comparison of water quality monitoring frequencies*, **Nelia White**, San Francisco State University and San Francisco Bay Regional Water Quality Control Board

098 *Improving Quality Assurance Project Plans with an Expert System*, **Beverly van Buuren**, San Jose State University Foundation, Moss Landing Marine Laboratories

099 *The Analysis of Turbidity Data: Establishing the Link between Sample Characteristics and Measurement Technologies*, **Michael Sadar**, Hach Company

100 *Interstate assessment: Cross-calibration of the Biological Condition Gradient among state monitoring programs in New England*, **Jeroen Gerritsen**, Tetra Tech, Inc.

101 *Four Ways to Get Biased Estimates of Pollutant Loads*, **R Peter Richards**, National Center for Water Quality Research, Heidelberg College

102 *Site Evaluation and Field Sampling Coordination for National Scale Surveys: Supporting the Probability Design Network*, **Jennifer Pitt**, Tetra Tech, Inc.

103 *Optical Dissolved Oxygen Sensors Maximize Accuracy, Minimize Downtime*, **Robert Mooney**, In-Situ Inc.

104 *Achieving Comparability for a Statewide Program through Careful Selection of Quality Assurance and Quality Control Systems*, **Beverly van Buuren**, San Jose State University Foundation, Moss Landing Marine Labs

105 *Importance of field QC Samples in Designing Monitoring Programs and Interpreting Data for Trace Elements in Aquatic Organisms*, **Lawrence DeWeese**, U.S. Geological Survey

BIOASSESSMENT ISSUES, APPROACHES, AND EXPERIENCES

106 *Watershed Stewardship Utilizing GPS Habitat and Bioassessment Surveys*, **Abby Fateman**, Contra Costa County

107 *Environmental Monitoring Program benthic Special Studies*, **Karen Gehrts**, Division of Environmental Services

108 *Relations of hydrologic and physical characteristics to aquatic assemblages in low-gradient streams in agricultural settings in North-Central and Northeastern U.S.,* **Jennifer Hogan**, U.S. Geological Survey, Illinois Water Science Center

109 *Validation of a Multimetric Index Using Probabilistic Monitoring Data*, **Jason Hill**, Virginia Department of Environmental Quality

110 *The effects of fine sediment accumulation on macroinvertebrate distributions below urban dams*, **Steven Fend**, U.S. Geological Survey

111 *The effects of intra-annual variability on interpreting long-term trends in macroinvertebrate-based bioassessments*, **James Carter**, U.S. Geological Survey

112 *Probabilistic Monitoring in Oklahoma*, **Monty Porter**, Oklahoma Water Resources Board

113 *Application of the Reference Condition Approach to Assessing Aquatic Ecosystem Health in Canada's National Parks*, **Rob Kent**, Environment Canada

114 *Assessing the importance of restoration in improving water quality within the Tomales Bay watershed*, **Lorraine Parsons**, Point Reyes National Seashore

115 *An Assessment of the Chemical, Habitat and Biological Condition of Wadeable Streams in the Lower Columbia Region of Oregon*, **Michael Mulvey**, Oregon Department of Environmental Quality

116 *An Assessment of the Chemical, Habitat and Biological Condition of Wadeable Stream Habitat of Threatened Oregon Coastal Coho Salmon*, **Michael Mulvey**, Oregon Department of Environmental Quality

117 *Effects of Climate and Hydrology on Biological Traits of Macroinvertebrate Communities in the Central United States*, **Jeffrey Mabe**, U.S. Geological Survey

NEW TECHNOLOGIES AND APPROACHES

118 *Low Cost Wireless Remote Monitoring Advancements*, **Stephen Cone**, American Innovations

119 *Event Monitoring Water Quality of Micro-Watersheds in Southern Alberta Utilizing Real Time Rom Communications*, **Lawrence Schinkel**, Government of Alberta

120 *Evaluation of Blood as a Surrogate for the Monitoring of Mercury in Largemouth- and Smallmouth Bass Muscle Tissue*, **William Brumbaugh**, U.S. Geological Survey, Columbia Environmental Research Center

121 *Evaluating nitrate sources in nested agricultural sub-basins using nitrate stable isotopes*, **Moon Kim**, USGS

122 *The Sensitivity of Whole-Stream Metabolism Calculations to Measurement Errors*, **Jerad Bales**, U.S. Geological Survey

123 *The Use of Geo-Informatics and Remote Sensing Techniques for the Assessment of Oil and Gas Pipeline Spills*, **William Roper**, George Mason University

124 *Technological advances in handheld computers and the impact on data collection and processing*, **Sandra Kinnaman**, U.S. Geological Survey

125 *Improvement of water quality monitoring by onsite and automatic monitoring*, **Olivier Thomas**, Université de Sherbrooke

126 *Towards a new procedure for wastewater discharge survey*, **Marie-Florence Pouet**, Université de Sherbrooke

127 *Use of In-Situ Amendments to Reduce Ecological Risk from Metals Contaminated Sediments*, **David Gratson**, Neptune and Company

128 *What's in a CUP of British Columbia Surface Water?,* **Melissa Gledhill**, Environment Canada

129 *Linear Regression of Water Quality Data with Nondetects - A New Method*, **Dennis Helsel**, U.S. Geological Survey

130 *Real-Time Monitoring of Organic Carbon and Selected Anions in the Sacramento/San Joaquin River Delta System,* **Steven San Julian**, California Department of Water Resources

INTEGRATING MONITORING WITH SIMULATION AND PREDICTION

131 *Characterization of Streamflow Requirements for Habitat Restoration*, Upper Salmon River Basin, Idaho, **Terry Maret**, U.S. Geological Survey

132 *Regional-scale sources, transport, and sinks of dissolved solids in water resources of the Southwestern United Sates*, **David Anning**, U.S. Geological Survey

133 *Nitrate in ground water: Using a model to simulate the probability of nitrate contamination of shallow ground water in the conterminous United States*, **Kerie Hitt**, U.S. Geological Survey

134 *Modeling the Fate of Particle-Associated Contaminants in San Francisco Bay, CA*, **John Oram**, SFEI

135 *Statistical optimization of a coastal water quality monitoring program*, **Carlton Hunt**, Battelle

136 *Predicting Sediment and Nutrient Loads in Tropical Watersheds in Puerto Rico*, **Edwin Martinez**, University of Puerto Rico

Words and Water Quality: Effective Communication through Better Publications

Facilitators
Abby Markowitz, Tetra Tech, Inc.
Eleanor Ely, *The Volunteer Monitor*

Biographical Sketches

Abby Markowitz manages the communications and outreach group in Tetra Tech's Center for Ecological Sciences (Baltimore, MD) and has worked in the arena of community-based environmental protection, workshop coordination and facilitation, technology transfer/communications, and program development for over 15 years. Abby is an experienced speaker, writer, facilitator and trainer on a wide variety of environmental, organizational and programmatic issues such as stakeholder involvement, capacity building, community-based environmental protection, strategic planning, community leadership development, and volunteer environmental monitoring. She is the co-author and/or technical editor of several USEPA publications, including *Volunteer Stream Monitoring: A Methods Manual* (EPA 841-B-97-003),*The Volunteer Monitor's Guide to Quality Assurance Project Plans* (EPA 841-B-96-003), *Bioassessment and Biocriteria Technical Guidance Manual for Lakes and Reservoirs* (EPA-841-B-98-007), *Stressor Identification Guidance Document (EPA-822-B-00-025), Revision to Rapid Bioassessment Protocols for Use in Streams and Rivers* (EPA 841-B-99-002), *Use of Biological Information to Tier Designated Aquatic Life Uses in State and Tribal Water Quality Standards* (draft, 2005). Since 1992, she has served on the editorial board of the *Volunteer Monitor* newsletter and has contributed numerous articles over the years.

Eleanor Ely has worked as a science writer and editor for 20 years. She specializes in making technical information clear and interesting for various audiences, including non-experts. Since 1990 she has been the editor of *The Volunteer Monitor*, a national publication about watershed monitoring by citizen volunteers. Eleanor has an M.A. in microbiology and has taken numerous writing and editing classes and workshops.

Description of Workshop

Few of us think of ourselves as professional writers or editors, yet we often use the written word to communicate about water quality. This interactive workshop will explore techniques for improving any publication, from a technical report to a general-interest article. Participants are invited to bring samples of publications they are working on.

Part 1: *Setting the Stage,* will answer the questions: What are we trying to accomplish? Who are our targeted audiences? What is our overall message? How will we distribute the publication?

Part 2: *Nuts and Bolts* will provide "how to's" for reviving bureaucratic language, avoiding common editing and layout mistakes, keeping your readers reading, and revising someone else's writing (while staying friends!).

Critical Elements of a Bioassessment Program for State and Tribal Monitoring

Facilitators
Michael T. Barbour, PhD – Director, Center for Ecological Sciences, Tetra Tech, Inc.,
Chris O. Yoder – Center for Applied Bioassessment and Biocriteria, Midwest Biodiversity Institute

Biographical sketches
Michael Barbour serves as a technical consultant to the USEPA and state and tribal water quality agencies, and is a primary author of Biocriteria guidance documents and the Rapid bioassessment Protocols. He facilitates workshops and symposia on bioassessment and Biocriteria strategies, and has presented papers at more than 100 such workshops. Currently, he directs a staff of 35 ecologists and toxicologists, who are involved in multiple projects across the Nation.

Chris Yoder is involved in the national development of biological assessments and biocriteria. He was most recently Manager of the Ecological Assessment Section at Ohio EPA where he was a biologist since 1976. He has served on national, regional, and state working groups and committees dealing with environmental indicators, bioassessment, biocriteria, and WQS development and implementation. Recently he served on the National Research Council committee to evaluate the role of science in the TMDL process.

Workshop Description
In designing or refining a bioassessment program, baseline technical elements are critical foundations to ensure data credibility for making informed decisions. A combination of survey design, field and sampling methods, data management and analysis, and indicator development are required at a known level of rigor to support conclusions that will result in quality management actions and outcomes. This workshop will be a forum for discussing these elements as they apply across the country and in various forms of monitoring and assessment programs. The workshop is designed as a facilitated discussion with introductory presentations and a data exercise to judge the adequacy or limitations of a given program. A self-assessment exercise on "How can I improve my bioassessment program" will better identify strengths and weaknesses in individual programs. Participants will be given documents and workshop materials for their use.

Data to Action: Empowering Citizens through the Acquisition and Understanding of Monitoring Data

Facilitators
Candie Wilderman, Alliance for Aquatic Resource Monitoring
Lauren Imgrund, Alliance for Aquatic Resource Monitoring
Faith Zerbe, Delaware Riverkeeper

Biographical sketches

Lauren Imgrund is Director of the Alliance for Aquatic Resource Monitoring (ALLARM) at Dickinson College, Carlisle, PA. ALLARM partners with PA community groups that are working to protect and restore watersheds through volunteer monitoring programs. She develops and executes technical assistance to watershed organizations and is responsible for leadership of ALLARM including overseeing the operation, managing the budget, fundraising, training, and staff supervision. She has worked in the conservation field for 17 years.

Candie Wilderman is a professor of Environmental Sciences at Dickinson College, in Carlisle PA, and the Founder and Science Director of the Alliance for Aquatic Resource Monitoring (ALLARM). She has been involved in the volunteer monitoring movement since 1985. Her teaching and research interests include: community-based research, watershed assessment and management, water quality, and aquatic ecology.

Faith Zerbe is the Monitoring Director for Delaware Riverkeeper Network. In this role, Faith coordinates DRN's Monitoring Programs built around restoration, advocacy, and protection. Faith also assists local watershed groups in the four states of the Delaware River Watershed to better collect and use monitoring data to make positive change for the resource.

Workshop Description

This workshop will begin by discussing the importance of volunteers engaging in the data analysis process in terms of: 1) the sense of ownership, increased understanding, and empowerment for action, and 2) the value of using local knowledge for interpretation of cause and effect. A two-phase model for training volunteers will be presented. Phase 1 is an analysis of a virtual watershed case study to teach statistical and graphical interpretation and to discover how water chemistry patterns may reflect geology and land use patterns; Phase 2 is the analysis and interpretation of actual data where participants' knowledge of local practices is used to identify the causes of the patterns detected and to inform action plans.

Participants in the workshop will receive copies of all materials and will actually engage in selected portions of the training, exploring the materials in a participatory manner. Our own successes and failures in training watershed groups will also be discussed and analyzed.

Assessing Ground Water Vulnerability Through Statistical and Mechanistic Methods

Trainers

Sandra Eberts, USGS, 6480 Doubletree Avenue, Columbus, OH, 43229
Leon Kauffman, USGS, 810 Bear Tavern Road, Suite 206, West Trenton, NJ, 08628
Stephen Kraemer, USEPA, 960 College Station Road, Athens, GA, 30605-2700
Mathew Landon, USGS, 4165 Spruance Road, Suite 200, San Diego, CA, 92101-0812
Rob Malone, USDA, 2150 Pammel Drive, Ames, IA, 50011-4420
Mike Muse, USEPA, 1200 Pennsylvania, Avenue, NW, Washington, DC, 20460
Bernard Nolan, USGS, 413 National Center, Reston, VA, 20192
Jeffrey Starn, USGS, 101 Pitkin Street, East Hartford, CT, 06108

Biographical Sketches

Sandra Eberts has been a hydrologist with the U.S. Geological Survey for over twenty years. She is currently team leader of the USGS National Water-Quality Assessment program Transport of Anthropogenic and Natural Contaminants to Supply Wells (TANC) topical study. Prior to her work on the TANC study, Sandra spent 8 years as a technical liaison to the U.S. Air Force for the clean-up of ground-water contamination at weapons manufacturing facilities nationwide.

Leon Kauffman has been a hydrologist with the U.S. Geological Survey for ten years. He currently is part of the Hydrologic Systems Team of the National Water Quality Assessment program providing technical support for various ground-water modeling activities. His research interests include coupling models, spatial data, and water quality results to better understand ground-water systems.

Dr. Kraemer is a hydrologist with the EPA Ecosystems Research Division in Athens, Georgia. ERD is part of the EPA National Exposure Research Laboratory of the Office of Research and Development. Dr. Kraemer conducts applied research in support of the Safe Drinking Water Act (e.g., source water protection) and the Clean Water Act (e.g., total maximum daily loads). He develops and applies computer models to represent regional and catchment-scale ground water flow, including ground water/surface water interactions. Dr. Kraemer received the M.S. and Ph.D. in Environmental Science from Indiana University, Bloomington, and a B.S. in Engineering Science from the University of Notre Dame.

Matt Landon has been a hydrologist with the U.S. Geological Survey since 1990. He has conducted studies of ground-water hydrology and ground-water quality in Minnesota, Nebraska, and California. He is currently working on studies of transport of anthropogenic and natural contaminants to public supply wells for the National Water-Quality Assessment Program and the California Ground water Ambient Monitoring and Assessment program.

Rob Malone is a research engineer with the USDA-Agricultural Research Service, National Soil Tilth Laboratory, Ames, IA (USDA-ARS-NSTL). He is currently working with a team of scientists to develop tools and methods to quantify the effect of agricultural management on water quality and crop production that will facilitate agricultural decision-making. Rob played a key role in the development of the preferential flow component of the Root Zone Water Quality Model (RZWQM), which was created by USDA-ARS to simulate water and chemical transport associated with agricultural systems.

Mike Muse joined EPA's Region IX in 1973, where he worked in data management and permits administration. Before transferring to EPA Headquarters in 1990, he served as the Section Chief for

Permits Administration, worked on redrafting the NPDES program documents for the California State Water Resources Control Board and set up the Clean Water Act State Revolving Fund (SRF) in Region IX. Today, he serves as a team leader for source water protection in the Office of Ground Water and Drinking Water.

Bernard T. Nolan is a ground-water specialist for the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS). He has worked in the area of nutrient data synthesis and interpretation since 1995. He assesses aquifer vulnerability to contamination through modeling and spatial analysis of water-quality data, soil and aquifer properties, and land-use characteristics.

Jeff Starn has been a hydrologist with the Federal government for over twenty years. He has worked overseas with the Peace Corps, with the USEPA in Region IV, and with the USGS in the Kentucky and Connecticut Water Science Centers. His current interests include probabilistic ground-water modeling and using combined watershed and ground-water models to help better understand hydrologic processes in glacial/crystalline rock aquifer systems.

Course Description

This multiple presenter short course will outline some of the needs and methods for assessing ground water vulnerability to contamination. Presentations will include material on USEPA's Wellhead Analytic Element Model (WhAEM) for generating screening level contributing areas, uncertainty associated with contributing area delineations, a data base of contributing area summary statistics for assessing supply well vulnerability in a variety of aquifer systems, considerations for movement of contaminants across the unsaturated zone, statistical methods for predicting ground water vulnerability at the regional scale, ground water age as a surrogate for vulnerability, and depth dependent sampling in pumping supply wells for improved understanding of vulnerability.

Using U.S. Geological Survey Spatial Data To Analyze Water Quality

Facilitators
Curtis Price, U.S. Geological Survey
Joseph Kerski, U.S. Geological Survey
Sandy Williamson, U.S. Geological Survey

Biographical Sketches
Curtis V. Price is a Physical Scientist with the U.S. Geological Survey at the USGS South Dakota Water Science Center in Rapid City, South Dakota. He provides GIS and database support to the USGS National Water Quality Assessment program, and also supports GIS activities throughout the USGS as a member of the USGS Enterprise GIS team. His research interests include development of techniques to describe landscapes in support of water data analysis.

Dr. Joseph J. Kerski serves as Geographer at the US Geological Survey in Colorado, where he seeks and fosters educational partnerships, conducts training in geography, science, and geotechnologies (Geographic Information Systems (GIS), Global Positioning Systems (GPS), and Remote Sensing for a wide variety of audiences and locations, creates curriculum focused on spatial thinking and geotechnologies in education, and conducts research in the effectiveness and implementation of these technologies in educational settings.

Since 1996, Sandy Williamson has been team leader of the National Water Quality Assessment (NAWQA) National Data Team. He leads a team of about 10 people across the country developing new data base and mapping tools on the web for the NAWQA program (http://water.usgs.gov/nawqa/data). From 1991-97, he led the Central Columbia Plateau NAWQA study unit team in Tacoma, Washington. He has worked for the USGS for 30 years, previously in Austin, Texas, and Sacramento, California. His interests are in web-based presentations of scientific studies, data, and mapping, systems analysis (especially of risk in environmental decision making), ground-water flow and quality, and effective use of statistics.

Workshop Description
This workshop will show how to access and use water-quality and geospatial data from the U.S. Geological Survey (USGS) National Water Information System, the USGS National Water-Quality Assessment (NAWQA) Data Warehouse, and the USGS National Map. Students will participate in exercises in finding and accessing these data sets and using them to characterize the watersheds and spatially analyze water-quality and related data sets using geographic information system (GIS) software. Laptops with internet access and software will be provided, and no GIS experience is required.

Probability Survey Design for Aquatic Resources using R Statistical Software

Facilitator
Anthony Olsen, U.S Environmental Protection Agency

Biographical Sketch
Anthony R. Olsen is an environmental statistician at the U.S. Environmental Protection Agency, NHEERL, Western Ecology Division, Corvallis, Oregon. He received a PhD in statistics from Oregon State University in 1973. He is a Fellow of the American Statistical Association and is a recipient of the Distinguished Achievement Award from the American Statistical Association's Section on Statistics and the Environment and the distinguished statistical ecologist award of the International Association for Ecology. Dr. Olsen's research focuses on the development of large–scale ecological monitoring studies based on probability survey designs and statistical graphics for geographical data.

Description of Workshop
This workshop will demonstrate software for the selection of sites for aquatic resources, including estuaries, streams, rivers, lakes, wetlands, and ground water wells. Alternative probability survey design options include simple random and spatially-balanced (GRTS) probability survey designs that may be stratified or have unequal probability of selection. ESRI shapefiles are used as input and output. Participants can bring their own laptop, though this is optional.

Elements for a Successful Low-Level National Scale VOC Assessment

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Bibliographical Sketches of Authors
David Bender is a hydrologist with the U.S. Geological Survey. His work includes analyzing and interpreting volatile organic compound surface water quality data and quality assurance and quality control data for the National Water-Quality Assessment Program. David has a Masters Degree in Civil Engineering from the South Dakota School of Mines & Technology.

Michael Moran is a hydrologist for the U.S. Geological Survey who works on analyzing and interpreting ground water quality data for the National Water-Quality Assessment (NAWQA) Program. His work includes analyzing and interpreting data on VOCs in ground water, designing national-scale ambient ground water monitoring programs, and developing statistical models to predict the probability of occurrence of VOCs in ground water. Michael holds a Ph.D. in geological engineering from the South Dakota School of Mines & Technology and is a member of the American Institute of Professional Geologists, the Association of Engineering Geologists, and the National Ground Water Association.

Abstract
In the mid-1990s the U.S Geological Survey's (USGS) National Water-Quality Assessment (NAWQA) Program requested that a new, low-level analytical method for volatile organic compounds (VOCs) be developed by the USGS National Water-Quality Laboratory. The low-level method that was developed in 1997 includes 85 analytes for which uncensored concentrations are reported above, at, or less than the method detection limits. The use of long-term method-detection limits (LT-MDLs) for individual analytes was incorporated into the method. The LT-MDL takes multiple instruments, multiple operators, multiple calibrations, and low-level verification standards into account. The LT-MDL is a measure of method performance over time.

Fifty-five of the 85 analytes on the new, low-level method were selected for emphasis in the NAWQA Program's national assessment based on the following criteria: (1) initial selection of candidate analytes and preliminary screening based on published knowledge; (2) laboratory studies on the feasibility of analysis; and (3) analysis of ground-water, surface-water, and quality-control samples to ascertain the performance of the method. The initial selection and preliminary screening process took into account a number of physical, chemical, environmental, and toxicological aspects of each compound.

Key elements for the success of the low-level VOC method in the national assessment include: 1) documentation of laboratory analytical and field methods; (2) collection and review of laboratory and field quality-assurance and quality-control (QAQC) samples; and (3) use of an assessment level for the analysis and reporting of VOC occurrence results. The assessment level is a common concentration applied to water-quality data when comparing detection frequencies or concentrations between different VOCs, groups of VOCs, or networks of wells. The laboratory incorporated standard operation protocols for the low-level VOC method. Emphasis has been placed on training field staff on sample-collection and QAQC protocols. Field quality-control samples are reviewed by local NAWQA staff and a national VOC team.

Lessons Learned in National Park Service Aquatic Vital Signs Long Term Monitoring Program

Roy J. Irwin

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Biographical Sketch of Author:
Roy Irwin is a senior contaminants specialist and biomonitoring coordinator in national office of the National Park Service. Roy has a Bachelors Degree in Biology from the University of Kansas and a Ph.D. in biology from Tulane University. Roy has 35 years of continuous service with three federal agencies: The National Park Service, the Fish and Wildlife Service, and the Environmental Protection Agency. He is the author of NPS "Part B lite" guidance for those developing QA/QC, study design, and practical statistics aspects in aquatic monitoring protocols and SOPs for the new Park Service Vital Signs Monitoring Program.

Abstract:
Lessons learned in helping 32 monitoring networks nationwide develop long-term aquatic monitoring in National Parks are summarized for the following categories of issues: 1) Targeted vs. Probabilistic Monitoring Designs; 2) Thresholds of Change and Safety Margins; 3) Sample Sizes vs. Detection Probabilities and Statistical Power, 4) Minimum Detectable Differences (MDDs) and Effect Sizes (ESs), 5) Data Comparability vs. QC Measurement Quality Objectives; 6) The Alphabet Soup of Low-Level Detection Limits, 7) Alternate Measurement Sensitivity (AMS) When All Measurements Are in the Quantitative Range and Low Level Detection Limits are Therefore Not Relevant, 8) Using NEMI, and 9) Overlapping Methods to Document Average Bias from Method Changes.

Meeting Programmatic Data Quality Objectives through a Standardized Verification and Validation System and Data Management

Beverly H. van Buuren

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Biographical Sketch of Author
Beverly H. van Buuren is manager of the Quality Assurance (QA) Research Group at Moss Landing Marine Laboratories (MLML). The QA Research Group consists of six full-time staff members that are currently focused on two large-scale programs: the State of California's Surface Water Ambient Monitoring Program (SWAMP), and the CALFED/California Bay-Delta Authority (CBDA) Mercury Speciation Monitoring and Research Studies. Ms. van Buuren is the QA Officer for both programs, and has designed and taught QA courses for the Northwest Environmental Training Center, the Washington State Department of Ecology, and for project/program-specific applications in the classroom, laboratory and field.

Abstract
The Surface Water Ambient Monitoring Program (SWAMP) was established to support Federal Directive AB 982, which mandated that each state develop a comprehensive surface water quality monitoring program. In California, such a program had to process data representing hundreds of analytes and methods assessed by numerous contract laboratories. This data had to then be presented to a diverse group of program participants for a variety of end uses. This inherent variability has required the SWAMP Quality Assurance (QA) Team and Data Management Team (DMT) to develop a rigorous verification and validation system that emphasizes data comparability. Data verification ensures that reported results accurately depict work performed by the contract laboratory. Data validation confirms that the verified data batch meets the programmatic quality objectives for SWAMP. To ensure consistency, Standard Operating Procedures (SOPs) were developed for each step in the process - from data verification at the contract laboratory level, to data validation at the programmatic level. The system begins with contract laboratories completing Quality Control (QC) Check Sheets prior to submitting their electronic data deliverables to the DMT. The QC Check Sheet readily identifies any results requiring qualification or reanalysis. As a result, participating laboratories submit fewer unusable data batches. After data is uploaded into the database, The DMT verifies data in relation to SWAMP's Measurement Quality Objectives (MQOs), and ensures that appropriate qualifiers are assigned to data batches. Then, the DMT validates data against the programmatic Data Quality Indicators (DQIs). Acceptable data is transferred to the permanent side of the database, where it is available to potential end users through the internet. Finally, the QA Team validates a representative percentage of this permanent data against a CLP-Level 4-style report. Ultimately, this process provides the end user with usable, properly qualified data. In addition, the system permits corrective action steps to occur in a timely manner.

Challenges of Conducting Analytical Chemistry in Environmental Matrices or Why is my Blank not Blank?

Margaret Sedlak and Donald Yee[1]

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Biological Sketches of Authors

Margaret Sedlak is a Senior Program Manager at the San Francisco Estuary Institute where she assists in the management of the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP). Prior to joining SFEI in 2004, Ms. Sedlak worked for an engineering consulting firm providing assistance to industrial clients on regulatory compliance issues and fate and transport modeling. Ms. Sedlak also has held positions at: the Swiss Federal Institute of Environmental Science and Technology where she conducted laboratory research on the fate of tributyltins and Resources for the Future, an environmental economic policy institute.

Donald Yee is SFEI's QA Officer. Dr. Yee has worked on various projects for the RMP, such as studies on atmospheric deposition of trace metals, and organic contaminants to the estuary, and a survey in SF Estuary waters of VOCs, dioxins, and other priority pollutants not yet regularly monitored by RMP. He is presently the principal investigator of a CalFed grant evaluating mercury cycling in the Petaluma Marsh. Dr. Yee has also conducted investigations of loads of PCBs and other organic contaminants from point source dischargers.

Abstract

The Regional Monitoring Program for Trace Substances (RMP) is an innovative collaborative program that conducts annual monitoring and research on the San Francisco Bay. One of the goals of the RMP is to develop an understanding of the impacts of contaminants on the beneficial uses of the San Francisco Bay. To fulfill this goal, the RMP collects and analyzes San Francisco Bay sediment, water, bivalves and fish for a multitude of contaminants including trace metals, polychlorinated biphenyls, polyaromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs) and pesticides.

All RMP data are subject to a rigorous quality assurance/quality control (QA/QC) program. Many of the concentrations measured in Bay samples are substantially below regulatory thresholds. As a result of the low concentrations of contaminants present and the high potential for interferences from environmental matrices, blank contamination is frequently identified as an issue during the QA/QC review.

Two compounds, PAHs and PBDEs, will be discussed because they exemplify two of the major types of blank contamination observed. Our experience indicates that PAH blank contamination is a result of the analytical method used. PAH methods will be compared and sources of blank contamination discussed. In contrast, blank contamination observed in PBDE samples is likely due to the ubiquitous use of these compounds (e.g., a flame retardant). A survey of typical laboratory blank contamination concentrations for PBDEs will be presented and potential preventive measures will be discussed. Implications for similarly widely used chemicals such as the perfluorinated compounds will also be addressed.

Pesticides in the Nation's Streams and Ground Water, 1992-2001

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Biographical Sketches of Authors
Robert Gilliom has been a hydrologist with the U.S. Geological Survey since 1978. He has directed the Pesticide National Synthesis Project of the National Water Quality Assessment Program since 1990. Previously, he served as project chief for USGS San Joaquin Valley Studies from 1984-1989, was with the Systems Analysis Group during 1981-1984, and was a member of the Puget Sound Earth Science Application Project during 1978-1981. Research and publications have focused on water-quality assessments, ranging from statistical methods for data analysis, to regional and national assessments of nutrients, trace elements, and pesticides.

Abstract
Pesticides were assessed across a range of land-use and hydrologic settings in 52 major hydrologic systems throughout the U.S. as part of the U.S. Geological Survey's National Water Quality Assessment Program. Water samples were collected from 186 streams; bed-sediment samples from 1,052; and fish samples from 700. Ground water was sampled from 5,159 wells. Water samples were analyzed for 83 pesticide compounds, most in current use, and bed-sediment and fish samples for 32 organochlorine compounds, most of which are no longer used.

Pesticides were present throughout most of the year in streams with developed watersheds—those with substantial agricultural, urban, or mixed-land-use. Pesticide concentrations in stream water followed strong seasonal patterns that were mainly correlated with the timing and intensity of pesticide applications. DDT and other organochlorine compounds were found in fish or bed-sediment samples from most streams, including more than half the streams draining undeveloped watersheds. Pesticides were less common in ground water, but were detectable in more than half of the shallow wells sampled in agricultural and urban areas.

Streams and ground water in areas with significant agricultural or urban land use usually contained mixtures of multiple pesticides. About 95 percent of all water samples from streams in developed watersheds contained two or more pesticides and 25 percent had 10 or more, indicating that mixtures are the primary mode of pesticide occurrence.

Annual mean concentrations in streams and concentrations in ground-water samples were seldom greater than human-health benchmarks for individual pesticides. Benchmarks were exceeded in about 1 percent of the 2,356 domestic wells and 364 public-supply wells sampled. More than 50 percent of streams with developed watersheds, however, had concentrations of one or more pesticides that exceeded a water-quality benchmark for aquatic life, indicating a widespread potential for effects on aquatic life that merits further investigation.

Nutrients in the Nation's Streams and Groundwater, 1992-2001

Neil M. Dubrovsky[1], JoAnn M. Gronberg[2], Keri J. Hitt[3], David K. Mueller[4], Mark D. Munn[5], Bernard T. Nolan[3], Stephen D. Porter[4], Larry J. Puckett[3], Barbara C. Ruddy[4], Norman E. Spahr[4]

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Biographical Sketch of Author

Neil Dubrovsky has been a hydrologist with the U.S. Geological Survey for 20 years. He has been the Chief of the Nutrients and Trace Elements National Synthesis team of the National Water-Quality Assessment (NAWQA) Program since 2003. He was a member of the California Water Science Center management team during 1997-2002, was the Project Chief for the San Joaquin-Tulare Basins NAWQA study unit from 1990-1997, and was a member of the USGS San Joaquin Valley Studies section from 1986-1990. His work has focused on ground-water chemistry and large-scale multidisciplinary water-quality investigations.

Abstract

Excessive nutrients are a major source of water-quality impairment. Ten years of data collected by the National Water Quality Assessment program describe current nutrient levels and help explain influential processes. Nutrient concentrations were low in 85 streams and 401 wells in relatively undeveloped settings. Nitrate concentrations were elevated in groundwater from both urban and agricultural landscapes, but exceeded the USEPA drinking water limit (10 mg/L as N) in only 3% of 329 public-supply wells and in 7% of 2,221 domestic wells. These data, and data on the distribution of nitrate sources and aquifer susceptibility, allow prediction of vulnerability of unmonitored areas to nitrate contamination across the U.S.

Nutrient concentrations at 481 stream and river sites were generally lower than those in groundwater, but increased with agricultural and urban development within the basin. Concentrations of ammonia, orthophosphate, and total phosphorus were similar in urban and agricultural streams, but nitrate and total nitrogen were higher in agricultural than in urban streams. Nutrient concentrations vary seasonally, with total nitrogen commonly greatest in winter and spring and total phosphorus greatest in summer and autumn; seasonal patterns also vary spatially in response to regional differences in streamflow seasonality. Nutrient enrichment in streams is common, as reflected by algal community structure. Nitrogen and phosphorus concentrations correlate with algal metrics indicative of trophic conditions, tolerance to organic enrichment, and low dissolved-oxygen concentration.

Two findings illustrate the complexity of nutrient enrichment. Studies of nitrate concentrations along groundwater flow paths show large reservoirs of high-nitrate water in shallow aquifers underlying many agricultural areas; whether this high-nitrate water will impact nearby drinking-water wells and streams in the future depends on geochemical and hydrogeologic setting. In addition, natural sources of phosphorus in groundwater and sediments in some undeveloped areas may complicate development of meaningful nutrient criteria.

The National Coastal Assessment: Results, Lessons Learned and Future Directions

J. Kevin Summers[1], Burgan Burgan[2] and Peter Grevatt[2]

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Biographical Sketches of Authors
Kevin Summers is the National Program Director for Ecological Research in EPA's Office of Research and Development with training and experience as a systems ecologist. From 1999-2005, he served as the Technical Director of the National Coastal Assessment, designing, implementing and reporting on the assessment of the nation's estuarine resources. The results of this program have been published in the National Coastal Condition Reports I and II, in 2001 and 2006, respectively.

Barry Burgan is a senior marine biologist with the U.S. Environmental Protection Agency's Office of Water. He has been with the agency over 26 years. Most recently he co-authored the interagency National Coastal Condition Report II and the Coastal Research and Monitoring Strategy. Prior to that, he managed the national 305(b) program and revitalized the state reporting and monitoring of water quality. He initiated efforts to regulate and monitor less-than-secondary sewage effluent into the marine environment, ocean disposal of dredged material and incineration at sea.

Peter Grevatt is the Chief of the Monitoring Branch in EPA's Office of Water and has served in that capacity since 2003. He is responsible for implementation of EPA's national water quality monitoring program and also manages EPA's STORET water quality database. Prior to joining the Office of Water, Peter served as the Senior Science Advisor for EPA's national hazardous waste cleanup program and as the senior health scientist for EPA's Region 2 office in New York.

Abstract
Since 1990, the coastal program of EPA's Environmental Monitoring and Assessment Program has been developing and testing a regional/national monitoring program for estuarine ecosystems. The effort conducted jointly with NOAA and USGS has resulted in the National Coastal Assessment Program and two reports of baseline condition of estuarine resources throughout the US. The results of the 1999-2002 surveys, the development, selection and testing of indicators, and the future directions of the program will be described. How the continuing baseline conditions developed for 2002-2004 will be used to assess overall trends in ecological condition, nationally and regionally, and will provide a succinct and consistent condition assessment for examining pre-Hurricane Katrina condition in Louisiana/ Mississippi/Alabama coastal areas will be described. The transition of NCA from a research program to an operational program will be discussed.

Perspectives on the State of the Nation's Waters

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Biographical information

Mr. O'Malley directs The Heinz Center's *State of the Nation's Ecosystems* project. He has also worked in the Department of the Interior, the White House Council on Environmental Quality (CEQ); the office of Governor Thomas H. Kean of New Jersey, and the New Jersey DEP. He holds a Masters degree from Harvard University's Kennedy School of Government and a Bachelor's degree from the State University of New York.

Abstract

The Heinz Center's 2002 *State of the Nation's Ecosystems* report identified key indicators of the use and condition of U.S. ecosystems; a second report, due out in 2007, is in preparation. These indicators can provide insight into the extent of aquatic ecosystems, their physical and chemical condition, the status of the biodiversity they support, and the uses of these systems by society. Continued tracking and reporting of those indicators for which data were available, and expansion of monitoring programs to address key data gaps, is crucial if decision makers and the public are to make informed choices. Unfortunately, there were many indicators for which data were not available in 2002 and not only are prospects for filling gaps dim, but erosion of existing monitoring and reporting capabilities has the potential to reduce the knowledge base on which key decisions are made.

This presentation will briefly review the suite of indicators chosen in 2002 to describe US freshwater ecosystems, review possible changes to this suite in the 2007 report, and highlight both data gaps and potential changes that might increase or decrease the availability of data.

The Fall and Rise of an Aquifer – Stakeholders Unite to Conserve and Monitor the Sparta Aquifer in South Arkansas

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Biographical Sketch of Author

Dave Freiwald is the Assistant Director with the U. S. Geological Survey in Little Rock, Arkansas where he serves as head of the Hydrologic Investigations Section directing water-resources research and studies. In his nearly 26 years working for the USGS, Dave has previously been project chief of the Ozark Plateaus National Water-Quality Assessment Program, a hazardous waste ground-water study on the Little Rock Air Force Base, and the Central Midwest Regional Aquifer Systems Analysis (RASA) study. In the early 1980's, Dave was a hydrologist with USGS in California for two years where he was born and raised.

Abstract

The Sparta aquifer supplies the majority of water for industrial, municipal, and agricultural uses in Union County, Arkansas and the surrounding area with resulting water-level declines of more than 360 feet in some areas. Ground-water flow models developed by the U.S. Geological Survey (USGS) demonstrate that water levels may be maintained at or above the top of the aquifer by reducing withdrawals from the Sparta aquifer in Union County by 72 percent. Water quality has degraded in some areas as usage has increased. Recently Union County stakeholders united to petition the governor to appoint a water board with taxing authority, which began an education program, initiated conservation and reuse of ground water measures, and tapped a surface-water supply as an alternative source for certain industrial use to prevent further water-level declines in the Sparta aquifer.

A 5-year study by USGS is providing real-time water-level data on the internet and periodic water-quality sampling from a network of wells to document water changes within the Sparta aquifer. Real-time water-level monitoring is conducted using a pressure transducer connected to a digital data logger. Data are retrieved automatically every 6-hours via telephone modem, processed, and placed on the USGS website. Water-quality samples are collected two times per year for specific conductance and chloride.

The internet based real-time water-level data allows citizens and officials to quickly assess the changing water levels. Water conservation efforts have allowed ground-water levels to rise 2 to 3 feet in less than 2 years in areas centered in the greatest water-level declines. In less than a year since surface water has been supplied to industry, water-level rises up to 14 feet have occurred in selected wells. Currently, median specific conductance ranges from 212 to 1,245 microsiemens per centimeter at 25 degrees Celsius, and median chloride ranges from 3 to 214 milligrams per liter in wells sampled.

Proposed National Ground Water Monitoring Program

Beverly L. Herzog[1], Christine Reimer[2], and Cartier Esham[3]

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Biographical Sketches of Authors

Beverly Herzog is a senior hydrogeologist and Assistant to the Chief for Environmental Initiatives at the Illinois State Geological Survey, where she has worked since 1980. She has co-authored approximately 60 publications on topics related to groundwater, two of which have won national awards. Herzog has an M.S. in hydrology from Stanford University. She is currently serving as Chairman of the Association of Ground Water Scientists and Engineers, a division of NGWA.

Christine Reimer is Director of Government Affairs for NGWA. NGWA is a membership organization representing nearly 15,000 U.S. and international ground water professionals. She is a graduate of the American Institute for Paralegal Studies and is a certified paralegal.

Cartier Esham is Assistant Vice President and Director of Research at Dutko Worldwide. She has a Ph.D. in Microbiology and has published papers in peer-reviewed science journals on water quality. She currently works variety of groundwater related issues, helping NGWA to establish and implement strategies on the federal level.

Abstract

Ground water, a critical component of the nation's water resources, is vital to public health, the environment, and the economy. Approximately 75% of community water systems rely on ground water. Nearly all of rural America, as well as large metropolitan areas, use ground water-supplied water systems. Ground water feeds streams and rivers, especially during periods of drought or low flow. The percentage of total irrigation withdrawals from ground water increased from 23 percent in 1950 to 42 percent in 2000.

NGWA surveys found that while states are gathering the necessary data to inform decision makers, no state has met its ground water data collection goals. A minimum of fifteen federal agencies collect a wide variety of water quality data, according to a U.S. General Accountability Office survey. These programs, in general, are not comprehensive and/or not well coordinated. Long-term ground water quality and quantity monitoring would provide information necessary for the planning, management, and development of ground water supplies to meet current and future water needs, both for humans and ecosystems.

The White House Office of Science and Technology Policy (OSTP) requested that NGWA provide a suggested design for a national groundwater monitoring program. During the 2005 NGWA Ground Water Summit, participants representing a broad spectrum of public and private sector ground water professionals met to discuss ground water monitoring needs. They recommended a three-tiered approach of monitoring ambient ground water, targeted areas and impacted areas. They suggested that the federal role should be to support a collaborative framework, develop guidelines, provide funding for federal and cooperative efforts, and establish a national clearinghouse. Roles for each level of government and for the private sector were identified. The OSTP has indicated that NGWA's ideas were considered during preparation of a long-term strategy for addressing science and technology needs related to water availability and quality. The draft strategy is expected to be released this summer for comment.

The Need for Renewed Emphasis on State, Tribal and Federal ground-Water Protection Programs

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Abstract
Over the past several years diminishing and fragmented emphasis on state, tribal and federal ground-water protection programs, coupled with the lack of dedicated funding to support such programs, has resulted in major obstacles to effective ground-water resource protection and management. The reduced emphasis on ground-water protection and management has become a more critical issue due to the dramatic increase in the rate of development of ground water in the USA. Currently the total volume of ground-water pumping in the USA exceeds 77 million gallons per day. This dramatic increase in pumping, coupled with widespread drought conditions, has led to significant aquifer mining, reduced ground-water recharge, reduced baseflow to streams and reduced ground-water discharge to wetlands and springs. The development and implementation of multiplescale, multiple objective ground-water monitoring programs is an essential element of a viable, effective ground-water management program. Some key elements of State-wide ground-water monitoring program include: 1. Establishment of monitoring programs that include ambient monitoring, aquifer-specific monitoring, program specific monitoring and regulatory monitoring. 2.Design and implementation of State ground-water monitoring programs should be coordinated with State Geological Surveys. 3. Monitoring wells should be dedicated well - not wells used for other purposes. Well construction and location must be suitable for monitoring objectives. 4.Monitoring schedules should consider seasonal hydrograph differences and the ability to do trend analysis. Selection of appropriate indicator parameters is critical. Monitoring data must be managed in a way that makes data analysis practical. To address these critical ground-water management issues, the Ground-Water Protection Strategy Workgroup was established in 2003. Membership in the Workgroup included representatives from state and Tribal ground-water protection programs, scientists from the USGS, USEPA and USFS. The GWPSW is working closely with the National Ground-Water Association and the Ground-Water Protection Council. The primary mission of the GWPSW is to develop and implement a strategy to re-focus and strengthen state, tribal and federal ground-water protection and management programs.

Developing a Ground-Water Monitoring Strategy for Half the Cost – Literally

David R. Wunsch

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Biographical Sketch

David R. Wunsch is the State Geologist and Director of the New Hampshire Geological Survey. He has a Ph.D. in hydrogeology, and is a Licensed Professional Geologist in two states. His specialty is in ground water geochemistry, with application to ground water monitoring. Prior to coming to New Hampshire, David served as a Congressional Science Fellow in Washington DC, and previously was the Coordinator of the Coal Field Hydrology Program at the Kentucky Geological Survey, located at the University of Kentucky.

Abstract

The state of New Hampshire maintains a network of 25 wells to monitor ground water in an effort to form a preliminary statewide monitoring network. These wells are relatively shallow, and are a subset of a larger set of wells installed as part of a previous cooperative study to evaluate the shallow, stratified drift aquifers in the state. Although 97 percent of all water wells in New Hampshire are drilled into the bedrock, only one well in the current network of 25 wells monitors this important statewide aquifer. NHGS presented a capital budget request in two successive legislative sessions to secure an appropriation funding the installation of twenty-four companion bedrock wells to measure water levels for drought management, and to determine ambient ground water quality. The state did appropriate funding for this request; however, only half of the original $205,000 request was made available for the current biennium. This creates a dilemma as half of the proposed budget will not fund half of a network because of upfront equipment and strategic planning needs. To optimize the reduced network size, NHGS will use data from over 100,000 wells stored in the state's Private Well Inventory database to develop statistical relationships for well placement based on well depth and yield relating to specific lithotypes prevalent in New Hampshire's complex geology. For example, valuable insight can be gleaned from histograms of well yields as a function of depth in specific lithotypes for deciding the appropriate number of wells to install in a particular region of the state, as well as a representative depth. GIS data related to population, land use, geology, and physiography will be integrated into the network design. Moreover, a successful design will involve an interactive strategy with all stakeholders to meet as many scientific and societal needs as is practical.

Characterizing the Landscape for Water-Quality Data Analysis: Methods and Implementation

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Curtis V. Price is a Physical Scientist with the U.S. Geological Survey at the USGS South Dakota Water Science Center in Rapid City, South Dakota. He provides Geographic Information System (GIS) and database support to the VOC National Synthesis Project of the USGS National Water Quality Assessment (NAWQA) program, and also supports GIS activities throughout the USGS as a member of the USGS Enterprise GIS Team. His research interests include development of techniques to describe landscapes in support of water data analysis.

Naomi Nakagaki is a geographer with NAWQA's Pesticide National Synthesis Project in Sacramento, California. She has been providing GIS support for the project since 1991. Much of her work has been focused on providing environmental characteristics of watersheds for surface-water sites sampled in the NAWQA program, as well as developing national spatial datasets of agricultural pesticide use.

Kerie J. Hitt is a GIS specialist with the USGS NAWQA Program in Reston, Virginia, and provides technical support for national studies of nutrients in ground water. She develops and applies ancillary spatial data on factors that influence water quality. Ms. Hitt joined USGS in 1981 and has been with the NAWQA Program since 1991.

Gail Thelin is a geographer with the Pesticide National Synthesis Project of the USGS NAWQA Program. Prior to joining NAWQA in 1991, she was a remote sensing specialist at NASA-Ames Research Center where she developed techniques to apply satellite data to a variety of hydrologic and agricultural applications. Since joining the NAWQA Program in 1991, she has focused on developing methods to estimate current and historical county pesticide use data and other characteristics of agricultural land use. Gail also represents the NAWQA Program on several intergovernmental committees addressing data requirements for national-scale pesticide use and land-cover information.

Sharon L. Qi is a Hydrologist with the USGS Colorado Water Science Center, and works from Cascade Volcano Observatory in Vancouver, Washington. She is currently the GIS Specialist and data base manager for the High Plains Regional Groundwater study; part of the USGS NAWQA Program. Recent work has included using GIS to assist in the development of a ground-water vulnerability model for the High Plains Aquifer.

Abstract

The U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program has developed methods to characterize the landscape near water-quality sampling sites using geographic information system (GIS) analysis. Factors affecting water quality can be better understood when landscape properties (such as soil characteristics) and anthropogenic variables (such as population density) are estimated for target areas representing source areas for water samples. Target areas in the NAWQA Program include watershed areas upstream from surface-water sampling sites, aquifer outcrop areas, and buffer areas defined near sampled wells. Landscape variables can be represented in many ways (for example, raster

surfaces or polygon and point features), and different data models suited to solve particular spatial analysis problems have been used by NAWQA. Two key ancillary data themes used by NAWQA for data analysis are population density and land use and land cover (LULC). Trend analysis is an important goal of the NAWQA Program. However, LULC data sets collected to measure changes at a national scale are not available. The NAWQA Program has developed techniques to combine several existing national LULC data sets and population data sets to estimate LULC at several time periods of interest, and spatially aggregate both population density and LULC data for use in characterizing NAWQA sampling sites. This paper will discuss several representative landscape variables used in the NAWQA Program and how they have been developed and applied to characterize water-quality sampling sites using GIS.

Characterizing the Landscape for Water Quality Assessment: Linking tabular county data on agricultural nutrient and pesticide applications to spatial land-cover data to estimate nutrient and pesticide use in watersheds and ground-water study areas

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Naomi Nakagaki is a geographer with NAWQA's Pesticide National Synthesis Project in Sacramento, California. She has been providing GIS support for the project since 1991. Much of her work has been focused on providing environmental characteristics of watersheds for surface-water sites sampled in the NAWQA program, as well as developing national spatial datasets of agricultural pesticide use.

Kerie J. Hitt is a GIS specialist with the USGS NAWQA Program in Reston, Virginia, and provides technical support for national studies of nutrients in ground water. She develops and applies ancillary spatial data on factors that influence water quality. Ms. Hitt joined USGS in 1981 and has been with the NAWQA Program since 1991.

Abstract

Information on the amount and spatial distribution of nutrient and pesticide use were key landscape variables used to characterize the agricultural setting of 51 major river basins and ground water systems being studied by the National Water-Quality Assessment (NAWQA) Program. Data from the Census of Agriculture which included animal counts and acres harvested for a variety of crops were combined with other published information on state-level fertilizer sales and pesticide use-coefficients and estimates of manure production to develop county-based estimates of total nutrient and pesticide inputs across the Nation. The spatial distribution of each of these variables was determined by combining the county-level tabular data with mapped land-cover data using a Geographic Information System (GIS). Through a series of GIS overlay functions, study areas, county boundaries, and National Land Cover Data were intersected, and weighting factors that represented the fraction of each county agricultural land use contained in each NAWQA study area were computed. These land-cover weighting factors then were associated with tabular information on fertilizer use and pesticide applications by county to spatially distribute nutrient and pesticide loads to agricultural land uses within the NAWQA study areas. The land-cover weighting factors computed for a study area can be used to apportion any other tabular county-based data to agricultural land in a study area outside of the GIS processing environment. This approach avoids multiple GIS overlays of study areas, counties and land cover.

The nutrient and pesticide load estimates have been used with water-quality data from NAWQA monitored sites to interpret and explain water-quality conditions. Since the tabular data have been

associated with mapped land cover for the entire conterminous United States, the estimates were used in the development of nitrate and atrazine models that extend NAWQA's interpretations to unmonitored areas.

The use of remotely sensed and GIS-derived variables to characterize urbanization in the National Water-Quality Assessment Program.

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James Falcone is a Physical Scientist with the U.S. Geological Survey in Reston, Virginia. He provides GIS and remote sensing support to the USGS National Water-Quality Assessment Program. Mr. Falcone has a B.A. in Environmental Science from the University of Virginia, an M.S. in Geography from George Mason University, and an M.S. in Remote Sensing from the University of New South Wales, Australia. He is also a doctoral student in Earth Systems and GeoInformation Sciences at George Mason University.

Abstract

An important goal of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program is an improved understanding of the effects of urbanization on stream ecosystems. A number of remotely sensed and GIS-derived data sources and techniques are being used as part of NAWQA's efforts to relate urban activities and landscape features to stream conditions. While the Program makes use of many "traditional" data sources and metrics for analysis (e.g. national land cover data, road density, etc.), numerous efforts have been made to develop derivative or "value-added" data products that may help in the analysis of urban effects. Examples of these are distance-weighted and "proximity to urban" measures, connectivity metrics, and multi-metric indexes. Because of the increasing fragmentation of the American landscape, both the pattern and intensity of urbanization may be important considerations. Of all anthropogenic features, roads play an especially important role, in that they are key factors in both landscape fragmentation and urban intensity, as well as serving as a near-perfect indicator of human presence.

Practical usage and tradeoff issues for GIS data in urban studies can also pose vexing questions: appropriate scale (when is spatial resolution "too coarse"?); data quality (what is "good enough" accuracy?); and the effect of currency (when are data "too old" in a rapidly urbanizing watershed?). Answering these questions may be the most useful guide in evaluating what the "best" data may be for any particular project.

StreamStats: A Web-based application for estimating basin characteristics and streamflows

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Biographical Sketch of Author

Alan Rea received dual B.S. degrees in Agricultural Engineering and Soil Science from Oregon State University in 1986. He received an M.S. degree in Agricultural Engineering, with a minor in Statistics, from Oregon State University in 1988. He has worked as a hydrologist and geographic information systems specialist for the U.S. Geological Survey since 1989, and is currently located in Boise, Idaho. He is registered as a Professional Engineer in the State of Oklahoma.

Abstract

StreamStats is a partnership between the U.S. Geological Survey (USGS) and Environmental Systems Research Institute (ESRI) to develop an online application that links USGS digital map data, streamflow statistics, and regression equations with ESRI's ArcHydro* tools. The application delineates the drainage basin above a user-selected point on a stream, calculates the basin characteristics (such as area, slope, elevation, and precipitation), and uses those characteristics with USGS regression equations to estimate a variety of low, mean, and peak streamflow statistics.

Why is this important? Every time a new bridge or culvert is designed or a channel modification is planned, an engineer calculates a design flow for the stream reach to serve as the basis for the design. Additionally, many environmental issues related to water-quality standards, pollutant discharge permits, and instream flows for fish habitat rely on good estimates of a stream's low-flow characteristics. Before digital maps, the calculation of these flow estimates was tedious and subject to errors or inconsistency depending upon approach, source data, and the individual doing the analysis. Calculations for even a modest-sized basin could take hours, whereas with StreamStats, the process can be done accurately and consistently in only a few minutes.

State highway departments and Federal land managers (such as the U.S. Forest Service) require these calculations to determine whether the designs for structures such as highways, culverts, and bridges are adequate. Federal and State emergency management agencies use estimates of peak streamflows to develop flood-prone area maps. The Idaho Department of Environmental Quality is currently working with the USGS to use StreamStats for developing a digital map of Idaho that identifies all stream reaches in the State as perennial, intermittent, or transitional. StreamStats also is being used in a partnership between the Bureau of Reclamation and USGS to provide a hydrologic basis for the evaluation of salmon and bull trout habitat in the upper Salmon River Basin in Idaho.

* Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Sustaining a Long-Term Water Quality Monitoring Program: The Lessons from San Francisco Bay

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Mike Connor is Executive Director of the San Francisco Estuary Institute. Dr. Connor's career has been devoted to making the link between environmental science and policy. He has worked for federal and regional agencies, as well as for the non-profit sector. Dr. Connor completed his undergraduate degree at Stanford University, his doctorate at the Woods Hole Oceanographic Institution/Massachusetts Institute of Technology Joint Program in Biological Oceanography, and his post-doctoral work at the Harvard School of Public Health's Interdisciplinary Programs in Health.

Dr. Davis is Program Manager for the Regional Monitoring Program (RMP). He has worked on contaminant issues in the San Francisco Estuary since 1986. He received his Ph.D. in Ecology at the University of California, Davis in 1997. Dr. Davis is manager of the Regional Monitoring Program for the San Francisco Estuary, and the principal investigator of the Fish Mercury Project, a $4.5 million project to examine mercury in fish in the Bay-Delta watershed, to increase public awareness of fish contamination issues, and to monitor changes in mercury concentrations from CALFED restoration and remediation projects. Dr. Gunther was the original manager of the Regional Monitoring Program (1993-1996), and is presently the Program Coordinator for the Clean Estuary Partnership (CEP), a collaborative effort to conduct science in the support of TMDLs. Dave Tucker leads the Environmental Services Department for the City of San Jose and is Technical Committee chairman for both RMP and CEP.

Abstract

The Regional Monitoring Program for Trace Substances in the San Francisco Estuary (RMP) is an innovative model for providing the scientific foundation needed for managing water quality in a treasured aquatic ecosystem. The RMP was initiated in 1993 through a permit requirement that all dischargers to the Bay contribute a program that would monitor the cumulative effects of all their discharges to Bay water quality. The program is implemented by a non-governmental organization, SFEI, and governed by committees of the key stakeholder groups. The RMP now has an annual budget of $3 million from nearly 100 participants and has become a key source of information that helps define regulatory priorities for the Regional Water Board. The long-term sustainability of the RMP is due to

- Stakeholder ownership in the monitoring program through their financial contributions and participation in program governance.
- Program relevance to water quality decision-making. This relevance was augmented in 2002 by a new collaboration of many of the same partners, the Clean Estuary Partnership (CEP) to develop Total Maximum Daily Load Allocations for the Bay using data and conceptual models developed from RMP monitoring.
- Trust in the quality of the data by all partners due to a sophisticated and well-supported QA/QC program and regular programmatic peer review from scientists outside the region.

Monitoring metals in San Francisco Bay: Quantification of Temporal Variations from Hours to Decades

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Abstract
As the systematic monitoring of metals in San Francisco Bay waters approaches two decades, it is now possible to quantify spatial and temporal variations in metal concentrations over hours and decades. This quantification provides resolution on the impacts of ongoing remediation efforts, as well as projections of the impacts of proposed alterations of the Bay, on metal contamination in the estuarine system. The efficacy of different remediation efforts can also be assessed in terms of their relative impact on water quality, as can the potential impacts of changes in land use of the watershed, catastrophic events, and global warming on that water quality.

Science, Consensus and Monitoring Strategies: The Art of Revising a Long-term Benthic Monitoring Program

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Abstract
The Interagency Ecological Program (IEP) Environmental Monitoring Program (http://www.iep.water.ca.gov/emp/) has actively monitored physical, chemical, and biological conditions in the upper San Francisco Estuary for 30 years. The IEP monitoring staff and management conduct an internal review of the program approximately every three years. Each review is an opportunity to assess current monitoring practices and implement refinements or improvements to the program. This presentation will examine the most recent review of the benthic monitoring component of the program. Efforts to refine research goals in response to the greater scientific community's evolving understanding of the estuary will be discussed, as will the constraints involved in translating those goals into real-world monitoring strategies. In particular, the conundrums specific to monitoring the benthos in a large, physically and biologically diverse system in a way that 1) preserves the long-term records, 2) represents the ambient biological conditions, 3) tracks species invasions, and 4) yields data that can help assess the ecosystem effects of water resource management in the Estuary are addressed. The merits and deficits of several monitoring approaches suggested during the review and the lessons learned thus far will be discussed.

Adapting an Ambient Monitoring Program to the Challenge of Managing Emerging Pollutants in the San Francisco Estuary

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Rainer Hoenicke is an aquatic biologist with the San Francisco Estuary Institute with more than 20 years of experience at the interface between science and policy. He served as technical lead of the Santa Monica Bay Restoration Project in the early 1990s, one of the three National Estuary Program areas in California. With the exception of a two-year conservation planning stint at the California Resources Agency, he has worked at the San Francisco Estuary Institute since 1994 as Quality Assurance Officer, manager of the Regional Monitoring Program, and most recently as Deputy Director.

Daniel Oros is a biogeochemist and joined SFEI in 2001 as the principal investigator of a pilot study with the primary objective to identify previously unmonitored organic contaminants and emerging pollutants of concern in the San Francisco Estuary. His experiences have included researching the chemistry and biology of deep-sea hydrothermal vent systems using the deep submergence vehicle "Alvin"; research on the chemical composition of combusted fuels such as biomass and coal and their contribution to atmospheric chemistry; and research on petroleum hydrocarbon contamination in surface waters.

Abstract

While over seven million organic and inorganic compounds that have been indexed by the American Chemical Society's Chemical Abstracts Service in their CAS Registry are commercially available, most pollution monitoring programs focus only on those chemical stressors for which regulatory benchmarks exist, and that were traditionally considered responsible for the most significant human and environmental health risks. Until the late 1990s, the San Francisco Estuary Regional Monitoring Program was no exception in that regard. After a thorough external review, the monitoring program responded to the need for developing a pro-active surveillance approach for emerging pollutants in recognition of the fact that the potential for the growing list of widely used chemical compounds to alter the integrity of water is high. We describe (1) the scientific and analytical bases underlying a new surveillance monitoring approach; (2) summarize approaches used and results obtained from a forensic retrospective; (3) present the growing dataset on emerging pollutants from surveillance monitoring and related efforts in the San Francisco Bay Area to characterize newly targeted compounds in wastewater streams, stormwater runoff, and biota; and (4) suggest next steps in monitoring program development and applied research that could move beyond traditional approaches of pollutant characterization. Based on the forensic analysis of archived chromatograms and chemical and toxicological properties of candidate compounds, we quantified a variety of synthetic organic compounds which had previously not been targeted for analysis. Flame retardant compounds, pesticides and insecticide synergists, insect repellents, pharmaceuticals, personal care product ingredients, plasticizers, non-ionic surfactants, and other manufacturing ingredients were detected in water, sediment, and/or biological tissue samples. Several of these compounds, especially polybrominated diphenyl ether flame retardants, exhibited concentrations of environmental concern. We also describe environmental management challenges associated with emerging pollutants and how pro-active surveillance monitoring might assist in a more holistic approach to pollution prevention and control before emerging pollutants become a burden on future generations.

Glyphosate Concentrations in Various Hydrological Compartments of a Small Watershed in East-Central Indiana

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Dr. Nancy T. Baker is a hydrologist with the U.S. Geological Survey Indiana Water Science Center. Since 1991 she has worked on National Water-Quality Assessment Program (NAWQA) studies for the White River Basin, Miami River Basin and White River-Miami River Basins. She is presently the lead scientist for the NAWQA White River-Miami River Basins Agricultural Chemical Transport and Fate Topical Study.

Dr. Michael T. Myers is a research scientist with the U.S. Geological Survey and is currently the director of the USGS, Kansas District Organic Geochemistry Research Laboratory. The focus of his research is development of analytical methods to study the nature of organic contaminants in surface water and ground water. His primary interest is the study of “emerging contaminants” such as pesticide degradates and pharmaceutical compounds. Collectively these studies have had an impact on our understanding of the occurrence, fate, and geochemical transport processes of organic compounds that are not routinely measured.

Abstract

Glyphosate is a widely used herbicide in the cropping of genetically modified herbicide resistant soybeans and corn. In 2004 in Indiana, approximately 94 percent of the soybeans were glyphosate resistant. Glyphosate has a very high organic carbon adsorption coefficient, which allows it to be readily bound to soil particulates on the land and in the water. To investigate the occurrence and transport of glyphosate in the agricultural environment, the U.S. Geological Survey collected samples from various hydrological compartments (precipitation, soils, soil water, shallow ground water, tile drain effluent, field surface runoff, and ditch water) in a small watershed in east-central Indiana. Glyphosate was detected more than 50 percent of the time in each of the hydrological compartments and 100 percent of the time in soils and field surface runoff. The highest glyphosate levels were also seen in soils, 476 parts per billion (ppb), and field surface runoff (427 ppb). As expected, the maximum glyphosate concentration in soil water (0.14 ppb), shallow ground water (0.13 ppb), tile drain effluent (4.71 ppb), and precipitation (1.09 ppb) were low; however, glyphosate was detected frequently in these compartments, 59, 100, 87, and 92 percent of the samples, respectively. The soil-binding properties of glyphosate strongly affect the hydrologic movement of this compound; transport pathways that move sediment and soil particulates also are the most important pathways for glyphosate transport. However, some glyphosate does move through the soils to tile drains. This is likely secondary to preferential flow pathways (macropores, shrink-swell fissures, and biota-created channels) during larger rainfall events.

Monitoring Pesticides in Iowa's Waters

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Biographical Sketch

Mary Skopec is the Section Supervisor of the Watershed Monitoring and Assessment Section at the Iowa Department of Natural Resources. Mary has been with the IDNR since 1991, and during that time she has been involved with a variety of water quality projects including assessing and modeling changes in pesticide occurrences in Iowa's water resources. As supervisor of the water monitoring program, Mary directs the collection, analysis, and management of information on Iowa's stream, lake, wetland, and groundwater resources. Mary earned her Ph.D. in environmental studies from the University of Iowa.

Abstract

Since 1991, the EPA has provided for states to take primary responsibility in developing management programs to deal with agricultural chemicals. Because of variations in geology, soil, and landscape features among the states, the strategy allows states to implement their own pesticide-specific SMP to best protect their water resources. For the past 14 years, the Iowa Department of Natural Resources - Water Monitoring Program has been developing a database of pesticide analyses and detections to make data more readily available for natural resource managers. This database, the Iowa Pesticide Water Resources Database (IAPEST), was developed to improve access to pesticide contaminant information and facilitate integration of these data with other natural resource information. Results from the analysis of herbicide occurrences in Iowa water resources have shown a steady decline in concentrations of some of the older formulation compounds in the State's surface and groundwater resources. Partly, this decrease is due to improved management on the landscape as well as changes in marketing and sales of herbicides. In more recent years, the introduction of new formulation herbicides (lower application rates, different modes of action) has resulted in a new class of compounds appearing in Iowa's water resources. This presentation will highlight these trends and discuss implications for future monitoring activities.

Assessment of Pesticides, Nutrients and Selected Organic Contaminants in Small Streams in the Midwestern United States, 2004

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Jim Stark is a supervisory hydrologist with the USGS in Mounds View, Minnesota. Jim manages USGS National Water Quality Assessment and studies section activities for the Water Science Center in Minnesota. Jim holds advanced degrees in geology, water resources and business administration.

Abstract
The U. S. Geological Survey (USGS), in cooperation with the U. S. Environmental Protection Agency (US EPA), collected water samples from 120 small streams (watersheds less than 200 square kilometers) across the Midwestern United States during the summer and fall of 2004. Streams were selected at random from watersheds representing a variety of geologic, hydrologic, topographic and climatologic conditions. Samples were collected during base-flow to represent long-term average effects of land use, and geologic, hydrologic, and climatic conditions.

The study focused on the presence of pesticides and nutrients. Water samples also were analyzed for perchlorate and for selected organic contaminants such as pesticide-breakdown, fragrance, pharmaceutical, plasticizer, and polyaromatic-hydrocarbon compounds. Many of these compounds were detected across the Midwest, although at concentrations typically less than one part per billion. The presence of these compounds in base flow indicates the combined effect of anthropogenic use of these compounds and the importance of ground-water as a mechanism to transport these compounds to streams over time.

This study is part of a long-term cooperative national research project among the US EPA and the USGS to collect comparable water-quality data from small streams and to develop regional predictive models that use landscape characteristics to estimate pesticide and nutrient concentrations in small streams.
Notice: Although this work was reviewed by EPA and approved for presentation, it may not necessarily reflect official Agency policy.

Trends in Herbicides in Streams of Corn-Soybean Agricultural Areas of the United States, 1991-2004

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Daniel Sullivan is the Lead Scientist for the Upper Midwest Regional Synthesis Team within the USGS National Water-Quality Assessment (NAWQA) Program. In addition, Mr. Sullivan is the Executive Secretary of the Methods and Data Comparability Board. Since 1999, he has also served as the project chief and lead database developer for the National Environmental Methods Index (NEMI) project.

Judith Thomas is the NAWQA ground water specialist in the Wisconsin Water Science Center of the USGS. Ms. Thomas is a hydrologist with expertise in ground water modeling, water quality, statistical analysis, and database development. In addition, she serves as project manager and assistant project manager on regional water quality investigations. Judith received her B.S. degree from Purdue University (1996) and a M.S. from Indiana University (2001).

Abstract

In the second decade of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program, a major focus is on regional assessments of surface-water quality conditions and trends. For the purpose of these assessments the nation has been divided into 8 surface-water regions, referred to as Major River Basins (MRBs).

These regional surface-water assessments expand upon NAWQA findings from 1991 to 2004 in 51 "Study Units" across the Nation. Regional assessments will complement and extend the findings of the Study Units to fill critical gaps in our understanding of surface-water quality over broad regions, and determine whether trends in surface-water quality exist at sites that have been monitored for more than a decade.

A water-quality concern in agricultural areas of the Midwestern United States is runoff of pesticides from areas of application to streams and rivers. Herbicide data collected at stream sites that drain watersheds where corn and soybean row crops constitute at least 20 percent of the land use were analyzed for spatial and temporal trends. The sites were located in sixteen NAWQA Study Units in the central and eastern United States.

Herbicide concentrations and changes in concentrations were compared to rates of application over the period of study to determine whether changes in use are reflected in streamwater concentrations. Trends were analyzed using a multiple linear regression technique on data collected during the growing season (April-September).

Creative Outreach: Solving the conundrum of using volunteer water quality data as a meaningful source of information

Amanda Ross

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Biographical Sketch
Amanda is a volunteer coordinator with the Lower Colorado River Authority's Colorado River Watch Network. Her past work experiences include developing curriculum to enhance the study of water quality, data analysis and database management, and working with communities to resolve water conflicts. Amanda's educational background includes a bachelor's degree from the University of Texas and a master's of science degree from Texas State University. Past work experiences include several positions with the National Park Service including Yosemite National Park, Lake Mead National Recreation Area, and as part of the ranger activities division in Washington DC.

Abstract
Like the waters it monitors, the Colorado River Watch Network is dynamic. Established by citizens in 1988 and managed by the Lower Colorado River Authority (LCRA) since 1992, the Colorado River Watch Network (CRWN) works to educate and involve citizens of all ages and backgrounds throughout the watershed in understanding, collecting, reporting and presenting information needed to sustain the health of the lower Colorado River and its tributaries in Texas. The individual volunteers that CRWN depends on are in constant flux. Students advance and graduate, teachers change jobs or schools, citizens move or withdraw to accept new opportunities.

The challenge many volunteer monitor programs face is how to more actively involve citizens in the environmental decision making process. CRWN's answer is creative outreach through programs such as LCRA's monthly Water Quality Index.

Beginning in 1996, CRWN has used data from selected sites to help produce the LCRA's Water Quality Index. The index, a monthly water quality update for 14 river and lake communities in the lower Colorado River basin, was recognized at the National Volunteer Monitoring Conference in August 1996 as a model example of volunteer data being used as a public awareness and information tool. The index also represents exceptional progress in coordination between volunteer and professional monitoring efforts.

Spring 2006 marks the 10th anniversary of the monthly collection of data for LCRA's Water Quality Index. This discussion will cover key elements to the success of the Water Quality Index and the challenges associated with using volunteer water quality data as a meaningful source of information.

Anthropogenic Impacts to Fish Assemblages in Northern New Jersey Streams

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Biographical Sketch of Author
John Vile is a research scientist for Water Monitoring & Standards within the New Jersey Department of Environmental Protection. He is certified as an Associate Fisheries Professional by the American Fisheries Society and specializes in aquatic ecological investigations. Currently he is in charge of overseeing the New Jersey Fish IBI Program. In addition, Mr. Vile has spent several years working as a fisheries biologist in the Midwest and Pacific Northwest. He has a B.S. in Biology from Rutgers University and a M.S. in Biology from East Stroudsburg University.

Biographical Sketch of Presenter
Leslie McGeorge is the Administrator for Water Monitoring & Standards, where she directs NJ's ambient water quality monitoring, standards and assessment program. Previously, she served as Assistant Commissioner for Environmental Planning and Science, and as a Research Scientist, Assistant Director, Deputy Director and Director in the Division of Science, Research and Technology. She sits on the National Water Quality Monitoring Council, co-chairs the NJ Water Monitoring Council, and represents NJ on ASIWPCA's Monitoring, Standards and Assessment Task Force. She has a B.S. in Biology (Lafayette College) and a M.S. in Public Health, Environmental Chemistry and Biology (University of North Carolina).

Abstract
The New Jersey Fish Index of Biotic Integrity (IBI) has been used to assess the health and condition of fish assemblages and to identify potential stressors from high gradient streams in New Jersey. Since the initiation of the program in 2000, a number of impacted waters have been identified. Seventy-six percent of urban streams sampled have been impacted or have suspected impacts as a result of human activities. The most common urban stressor to the aquatic community is loss or degradation of natural habitat. Bank erosion and siltation have eliminated overhead cover, bank vegetation, riparian buffer, and suitable substrate in many urban streams. The effects of such habitat alterations are evident in the fish community, as benthic insectivores, which require clean substrate, have exhibited a decreasing trend in response to urbanization. Trophic imbalance is often evident in urban waters, as specialized feeders such as insectivorous cyprinids are replaced by generalists. In addition, data from the 2005 season indicates external deformities in fish are more common in urban settings, likely a result of environmental stress or input of contaminants.

Effects of Hydrologic Factors on Ecological Conditions of Streams in the Northeast, USA

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Jonathan Kennen is an aquatic ecologist with the U.S. Geological Survey's New Jersey Water Science Center (NJWSC). Since 1995, he has served as lead biologist for the Long Island-New Jersey (LINJ) study unit of the National Water-Quality Assessment (NAWQA) Program and as the biological specialist for the NJWSC. Jonathan is involved with many ongoing cooperative research projects aimed at evaluating the effects of urbanization and hydrologic alteration on aquatic ecosystems. Dr. Kennen is currently the Lead Scientist for the NAWQA Program's northeast Major River Basins where he administers a series of projects looking at trends in ecology and water-quality.

Karen Riva-Murray has been an aquatic ecologist with the U.S. Geological Survey's New York Water Science Center since 1991. As lead biologist for the Hudson River Basin (HDSN) and Delaware River Basin (DELR) NAWQA Program studies, her research interests include mercury cycling and bioaccumulation in streams, effects of urbanization on stream ecosystems, occurrence and distribution of contaminants in aquatic biota, ecological effects of landscape fragmentation, and responses of aquatic assemblages to hydrologic alteration and land use change.

Karen Beaulieu is a Biologist with the U.S. Geological Survey's Connecticut Water Science Center. Since 1996, she has been involved with many NAWQA Program studies including the LINJ, Central Arizona Basins (CAZB), Connecticut River Basins (CONN), and New England Coastal Basins (NECB) and assisted in the implementation of a Northeastern Urban Land Use pilot study. Currently, Ms. Beaulieu is the lead biologist for the CONN and NECB studies and oversees all ongoing NAWQA biological activities in New England including field coordination and assessment of aquatic assemblages.

Abstract

Data collected between 1993 and 2003 as part of the U.S. Geological Survey's National Water-Quality Assessment Program were evaluated to assess effects of hydrologic modifications and other environmental stressors on aquatic-invertebrate assemblage structure in the north-eastern United States. Macroinvertebrate and hydrologic data were aggregated for more than 70 upland stream sites having three or more years of continuous flow data. Data on geology, landscape composition and configuration, and chemical and physical stream conditions were also compiled for these sites. The recently-developed USGS Hydrologic Indices Program was used to calculate 171 ecologically relevant flow and flow-related parameters, which were used to characterize sites according to the five major components of streamflow - timing, magnitude, duration, frequency, and rate of change.

Patterns in macroinvertebrate-assemblage structure among sites were examined with nonmetric multidimensional scaling (NMDS). The primary NMDS axis, which explained 40% of the variation in assemblage structure, was interpreted as a disturbance gradient that was significantly related to indicators of landscape composition (e.g., urbanization and forest fragmentation) and flow regime (e.g., high- and low-flow duration). Results will be used to identify important landscape and hydrologic parameters associated with ecosystem disturbance and provide water managers with a strong scientific basis for establishing targeted limits on hydrologic alterations for maintaining ecosystem health.

Assessment of Aquatic Biological Communities along a Gradient of Urbanization in the Willamette Valley Ecoregion and a Predictive Application to Unsampled Sites

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Ian Waite has been a research ecologist for the USGS Water Resource Discipline since 1992. Ian's research interests include better understanding of how complex mixtures of natural and anthropogenic factors cloud our interpretation of stream bioassessments, the application of multivariate statistics, and improving our understanding of habitat requirements and tolerances of macroinvertebrates. Ian has a Master's in fisheries biology and a Ph.D. in entomology.

Kurt Carpenter, a colleague with Ian, has completed extensive research addressing the issues of nutrient biogeochemistry, hydrology and algal ecology. He is a leading algal ecologist for the NAWQA program and continues to develop creative solutions to difficult bioassessment research questions. Kurt has worked for the USGS since 1992 and has a Master's in Environmental Science.

Kurt and Ian have worked extensively with colleagues from the Oregon Water Science Center including: Andrew Arnsberg a hydrologic technician with extensive experience in water quality and biological systems; Frank Rinella (retired) a research water chemist with 30 plus years experience studying a variety of water quality issues in streams; Steven Sobieszczyk a geographer and GIS specialist applies GIS/landscape ecology to water quality issues; and Michael Sarantou a hydrologic technician with 16 years experience on a variety of difficult stream systems.

Abstract
From late 2003 through summer 2004, the U.S. Geological Survey's National Water Quality Assessment Program sampled 28 streams within the Willamette Basin to investigate effects of urbanization on aquatic biology (fish, macroinvertebrates, and algae), habitat, and water chemistry. The 28 watersheds fall along an urban land use gradient index (Urban Intensity Index, 0 to 100, lowest to highest) based on land use and census data developed for this region. Watershed areas range from 13 to 96 square kilometers and contain greater than 20 percent of the Willamette Valley ecoregion. Ten streams were sampled for water chemistry six times during study period. The other 18 streams were sampled twice for water chemistry—once during high sustained flow, and once during summer low flow. Fish and macroinvertebrates showed a linear decrease in numbers, quality and diversity as urban intensity increased, with no detection of a threshold. Population density and the urban intensity index were highly correlated with fish and macroinvertebrate assemblage patterns among sites. Variables that seemed to be important in explaining the decline in biological assemblages were water temperature, dissolved oxygen, stream gradient, habitat diversity, and the number and concentration of pesticides. We also tested two groups of highly developed sites, both with high percent-developed landuse of agriculture plus urban, but one with relatively low population density (low urban intensity) and the other with high population density (high urban intensity). We could not statistically detect any difference based on biological assemblages and stream chemistry between these highly developed watersheds even though the amount of urbanization was different between the two groups of sites. We will discuss the possible application of and results from the use of the urban intensity index as a predictive model on unsampled sites.

Getting Started in Volunteer Monitoring

Facilitators
Linda Green, University of Rhode Island Watershed Watch
Danielle Donkersloot, New Jersey Department of Environmental Protection

Biographical Sketches
Linda Green is Program Director of the nineteen year old URI Watershed Watch Program. This science-based volunteer water quality monitoring program promotes active volunteer monitoring, informal educational outreach and generates virtually all the of the RI lake water quality monitoring data. She represents the volunteer monitoring community on the National Water Quality Monitoring Council, co-chaired its Collaboration and Outreach subcommittee, co-chaired the May 2002 NWQ Conference as well as this one. She shares leadership of a national Extension project to expand and enhance volunteer monitoring in Extension programs across the country. She is a longtime member of the editorial board of *The Volunteer Monitor* newsletter. She holds a BS in Natural Resources and an MS in Resource Chemistry from the University of Rhode Island.

Danielle Donkersloot is the Volunteer Monitoring Coordinator for the New Jersey Department of Environmental Protection. She started with the NJDEP in the Threaten and Endangered Species Program and has been working for the Division of Watershed Management for the past 6 years. She has been coordinating and facilitating all the volunteer monitoring program within the State under one umbrella organization called the Watershed Watch Network. She has been integrating volunteer monitoring information into the overall State's monitoring matrix, and providing support and guidance to the volunteer community. Danielle represents the volunteer monitoring community at the NJ Water Quality Monitoring Council.

Workshop Description
This workshop will focus on helping new program coordinators, or those thinking of starting a program, get it going. Our goal is to provide you with questions to consider, steps to follow, examples of what's worked, and direct you to resources available to assist you in your monitoring efforts. We will also introduce a tiered approach to volunteer monitoring that allows agencies to identify their data quality needs so that volunteers can target their monitoring efforts for specific uses. The tiers are defined by the purpose of monitoring, the intended data use, and the intended data users.

Uncertainty in Measured Streamflow and Water Quality Data for Small Watersheds

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Daren Harmel, PhD, the corresponding author, is an agricultural engineer with USDA-ARS in Temple, TX. Since joining USDA-ARS in 1999, Daren's research has focused to a large degree on hydrology data collection and water quality sampling methodology. He has published numerous articles on the subject that are available at http://ars.usda.gov/Research/docs.htm?docid=12581 or by contacting him at (254) 770-6521 or dharmel@spa.ars.usda.gov.

Richard Cooper, PhD, is an environmental scientist at the Macaulay Institute in Aberdeen, Scotland, UK.
Raymond Slade, PH, is a former USGS Texas District Surface-Water Specialist.
Richard L. Haney, PhD, is a soil scientist with USDA-ARS in Temple, TX.
Jeff G. Arnold, PhD, is an agricultural engineer with USDA-ARS in Temple, TX.

Abstract

The scientific community has not established an adequate understanding of the uncertainty inherent in measured water quality data, which is introduced by four procedural categories: streamflow measurement, sample collection, sample preservation/storage, and laboratory analysis. Although previous research has produced valuable information on relative differences between procedures within these categories, little information is available on the cumulative uncertainty in resulting water quality data. As a result, uncertainty is typically either ignored or accounted for with an arbitrary margin of safety. Faced with the need for scientifically-defensible estimates of data uncertainty to support water resource management, the objectives of this research were to compile selected published information on uncertainty and to present an error propagation methodology for comparison of procedural categories and determination of the cumulative probable uncertainty in resulting measured streamflow, sediment, and nutrient data for small rural watersheds. Best case, typical, and worst case "data quality" scenarios were examined. Averaged across all constituents, the calculated cumulative probable uncertainty (+/- %) contributed under typical scenarios ranged from 6% to 19% for streamflow measurement, 4% to 48% for sample collection, 2% to 16% for sample preservation/storage, and 5% to 21% for laboratory analysis. Under typical conditions, errors in storm loads ranged from 8% to 104% for dissolved nutrients, from 8% to 110% for total N and P, and from 7% to 53% for TSS. Results also indicated that uncertainty can increase substantially under poor measurement conditions and limited quality control effort. This research provides introductory scientific estimates of uncertainty in measured water quality data. The results and procedures presented should also prove valuable for modelers in quantifying the "quality" of calibration and evaluation data sets, determining model accuracy goals, and evaluating model performance.

Automated Validation and Grading of Aquatic Time Series Using a Probabilistic Parity Space Method

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Abstract
In recent decades, automated water quality and quantity monitoring has grown increasingly common in the study and assessment of aquatic systems. However, sensor and maintenance problems can lead to faulty measurements, and retrospective manual identification of errors in voluminous high-frequency data can be challenging and highly inefficient. The problem of sensor validation has been extensively studied in the fields of chemical plant, aviation, and nuclear power engineering. We adapt the method of parity space validation to the problem of aquatic data validation, by using a gamma distribution of the parity vector magnitudes to assign point-by-point data validation flags. Three applications of the method are presented. First, four water temperature sensors from one watershed are examined and data anomalies are identified. Second, storm water runoff data and a statistical rainfall-runoff model are used to validate a second runoff dataset. Third, three dissolved oxygen signals are examined and a drift is identified. In all cases, data anomalies are easily identified and flagged for further investigation. In the case of the drifting dissolved oxygen sensor, point-by-point data grading before the sensor began to obviously drift gives information regarding the potential quality of the data leading up to the drift. The probabilistic parity space method offers the data manager the ability to validate a high-frequency signal more finely than in bulk sections between site visits. It further allows the data manager to generate point-by-point data validation flags for huge datasets.

Pre-mobilization Error Checks of Multi-parameter Field Instruments: One Way of Promoting Servicewide Consistency in a Water Quality Monitoring Program

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Abstract
The National Park Service is engaged in implementing long-term monitoring of key vital signs under the Natural Resource Challenge. All of the 32 monitoring networks in the NPS Vital Signs monitoring program have recognized the importance of water quality and its relation to the general health of park aquatic resources. The NPS Water Resources Division has established 4 core water column field parameters (at a minimum) to be collected at all aquatic monitoring sites Servicewide and is encouraging the collection of these field parameters (temperature, specific conductance, pH, dissolved oxygen) in situ with multi-parameter instruments whenever feasible. Significant technological advances in software and hardware including new sensor developments (e.g. for measuring DO) have occurred in the last several years by multiple water quality instrument manufacturers. There are now sufficient similarities and capabilities among various manufacturers' multi-parameter field instruments that developing some standardization in approach to post-calibration error checking and confirming measurement linearity in the office/lab prior to field mobilization seems warranted. A draft protocol is proposed in the hopes that through review, discussion and testing/trials by various monitoring agencies, a consensus may be reached on a streamlined method of error checking and documentation so that quality control and consistency may be enhanced among federal and state agencies and other organizations conducting water quality monitoring with these instruments.

RPD between Successive Measurement: A Simple but Neglected Tool for Assessing Monitoring Well Data Quality

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Abstract

When dealing with masses of measurement data such as are routinely generated during groundwater monitoring, it is difficult to identify a defective product. Ordinary batch quality control measures are inadequate at detecting sporadic errors that arise from sample switching, inaccurate dilutions, instrument fluctuations and many other causes. The identification of such errors tends to be informal. However, there is a simple way to supplement this process with a quantitative measure, the relative percent difference between successive measurements. The RPD of successive measurements helps objectively answer the question: How much difference is too much difference? The approach can be implemented as a simple statistical check. For each monitoring well, take historic data and calculate the RPDs between all successive pairs of measurements and combine this into a distribution. Unlike most data distributions encountered in environmental work, the RPD distribution closely approximates a Normal Gaussian distribution. The resultant RPD distributions model the total variability between successive monitoring events, i.e., sampling variability, analytical variability, and short term temporal variations in groundwater quality. Because the RPD distributions closely fit the Normal case, it is easy to define control limits for assessing data quality. One approach is to use the 1 percent and 99 percent quantiles as control limits for separating usual from unusual data. Alternatively, unusual data series can be identified using pattern rules as has historically been done with industrial control charts. The advantages of the RPD approach are simplicity, a focus on individual results instead of batches, and QC limits that reflect the totality of how a project's data are actually collected. QC limits are derived from the project data itself, not artificial QC samples. Using VOC and metals data from a variety of groundwater monitoring projects, the RPD approach to data quality assessment is illustrated.

A National Surveillance Study on Priority Pesticides in Canadian Aquatic Ecosystems

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Biographical Sketches of Authors
Janine Murray is a Senior Environmental Monitoring Specialist with the National Water Quality Monitoring Office of Environment Canada. Janine has worked on environmental monitoring issues since 1992, firstly in northern ecosystems with the Northern Contaminants Program of Indian and Northern Affairs Canada and with the international Arctic Monitoring and Assessment Program in Norway. Since 2000, Janine has worked with Environment Canada on national coordination of water quality monitoring. Janine currently manages a national surveillance project on pesticides in water, working closely with water quality monitoring staff in each of EC's regional offices.

Don Andersen completed a B.Sc. in Environmental Biology at McGill University in Montreal, and M.Sc. and MBA degrees at the University of Ottawa. During his M.Sc. program Don worked in a fish physiology lab, and conducted research on the metabolic costs to fish living in acidified environments. Don joined Environment Canada in the early 1990s, and spent several years developing National water quality guidelines for the Canadian water quality monitoring community. More recently, Don has worked with Environment Canada's Water Quality Monitoring Branch to help coordinate National water quality monitoring programs such as the Pesticides Water Quality Surveillance Project.

Abstract
There are limited data on the occurrence, distribution and fate of current-use pesticides in surface waters, groundwaters and sediments of Canada. To address this gap, Environment Canada began a three-year national pesticides surveillance program focused on vulnerable watersheds. This program started in 2003 with surface water samples being collected from over 100 sites across the agricultural regions of Canada. Most samples were collected during or immediately following rain events. At select sites, sediment, groundwater and tissue samples were also collected.

Pesticide occurrences in waterways vary by geographic use patterns, local climate, relative timing of rainfall events and pesticide applications, intensity of pesticide use, and fate and transport properties of pesticides. Given that each region has unique aquatic environments, agricultural practices, and pest management issues, priority pesticides were identified for surveillance on a region by region basis. Existing knowledge about pesticide product use, agricultural practices, and known environmental effects (e.g., toxicity, persistence, mobility) provided the basis for this priority setting exercise. Taken together, a total of 145 pesticides and degradation products, are included in this surveillance project; however, each region monitored a subset of this list, reflecting the unique agricultural and pest management practices in their region.

Most receiving water samples contained several different pesticide residues. Triazines and phenoxy herbicides were the most frequently detected pesticides. Endosulphan was detected in all regions of the country, reflecting its continued use. Several pesticides were detected at levels that exceeded CCME water quality guidelines for the protection of aquatic life, including: azinphos-methyl, chlorthalonil, endosulphan, atrazine, chlorpyriphos, and 2, 4-D.

Trends in Metals and Hydrophobic Organic Contaminants in Urban and Reference Lake Sediments Across the United States, 1970 to 2001

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Peter Van Metre is a Research Hydrologist with the U.S. Geological Survey at the Texas Water Science Center in Austin, Texas. He is the Project Chief of the Contaminant Trends in Lake Sediment study, which is part of the NAWQA Program National Synthesis. He developed the study in the mid-1990s to identify national trends in particle-associated contaminants.

Barbara Mahler is a Research Hydrologist with the U.S. Geological Survey at the Texas Water Science Center in Austin, Texas. She divides her time between studies of particle-associated contaminants at local and national scales and karst ground-water research. She came to the USGS after a year of post-doctoral study in France, and continues to develop U.S.-French scientific collaborations.

Abstract

Major shifts in environmental policy, urban land use, population distribution, and vehicle use have occurred in the United States over the past three decades. To assess the effects of these environmental changes on the water quality of streams and lakes, the U.S. Geological Survey collected and analyzed sediment cores for historical trends in pollutants from 38 lakes and reservoirs across the United States. Watershed land use for the sampled lakes ranged from undeveloped forest or grassland to dense urban. Core samples were analyzed for major and trace elements, polycyclic aromatic hydrocarbons (PAHs), and chlorinated hydrocarbons (organochlorine pesticides and polychlorinated biphenyls (PCBs)), and contaminant trends from the core profiles were tested for statistical significance from 1970 to the tops of the cores (1996–2001). Decreasing trends outnumber increasing trends for all seven metals analyzed (Cd, Cr, Cu, Pb, Hg, Ni, and Zn). The most consistent trends are for Pb and Cr: for Pb, 83% of the lakes have decreasing trends and 6% have increasing trends; for Cr, 57% of the lakes have decreasing trends and none have increasing trends. Significant trends in total DDT, p,p'-DDE, and total PCBs were all downward. Trends in chlordane were split evenly between upward and downward, and trends in PAHs were mostly upward. Concentrations and mass accumulation rates of all contaminants evaluated correlated strongly with urban land use and direction of trends for some contaminants (Pb, Zn, PAHs) varied between reference and urban settings.

Volatile Organic Compounds in Ground Water and Drinking-Water Supply Wells

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John Zogorski is a supervisory hydrologist with the U.S. Geological Survey. Since 1993 he has coordinated the national assessment of volatile organic compounds (VOCs) in the Nation's water resources. He holds a B.S. degree in Civil Engineering and M.S. and Ph.D. degrees in Environmental Science.

Abstract

Volatile organic compounds (VOCs) have had extensive use in the United States since the 1940s in many industrial, commercial, and agricultural applications, as well as in components of numerous household products. The occurrence of VOCs in ground water is of continuing concern because of the toxicity of these compounds to humans and a tendency for some VOCs to persist in and migrate with ground water to drinking-water supply wells.

As part of the first decade of assessments in the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program, a large number of VOCs were analyzed in samples for many of the Program's ground-water studies. Especially noteworthy was the routine inclusion of VOCs in aquifer studies (that is resource assessments) that were completed in about 50 study areas across the United States and that sampled a variety of well types including domestic wells, public wells, monitoring wells, and other wells. In addition, VOC data from previous, comparable studies with a similar design were included in the assessment. Overall, the goal of aquifer studies was to describe the detection frequencies, concentrations, aerial distributions, and mixtures of VOCs in these aquifers, many of which are an important supply of drinking water. To address the needs of some agencies, VOC occurrence information was assessed separately for domestic wells and public wells.

VOCs were detected in a large fraction of the samples from aquifer studies, and in samples from domestic and public wells at an assessment level of 0.02 microgram per liter (□g/l). For example, about 50 percent of the samples from aquifer studies contained at least one compound. However, many of the detections were low concentrations (that is less than 1 µg/L). Because of their frequent occurrence, VOCs remain a contaminant group of concern for ground water, especially for those aquifers used extensively as a supply of drinking water. This presentation will describe the major VOC occurrence findings from NAWQA's national assessment that may be most relevant to the continued management and monitoring of aquifers and drinking-water supply wells of the United States.

Assessing the Ecological Conditions of the Great Rivers of the Central United States

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Biographical Sketches of the Authors
Brian Hill is Chief of the Watershed Research Branch at the US EPA's Mid-Continent Ecology Division and a principal investigator on the Agency's Environmental Monitoring and Assessment Program for Great Rivers (EMAP-GRE).

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Ted Angradi is a research biologist at the Mid-Continent Ecology Division and a principal investigator on the EMAP-GRE.

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Mark Pearson and Debra Taylor are staff biologists at the Mid-Continent Ecology Division and investigators on EMAP-GRE.

Abstract
To date, assessments of the Great Rivers depend on data that are available, rather than data that are most appropriate. This conundrum is the motivation behind the EPA's probability-based ecological assessment framework for the Upper Mississippi, Missouri, and Ohio Rivers. Beginning in 2004, the EMAP-Great Rivers project collects water quality, habitat and biological assemblage data from > 400 main-channel sites. We use consistent field and laboratory methods and a proven sampling design across these three systems to provide statistically robust and unbiased estimates of summer conditions at regional, state, and whole-river scales. We trained scientists from 6 USGS centers and 12 state agencies, universities & river commissions to sample river chemistry, chlorophyll, particulate matter, metals; and fish, benthic macroinvertebrates, periphyton, phytoplankton, and zooplankton. Riparian land-cover, littoral habitat, woody debris, and aquatic vegetation are also measured. A web-based sample tracking and information management system facilitates the flow of data and samples from the field to the labs, and through analyses. We are coordinating data analyses with state and federal agencies and will emphasize novel and complementary uses of monitoring data, and improved biological indicators and nutrient criteria. An important research objective is to use landscape features and existing data to define regional reference conditions so that current river conditions may be assessed relative to least-disturbed (or best available) conditions. Preliminary analyses of the data reveal strong natural/longitudinal gradients along the three rivers for most water quality parameters that have implications for determining reference conditions. While data from the probability sites include the full range of conditions within each assessment unit, we will supplement targeted sampling to improve our understanding of reference conditions. The EMAP-Great Rivers project demonstrates an integrated approach for the collection appropriate indicator and reference condition data for Great River assessments. This abstract does not reflect US EPA policy.

Water Quality Monitoring of the Cambrian-Ordovician Aquifer System in Iowa and Illinois

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Biographical Sketch of Author

Kimberlee Barnes is a hydrologist and the GIS specialist for the Iowa Water Science Center of the U.S. Geological Survey. She has worked on various projects since 1988 and has been a part of the National Water Quality Assessment Program, Eastern Iowa Basins study since 1994. Her other research interests include the occurrence of emerging contaminants in surface water and ground water.

Abstract

The Cambrian-Ordovician aquifer system in the upper Midwest United States was selected as one of 16 aquifers to be studied as part of the U.S. Geological Survey's National Water Quality Assessment (NAWQA) Program's regional assessment of ground-water quality conditions and trends. In 1990, these 16 aquifers accounted for approximately 75 percent of estimated ground-water withdrawals for drinking-water supply in the United States. In 1985, a little over half of the total fresh ground-water withdrawals from the Cambrian-Ordovician aquifer system were used for public supply. The purpose of the regional assessment is to provide additional information to supplement data collected from 1991-2001 for the NAWQA program on ground-water quality. In addition, this study will focus on the particular water-quality issue in the aquifer of mixtures of urban pesticides and radon. Initial data collection for the study began in Iowa in 2005, with subsequent sampling in Illinois scheduled for 2009.

The Cambrian-Ordovician aquifer system covers approximately 177,000 square miles in the upper Midwest. Cambrian-Ordovician rocks are present throughout Iowa except in the extreme northwestern corner. The rocks outcrop in the northeastern corner and dip southwestward under Silurian and younger age rocks. The Cambrian-Ordovician aquifer system consists of sandstone in the lower part and sandstone and shale interbedded with limestone or dolomite in the upper part creating multiple aquifer units. During the months of June, July, and August 2005, ground water from 30 public-supply wells across Iowa was sampled for nutrients, selected trace elements, pesticides, volatile organic compounds (VOCs), and radon. In addition, tritium and radiocarbon (carbon-14) concentrations will be used to assess ground-water age. Data collected from these 30 sites will be used in conjunction with data collected throughout the Midwest within the extent of the Cambrian-Ordovician aquifer system to gain a better understanding of the conditions and trends in water-quality.

Assessment of Shallow Ground-Water Quality in Agricultural and Urban Areas Within the Arid and Semiarid Western United States

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Biographical Sketches of Authors

Angela Paul is a hydrologist with the U.S. Geological Survey in Carson City, Nevada. In 1992 she received a Bachelor of Science in Environmental Toxicology from UC Davis, in 1996 she received a Masters of Science in Ecotoxicology from Clemson University. Angela began working for the U.S. Geological Survey in 1998 and currently coordinates the surface-water sampling efforts for the Nevada Basin and Range (NVBR) Study Unit as part of the National Water Quality Assessment (NAWQA) Program and participates in other ongoing water-quality investigations.

Ralph Seiler has worked as a hydrologist with U.S. Geological Survey in Nevada since 1988. He obtained his PhD from the University of Nevada, Reno in 1999 and is involved in ground-water quality investigations.

Abstract

Urban growth is rapidly increasing in the western United States. Currently (2005), Nevada and Arizona are projected to have the most rapid population growth in the country from 2000 to 2030. Many desert and agricultural lands are being converted into urban and residential areas. The arid to semiarid western United States relies heavily upon ground-water supplies for municipal and domestic needs, and crop irrigation. Land use can have significant impacts on shallow ground-water quality and potentially contribute to contamination of deeper aquifers.

An assessment of land use and water quality was made using 463 ground-water samples collected from 1993 through 2004 in Arizona, California, Nevada, New Mexico, and Utah. Samples were analyzed for nutrients, 87 volatile organic compounds, and 80 pesticides to determine differences in the occurrence and concentrations of these substances in shallow ground water underlying urban and agricultural areas. Detection frequencies for all nutrient species were similar between the agricultural and urban landscapes. Nitrate, total dissolved phosphorus, and dissolved orthophosphate were the most frequently detected nutrients. Methyl *tert*-butyl ether, trihalogenated methanes (THM), and solvents were detected most frequently in ground-water samples from urban areas; chloroform was the predominant THM and perchloroethylene was the predominant solvent. In general, fumigants and chlorofluorocarbons were more commonly found in samples from agricultural areas than from urban areas. Triazine herbicides were the most frequently detected class of pesticide. The triazines, atrazine and prometon, were most commonly associated with samples from urban areas, whereas simazine was found to be more commonly associated with samples from agricultural areas. Generally, carbamates, ureas, and metolachlor were detected more frequently in samples from agricultural areas than in samples from urban areas. Although detection frequencies were less than 10 percent, bentazon, dinoseb, and norflurazon were found more frequently in samples from agricultural areas than in samples from urban areas.

Development of a Source Water Quality Monitoring Protocol for First Nations in Canada

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Biographical Sketches of Authors
Born in Vancouver BC, Canada, Rob Phillips now lives in the Gatineau Hills in Québec north of Ottawa. Background academic and post-graduate training is in isotope hydrogeology and environmental geochemistry, and work experience includes risk assessment, ecotoxicity, chemical evaluation, research planning, natural hazards, water quality, facilitation and environmental outreach. Leisure pursuits include music, skiing, cycling, scuba, and hobby farming.

Abstract
The First Nations Water Management Strategy (FNWMS), initiated in May 2003, is a comprehensive federal programme dedicated to improving water quality on First Nations reserves in Canada. Environment Canada, in collaboration with Health Canada and lead federal department Indian and Northern Affairs Canada, is tasked with providing the necessary tools and training. The development of a plain-language Source Water Monitoring Protocol for First Nations is the focus of the National Water Research Institute work under the FNWMS. The final product will include detailed how-to instructions for sustainable reserve-based monitoring of source water quality. It will also consider a broad range of source water types and water quality threats specific to each source type. As drinking water sources vary amongst reserves and can be derived from lake, river, stream, spring, deep well or surface well environments, specific monitoring challenges vary as well. For example, river waters require near-continual turbidity monitoring as changes in this parameter are often associated with influx of sediments and pathogens, one of the key causes of gastrointestinal illnesses world-wide. In recent years, the number of boil water advisories and incidences of gastrointestinal illness on reserves has been on the increase. Effective source water monitoring with more routine observations is necessary to detect such periodic threats. Upon completion, the Source Water Monitoring Protocol will be validated through field testing at regionally-selected pilot project sites. These sites will be selected to represent a range of source water types and associated vulnerabilities or threats, as well as to address specific regional challenges facing First Nations peoples in their quest to regain sources of water of the highest quality.

Application of Filtration-based Luminescence Methods for Rapid monitoring of Microbial Contamination in Water

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Biographical Sketches of Authors
Dr. Jiyoung Lee is an environmental and public health microbiologist. Dr. Lee's research interest include rapid detection of microbial pathogens such as E. coli and enterococci in beach water, water quality of water supply system, rapid screening of bacterial spores in powder samples, efficiency of disinfectants. She is a member of American Society of Microbiology, American Water Works Association, and International Water Association.

Carmen Dumas is employed as an analytical chemist at the City of Ann Arbor Water Treatment Plant. Ms. Dumas specializes in analytical testing of raw and finished water using Microbiological and Instrumentation methodology. Ms Dumas has been involved in the Michigan Section American Water Works Association where she has chaired the Laboratory Practice Committee for the past 4 years.

Abstract
Rapid monitoring of the microbial water quality in drinking water in drinking water is important to the operators of treatment plants and distribution systems as well as customers. It will allow timely response when the water quality changes occur. The present heterotrophic plate count (HPC) analysis takes seven days and is not useful for the prevention of possible health risks or assessment of water quality deterioration. The purpose of this study was to evaluate a filtration-based luminescence method using Luminos as a tool for rapid screening of water contamination. Experimental procedure was modified significantly from the manufacturer's instructions in order to make it feasible and easy to use for water utility personnel. The results from the luminescence method were compared with the results from the current HPC methodology. Two different water types that have ground water or surface water as source water were tested to investigate the effects of water chemistry, hardness and pH, on the luminescence method. The results show that the filtration-based luminescence method can be used as a fast routine monitoring tool at a water plants to ensure the efficiency of disinfection process, and the bacterial levels in finished water and in distribution systems.

Critical Evaluation of Waterbody Assessment Processes

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Biographical Sketch of Author

Lindsay M. Griffith, P.E., is an environmental engineer employed with Brown and Caldwell in Golden, Colorado. She has over 5 years experience in their water resources group, working on projects ranging from monitoring network design, water quality data analysis, water supply planning, NPDES permitting, TMDL development and water rights litigation support. Lindsay's Master's thesis at Colorado State University was supported by the NWQMC, and became the basis for their Technical Report 01-01: *Data Analysis Considerations in Producing 'Comparable' Information for Water Quality Management Purposes*.

Abstract

The states' ability to confidently determine compliance of ambient conditions with water quality standards is limited by the availability of data and selection of appropriate assessment methodologies, resulting in greater likelihood of misinterpretation of the status of our nation's waters. In order to facilitate more effective integration of monitoring data and technically sound assessment methodologies by the states into the waterbody listing process, a critical evaluation of current methodologies employed by the states is warranted. In August of 2005, Brown and Caldwell was selected by the Water Environment Research Foundation to perform this critical evaluation, and develop peer-reviewed guidance of appropriate evaluative methods for various data sources to improve consistency and comparability in the waterbody assessment process.

The objective of this research is to critically evaluate the methodologies states employ when assessing waterbodies for the Integrated Reporting process and provide recommendations to facilitate more effective integration of monitoring data and technically sound assessment methodologies into the waterbody assessment process. Specific objectives include the following:

1. Gather information on current methodologies that regulatory agencies and others use to assess waterbody conditions.

2. Identify current assessment approaches which optimize available monitoring data and best characterize waterbody conditions and associated uncertainty.

3. Provide recommendations of appropriate assessment methodologies to more reliably determine attainment/non-attainment of beneficial uses. These recommendations will serve as guidance to the states on how to:

    a. Integrate data monitoring design with analysis methods and quality assurance so that better information can be produced.
    b. Evaluate data using methodologies that are robust and can adequately characterize water quality with greater confidence.
    c. Determine with greater reliability waterbodies which should be designated as impaired and included on the states' 303(d) list.

The research project will be nearing completion in May of 2006, with research results and preliminary recommendations available for presentation at the NWQMC's 2006 National Monitoring Conference.

Whatever Happened to Pollution Surveys? The Case for Intensive River Segment Survey Designs

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Biosketch of Author
Chris Yoder is involved in the national development of biological assessments and biocriteria. He was most recently Manager of the Ecological Assessment Section at Ohio EPA where he was a biologist since 1976. He has served on national, regional, and state working groups and committees dealing with environmental indicators, bioassessment, biocriteria, and WQS development and implementation. Recently he served on the National Research Council committee to evaluate the role of science in the TMDL process.

Abstract
Water pollution surveys were routinely conducted by state and federal agencies in the 1950s and 1960s to ascertain the extent and character of water pollution problems. Later on these surveys included a wider array of indicators including biological assemblages. The design of these surveys followed the concept of pollution zones originally described by early researchers such as Bartsch (1948) and Doudoroff and Warren (1951). This concept describes what happens when pollutants are discharged into a lotic system □ biological impacts progress along a longitudinal continuum from immediate impact through various stages of assimilation and ecological recovery. Ohio EPA routinely practiced this design between 1980 and 2002 by conducting systematic assessments of non-wadeable river segments (Yoder et al. 2005) that were further linked to management needs and outcomes. Other states also practiced this design to varying degrees in the 1970s and 1980s. Recently, the introduction of regional probabilistic designs and an emphasis on watersheds spurred by TMDL related issues have seemingly supplanted this design. The reasons for this include the promise of extended assessments with fewer resources and a need to address TMDL issues at increasingly localized scales. While each is a legitimate monitoring need and design, the historical archive of river pollution surveys has in some places been seriously interrupted. This raises several concerns including a potential lack of awareness of adverse changes in river conditions. There is a strong perception among the mainline water quality management programs (i.e., NPDES permitting, WQS, modeling) that the battle against point source pollution has been won. While documented successes in this area are available (e.g., Yoder et al. 2005), emerging and future impacts threaten to undo these hard won improvements. Some of these include the urbanization of formerly rural landscapes and generic WQS and permitting policies that rely much less on source and site-specific information. As a result, any backsliding in river quality will likely go undetected until the impacts are sufficiently severe so as to trigger anecdotal feedback. Re-inventing this design would do much to preclude a reoccurrence of these types of water quality problems and would more effectively guide management programs.

Combining Dynamic Assessments with Traditional Monitoring Approaches to Improve Understanding of NPS Pollution Impacts

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Biographical Sketches of Authors

William T. Stringfellow, Ph. D., is Director of Environmental Engineering Research and Adjunct Associate Professor at the University of the Pacific and has a joint appointment with Lawrence Berkeley National Laboratory. His research expertise includes biological treatment of industrial wastes and assessment of surface water quality. Dr. Stringfellow is the Chief Principal Investigator on an eleven agency effort to quantify the fundamentals of algal growth in the San Joaquin River and to provide scientific tools for implementation of a TMDL program for dissolved oxygen.

Sharon Borglin, Ph. D., is a Research Scientist and Adjunct Associate Professor at the University of the Pacific. Her research expertise includes bioremediation and water quality monitoring. Her current research focus is evaluating the use of lipid biomarkers to measure zooplankton impacts on algal biomass accumulations in eutrophic waters.

Gary M. Litton, Ph. D., is a Professor in the Department of Civil Engineering at the University of the Pacific. His research and teaching expertise includes wastewater treatment and environmental engineering. Dr. Litton has been the principal investigator of numerous water quality studies in the San Joaquin River and Delta investigating sediment transport, oxygen demands, and the effects of algal photosynthesis on water quality parameters. His current research focus is real-time measurement of algal dynamic processes in tidal zones.

Abstract

Traditional water quality monitoring programs directed at non-point source (NPS) pollution typically involve the collection of grab sample data at a fixed location and a routine time interval with the objective of identifying areas of degraded water quality. The frequency and locations of measurement are often determined by regulatory concerns, rather than based on a scientific analysis, and it is not obvious that the collected samples are representative of the true population. Additionally, routine monitoring rarely provides fundamental information concerning the root causes of NPS pollution and therefore are of limited use in designing management and remediation plans.

We are assessing the usefulness of dynamic methods, including longitudinal surveys, intensive monitoring schedules, and continuous monitoring devices for providing information in addition to, or in place of, traditional intermittent sampling. We are evaluating the efficacy of grab sampling for measuring the true population and determining if dynamic measurements are more effective at providing information useful for the development of remediation and management plans.

In the case of the San Joaquin River (California), traditional monitoring has identified areas of impaired water quality, but has not provided critical information needed to establish scientific approaches to reducing non-point source pollution. For example, fixed-location monitoring of up-stream and down-stream locations failed to present a clear picture of algal growth dynamics in nutrient enriched tributaries. Dynamic investigations, using longitudinal and Lagrangian approaches, demonstrated that assumptions by regulatory agencies concerning algal growth patterns in the region were simplistic and reveled insights that suggest a strategy for engineered control for algal blooms in the region.

Introducing NHDPlus! – A Tool for Watershed Planning

Richard Moore

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Biographical Sketch of the Author
Richard B. Moore attended the University of New Hampshire and obtained a Bachelor of Science degree in Hydrology and a Master of Science degree in Geology. In 1979, Richard began working for the U.S. Geological Survey where has since conducted numerous projects, including, most recently the New England Spatial Regression on Watershed Attributes (NE SPARROW) and catchment delineations for NHDPlus.

Abstract
NHDPlus is a suite of geospatial data products that incorporates many of the best features of the National Hydrography Dataset (NHD) and the National Elevation Dataset (NED). NHDPlus is the outcome of a multi-agency effort aimed at developing NHD stream flow volume and velocity estimates to support pollution fate-and-transport models, such as the EPA/OW Riverspill and USGS SPARROW models. NHDPlus includes a stream network (based on the 1:100,000-scale NHD) with improved networking, naming, and value-added attributes, such as stream order. NHDPlus also includes elevation-derived catchments (drainage areas) for each NHD reach, a flow direction grid, a flow accumulation grid, and National Land Cover Dataset attributes assigned to the catchments. This presentation will describe NHDPlus content and how it can be used to support watershed planning.

The Northeast AVGWLF: A Watershed Scale Model to predict Sediment and Nutrient Transport

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Abstract
The New England Interstate Water Pollution Control Commission (NEIWPCC) is collaborating with Pennsylvania State University to develop the Generalized Watershed Loading Function with an ArcView (AV) geographic information systems (GIS) interface (AVGWLF) for the New England states and New York State. The Northeast AVGWLF is a watershed scale model that uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical watershed-related characteristics to model sediment and nutrient transport within a watershed. AVGWLF is a powerful tool that will provide its user with a means for quantifying pollutant loads within a watershed and to evaluate various strategies to mitigate water quality impacts. The specialization of this tool for the New England and New York region will provide the states and their partners with an enhanced technical tool kit for use in the modeling of nonpoint source pollutant load reduction scenarios and for the development of Total Maximum Daily Loads (TMDLs). The goal of the development of the Northeast AVGWLF is to assist the New England states and New York State to more effectively implement their water quality programs, while encouraging the implementation of these programs on a watershed, interstate, and regional scale. The Northeast AVGWLF will not only provide this region with a common tool to develop pollutant load reduction estimates and TMDLs, it will also provide regional users with a common database, ultimately enhancing and promoting interstate collaboration on the management and improvement of water quality throughout New England and New York State.

Modeling to Support the Development of Nutrient TMDLs in Baltimore Harbor

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Abstract
The Baltimore Harbor directly drains to the Chesapeake Bay, and is part of the Patapsco/Back River Tributary Strategy Basin. Baltimore Harbor has been polluted by discharge of sewage and industrial wastes, and has been used for navigation, industrial water supply, recreation and waste disposal. Due to excessive nutrient loadings that result in low DO, Total Maximum Daily Loads (TMDLs) for the nutrients nitrogen and phosphorus in the Baltimore Harbor are required by the U.S. Environmental Protection Agency□s (EPA) under Section 303(d)(1)(C) of the federal Clean Water Act (CWA). For better water quality management, numerical models have been developed and applied to determine the TMDLs for the nutrients nitrogen and phosphorus using a time-variable, three-dimensional water quality eutrophication model package, which consists of a three-dimensional hydrodynamic model (CH3D), a comprehensive water quality model (Ce-Qual-ICM), and a sediment diagenesis model. The hydrodynamic model produces three-dimensional predictions of velocity, diffusion, surface elevation, salinity and temperature on an intra-tidal time scale. The water quality model, incorporating 22 state variables and 140 parameters, is directly linked to the predictive benthic-sediment model. The models used in this project have been successfully calibrated, verified, and reviewed by the US EPA Chesapeake Bay Program Modeling Subcommittee and Stakeholders. Several what-if scenarios were tested. Designated uses, DO and chlorophyll a criteria, are recommended by the US EPA Chesapeake Bay Program. The reduction of nitrogen and phosphorus loads to levels that are expected to result in meeting water quality criteria, associated with eutrophication, and support the designated uses of the Harbor, have been explored. Additional work is on going including comparison of TMDL loads with Maryland Tributary Cap Loads to ensure better water quality protection by both regulatory agencies and voluntary efforts from Stakeholders.

Nutrient TMDLs for the Cahaba River Watershed

Chris Johnson

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Abstract
Over the last several years ADEM and EPA Region 4 have invested considerable time, effort, and resources into the development of a nutrient target and nutrient TMDL for a portion of the Cahaba River Watershed. On October 10, 2004 the hard work resulted in a jointly proposed (ADEM and EPA Region 4) Cahaba River Nutrient TMDL. This TMDL is very unique in that it is one of only a few in the Nation that have been developed for a large river system using an adaptive management approach. The Draft Cahaba River Nutrient TMDL addresses nutrient impacts to 4 mainstem segments of the Cahaba River that are identified on Alabama□s §303(d) List of Impaired Waters encompassing 105 river miles, draining over 1,000 square miles of watershed to include the Birmingham Metropolitan Area. Development of this TMDL involved extensive data collection and analysis, complex hydraulic and water quality modeling and rigorous deliberation over the nutrient target. The TMDL is based on an instream nutrient target for total phosphorus (TP) of 35 µg/L. The target will be applied as a growing season mean measured at three critical points along the Cahaba River. Implementation of the TMDL is proposed in three phases based on 5-year increments from the time the TMDL is finalized. Throughout the TMDL process ADEM plans to use an adaptive management approach as a means to move forward with mitigation efforts to address known water quality impacts while continuing to address uncertainties that are encountered along the way, such as those associated with the nutrient target. Flexibility is built into the plan so that load reduction targets and control actions can be reviewed and updated when future monitoring indicates needed changes to the TMDL.

Supporting Nutrient Criteria Development Nationwide: Web application & Technical REQuest System (T-REQS)

Kristen L. Pavlik, Michael J. Paul

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Biographical Sketch of Presenter

Jeroen Gerritsen has more than 28 years of experience in aquatic environmental sciences, including basic and applied research, teaching, and assessment. His technical abilities include biological assessment, statistical design and analysis, systems ecology and modeling, ecological risk assessment, limnology, wetlands ecology, estuarine ecology, and stream ecology. He served as a member of a scientific workgroup to prepare guidance for developing nutrient criteria for lakes and reservoirs for US EPA's Office of Water. He was the principal author of two chapters: *Characterizing Reference Conditions* and *Data Analysis*. Jeroen currently serves as a technical expert on T-REQS for lakes, streams, and statistics.

Abstract

EPA's Health & Ecological Criteria Division (HECD) has provided technical guidance to the States and Tribes for developing quantitative nutrient criteria for their water resources for several years. As more States and Tribes begin developing and refining numeric nutrient criteria, there is a need for providing continued technical support in answering questions, addressing issues, and creating a central mechanism for documenting and distributing consistent and standardized information. The Nutrient Scientific Technical Exchange Partnership & Support (N-STEPS) has been created to fill that role.

N-STEPS will provide support to EPA Regional nutrient coordinators, States, and authorized Tribes on any range of technical issues related to the effects of nutrients on aquatic biological communities, the assessment and management of nitrogen and phosphorus, and development of nutrient criteria. A major tool of N-STEPS is the Technical REQuest System (T-REQS). T-REQS will provide timely and helpful expert advice on topics such as cause-response relationships, sampling design, data collection, data evaluation, statistical analysis, classification of ecosystems, and implementation of numerical nutrient criteria. N-STEPS will coordinate with existing EPA programs, other federal agencies and academicians to provide the necessary expertise to assist States and Tribes in the different stages of their programs. It is not intended to replace the assistance that is currently being provided by these organizations, but rather to provide easy access to additional resources for state specific nutrient related assistance. In addition to the question-and-answer tracking format of T-REQS, the website will include a variety of valuable technical resources, including links to useful literature (guidance documents, other peer reviewed literature, white papers, and fact sheets); a discussion board where states can talk about similar issues or problems; and a news page, where state or tribal advances in or stories related to nutrient criteria are posted.

Designing Your Monitoring Plan: Linking Citizen Monitoring & Data Use

Angie Becker Kudelka[1], Geoff Dates[2], Sandra Holm[1], Mary Karius[1]

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Biographical Sketch of Authors

Angie Becker Kudelka is the Director of Citizen Monitoring and Water Education for Minnesota Waters*, a statewide nonprofit organization devoted to helping citizens protect and restore Minnesota's lakes and rivers. She has over seven years of program management and leadership experience and facilitates for citizen-based river groups and local government units seeking to launch or enhance citizen involvement in watershed management. Angie spearheaded the creation and development of this "Designing Your Monitoring Plan" Program for citizen volunteers to collect useful water quality data for assessing the condition of Minnesota's lakes and streams. Together with partners Sandra Holm, Geoff Dates, and Mary Karius; the program has been piloted with 19 groups across Minnesota.

Abstract

Citizen monitoring is an important contribution to water resources management, but many programs find themselves "collecting" lots of data without a solid plan of what to ***do*** with the data they collect, often struggling with ***data use***. Based on extensive research of the effectiveness of citizen monitoring, Minnesota Waters, with support from River Network (nonprofits each with a history of citizen monitoring), developed an innovative program that teaches people how to PLAN their monitoring program. The program includes 12-steps of plan worksheets, 3 training days (spaced over 6 weeks), and follow-up support to create and implement personalized plans. The 12-steps include:

Step 1: What is Known About Your Watershed?
Step 2: Issues & Monitoring Questions
Step 3: Data Uses and Data Users
Step 4: Choosing Assessments
Step 5: What, How, & When will You Monitor?
Step 6: Where will You Monitor?
Step 7: Data Requirements & QA/QC
Step 8: Data Storage & Management
Step 9: Data Analysis &Interpretation
Step 10: Report, Present, Plan for Change
Step 11: Tasks, Roles, Timeline
Step 12: Feedback & Evaluation

When finished, groups have a monitoring plan that identifies their specifics goals, how they plan for data to be used (and by whom), and the technical pieces they will implement. Thirteen citizen-based lake and river groups throughout Minnesota have completed detailed monitoring plans, and the model has been requested in other states.

Through the two pilot programs and an extensive evaluation process, we have learned how to better help groups network and meet their citizen monitoring needs. This presentation will explain the program's success and challenges, the research on effectiveness of citizen monitoring programs, and offer participants templates of the program materials.

* O*n January 1, 2006, the River Council of Minnesota (RCM) and Minnesota Lakes Association (MLA) merged to form* *Minnesota Waters. Materials produced prior to January 1 may contain RCM and MLA identities and addresses.*

The Nuts and Bolts of a Volunteer Monitoring Day

Diane Cross

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Biographical Sketch of Author:
Diane Cross has been a volunteer river monitor in SYRCL's river monitoring program since the program's inception in 2000. For the past year she has been SYRCL's River Monitor Trainer, exporting SYRCL's program and training volunteer river monitors in other Sierra Nevada watersheds. She has a background in environmental science and natural history.

Abstract
Your volunteers are trained, your monitoring program and QAPP are in place and your equipment is purchased. Now you're faced with the logistics of how to successfully get volunteers and equipment out of the door, down to the river and back again having collected good data. Preparation for a successful Monitoring Day starts weeks before the day itself and involves many steps and the involvement of staff and volunteers. "The Nuts and Bolts of a Volunteer Monitoring Day" will illustrate how imperative it is to be highly organized and professional on Monitoring Day, so that your volunteers can collect their samples and data with as few problems as possible. The model used in this poster session builds on the success of the South Yuba River Citizens League's (SYRCL) successful volunteer river monitoring program, which is widely viewed as a model program in California. Diane Cross, SYRCL's River Monitor trainer will exhibit a tried and true template for how to run a problem-free monitoring event including an organizational timeline. The poster session will also be the launch of a series of Citizen Monitoring Handbooks written by SYRCL and the Natural Heritage Institute which is a "how-to" guide for new and existing monitoring groups. With a focus on using citizen monitoring programs to advance adaptive management goals, the handbooks cover everything from monitoring day timelines to data analysis and statistics. Free copies will be available at the poster session.

The Study Design – The Game Plan Behind Successful Monitoring Strategies and Effective Data Use

Cheryl Snyder

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Biographical Sketch of Author
Cheryl Snyder works as a biologist in the Pennsylvania Department of Environmental Protection's (DEP) Bureau of Watershed Management and is DEP's Citizens' Volunteer Monitoring Coordinator. She coordinates various activities for this statewide program and provides assistance to volunteer monitors in water quality sampling, biological monitoring, habitat assessment, streamside physical monitoring and watershed assessment project monitoring as well as helping volunteers develop study designs for their monitoring programs. Cheryl has worked in a number of water programs for DEP over the last 20 years.

Abstract
Successful sports teams rely on planning and strategizing from coaches and implementation of the game plan by players in order to be effective on game day. The same applies to volunteer monitoring programs. Up front planning and consultation with prospective data users results in credible data and willingness by data users to use the data. The Citizens' Volunteer Monitoring Program (CVMP) advocates the use of the ten-step study design process, the who's, what's, when's, where's, and why's of monitoring, to enable volunteers to meet their "game day" goals and assists volunteers with the study design development. The study design process and the role the CVMP plays will be reviewed. Also, highlights from some successful volunteer monitoring programs whose "game day" goals, for data use, were met through the use of the study design will be discussed.

Monitoring – Just Do IT
Baywatchers: 14 years, QA data, improved understanding, being creative. The Coalition for Buzzards Bay Citizen's Water Quality Monitoring Program

Tony Williams

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Biographical Sketch of Author

Tony Williams is the Director of Monitoring Programs for The Coalition for Buzzards Bay. He coordinates the Citizen's Water Quality Monitoring Program, or Baywatchers in Buzzards Bay Massachusetts. Since1996, he has organized and trained 130+ volunteers each summer as the program is moving into its 15th year of monitoring 30 Harbors and Coves of Buzzards Bay, one of the largest coastal monitoring programs in Massachusetts. He has expanded the Baywatchers monitoring design, quality assurance plan, and sampling methods, and continues to coordinate all environmental monitoring activities for the Coalition. Before joining the Coalition he was employed with the Northern Virginia Park Authority, Mevers and Associates- Environmental Consultants, Pennsylvania Department of Agriculture/Penn State University, and with the Florida Department of Natural Resources Marine Research Institution.

Abstract

Excessive nutrient inputs from land use, sprawl impacts to the surrounding watershed are resulting in changes in habitat health and water quality along the coastline. At greatest risk are the Bay's more than 30 harbors, coves and rivers which receive the bulk of the nutrient load from the watershed. The program task is collecting data on nutrient overloading. Nutrient pollution (eutrophication) is mostly rooted in the watershed's ever-growing population with development and land use changes. Management is often challenging and difficult because of its widespread distribution from a wide array of sources- runoff, septic, sewage, agriculture. Involving more than 500 citizen volunteers since 1992 allows The Coalition for Buzzards Bay to monitor all of Buzzards Bay's major embayments – an area covering more than ¼ of the Massachusetts coast. The program has the dual benefit of collecting comprehensive water quality data while educating and empowering people. This program's success relies in getting citizens involved with monitoring, management and restoration of the Bay's resources at the local level. The program is recognized for providing water quality data to both the Local and State Environmental Managers as a cost effective alternative where other resources are absent for initiating 303(d) listing and TMDL reporting. The monitoring objective is to collect data to better understand the Bay ecosystem and its response to human– related impacts, in order to guide restoration and protection. This citizen's monitoring program has documented and evaluated nitrogen-related water quality going on 15 years. The data is then represented in a Bay Health Index, showing long-term ecological trends and as method to improve the public and town elected officials understanding of current local water quality.

Just DO IT -Applying consistent methods while being creative and thinking outside the box has helped the program with new collaborations and new long-term data for watershed and ecosystem health.

Water Quality Impairment from Roadway Run-off: Characterizing Fine Particles

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Biographical Sketches of Authors
Peter Green is a Research Engineer studying a variety of water quality and air quality issues. He has been living in Davis since 2000 after working for 11 years at Caltech.

Hyun-Min Hwang is a Post-doctoral Scholar with interests in stormwater characterization and mitigation, sediment quality, and bioavailability of persistent pollutants such as PAHs.

Masoud Kayhanian is a Research Engineer. Most of his current research activities are related to characterization and treatment of stormwater runoff from transportation facilities with an emphasis on fine particles and the contaminants associated with them.

Tom Young is a Professor whose research centers on physical-chemical processes important in treating contaminated water, groundwater, and soil.

Small particles critically affect water quality. Besides reducing water clarity, sparingly soluble pollutants such as polycyclic aromatic hydrocarbons (PAHs) and some heavy metals are predominantly transported on particles. We have conducted a series of studies on non-point-source (NPS) roadway-derived fine particles, defined here as <63um – traditionally the upper limit of 'silt' and a size range which is readily suspended in moving water and which settles slowly. At the finest, we have examined the elemental composition of particles in the size range of 0.1 to 0.3um, commonly considered 'colloidal' – that is, non-settling.

We have examined both re-suspended road-surface 'dust' which has been collected as a dry material and initially dry-sieved to remove sand-size particles (>63um), as well as actual highway stormwater. Size separations were conducted by two methods: traditional Stokes-law settling (for sizes >2um), and by particle sizing and separating in a flow cytometer (for sizes <1.5um). Both techniques reduce the potential artifacts of filtration: analyte sorption/desorption to/from flowing solution and fine particle straining onto larger particles.

For PAHs (especially heavier PAHs) dramatic water quality improvements are only achieved where all but the finest (~1um) particles are removed. For heavy metals, continuous improvement in water quality is seen as ever smaller particles are removed – all the way into the colloidal (<0.5um) range. The latter result is true for road-surface dust collected from roads with modest traffic counts and from a wide variety of surrounding land uses: whether primarily industrial, residential, agricultural or commercial.

The lessons learned are several: impervious surfaces such as roads harbor significant quantities of fine particles -- carrying toxic pollutants – regardless of surrounding land-use, and even for roads without heavy traffic. For water quality improvements, one can measure the amount which will be achieved by management practices designed to remove particles down to a certain size.

A Comparison of Ocular Turbidity Instruments for Shallow Waters

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Abstract
Stream volunteer monitoring programs are increasingly using instruments such the Australian turbidity tube, which is held vertically, and the New Zealand clarity tube, which is horizontally held, for situations where transparency exceeds water depth. With the turbidity tube, water is drained out until a contrasting target on the bottom of the tube can be seen. The clarity tube is held horizontally and a black target is slid towards the eye until it can be seen. We compared both tubes during the summers of 2004 and 2005 in tributaries and main stems of Delaware and Chesapeake Bays. The readings of the two tubes was closely correlated (r2=0.85), but gave significantly different readings for the same water samples. It is claimed that the clarity tube is a superior instrument because it measures horizontal beam attenuation, while the vertical tube, like the Secchi disk, measures beam attenuation and vertical extinction simultaneously. However, we found that there was no significant difference in the readings when the clarity tube is held vertically or horizontally. Moreover, if the slider is used in the vertical turbidity tube the results are not significantly different from those of the horizontal tube. We hypothesize that both tubes, independent of orientation, measure beam attenuation since light enters throughout the length of the tube. There appears to be no theoretical advantage to the horizontally-held tube. The differences in readings between the tubes appear to be in the nature of the targets: the slider target is backlit by the water, while the turbidity tube's target can be seen only when the white portion of the target can be discriminated from the black. It may be that accurate calibration equations can be made between the two instruments.

Transparency Tube as a Surrogate for Turbidity, Suspended Solids and Total Phosphorus in Rivers and Reservoirs

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Biographical Sketches of Authors

Nicole Reid holds a B.S. from Florida A&M University in biology and an M.S. degree in zoology from Michigan State University. Her area of study is water quality with an emphasis on nutrient cycling in reservoirs.

Jane Herbert is a District Water Quality Educator serving thirteen counties in southwest Michigan. She is a member of the natural resources team located at MSU's Kellogg Biological Station Extension Land & Water Program. Jane holds a B.S. in Natural Resources from the University of Michigan and an M.S. in Agricultural and Extension Education from Michigan State University. Jane's extension programming is focused on nonpoint source pollution prevention, water quality monitoring and lake-friendly management of sensitive shoreline areas. Jane also serves as the field co-chair for MSU Extension's Water Quality Area of Expertise Team.

Dean Baas is a PhD candidate in the Geological Sciences and Agricultural Engineering Departments at Michigan State University. His research is focused on the biogeochemistry of phosphorus sourcing, fate and transport in the Kalamazoo River basin in southwest Michigan. His work is coordinated at the MSU Kellogg Biological Station Extension Land & Water Program in support of research, education and extension efforts for the Lake Allegan/Kalamazoo River Phosphorus TMDL. Dean holds a B.S. in Agricultural Engineering from Michigan State University. Prior to returning to MSU for graduate study, he had a 20-year career with the Kellogg Company.

Abstract

A pilot study was conducted on the Kalamazoo River (Michigan, USA) to evaluate the effectiveness of using transparency tubes to predict total suspended solids (TSS, measured by weight of material collected on filters) and turbidity (measured with a nephelometer). Thirteen sites including the mainstem, reservoir outflows, and tributaries were sampled for 10 weeks (August-September), spanning a wide range of discharge and algal abundance. Across all sites and dates, the transparency tube was a better predictor of turbidity (R^2=0.78) than of TSS (R^2=0.61). Prediction of TSS improved at low discharge. Within each sampling site, the transparency tube was a better predictor of turbidity, although at some sites the transparency tube also predicted TSS well. A possible reason for the variation in the predictability of turbidity, and TSS from transparency tube measurements is variation in soil types and variable presence of algae. The transparency tube also predicted total phosphorus (TP) concentrations within the watershed (R^2 0.69-0.94). Predictions were weakest below impoundments on the mainstem and strongest in subbasin tributaries. These findings will be applied through a volunteer stream monitoring network using transparency tubes to predict total phosphorus within the context of the Lake Allegan/Kalamazoo River Total Maximum Daily Load (TMDL) for phosphorus.

Gaining Clarity On Secchi Disk Measurements (Part 2): Are All Things Really Black And White?

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Biographical Sketches of Authors

Jeffrey A. Schloss holds a joint appointment at the University of New Hampshire as an Extension Professor in the Department. of Zoology, a Research Scientist in the Center for Freshwater Biology and as a Water Resources Specialist with Cooperative Extension. Since 1986, he has been the coordinator of the New Hampshire Lakes Lay Monitoring Program and he currently lectures in Water Resources, Limnology, Watershed Ecology, Community Mapping with GIS, and Lake and Watershed Management classes. He is a past President of the North American Lakes Management Society and the NWQMC member representing watershed related organizations.

Robert Craycraft is the Educational Program Coordinator of the New Hampshire Lakes Lay Monitoring Program a volunteer lake and tributary monitoring program initiated in 1979 that has trained over 500 volunteers. He serves as the Field and Laboratory Manger for the UNH Center for Freshwater Biology Analytical Services Laboratory. He provides guidance and support for UNH faculty and students. He also works directly with individuals, associations, communities and cooperating agencies throughout NH that are concerned with monitoring and protecting their surface water resources.

Abstract

To date there is no standard method agreed upon for deriving Secchi Disk depth, a commonly used measurement of water transparency. Our earlier investigations (Schloss and Craycraft 2000) of Secchi Disk measurements conducted by volunteer monitors and professionals on over 30 NH lakes summarized a five year effort comparing viewscope use, sun location (*ie*: shady side vs. sunny side), and water surface conditions in the context of precision (replicate error) and measurement sensitivity. More recent and expanded studies using professionals have confirmed these findings, especially the utility of viewscope use. In the late 1980's the introduction of the all black disk was suggested as an improved measurement technique. The latest black disk studies propose that since (theoretically) it better approximates the beam attenuation coefficient it should be a superior tool for the measurement of water clarity. However, the typical use of Secchi Disk data is as a surrogate for water quality parameters not as easy and economical to measure. Also, intensive studies done on a construct a theoretical argument that sun angle can have an important influence on Secchi Disk readings and suggest readings be corrected to the solar zenith. Thus, the question we addressed was one of practicality: Does any one technique or device better correlate to optical and water quality parameters that are of interest to a majority of monitoring programs? Our continued comparative studies and analyses for over a decade have allowed us to examine these methods on a larger dataset representing lakes of a wider range of productivity. The presentation will summarizes our results on how the various method particulars effect the correlation with underwater irradiance (extinction), chlorophyll concentration and dissolved organic color. We also present regression and precision comparisons between the black and white and all black disks and discuss which conditions favor each one.

Statistical Tools for Supporting the Development of a Multi Metric Index (MMI) for Macroinvertebrate Communities

Trainer
John Stoddard

Description of Short Course
This short course on building a Multi-Metric Index (MMI) (or Index of Biotic Integrity) will lead attendees through the process developed by EMAP scientists tasked with producing MMIs from large regional datasets for the EMAP West stream and river assessment and the Wadeable Streams Assessment. It will use numerous examples taken from macroinvertebrate MMIs, but the concepts are equally applicable to fish and periphyton datasets. The goal of the workshop is to have attendees discuss, understand, and critique each of the steps used to (1) produce a short list of responsive, repeatable, and non-redundant metrics, (2) score the metrics, and (3) combine into an MMI with good performance characteristics.

The Biological Condition Gradient and Tiered Aquatic Life Uses

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Abstract
The Biological Condition Gradient (BCG) is a scientific model for interpreting biological response to increasing effects of stressors on aquatic ecosystems. It was developed by a USEPA-sponsored national workgroup of state, tribal and aquatic research scientists from 23 states throughout the U.S. The model describes how ten attributes of aquatic ecosystems change in response to the increasing levels of stressors. The attributes include several aspects of community structure, organism condition, ecosystem function, and spatial and temporal attributes of stream size and connectivity. The BCG presents, in a generalized conceptual model, the accumulated biological knowledge of scientists involved in long term biological monitoring programs. In particular, it is an outgrowth of the scientific and management experience gained by two mature state biomonitoring and biocriteria programs with tiered aquatic life uses (Maine and Ohio). The BCG is divided into six tiers of biological condition along the stressor-response curve, ranging from observable biological conditions found at no or low levels (Tier 1) to those found at high levels of stressors (Tier 6). The BCG model was developed to provide a common framework for interpreting biological information regardless of methodology and geography. When calibrated to a regional or state scale, States and Tribes can use the model to more precisely evaluate the current and potential biological condition of their waters and use that information to better define their aquatic life uses. Additionally, States and Tribes can use this interpretative model to more clearly communicate the condition of their aquatic resources to the public.

Rule-based models for uniform assessments on the Biological Condition Gradient

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Biological Sketch of Presenting Author

Jeroen Gerritsen has more than 28 years of experience in aquatic environmental sciences, including basic and applied research, teaching, and assessment. His technical abilities include biological assessment, statistical design and analysis, systems ecology and modeling, ecological risk assessment, limnology, wetlands ecology, estuarine ecology, and stream ecology. He served as a member of a scientific workgroup to prepare guidance for developing nutrient criteria for lakes and reservoirs for US EPA's Office of Water. He was the principal author of two chapters: Characterizing Reference Conditions and Data Analysis. Current projects include the statistical analysis of biological data for developing TMDLs for impaired streams throughout West Virginia; development of nonlinear decision support models for tiered biological assessment; and data analysis for EPA's National Wadeable Stream Assessment.

Abstract

The Biological Condition Gradient (BCG) is grounded in natural biological assemblages that are present in ecosystems with no or minimal disturbance. The BCG can be related directly to water quality management decisions under a state's water quality criteria and standards. Developing the BCG entails specific descriptions of the natural aquatic assemblages, and requires biological knowledge of the region. Regional experts from New Jersey DEP, USEPA, USGS, and other agencies described the BCG for high gradient streams of New Jersey. Decision rules for consistent determination of BCG tiers were developed from the qualitative descriptions, where rules can be statements of the form: "If richness of sensitive taxa is high, then Tier is 2." Assessment of a site and assignment to a tier is then based on multiple decision rules determined by the group of experts. To quantify and automate this process, we developed a nonlinear fuzzy-set model to replicate the consensus of the state biologists. Since the model was built from the expert rules, it replicated the expert consensus. The model directly incorporates expert judgment and nonlinear relationships in assessment decisions, which are not explicitly included in the more familiar biotic indexes.

ADEM's Monitoring Strategy for Streams and Rivers: Developing and Testing a Human Disturbance Gradient in the ACT

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Biographical Sketch of Author
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Abstract
In 2005, the Alabama Department of Environmental Management (ADEM) revised its monitoring strategy to meet requirements of EPA's Elements of a State Water Monitoring and Assessment Program and ADEM's draft 2005 Listing and Assessment Methodology, as well as to provide data that could be used to assess overall water quality and to develop biological condition gradients and indicators. The strategy incorporated a watershed-based probabilistic monitoring design and a Generalized Disturbance Gradient (GDG) to classify each watershed by its potential level of disturbance. By monitoring watersheds in proportion to the number of watersheds in each HDG category, the Monitoring Strategy will provide an estimate of overall water quality throughout the basin group. Additionally, by sampling the entire gradient of watershed conditions within the basin group, the Monitoring Strategy will increase ADEM's monitoring capacity by providing data to develop indicators and criteria appropriate for wadeable rivers and streams.

A pilot project to evaluate the strategy was implemented in 2005. The project focused on the wadeable rivers and streams located in the Alabama, Coosa, and Tallapoosa (ACT) River Basins. To more closely link assessment results to watershed conditions, 520 monitoring units (MUs), representing true watersheds, were delineated based on the 2004 12-digit hydrologic units of Alabama. Florida's Landscape Development Index (LDI) was applied to the 278 flowing, wadeable MUs of the ACT using the 1993 USEPA MRLC dataset, Departmental permit databases, population estimates, and the number of road crossings to place each MU into one of 8 Generalized Disturbance Gradient (GDG) categories. ADEM also conducted roadside reconnaissance to assess the potential for impairment from landuses not currently incorporated into the GDG.

One-hundred and thirty sites were assessed throughout the ACT. These included 92 randomly-select, accessible sites in 68 (24%) of the 278 wadeable, flowing MUs and 25 established ecoregional reference reaches. MUs were selected for assessment in proportion to the number of MUs in each HDG category. Site assessments included intensive water quality sampling conducted March-October, as well as habitat and macroinvertebrate assessments. At forty sites, intensive periphyton bioassessments were also conducted monthly. These include rapid periphyton surveys, periphyton biomass as chlorophyll a, and diatom community assessments. One-time, intensive periphyton assessments were conducted at all other sites during the macroinvertebrate site visit. Fish IBI assessments, including completion of a HA/PC datasheet and measurement of field parameters and stream flow, were conducted once at the 40 monthly periphyton stations during September.

Key Issues and Underlying Concepts in Use Attainability Analyses for Aquatic Life Designated Uses

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Biographical Sketch

Chris Yoder is involved in the national development of biological assessments and biocriteria. He was most recently Manager of the Ecological Assessment Section at Ohio EPA where he was a biologist since 1976. He has served on national, regional, and state working groups and committees dealing with environmental indicators, bioassessment, biocriteria, and WQS development and implementation. Recently he served on the National Research Council committee to evaluate the role of science in the TMDL process.

Abstract

Use attainability analyses (UAAs) are generally recognized as being needed to address surface waters that cannot meet prescribed designated uses for reasons described by U.S EPA's water quality standards regulations developed in the mid-1970s. The progress that has been made by selected states in the integrated development of tiered aquatic life uses, biological assessment, biological criteria, and integrated chemical, physical, and biological monitoring has provided both the tools and process by which meaningful use designation assignments can be made. The perception and actual practice of UAAs have varied widely across the U.S. Based on our experiences during the past 25 years there can be a fundamental and standardized process by which UAAs can be accomplished to produce consistent and defensible outcomes. Key to the success of such a process is the development and adoption of tiered aquatic life uses (TALUs), numerical biological criteria as an operational measure of TALUs, and a systematic approach to the monitoring and assessment of surface waters. With such an approach, the principal objectives of the monitoring and assessment program are: 1) assure that assessed waters are properly classified in accordance with the tiered aquatic life uses, 2) determination of the current attainment status, and 3) monitoring changes through time. Achieving desirable results requires the practical integration of water quality standards with the monitoring and assessment program, with the latter being implemented with adequate assessment tools, underlying applied research, and appropriate spatial and temporal coverage. Case examples will be used to illustrate the fundamentals of such an approach.

Making the Connections Between Surface Water and Ground Water

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Biographical Sketch of Author
Pixie Hamilton received a B.S. from the College of William and Mary in Environmental Sciences, and a Masters in Civil and Environmental Engineering from the University of Virginia. She has worked as a hydrologist for the USGS since 1984, primarily doing regional ground-water modeling and regional and national water-quality assessments. She currently serves as a Staff Hydrologist and Water Information Coordinator for the National Water-Quality Assessment (NAWQA) Program, which assesses water-quality conditions and trends in some of the Nation's most important streams and aquifers. Her current emphasis largely is on communicating research and technical implications of water-quality information to government, research, and interest-group partners in order to help guide water-resource management and protection strategies and policy.

Abstract
Monitoring and understanding connections between surface water and ground water are essential for protecting watersheds and for sustaining clean water for safe drinking water, aquatic ecosystem health, recreation, irrigation, and other beneficial uses.

Ground water can be a major contributor to rivers and streams. Quantifying ground-water contributions is therefore critical in developing water-quality standards and criteria, issuing permits, establishing total maximum daily loads (TMDLs) of selected pollutants, and meeting Clean Water Act (CWA) goals.

Similarly, surface water can be a major contributor to ground water. Ground water from wells near surface water can host the same contaminants as the surface water recharging the well—an important consideration in designing source-water and well-head protection strategies.

Monitoring and assessments by the U.S. Geological Survey (USGS), such as by the National Water-Quality Assessment (NAWQA) Program, demonstrate the importance and complexity of surface- and ground-water interactions. The studies show that the interactions vary among different geologic and hydrologic landscapes; that they are affected by human activities, such as pumping and regulation; and that they continually change seasonally and over time. For example, exchanges of water and contaminants can be relatively rapid in much of the Mid-Atlantic coastal plain, which is underlain by permeable and well-drained sediment, and near San Antonio, Texas, which is underlain by fractured carbonate rocks. Connections are less pronounced in parts of the Southeast coastal plain, which are underlain by more impermeable and poorly drained sediment. Studies show accelerated exchanges in areas of the Midwest where high-capacity public-supply wells are located near rivers and streams. Studies also demonstrate the important role of water regulation, common throughout much of the arid West, in governing surface- and ground-water exchanges.

Yesterday's surface water is often today's groundwater, and likewise, yesterday's ground water may be today's surface water, therefore reminding us of the importance of monitoring and protecting both waters as a single resource.

Importance of ground-water flow and travel time on nitrogen loading from an agricultural basin in Connecticut

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Biographical Sketch of Author
John Mullaney is a hydrologist in the USGS Connecticut Water Science Center. Over the last 20 years he has worked on a variety of projects that relate land use to ground-water and surface water quality. John is currently working on projects to determine nitrogen loading from ground-water discharge to an estuary in Long Island Sound and is a lead investigator on a USGS National Water Quality Assessment project to determine the impacts of road salt on ground-water and surface-water quality in the glaciated United States.

Abstract
Nitrogen loading and ground-water travel times were studied in the Broad Brook basin (15.5 square miles), an agricultural area in north-central Connecticut, to assist the Connecticut Department of Environmental Protection with Total Maximum Daily Load development and the formulation of appropriate Best Management Practices (BMPs). The median total nitrogen concentration measured in Broad Brook from 1993-2004 was 4.2 mg/L or about 10 times higher than forested basins in Connecticut. The average load of total nitrogen from the basin was 218,000 lbs/year from 1993-2004. The average base-flow nitrate nitrogen load for the same period was 155,000 lbs/year, or about 71 percent of the annual load.

Ground-water samples were collected from 12 monitoring wells in the basin and analyzed for nutrients, dissolved gases, tritium/helium-3 (^3H-^3He) and sulfur hexafluoride (SF_6). Nitrite plus nitrate nitrogen concentrations in ground water ranged from 0.4 – 9.7 mg/L. Dissolved gas analyses determined excess nitrogen gas in only one sample, indicating that denitrification may not be occurring in this aquifer. Apparent ground-water ages ranged from 2 to greater than 50 years, based on measurements of ^3H-^3He and SF_6.

A three-dimensional ground-water-flow model was used in conjunction with a particle tracking program to determine advective travel times to streams from all subareas in the basin. The effects of changes in nitrate loading at the water table were evaluated by applying new loading rates and the advective travel times. Model results indicate that a 50-percent reduction in the concentration of nitrate beneath urban and agricultural areas will result in a load reduction of 57,000 lbs (37 percent) of nitrate, but will require 20 years due to ground-water travel times. The results of this project underscore the importance of understanding the basin hydrogeology to evaluate the long-term effectiveness of BMPs to reduce base-flow constituent loads.

Predicting the Occurrence of Nutrients and Pesticides during Base Flow in Non-tidal Headwater Streams of the Mid-Atlantic Coastal Plain

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Anne Neale is a physical scientist with the U.S. Environmental Protection Agency's Office of Research and Development where she has been employed since 1991. She received a B.S. in Environmental Science from Utah State University in 1984. Anne is interested in studying the fate, transport, and effects of non-point source pollution to the aquatic environment and how these are affected by the biological, physical, and geological setting.

Judy Denver received a B.S. in Geology and M.S. in Marine Studies from the University of Delaware. Since 1980 Judy has worked as a hydrologist with the USGS. Judy's research interests include investigation of the effects of agricultural chemicals and septic-system effluent on ground-water chemistry, transport and transformation of agricultural chemicals in aquifers and near-stream environments, and the effects of geologic setting on water chemistry and chemical transport. Judy is currently project chief of the Potomac River Basin and Delmarva Peninsula National Water Quality Assessment (NAWQA) study unit.

Scott Ator has been a hydrologist with the U.S. Geological Survey since 1994. He holds a B.S. in geology from the University of Maryland, and an M.S in environmental science and policy from Johns Hopkins University. Scott's research interests include the effects of natural and anthropogenic processes on the hydrology and chemistry of freshwater streams and ground water, ground-water/surface-water interactions, and the movement and transformation of pesticides and nutrients in shallow ground water and small streams.

Ann Pitchford has worked at the U.S. Environmental Protection Agency as an environmental scientist since 1975. She holds a B.S. and M.S. in physics from University of Nevada, Reno and University of Nevada, Las Vegas (UNLV), respectively, and a Ph.D. in civil and environmental engineering from UNLV. Ann's research interests include landscape indicators, pesticides in the environment, field survey design, and spatial data analysis and statistics.

Abstract

Water quality in non-tidal headwater (first-order) streams of the Mid-Atlantic Coastal Plain (MACP) during base flow in the late winter and spring is related to land use, hydrogeology, and other natural or human influences in contributing watersheds. A random survey of 174 headwater streams of the MACP was conducted in 2000 as part of a cooperative research study between the U.S. Environmental Protection Agency and U.S. Geological Survey. Base flow was selected for sampling because it represents an integration of primarily shallow ground water from upstream watersheds and can be a possible source of chronic chemical exposures to aquatic communities. Nitrate concentrations (as nitrogen) in streams during base flow were measured as high as 12.4 milligrams per liter (mg/L), with a median of approximately 0.42 mg/L. Metolachlor, atrazine, and selected degradates of each were also commonly detected, but concentrations rarely exceeded 1.0 microgram per liter.

Logistic regression models were developed to relate measured water quality parameters to natural and human influences in contributing watersheds using landscape metrics computed from soils, land use, and topographic data. These models were then used to predict the occurrence of selected nutrients and pesticides in base flow for more than 9,000 non-tidal headwater streams of the MACP. Streams most likely to contain nitrogen at concentrations exceeding 0.71 mg/L (ecoregional criterion) during base flow are typically located in agricultural areas in well-drained parts of the Delmarva Peninsula, Virginia, and North Carolina, or in urban areas along the Fall Line. The likelihood of occurrence of the herbicide metolachlor and associated degradates is related specifically to the presence of agriculture, particularly on the Delmarva Peninsula and in southern New Jersey, southern Virginia, and North Carolina. These models will help managers compare small watersheds when making preliminary decisions about the allocation of resources for additional monitoring or remediation.

Notice: Although this work was reviewed by the U.S. Environmental Protection Agency and approved for presentation, it may not necessarily reflect official Agency policy.

South Carolina Surface Water Monitoring: Different Designs for Different Objectives

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Biographical Sketch of Author
David Chestnut is a Senior Scientist in the Bureau of Water of the South Carolina Department of Health and Environmental Control. He is responsible for the design and oversight of the SCDHEC Ambient Surface Water Quality Monitoring Program and the assessment of water quality data for the SCDHEC Watershed Water Quality Assessments as well as the §305(b) report and the §303(d) list of impaired waters. Mr. Chestnut has been involved with the monitoring and assessment of South Carolina's water quality for over 21 years.

Abstract
Typically a water quality regulatory agency has a variety of information needs to:

Make representative "Big Picture" statements about water quality (§305(b))
Identify waterbodies not meeting classified uses (§303(d))
Examine long-term trends in important water quality parameters
Track implementation success of control strategies
Respond to emerging issues
Conduct other special studies

The South Carolina Department of Health and Environmental Control employs a variety of tactics in its water quality monitoring design to address these wide-ranging data requirements including permanent fixed-site locations, an annual basin-specific focus, a statewide probability-based design with new sites selected each year, and the capability for supplementary sites to satisfy special issue needs.

Monitoring sites are generally sampled as point locations in or on a waterbody. Historically site locations were selected to track specific activities: point source discharges, land use activities, etc. Each site can be evaluated individually to determine classified use attainment and the need for inclusion on the §303(d) list of impaired waters.

Because §305(b) requires reporting the sizes of different waterbody types by classified use attainment condition and the size impacted by various causes, it necessitates assigning a distance or area "represented" by each monitoring site. This is generally a subjective process conducted with each state using a different approach. Since monitoring site selection typically favors locations with suspected problems this can result in a skewed picture of overall conditions.

Statewide probability-based monitoring for streams, lakes, and estuaries is one of SCDHEC's newest tactics. The main intent is to make statements about statewide resource conditions, with confidence estimates, to satisfy §305(b) reporting requirements. Multiple site visits also provide sufficient data to support our assessment methodology and allow §303(d) listing of impaired waters.

This presentation will focus on a comparison of the probability assessment results with the traditional §305(b) approach based on fixed sites.

Key Considerations in Monitoring Design

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Lyle Cowles is an Environmental Scientist within the U.S. EPA's Region 7 Environmental Services Division in Kansas City, KS. Mr. Cowles received his Bachelor of Science degree from Drake University in Des Moines, Iowa. He currently coordinates all the Regional R-EMAP projects for EPA Region 7 and, is the Region's Water Monitoring Coordinator. His duties include working with the states on drafting and implementing their state water monitoring strategies and, he is also responsible for creating and coordinating Region 7's water monitoring strategy including the Regional fish tissue tissue monitoring program. He has over 25 years experience planning, conducting and analyzing data from a wide variety of water quality studies. Mr. Cowles recently led a Regional multi-agency (federal and state) collaboration effort to redesign Region 7's fish tissue monitoring program.

Abstract

Monitoring to obtain critical environmental information, such as that needed for understanding the distribution and concentration of contaminants, is an essential requirement of the Clean Water Act. It is an on-going challenge for the states, tribes and EPA to gather, assess and provide this information (as well as other types of information) to the public and, to do so at multiple spatial scales and for many types of water resource classes (lakes, streams, estuaries, oceans) simultaneously.

This presentation provides a discussion of the key considerations in designing sampling programs to meet multiple Clean Water Act monitoring objectives. We discuss the appropriate use of random/probability-based sampling and deterministic/targeted hot spot sampling. We review important aspects of these two different monitoring design strategies, limitations and strengths of each strategy in monitoring to determine for example, human health risks from consumption of chemically-contaminated fish. We also discuss how both strategies can be used together in a complimentary manner within a monitoring program, the challenges to balancing the use of both and lessons learned.

Water Quality Monitoring Designs for Multiple Objectives and Spatial Scales: An Evaluation Based on Detection of Expected and Actual Impairment

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Biographical Sketch of Author

John Hunt is a Research Specialist in the Department of Environmental Toxicology at UC Davis, and has been conducting research in applied toxicology at the Marine Pollution Studies Laboratory at Granite Canyon for 20 years. He received a bachelor's degree in Geography at UC Berkeley and a Master of Science degree in Marine Science at the Moss Landing Marine Laboratories. John has authored or co-authored about 40 journal articles on topics such as toxicity test development, sediment quality assessment, toxicity identification, and watershed investigations of biological impacts from contaminated runoff.

Abstract

Water quality monitoring is conducted to provide resource managers with information needed to make policy decisions. Federal, state, and local jurisdictions usually have different information requirements, and monitoring programs often address multiple and sometimes conflicting objectives. Objectives are often linked to spatial scale: status and trends monitoring has been applied on continental scales, while cause-and-effect monitoring generally targets sub-watersheds. Funding limitations force many programs to address multiple objectives. This presentation describes an evaluation of alternative statewide monitoring designs for the California Surface Waters Ambient Monitoring Program (SWAMP), which is directed by the State and Regional Water Boards to address a variety of legislative and stakeholder mandates. Monitoring designs are evaluated based on their ability to detect expected impairment from multiple stressors at different spatial scales, as well as their ability to detect known impairment from well-studied watersheds. Expected impairment levels in stream reaches and estuaries throughout California are calculated using GIS based modeling of selected stressors that occur frequently on impaired water body lists from regions throughout the state. Modeling relies on relationships between anthropogenic activities (land cover, land use, pesticide use, impervious surfaces, mining, etc.), physical factors (precipitation, slope, soils, vegetation, etc.) and in-stream water quality. Monitoring designs (e.g., stratified probabilistic, targeted, confluence based, fixed site, fixed parameter) are evaluated for their ability to detect impairment at sub-watershed, watershed, regional, and statewide scales, and for their ability to provide information useful at multiple jurisdictional levels.

Essentials of specification of information needs

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Jos Timmerman is Program manager in the Department of International Policy Affairs within the Institute for Inland Water Management and Waste Water Treatment RIZA with expertise in the field of environmental information management. Since 2004 he is responsible for coordinating the International Water Assessment Centre (IWAC), a collaborating centre under the UNECE Water Convention. He has developed a methodology for the specification of information needs and applied this methodology in several national and international projects for the development of monitoring networks.

Abstract

In water monitoring, large amounts of data are produced and processed each year to support water policy development and evaluation, and operational water management. Nonetheless, policymakers are not satisfied with the information they obtain from water monitoring. This problem, that water monitoring does not satisfy the needs of policymakers is widely acknowledged in the literature. The importance of specification of information needs to overcome this problem is systematically stressed in water monitoring and water management literature. A systematic effort to consider the purpose of data collection ahead of designing/executing a monitoring program supported by scientifically sound information need assessment methodologies - is considered as a way out of these shortcomings.

The major problem that a methodology for specification of information needs has to address is the transformation of policy goals into information requirements, and in general the way to assess the fitness of information provision to policy needs. Analysis of the policy making process provides insight into the nature of policy goals (guiding principles or operational goals; scale and time dimension of goals; uncertainty of goal definition; etc.), and the association between nature of the goal and policy type. A methodology for specification of information needs has to address these problems. To improve the interaction, a transparent process is needed in which ample opportunities are incorporated for interchange of views and needs. The methodology also has to support information users to come loose from their everyday work. At the basis of all this is a proper definition of the problem situation, expressed as a lack of useful information. In this presentation is described how the problem structuring process is included in a methodology that supports specification of information needs, and will provide cases in which this methodology has been tested.

Transport of Agricultural Chemicals: Mass Budget Approach

Kathleen A. McCarthy[1] and Hedeff I. Essaid[2]

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Biographical Sketches of Authors
Kathleen McCarthy is an environmental scientist and project manager at the Oregon Water Science Center of the U.S. Geological Survey. She works on a variety of projects examining the affects of land-management practices on water quality. Her particular interests include mass-exchange processes among environmental compartments and the theory and application of passive, integrative water-sampling methods.

Hedeff Essaid is a Research Hydrologist in the Western Region Office of the U.S. Geological Survey. Her research has focused on the impact of heterogeneity and hysteresis on multiphase flow, the incorporation of sequential biodegradation processes into transport models, and the role of dissolution and biodegradation on the fate of hydrocarbon components in the subsurface. More recently her research has shifted to studying the transport and fate of solutes at the watershed-scale, including surface water - ground water interactions.

Abstract
Knowledge of how water moves through the environment is a fundamental and necessary first step toward quantitative understanding of the transport, fate, and environmental impacts of agricultural chemicals.

For this whole-system approach, we selected five agricultural subbasins across the country and in each, collected data from five environmental compartments—surface water, ground water, unsaturated zone, ground-water/surface-water interface, and atmosphere—and from several of the pathways that connect them. In addition, data were compiled on several watershed characteristics that can influence local hydrology and chemical transport. These characteristics include catchment area, soil characteristics, crop types, chemical application and irrigation practices, drainage enhancement, streamflow, and the connectivity of the local subsurface flow system to the deeper, regional ground-water system.

In addition to overall water balances for each study subbasin, this comprehensive dataset provided the opportunity to develop detailed numerical models of the surface-water, ground-water, and unsaturated-zone compartments of each study area, as well as some of the interactions between these compartments. Here we present subbasin water balances for the five diverse study areas, and compare and contrast data collection, interpretation, and modeling of various environmental compartments in these different settings.

Transport of Agricultural Chemicals: Atmosphere to Land Surface

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Biographical Sketches of Authors
Michael Majewski has been a research chemist with the U.S. Geological Survey since 1991. His research is focused on studying the behavior and fate of contaminants in the hydrologic cycle, including the short- and long-range atmospheric transport and deposition of pesticides, VOCs, PAHs, and trace metals. He is also investigating the affects of these compounds have on surface- and ground-water quality at the local and national scales.

Paul Capel is an environmental chemist with the U.S. Geological Survey. Since 2001, he has served at the team leader of the USGS NAWQA study "Agricultural Chemicals: Sources, Transport, and Fate." Prior to this, he worked with the USGS Office of Water quality and the NAWQA National Pesticide Synthesis Project. His main areas of research are environmental chemo-dynamics and the environmental behavior and fate of organic chemicals in the air and surface water.

Abstract
Agricultural chemicals can be introduced into the atmosphere during and after application, through spray drift, volatilization, and wind erosion. Once airborne, the pesticides will distribute between the gas and particle phases, be transported by wind, and be aerially distributed on local, regional, and sometimes global scales. Removal processes include photochemical transformations and dry (gas and particle) and wet (rain and snow) deposition. This deposition can occur close to the point of application or it can occur after the chemical has undergone long-range transport. The deposited residues can then revolatilize, reenter the atmosphere, and be transported and redeposited downwind repeatedly until they are transformed or accumulate at the surface, usually in areas with cooler climates. Wet deposition can be measured directly and relatively easily with rain collectors, but dry deposition is much harder to measure because the nature of the surface itself influences how much accumulates. Dry deposition often is estimated on the basis of air concentrations and particle settling velocities. This study measured the seasonality and magnitude of pesticide concentrations for more than 80 pesticides and select transformation products during the growing season of five agricultural areas across the country. Rainfall samples were collected at study areas in California, Indiana, Maryland, and Nebraska. In the arid, agricultural Yakima Valley of Washington, dry deposition for the same compounds was estimated using air concentration measurements and depositional models. In the Central Valley of California, dry deposition also was sampled by direct collection in Teflon-lined buckets for periods of three weeks to three months. The results of these studies show the importance of the atmosphere as an additional source of pesticide loading to agricultural watersheds.

Transport of Agricultural Chemicals: Tile Drains to Surface Water

Wesley W. Stone

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Biographical Sketch
Wesley Stone is a hydrologist with the U.S. Geological Survey's Indiana Water Science Center. He began working with the National Water-Quality Assessment Program's Agricultural Chemicals: Source, Transport, and Fate study on Leary Weber Ditch and Sugar Creek basins in 2002. The focus of Wesley's work is stream water quality related to the influence of subsurface tile drains and overland flow.

Abstract
Agricultural subsurface drains, commonly referred to as tile drains, are potentially significant transport pathways for the movement of fertilizers and pesticides to streams and ditches in heavily drained portions of the Midwest. Research and interest in this pathway has steadily grown over the last 20 years in conjunction with the growing attention to nonpoint source issues. Monitoring the water flow and chemistry of tile drains is a vital part of agricultural watershed transport studies in heavily drained regions. Equally vital is trying to understand the transport pathway of water to the tile drain.

During 2003 and 2004, the U.S. Geological Survey monitored tile-drain flow, effluent concentrations of various constituents, precipitation, and nearby water-table levels in a small agricultural watershed in east-central Indiana. The tile-drain monitoring effort was part of a larger study that included monitoring all hydrological compartments in this small agricultural watershed. This presentation highlights design considerations used in the tile-drain monitoring effort and briefly discusses various techniques of monitoring tile-drain flow without significant construction or impacts on farm fields. In addition, the results from the study will be used to highlight significant parameters that were found to be useful in the understanding of transport of water to the tile drain. Commonly, the focus of tile-drain monitoring has been on flow, nutrients, and pesticides. However, other parameters such as major ion chemistry and specific conductance, in conjunction with flow, nutrient, and pesticide data, may be of great assistance in differentiating how and from where water moves to the tile drain.

Pesticide and nutrient behavior in a karst watershed located in southeastern Minnesota

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Biographical Sketches of Author
Paul J. Wotzka is a Hydrologist with the Minnesota Department of Agriculture. Since 1990 he has had the primary responsibility to design and implement a statewide surface water monitoring network for pesticides and nutrients. His work on the Middle Fork of the Whitewater emphasizes the need for long term monitoring to understand changes in water quality.

Abstract
The Middle Fork of the Whitewater River is a twenty-five square mile watershed located in eastern Olmsted County. This watershed is part of the karst landscape of southeastern Minnesota that is characterized by thin loess soils underlain by fractured limestone. It is also a rich agricultural area of the State dominated by feed grain and forage for dairy farming and other livestock. The Middle Fork is a designated trout stream and has undergone substantial habitat improvement work to support brown and brook trout. The Minnesota Department of Agriculture began monitoring for water quantity and quality in 1992. In addition to flow, the stream is continuously monitored for temperature, dissolved oxygen, and pH. Water quality monitoring is conducted during both storm event and base flow conditions for twenty-six commonly used pesticides, nitrates, ammonia, total phosphorus, and orthophosphate. Storm events are intensively sampled by flow-weigh compositing. Base flows are grab sampled. Results of the pesticide monitoring indicate that one or more of the herbicides alachlor, acetochlor, atrazine, de-ethyl atrazine, cyanazine, and metolachlor were detected in all storm runoff and snowmelt events. Concentrations and frequency of detection of these compounds peaked during storm runoff events occurring shortly after product applications on crops. Atrazine, and one of its metabolites de-ethyl atrazine, were detected throughout the year in base flows. Dimethoate, a commonly used insecticide, was detected in storm runoff during the growing seasons of 1998 and 1999. Phosphorus and ammonia concentrations also increased during storm events. The highest ammonia concentrations occurred during early spring snowmelts. Nitrate concentrations were diluted during storm events and their concentrations peaked during winter base flows. Beginning in the 2000 growing year, elevated concentrations and loadings of pesticides have been recorded. Stream standards for atrazine were exceeded 45 times during the time period 2000-2004 with peak concentrations greater than 30 [ug/L]. Results of the nutrient monitoring indicate nitrate concentrations have steadily increased over the period of record. Annual flow-weighted mean concentrations for nitrate on the Middle Br. increased 34%. The primary reason for the increase in pesticide and nitrate loss is the shift in cropping patterns from a corn, alfalfa, and small grain rotation to a corn-soybean rotation.

WHAT THE HERON SEES – How to design and implement a Volunteer Water Watch program in a rural setting engaging available community partners

158 Trained RSVP Water Monitors and Jean-Ann Moon

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Biographical Sketch of Author

Jean Ann Moon has been the director of RSVP since 1992. She manages over 1,000 volunteers who give 140,000 hours of service to their rural county each year in education, homeland security, health and human services, public safety and the environment. Ms Moon started the water monitoring program in 1998 with the Tennessee Valley Authority. Their program has received national, regional and state recognition and has presented at international and national conferences.

Abstract

"Great Blue Heron, I know your secret.
You know the river and so do I.
We watch the water.
When we hear the sound of splashing,
We know the fish are there."

Due to limited state and federal resources there was inadequate water quality data for Marshall County, a rural county with 41,000 acre Guntersville Lake and 250 miles of major creeks located in the foothills of the Appalachian Mountains of North Alabama. Marshall County watersheds have a wealth of natural and human resources, but no centralized place to consolidate water quality public awareness, protection and restoration efforts. The Marshall County Retired and Senior Volunteer Program stepped forward to take the lead in generating baseline data. Since the monitoring program's inception 158 RSVP volunteers have contributed 12,572 hours collecting data on 54 stream sites and 5 embayments.

This workshop will cover how to:

- Identify partners, leverage resources and design an achievable monitoring plan
- Recruit, train, manage and recognize an intergenerational/diverse group of men and women, each with their own interest in preserving the watershed, such as farmers, fishermen, mussel divers, scientists, engineers, boaters, water fowl enthusiasts, etc
- Work with the media to provide awareness, education and support for your monitoring effort
- Participate in National events, such as Earth Day, Public Lands Day, to tell your local story
- Use environmental education tools to teach children and adults through classroom demonstrations, field trips, and community events.
- Report your program's impact on maintaining water quality necessary to support a clean and safe water supply, swimming, fishing and wildlife habitat. Monitors are not only collecting valuable water quality

information, but the knowledge and experience they gain in doing so will be a major factor leading to better water quality and better water policy.

Communication is Key to Sustaining Long-Term Volunteer Water Quality Monitoring Programs

Jacob Daniel Apodaca

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Biographical Sketch of Author

Jacob Daniel Apodaca has worked in volunteer water quality monitoring since 1992. He is currently the program coordinator for the Colorado River Watch Network (CRWN) at the Lower Colorado River Authority (LCRA) in Austin, Texas. He was Program Coordinator for the Austin Youth River Watch Program from 1992 until 1999, when he joined the CRWN team at LCRA. He supervises CRWN staff, whose purpose is to engage the public as volunteer monitors, address community water quality concerns, coordinate outreach presentations and workshops, manage monitoring site distribution, and represent CRWN within LCRA and among supporting entities.

Abstract

Established by citizens in 1988 and managed by the Lower Colorado River Authority since 1992, the Colorado River Watch Network educates and involves citizens of all ages and backgrounds throughout the watershed in understanding, collecting, reporting, and presenting information needed to sustain the health of the lower Colorado River and its tributaries in Texas. CRWN supports 120 certified water quality monitors at over 100 monitoring sites throughout the 600-mile Colorado River watershed. Volunteers commit to monitoring their site and submitting data once a month for two years. CRWN is directly involved in LCRA's mission "to use our leadership and environmental authority to ensure the protection and constructive use of the area's natural resources."

Communication between CRWN staff, volunteer monitors, and LCRA scientists and administrators is vital to the success and longevity of the program. Staff communicate via the *Aqua Vitae* newsletter, the CRWN website, face-to-face interactions, phone, email, and memos. Through this frequent communication, CRWN staff provide volunteers with the support they need. Incentives to keep monitors engaged include continuing education credits for teachers and monitor profiles in the newsletter. LCRA aquatic scientists use CRWN's online volunteer data to produce a Water Quality Index report for communities throughout the watershed. Reports are published in local newspapers, where monitors see their data being used. CRWN staff also communicate with LCRA administrators to provide updates on the program status, changing needs, new monitoring techniques, and activities of other volunteer monitoring programs.

The long-term success of a volunteer monitoring program depends on staff who can effectively communicate with volunteers and on the support of an agency committed to environmental leadership. It is also critical to demonstrate to the volunteers the value of their data, which in itself motivates them to continuously collect and submit data.

Involving Volunteers Beyond Water Monitoring

Gayla Stock

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Biographical Sketch of Author
Gayla Stock is employed as the Texas Watch Volunteer Monitoring Coordinator in the Community & Environmental Planning Department of the Houston-Galveston Area Council (H-GAC). She has served in this position to coordinate the agencies water quality volunteers since August 2004. Ms. Stock has 20 years of experience working in Volunteer Management and Fundraising programs for several non-profit organizations. She remains active as a volunteer herself, in a consultant role on volunteer management for the American Red Cross and as a docent for the Battleship TEXAS.

Abstract
As a member in the Texas Clean Rivers Program, the Houston-Galveston Area Council (H-GAC) coordinates water monitoring in four river basins, 39 watersheds, and 51 stream segments - draining over 9,130 square miles and over 16,000 stream miles.

H-GAC Clean Rivers Program has been a partner with the Texas Watch volunteer monitoring program since 1992. Texas Watch is designed to facilitate environmental stewardship by empowering a statewide network of concerned volunteers, partners and institutions in a collaborative effort to promote a healthy and safe environment. H-GAC shares the goal of the Texas Watch program: to improve water quality through public education and participation. H-GAC demonstrates support of Texas Watch with a paid staff dedicated to coordinating volunteer monitors.

In an effort to increase the retention rate of volunteer monitors, we have implemented a process for H-GAC Texas Watch volunteers to become involved beyond regular water quality monitoring. Our Volunteer Monitoring Workgroup provides four key components for volunteer participation: Training, Quality Control and Data Management, Non-Point Source Education, and Program Support. The Volunteer Monitoring Workgroup will develop a stronger network of active monitors to share ideas on how to expand local involvement, promote best practices, and improve representation on our Clean Rivers Program Steering Committee.

This presentation will review the process of establishing the Volunteer Monitoring Workgroup; discussing the successes and challenges of organizing volunteer monitors into a functioning committee and the tools used to make it possible.

Capture, Care and Feeding of Volunteers

Dwight Holford

Watershed Coordinator, Upper Putah Creek Stewardship, Box 27, Middletown CA 95461

Biographical Sketch of Author

Dwight Holford is the Watershed Coordinator for the Upper Putah Creek Stewardship based in Middletown CA. He has been with the Stewardship since its beginning in 1996. Dwight is a Federal retiree with experience as an administrator in the military housing field. His graduation from Humboldt State College with a BSc in Fisheries Biology now aids in his bioassessment and watershed work with the Stewardship.

Abstract

The Upper Putah Creek Stewardship, a public service organization was formed in 1996. Since its inception it has supported has supported citizen monitoring. In the beginning it had no one trained in bioassessment. Now it has a well trained team, a coordinator, a scientific advisor and a crew of citizen monitors. It has executed one 319(h) grant and is presently in its second one. Because of criteria for the next round of 319(h)s the UPCS will have to keep its monitoring plan alive by use of private funds. The team has also sponsored, or co-sponsored several citizen monitoring workshops. To be discussed will how networking, grant writing, fund seeking and volunteer involvement made this watershed group a successful operation.

Effects of Multiscale Environmental Characteristics on Agricultural Stream Biota in the Midwestern USA

Julie Hambrook Berkman[1], Barbara Scudder[2], and Michelle Lutz[2]

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Biographical Sketches of Authors

Julie Hambrook Berkman is an ecologist with the U.S. Geological Survey with training and experience in freshwater and marine ecosystems. Since 1992 she has worked on a variety of projects assessing environmental characteristics that influence aquatic communities and water quality in our nation's rivers. Her investigations have focused on hydrologic disturbance of the benthic community in response to storms, linkages between nutrients and algal community composition and biomass; and responses of the algal community along land use gradients. She has contributed to the national protocols and to a summary of algal research in the National Water Quality Assessment (NAWQA) Program.

Barbara Scudder's expertise is in the effects of water quality on stream biota, with emphasis on trace elements, bioaccumulation, and toxicity; she also studies community ecology of benthic algae, invertebrates, and fish. She received a B.A. in Aquatic Biology in 1979 from the University of California, Santa Barbara and a M.S. in Marine Science in 1984 from California State University, Hayward (Moss Landing Marine Laboratories). At the USGS, as the lead study unit biologist for the Western Lake Michigan Drainages study unit of NAWQA, she is involved in multi-year biological research efforts on water quality using aquatic biota.

Michelle Lutz received her Bachelor's degree in Bacteriology from the University of Wisconsin - Madison and has been at the USGS since 2001. She has been part of the Western Lake Michigan Drainages study unit team of NAWQA, and has been involved in water quality studies examining microbiology, streambed sediment, and habitat.

Abstract

Evaluations of the effectiveness of agricultural land-use management practices in improving water quality can be misleading because environmental indicators respond to changes at multiple scales. This study will evaluate the response of a set of environmental indicators--biotic communities at multiple trophic levels (algae, invertebrates, and fish)--to physical and chemical environmental characteristics at the reach and watershed scale (Midwest agricultural setting). The 86 sites selected for study are in predominantly agricultural basins (cropland and pasture, median land cover = 86%) and were sampled for biological-community data as part of the U.S. Geological Survey National Water-Quality Assessment Program. Community taxonomic data and metrics were assessed to determine which aspects of the communities were most responsive to riparian and in-stream habitat characteristics at the reach and watershed scale. Land-cover Digital Ortho Quarter Quads were used for analyses of riparian conditions at the reach and segment scales. For a subset of sites hydrologic variability representing five components of streamflow (timing, magnitude, duration, frequency, rate of change) was calculated from historical records of daily mean discharge over the period of gaging-station record as well as from 1, 2, and 3 years preceding the collection of biological data. Nutrient, pesticide, and common-ion data also are being examined for this subset. Results of analyses within-site temporal variability from multiple years of data will be used to determine which characteristics are most stable from year to year. For example, the measure of 'Richness of tolerant invertebrate taxa' had the lowest median coefficient of variation (0.04) among all the invertebrate metrics evaluated. The ability to identify the most stable biological characteristics as well as

the scale at which the algal, invertebrate, and fish communities show the strongest responses should help focus efforts to manage key environmental variables to best protect aquatic communities.

Protocols for the Evaluating the Effects of Land-use Patterns and Runoff Management on Urban Streams

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Biographical Sketches of Authors

Christine Rohrer is a Ph.D. candidate in Civil Engineering at Colorado State University. Ms. Rohrer currently serves as co-principal investigator and project manager for the Water Environment Research Foundation project Protocols for Studying Wet Weather Impacts and Urbanization Patterns. In addition to her academic experience, Ms. Rohrer has also worked as a consult for CDM since 1995, primarily focusing on watershed management efforts as part of the Rouge River National Wet Weather Demonstration Project in Michigan.

Larry Roesner is a professor of Civil Engineering at Colorado State University. Dr. Roesner's area of specialization since 1970 has been urban hydrology and nonpoint source pollution control. He is a principal developer of the Corps of Engineers model STORM, a simplified urban stormwater management model; EPA's SWMM EXTRAN model, a sophisticated flow routing model for urban drainage systems; and QUAL II, a stream water quality model developed for USEPA. Dr. Roesner's current research addresses the development of improved methods for controlling the quantity and quality of urban runoff, so that urban streams are an asset to the community.

Abstract

The design of urban runoff management facilities generally includes peak shaving for flood control, and best management practices (BMPs) for removing pollutants from the runoff. A number of scientists have concluded that the combination of these two control practices, which were developed independently of one another, is not sufficient to protect aquatic ecosystems. These conclusions, however, have focused solely on the bioassessment of urban streams and have not taken into account the design criteria used for peak flow reduction facilities and BMPs.

Current research is now focusing on the development of a protocol for data collection along urban gradients combined with mathematical modeling to determine the ecologic impacts of urban runoff resulting from different land use patterns and/or implementation of alternative runoff management technologies. This protocol allows for the examination of tradeoffs between: 1) flood mitigation versus channel roughness, habitat heterogeneity, debris inputs, and riparian protection; 2) chemical water quality improvement through extended detention versus geomorphically-based flow regime controls; and, 3) rehabilitation of aquatic habitat using static features versus allowing the potential for dynamic adjustments in channel form and habitat structure.

This paper describes the protocol that has been developed and shows the results of testing it in the North Carolina Piedmont, using data gathered by the USGS in their Urban Gradient Studies under the NAWQA program. The protocol includes a procedure for data collection and analysis to determine how statistical characteristics of stream-flow change with urbanization and runoff management, and how these statistical characteristics can be used to estimate geomorphic stability and health of the stream ecologic system under alternative development and/or runoff control scenarios.

Assessing Rain Garden Effectiveness

Brooke C. Asleson[1], Sam Johnson[2], John S. Gulliver[3], Ray Hozalski[3], and John Nieber[4]

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Biographical Sketches of Authors
Brooke Asleson is currently a graduate research assistant working towards a M.S. in Water Resources Science with a focus on watershed science and management at the University of Minnesota. She earned her B.S. in Environmental Science with a minor in Soil Science from the University of Minnesota. Current research includes assessment of rain gardens as a stormwater BMP and the evaluation of various techniques used for measuring infiltration rates of soils.

Sam Johnson recently obtained his M.S. in Natural Resources Science and Management with a forest hydrology and watershed management focus from the University of Minnesota. As a graduate student Sam worked on two projects; one was examining the hydrology of alternative stormwater practices and their impacts on adjacent infrastructure and another which evaluated the efficiency of various drainage configurations under roadways. He has a B.S. in Environmental Studies and Geology from Gustavus Adolphus College.

Dr. John S. Gulliver is the Joseph T. and Rose S. Ling Professor and Head of the Department of Civil Engineering at the University of Minnesota. He earned his B.S. in Chemical Engineering at the University of California in Santa Barbara and a M.S. and Ph.D. in Civil Engineering from University of Minnesota. Research interests include environmental fluid mechanics, mass transport in environmental systems, and flow and mass transport at hydraulic structures. Currently is the co-PI of a project assessing storm water best management practices and developing a protocol for the Minnesota Pollution Control Agency.

Dr. Raymond Hozalski earned his Bachelors in Chemical Engineering from Villanova University and a M.S. and Ph.D. in Environmental Engineering from John Hopkins University. He has been a professor of Civil Engineering at the University of Minnesota since 1997. Research interests include fundamental and applied aspects of water and wastewater treatment and storm water management.

Dr. John Nieber earned his B.S. in Forest Engineering from Syracuse University, a M.S. in Civil and Environmental Engineering and a Ph.D. in Agricultural Engineering from Cornell University. Current research activities include; mathematical models describing multiphase fluid flow, and mass/energy transport in the unsaturated zone including phase change, chemical reactions and biodegradation. Numerical solutions to solve coupled partial differential equations governing flow, transport and reaction processes. Adaptation of sensors and measuring systems for monitoring flow and transport in the unsaturated zone. Modeling runoff generation processes and source identification in watersheds. Modeling wetland, hydrologic, and mass transport processes for TMDL assessments.

Abstract
Rain gardens are a low impact and aesthetically pleasing, stormwater best management practice (BMP). Monitoring rain gardens and other stormwater BMPs can be difficult and time consuming due to the

unpredictability of storm events. Alternatives to monitoring are needed to assess rain gardens as an effective long-term stormwater BMP. For assessment of rain gardens ability to control runoff, proposed methods include the use of infiltrometers and permeameters for point infiltration measurements, or whole rain garden infiltration measurements using synthetic simulated storm events. These field “testing” methods provide input parameters to infiltration models to facilitate investigation of rain garden performance over a wide variety of conditions. Research has been conducted over the past two years, and will continue during the next year to evaluate the various techniques for measuring infiltration and will be used to further examine their accuracy in the field. This research is part of an overall project to create a stormwater BMP assessment protocol. Results of field measurements performed during the past two years will be summarized in this presentation. Partners on this project include: the University of Minnesota, Metropolitan Council Environmental Services (MCES), MN Pollution Control Agency (MPCA), and the Dakota County Soil and Water Conservation District (SWCD). The rain garden infiltration measurements made during the growing season will be combined with winter infiltration measurements made by the Dakota County SWCD as part of a Water Environment Research Federation (WERF)-funded project that is evaluating the performance of rain gardens in cold climates. The final product of this and related efforts will be an assessment protocol that will explain both monitoring and cost-effective testing procedures for stormwater BMPs. In addition, understanding the infiltration performance of rain gardens will facilitate improvements in their design, use, and maintenance.

Uses of Real-Time Data: Capabilities, Limitations, Applications, Costs and Benefits

Trainers
Andy Ziegler, U.S. Geological Survey
Trudy Bennett, U.S. Geological Survey
Teresa Rasmussen, U.S. Geological Survey

Biographical Sketches
Andrew C. Ziegler is the Hydrologic Investigations Section Chief and Water Quality specialist with the USGS Kansas Water Science Center. He has conducted numerous water-quality studies in Missouri and Kansas in the last 20 years related to acidic mine drainage, transport of agricultural chemicals in ground and surface water, aquifer storage and recovery, reservoir sediment and quality studies, and the use of real-time water quality monitors and statistical analysis to continuously estimate constituent concentrations and loads

Trudy J. Bennett is a Lead Hydrologic Technician for Hydrologic Investigations in the Wichita, KS Field Office with the USGS Kansas Water Science Center. She has worked on numerous water-quality studies in Kansas involving surface water, groundwater, and real-time water-quality monitoring. Trudy helped develop the protocols for real-time water-quality monitoring program and is a co-instructor for the NTC class “Water-Quality Monitoring and Record Working” and has helped teach the class at various Science Center across the United States.

Teresa Rasmussen is a hydrologist specializing in surface water quality with the USGS Kansas Water Science Center. Since joining the USGS in 1998, she has conducted studies describing streamflow trends and investigated water quality in large agricultural and small urbanizing watersheds using continuous data.

Description of Short Course
The short course presents an overview of some currently operational technologies, specific examples of the critical components for continuous water-quality monitoring including probe operation and maintenance protocols (dissolved oxygen and turbidity); records review and quality assurance, statistical approaches to estimate in-stream concentrations of sediment, indicator bacteria, and nutrients, applications of continuous water quality, and examples. The workshop is a series of presentations on the workshop topics with lively and informative informal discussions with the attendees anticipated and expected during the session.

The Pacific Northwest Aquatic Monitoring Partnership: A Forum for Regional Coordination

Jennifer M. Bayer

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Biographical sketch of the author:
Jennifer Bayer is a biologist with the US Geological Survey, where she currently serves as the Coordinator of the Pacific Northwest Aquatic Monitoring Partnership. As the lead staff person for PNAMP, she coordinates PNAMP efforts to integrate resource monitoring programs of state, federal, tribal, local, and private organizations in the Pacific Northwest. Jennifer has been with the USGS since 1994, where she has worked as a fishery biologist at the Columbia River Research Laboratory studying native fishes of the Columbia River Basin prior to her current assignment began in 2004

Abstract
The purpose of the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) is to provide a forum for coordinating state, federal, and tribal aquatic habitat and salmonid monitoring programs. Improved communication, shared resources and data, and compatible monitoring efforts provide increased scientific credibility, cost-effective use of limited funds and greater accountability to stakeholders. PNAMP provides leadership through the development and the advancement of recommendations and agency level agreements that are considered for adoption by the participating agencies. PNAMP has adopted the following goals:1) improve communication between monitoring programs across state, tribal, and federal organizations; 2) improve scientific information needed to inform resource policy and management questions and decisions; 3) seek efficiencies and cost-effectiveness across monitoring programs through compatible and cooperative monitoring efforts; 4) promote science-based credibility of monitoring and assessment efforts; 5) share resources and information between monitoring programs across state, tribal, and federal organizations. PNAMP receives significant policy support and direction by member organizations, commitments of technical resources and staff time and funding for the coordination itself. As part of a monitoring coordination structure, PNAMP has identified and developed technical working groups for five key elements of monitoring: watershed condition monitoring, effectiveness monitoring, fish population monitoring, estuary monitoring, and data management. PNAMP is seeking to coordinate and collaborate our work with regional and national efforts to coordinate water quality monitoring.

Interagency Monitoring Coordination: The Oregon Plan Monitoring Team

Greg Pettit

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Biographical Sketch of Author

Greg Pettit is the Manager of the Watershed Assessment Section within the Laboratory Division of the Oregon Department of Environmental Quality (ODEQ). He has held that position since 1990. The Watershed Assessment Section conducts surface and groundwater monitoring programs statewide, including habitat and biological monitoring. Assessment tools developed under Mr. Pettit's direction include the Oregon Water Quality Index and a macroinvertebrate predictive model for Oregon. Prior to his current position, he has held a number of positions at ODEQ including, groundwater water quality protection coordinator, where he was instrumental in the development of the Oregon Groundwater Quality Protection Act.

Abstract

The Oregon Plan for Salmon and Watersheds (OPSW) is Oregon's cooperative effort to restore salmon runs, improve water quality, and achieve healthy watersheds and strong communities throughout the state. Monitoring activities conducted to support the OPSW are coordinated through the Oregon Plan Monitoring Team. Six state agencies, Oregon State University and four federal agencies are represented on the Monitoring Team. The Monitoring Team identifies critical monitoring questions to assess the effectiveness of the OPSW and determines how the monitoring effort will be organized, coordinated, and implemented. The Monitoring Team has developed a charter and a monitoring strategy that identifies desired monitoring outcomes, questions, strategies, and indicators. The Monitoring Team has proven to be an effective method for coordinating Oregon's watershed monitoring efforts, standardizing monitoring designs and indicators, sharing data, and developing cooperative reports.

The Development of the Florida Water Resources Monitoring Atlas

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Abstract

The Florida Water Resource Monitoring Council is a fledgling association of state and local government, academia, private consultants, and volunteer monitoring entities interested in the tenets of the National Water Quality Monitoring Council as well as those specific issues within the Florida water resources monitoring community. Our first organizational retreat was conducted in July 2004 with over 80 participants spanning all areas of monitoring interests. A second retreat was held in November 2006 where the council was official created. One of the first of several agenda items was to create a statewide monitoring atlas. This goal has also been a top priority item for the Florida Department of Environmental Protection going back many years. The monitoring atlas is an interactive Internet data repository for all monitoring activities in Florida. The Atlas is not limited to only water chemistry data but encompasses biology, sediment, and habitat resources as well. Florida currently has a large constituency involved in monitoring and the atlas should aid in the overall monitoring goals of communication, collaboration, and coordination. The development and interactive templates of the atlas will be presented.

Sustaining Long Term Regional Coordinated Monitoring Programs

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Todd Running is the Clean Rivers Program Manager for the Houston-Galveston Area Council of Governments in Houston, Texas. He has been with the Clean Rivers Program since 1992 serving in many capacities: GIS technician, Volunteer Monitoring Trainer, Quality Assurance Officer, Data Manager, Project Manager and Program Manager. He has managed over a dozen special studies in the last 5 years ranging from Dioxin in fish tissue to finding and correcting illicit connections.

Abstract

The Houston-Galveston Area Council (H-GAC) has been coordinating water quality monitoring under the Texas Clean Rivers Program since 1992. Since that time, H-GAC has brought seven local agencies together under one Regional Quality Assurance Project Plan (QAPP) to conduct coordinated ambient water quality monitoring. Collectively, there are over 40 parameters monitored at over 280 stations throughout a 13 county region.

This was accomplished by leveraging Clean Rivers Program funds with local, state and federal dollars and in-kind services. This enables H-GAC to not only conduct its ambient water quality monitoring program, but to conduct a large number of special studies that have been prioritized by local stakeholders.

H-GAC maintains a water quality data clearinghouse that is distributed through H-GAC's web-site, where users of all levels can access the data. Users can interactively map stations based on their area of interest and view information associated with each station. The database contains field and conventional parameters, bacteriological, metals, and Quality Assurance data. Users may view the data by parameter, station, or TCEQ-designated segment, interactively graph data for a user-defined time period, or download data directly.

The Clean Rivers Program has matured over the last 13 years and is now the largest collector of ambient water quality data in the State. However, stakeholders and other State programs are looking for the program to shift part of its focus to implementation projects to help solve some of the water quality problems it has found. This presents H-GAC with the challenge of continuing to collect water quality data while starting to implement and evaluate mitigation projects with no additional funds.

National Stream and River Assessment Monitoring Design

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Dave Peck is an Ecologist at the U.S. EPA National Health and Environmental Effects Research Laboratory-Western Ecology Division in Corvallis, OR. He received an M.S. degree in Biological Sciences from Florida Institute of Technology, and did additional post-graduate work in aquatic community ecology at the University of Oklahoma. He is currently involved with the Environmental Monitoring and Assessment Program in the areas of ecological indicator development, analysis of ecological survey data, logistics and implementation of large-scale monitoring surveys, field protocol development and training, and quality assurance of ecological data.

Steven G Paulsen is a senior aquatic ecologist at the U.S. Environmental Protection Agency, Office of Research and Development, Western Ecology Division, Corvallis, Oregon. He received a PhD in limnology from the University of California-Davis in 1987. He received ORD's highest research award for communicating science in 2004 and is recipient of multiple agency awards for research excellence. Dr. Paulsen's research focuses on the development of large–scale aquatic monitoring studies based on biological, chemical and physical indicators of aquatic resource quality and probability survey designs.

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Abstract
The USEPA designed two large-scale regional monitoring efforts on streams and rivers in the United States and implemented them between 1999 and 2005. The Environmental Monitoring and Assessment Program (EMAP), in cooperation with USEPA Regions 8, 9, and 10 and twelve western states, initiated an assessment of all streams and rivers in the 12 states (EMAP-West). A stratified, unequal probability survey design (50 sites per state), and additional sites in five intensive study areas, was selected from all perennially-coded streams and rivers in EPA's River Reach File (RF3). The unequal selection depended on Strahler order, aggregated Omernik Level 3 ecoregions, and intensification regions. A second stratified survey design of 50 sites per state was selected from all non-perennially-coded streams and rivers in RF3. Both surveys were used to estimate the actual total length of perennial streams and rivers in the western U.S. The EPA Office of Water, in cooperation with USEPA Regions, States, and EMAP, subsequently initiated the Wadeable Stream Assessment (WSA), an assessment of all wadeable streams and rivers in the United States. The WSA, used the EMAP-West study's wadeable streams and

augmented it with a design for the remaining 36 eastern conterminous states (WSA-East). The WSA-East design is an unequal probability survey design with the unequal selection depending on Strahler order, Omernik Level II ecoregions, and USEPA Regions.

Each selected site was classed as perennial/non-perennial/not-stream and as wadeable/boatable. The determination was based on an initial office evaluation, followed by a field visit when necessary. The estimated length of wadeable streams and rivers in the 48 conterminous states is 1.30 ±0.05 million km. The estimated length in the EMAP-West study region is 0.38 ±0.02 million km and in WSA-East region is 0.92 ±0.09 million km wadeable streams and rivers.

Defining Least-Impacted Reference Condition for the National Wadeable Streams Assessment

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Alan Herlihy is a senior research Associate Professor at Oregon State University in the Department of Fisheries and Wildlife. Current research projects focus on developing survey methodology, assessment approaches, and ecological indicators for assessing surface water ecological condition. He has been involved in a number of projects over the last 15 years analyzing regional ecological data from EPA's Environmental Monitoring and Assessment Program.

John L. Stoddard is a freshwater ecologist with the Western Ecology Division of the U.S. Environmental Protection Agency's National Health and Environmental Effects Research Laboratory in Corvallis, Oregon. He has a Ph.D. in Biological Sciences from the University of California at Santa Barbara (1986). His research focuses on the science of ecological assessment, including indices of biological condition, and reference condition.

Charles Hawkins is Professor of Aquatic Ecology in the Department of Aquatic, Watershed, and Earth Resources at Utah State University and Director of the Western Center for Monitoring and Assessment of Freshwater Ecosystems. His main research activities involve development and testing of biological indicators, classification of reference conditions, modeling effects of natural factors on the distribution of aquatic biota, and use of taxon-specific responses to different stressors to diagnose causes of biological impairment.

Susan Holdsworth is project manager for the wadeable streams assessment with the Office of Water of the U.S. Environmental Protection Agency. She joined the monitoring branch in 1998 and has been working on national and state water quality monitoring issues related to the implementation of the Clean Water Act.

Abstract

Reference condition data from many sites are necessary to define expectations for biological condition under least disturbed settings. One of the objectives of the Wadeable Streams Assessment (WSA) was to characterize stream condition across the conterminous United States as represented by macroinvertebrate assemblages using both multimetric and predictive modeling approaches. As part of this process, we compiled macroinvertebrate data for over 1,600 reference sites from available WSA, EMAP, REMAP, NAWQA, STAR grant, and State sampling efforts. Only data that had Chironomids identified to at least genus and a minimum count of 250 individuals per sample were used in the compilation. In this compiled data set, reference sites were identified by either of two methods, best professional judgment (BPJ) or screening of probability survey data. The latter method involved developing ecoregional specific chemical and habitat criteria to identify least disturbed sites. Probability sites exceeding any one of the criteria were removed from consideration as reference sites. Of major concern with making this kind of data compilation was the difference in field and lab protocols among surveys. One state database (30

sites) was removed after analysis showed it to have consistently higher mayfly, stonefly, and caddisfly richness than ecoregionally similar sites indicating a bias towards gathering those orders of insects. Biases in macroinvertebrate metric scores were not evident in the remaining reference site data and all of it was used to develop the scoring thresholds needed for the multimetric index. Predictive models are based on specific taxa names and are more sensitive to identification and protocol issues. Cluster analysis did show some distinct clusters around much of the state data so sites in these data sets were not used as reference sites in developing the predictive models.

Process for developing a Macroinvertebrate Index of Biotic Integrity for the Wadeable Streams Assessment

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Abstract
We describe the process used to develop a national-scale Index of Biotic Integrity (IBI) for macroinvertebrate samples collected as part of the Wadeable Streams Assessment. Roughly 100 metrics were calculated, representing 6 different metric classes, each designed to capture an important aspect of biotic integrity: taxa richness, taxonomic composition, diversity, pollution tolerance, feeding group, and habit group. Metrics were screened in an iterative process, designed to eliminate those metrics that were unlikely to discriminate the least-disturbed sites from most-disturbed sites. Metrics were subjected to these tests: (1) range test (does range of scores allow for potential discrimination); (2) signal: noise test (repeatability); (3) test for natural variability (do correlations with natural gradients, like stream size, create need for calibration); (4) discrimination between a set of least-disturbed reference sites and most-disturbed trashed sites; and (5) redundancy. The process was carried out with the goal of finding the best metric in each of the 6 metric classes described above. The 6 best metrics were then scored, combined, and scaled to produce an IBI that ranges from 0 to 100. Two national IBIs were produced using this process. The Best 6 IBI was produced using a slightly different lists of 6 metrics in each of 9 aggregated ecological regions where the most responsive metric in each metric class was used, according to its performance in each ecoregion. In the course of this exercise, we also produced a Same 6 IBI, using 6 metrics that were responsive in every ecoregion and passed all of the iterative tests used in the metric selection process described above. For both IBIs, the metrics were scored separately in each ecoregion, and combined into a single IBI. We will present a comparison of the performance of the Best 6 and Same 6 IBIs, as well as some results of the national assessment for macroinvertebrate biotic integrity.

National Assessment of the Condition of Wadeable Streams in the Conterminous U.S.

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Susan Holdsworth is project manager for the wadeable streams assessment with the Office of Water of the U.S. Environmental Protection Agency. She joined the monitoring branch in 1998 and has been working on national and state water quality monitoring issues related to the implementation of the Clean Water Act.

Abstract

The first assessment of the condition of wadeable streams in the conterminous U.S. was conducted by collaboration among EPA and the States. Over 1700 sites were sampled using a common set of field protocols and a common survey sampling design for site selection. The design provided a statistically defensible approach for making inferences to all streams within the U.S. from the subsample selected. Sufficient sites were selected to provide a national assessment with the ability to describe 10 - 15 subregions within the U.S. A suite of biological, chemical and physical indicators were selected to estimate both the biological quality and the relative ranking of a subset of stressors potentially impacting the biota. Results of the assessment for the nation streams will be presented.

Proposed Tools and Approach for Ground-Water Vulnerability Assessment (GWAVA) Using a Geographic Information System and Simulation Modeling

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Jack Barbash has been studying environmental science, with an emphasis on environmental chemistry, since 1974. He received an A.B. degree in earth sciences from Harvard University in 1978, worked as a consultant for Energy Resources Co. from 1978 to 1981, received an M.Sc. degree in hydrogeology from the University of Waterloo (Ontario, Canada) in 1983, and completed a Ph.D in environmental engineering and science from Stanford University in 1994. Since 1991, he has served as a Research Chemist and ground-water specialist on the Pesticide National Synthesis team for the U.S.Geological Survey's National Water-Quality Assessment (NAWQA) program.

Abstract

Over the past two decades, many different tools have been employed to predict the likelihood of detecting surface-derived contaminants in ground water, including (1) scoring methods to rate the relative tendencies of different site characteristics to facilitate contaminant movement to (and within) ground water, (2) statistical relations between contaminant occurrence and site-based parameters, and (3) computer simulations of contaminant fate and/or transport in the subsurface (vadose zone and ground water). To date, most of the ground-water vulnerability assessments (GWAVAs) conducted for the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) program have used regression equations, neural networks and other statistical relations to predict (or explain) contaminant occurrence in ground water from estimates of contaminant loading and other site-specific parameters.

Recent work, however, has led to the development of a variety of methods that can be used to conduct GWAVAs using numerical simulations of contaminant transport and fate in the subsurface. This discussion will present a proposed approach for assembling several of these tools into a system to predict the concentrations of surface-derived compounds in ground water anywhere in the conterminous United States. For a well of a specified location and depth, the approach uses a geographical information system and simulation models to: (1) delineate the most likely zone(s) of contribution to the well, (2) assemble the input data required for simulating the transport and fate of the contaminant of interest in the subsurface beneath the inferred zone(s) of contribution, (3) simulate the transport and fate of the contaminant within the vadose zone, and (4) simulate the transport and fate of the contaminant as it moves from the water table to the well screen. The accuracy of the predictions will be evaluated for selected pesticides by comparing predicted concentrations with those measured in ground water at a subset of the nearly 5,200 wells sampled by NAWQA between 1992 and 2001.

Using the National Hydrography Dataset Plus for Drainage Area Delineation and Site Matching

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Kirsten Cassingham has worked for the U.S. Geological Survey in North Carolina since 1999. After receiving her B.A. in Anthropology from San Diego State University she served as a Peace Corps Volunteer in Guatemala and Bolivia. She currently works with the National Water Quality Assessment (NAWQA) program in Raleigh, where she provides GIS support and assists with trend analysis and basin delineation/characterization. Kirsten received her M.S. in Natural Resources (forestry) from North Carolina State University in 2000.

Silvia Terziotti is a GIS Specialist with the U.S. Geological Survey North Carolina Water Science Center in Raleigh. She provides GIS support and technical guidance for hydrologic studies in North Carolina and on National USGS programs. Her current work includes deriving hydrologic features from LiDAR-derived Digital Elevation Models, using GIS techniques to automate flood inundation models, and using the NHD to link multiple datasets for analysis.

Abstract
National Hyrography Dataset Plus (NHD-Plus) linework and associated subwatersheds (catchments) are being used in the U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program to accelerate the completion of tasks that previously have been extremely time-intensive, such as drainage area delineation and site matching for water-quality sites. The lines, representing streams from the NHD-Plus are corrected so all are pointing upstream, and a one-to-one relation exists between each stream segment and the subwatershed that drains to it. In basin delineation, the outflow point (usually a streamgage) is used to initiate a trace of upstream reaches, collecting the catchments as the stream network is traced. This process is being used to automate the delineation of hundreds of basins, much more quickly and accurately than using elevation data alone.

The NHD-Plus also is extremely valuable in matching drainage characteristics of two separate data sets. The study area includes a large number of water quality monitoring sites without stream flow data. Drainage area ratio was used as the criterion for a goodness of match between monitoring site and gaging station; a paring with a ratio between 0.75 and 1.25 was considered an acceptable match. The trace command was automated to find the closest NHD stream to the ungaged site and collect associated catchments and calculate the drainage area. If any gaged sites were within the upstream or downstream catchment areas, drainage areas were compared to see if they were within the threshold. The program creates screen snapshots of each site and a file listing potential matches. The NHD-Plus enables accurate basin delineation and site matching more consistent with national data.

New NHD Tools for the Evaluation of Watershed Condition and Management Performance

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Abstract

The National Hydrography Dataset (NHD) supports a set of value added tools providing a robust analytical infrastructure for the flexible integration of monitoring and assessment information using both standard and custom, watershed units. This new system, called NHDPlus, represents a joint effort on the part of the EPA and the USGS to provide a consistent national platform that can facilitate the sharing of information on measures of watershed condition and management program performance. Examples are provided on applying this NHD-based platform using enhanced upstream-downstream analysis techniques and other tools for the rapid integration of data related to conventional GIS vector layers (point, line or polygon data) as well as raster data such as the National Land Cover Data (NLCD). NHDPlus is built around a set of small catchment polygons related to the drainage areas of individual flow paths in the NHD. These catchments are aggregated to define the standard units (e.g., HUC12 subwatersheds, HUC10 watersheds, or HUC8 subbasins) for the Watershed Boundary Dataset (WBD).

Catchments can also be flexibly aggregated to define custom watershed units geared to the needs of specific management programs. In our examples we show how criteria such as time of travel or shifts in land cover patterns can help define watershed-based analysis envelopes for monitoring sites, regulated facilities, urbanized areas, public lands, tribal lands, transportation corridors, and other management units or areas of investigation. These focused analysis envelopes can be applied to integrate monitoring data and water quality standards assessment data to support a wide range of water quality programs conducted by federal, state (including tribal groups), or local management authorities.

GIS and Remote Sensing Applications in the Hydropolitics of Sub-Saharan Africa: The Case of Multinational Management of River Niger Basin of West Africa

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Dr. Edmund Merem completed his M.E.S. at York University, Toronto and Ph.D. from Jackson State University, Mississippi. He has 10 years of experience in Global environmental planning and accounting for oil and gas and hydro-politics. He has published in academic journals. His new book entitled "*Environmental Accounting For Changes in Farmland Use: A Canadian Case Study"* was recently published and he is working on a second book. He worked as an Environmental Analyst in the Environment Bureau of Agriculture Canada. Dr. Merem is an Assistant Professor of Environmental Planning in the Urban and Regional Planning Department at Jackson State University.

Dr. Yaw Twumasi received a BA in Geography and MES in Environmental Planning and GIS, both from York University, Canada and a Ph.D. from Alabama A&M University, U.S.A. Dr Twumasi's published research focuses on the application of remote sensing and GIS technology in natural resources management. He has published in academic journals and his new book entitled "*Park Management in Ghana Using GIS and Remote Sensing"* was recently published. He is a Research Assistant Professor of Remote Sensing and GIS at Alabama A&M University.

Abstract

In the Sub-Saharan African region of River Niger Basin, where none of the major rivers is fully contained within the borders of a single nation, transnational water sharing is essential for survival. Even the globally proclaimed goals of sustainability and environmental security are unattainable in the absence of bilaterally negotiated water agreements. Yet the systematic study of the nature, conduct of conflict, and cooperation between states over shared water resources in troubled areas of the Middle East continues to dominate the literature with minimal coverage of the Sub-Saharan Africa experience and the role of GIS and remote sensing in monitoring the problem. Considering the intense ecosystem stress inflicted on River Niger by human activities and natural forces emanating from upstream and downstream nations. Researching the growing potential for acute conflict and the need for negotiated water sharing agreements and environmental cooperation among nations of River Niger Basin with the latest advances in spatial information technology as a decision support tool not only helps in averting conflicts, but it has the potentials to bring nations much closer through information exchange.

From a geopolitical standpoint, the nature of hydropolitics embodies the complex arenas of interactions between states that share river basins. While this complexity remains compounded due to the depletion of nationally available water resources, the lack of hydropolitical cooperation extracts socioeconomic, political and environmental costs from all players. This is essential as the Niger Basin nations move towards a multi-national watershed management as a conduit for sustainability and equity. This paper uses GIS and remote sensing technologies in the analysis of hydropolitics of West Africa with emphasis on the issues and the nature of water politics. Other aspects of the paper cover a regional case study of the River Niger Basin highlighting environmental analysis and efforts towards multinational water sharing.

Incorporating Remote Sensing into an Ambient Monitoring Strategy

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Dr. Nelson is the monitoring and assessment program manager for the Idaho Department of Environmental Quality. Since joining the agency in 2003, she has been working on expanding the State's ambient monitoring strategy to include lakes, reservoirs and rivers as well as coordinating and directing monitoring efforts of state and federal agencies in Idaho for wadeable streams. She received her Ph.D. in Analytical Chemistry in 2003 from the University of Nebraska-Lincoln.

Clyde Lay is a water quality analyst in the Twin Falls Regional Office of the Idaho Department of Environmental Quality with training and experience as a limnologist. Since 1999, he has served as a regional office TMDL project coordinator. TMDL Project coordination includes all phases of TMDL development from monitoring plan development, sample collection to report generation. I have completed four subbasin-wide TMDLS for nutrients, sediment, pathogens, and temperature. From 1996 through 1999 he served as the Beneficial Use Reconnaissance Program contact for the Twin Falls Regional Office of DEQ. After receiving a BS in Fish and Wildlife Management from Utah State University Mr. Lay completed Post Graduate studies in Aquatic Ecology at Utah State University where he focused on food web interactions in large oligotrophic lakes.

Abstract
Research has shown that satellite imagery has been successfully employed as a cost-effective means of reviewing water quality issues over very large areas. Specifically, studies have shown that this imagery is effective in determining the extent of suspended solids and in characterizing the level of chlorophyll-a present in large water bodies. Landsat data represents a comprehensive and accessible source of information dating from 1972 which will allow for trend analysis of water body condition over several decades.

Idaho DEQ is building and calibrating a lake water quality model using Landsat data to include in a tiered monitoring and assessment approach at a reconnaissance level effort. For this study, the focus was on acquiring relevant information such as spatial relationships, chlorophyll a concentrations and Secchi depth, to build a model for lakes and reservoirs. A group of eight lakes and reservoirs representing a range of natural and man-made conditions was monitored over the course of several months to gather relevant data. After collecting this data, the Landsat scenes were geo-referenced and corrected to allow for scene to scene comparisons. The pixel values from the corrected scenes were correlated with the data collected on the various lakes to build a predictive model used to assess water quality. Calculation of trophic state from the Landsat scenes gives a rapid screening of lakes and reservoirs within the state and water quality trends in those lakes were evaluated.

Transport of Agricultural Chemicals: Unsaturated Zone to Ground Water to Surface Water, San Joaquin Valley, California

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Joseph Domagalski is a hydrologist with the U.S. Geological Survey Water Science Center in Sacramento, California, He is currently the Project Chief for the Sacramento River Basin study unit of the National Water Quality Assessment (NAWQA) Program of the U.S. Geological Survey , and the Study Unit Scientist for the Agricultural Chemicals Transport Study for the San Joaquin-Tulare Basins study unit of the NAWQA Program.

Steven P. Phillips has been a Hydrologist with the U.S. Geological Survey for 20 years. His primary experience and interests involve using simulation models to better understand hydrologic systems and developing tools to help manage these systems. Most of his career has been spent addressing irrigation-driven management issues in the San Joaquin Valley, and artificial recharge, land subsidence, and public water supply issues in Antelope Valley, California.

Abstract

Transport of agricultural chemicals was examined along a 1-kilometer flow path from an almond orchard to the Merced River in the San Joaquin Valley, California, as part of a national study on the fate of these chemicals within the hydrological cycle of small watersheds. Fruit and nut orchards represent a major agricultural commodity in the valley, and interest has grown regarding the management of these fields to prevent degradation of water resources. The soil and aquifer mineralogy in this location is dominated by granitic sand (derived from the adjacent Sierra Nevada) with low amounts of organic carbon within the upper soil horizon. Nitrogen application rates of 200 kg/hectare per year result in nitrate concentrations in the unsaturated zone (approximate thickness of 6.5 meters) of up to 40 mg/L as N, and concentrations in ground water exceeding the drinking water standard of 10 mg/L to a depth of 30 meters below land surface. Redox conditions along the flow path are consistent with low dissolved oxygen and manganese reduction. Dissolved gases and isotopic data show excess nitrogen indicating nitrate reduction is taking place. The age distribution of water along this flow path is from 6 to 20 years. The redox chemistry changes substantially across the riparian buffer between the orchards and the river. Within the riparian part of the flow path, there is evidence of iron and sulfate reduction, and nitrate concentrations decrease to 1 mg/L or less in many locations. The riparian buffer is an apparent effective environment for removing nitrate from ground water. The flow path terminates at the riverbed, with seasonal groundwater discharge into the river, depending on the river stage. Unlike nutrients, few pesticides were detected in either the unsaturated or saturated zone. Simazine was the most frequently detected, and was present in all water younger than 20 years.

Linking Ground Water Age and Chemistry Data along Flow Paths: Implications for Trends and Transformations of Nutrients and Pesticides

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Jim Tesoriero is a research hydrologist with the Oregon Water Science Center of the U.S. Geological Survey (USGS). Since 1994, his research has focused on the fate and transport of agricultural contaminants in ground water systems and ground water–surface water interactions for the National Water Quality Assessment (NAWQA) program.

Karen Burow is a supervisory hydrologist with the USGS California Water Science Center. During the last 14 years, Karen has studied a wide range of ground-water quality topics, including contaminant transport and fate and long-term regional ground-water quality in urban and agricultural areas of the San Joaquin Valley of California.

David Saad is a hydrologist with the Wisconsin Water Science Center of the USGS. He is currently the chief of the Western Lake Michigan Drainages study unit of the NAWQA program and has been the ground-water specialist of the study unit since 1991. Agricultural effects on ground-water quality have been the focus of several of his NAWQA ground-water studies.

Elizabeth Frick is a hydrologist with the Georgia Water Science Center of the U.S. Geological Survey (USGS). She has primarily studied regional water-quality issues in ground- and surface-waters related to nutrients, pesticides, microbial indicators, and emerging contaminants.

Larry Puckett is a research ecologist with the U.S. Geological Survey National Water Quality Assessment (NAWQA) program. His primary research interests are the transport and fate of nitrogen in shallow aquifers and at the ground-water-surface-water interface.

Abstract
Tracer-based ground-water ages, along with concentrations of pesticides, nitrogen species, and other redox-active constituents, were used to evaluate the trends and transformations of agricultural chemicals along flow paths in diverse hydrogeologic settings. A range of conditions (e.g., thickness of unsaturated zone, redox conditions) affecting the transformation of nutrients and pesticides were examined at study sites in Georgia, North Carolina, Wisconsin, and California.

Transformations of nitrate and atrazine were examined by measuring parent and transformation product concentrations in ground water and relating these levels to ground-water age. The fraction of the initial nitrate concentration found as excess N_2 (N_2 derived from denitrification) increased with ground-water age only at the North Carolina site, where oxic conditions were generally limited to the top 5 meters of saturated thickness. Deethylatrazine (DEA), a transformation product of atrazine, was typically present at higher concentrations than atrazine at study sites with thick unsaturated zones but not at sites with thin unsaturated zones. Furthermore, the fraction of atrazine plus DEA that was present as DEA did not

increase as a function of ground water age. These findings suggest that atrazine degradation occurs primarily in the unsaturated zone with little or no degradation in the saturated zone at these study sites.

Trends were evaluated by estimating the time of recharge of a ground water sample using chlorofluorocarbon concentrations and estimating concentrations of parent and transformation products at the time of recharge by summing the concentrations of these compounds in the age-dated sample. This approach assumes that all significant transformation products have been measured. Using this approach, nitrate concentrations were estimated to have increased markedly from 1960 to present at all study sites.

Transport of Agricultural Chemicals: Estimating Lag Times in Different Hydrologic Environments

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David Wolock is a research hydrologist in the Kansas Water Science Center of the U.S. Geological Survey. Since 2001, he has served as the team leader of NAWQA's Hydrologic Systems Team. The Hydrologic Systems Team helps plan and implement modeling studies in NAWQA. His main area of interest is natural and human effects on the water balance at broad spatial scales.

Paul Capel is an environmental chemist with the U.S Geological Survey. Since 2001, he has served at the team leader of the USGS NAWQA study "Agricultural Chemicals: Sources, Transport and Fate." Prior to this, he worked with the USGS Office of Water quality and the NAWQA National Pesticide Synthesis Project. His main areas of research are environmental chemo dynamics and the environmental behavior and fate of organic chemicals in the air and surface water.

Abstract

Agricultural chemicals that are applied to cropland can move into the broader environment and become contaminants. This transport occurs through a variety of environmental pathways that include the soil surface, vadose zone, saturated zone, tile drains, and streams. The time scale of this transport varies substantially depending on the pathway followed by water from the land surface to the stream. For example, surface runoff to a stream may take minutes to days, whereas leaching to ground water followed by discharge to a stream may take months to decades. Knowledge of these time scales (the lag times between application of chemicals to the land surface and their occurrence at a given water-quality sampling location) is critical to water-resources management. The U.S. Geological Survey's National Water-Quality Assessment Program Agricultural Chemicals Team (ACT) has developed methods to study lag times at several study locations that reflect a variety of agricultural management practices in diverse hydroclimatic settings. The methods used to estimate lag times include a variety of data- and model-oriented approaches. The estimated lag times for three of the ACT studies in Maryland, Indiana, and Nebraska will be compared. The implications of different lag times in the three studies will be evaluated by demonstrating how the three locations differ in their responses to changes in agricultural practices.

Effective Policy Based on Sparse Data: TMDLs in the San Joaquin River Basin, California

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Leslie Grober is a Senior Land and Water Use Scientist in the California Central Valley Regional Water Quality Control Board, responsible for development of Total Maximum Daily Loads (TMDLs) and water quality control programs in the San Joaquin River Basin. He has 16 years of experience working on technical and regulatory aspects of San Joaquin River water quality, including the development and use of water quality models to evaluate the potential to manage water quality in real time.

Abstract

The San Joaquin River (SJR) in the Central Valley of California has undergone extensive hydromodification resulting in a river with seasonally low flows, dominated by discharges from agricultural sources. Portions of the SJR on the valley floor have been listed on the federal Clean Water Act (CWA) 303(d) list of impaired waters for low dissolved oxygen, and diazinon and chlorpyrifos. The CWA requires Total Maximum Daily Loads (TMDLs) to be developed for these listings. California's Porter Cologne Water Quality Control Act requires development of control programs to implement load reductions identified in these TMDLs. The California Regional Water Quality Control Board, Central Valley Region (Regional Board) is responsible for developing TMDLs in the Central Valley of California. The Regional Board, however, has limited resources to conduct all the monitoring and assessment needed to develop these TMDLs. Though monitoring and assessment studies such as those conducted as part of the NAWQA program, and others funded by the California Bay Delta Authority have provided much of the foundational data and analyses needed for these TMDLs, many unanswered questions remain. TMDLs and programs of implementation must, however, be developed before all sources, and fate and transport processes are completely understood. Proposed diazinon and chlorpyrifos water quality targets are based on readily available information on the effects of these pesticides on aquatic life. Load allocations are applied to large geographic areas based on varying hydrology and the ability to monitor compliance. The proposed dissolved oxygen control program relies on a conditional prohibition of discharge of oxygen demanding substances and its precursors, such as nutrients. The prohibition is conditioned, among other things, on a requirement to conduct studies to better understand the fate and transport of oxygen demanding substances. Each control program establishes a schedule to periodically review and update the regulation based on new information.

Nitrogen and Phosphorus Loadings to the Neuse and Pamlico River Estuaries, North Carolina

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Jerad Bales is a hydrologist with the USGS and conducts research and investigations in rivers, reservoirs, estuaries, and coastal systems to address effects of management actions on flow and water-quality. He has participated in and provided consultation on hydrodynamic and water-quality modeling projects in more than a dozen states, served on numerous interagency review panels, and is currently working with NOAA on a flood forecasting – flood mitigation project in India. Bales has authored or co-authored more than 100 articles and technical reports, and was primarily responsible for the river network monitoring design of the proposed National Monitoring Network.

Abstract

Many of the Nation's estuaries are experiencing excessive loadings of nitrogen and phosphorus, leading to eutrophic conditions, low dissolved-oxygen levels, and fish kills. Streamflow and nutrient data needed for accurate calculation of nitrogen and phosphorus loads at the head of estuaries are seldom available. Loads to the estuary are typically estimated from data collected at monitoring stations in upstream freshwater reaches of these rivers and extrapolated downstream to the head of the estuary, but these estimates may not be reliable.

Using acoustic instruments to measure tide-affected flow, the U.S. Geological Survey, in cooperation with the North Carolina Division of Water Quality, implemented a data-collection program that provides information on freshwater flow from 100 percent of the Pamlico River estuary drainage basin and 97 percent of the Neuse River estuary basin. These data, combined with nutrient concentrations measured at daily to weekly intervals, were used to calculate nitrogen and phosphorus loads to the two estuaries for the period 1997 - 2004.

Streamflow records were digitally filtered to remove tidal effects so that only net flows to the estuaries are used in loading calculations. Methods for estimating missing nitrogen and phosphorus data were investigated. An autocorrelation analysis of the nutrient concentrations indicated that during moderate flow periods, concentrations measured within about two weeks were substantially correlated. During high-flow events, missing data were estimated by using discharge – concentration relations. Calculated nitrogen and phosphorus loads can be used to evaluate the effectiveness of mandated watershed nutrient management strategies for the two basins, as well as provide guidance on required sampling frequency to maintain adequate reliability in load calculations.

Monitoring Wetlands in California

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Josh Collins received his Ph.D. in Entomological Sciences at the University of California at Berkeley and conducted post-doctoral studies in Geography and Ecology at the University of California at Berkeley and Davis. His current research focuses on rapid assessment and intensive functional assessment of wetlands and streams, spatial distribution of bio-geochemical processes in coastal wetlands, and scale-dependent habitat fragmentation profiles for wetland and riparian landscapes. Dr. Collins directs the Wetland Science program at SFEI.

Abstract

A comprehensive program to assess the performance of wetland projects and the ambient condition of wetlands is being developed through eco-regional technical teams with advice and review from federal and state wetland managers and regulators. The broad input is needed to assure that the assessment methods will work well for all wetlands throughout the state. The program is based on a 3-level approach to wetland assessment plus information management. Level 1 consists of wetland inventories and landscape profiles. The inventory relies on updates of the National Wetland Inventory with regional intensification. Wetland habitats within restoration and mitigation projects and impacted wetlands are mapped as sub-populations of each wetland class. Level 2 consists of rapid assessment to provide cost-effective probabilistic surveys of ambient condition using the Level 1 inventory as the sample frame. The rapid method of choice is the California Rapid Assessment Method (www.wrmp.org). Ambient surveys using CRAM can occur at spatial scales ranging upwards from small watersheds. A statewide assessment of estuarine wetlands and three watershed demonstration projects using CRAM are underway. CRAM can also be used to assess wetland projects and impacted sites, when more intensive methods are not required. Level 3 consists of standardized, intensive, quantitative monitoring methods. These are required to calibrate the Level 2 methods, and to assess the performance of projects where rapid methods do not provide adequate assurances of project status. The Wetland Tracker (www.wetlandtracker.org) is designed to assess the performance of wetland policies by tracking the effects of projects on the total quantity and ambient quality of wetlands. This 3-level approach is being piloted through coastal regions of state regulatory government for later transfer to inland regions. The intent is to create one program of wetland monitoring administered through regions for the state as a whole.

Assessing the Health of National Park Service Southeast Coastal Waters Using the United States Environmental Protection Agency's National Coastal Assessment Protocols

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Eva DiDonato is an aquatic ecologist for the National Park Service Southeast Coast Network Inventory and Monitoring Program where her primary duty is to design and implement a water quality monitoring program for 17 National Parks in the Southeast Region. Eva comes to the Southeast with water quality monitoring experience from the coastal areas of the Gulf of Mexico, American Samoa and Hawaii.

Virginia Engle is an ecologist with the U.S. Environmental Protection Agency's Office of Research and Development with expertise in estuarine ecology, monitoring and assessment methods, and statistical analysis. Since 1990, she has been involved in EPA's Environmental Monitoring and Assessment Program, focusing on development of tools to conduct national assessments of the condition of estuaries. Since 2000, she has been the Gulf of Mexico Regional Coordinator for the National Coastal Assessment and has collaborated on several National Coastal Condition Reports.

Lisa Smith is a Research Biologist at the Gulf Ecology Division within the US Environmental Protection Agency's Office of Research and Development with training and expertise in estuarine ecology and chemistry. Since 1996, she has been involved in multiple aspects of the US EPA Environmental Monitoring and Assessment Program (EMAP) ranging from field collections to data analyses. She currently serves as project officer for National Coastal Assessment Gulf Region (Alabama and Mississippi) and American Samoa.

Joe DeVivo is the Program Coordinator for the National Park Service Southeast Coast Inventory & Monitoring Network. Prior to working with NPS, Joe worked with the USGS National Water Quality Assessment Program in Atlanta, and for the US Fish and Wildlife Service where he designed a long-term water quality monitoring program for Eglin Air Force base in the panhandle of Florida.

Abstract

The Southeast Coast Network (SECN) of the National Park Service (NPS) contains seventeen National Park units located between Florida and North Carolina and as far west as Alabama. All parks contain significant natural resources, but six contain significant estuarine habitats. The SECN is currently developing a water quality monitoring program for the estuarine habitats within these parks. The SECN has partnered with US EPA to assess existing data, develop survey designs and select appropriate indicators for long-term monitoring of estuarine waters. The US EPA, in partnership with the states, sampled these waters between 1999 and 2004 as part of the National Coastal Assessment (NCA) program. Using these data, SECN has assessed the health condition of network estuarine waters over the past six years and developed a baseline for future monitoring efforts. As part of the Network's long term monitoring program, the SECN plans to utilize the NCA model and sample intensively one park per year on a rotating basis. This will allow an assessment of the condition of estuarine habitats within one park each year; more importantly, this approach will facilitate a network-wide assessment of estuarine condition every six years.

NOAA's National Estuarine Research Reserve's System Wide-Monitoring Program: Over Ten Years of Developing Capabilities, Applications, and Expansions

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Dr. Susan White is the National Research Coordinator for National Oceanic and Atmospheric Administration's Estuarine Reserves Division and National Estuarine Research Reserve System. Her research background is in estuarine ecology, with a focus on plant community ecology. Susan supports both national level research initiatives as well as site-based research priorities at the 26 Reserves throughout the United States through partnerships with federal, state and NGO's programs to attain research goals that support improved coastal management decisions.

Abstract

The National Oceanic and Atmospheric Administration's (NOAA) National Estuarine Research Reserve System (NERRS) was established by the Coastal Zone Management Act of 1972. There are 26 reserves protecting over one million acres of estuarine waters and adjoining lands across the continental United States, Alaska, and Puerto Rico. In 1995, the NERRS established a System-Wide Monitoring Program (SWMP) with three ecosystem foci: abiotic factors (including water and weather parameters), biological monitoring (including biodiversity and habitat characteristics), and watershed/land use classifications (including changes in human uses and land cover types). SWMP was designed to track short-term variability and long-term changes in estuarine waters to understand how human activities and natural events can change ecosystems. The design, data synthesis/dissemination, and the development of the three components of SWMP are realized through interactions with multiple user groups (ie. academic/governmental researchers, K-12 educators, and coastal decision makers) and multiple state and federal partnerships (ie. academic institutions, state resource departments, and NOAA's Integrated Ocean Observing System). More than 33,600 measurements of estuarine water and weather quality conditions are reported daily (ca. 42 million measurements per year) from more than 117 dataloggers deployed throughout the NERRS. The biological monitoring and classification components of SWMP are being implemented or piloted in the reserves with the expectation that the lessons learned will improve our understanding, protection of and efforts to restore coastal resources. These data are applied in a multitude of ways to improve and protect coastal resources, including: providing continuous water quality data for assessments, designing restoration projects, measuring impacts and estuarine recovery from natural disturbances, and integrating data into education curricula and workshops for coastal decision makers. The NERRS monitoring efforts, when integrated with programs for coastal training and education, provide timely scientific data to a diverse group of users who ultimately influence coastal resource decisions.

Capture, Care and Feeding of Volunteers

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Biographical Sketch of Author

Dwight Holford is the Watershed Coordinator for the Upper Putah Creek Stewardship based in Middletown CA. He has been with the Stewardship since its beginning in 1996. Dwight is a Federal retiree with experience as an administrator in the military housing field. His graduation from Humboldt State College with a BSc in Fisheries Biology now aids in his bioassessment and watershed work with the Stewardship.

Abstract

The Upper Putah Creek Stewardship, a public service organization was formed in 1996. Since its inception it has supported has supported citizen monitoring. In the beginning it had no one trained in bioassessment. Now it has a well trained team, a coordinator, a scientific advisor and a crew of citizen monitors. It has executed one 319(h) grant and is presently in its second one. Because of criteria for the next round of 319(h)s the UPCS will have to keep its monitoring plan alive by use of private funds. The team has also sponsored, or co-sponsored several citizen monitoring workshops. To be discussed will how networking, grant writing, fund seeking and volunteer involvement made this watershed group a successful operation.

Comparing *E. coli* Results Analyzed by Colilert® and Membrane Filtration Techniques

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Biographical Sketch of Author

Sam Dinkins has worked as an Environmental Specialist for the Ohio River Valley Water Sanitation Commission (ORSANCO) since 1995. Sam has primarily worked as the project coordinator on the Ohio River Watershed Pollutant Reduction Program, focusing on PCB, dioxin and bacterial contamination within the Ohio River Basin. He played a key role in the development of Total Maximum Daily Loads (TMDLs) for dioxin and PCBs for the Ohio River. His current efforts are focused on quantifying bacteria levels in the river and characterizing sources to support the development of a bacteria TMDL.

Abstract

The Ohio River Valley Water Sanitation Commission (ORSANCO) has completed two large-scale bacteria surveys covering the entire length of the Ohio River. The sampling consisted of conducting three-point cross-sections approximately every five miles, with additional samples collected at the mouths of tributaries and downstream of municipal wastewater treatment plants. To meet the strict six-hour hold time for bacteria samples, ORSANCO utilized a mobile water quality laboratory to analyze over 9000 samples for *E. coli* using the IDEXX Colilert® method.

The primary goal of the surveys was to assess bacteria levels in the Ohio River, especially for areas that had been previously unmonitored. A secondary objective, however, was to compare *E. coli* results generated by the Colilert® method in the mobile laboratory to sample results analyzed by contract laboratories using the more conventional membrane filtration (MF) technique. Over the course of the two-year study, more than 1000 samples were analyzed by both Colilert® and MF methods.

Seven different contract laboratories analyzed samples for *E. coli* using a membrane filtration technique for comparison to Colilert® results generated by ORSANCO. When comparing the Colilert® results to the individual contract lab data, clearly defined, but biased, relationships were observed. Results generated by three of the seven contract labs were typically 12% to 25% higher, depending on the lab, when compared to Colilert® results for the same samples. Conversely, the other four labs participating in the study typically produced values 15% to 50% lower than the Colilert® method. The inconsistent relationship of Colilert® and MF results across laboratories despite following standardized methods indicates that the inter-laboratory variability for the membrane filtration method may be significantly biased. Such bias among laboratories makes it difficult to develop consistent assessments over large geographical areas that draw upon data from multiple labs.

Volunteer Monitoring of *E. coli* in Upper Midwest Streams: A Comparison of Methods and Preferences

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Kristine Stepenuck received her B.S. in Water Resources Management from the University of New Hampshire and her M.S. in Natural Resources from the University of Wisconsin-Stevens Point. Since 2001 she has been the coordinator of Wisconsin's volunteer stream monitoring program. She also serves as a staff member on a USDA funded project with the University of Rhode Island Cooperative Extension which is designed to help increase coordination and communication among volunteer water quality monitoring programs across the nation.

Abstract
Bacterial contamination of surface waters is a common public health concern. Laboratory analyses can be expensive, yet such monitoring is important to ensure safe recreational opportunities. In 2004, volunteer monitoring programs in six upper Midwestern states were awarded a grant from USDA-Cooperative State Research, Education and Extension Service (CSREES) to evaluate five test methods for monitoring *E. coli* bacteria suitable for home use. Methods chosen for this project included Coliscan Easygel (incubated and not incubated), 3M Petrifilm, Coliscan MF Method, and IDEXX COLISURE. The methods were evaluated both by comparing home lab results to laboratory analyses of *E. coli* and volunteer preferences in using the home lab methods. After one season of monitoring by volunteers using these five methods in Indiana and Iowa, the project team identified two methods for volunteers in the other four participating states to assess; these were: Coliscan Easygel (incubated) and 3M Petrifilm. In 2005, nearly 40 volunteers in these states, Michigan, Minnesota, Ohio, and Wisconsin, were trained to use these two methods and asked to assess each based on their own preferences. These volunteers' samples were also sent to a lab in their state for comparison of bacterial counts between home lab methods and lab results. Volunteers in Indiana and Iowa continued to monitor using all five methods and one additional method (IDEXX Colilert) during 2005 to ensure the most appropriate home methods were recommended for use by volunteers in the other four states. Bacterial testing will continue in 2006 based on results from both years of monitoring. Ultimately, the project team will produce a training curriculum, educational materials, and recommendations about the methods which will be transferable to other regions. This presentation will describe the project's experimental design and summarize 2004 and 2005 results on the accuracy and usability of the home lab methods.

Development of Rapid QPCR Approaches for Measurement of *E. coli* and Enterococcus in Environmental Waters: The Future for Routine Monitoring?

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Rachel Noble is an assistant professor at the University of North Carolina at Chapel Hill Institute of Marine Sciences. The research in her laboratory is focused on assessments of water quality in recreational waters, shellfish harvesting waters, and the impacts of stormwater runoff on both. She has been a professor at UNC Chapel Hill for 5 years, and has been working during that time to develop rapid assays (less than 2 hours from sample to result) for Enterococcus and E. coli for water quality assessments. She is also interested in the microbial ecology and particle attachment mechanisms of allochthonous and autochthonous pathogens alike in estuarine environments.

Denene Blackwood is a research analyst at the University of North Carolina at Chapel Hill Institute of Marine Sciences and has been involved in the research and development involved in the development of the rapid assays at the Institute of Marine Sciences.

Abstract

Microbiological water quality of recreational and shellfish harvesting waters is currently determined by using bacterial indicators, such as total coliforms, fecal coliforms (or *E. coli*), and Enterococcus, to infer the presence of microbial pathogens found in fecal contamination. The available methods to measure these indicators (membrane filtration, directed substrate technology, and multiple tube fermentation), all require from 18-96 hours from sample to result, making management of aquatic resources inherently inaccurate. In the last few years, a range of molecular approaches have been developed to reduce the time to results to less than 4 hours. These methods have largely been amplification based approaches (e.g. based upon PCR or Transcription Mediated Amplification). We present results from blind studies using QPCR assays for E. coli that were completed in 1.5 hours, and demonstrated no false positives on blank samples. The QPCR E. coli assay was significantly correlated to results from routine methods (such as Colilert-18 and modified mTEC membrane filtration analyses, r=0.66). The QPCR assay for Enterococcus demonstrate no false positives on blank samples and significant relationships with membrane filtration and Enterolert results, with r values of 0.90 and 0.85, respectively. Both assays are being tested on a wide range of recreational and shellfish harvesting water samples from all regions of the coastal United States. Features of the assays in their application to commercial use are a bead format (lyophilized bead containing all necessary reagents), allowing the user to complete the assay with only two pipetting steps, and the use of Scorpions primer probe chemistry (DsX Limited), permitting a limit of detection of 1 cell per reaction, and virtually no background fluorescence. The results of these studies, application of these assays to a wide range of sample types and relationships of QPCR assay results to human health effects will be presented.

IMS/ATP Rapid Method for the Determination of *E. coli* Concentrations in Recreational Waters

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Rebecca Bushon is a hydrologist with the U.S. Geological Survey, Water Resources Discipline, in Columbus, Ohio. Ms. Bushon is the laboratory coordinator for the Ohio Water Microbiology Laboratory and has training and experience in environmental microbiology with the USGS for the last 9 years. She has served as project chief on studies addressing recreational water quality in rivers and lakes, indicator and pathogen detection, and rapid bacterial methods. She is currently involved in a project with the USEPA, National Homeland Security Research Center, to detect bioterrorism agents in drinking water.

Amie Brady is a hydrologist with the U.S. Geological Survey, Water Resources Discipline, in Columbus, OH. She received bachelor's degrees in Environmental Science and Plant Biology and a Master's degree in Environmental Science from Ohio State University, Columbus, Ohio. Ms. Brady has been involved with microbiological monitoring projects dealing with recreational water quality in Ohio rivers, streams, and lakes for the last 6 years.

Christina Likirdopulos is a hydrologist with the U.S. Geological Survey, in Columbus, OH. She received a bachelor’s degree in Chemistry from Berea College and a Master of Science degree in Public Health from the University of North Carolina at Chapel Hill. At the USGS, she has worked on optimizing a rapid method to detect *E. coli* in recreational waters and is involved in a project to detect bioterrorism agents in drinking waters.

Abstract
The need for a method to rapidly determine concentrations of fecal-indicator bacteria in recreational waters is widely recognized. Current monitoring methods to determine bacterial concentrations require at least 18-24 hours to obtain results. This timeframe is too long to adequately assess the safety of the water relative to recreational standards. Bacteria concentrations in the water can change overnight, and because the current day’s concentrations are not available until the following day, recreational users may be at risk of coming into contact with water that is not considered safe for recreation. Alternatively, the river or beach may be posted when the risk is low, resulting in lost recreational use and revenue. A rapid, cost-effective method is needed to obtain more accurate short-term information than is available by traditional monitoring methods.

A rapid method for determining concentrations of *E. coli* in water in less than 1 hour was developed by researchers at the University of Michigan. The method is based on immunomagnetic separation (IMS), which selectively captures target bacteria through the use of antibodies attached to magnetic beads. Adenosine triphosphate (ATP) bioluminescence is used for quantification of the captured target bacteria.

The IMS/ATP rapid method was field tested by the U.S. Geological Survey in river and lake recreational waters. During the recreational seasons of 2004 and 2005, the method was tested in the Cuyahoga River within the Cuyahoga Valley National Park, Ohio, in collaboration with the National Park Service. It was also tested in another study during the recreational season of 2005 at two beaches in Cleveland, Ohio—Edgewater and Villa Angela—in cooperation with the Northeast Ohio Regional Sewer District. Preliminary results from both studies showed significant correlations between the IMS/ATP rapid method and the standard method for *E. coli*.

Building Credibility: Quality Assurance and Quality Control for Volunteer Monitoring Programs

Facilitators
Elizabeth Herron, University of Rhode Island Watershed Watch
Ingrid Harrald, Cook Inlet Keeper

Biographical Sketches
Elizabeth Herron is the Program Coordinator for the University of Rhode Island Watershed Watch (URI WW) program, a URI Cooperative Extension citizen volunteer water quality monitoring program. Her initial role with the program was to conduct a quality assurance and quality control assessment of the program. That project focused on determining if volunteers using the URIWW methods could collect data that was a good as professionally collected data. They could, and do. Since then she has developed several advanced training programs for volunteer water quality monitors, and helps to coordinate all aspects of the URI Watershed Watch program, the primary source of lake water quality data for the state of Rhode Island. Helping to support volunteer monitoring efforts regionally and nationally, Ms. Herron is a principal in the Cooperative State Research, Education and Extension Service (CSREES) National Facilitation of Volunteer Monitoring Efforts project and the New England Volunteer Monitoring Focus Area. She conducts workshops nationally and regionally, and is a regular presenter at international symposia hosted by organizations such as the North American Lake Management Society, CSREES National Water Conference and the National Water Quality Monitoring Council Conference. With both her bachelors and masters degrees from URI, Ms. Herron has spent her entire adult life in Rhode Island, but will never be considered a Rhode Islander.

Ingrid Harrald is currently a volunteer coordinator for Cook Inlet Keeper, private nonprofit organization dedicated to protecting the vast Cook Inlet watershed and the life it sustains. She coordinated Cook Inlet Keeper's Citizens' Environmental Monitoring Program. She received a Bachelor of Science degree in Biology from Virginia Tech. She worked as a Biology Technician studying seabirds for the U.S. Fish and Wildlife Service for 8 years on remote islands throughout Alaska and California. She also spent time coordinating volunteer programs in California, working with the Gulf of the Farallones Marine Sanctuary and the National Park Service to manage their citizen science and site stewardship programs. More recently, Ingrid has worked for the Alaska Maritime National Wildlife Refuge in Homer studying the breeding biology and diet of storm-petrels in Southeast Alaska.

Workshop Description
The ultimate goal of most volunteer monitoring programs is to ensure that well-trained volunteers collect high quality data and that the data are used. That means that the data must be credible, which typically means that it is documented and defensible. This workshop will focus on the three elements of the Quality System - Assurance, Control and Assessment, and present ideas on how you can incorporate them into your monitoring program, helping you to generate data that meets your data users' needs. In particular, this interactive workshop will include an discussion of the Quality Control tools - what the various terms mean, which parameters they pertain to, and how volunteer programs can implement these tools. Participants are asked to bring data sheets, manuals and Quality Assurance Project Plans from their own programs to review and share.

Effects of Urbanization on Stream Ecosystems: Overview and Study Design of the U.S. Geological Survey's Urban Stream Studies

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Tom Cuffney is a Research Ecologist in the U.S. Geological Survey's Water Resources Discipline. He joined the Survey in 1990 and has worked for the National Water-Quality Assessment (NAWQA) Program for the past 16 years. He has made many contributions to NAWQA including program design (urban stream studies), sampling protocols (invertebrates), and data analysis methods and tools (IDAS, ADAS, GRAN). From 1999-2001 he led the effort to evaluate land-use gradients as a mechanism for understanding the effects of urbanization on streams. Tom has a Ph.D. in Entomology/Aquatic Ecology from the University of Georgia and a M.S. in Biology from Idaho State University.

Abstract

A major emphasis of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program is to understand the effects of urbanization on stream ecosystems. This study assesses the magnitude and pattern of response in biological (fish, invertebrates, and algae), physical (flow, temperature, in-stream habitat) and water chemistry (specific conductance, suspended sediment, nutrients, pesticides, organics) variables to varying intensities of basin urbanization in 11 major metropolitan areas of the United States. Studies are conducted on a rotational schedule including Birmingham, Alabama; Boston, Massachusetts; and Salt Lake City, Utah, in 2000; Raleigh, North Carolina; Atlanta, Georgia; and Denver, Colorado, in 2003; Dallas/Fort Worth, Texas; Milwaukee/Green Bay, Wisconsin; and Portland, Oregon, in 2004; and Seattle, Washington, and Sacramento, California, in 2007-2008. The nationally consistent study design uses a multimetric index of urban intensity to identify representative gradients of urbanization (low to high) for about 30 basins in each metropolitan area. The urban intensity index is derived from land cover, infrastructure, and socioeconomic variables. Study basins typically are located within a single ecoregion in each metropolitan area to control for natural landscape variability. This design provides a method for limiting the variability of natural landscape characteristics while assessing the magnitude of urban effects. Common protocols to measure biological, physical, and chemical responses are used nationwide. Use of a consistent study design across the 11 metropolitan areas allows us to make direct comparisons among metropolitan areas. Understanding the similarities and differences

in how urbanization affects biological, physical, and chemical characteristics of streams across the United States is important for managing aquatic resources. The intended result of this study is an improved scientific basis for decision makers to protect urban waters in a variety of geographic and environmental settings across the Nation.

Ecological Responses of Streams to Urbanization: a Review of Results from the U.S. Geological Survey's Urban Streams Studies

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Abstract

U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program personnel have been investigating biological (fish, invertebrates, and algae), chemical (major ions, pesticides, nutrients), and physical (temperature, stage, discharge, in-stream habitat) responses along gradients of urbanization in 11 major metropolitan areas of the conterminous United States. Results from these studies indicate that stream biota, water chemistry, and hydrology respond to urbanization in predictable ways, with many similarities among metropolitan areas that are geologically and climatically different. For example, the rates at which invertebrate assemblages change along the urban gradient were similar for Birmingham, AL; Raleigh; NC, Atlanta, GA; Boston, MA; and Salt Lake City, UT.

Invertebrate assemblages exhibited the strongest and most consistent responses to urbanization with richness and biotic integrity decreasing and average tolerance increasing as urbanization increased. Fish and algal assemblages also changed as urbanization increased (e.g., decreases in fish biotic integrity, increases in algal diversity and eutrophic species), but not as frequently nor as strongly as invertebrates. The mobility of fish, the large number of introduced tolerant species, and the ability of some species to exploit terrestrial food resources tended to obscure the effects of urbanization. The rapid turnover of algae made them better indicators of local-scale conditions (e.g., spates) than basin-scale conditions associated with urbanization. Water chemistry, particularly indices derived from the aggregation of nutrients and pesticides, increased with increasing urbanization. Changes in all three biological assemblages, however, typically preceded significant changes in water chemistry. Changes in stream hydrology (timing and duration of flows) also were frequently associated with increases in urbanization and changes in biota. Similarities in responses among urban areas and in the environmental factors (e.g., amount of developed lands, density of roads) associated with these responses indicate that similar management and mitigation practices may be effective in metropolitan areas in diverse regions of the country.

Identifying the Changes to Stream Condition Caused by Urbanization, and How Modeling the Responses Can Be Used to Improve Ecological Risk Characterizations

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James Coles is an ecologist with the USGS, Patuxent Wildlife Research Center, and currently works with EPA Region I providing technical assistance to the Superfund Program. Jim began with the USGS in 1992 working for the National Water-Quality Assessment (NAWQA) Program, first as lead ecologist for the Connecticut River Study, and in 1997, for the New England Coastal Basins Study. In this latter role, Jim worked with Tom Cuffney and others in the Urban Gradient Study for New England. Jim has a B.A. in Biology from the University of Virginia and a Ph.D. in Aquatic Ecology from George Mason University.

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Cornell Rosiu is an environmental scientist in the Office of Site Remediation and Restoration at the U.S. EPA's New England Region I office, with educational background and 19-years experience in environmental toxicology and chemistry. In the Superfund Program since 1998, he has provided technical support in ecological risk assessment and contaminated sediment site cleanup. He has had collateral assignments during that time as regional coordinator of EPA's Urban Rivers Restoration Initiative, and Superfund Biological Technical Advisory Group. He has a B.S. degree from Michigan State University an M.S. degree from the University of Rhode Island.

Abstract
The results of a USGS urban land use gradient (ULUG) study in New England indicated how urbanization was effectively characterized among 30 watersheds in the Northeastern Coastal Zone Ecoregion by the use of an *a priori* urban intensity index (UII), derived from 24 census and landuse variables. However, before the *a priori* UII could be applied as a tool to monitor urbanization in developing watersheds, further investigation was needed to develop an index that was more concise and which was applicable to additional watersheds. For example, there was strong evidence that only a subset of the 24 variables from the *a priori* UII was needed to effectively characterize urbanization from an ecological perspective. Additionally, because the *a priori* UII was scaled only to the relative degree of urban intensity among the 30 study sites, a more definitive model would be required to derive values of urban intensity for sites that were not in the original 30-site network. We used the findings reported in the original ULUG study to: 1) derive an urban intensity index with fewer variables than the *a priori* UII, but which still effectively characterized urban intensity in the region, 2) identify biological variables that responded most consistently to urbanization in the region, so that they could be used as indicators of ecological condition. Achieving these objectives is expected to result in a relatively simple method to

characterize urban intensity, and to provide a reference for how the baseline ecological conditions of a stream are expected to change with urbanization. For example, given the landuse intensity for a site, this method could be used to define expected ecological conditions at the site. Prediction of the baseline ecological conditions will improve the process of assessing impacts to a site from recognized sources of contamination when conducting watershed-level ecological risk assessments.

Modeling Urban Landscape Patterns and their Effects on Aquatic Ecosystems

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Abstract
Patterns of urban development across the United States are changing natural landscapes and their dynamics. Although scholars in landscape ecology are increasingly studying the relationship between urban development and ecological conditions, little is know about how urban landscape patterns emerge and affect ecosystems In this paper I first propose that landscape patterns emerge from the spatial interactions between biophysical and socioeconomic processes. I then propose that distinct landscape signatures relevant to various ecosystem processes can be identified for different urban development patterns. Using selected landscape metrics I describe patterns of landscape change in the Central Puget Sound region and their influence on aquatic macroinvertebrates. The analysis is developed around three major steps. First I develop a set of spatially explicit multinomial logit equations of land cover transitions to show that landscape change, both its composition and configuration, is influenced by both socio-economic and biophysical variables. I then use selected landscape metrics to explore landscape trends in Central Puget Sound. Using data from 42 sub-basins I show how identified trends have significant consequences for the response that aquatic ecosystems have to these human landscape alterations.

Application of Ground Water Dating Techniques for Evaluating the Susceptibility of Aquifers and Public-Supply Wells to Contamination

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Sandra Eberts has been a hydrologist with the U.S. Geological Survey for over twenty years. She is currently team leader of the USGS National Water-Quality Assessment program Transport of Anthropogenic and Natural Contaminants to Supply Wells (TANC) topical study. Prior to her work on the TANC study, Sandra spent 8 years as a technical liaison to the U.S. Air Force for the clean-up of groundwater contamination at weapons manufacturing facilities nationwide.

Dr. John Karl Böhlke is a Research Hydrologist in the USGS National Research Program in Water Resources. He received his PhD degree in Geology and Geophysics at the University of California, Berkeley, and has worked for the Geologic Discipline and the Water Resources Discipline at USGS for approximately 20 years, specializing in geology and geochemistry. His published work includes field and laboratory-based studies of water-rock interactions, geochronology of rocks and groundwaters, and contaminant transport in diverse hydrogeologic settings, with recent emphasis on application of isotopes and other environmental tracers to track nitrate and related compounds in the near-surface environment.

Leon Kauffman has been a hydrologist with the U.S. Geological Survey for ten years. He currently is part of the Hydrologic Systems Team of the National Water Quality Assessment program providing technical support for various ground-water modeling activities. His research interests include coupling models, spatial data, and water quality results to better understand ground-water systems.

Abstract
Scientists with the USGS National Water-Quality Assessment Program evaluated age-dating techniques for their utility in screening aquifers and public-supply wells (PSWs) for susceptibility to contamination; four principal-aquifer settings (Central Valley, Floridan, Glacial Deposits, High Plains) were addressed. Multiple environmental tracers (sulfur hexafluoride, chlorofluorocarbons, tritium/helium-3, tritium) were compared with ground-water age distributions generated by use of lumped parameter models and numerical flow models for PSWs and for monitoring wells installed throughout their contributing areas. Results for samples collected at multiple depths within several of the PSWs during pumping also were compared with results from nested monitoring wells adjacent to the PSWs.

Young water (less than 50 years old) was detected in all of the PSWs. Comparison of environmental tracer data with lumped-parameter models and numerical flow models indicate a variety of age distributions in which young water in the PSWs ranged from 20 to nearly 100 percent of the water produced. Comparison of the dating results from the PSWs and monitoring wells, in combination with the age distributions from the numerical flow models, provides insight into which PSWs contain young water consistent with recharge from their simulated contributing areas and which contain young water drawn down locally by short circuiting through natural conduits (such as sink holes) or anthropogenic features (such as irrigation wells). This additional knowledge of where and how young waters actually enter PSWs, which is facilitated by understanding the distribution of ground-water ages in the surrounding aquifer, may be necessary to develop monitoring strategies and plans that are capable of protecting PSWs from contamination.

Evaluating Uncertainty in Areas Contributing Recharge to Wells for Water-Quality Network Design

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Abstract

Estimates of areas contributing recharge (ACRs) to wells are essential to understanding the relation between land use and drinking-water quality. Simulation models commonly are used to estimate ACRs, but the effects of uncertainty in the models often are not considered. As part of the U.S. Geological Survey's National Water Quality Assessment, uncertainty was evaluated in four simulation models used to estimate ACRs in California, Connecticut, Florida, and Nebraska. These analyses resulted in a series of maps showing the probability of an area being in the true ACR. The maps were then used in the design of water-quality sampling networks. Although the initial study design was to place wells along a specific flow path, the uncertainty analysis indicated that wells should be located in a broader area so that all potentially contributing land uses are sampled. The four models represent very different hydrogeologic settings, and uncertainty arises from different parameters in each model. The distribution of hydraulic conductivity is an important source of uncertainty. One common method to assess this source of uncertainty is to use statistically derived distributions as input to the model. The method in this study uses the covariance structure of parameters, as determined using a nonlinear parameter-estimation procedure, in a Monte Carlo simulation. The sources of uncertainty in this method include model parameters other than hydraulic conductivity, such as recharge rates, but do not include a detailed representation of hydraulic conductivity. In addition to affecting the estimated ACR, uncertainty affects the distribution of estimated travel times in the aquifer. Monte Carlo results indicate that uncertainty is related to travel time; longer travel times lead to greater uncertainty in the estimated ACR. This result can be used to predict the probability of sampling a combination of water from different sources in a well.

Use of Multiple Tracers and Geochemical Modeling to Assess Vulnerability of a Public Supply Well in the Karstic Upper Floridan Aquifer

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Brian G. Katz, PhD, is a research hydrologist with the U.S. Geological Survey in Tallahassee, Florida. During his career with the USGS, he has conducted numerous geochemical studies of processes that control the composition of natural and contaminated waters. His current research involves the use of isotopic and other chemical tracers to quantify hydrochemical interactions between ground water and surface water, determine sources and chronology of contamination in karst aquifers, and assess flow-system dynamics in complex aquifer systems.

Christy A. Crandall is a hydrologist with the U.S. Geological Survey's National Water Quality Assessment Program with training and experience in hydrology and water quality. Since 2002, she has served as project manager and ground-water modeler for the Transport of Anthropogenic and Natural Contaminants to Supply Wells project from its planning phase into full implementation. Christy moved to the U.S. Geological Survey in 1993 from the National Park Service and has worked in a variety of water programs over the last 20 years.

W. Scott McBride is a hydrologist with the U.S. Geological Survey in Tampa, Florida. He has 17 years of experience in surface and groundwater investigations, water quality sampling and analysis, technical equipment procurement and use, specialized sampling techniques, and project management. He has coordinated and implemented several groundwater studies for the Georgia-Florida Coastal Plain Study Unit of the National Water-Quality Assessment Program, and is currently project chief of a watershed study in central Florida.

Marian P. Berndt is a hydrologist with the U.S. Geological Survey in Tallahassee, Florida. She is currently the project chief for the Georgia-Florida Coastal Plain study of the National Water-Quality Assessment program. She has worked on a variety of water quality and ground water geochemistry studies and is currently working on studies on the geochemistry and occurrence of contaminants in the surficial and Floridan aquifer systems in the southeastern U.S.

Abstract
As part of a USGS national study of contaminants in public supply wells, multiple chemical indicators and geochemical modeling techniques were used to assess contaminant movement in a karstic ground-water system in Tampa, Florida. Six volatile organic compounds and four pesticides were detected in trace concentrations in water from a public supply well (PSW) tapping the carbonate Upper Floridan aquifer (UFA) with an open interval from 119-174 ft below land surface. These contaminants were detected more frequently in water samples from 11 monitoring wells in the overlying clastic surficial aquifer system (SAS) than in water from 13 monitoring wells in the UFA in the study area. Likewise, nitrate-N concentrations in the PSW (0.72-1.4 mg/L) were more similar to median concentrations in the oxic SAS (2.1 mg/L) than the anoxic (sulfate-reducing) UFA (0.06 mg/L). Elevated concentrations of ^{222}Rn and U in the PSW appear to originate from water moving downward through sands and discontinuous clay lenses that overlie the UFA. SF_6 and $^3H/^3He$ concentrations in water samples from the SAS were consistent with recent recharge (4-year median age), but water from the UFA indicated binary mixtures of recent recharge with tracer-free waters (>50 years). Tracer concentrations in the PSW also

indicated the presence of some young water (< 7 years), and SF_6 apparent ages for water from 140-160 ft depth in the PSW were slightly younger (1-2 years) than ages of water from shallower depths in samples collected during pumping and non-pumping conditions. Additional chemical and geophysical data indicated that movement of young water into the 140-160 ft zone is enhanced by solution features that likely are directly connected to the surface and SAS. Geochemical mass-balance models for the PSW indicate mixing scenarios that include 50-80% contribution of water from the SAS, along with dissolution of minor amounts of calcite, gypsum, and dolomite from the UFA.

Depth-Dependent Sampling to Determine Source Areas and Short-Circuit Pathways for Contaminants to Reach Public Supply Wells, High Plains Aquifer, York, Nebraska

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Matt Landon has been a hydrologist with the U.S. Geological Survey since 1990. He has conducted studies of ground-water hydrology and ground-water quality in Minnesota, Nebraska, and California. He is currently working on studies of transport of anthropogenic and natural contaminants to public supply wells for the National Water-Quality Assessment Program and the California Ground water Ambient Monitoring and Assessment program.

Brian Clark is a hydrologist at the USGS Arkansas Water Science Center. He currently serves as the primary modeler for the High Plains Ground Water study unit of the NAWQA Transport of Anthropogenic and Natural Contaminants (TANC) topical study and is the project chief of the newly formed Mississippi Embayment Regional Aquifer Study.

Allen Christensen has been a hydrologist with the USGS since 1991. He has conducted studies throughout the desert southwest using gravity, microgravity, well-bore flow analysis, and depth-dependent water-quality analyses in pumping wells to determine vertical differences in saturated and unsaturated flow and water chemistry.

Abstract
As part of the U.S. Geological Survey's National Water-Quality Assessment Program, an investigation of the processes controlling the transport of contaminants to public-supply wells was conducted in layered unconsolidated deposits of the High Plains aquifer near York, Nebraska. Analysis of samples collected from a public-supply well that integrate water from the entire screened interval within a confined sand aquifer revealed concentrations of PCE, TCE, and uranium that were below drinking-water standards but of concern as indicators of contamination. Samples also were collected from the supply well under typical pumping conditions at five depths in the 18-m long screen using a submersible bladder pump. The samples from the bottom half of the screen had oxygen and hydrogen isotopic values and concentrations of PCE, TCE, major ions, excess nitrogen gas, and uranium consistent with water derived from shallow recharge areas in the urban area mixed with relatively older native water from the confined aquifer. The presence of the unconfined-source water only at the bottom of the supply-well screen implies that well-bore leakage in the supply well itself was not the pathway for contaminant movement. Similar mixed water signatures were detected in a few monitoring wells screened in the confined aquifer along the zone of contribution. This non-uniform distribution of unconfined-source water implies that there are preferential flow paths that permit urban recharge water and contaminants to move across the confining unit. The primary pathway is probably downward leakage of water through well bores or annular spaces of irrigation or older supply wells that penetrate the confining unit.

The depth-dependent sampling, combined with monitoring-well data, provided an improved conceptualization of how contaminants enter the supply well. Results of a numerical solute transport model are consistent with an interpretation that supply-well contamination is dependent upon preferential pathways and transient seasonal vertical-head gradients.

Integrating a Continuous Water Quality Monitoring Network into Texas' Surface Water Quality Monitoring Program

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Abstract
Continuous water quality monitoring is conducted across the country to characterize water quality in greater detail than is possible with the traditional grab sampling. Collecting data in "real-time" is marketed as a cost-effective alternative to the time-consuming and costly expenditures associated with the collection of traditional routine grab samples. However, few programs have successfully incorporated continuous water quality data into the decision making process. Making the effective use of the large volume of data and documenting the quality of data produced is difficult and often can not be accomplished with guidance written specifically for grab sample collection. The Texas Commission on Environmental Quality has established a network of twenty-two stations continuously collecting water quality data, and is attempting to find solutions to these problems in order to make the data useful. This paper describes: the process by which TCEQ established a continuous monitoring network for basic field measurements and limited nutrient sampling, the collaborations formed with other monitoring entities to share the data and resource burden, how this network is supported, and the quality assurance the agency has in place to determine the best use of this new technology.

Continuous In-Stream Monitoring To Measure and Estimate Water-Quality Concentrations, Densities, and Loads

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Andrew C. Ziegler is the Hydrologic Investigations Section Chief and Water Quality specialist with the USGS Kansas Water Science Center. He has conducted numerous water-quality studies in Missouri and Kansas in the last 20 years related to acidic mine drainage, transport of agricultural chemicals in ground and surface water, aquifer storage and recovery, reservoir sediment and quality studies, and the use of real-time water quality monitors and statistical analysis to continuously estimate constituent concentrations and loads.

Victoria Christensen is a hydrologist with the USGS Minnesota Water Science Center. Her current studies include those related to reservoir eutrophication, real-time water quality, and effects of agricultural land retirement on stream quality.

Patrick P. Rasmussen is a hydrologist with the USGS Kansas Water Science Center. He has conducted numerous hydrologic studies in Kansas in the last 16 years related to flood frequency, ground- and surface-water quality, reservoir quality, surface-water-quality modeling, and the use of real-time continuous water quality monitors in river and reservoir applications.

Casey Lee is a hydrologist with the USGS Kansas Water Science Center. He has participated in water-quality studies involving the use of water-quality monitors to estimate constituent concentrations and loads, and the sources and transport of emerging contaminants in urban environments.

Teresa Rasmussen is a hydrologist specializing in surface water quality with the USGS Kansas Water Science Center. Since joining the USGS in 1998, she has conducted studies describing streamflow trends and investigated water quality in large agricultural and small urbanizing watersheds using continuous data.

Abstract

Continuous in-stream water-quality monitoring provides real or near real-time data on the variability of water quality in streams and reservoirs in response to changes in hydrologic conditions. Continuous real-time water-quality data are needed for decisions regarding water treatment, regulatory programs, and public safety. Additionally, increased data-collection frequency provides an improved understanding of cause-and-effect relations that result in observed water-quality characteristics.

Improvements in sensor and data recording technology since the late 1950s and 1960s have now made it possible to directly measure or estimate many water-quality constituent concentrations. Sensors that measure or estimate water-quality constituent concentrations using electrometric methods are available for specific conductance, pH, water temperature, and dissolved oxygen, and ion-specific electrodes (for chloride or nitrate). Sensors are available that measure portions of the electromagnetic spectrum that indicate adsorption or scatter (turbidity, Dopler technology, and fluorescence). Finally, in-stream chemical analyzers are available (bench chemistry in-situ for nitrate and phosphorus,), and portable field laboratories.

A continuous in-stream water-quality monitoring system developed by the U.S. Geological Survey in Kansas provides real-time estimates of constituent concentrations, densities, and loads for sediment, major ions, selected nutrients and metals, atrazine, geosmin, and indicator bacteria that cannot be measured directly. Regression models are used to relate constituent concentrations in laboratory-analyzed discrete samples to in-stream sensor measurements such as specific conductance and turbidity. At each monitoring site, estimates of uncertainty and probability of exceeding relevant water-quality criteria are provided that improve the characterization of water quality compared to traditional approaches (http://ks.water.usgs.gov/Kansas/rtqw/). Examples of operational requirements, statistical models, and interpretations from selected stream and reservoir sites in Kansas and other locations in the United States will be presented.

A Real-Time Water Quality Monitoring Network for Investigating the Strengths and Weaknesses of Existing Monitoring Techniques

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David is a Professor in Civil and Environmental Engineering and a researcher at the Utah Water Research Laboratory at Utah State University, a land grant Carnegie I research university. He has over 20 years of experience in many facets of Environmental Engineering, of which over 10 years have been spent specifically in the area of watershed water quality management. His expertise includes surface and ground water quality modeling, monitoring, and decision support. He has developed or supported development of a number of tools for managing, analyzing, and communicating water quality monitoring data for researchers, regulators, consultants and stakeholders.

Jeff has worked for the past five years at the Utah Water Research Laboratory at Utah State University in the areas of surface water quality, watershed management, and decision support. Trained in Environmental Engineering with an emphasis in surface water quality, he is working to create stand alone and Internet-based tools for managing, analyzing, and disseminating water quality and watershed related data. Mr. Horsburgh's professional experience includes projects providing technical support for development of Total Maximum Daily Loads, water quality data management and analysis, surface water quality model selection and development, information dissemination to stakeholders, and integrated watershed management planning.

Nancy is an assistant professor in the Department of Aquatic, Watershed and Earth Resources, with graduate degrees in limnology and environmental engineering at the University of Washington. She has worked as a private consultant, for a regional water quality agency and for a state natural resources agency as an Extension Specialist for water quality, and presently spends much of her time on state-wide and regional water quality efforts. Her water quality Extension program focuses on watershed management, on developing techniques to better monitor and evaluate impacts to our waters and responses to remediation, and on helping citizens understand the linkage between activities on the land and impacts to our waters.

Abstract

Traditional water quality monitoring approaches have generally relied on discreet grab and/or composite samples analyzed for a standard set of water quality parameters, with supporting in-stream measurements of temperature, dissolved oxygen, pH, and specific conductance. In many systems, however, monthly, biweekly, or even weekly grab samples may be inadequate to capture the natural or anthropogenic variability in pollutant concentrations. This can lead to an underestimation of pollutant loads and a greater focus on steady point source loading when intermittent or infrequent nonpoint source loads are important but not characterized by grab samples. This presentation will introduce a continuous water quality monitoring effort in the Little Bear River of Northern Utah that has been paired with periodic and storm event sampling using hand grab and automated samplers paced to stream flow during storm and spring runoff events. The monitoring program has been designed to evaluate the strengths and weaknesses of each of the water quality monitoring techniques and will focus on correlating the results of continuous

turbidity, oxygen, temperature, conductance and pH monitoring with those of traditional grab samples and higher frequency automated sampling in the context of estimating pollutant loading.

Monitoring Surface-Water-Quality in the Tongue River Watershed of Montana and Wyoming

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Stacy Kinsey is a hydrologic technician with the U.S. Geological Survey in Billings, Montana. She has been with the U.S. Geological Survey for 6 years. During this time she has contributed to various studies, including NAWQA and EMAP. Currently, she oversees the water-quality collection and monitoring for the Tongue River Monitoring Program.

Peter Wright is a hydrologist with the U.S. Geological Survey in Billings, Montana. He has coordinated and participated in the collection of ecological and water quality data for several monitoring programs in Montana and Wyoming including the Yellowstone NAWQA and EMAP Western Pilot. He has worked for the U.S. Geological Survey since 1992. He received his B.S. degree in Environmental Science from Allegheny College.

David Nimick has been a research geochemist with the U.S. Geological Survey in Helena, Montana, for 17 years. His work has focused on the fate and transport of inorganic contaminants such as arsenic, selenium, heavy metals, nutrients, and salinity.

Thomas Chapin is a research chemist with the U.S. Geological Survey, Denver, Colorado. He received his PhD in Chemical Oceanography from the University of Washington. His research interests are the development and application of novel in-situ chemical analyzers to investigate biogeochemical cycling of metals, nutrients, and pollutants in freshwater and marine systems.

Abstract

Coal-bed methane (CBM) production is increasing in the Tongue River watershed of Montana and Wyoming. The U.S. Geological Survey has been operating an enhanced monitoring network in the watershed since January 2004 to provide information for evaluating potential changes in surface-water quality. Water samples are collected regularly for laboratory analysis and continuous monitors are operated to measure specific conductance (SC) at seven mainstem and five tributary sites. Data are disseminated primarily by the Internet.

Sodium-adsorption ratio (SAR) is important to irrigators. Real-time SAR is provided to the public by converting continuous SC data for sites with statistically significant SC-SAR relations. However, because SC-SAR relations are sometimes poor and can be affected by temporal variability in the composition of dissolved solids in the water, an onsite analytical instrument is being developed. This SAR analyzer, which is being tested at two sites, analyzes samples and calibration standards using an ion-selective micro-electrode for sodium and spectrophotometric methods for magnesium and calcium. Results of monitoring for March through October 2004 provide an initial overview of water quality in the watershed. SC and SAR values in the Tongue River gradually increase downstream, with a distinct increase near the mouth. No samples had values that exceeded either the Montana irrigation-season SC standard of 1,500 microsiemens per centimeter or the Montana irrigation-season SAR standard of 4.5 for individual samples. SAR values in the mainstem generally were near or less than 1, except at Tongue

River at Miles City, Mont., where values ranged from about 2 to 4. Data collected thus far probably do not adequately represent a sufficiently broad range of hydrologic and water-quality conditions to support assessments of compliance with Montana water-quality standards for irrigation. Changes in water quality over time associated with hydrologic conditions, climate variations, or CBM development and other land-use activities will require long-term monitoring to characterize variability, detect trends, and understand processes or potential causes of change.

Pennsylvania's Application of Probability-Based Sampling for Statewide Surface Water Assessments

Tony Shaw

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Biographical Sketch of Author

Tony Shaw bas been a field biologist with Pennsylvania's Department of Environmental Protection for over 25 years and currently is a Biologist Supervisor in that agency's Water Quality Standards Section. He has training and experience in benthic macroinvertebrate biology and has conducted many aquatic life use surveys and biological stream assessments for Pennsylvania's water quality monitoring and Antidegradation Programs. He is directly involved in the development of PA's surface water assessment protocols and biocriteria projects and serves as a first level manager for PA's water quality monitoring programs.

Abstract

In recent years, probability-based sampling has been advanced by EPA as an important component of state water quality monitoring programs so that nationwide water quality conditions and trends can be characterized over time in a statistically valid manner. However, probabilistic approaches often cannot answer important regional, state, or local program questions such as "where are the water quality impairments and how far do the impairments extend?" Given these probability-based limitations and the need for a statewide assessment, Pennsylvania used a targeted approach for its Statewide Surface Water Assessment Program (SSWAP). As of September 2005, SSWAP has completed its 9th year with one year remaining. Upon completion, the SSWAP program will have taken a water quality "census" of all wadeable streams statewide. The benefits and progress of Pennsylvania's census approach was presented at the NWQMC 2004 Conference.

While Pennsylvania's water quality monitoring programs have traditionally employed targeted sampling designs, new and evolving water quality program issues call for probability-based sampling implementation. As SSWAP nears completion, Pennsylvania is transitioning from a basic biological screening assessment to a more rigorous, RBP-based Instream Comprehensive Evaluation (ICE) protocol for the next assessment cycle. This next cycle will incorporate elements of targeted and probability-based sampling designed to provide site-specific data as well as information on a larger spatial scale. Targeted sampling will focus on localized assessments to clarify and confirm impairment sources and causes while providing data for TMDL development. Probabilistic sampling will serve two different purposes. With assistance from EPA's Corvallis NHEER Laboratory, the first probability-based application was designed to review SSWAP's non-impairment decisions and to allow for comparison between SSWAP and ICE assessment methodology. Data collection for this effort has been completed and is being analyzed. The second application of probability-based sampling will be to direct ICE surveys on a smaller regional, watershed basis.

Probabilistic Monitoring in Virginia: Experiences From the First Five Years

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Biographical Sketches of Authors

Larry Willis and Jason Hill coordinate the Virginia DEQ Probabilistic Monitoring Program (ProbMon) and with coauthors George Devlin and Mary Dail perform most of the design, data analysis and report writing for the program. All four authors work in the West Central Regional Office (WCRO) in Roanoke, VA. Larry is the Regional Monitoring Coordinator, Jason is the Regional TMDL Program Coordinator, George is the Regional Biologist and Mary splits her time between TMDL and Wetlands Programs.

Abstract

In 2001, the Virginia Department of Environmental Quality (DEQ) started a 5 year project to assess the utility of a probability-based monitoring program (ProbMon) as an addition to existing targeted and watershed based water quality monitoring programs. One reason for initiating ProbMon was to determine the extent of water quality problems with statistical accuracy. The program design was based on EPA's Environmental Monitoring and Assessment Program (EMAP). A major factor in our decision to use an EMAP design was the support we received from EPA, Corvallis and EPA Region III in study design, station selection and training. DEQ has adapted the study design to fit specific needs by altering how stations are chosen, adapting testing methods and expanding the parameters sampled. One of the primary goals was to comprehensively assess each site. This resulted in the sampling of a variety of chemical, physical habitat and biological parameters and GIS based land use analysis. The data have proven useful for statewide and regional assessments, assessing the effect of new criteria, developing and testing of biomonitoring methods, prioritizing problems, and assessing effectiveness of our programs. The design allows DEQ to sample parameters that are expensive to analyze at a limited number of sites and still achieve a meaningful statewide assessment. Virginia has decided to continue its probabilistic program for another five years.

Idaho's Experience with Random Design Using NHD: Intermittent Streams and Other Considerations

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Biographical Sketch of Authors

Dr. Nelson is the monitoring and assessment program manager for the Idaho Department of Environmental Quality. Since joining the agency in 2003, she has been working on expanding the State's ambient monitoring strategy to include probabilistic monitoring on lakes, reservoirs and rivers as well as coordinating and directing monitoring efforts in Idaho for wadeable streams. She received her doctoral degree in 2003 from the University of Nebraska-Lincoln.

Glen Pettit is a water quality analyst for the Idaho Department of Environmental Quality and has been involved with the State's Beneficial Use Reconnaissance Program since its inception. In 2003 Mr. Pettit coordinated a project for probability monitoring in remote locations and he has also served as the lead for monitoring on lakes, reservoirs and rivers in Northern Idaho.

Abstract

Randomly selected stream sites have been used by Idaho Department of Environmental Quality (IDEQ) for the last two years to estimate the overall condition of waters in the State. This probability based design is similar to that used in the EMAP Western Pilot Project and uses a multi-density categorization based upon Strahler order and state departmental regions. These sites are selected from the NHD coverage for the State at a 1:100,000 scale. IDEQ ensures a representative sampling of all perennial waters in the state by using a weighted approach where 1st and 2nd order streams are selected 50% of the time, 3rd order streams are weighted at 30% and 4th and 5th order streams are weighted at 20%. Two major issues that have arisen during monitoring are accessibility of these sites and intermittent waters inadvertently being selected as perennial stream sites. This presentation describes ways in which both of these have been addressed in the final data analysis. Many sites have been rejected because the site was inaccessible due to physical barriers or permission denied from the landowners. There have also been a significant number of sites that were dry (30-40%) when the field crews arrived to monitor. A method for dealing with intermittent streams in Idaho is determining the hydrologic capacity of the watershed above the site using GIS data. Use of spatial analyst in the ArcGIS software is highly valuable in determining whether the site will be dry during the index period that the State uses in monitoring. Thus, the field coordinator is able to better utilize resources when determining where field crews will conduct monitoring.

Utility of Probability-Based Survey Design for Tracking Fish Species of Interest

Matt Combes

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Biographical Sketch of Author

Matt Combes is a Resource Scientist in the Missouri Department of Conservation's Agricultural Systems Field Station. His primary duty is coordinating MDC's Resource Assessment and Monitoring Program (RAM), a probability-based stream assessment program. Other duties include applying RAM sampling protocols to targeted research or monitoring questions, and conducting a methods comparison study within EPA's Wadeable Streams Assessment. Matt has been involved with the RAM program since 2002.

Abstract

One of many objectives for most monitoring programs that include fish community sampling is to track the locations of fish species of interest to the entity supporting the monitoring program. Probability-based sampling designs are often thought to be incapable of addressing this objective. Locations of fish species can be interesting for several reasons including: location of a rare species, location of an exotic species, location outside the known range of the species, and location where the species is thought extirpated. A cursory examination of interesting fish locations from 59 random sites sampled across the state of Missouri in 2002 reveal that 97 individuals of 10 species considered to be in need of conservation were found. Two species were located in watersheds they were considered extirpated from, another species was captured at least 146 river km from the closest historical record, and 1 other species was only the 5^{th} collection in north Missouri. I will present a more complete analysis of approximately 500 visits to random sites across Missouri.

QA/QC and QAPP: How to Get Professional Quality Data from a Volunteer Program

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Abstract
Throughout the United States, citizens have been collecting valuable information on the health of the local environment. At least 750 organizations, involving more than half a million people, are actively involved in watershed monitoring across the nation. As state and federal budgets for water quality monitoring continue to decline, more and more citizens are stepping forward to help gauge the health of our public resources. Data use by a government agency is often a function of the quality assurance/quality control (QA/QC) measures instituted by the volunteer monitoring program. Although volunteer programs have become an integral part of efforts to protect natural resources, questions still arise about the credibility and appropriateness of citizen- collected data. In 1996, Cook Inlet Keeper and the Homer Soil and Water Conservation District established the Citizens Environmental Monitoring Program (CEMP) to involve citizens in collecting reliable water quality data in the Cook Inlet Basin. Priority was placed on ensuring high quality data. This was achieved by development of a Technical Advisory Committee (TAC) made up of professionals representing various federal, state, and local agencies and diverse scientific backgrounds. With assistance from the TAC, Keeper selected water quality parameters and testing methods that have proven successful in citizen-based programs throughout the United States. Primary parameters are measured using standard EPA-approved procedures. To ensure quality assurance oversight and consistency of CEMP data, Cook Inlet Keeper produced a Quality Assurance Project Plan (QAPP) which describes both how the program is managed (quality assurance) and how its technical activities are carried out (quality control). This includes training requirements, recertification procedures, blind performance evaluation standards, duplicate sample analysis, and split sample analysis with a state-certified. CEMP data are compiled annually and submitted to the ADEC and distributed to concerned citizens, decision makers, resource managers, and available on Keeper's web page.

What is Representativeness, and Why are We Confused?

Revital Katznelson

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Biographical Sketch of Author
Dr. Katznelson has many years of experience in environmental research, including collection, documentation, quality assurance, and interpretation of monitoring data. In recent years she has developed and implemented a Data Quality Management system that can be used by small monitoring groups for data capture and documentation, as well as for communication of what the data represent in the environment. She has also been involved in preparing and teaching a number of specialized courses in ecology and in environmental monitoring. She is currently implementing her experience in the development of distance learning tools and expert-system educational materials.

Abstract
Definitions of the words Representativeness and Representative Sample abound, and—in the context of environmental monitoring—reflect a variety of mindsets typical of different scientific disciplines. For the field operators, a representative Sample is the chunk of water they caught in a Sample container at the centroid of the flow (as opposed to side channels or backwater pool), because it represents the bulk of the water flowing through the stream at the time of collection. For the statistician, a representative sample is actually lots of full Sample containers, enough of them to provide a good representation of the average conditions in the monitored entity (e.g., river, lake, or Brownfield). They often talk about The Degree of Representativeness, which implies a quantitative measure of representativeness and sometimes translates to confidence level. Others talk about 'The degree to which data accurately and precisely represent characteristics of a population, parameter variations at a sampling point, a process condition, or an environmental condition', a definition that may be interpreted as a combination of measurement error (accuracy and precision) and inherent variability (parameter variations). Analysts often use the term Representative Sample in the context of how well the sample represents itself when they refer to sample integrity (i.e., lack of contamination and lack of deterioration), or when they mean to say that the sample is thoroughly homogenized. Data users, on the other hand, are always eager to know what the monitoring Result (i.e., the outcome of a field measurement or lab analysis of a Sample) actually represents in the environment; they want metadata about the waterbody type, the flow conditions, the reasons it was collected at a particular location and at a particular time, and the sampling design principle (e.g., random or directed) that was used to select the location and the timing. A new communication system has been developed which addresses the question of what the monitoring Result actually represents in the environment, and clearly distinguishes between inherent variability and measurement error. This system has been used as a training tool to teach the basic concepts of variability, as a planning tool to hone in on the intent and the design of the study, as a dialogue tool to solicit feedback from experts, as an instruction tool to guide Project operators, and as a communication tool to inform data users.

Evaluation of the New York City Watershed-Hudson Basin River Watch Volunteer Monitoring Pilot Project

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Biographical Sketches of Authors
Heather Clark Dantzker serves as the president of the Board of Directors of the Community Science Institute, in Ithaca, New York. She has been involved with the Community Science Institute since its establishment in 2000 as an organization devoted to supporting volunteer monitoring groups in their efforts to protect local watersheds and ecosystems. She is a Research Associate at Cornell University.

Stephen Penningroth is the Executive Director of the Community Science Institute (CSI) and the Technical Director of CSI's NELAC-certified water quality testing laboratory. He works to develop volunteer monitoring partnerships between citizens groups and local governments in and around Ithaca, NY, supporting their long-term watershed monitoring programs with certified laboratory analyses.

Yvette de Boer serves on the Board of Directors of the Community Science Institute. She served as chair of the Fall Creek Watershed Committee, a volunteer water monitoring organization in Ithaca, NY. She earned a BS from Cornell and M.A.T. from SUNY Cortland. She teaches 6th grade science in Ithaca, NY.

Anne Gallagher Ernst is a physical scientist in the New York Water Science Center of the US Geological Survey. Anne spent several years working for the Community Science Institute in Ithaca, NY, as an aquatic macroinvertebrate specialist, training volunteer monitoring groups to use BMI methods as a tool for assessing stream quality. She earned her master's degree in aquatic ecology from Cornell University.

Abstract
The goal of the New York City Watershed-Hudson Basin River Watch Volunteer Monitoring Pilot Project was to 1) develop and evaluate a model for community-agency cooperation in the generation and use of volunteer water quality monitoring data, and 2) identify how and to what extent volunteer monitoring data might be used by government agencies and community groups. A quality assurance and quality control (QA/QC) protocol was developed. The model was based on standard water quality monitoring practices and included user-friendly sets of internal and external QA/QC criteria for benthic macroinvertebrate (BMI) and chemical monitoring. Training in how to use QA/QC in conjunction with test protocols from the Hudson Basin River Watch (HBRW) Guidance Document was provided to a broad cross-section of volunteer groups in the New York City watershed. A total of 67 BMI and chemical data sets produced by 21 volunteer groups were evaluated both for adherence to the QA/QC working model and for scientific credibility. In addition, thirteen interviews were conducted with various agencies and organizations with the potential to use volunteer monitoring data. Results of the interviews indicated three broad program areas where agencies may be open to using volunteer monitoring data: regulatory input and enforcement, community natural resource planning, and environmental science and education. Results of the Pilot Project show that 1) volunteers are capable of implementing QA/QC procedures and producing scientifically credible monitoring data and 2) that government agencies at all levels are willing to use volunteer data as long as they can be assured of its credibility. A series of goals and action items are recommended to improve the production and use of volunteer data in the New York City watershed and across New York State.

Experiences in Monitoring

Eric Russell

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Abstract
I am offering a presentation to your council that may be of the greatest relevance, avoiding duplication with another presenter. I have been the lab Director with the Surfrider Foundation for 5 years and I am prepared to discuss building and maintaining a volunteer network, technical aspects for data reliability within volunteer monitoring groups, and experiments we've performed such as bacteria testing at various depths within ocean waters. As Executive Director of the Aquatic Protection Agency I can present about cruise ship monitoring, and outfall monitoring. I can easily present for 18 minutes on any of these subjects.

First Flush Volunteers Do It in the Dark

Bridget Hoover

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Biographical Sketch of Author

Bridget Hoover is the Coordinator of the Monterey Bay Sanctuary Citizen Watershed Monitoring Network (Network). She has been a contractor for the Monterey Bay National Marine Sanctuary since January 1999 and has worked on a variety of water quality issues, including urban runoff. As Coordinator of the Network, Bridget provides technical assistance to a wide range of school programs, watershed groups and government agencies. She provides training, equipment and data management assistance to volunteers throughout the Sanctuary and coordinates several Sanctuary-wide monitoring events each year, including Snapshot Day, First Flush and the dry weather Urban Watch program.

Abstract

The Monterey Bay Sanctuary Citizen Watershed Monitoring Network and Coastal Watershed Council have organized a First Flush monitoring event for the past six years. The first major storm of the season, in which there is "sheeting" water on the roadways, is defined as "First Flush". The goal of this effort is to characterize the storm water runoff that is being discharged into the Monterey Bay National Marine Sanctuary. Three sets of measurements and sample collection occur every 30 minutes. The tests and observations collected in the field include water temperature, pH, conductivity, and transparency. Samples are sent to a certified lab for analysis of total coliform, *E. coli*, oil and grease, total suspended solids, total dissolved solids, orthophosphate, nitrate, zinc, copper, lead and hardness. In 2004, an additional component to this event was added. Teams now monitor their site at a designated date and time prior to the rain. The purpose if this is two-fold: the volunteers go to their site in the daylight and follow the monitoring protocols in a relaxed atmosphere. They take the same measurements and collect the same samples for lab analysis as for the First Flush. These results provide a comparison of what is in the runoff before it rains. This program continues to grow each year in the number of cities that participate as well as the number of volunteers. In 2005, 83 volunteers monitored 32 storm drain outfalls. Each year the data is published in a report and distributed to local city engineers, environmental managers, and resource agencies. Reports are available online at www.montereybay.noaa.gov/ monitoringnetwork/events.html. The results of this program have led to additional upstream source tracking. Currently, a copper study is underway in Monterey, CA to determine the source of high copper and zinc concentrations consistently detected during the First Flush event.

Monitoring of Priority Toxic Pollutants in Highway Stormwater Runoff

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Biographical Sketches of Authors

Hyun-Min Hwang is a Post-doctoral Scholar with interests in stormwater characterization and mitigation, sediment quality, and bioavailability of persistent pollutants. Peter G. Green is a Research Engineer studying a variety of water quality and air quality issues. He has been at Davis since 2000 after working for 11years at Caltech. Masoud Kayhanian is a Research Engineer and most of his current research activities related to characterization and treatment of stormwater runoff from transportation facilities with an emphasis on fine particles and the contaminants associated with them. Thomas M. Young is a Professor whose research centers on physical-chemical processes important in treating contaminated water, groundwater, and soil.

Abstract

During dry period, contaminants from various sources are deposited on surfaces and accumulate until precipitation occurs. When it rains, stormwater scours contaminants mainly from impervious paved surfaces and then transports them into the receiving waterbodies. The U.S. EPA now considers that stormwater runoff is one of the most important nonpoint sources of pollutants that degrade water quality. This study monitored contaminants listed in California Toxics Rule (CTR). This project provides insight into the types and concentrations of hazardous chemicals in highway runoff so cost-effective stormwater runoff control strategies can be developed. In order to assess toxic potentials of highway stormwater runoff, concentrations of contaminants are compared to California water quality standards. Heavy metals closely related to vehicle operation are likely to exceed California water quality standards. Nickel exhibited higher concentrations than water quality standards in about 30% of samples. Copper and zinc exceed ambient water quality standards more frequently. Among organic contaminants, 4,4-DDE, chlordane, and 1,1-dichloroethylene are likely to exceed CTR standards frequently. These contaminants are not related to vehicle operation and highway maintenance. So atmospheric wet deposition and/or dry deposition of particles driven by wind from agricultural fields may be suspected as a source of 4,4-DDE and chlordane. Atmospheric wash-off may be the source of 1,1-dichloroethylene. PAHs such as chrysene that comes mainly from vehicle emission were also above the CTR standards at some events. Monitoring data revealed that highway stormwater runoff may be harmful for aquatic organisms. So contaminants in highway stormwater runoff need to be reduced to meet the water quality standards. It can be accomplished by adopting appropriate BMPs, source control and/or post-attenuation (treatment control).

Monitoring and Analytical Issues for BMP Performance Evaluation

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Biographical Sketches of Authors

Dr. Lin received her Ph.D. degree in civil engineering in 2003 with her dissertation research focused on granulometry, physical and chemical characteristics of particulates in urban rainfall runoff. She joined CDS Technologies in 2004 and works at their Morgan Hill office in California as a project manager. She manages testing and monitoring programs of CDS stormwater treatment devices across the States. Meanwhile, she participates in engineering design and development of CDS storm water treatment devices for various development and retrofitting projects. Prior to CDS, she worked in water and wastewater area as a project engineer in New York.

Mr. Lippner is a Regional Manager for CDS Technologies Inc. He manages and oversees the sales, design, and construction of storm water treatment units in Northern California, Nevada, and Utah. Mr. Lippner holds both a B.S. and M.S. in Civil Engineering with an Environmental/Water Quality Focus. He has more than 10 years of storm water experience that includes five years with CDS Technologies and five years as a CSUS Staff Research Engineer working with the Caltrans-CSUS-UCD Storm Water Program.

Abstract

State and local agencies have developed extensive protocols for Best Management Practice (BMP) monitoring and evaluation. These protocols often address site-specific and BMP considerations, rainfall, runoff flow and sampling equipment selection, sample collection and management, analytical methods, data evaluation and management, quality assurance and quality control (QA/QC), and BMP maintenance. The techniques and equipment used for flow measurement, sample collection, sample management and analytical methods can significantly affect the reported results of the characteristics of pollutants in urban storm water runoff. Many of the BMP monitoring programs have been implemented without a complete understanding of the application limitations of these instruments and equipments. Results of the monitoring data may appear to be contradictory to the common sense.

This paper will present a complete review of the most employed protocols and address limitations of these protocols that when followed inappropriately can lead to erroneous information on BMP performance. Knowledge of the limitations of the protocol as well as the application limitations of some monitoring instruments will allow storm water managers to better assess the BMP monitoring program study methods and techniques before using results from these studies for selecting BMPs that are needed to comply with water quality standards and achieve Total Maximum Daily Load (TMDL) pollutant load reductions. The financial implications in terms of cost of BMP implementation, maintenance, and compliance with National Pollution Discharge Elimination System (NPDES) permits are of critical importance to all storm water managers.

Evaluation of Water Quality Monitoring Data at the Local Level, a Reality Check

Jeff Hieronymus

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Biographical Sketch of Author

Jeff Hieronymus is a water quality modeler with Charlotte-Mecklenburg Storm Water Services in Charlotte, North Carolina. Prior to joining the City in 2002, Jeff was employed as a research associate at UNC-Charlotte where he studied nutrient effects on phytoplankton dynamics in estuarine systems. Jeff's current responsibilities include providing support for the City's environmental policies and initiatives through computer modeling, data analysis, and data management.

Abstract

The City of Charlotte, North Carolina maintains a dense network of water quality monitoring stations. Quarterly baseflow samples are collected to characterize stream health and evaluate whether conditions are improving or degrading. Supplemental stormwater samples are collected at select sites. The City recently investigated the usefulness of the quarterly baseline sampling program in establishing water quality concentration and pollutant loading status and trends. Until recently, the data had not been examined to determine if the monitoring program produced meaningful information in relation to program goals.

It appears it is not uncommon for jurisdictions, particularly at the local level, to spend time and effort collecting water quality data without considering what the data indicates or whether the sampling methodology is appropriate to answer water quality management questions. The approach taken for this investigation was to analyze data from streamflow monitoring performed by the USGS and water quality monitoring collected locally to determine monitoring program capability. Daily streamflow cumulative frequency distributions, stormwater time plots and box plots, and two-sample t-tests were generated to answer questions regarding what information the data was capable of producing in relation to evaluating stream conditions and to assess whether collection protocols need modification to meet objectives of the monitoring program.

Results of the analysis indicate current protocols are capable of capturing the full range of flow conditions. However, nutrient versus time plots of stormwater data showed no statistically significant temporal trends given the available dataset. Further, given the observed variability in measured water quality concentrations, the sampling program as currently implemented can only detect sudden changes in excess of 25-50% as smaller changes are difficult to discern. Future efforts will investigate statistical methods to reduce variability in the dataset in order to derive significant trends from available data and investigation of changes in the flow regime over time.

Bioassessment Method Performance and Comparability

Facilitators
Jerry Diamond, Tetra Tech, Inc.
Laura Gabanski**,** U.S. Environmental Protection Agency

Biographical Sketches
Dr. Jerry Diamond is a co-Director of Tetra Tech's Biological Research Facility in Baltimore, MD. Since 1994, he has provided EPA technical support to the Methods and Data Comparability Task Group under ITFM and later the Methods and Data Comparability Board regarding ways to document bioassessment method performance and data comparability. He is currently assisting EPA in developing a guidance document that presents current thinking as to how bioassessment method performance should be analyzed and documented and will give step-by-step procedures for when and how it is acceptable to combine bioassessment information from different sources.

Laura Gabanski is a biologist with EPA's Office of Wetlands, Oceans, and Watersheds (OWOW). She manages projects related to bioassessment comparability and is OWOW's research planning and coordination liasion with EPA's Office of Research and Development.

Workshop Description
Biological assessments are a key tool used by monitoring and regulatory organizations to determine status and trends regarding water resources identify emerging issues, and to help prioritize remediation and protection efforts. With increasing use of biological assessment data in state and federal regulatory programs, and the different methods used by different organizations, there is a need to ensure that methods are comparable and the quality of the data obtained are satisfactory so as to meet the needs of different programs. Development of performance-based bioassessment methods is seen as one key to achieving known data quality and comparable methods. This workshop will discuss the current state-of-the-science in defining performance-based bioassessment methods and comparability at the methods, data, and assessment levels. An interactive poster session format will be used, along with facilitated break out sessions to solicit input from participants concerning: (1) extent of sampling and analysis that should be recommended to document bioassessment performance; (2) methods that should be used to evaluate data or assessment comparability; and (3) feedback on EPA's current projects in this field, including a guidance document and analyses of comparability data generated under EPA's Wadeable Stream Assessment.

Monitoring Mercury in Biosentinel Fish in San Francisco Bay

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Biographical Sketch of Author
Mr. Greenfield received his B.A. in Biology from Brown University in 1993 and his M.S. in Zoology from the University of Wisconsin in 2000. He has worked in aquatic ecology research projects in Oregon, Utah, Arizona, Washington D.C., Wisconsin, and California and has worked with federal and state agencies, academic research programs, AmeriCorps, and The Nature Conservancy. Mr. Greenfield's research interests include monitoring and restoration of native fish and amphibians, and the uptake of contaminants by aquatic food webs.

Abstract
Significant management actions are underway that have the potential to change mercury (Hg) concentrations in fish from the San Francisco Estuary. The Hg TMDL is a major effort to reduce mercury accumulation in Estuary fish, and there is concern that extensive tidal marsh restoration could increase mercury in the food web. Small fish are a useful tool for monitoring inter-annual changes in methylmercury in aquatic ecosystems. They integrate finer-scale spatial and temporal patterns of methylmercury uptake into the food web, while providing more localized data than large fish. From November through December of 2005, we sampled small fish (Atherinopsidae and Gobiidae) from two habitat types (benthic and pelagic) at eight locations in the Estuary. Multiple composite samples of five to ten individuals each were collected at each sampling location, weighed, measured, and sent for whole-body analysis of total mercury concentration. Results indicated higher tissue concentrations in fish captured from south San Francisco Bay, than fish from Oakland harbor or San Pablo Bay sites. Higher and more variable concentrations were also observed in Mississippi silverside (*Menidia audens*), a brackish water fish, when compared to marine pelagic and benthic fish species. Elevated concentrations in South Bay may result from a number of factors including historic mining sources, and higher sediment residence time.

Recovery and Monitoring Challenges with Water Quality Issues in New Orleans during Hurricane Katrina Recovery Operations

William E. Roper[1], Kevin J. Weiss[2] and James F. Wheeler[2]

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Biographical Sketch of Authors
Dr. Roper is a Research Professor with the College of Science at George Mason University in Fairfax, Virginia. He joined George Mason following an academic appointment as Professor and Chair of the Department of Civil and Environmental Engineering at George Washington University. His research interests include environmental engineering, remote sensing, infrastructure security, sustainable development and geospatial informatics applications. Prior to joining academia, he was a career member of the Federal Senior Executive Service for over twenty years as Director of the Army's Topographic Engineering Center and Director of the Corps of Engineers World-Wide Civil Works R&D Program.

Kevin Weiss is a senior program manager in the Municipal Permits Branch, Permits Division, Office of Wastewater Programs at the Environmental Protection Agency. His areas of interest include Legal issues related to permit compliance, permit regulatory policy development and water quality monitoring strategies. He was a member of the EPA Task Force for water issues in the Hurricane Katrina and Rita recovery effort.

James Wheeler is a senior environmental engineer in the Municipal Technology Branch, Municipal Support Division in the Office of Wastewater Management of the Environmental Protection Agency. He holds registration as a Professional Engineer. His interested include advanced wastewater treatment technology, emergency response planning and Technology Transfer applications. He was a member of the EPA Task Force for water issues in the Hurricane Katrina and Rita recovery effort.

Abstract
Following the passage of Hurricane Katrina, New Orleans was left with eighty percent of its land area flooded. In some locations the flood waters were over thirty feet deep. In the heat and stagnation that followed the waters quickly became heavily polluted with petroleum products, industrial chemicals, raw sewage, dead animals etc. In addition, a super fund cleanup site was flooded and contributed to the water pollution problem. Pump out operations began in early September 2005 as a high priority to get the city dried out and on the road to recovery. Lake Pontchartrain was the primary receiving water body with the Mississippi River as a secondary receiver. A variety of approaches and technologies were evaluated to achieve treatment with minimal impact on pumping operations. Some of these methods and technologies included; sorbet booms in the channels and the lake near outfalls, oil and debris removal skimmers in channels and near outfalls, floating and bottom anchored containment screens around outfalls, sediment control devises for hot spots within the city, application of flocculation chemicals in contained areas, aerators in the channels and near the outfalls, application of specialized bacteria, etc. Over 100 water quality sampling sites were setup throughout the city to characterize water conditions as the pump out proceeded. High risk areas were identified in a dynamic process and decisions make for best corrective action. Lake Pontchartrain continues to be monitored and long term rehabilitation efforts will be predicated on water quality monitoring results. Lessons learned from a water quality perspective during this massive disaster are presented with the goal of assisting future recovery efforts.

The Regional Bypass Work Group – A Successful Application of Water Quality Prediction and Interagency Communication

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Employed by the Interstate Environmental Commission for over 25 years, Peter Sattler is involved with all aspects of the ambient and effluent monitoring programs including all field logistics and operation of the IEC research vessel, R/V Natale Colosi. He is an active participant in a number of regional projects and workgroups including the Harbor Estuary Program and the Long Island Sound Study. He is also active in the IEC public outreach and education activities. He holds a BS in chemical oceanography from the Florida Institute of Technology (1976), is an US Coast Guard certified captain since 1990 and has logged nearly 1,900 scuba dives throughout the western hemisphere.

Charles Dujardin is an Associate with HydroQual, Inc. and has over thirty years experience with the assessment and projection of water quality conditions regarding bacteria, nutrients, and dissolved oxygen. He has been particularly involved in the assessment of combined sewer overflow (CSO) impacts in New York Harbor. He was project manager for several NYC Facility Planning Projects for control of CSOs and is presently the project manager to develop pathogen TMDLs in New York Harbor for Region II EPA He is the prime developer of the Regional Bypass Model utilized in New York Harbor by State and local agencies to assess the impact of unplanned spills in the Harbor.

Abstract
During June 1997, a force main failure under Eastchester Bay in western Long Island Sound initiated the closing of public and private beaches in the Bronx, adjoining Westchester County and Connecticut (~10 miles to the east). The necessity to close beaches in the vicinity of the sewage release for the public welfare was paramount, but it became obvious that there was a need to be able to predict which beaches and shellfish harvest waters may be affected by a sewage spill, and to establish a regional protocol to notify responsible authorities of potential threats to these sensitive areas from unplanned sewage releases. This incident, in conjunction with several other sewage releases, stimulated environmental and health officials to assess the notification process among the agencies and to the public.

In July 1997 a meeting of New York and Connecticut environmental and health officials, as well as the Interstate Environmental Commission, was convened to discuss unplanned sewage bypasses that resulted in beach closures in New York and Connecticut. A modeling work group representing 15 agencies– federal, state, local and interstate-- was formed to discuss modeling scenarios/strategies for unplanned sewage bypasses. These discussions led to the framework and development of a Regional Bypass Model. The model enables quick predictions of whether a discharge occurring at certain point will affect another area, and if there should be concern as to whether a beach or a shellfish area should be closed.

The work group met its goals of having a predictive modeling tool and regional notification protocols developed and put in place for the 1998 summer bathing season and has been in place ever since. Annual meetings are held before the bathing season to update the regional notification protocols, raise concerns about model updates/improvements and discuss unique events of the past year. The agencies have been committed to maintaining a high degree communication. This work group can be used as a model of multi-agency cooperation bringing together various disciplines for a common purpose.

Combining prediction and monitoring for reduction of toxics: the Lake Michigan Mass Balance Study

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Glenn Warren is an Aquatic Biologist with the Great Lakes National Program Office of the U.S. Environmental Protection Agency. He was the project manager of the Lake Michigan Mass Balance Study. He is currently the team leader for the program office's Great Lakes monitoring efforts, with special interests in nutrient chemistry and eutrophication. He received his Ph.D. in Limnology and Masters degree in Biological Sciences from the University of Wisconsin-Milwaukee, and his Bachelors degree from the University of Wisconsin.

Russell Kreis is the Station Director and Branch Chief at the USEPA's Station, Grosse Ile, Michigan, which is part of the USEPA's Office of Research and Development NHEERL, MED at Duluth, MN. He worked for the EPA for 20 years and on the Great Lakes for 30 years. He received his Ph.D. from the University of Michigan in Natural Resources and Bachelors and Masters degrees from Eastern Michigan University in Biology. Current research is focused on the integration of multimedia, mass balance, mathematical models for forecasting the effects of nutrients and contaminants on food webs.

Paul Horvatin is Program Manager for the Monitoring, Indicators and Reporting Branch with responsibilities for indicator development and monitoring programs for USEPA in the Great Lakes including: open lakes monitoring, Integrated Atmospheric Deposition Network (IADN), contaminated fish monitoring, and biological monitoring (phytoplankton, zooplankton and benthic). He also serves as the U.S. Co-Chair for the State of the Lakes Ecosystem Conference (SOLEC) which is a bi-national effort to report on the chemical, physical and biological condition of the Great Lakes using a system of indicators. He received a B.Sc. in Biology from the University of Illinois-Urbana in 1975 and M.Sc. in Environmental Engineering from the University of Illinois-Urbana in 1977

Abstract

The Lake Michigan Mass Balance Study is an effort to provide environmental managers with a sound, scientific basis for decision-making to reduce contaminants in the Lake Michigan ecosystem. This is being achieved through a combination of mathematical modeling and integrated monitoring which provided data supporting model development and validation. This large study, which has generated over one million analytical results from thirty-eight thousand samples required coordination of sampling, analysis and data management. The U.S. EPA, Great Lakes National Program Office and Office of Research and Development, university, and agency investigators worked cooperatively to ensure success of data gathering activities. The original objectives: to identify relative loading rates from major tributaries, to evaluate relative loading rates by media, to develop predictive ability, to improve our understanding of cycling and bioavailability of contaminants have been met. Ecosystem models for PCBs and atrazine have been developed and are providing forecasts of expected results from management actions. Many lessons were learned during the study, particularly in the areas of planning, quality assurance, and data management and will be shared during the presentation.

You're standing on it! Parking lot Sealcoat and Urban PAHs

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Barbara Mahler is a Research Hydrologist with the U.S. Geological Survey at the Texas Water Science Center in Austin, Texas. She divides her time between studies of particle-associated contaminants at local and national scales and karst ground-water research. She came to the USGS after a year of post-doctoral study in France, and continues to develop U.S.-French scientific collaborations.

Peter Van Metre is a Research Hydrologist with the U.S. Geological Survey at the Texas Water Science Center in Austin, Texas. He is the Project Chief of the Contaminant Trends in Lake Sediment study, which is part of the NAWQA Program National Synthesis. He developed the study in the mid-1990s to identify national trends in particle-associated contaminants.

Abstract
Polycyclic aromatic hydrocarbons (PAHs) are a ubiquitous contaminant in urban environments and are increasing in concentration in a majority of urban lakes sampled by the USGS National Water-Quality Assessment Program. Although numerous sources of PAHs to urban runoff have been identified, their relative importance remains uncertain. We show that a previously unidentified source of PAHs in urban environments, parking lot sealcoat, might dominate loading of PAHs to urban water bodies in the United States. Particles in runoff from six parking lots with coal-tar emulsion sealcoat had a mean concentration of PAHs of 3,500 mg/kg, 65 times higher than the mean concentration from four unsealed asphalt and cement lots. Contaminant yields projected to the watershed scale for four urban watersheds indicate that runoff from sealed parking lots could account for the major part of PAH loads in streams. Diagnostic ratios of individual PAHs indicate similar sources for particles from coal-tar emulsion sealed lots and suspended sediment from the four urban streams. PAH ratios in sediment cores from lakes undergoing rapid urbanization and coincident increases in PAH concentrations also indicate sealcoat as an important source of PAHs.

City of Austin Biological Studies on the Toxicity and Effects of Coal Tar Sealants on Stream Communities

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Mateo Scoggins is an aquatic biologist for the City of Austin, working primarily on biological assessment of surface water quality. His 12 years of research in stream ecology has focused on hydrology, riparian buffers and PAHs in sediments.

Nancy McClintock is the assistant director of the Watershed Protection and Development Review Department. She has spearheaded a wide range of technical and policy-related efforts to protect water resources in her 20 years with the City of Austin.

Leila Gosselink is an engineer with the Watershed Protection and Development Review Department. She has 10 year of experience working with contaminated sediments in streams and structural controls.

Pam Bryer is a PhD candidate at Texas Tech University, working primarily on the dermal uptake of metals by amphibians. She also has contributed significantly to research on coal tar sealants and ecosystem effects.

Abstract
Routine stream sediment sampling in Austin, Texas, identified unexpectedly high levels of polycyclic aromatic hydrocarbons (PAHs). Although PAHs have numerous urban sources, follow-up investigations indicated that particulates associated with sealed parking lot surfaces were a significant contributing source in the localized areas with the highest PAH levels. Chemical analyses were performed on the source materials (sealants), on abraded materials, on soils found on and adjacent to parking lots, and on creek sediments in waterways downstream of parking lot surfaces. Results from these analyses along with cooperative studies with the United States Geological Survey (USGS) have confirmed that high concentrations of PAHs are leaving sealed parking lots as suspended solids and are entering Austin area streams. City of Austin biological studies, including standard laboratory toxicity testing, a controlled microcosm study and a multi-watershed field study were undertaken to evaluate the potential effects that coal tar sealants were having on our stream communities. Results confirm that coal tar sealants are toxic to aquatic organisms at levels observed in Austin area streams and that coal tar sealed parking lots can cause elevated levels of PAHs in stream sediments, degrading stream communities at concentrations around and below the Probable Effect Concentration of 22.8 mg/kg TPAH. The combination of chemical tracing, laboratory toxicity, and field verified degradation provides a triad, or weight of evidence approach, that identifies a significant source of PAHs in Austin streams and documents its negative effect on stream ecosystems.

Assessing the Effects of Urban Land Use on Stream Ecosystems: Integrating Chemistry, Toxicity Test, and CYP1A1 Gene Activation Data from Extracts of Semipermeable Membrane Devices

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Abstract
Studies to assess the effects of urbanization on stream ecosystems are being conducted as part of the U.S. Geological Survey's National Water Quality Assessment (NAWQA) Program. The overall objectives of these studies are to: (1) determine how hydrologic, geomorphic, water quality, habitat, and biological characteristics respond to land-use changes associated with urbanization in specific environmental settings, and (2) compare these responses across environmental settings. As part of an integrated assessment, semipermeable membrane devices (SPMDs) were deployed in streams along a gradient of urban land-use intensity in the metropolitan areas of Atlanta GA, Denver CO, and Raleigh-Durham NC. SPMDs are polyethylene membrane tubes containing a purified synthetic lipid (triolein) that concentrate freely dissolved neutral organic molecules, the fraction that is bioavailable. SPMDs were originally developed to concentrate organics from the water column for subsequent chemical analysis. While useful, the presence and concentration of known pollutants do not provide information on complex mixtures containing unknowns or potential biological effects. To investigate potential effects, we conducted 3 assays in addition to standard chemical analysis: (1) Fluroscan which provides an estimate of total concentration of PAHs; (2) Microtox ® which measures the light production of photo-luminescent bacteria to determine the concentration that causes a 50 percent decrease compared to controls; and (3) CYP1A1 gene activation which indicates the presence and levels of aryl hydrocarbon receptor agonists such PAHs, planar polychlorinated biphenyls, chlorinated dibenzo-p-dioxins, chlorinated dibenzofurans, chlorodiphenylethers, chlorinated napthlenes and plant flavones. A positive correlation was found between the amount of urban land use in the basins and the concentration of many of the contaminants measured, particularly PAHs and several pesticides. In addition, the results of Fluroscan and CYP1A1 gene activation were correlated with urban land use. Differences in responses of the assays and between the three areas were observed.

Pesticides in Urban Settings -- Use of a Pesticide Toxicity Index to Evaluate Potential Toxicity of Stream Water Samples to Macroinvertebrates

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Karen Riva-Murray has been an aquatic ecologist with the U.S. Geological Survey since 1991. As lead biologist for the Hudson River Basin and Delaware River Basin National Water-Quality Assessment Program studies, her research includes mercury cycling and bioaccumulation in streams, effects of urbanization on stream ecosystems, occurrence and distribution of contaminants in aquatic biota, and responses of macroinvertebrate communities to hydrologic alteration. Ms. Riva-Murray has a B.A. in Environmental Studies from Northland College (Ashland, Wisconsin), and is a doctoral candidate at the State University of New York College of Environmental Science and Forestry (Syracuse, New York).

Patrick Phillips has been a hydrologist with the U.S. Geological Survey for nearly 20 years, first in Maryland and since 1992 in the Troy, NY office of the USGS. Mr. Phillips' research focuses on the transport and fate of organic compounds in surface and ground water, and he has published numerous referred journal articles and USGS reports. Since 1996 he has led an interdisciplinary team investigating water quality and its relation to biology. Mr. Phillips received a BA at Middlebury College, an MA at the University of Oklahoma, and did additional post-graduate work at the Johns Hopkins University.

Robert W. Bode is a research scientist in the Division of Water of the New York State Department of Environmental Conservation. He is the head of the Stream Biomonitoring Unit, and has been with the Unit since 1972, assessing water quality in streams across New York State using macroinvertebrate communities. Mr. Bode has a M.S. degree in aquatic entomology from Cornell University, a B.A. in biology from Calvin College, Grand Rapids, Michigan, and also previously attended Western Washington University. He has specialized in the taxonomy and identification of larval midges.

Mark D. Munn has been a stream ecologist with the U.S. Geological Survey for the past 14 years. His research includes benthic ecology (algae and inverts), stream metabolism, and large-scale ecological studies. Dr. Munn is currently Team Leader of the NAWQA study – 'Effects of Nutrients on Stream Ecosystems'. He holds a Ph.D. in aquatic entomology from the University of Idaho, and a M.S. from Central Michigan University.

Abstract

Urbanization has been linked to the composition and concentration of pesticides detected in stream water, and to observed declines in health of aquatic assemblages. Defining the role of pesticides in this decline is difficult, however, because (1) biota are exposed to mixtures of various pesticides that differ in potential toxicity, (2) pesticide concentrations can fluctuate seasonally, and in response to storms, and (3) biological responses can be confounded by responses to other factors such as habitat disturbance, hydrologic alteration, and nutrient enrichment. A recently developed Pesticide Toxicity Index (PTI), along with data from multidisciplinary studies, can help address these issues. The PTI provides for comparison of relative potential toxicity(towards a specified organism group) among samples and sites, by summing concentrations of individual pesticides, after weighting each by a laboratory-based toxicity quotient. Data from a 2000-03 study of 47 streams in the Croton River basin in southeastern New York

indicate an increase in invertebrate PTI with increasing catchment population density, and a corresponding decline in macroinvertebrate-assemblage integrity. Biweekly monitoring of one site during 2000-03 indicated that PTI is influenced by pesticide-application patterns and storm-flows. Insecticides, primarily carbaryl and diazinon, dominated the PTI most of the time, even when their contributions to total concentration were small. The application of insecticides throughout the growing season in urban and suburban settings may explain why PTI remained relatively high throughout the summer, even as total pesticide concentration (including herbicides as well as insecticides) declined. The Pesticide Toxicity Index does not quantify actual toxicity, nor demonstrate cause and effect, but can be a useful tool for ranking samples according to the potential toxicity of the pesticide mixtures detected. The observed loss of sensitive invertebrate species with increasing PTI in this study suggests that pesticides may be important stressors to aquatic biota in the urban environment.

Groundwater Age as a Predictive Tool for Water Quality Monitoring

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Jean Moran has been a researcher in the Environmental Radiochemistry group at Lawrence Livermore National Laboratory for the past seven years. Her research focuses on using natural and artificial isotopes to examine geochemical and transport processes in groundwater. She is currently principal investigator and LLNL project director for the Groundwater Ambient Monitoring and Assessment project sponsored by the California State Water Resources Control Board. Dr. Moran has a Ph.D. in Geochemistry from the University of Rochester, Bachelor's degrees in physics and geology and a Master's degree in geophysics.

G. Bryant Hudson is a physicist (retired) in the Chemistry & Materials Science Directorate at LLNL. Bryant completed his Ph.D. in physics at Washington University in St. Louis, Missouri working on early solar system chronologies. In 1981 he joined LLNL as a postdoctoral fellow studying isotopic tracers of environmental processes and continued on as a full time LLNL scientist developing noble gas isotope tracer techniques for diagnostic measurements of nuclear explosions. With the end of nuclear testing, he extended these noble gas tracer techniques to tracking the movement of groundwater.

Abstract

Water quality monitoring at drinking water wells for regulatory purposes is effective at identifying a problem only after contaminant concentrations approach or surpass regulatory limits. Certain groundwater tracers can provide a predictive capability for assessing the vulnerability of wells to contaminants. One such tracer is groundwater age. A collection of groundwater ages in a basin allows delineation of recharge areas (youngest ages), bulk flow rates and flowpaths, as well as a means of assessing susceptibility to modern-day contaminants. Sources of contamination to groundwater occur at and near the earth's surface, and have been present mostly in post-industrial times. Therefore, wells that capture water that has recharged in the recent past (young groundwater ages) are more likely to intercept contaminants transported by advection.

The Groundwater Ambient Monitoring and Assessment Program, sponsored by the California State Water Resources Control Board, and carried out in collaboration with the U.S. Geological Survey, has provided the means to gather an unprecedented number of tritium-helium groundwater ages in the basins of California. Because of the relatively high spatial density of well water samples, the major basins used for drinking water supply can be compared and contrasted in terms of relative vulnerability. A large volume of both imported and locally captured water is artificially recharged in the urbanized, intensively managed basins of coastal California. In these basins, the presence of a continuous confining unit can be the key feature for protecting deep aquifers in areas with ubiquitous surface contamination. De-convolution of the mixed groundwater age observed at these generally deep, long-screened wells, provides an estimate of the degree of 'dilution' of a recently-introduced contaminant by pre-industrial groundwater that is usually free of anthropogenic compounds.

This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

Simulation of Short Circuit Flow Paths and Transient Conditions to Understand Vulnerability of Public Supply Wells to Contamination in the High Plains Aquifer, York, Nebraska

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Brian Clark currently serves as the primary modeler for the High Plains Ground Water study unit of the NAWQA Transport of Anthropogenic and Natural Contaminants (TANC) topical study.

Matt Landon has been a hydrologist with the USGS since 1990. He is currently working on studies of transport of anthropogenic and natural contaminants for the National Water-Quality Assessment Program and the California Ground water Ambient Monitoring and Assessment program.

Leon Kauffman has been a hydrologist with the USGS since 1995. Currently he is working on the Hydrologic System Team of NAWQA, providing technical support for ground-water modeling activities.

George Z. Hornberger graduated from the University of Vermont in 1993. Since then he has been developing ground water solute transport models as part of the National Research Program of the USGS.

Abstract

The High Plains aquifer is a primary source for drinking-water supply in many areas of the High Plains. Several wells in the area are known to be screened in both the unconfined and confined portions of the aquifer which may provide a preferential pathway, or "short circuit", for water moving from the unconfined to the confined units of the aquifer. As part of the U.S. Geological Survey National Water-Quality Assessment Program, a ground-water flow and transport model was developed to simulate processes controlling movement of contaminants to public supply wells in the layered unconsolidated deposits of the High Plains aquifer near York, Nebraska.

Water-quality samples were collected from wells screened through unconfined and confined water-bearing units. Samples also were collected from a public supply well, screened in the confined portion of the aquifer. Analytical results show that samples collected from the public supply well have chemistry and age-tracer concentrations consistent with young water derived from unconfined recharge areas mixed with relatively older waters from the confined part of the aquifer. This implies the existence of preferential flow paths that permit shallow recharge water and contaminants to move through the confining layer.

To test the conceptual model developed from the measured water-quality data, a transient ground-water flow and transport model was constructed assuming seasonal ground-water withdrawals over a 60-year period simulated using the multi-node well package, which allows water to flow between different layers through the simulated well. A new version of MODFLOW-GWT (Ground-Water Transport) was used to simulate particle movement through the system, while also assigning ages to the particles. The simulations indicate that the transient conditions and wells screened through multiple layers can introduce shallow recharge waters and contaminants to lower layers, increasing the vulnerability of public supply wells completed in the confined system to contamination from unconfined waters.

GAMA Special Studies on Nitrate in California Groundwater

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Brad Esser is the Environmental Radiochemistry group leader at Lawrence Livermore National Laboratory (LLNL), and has been at LLNL for 15 years. His research focuses on the use of groundwater age-dating, isotope biogeochemistry, and reactive transport modeling to characterize groundwater contamination. He is currently the lead for the LLNL Environmental Radiological Monitoring Laboratory, and a research scientist on the Groundwater Ambient Monitoring and Assessment project sponsored by the California State Water Resources Control Board. Dr. Esser has a Ph.D. in Geochemistry from Yale University, and a B.S. in Earth Sciences from the University of Arizona.

Jean Moran has been a researcher in the Environmental Radiochemistry group at LLNL for the past seven years. Her research focuses on using natural and artificial isotopes to examine geochemical and transport processes in groundwater. She is currently principal investigator and LLNL project director for the Groundwater Ambient Monitoring and Assessment project sponsored by the California State Water Resources Control Board. Dr. Moran has a Ph.D. in Geochemistry from the University of Rochester, Bachelor's degrees in physics and geology and a Master's degree in geophysics.

Michael Singleton is currently a postdoctoral researcher at LLNL's Chemical Biology and Nuclear Science Division, where he uses isotope geochemistry to measure groundwater flow and track contaminants through vadose zone and groundwater systems. Current projects include studying denitrification at dairy operations, development of manure lagoon water tracers, and determining transport and fate of nitrate from septic tanks. Michael holds a Ph.D. in Earth and Planetary Sciences from Washington University, and a B.S. in Geology from Southern Methodist University.

Abstract

The California Water Resources Control Board, in collaboration with the US Geological Survey and Lawrence Livermore National Laboratory (LLNL), has implemented the Groundwater Ambient Monitoring and Assessment (GAMA) Program to assess groundwater quality across the entire state of California. A critical component of the program is to consider the major threats to groundwater resources that supply drinking water to Californians. Nitrate is the most pervasive and intractable contaminant in California groundwater and is the focus of three special studies in the GAMA program. The GAMA nitrate studies build on LLNL expertise in (1) using groundwater age and low-level VOCs to assess aquifer vulnerability and groundwater flow path, (2) using stable isotopic techniques in conjunction with low-level determination of co-occurring organic contaminants to attribute nitrate source, and (3) using innovative techniques to quantify denitrification. Denitrification, the microbial conversion of nitrate to molecular nitrogen, is the primary sink for nitrate in the saturated zone, and, when present, controls nitrate residence time and assimilative capacity. LLNL has developed simple and robust methods for quantifying the extent of denitrification in groundwater by measuring excess nitrogen (using membrane inlet mass spectrometry) and denitrifying bacterial populations (using quantitative real-time PCR). Determining the prevalence of denitrification in major California drinking water aquifers is the goal of the first study. The ability to constrain groundwater age and flow paths in conjunction with nitrate source and degradation is especially valuable in assessing the impact of management practices on groundwater nitrate levels. The second study applies this approach to assess the impact of dairy operations on local groundwater quality; the third study assesses the impact of county-wide conversion of septic to sewer on regional groundwater

quality. This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

Understanding agriculture-related trends in ground-water quality in the Western Lake Michigan Drainages, Wisconsin

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David Saad has been a hydrologist with the U.S. Geological Survey since 1987. Since 1991 he has been the ground-water specialist for the Western Lake Michigan Drainages study unit of the National Water-Quality Assessment (NAWQA) Program. Agricultural effects on ground-water quality have been the focus of several of his NAWQA ground-water studies. David is currently the chief of the Western Lake Michigan Drainages study unit and team leader of the Wisconsin Water Science Center Regional and National Assessments Team.

Abstract

Agricultural chemical use has affected ground-water quality in Wisconsin. In an effort to improve ground-water quality where adversely affected, the State has limited the use of some chemicals such as atrazine. To determine whether changes in use are having the desired effect it is necessary to measure trends in ground-water quality.

Trends in nitrate and atrazine concentrations in ground water, in an area of central Wisconsin underlain by sand and gravel, were examined using water-quality data collected in 1994 and 2002 as part of the National Water-Quality Assessment Program in the Western Lake Michigan Drainages. To help characterize the environmental setting and interpret the water chemistry results, ground-water recharge dates based on chlorofluorocarbons, nitrogen- and atrazine-use histories, well information, hydraulic conductivities, and other ancillary data such as climate and soils were used.

Statistical comparisons of the 1994 and 2002 sample sets indicated nitrate concentrations increased significantly while atrazine concentrations decreased. Chlorofluorocarbon-based ground-water recharge dates allowed for measured concentrations to be related to historical chemical use and climatic conditions. Comparisons with static characteristics like soils and well information also proved important for understanding ground-water concentrations. Nitrate concentrations were correlated to historical fertilizer use, dissolved oxygen concentrations, and well depth. Atrazine concentrations were correlated with historical atrazine use and precipitation as well as several soils characteristics.

Arkansas Monitoring Data Assessment Program (AMDAP) Using the Segment Evaluation Spreadsheet (SEGEVAL.XLS)

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Philip Hutchison is an Environmental Engineer on the Permit Oversight Team within the U.S. Environmental protection Agency's Oversight and TMDL Section in Region 6. Philip provides assistance to the State of Arkansas in the development and review of total maximum daily loads (TMDLs). His expertise with Excel in writing mini programs to improve the efficiency of mundane tasks was utilized in developing this Excel spreadsheet to assist the State of Arkansas with the development of its '303(d) list.

Abstract

The data analysis needed to prepare the Integrated Report for 305(b) and 303(d) requirements entails a very large number of repetitive mathematical calculations and logical comparisons. Performing the calculations by hand has a higher probability of error than an electronic system. Performing logical comparisons in person has a higher probability of variability of application of the acceptance criteria.

The Arkansas Monitoring Data Assessment Program (AMDAP) Team developed an Excel Segment Evaluation Spreadsheet (SEGEVAL.XLS) tool capable of making an automated, electronic analysis of monitoring data as a major need for improving the Arkansas monitoring assessment program. The initial tool has been updated to analyze 5 years worth of monitoring data. Use of this tool will result in an annual reduction of between 3,174 and 7,268 man-hours related directly to analyzing data and an additional 15,870-36,340 man hours in streamlining the process for preparing its Integrated Report and 303(d) list of impaired waters. That translates into a savings of $477,000 to $1,092,000 on each report. The cost benefit for use of the Cross-Reference file in answering Water Quality Standards questions has not been estimated.

Team members provided hands-on training to the State. Since the training, the State has endorsed the use of the tool in preparation of its 2004 Integrated Report and contributed feedback for the continued improvement of the program. The tool is transferable to other states for an overall water quality enhancement at both the state and federal level. Other benefits include 1) a more detailed understanding by all parties involved of how monitoring data uses the standard to determine waters that are impaired and 2) a saving of countless hours of research regarding questions that will arise in the future pertaining to the applicable standard on a particular water segment.

Managing Monitoring Data from Many Sources – A New Hampshire Experience

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Deb Soule has worked at the New Hampshire Department of Environmental Services for 16 years in various programs such as GIS development, source water protection, public water supply monitoring and compliance, and database management. For the last 6 years she has worked as a business systems analyst for the Watershed Management Bureau.

Abstract

Until recently, finding monitoring data for New Hampshire's waters was difficult. The data was scattered across many organizations in several formats such as spreadsheets, small databases, or paper copy. Availability of the various datasets was also not readily known. This framework was not conducive to sharing data and certainly wasn't helpful when assessing waters for designated uses.

To remedy this situation, the New Hampshire Department of Environmental Services (NHDES) created an Environmental Monitoring Database (EMD). The database houses NHDES monitoring data as well as data for many organizations outside the agency. Data is available on-line both through the Department's web site and in many cases also through EPA's STORET warehouse.

Using STORET as a model, EMD was built in-house in Oracle. This STORET basis allows for easy creation of STORET Import Module (SIM) compatible files which can be uploaded to the national STORET warehouse. Organizations that participate with NHDES to house their data in EMD can get their data uploaded to STORET free of charge so their data can be available through a national framework and/or meet their reporting requirements. Plans are now underway to make the EMD compliant with the Environmental Sampling, Analysis and Results (ESAR) data standards so data can be reported via the Water Quality Data Exchange schema. This is expected to lead to more effective data availability, with the eventual elimination of NHDES' local copy of STORET.

This process has been a win-win situation for NHDES and cooperating organizations. NHDES receives much needed data to make 305(b) assessments. The participating organization receives assistance in standardizing and enhancing their monitoring data with metadata (which is often missing in smaller organizations), publishing their data via the NHDES web site, and (as an option) uploading their data to STORET.

Expanding Water Quality Assessments beyond the Realm of 'Impairments' and into a Tool Useful to Watershed Managers at the Local Level

Ken Edwardson

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Biographical Sketch of the Author

Ken Edwardson is the coordinator for the Water Quality Assessment Program where he has been instrumental in implementing a uniform, well documented assessment process. His work at the New Hampshire Department of Environmental Services started with hydrologic assessments and GIS work for the Instream Flow program. He came to the New Hampshire Department of Environmental Services in 2000 with six year of experience in solute transport, streambed hydraulics/geochemistry, and primary production measurements in arctic systems.

Abstract

For New Hampshire, management of the data needed to generate the 305(b)/303(d) assessments has been a mix of paper files, Excel spreadsheets, and some MS Access queries. Answering questions about the basis of a decision after the fact was at times quite difficult. With the advent of New Hampshire's Environmental Monitoring Database (EMD) approximately 1.6 million sampling results relating to over 5200 separate assessment units (AU) needed to be assessed for the 2006, 305(b)/303(d) Integrated Report. We set a data submittal deadline of October 1, 2005 with a target date for submitting a draft assessment of January 6, 2006. This required the evaluation of at least one result every 1.2 seconds of work time. In addition, within those 3 months, all of the data needed to be summarized and documented for each AU, a written report generated, and the assessment results entered in the EPA's Assessment Database (ADB).

To make that all happen and to create a thoroughly documented assessment DES assessment staff worked with our in-house ORACLE developers to build a database that could apply all of our Water Quality Standards and Consolidated Assessment and Listing Methodology criteria to each sample from the EMD, store that answer, summarize it by AU/designated use/parameter, allow for additional documentation, and receive cues from the ADB. While EPA's ADB tracks the impairments to specific waterbodies it does not track anything about what samples were used to make the assessment, what core parameters are used to assess for a given designated use, or the degree of support/non-support. DES's new DB allows for extended reporting options that go beyond the standard ADB information "AU #-X is impaired", making the results more useful to watershed managers at the local level.

This is the story of that process, what was built, and how well it worked.

Vital Signs Water Quality Data Management in the National Park Service

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Dean Tucker is a Natural Resource Specialist with the National Park Service Water Resources Division with training and experience in forestry, resource economics, geographic information systems, and data management. Dean coordinates the national Vital Signs Water Quality Data Management Program. He has been with National Park Service for the last 16 years.

Michael Matz is a Senior Research Associate in Colorado State University's Department of Civil Engineering and supervises the preparation of park water quality data for entry into STORET and the preparation of the National Park Service's Baseline Water Quality Data Inventory and Analysis Reports.

Paula Galloway is a Research Associate in Colorado State University's Department of Civil Engineering. She is a chemical engineer by training with expertise in database and application programming. Since 2005, Paula has worked on the development of NPSTORET after years of developing databases and applications for companies including the Fred Hutchinson Cancer Research Center and Chevron Research and Technology Company.

Abstract
The National Park Service has embarked on a national effort to assess water quality status and trends throughout the National Park System as part of its Natural Resource Challenge Vital Signs Monitoring Program. Thirty-two networks (groups of parks) are or soon will be collecting a variety of physical, chemical, and biological data from both pristine and impaired park waters. All water quality data will be uploaded to the Environmental Protection Agency's STORET database to make them accessible for Clean Water Act reporting and other purposes. The challenges of flowing data from decentralized networks of parks into a national database are significant. To facilitate this data flow and provide basic statistical and graphical analyses, reports, and import/export capabilities (including direct import of data from Legacy and Modern STORET and the U.S. Geological Survey's National Water Information System), the NPS Water Resources Division has developed a Microsoft Access database named NPSTORET. NPSTORET allows users to enter projects, stations, characteristics, metadata, station visits, activities, and results in a format amenable to upload into EPA STORET via the STORET Import Module. To provide maximum flexibility and accommodate those networks that might opt to use some other data system, the Water Resources Division has also developed electronic data deliverable specifications. This presentation will discuss the NPS Water Resources Division's data management strategy, introduce NPSTORET and its capabilities, and highlight the importance of data standards and quality assurance in decentralized data management.

The Regional Kendall Test for Trend

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Dennis Helsel is a research geologist with the USGS and author of the textbook *Nondetects And Data Analysis: Statistics for Censored Environmental Data*, published by Wiley (2005). For years his research has focused on practical methods for interpreting environmental data. In 2003 he received the Distinguished Achievement Award from the American Statistical Association's Section on Statistics and the Environment, for both his research and training courses on applied statistics.

Abstract

Trends in water quality are often investigated within a study region at more than one site. An individual trend analysis such as the Mann-Kendall or Seasonal Kendall test is conducted at each site to determine if a trend has occurred. Yet often also of interest is whether a consistent trend is evident throughout the entire region. To date, this determination has been made "by eye", summarizing results from multiple sites without a formal test of significance. The Seasonal Kendall test, perhaps the most popular test for trend in environmental studies, is adapted to form the Regional Kendall test in order to determine whether a consistent regional trend in water-quality has occurred.

Water Quality Trends Along the Central Coast of California

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Biographical Sketch of Authors

Marc Los Huertos is a research scientist at the University of California, Santa Cruz and has been working on water quality issues along the Central Coast of California for 15 years. He has maintained a monitoring program along the central coast and works with growers to test best management practices.

Carol Shennan, Ph.D. is the Director of the Center for Agroecology and Sustainable Food Systems and has worked on water quality issues associated with agroecosystems for 20 years.

Abstract

Water quality in surface waters along the central coast of California has been subject to many anthropogenic influences including industry, urban development and extensive farming practices. These activities have the potential to greatly impact on the Monterey Bay National Marine Sanctuary which provides a critical habitat for many plant, animal and bird species as well as an important regional fish nursery. The aim of this work was to determine the effect of these land uses on the water quality in the Monterey Bay watershed. This was achieved through monitoring for trends in nutrient levels and other water quality parameters in the Pajaro River and Elkhorn Slough watersheds, both key inputs to the Monterey Bay.

Nutrient concentrations have progressively increased over the past 30 years in the Pajaro River, while more recently, dissolved nutrients and a number of other water quality parameters have been increasing in Elkhorn Slough. Notwithstanding the difficulty of monitoring water quality parameters in highly variable discharge conditions, combined monitoring data shows that nitrate concentrations in the Pajaro River have increased steadily since the 1960's and more recently have greatly exceeded the drinking water guidelines of 10 mg N L^{-1}. In response to these high and fluctuating nitrate levels, a biweekly monitoring program was established to determine trends in both the amount and export of flow-weight mean (FWM) nitrate concentrations in the Pajaro River. Additionally, monitoring of the Elkhorn Slough itself, the most important estuary in the Monterey Bay watershed, demonstrated a recent trend for an increase in most of the measured water quality parameters, including dissolved nutrients, temperature, dissolved oxygen and turbidity. These increases are tied to land use change and will be discussed in relation to agriculture, the dominant land use in the region.

Lessons Learned from Monitoring Compliance with a Phosphorus Standard in the Florida Everglades and Assessing the Linkage between Phosphorus Control and Marsh Water Quality

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Biographical Sketches of the Authors
Garth Redfield is a Chief Environmental Scientist for the South Florida Water Management District specializing in applications of ecological science to environmental management and water quality. He was the Associate Program Director for the Ecology Program of the National Science Foundation from 1982 to 1990, and has been a Certified Senior Ecologist (C.S.E.) since 1982. He serves as an Expert Witness for court cases involving water quality, standards compliance and environmental restoration in South Florida.

Nenad Iricanin and Cheol Mo are Lead Environmental Scientists also with South Florida Water Management District. They conduct advanced data analyses concerning water quality and other environmental parameters, and provide expert interpretation of regional monitoring data for use in agency reporting and decision-support. Steven Hill is a Senior Environmental Scientist/Senior Statistician specializing in statistical analyses of large, long-term environmental data sets, often involving water quality.

Abstract
In 1998, the United States sued the State of Florida to compel it to regulate phosphorus inflows to the Everglades. The case was resolved through a Settlement Agreement in which the State agreed to implement a broad control program to reduce phosphorus loading into the Everglades. The Settlement also set forth a monthly compliance test that attempts to replicate water quality in a 1978-79 baseline period. A decade of compliance monitoring in the northern Florida Everglades provides a high quality data set to examine factors influencing compliance with the Phosphorus Standard. Apparent exceedances of the monthly total phosphorus (TP) levels triggered a scientific analysis to determine whether TP concentrations in the monitoring network are driven more by internal marsh TP dynamics or by external phosphorus inputs. Even though TP loading continued during implementation of the Settlement Agreement programs, trend analysis of the data set reveals very little change in marsh TP levels over the past 10 years and some decline in more recent years. Marsh water column levels remain below 10 ppb, as they were in the baseline period. No significant correlation could be established between external TP loads to the marsh and monthly geometric mean concentrations in the marsh interior. Variability from field sampling and laboratory analysis produces an uncertainty of about +/- 2 ppb; therefore, values over the Phosphorus Standard by 2 ppb or less could easily be interpreted as false positives for the compliance system. Finally, exceedances tend to occur largely during periods when marsh water depth changes rapidly, suggesting that the compliance equation does not fully accommodate depth dynamics. Together, these findings establish that exceedances of the Phosphorus Standard using monthly data are not meaningful and that a compliance system using longer term data is more appropriate to protect the marsh resource.

Wisconsin's Surface Water Quality Monitoring Network

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Biographical Sketch of Author
Kenneth Schreiber is a water quality specialist with the Wisconsin Department of Natural Resources. Since 2004, he has served as team leader of the state surface water quality monitoring program. Ken has worked with the Wisconsin DNR since 1977 in a variety of roles including water quality specialist, limnologist and planning analyst. He has functioned as a regional water quality biologist since 1990 and TMDL program coordinator since 2000. He is primarily involved in developing study designs, quality assurance procedures, sampling methods and policies related to the state water quality monitoring network.

Abstract
The Wisconsin Department of Natural Resources (WDNR) has a variety of surface water monitoring programs to address impaired waters, attainable uses and water quality standards development. The program includes both trend and condition monitoring of lakes and streams across the state. The surface water quality trend-monitoring network consists of 42 large river sites and 68 lakes. Some of the river sites have a nearly continuous monthly monitoring record since 1961 and some lake sites have been monitored consistently since 1986. Results of river and lake monitoring and examples of trend analysis will be presented

Primary selection criteria for the river trend monitoring sites included: broad spatial coverage, representation of a wide range of water quality and land use conditions, and availability of continuous flow data (preferably from a nearby USGS station). Water quality parameters were selected that would most likely be influenced by changes in land use and management activities over time. Sampling frequency was determined by reviewing historic data sets and examining the effects of various sampling strategies on the strength of trends detected in those data sets.

Trend lakes were selected to represent "typical" lakes within specific categories and ecoregions across the state. The trend lake network provides information about inter-annual variability (esp. climatic influences) and the influence of long-term land use changes on lake ecosystem health.

The overall state monitoring strategy including the purpose, rationale for site selection, geographic distribution of sites and sampling protocols will be discussed. Some of the challenges of sustaining a state water quality trend monitoring network will also be discussed.

The Vermont Lay Monitoring Program: Afloat For 26 Years!

Amy Picotte

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Biographical Sketches of Author

Amy Picotte is an Environmental Analyst in the office of the Vermont Water Quality Division. For thirteen years she has directed the Vermont Lay Monitoring Program, the state's long-term, volunteer lake sampling program. Additionally, she coordinates the Vermont Project WET program, providing resources and consultation to schools on water-related issues and is Editor for the Division's newsletter, Out of the Blue.

Abstract

The Vermont Lay Monitoring Program, a citizen-based, statewide, lake monitoring program is a cooperative effort between the Vermont Department of Environmental Conservation and lake users. The Lay Monitoring Program will start its 28th sampling season in 2006 under the same goals established at its inception in 1979. Through this program, meaningful and credible water quality data has been collected on more lakes than could ever have been sampled by VTDEC staff alone, making it a valuable and cost-effective program for the state. The program's long-term, water quality databases provide the basis for understanding Vermont lake conditions in terms of nutrient enrichment. This session will discuss how the Lay Monitoring Program works, including how volunteer and staff data are collected, analyzed and compared, and most importantly, how the volunteer data are used to protect Vermont lakes.

Improving Watershed Health using Citizen Monitoring Bioassessment and Water Quality Data in Collaboration with State, County and Local Governments

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Biographical Sketch of Author
Joanne Hild has been the biologist and Executive Director at Friends of Deer Creek in Nevada City, California since February 2000. She coordinates and designs the water quality and biological studies and various watershed projects using the help of 75 citizen volunteers along Deer Creek and its tributaries. Joanne is directing the use of EPA's Rapid Bioassessment Procedure to sample and identify macroinvertebrates to the family level of classification. She was a Biology Professor at Sierra College for 18 years and recently developed a college class about the biology of Deer Creek and uses of data for watershed health improvements.

Abstract
Friends of Deer Creek, a citizen-based watershed organization located in Nevada City, California, is science-based and project-oriented, partnering with many local, state and federal agencies to implement numerous projects which, when completed, will directly benefit the health of the Deer Creek watershed. Projects include bacterial source surveys, algae dry mass and nutrient studies, macroinvertebrate health analyses, sediment and storm drain installations, riparian trail design and construction, restoration projects, writing a macroinvertebrate identification manual, and development of Best Management Practices for erosion control. Four years ago, baseline water quality and benthic macroinvertebrate data was used by the California State Water Resources Control Board to issue a 303(d) impaired water body listing for pH on a 4 mile stretch of Deer Creek. FODC has continued its data collection and analyses and initiated discussions with the County wastewater treatment plant staff in preparation for a future TMDL to prevent high pH's and associated algae blooms. FODC is currently partnering with the California Regional Quality Control Board to sample mercury which was added to the creek 100 -150 years ago to amalgamate gold The data will be used to prioritize mercury hotspots from mine tailings for future cleanup and to better understand mercury transport in water and sediment during storm events. This is another example of using a citizen-state partnership to foster scientifically rigorous work to solve local problems. All FODC data is consistent with a Quality Assurance Plan developed jointly by Friends of Deer Creek and the State Water Resources Control Board and approved quarterly by a Technical Advisory Committee consisting of member scientists from state and federal agencies and local organizations.

The Oregon DEQ Volunteer Monitoring Program: Working at a Statewide Scale to Manage and Apply Water Quality Data Generated by Volunteer Organizations

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Biographical Sketch of Author

Steve Hanson is the Volunteer Monitoring Coordinator at the Oregon Department of Environmental Quality (DEQ) Laboratory. He has been in this position since November 2002 when the Volunteer Monitoring Program was restarted after being cut for several months due to state budget restraints. One of Steve's goals is to transform volunteer collected data into information that can be used locally and at a state level. His previous experience with the Oregon DEQ includes water quality monitoring and data analysis for TMDL development.

Abstract

In 1997 Oregon's Coastal Salmon Restoration Initiative, and later the Oregon Plan for Salmon and Watersheds recruited community based organizations to assist in the recovery of anadromous fish populations. These efforts empowered local watershed based organizations to improve water quality and stream habitat through locally-initiated stream restoration and monitoring programs. The Oregon Department of Environmental Quality (DEQ) Volunteer Monitoring Program has participated in this grassroots initiative since its inception. In an effort to improve the quality of volunteer data and increase the quantity of data available, the DEQ provides technical assistance and equipment to groups conducting monitoring. In return for assistance from the DEQ, volunteer groups submit their data to DEQ where the data becomes public information. Volunteer data submitted to the DEQ is diverse in its original intended use and in its spatial scale and temporal distribution. Now the DEQ and other state agencies are challenged with the task of gathering the information collected by these independent organizations and applying the data to make informed management decisions. The proposed presentation describes how the Oregon DEQ implemented its Volunteer Monitoring Program and the effect this has had on the application of data generated by volunteers. The presentation emphasizes issues dealing with data management, defining data quality and the how to apply the diverse volunteer data set to learn about Oregon's rivers and streams.

New Jersey's Answer to Multiple Volunteer Data Sources

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Biographical Sketch of Author
Danielle Donkersloot is the Volunteer Monitoring Coordinator for the New Jersey Department of Environmental Protection. She started with the NJDEP in the Threaten and Endangered Species Program and has been working for the Division of Watershed Management for the past 6 years. She has been coordinating and facilitating all the volunteer monitoring program within the State under one umbrella organization called the Watershed Watch Network. She has been integrating volunteer monitoring information into the overall State's monitoring matrix, and providing support and guidance to the volunteer community. Danielle represents the volunteer monitoring community at the NJ Water Quality Monitoring Council.

Abstract
The New Jersey Department of Environmental Protection (NJDEP) continuously looks to manage New Jersey's water resources more holistically. Volunteer collected data is recognized as part of the State's monitoring matrix and is viewed as a viable data source for the State, however it has been difficult for the State to access and standardize the data of the many organizations throughout the State.

The Watershed Watch Network, NJDEP's volunteer monitoring program, has learned through its work with volunteer coordinators around the state, that many organizations have difficulty managing the data they collect. In order to manage data, it must be put into a data spreadsheet and then retrieved to be used in reports or for comparisons.

The reports are designed to tell the story. For example, is the water quality improving? Is it being degraded? Are there unexplainable changes in the data from one year to the next?

Running the statistics, defining the changes in water quality and graphing results can be a challenge to any organization. There are also the challenges of storing and protecting data. For example, what happens if the data is only stored on one computer and that computer crashes?

Currently the Watershed Watch Network is working to develop a user-friendly data management system with DEP data experts, consultants, and the volunteer program coordinators. This system will allow for data to flow into the DEP as well as allow for the data to flow out of the system for public use. This online data management system will help alleviate the burden of data management for organizations and allow for volunteer collected data to be used at the DEP. The system will be a powerful tool for the volunteer community because it will allow volunteers to run simple statistics and create graphs for visual comparisons.

Spatial and Temporal Trends of Algal Biomass in Small and Large Streams in Indiana, 2001-04

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Biographical Sketches of Authors

Jeff Frey is a hydrologist with the USGS Indiana Water Science Center and has worked on water-quality projects, including fish-community assessments, transport of nutrients and pesticides, and effects of nutrients on biological communities. Since 2001, he has been the Project Chief for the National Water-Quality Assessment (NAWQA) White River-Great and Little Miami study.

Scott Lowe is a hydrologic technician with the USGS Indiana Water Science Center, and has worked on various projects ranging from chlorophyll a to ground- and surface- water quality sampling. He has worked for the USGS National Water-Quality Assessment (NAWQA) Program since 2004.

Donald R. Leer is a hydrologic technician with the USGS Indiana Water Science Center, and has worked on various projects ranging from chlorophyll a to ground- and surface- water quality sampling. He has worked for the USGS National Water-Quality Assessment (NAWQA) Program since 2002.

Abstract

One area of limited data in the U.S. Environmental Protection Agency's development of Nutrient Criteria has been chlorophyll a in seston and periphyton. Typically, correlations between nutrient concentrations and biological community attributes are low because nutrient concentrations in streams are not linked directly to biological communities. It is thought algal growth associated with excessive nutrients is an important variable in explaining the effects of nutrient enrichment on biological communities. Between 2001 and 2004, samples were collected by the Indiana Department of Environmental Management and U.S. Geological Survey at 224 sites throughout Indiana to help the State of Indiana derive refined Nutrient Criteria for streams. Samples were analyzed for algal biomass (chlorophyll a and ash-free-dry-mass in periphyton, and chlorophyll a and particulate organic carbon in seston), nutrients, habitat, and fish- and invertebrate-community attributes. Samples were collected in spring, summer, and fall to measure seasonal variability. Additionally, several samples were collected each year at selected National Water-Quality Assessment Program sites to measure annual and temporal variability. Sestonic chlorophyll a concentrations ranged from less than 1 to 250 micrograms per liter, with a median concentration of 2.68 micrograms per liter. Periphyton chlorophyll a concentrations ranged from less than 1 to 1,550 milligrams per meter squared, with a median concentration of 45 milligrams per meter squared. The frequency and magnitude of storms affected periphytic chlorophyll a concentrations, as the increased flow and sediment tend to scour the periphyton and reset the substrates for recolonization. Concentrations in low-flow years were higher than in wet years, and depending upon the number and timing of storms within the basins, the highest concentrations for periphyton were in low-flow periods in August to October. Seston chlorophyll a concentrations tended to be higher in the larger rivers than in the smaller streams.

Influences of Stream Size in Determining Nutrient Criteria for streams in the Eastern Corn Belt Plains Ecoregion

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Brian J. Caskey is an aquatic biologist at the U.S. Geological Survey (USGS) Indiana Water Science Center. He is a Certified Fisheries Research Biologist by the American Institute of Fisheries Research Biologist and a member of the American Fisheries Society, the North American Benthological Society, and the Indiana Biological Survey. Mr. Caskey has worked on the USGS National Water-Quality Assessment Program since 1997, where he specializes in developing understandings of how human influences are reflected in biological communities. He has worked in a variety of federal, state, and university stream-ecology studies across the U.S. over the past 14 years.

Jeff Frey is a hydrologist with the USGS Indiana Water Science Center and has worked on water-quality projects, including fish-community assessments, transport of nutrients and pesticides, and effects of nutrients on biological communities. Since 2001, he has been the Project Chief for the National Water-Quality Assessment (NAWQA) White River-Great and Little Miami study.

Abstract

States have been mandated either to accept nutrient criteria developed by the U.S. Environmental Protection Agency (USEPA) or develop criteria appropriate for their particular state. In 2003 and 2004, the U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program implemented studies to address nutrient enrichment in rivers in five basins across the United States. The objective of this analysis was to illustrate how fish communities respond along a prior-determined gradient of nutrient concentrations (TN and TP) in streams within the Eastern Corn Belt Plains Ecoregion. The USEPA proposed nutrient criteria were based on nutrients as a causal variable and chlorophyll a as a response variable at the ecoregion level. The USGS NAWQA Program nutrient studies have shown that relations between chlorophyll a and nutrient concentrations are not statistically significant in streams within the Eastern Corn Belt Plains Ecoregion. Preliminary analysis of the USGS NAWQA Program's Nutrient Studies has shown that Detrended Correspondence Analysis (DCA) sites scores, a measure of community structure and composition, have shown statistically significant relations to nutrient concentrations. The USGS NAWQA Program nutrient study in the Eastern Corn Belt Plains Ecoregion showed the fish-community response can differ, depending on the basin size (scale) of the streams sampled. The original fish-community data set in the Eastern Corn Belt Plains Ecoregion contained headwater to medium-sized streams. The fish-community composition within this data set (n=30) contained fish species that are common in small streams (i.e., dace, darters, and sculpins) as well and larger streams (i.e., carp, redhorse, and buffalo). Because of the natural differences in fish communities found in headwater and larger streams, the relations of the DCA fish-community site scores to nutrient concentration were weak. After the influences associated to basin size were reduced by removing the small headwater sites and the larger streams, the fish communities in the new data set (n=23) contained fish communities that were similar to one another; the relations of DCA fish-community site scores to nutrient concentration were strengthened. These findings suggest that if biological communities are used to develop nutrient criteria, future analyses need to address the natural variation associated with basin size before biological communities can be used to develop nutrient criteria and the proposed criteria can be adopted.

Algal Pigments in Benthic Organisms and Fish: Development of Biomarkers to Trace Food-Web Relationships

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Abstract
Outbreaks of type E botulism in fish and piscivorous birds of Lake Erie have generated interest in biomarkers of food web relationships between benthic invertebrates and fish. Type E botulism is a consequence of ingestion of the type E botulinum neurotoxin, produced by the anaerobic bacterium Clostrodium botulinum. This presentation will discuss development of methods using algal pigments to trace benthic-pelagic foodweb connections: the set of target analytes includes 9 chlorophylls and 23 carotenoids, which have been shown to selectively differentiate 7 major divisions of algae; moreover, carotenoids have been detected in the tissues of aquatic organisms, and attributed to accumulation from the diet. Therefore, methods are being developed to determine the pigment composition of diverse benthic organisms and fish collected from Lake Erie, combining solvent extraction of homogenized, freeze-dried tissue specimens, with analysis by high performance liquid chromatography with photodiode array detection. Because these methods of sample preparation and analysis are new, particularly to large-scale monitoring programs, a large part of the work involves documenting procedures for preparation of standards and sample extracts, as well as method performance (precision, recovery, detection limits, quantitation range), at each stage of method development. To date, the analytical results have profiled the diet of two groups of benthic invertebrates, both dependent on primary productivity: i) grazing of epiphytic diatoms from filamentous Cladophora by epiphytic gastropods; ii) filtration of planktonic diatoms, chlorophytes, cryptophytes and cyanobacteria by quagga mussels (Dreissena bugensis). Progress in applying these methods of analysis to higher trophic levels will be discussed for various species of benthic and pelagic fish collected from Lake Erie, particularly organisms involved in outbreaks of type E botulism. The current work is supported by New York Sea Grant and US EPA Great Lakes National Program Office.

Screening for Algal Toxins in Volunteer-Monitored Lakes

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Biographical Sketch of Author

Gene Williams is a senior planner in the Surface Water Management Division of Snohomish County, Washington. Since 1989, he has been project manager of Snohomish County's lakes program. The program involves May-October monitoring of 33 lakes, 25 of which are monitored by volunteers. He has also managed invasive aquatic plant control projects and water quality restoration projects at eight lakes.

Abstract

In recent years, there has been a growing awareness of the potential threat to animals and humans from blue-green algal toxins in lakes. Ingestion of algal toxins can damage neurological and liver functions, and even cause death. However, the conditions under which blue-green algae produce toxins are not clearly understood; and laboratory analyses for toxins are expensive, so frequent tests of lake waters are not realistic.

To gain a better understanding of the potential risks of algal toxins in local lakes, the Snohomish County (Washington) Surface Water Management (SWM) staff worked with volunteer lake monitors at 25 lakes to implement a pilot program in 2005 to screen for algal toxins.

Volunteers collected grab samples of water and algal scum from their lakes during monthly monitoring sessions and at other times when dense algal blooms were present. SWM staff then examined these samples under a microscope to identify any of three blue-green algae that are most commonly associated with toxic blooms—Anabena, Aphanizomenon, and Microcystis. If these algae were abundant in any sample, new samples were collected from that lake by SWM staff and tested for the presence of microcystin, one of the most common toxins. Tests were performed using QualiTube™ kits (an ELISA process) from Envirologix to indicate the level of microcystin compared to two calibration concentrations. When toxins were found, SWM worked with the local health district to evaluate the risk and notify lake residents and users. Follow-up tests were performed to determine when the threat of blue-green toxins had passed.

Several lessons were learned during the first season of testing. These led to refinements in the screening/testing procedures and identified the need for a clear follow-up plan of action whenever algal toxins are identified.

Bioassessment Method Performance and Comparability

Facilitators
Jerry Diamond, Tetra Tech, Inc.
Laura Gabanski**,** U.S. Environmental Protection Agency

Biographical Sketches
Dr. Jerry Diamond is a co-Director of Tetra Tech's Biological Research Facility in Baltimore, MD. Since 1994, he has provided EPA technical support to the Methods and Data Comparability Task Group under ITFM and later the Methods and Data Comparability Board regarding ways to document bioassessment method performance and data comparability. He is currently assisting EPA in developing a guidance document that presents current thinking as to how bioassessment method performance should be analyzed and documented and will give step-by-step procedures for when and how it is acceptable to combine bioassessment information from different sources.

Laura Gabanski is a biologist with EPA's Office of Wetlands, Oceans, and Watersheds (OWOW). She manages projects related to bioassessment comparability and is OWOW's research planning and coordination liaison with EPA's Office of Research and Development.

Workshop Description
Biological assessments are a key tool used by monitoring and regulatory organizations to determine status and trends regarding water resources identify emerging issues, and to help prioritize remediation and protection efforts. With increasing use of biological assessment data in state and federal regulatory programs, and the different methods used by different organizations, there is a need to ensure that methods are comparable and the quality of the data obtained are satisfactory so as to meet the needs of different programs. Development of performance-based bioassessment methods is seen as one key to achieving known data quality and comparable methods. This workshop will discuss the current state-of-the-science in defining performance-based bioassessment methods and comparability at the methods, data, and assessment levels. An interactive poster session format will be used, along with facilitated break out sessions to solicit input from participants concerning: (1) extent of sampling and analysis that should be recommended to document bioassessment performance; (2) methods that should be used to evaluate data or assessment comparability; and (3) feedback on EPA's current projects in this field, including a guidance document and analyses of comparability data generated under EPA's Wadeable Stream Assessment.

Water Quality Data Elements (WQDE): Enhancing comparability of monitoring information

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Biographical sketches of authors

LeAnne Astin is an Aquatic Ecologist and data analyst for the Interstate Commission on the Potomac River Basin's Living Resources Division. She currently serves on the Water Quality Data Elements Workgroup of the Methods and Data Comparability Board, and has been a Board member since April 2002.

Eric Vowinkel, Ph.D., has been a hydrologist with the New Jersey Water Science Center (NJWSC) of the U.S. Geological Survey (USGS) for 27 years. He currently serves as the USGS Co-Chair of the Methods and Data Comparability Board of the National Water Quality Monitoring Council and has been a member of the Board since January 2004.

Abstract

Many entities collect water quality monitoring data. However, inconsistent use of metadata impedes coordination of data collection efforts and the productive exchange of water quality information among different monitoring entities. Metadata describe datasets or information products by documenting subject matter; how, when, where, and by whom the data were collected; and the quality of those data. Metadata allow data generators to interpret "legacy" data collected in the past for their own program, and allow data users to evaluate the appropriateness of using data from other programs. The Methods and Data Comparability Board (MDCB), in conjunction with federal, state, and private partners, has developed approved sets of data elements which it believes are the minimum elements necessary to facilitate the exchange of chemical, microbiological, population/community, and ecotoxicological assessment data. Data elements for physical/geomorphometric assessments are under development. The data elements are constructed in modules that address the "who," "where," "when," "why," and "how" data are collected. The Advisory Committee on Water Information (ACWI), the National Water Quality Monitoring Council, and the MDCB recommend that organizations collecting and managing water quality data use these data elements to facilitate data sharing and ensure data comparability and longevity. A Guide ("Data Elements for Reporting Water Quality Monitoring Results for Chemical, Biological, Toxicological, and Microbiological Analytes") has been developed that describes the rationale for developing the data elements, explains the modular concept, and includes case studies where the data elements have been implemented. Appendices to the Guide present the individual data elements.

Water Quality Exchange (“WQX”) – EPA’s new look at Water Quality Data Management

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Kristen Gunthardt is an IT Specialist in the Office of Wetlands, Oceans and Watersheds in EPA’s Office of Water. She has been a part of the STORET team in the water program for over a year, and served to help bring the OWWQX Pilot project to a finish.

Curtis Cude is a Data Exchange Specialist in the Information Services section of Oregon Department of Environmental Quality. He is the project coordinator for the Pacific Northwest Water Quality Exchange and was on the development team for the ESAR data standard. He coordinated Oregon’s participation in the OWWQX pilot.

Abstract

EPA Office of Water’s Water Quality Exchange (“WQX”) is a database re-engineering effort that is taking a new look at the STORET system. As aging technology continues to push data managers towards implementing new and better solutions, the Office of Water is leveraging more standardized and platform-independent approaches to data exchange through updated tools and the Federal Enterprise Architecture.

The development of “WQX” is building on lessons learned from the Office of Water’s Water Quality Exchange pilot (OWWQX) that is scheduled to be completed in December of 2005. The pilot is a cooperative effort between EPA’s Office of Water, Office of Environmental Information, and pilot participants including OR, MI, TX and the Wind River Environmental Quality Commission (WREQC). The goal of the OWWQX pilot is to flow water quality data from pilot participants to EPA through EPA’s data Exchange Network. OWWQX is an implementation of the Environmental Sampling, Analysis and Results (ESAR) Data Standard, which was built upon the foundations of the WQDE chemical and microbiological lists, developed by NWQMC and approved by ACWI.

We will discuss lessons learned from OWWQX pilot project and how they are helping the Office of Water look ahead towards “WXQ” implementation in 2006. Strategic discussion of how outbound data flows can be developed such that other large data holders, such as other federal agencies, might join the Exchange Network and make their data available will also take place.

Compiling a Baseline Water Quality Database from Heterogeneous Data Sources: Lessons Learned

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Nenad Iricanin (nirican@sfwmd.gov) is a Lead Environmental Scientist in the Environmental Assessment Department of the South Florida Water Management District. He holds Bachelor's, Master's and Doctorate degrees in Chemical Oceanography from the Florida Institute of Technology. He conducts advanced data analyses concerning water quality and other environmental parameters, and provides expert interpretation of regional monitoring data for use in agency reporting and decision-support.

Brian Turcotte (bturcott@sfwmd.gov) earned a Master of Science degree from Cornell University and is a licensed Professional Engineer in the State of Florida. He has 19 years professional experience in planning, research, analysis, development, and management of hydrologic, water resources, and database related projects. He is presently the Enterprise Scientific Data Manager for the South Florida Water Management District.

Scott Huebner (huebner@sfwmd.gov) is a Lead Engineer in the Environmental Resource Assessment Department of the South Florida Water Management District. His undergraduate degree is in Civil Engineering from Northwestern University and he holds a Master's degree in Civil Engineering and Public Administration and a Doctorate degree in Civil Engineering from Penn State University. He is a professional engineer in California and Florida. He has been active in the area of water resources management, research and instruction for over twenty-five years.

Abstract
The Comprehensive Everglades Restoration Plan (CERP) is the largest restoration project ever undertaken, covering 16 counties over an 18,000 square mile area of central and southern Florida. The plan provides a framework for restoring, protecting, and preserving the water resources of this portion of Florida, which includes the Everglades. The Restoration Coordination and Verification (RECOVER) portion of CERP provides essential scientific and technical support for restoration, and is charged with by evaluating and assessing the performance of the restoration plan. As an essential first step in assessing performance, the U.S. Army Corps of Engineers and the South Florida Water Management District (District) are jointly establishing a baseline database for assessing the restoration process. The purpose of the database is to establish baseline conditions for water quality and hydrological performance measures in a number of ecoregions identified by CERP. Approximately 70 organizations were identified as potential data sources. Ultimately, data from 290 studies were chosen because they met the requirements of the baseline database. Initially, the baseline database contained approximately 80 million data records with greater than 58 percent of the data coming from the District's corporate database, DBHYDRO. As the technical and scientific review of this relatively large database progressed, a multitude of problems emerged that resulted in a re-evaluation of the original baseline database structure. The challenges faced and lessons learned during the compilation of this baseline database will be presented along with recommendations for any future undertakings of this magnitude in compiling a database from a variety of sources.

Data Comparability and Modernization of Environment Canada's Water Quality Information Holdings

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Chris Lochner is a Water Quality Information Specialist and Scientist with the National Water Quality Monitoring Office of Environment Canada. He is a geochemist with specialization in radio-isotopes. He began his government career in 2003 and has been involved in several water-related information initiatives that have included mostly the federal government, provinces and NGOs. Aside from a three year hiatus to work as a professional musician, Chris spent much of his pre-government career, working as a consultant with World Bank and Asian Development Bank projects in China with a company called Chreod Ltd.

Abstract

Environment Canada generates and manages large quantities of water quality data across a wide variety of networks and issues based primarily on the needs of our five regional offices. Each of these jurisdictions has, for more than a decade, operated autonomously from one another with regionally focused monitoring programs and research and little or no national synthesis. Since the water quality issues can vary significantly among these regions, this results in an extremely complex platform from which to meet the increasing need for credible reporting on nationally-scoping issues. This reality has resulted in data that is based on regionally diverse objectives, regionally independent laboratory analyses and methods as well as data management needs. In an effort to improve the credibility of national-scale synthesis of water quality, a significant effort has been undertaken to assess, document and improve the state of comparability of Environment Canada's water quality holdings. This effort involves three principle components: a) a detailed assessment of the comparability of the laboratory methods across our data; b) implementation of a process that will allow for direct, dynamic, national-scale access to these data across a distributed online network of databases using web services and tools (rather than a massive central data warehouse); and c) implementation of a more standardized approach to coding and identification of our water quality parameters to ensure a more nationally consistent way of managing the data and analytical methods behind them.

Inventory of Ocean Monitoring in the Southern California Bight

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Biographical Sketch of Primary Author

Stephen B. Weisberg is a biologist who specializes in the design of environmental monitoring programs. He received his undergraduate degree from the University of Michigan in 1974 and his Ph.D. from the University of Delaware in 1981. Dr. Weisberg joined SCCWRP in September 1996. His present research efforts focus on the development of coordinated, integrated, cost-effective regional monitoring in the Southern California Bight.

Abstract

Monitoring of the ocean environment in southern California has been conducted by a diverse array of public and private organizations with different motivations, working on a variety of spatial and temporal scales. To create a basis from which to integrate information from these diverse programs, we conducted an inventory of ocean monitoring activities in the Southern California Bight to address the following questions: (1) How many dollars are being expended annually on marine monitoring programs? (2) Which organizations are conducting the most monitoring effort? and (3) How are resources allocated among the different types of monitoring programs? This inventory focused on existing programs, or expected to be in existence, for at least 10 years and that were active at any time between 1994 and 1997. For each program identified for inclusion in this study, information was collected on the number of sites, sampling intensity, parameters measured, and methods used. Levels of effort were translated into cost estimates based upon a market survey of local consulting firms. One hundred and fourteen marine monitoring programs, conducted by 65 organizations and costing $31 million annually, were identified. Most of the effort (81 programs, 65% of samples, 70% of costs) was expended by ocean dischargers as part of their compliance with National Pollutant Discharge Elimination System (NPDES) permit requirements. Federal programs (11 programs, 25% of samples, 10% of total expenditures) expended more than state or local government programs. More than one-quarter of monitoring expenditures were conducted to measure concentrations and mass of effluent inputs to the ocean. The largest effort expended on receiving water monitoring was for measuring bacteria, followed by sediments, fish/shellfish, water quality, and intertidal habitats. The large level of expenditures by individual agencies has presented opportunities for integrating small, site-specific ocean monitoring programs into regional- and national-scale monitoring and assessment programs.

Southern California Bight Regional Marine Monitoring Program

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Kenneth Schiff is SCCWRP's Deputy Director and is responsible for helping manage day-to-day operations, supervision of senior level staff, and developing the long-term vision of the research agency. His duties include management of large projects that cut across several scientific disciplines and agency departments, such as southern California Regional Monitoring, Total Maximum Daily Loads (TMDLs), and watershed research. He received his undergraduate degree from San Diego State University in 1984 and his Master of Science Degree from California State University Long Beach in 1988. Mr. Schiff joined SCCWRP in August 1995.

Abstract

Although more than $31 million is spent monitoring the marine environment of the southern California Bight (SCB), only 5% of the area is assessed on a routine basis. As a result, environmental managers have begun asking regional based questions including: 1) What is the extent and magnitude of impairment throughout the entire SCB?; and 2) How does impairment compare among various habitats of the SCB? Rather than any single program undertaking such a large task, an ambitious collaborative program was launched, whereby all of the routine monitoring was postponed for a season and the effort redistributed throughout the SCB. Over 65 agencies, including State and Federal regulators, regulated NPDES Permittees representing cities, counties and private industry, as well as environmental advocacy organizations participated in this regionwide assessment. Indicators included coastal ecosystem parameters (sediment, water and tissue chemistry, sediment toxicity, benthic infauna, fish and macrobenthic invertebrates), physical oceanography and remote sensing, and shoreline microbiology. Moreover, a number of different habitats were targeted including estuaries, embayments (i.e. marinas, ports, bays, harbors), continental shelf, slope and basins, and offshore islands, as well as potential areas of significant inputs such as publicly owned treatment works. This regional monitoring paradigm has become so successful that the collaborators have conducted this survey three times (1994, 1998, 2003) and plan on repeating every five years (the next is in 2008). Overall, the value of such an exercise is not only the high quality assessments, but the high degree of communication that occurs during such an integrated monitoring program. In addition, a large variety of regional tools have been developed as a result of the surveys including sediment quality guidelines, biocriteria, sampling methods, regional reference conditions, remote sensing technology, and laboratory methods.

MARINE: A Long-term Monitoring Program for Detecting Change in Rocky Intertidal Environments

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Biographical Sketch

Steve Murray is Dean of the College of Natural Sciences and Mathematics at California State University, Fullerton. His research interests include marine herbivory and the ecology of coastal populations and communities. Dr. Murray is lead author of "Monitoring Rocky Shores", a book published by University of California Press, and is a principal investigator in MARINe (Multi-agency Rocky Intertidal Network), a collaboration of scientists and agency representatives analyzing the spatial and temporal dynamics of key rocky intertidal populations. He currently serves on the Federal Advisory Committee on Marine Protected Areas and the Science Advisory Team for California's Marine Life Protection Act.

Abstract

The Multi-Agency Rocky Intertidal Network (MARINe) is a collaborative effort to monitor spatial and temporal variation in the distributions and abundances of rocky intertidal populations in California. A total of 33 unique partners participate in MARINe, and scientists from federal and state agencies, local government, universities, and private and volunteer organizations work together to perform MARINe monitoring. There are 80 core monitoring sites located along the California coast, including the offshore Channel Islands. Monitoring of key species populations, including mussels, sea stars, black abalone, acorn and gooseneck barnacles, owl limpets, surf grasses, rockweeds, and other algal species, occurs during the fall and spring of each year. Sites range from those monitoring a single target species to those following multiple species. The program relies on established sampling methodologies, which are carried out uniformly by MARINe participants across all sites, and data are input into a combined data base. Implementation of such a long-term, regional program provides the ability to document and understand the dynamics of rocky intertidal populations resulting from catastrophic events such as an oil spill or from changes in environmental parameters, such as shifts in ocean climate, increases in human use, or improvements in water quality. Moreover, data generated from programs like MARINe facilitate the scientific understanding of the process implications of spatial and temporal changes in California coastal communities. Despite the scientific and managerial value of the information obtained, however, maintaining the continuity of MARINe and other long-term, regional monitoring programs is a challenge because of the need for sustained funding commitments from multiple partners and the required cooperation of monitoring participants.

The Value of Communication, collaboration and coordination for Statewide Decision Making: The Example of the Beach Water Quality Workgroup

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Robin has worked for the State Water Resources Control Board for over 25 years in a variety of water quality control capacities. Robin currently serves as the Clean Beaches Coordinator for the Office of Statewide Initiatives. Robin coordinates the Water Board's outreach to improve beach water quality by leading a variety of collaborative work groups in both Northern and Southern California that focus on coordinating efforts to reduce bacterial contamination in coastal waters. Robin received a Bachelor degree in Biology from California State University, Northridge and a Masters in Physiological Ecology and Doctorate in Environmental Science and Engineering from UCLA.

Abstract

In 1998, the State Water Resources Control Board (SWRCB) formed the Beach Water Quality Workgroup (BWQW) to gather together stakeholders responsible for beach water quality to develop ways to reduce bacterial contamination of ocean and bay waters. The mission of the Beach Water Quality Workgroup is to achieve continuous and immediate improvement in the water quality at beaches throughout California. The BWQW is a coalition of federal, state, county and local governmental agencies, environmental advocacy groups, academia, environmental consultants, and scientific researchers. The BWQW is a driving force for development of better public health protection tools such as consistent monitoring and reporting protocols throughout California, and continues to coordinate the development of research tools, as well as better and faster bacterial indicator analysis methods.

The Monitoring and Reporting Subcommittee (M&RS) of the BWQW was established to develop consensus among the parties responsible for coastal monitoring that lead to a consistent approach to monitoring and public health notifications for California's marine beaches. The M&RS provides a forum for regulators, agencies responsible for monitoring, and non-governmental environmental groups to come together to discuss their mutual concerns. Although there have been instances where the parties agreed to disagree, the subcommittee's work has generally led to consensus among the parties for developing approaches on a wide range of issues creating win-win outcomes for the participants and the public.

The Monitoring and Reporting Subcommittee continues to be a highly effective and active group contributing to the public's health and safety at California's marine beaches. Its accomplishments include the following: development of a statewide database; consistent use of signage for public notification; coordinated approach to station location selection and monitoring strategy; consistent application of rain advisories; guidance for CWA 303(d) listing and delisting of beaches for bacteria; review of the current beach monitoring and regulatory program; and development of guidance to improve the reliability and accuracy of the public health monitoring and notification system. Most recently we have been involved in the development of rapid indicators and the criteria with which the new methods would be evaluated.

Water Quality Monitoring and Assessment of Global Change

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Biographical sketch
Richard Robarts is Director of the UNEP GEMS/Water Programme for global water quality monitoring and assessment, a multi-faceted water science centre oriented towards knowledge development in inland water quality issues throughout the world. As an aquatic microbial ecologist he has worked in regions extending from the Arctic to the sub-Antarctic, including the tropics and subtropics with14 years in Africa. His recent research focus has been the wetlands and saline lakes of the prairies. He has published extensively on the ecology and production of bacteria and bloom-forming cyanobacteria in lakes, reservoirs, wetlands and the Eastern Mediterranean Sea.

Abstract
Evaluation and assessment of fresh and inland water quality at the regional and global scales are not simple tasks. UNEPs GEMS/Water has operated a comprehensive freshwater quality monitoring and assessment programme for over 25 years and is the only such global programme. It operates primarily by inviting national governments to provide water quality data from their water quality monitoring programmes. The data is then compiled into a global database, GEMStat, a value-added process. GEMS/Water, United Nations agencies and other international organizations use the data to undertake global and regional scale water quality assessments and to assess the effectiveness of multilateral and other agreements. More than 100 countries participate in the programme that has a database of more than 2 million data entries. Participating countries control the type of data collected, the location of sampling sites, the frequency of monitoring, the analytical and field methods used and the frequency at which data is transferred to GEMS/Water. In order to make effective assessments and identify emerging water quality issues, data must be of good quality, comparable between countries for a specific parameter, be geographically representative for a given region and be up-to-date. GEMS/Water could only ensure that all these characteristics are satisfied in GEMStat by operating its own global water quality-monitoring programme, which is economically impossible. However, GEMS/Water has a comprehensive QA/QC programme to help countries with data quality. Users can now access data through a new interactive website (www.gemstat.org) and generate statistical tables and different types of graphs. A module has recently been added to allow users to calculate riverine fluxes.

Evaluating the Potential Human-Health Relevance of Volatile Organic Compounds in Samples from Domestic and Public Wells in the United States

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Patricia Toccalino is a hydrologist with the U.S. Geological Survey, with expertise working at the interfaces between environmental chemistry, toxicology, risk assessment, and contaminant fate and transport. Since 1998, Dr. Toccalino has led an interagency collaborative effort with the USGS to communicate the potential relevance of the water-quality findings of its National Water-Quality Assessment (NAWQA) Program in a human-health context. Prior to moving to USGS in 2005, she was an assistant professor at the Oregon Health & Science University.

Julia Norman is a research associate with Oregon Health & Science University, where she received an MS in Environmental Science and Engineering. Since 2002, she has worked in support of a USGS NAWQA effort to evaluate the potential human-health relevance of contaminant concentrations in ground water. Ms. Norman formerly worked for the Orange County (California) Water District evaluating advanced water treatment processes for wastewater reclamation and potable reuse.

Barbara Rowe is a hydrologist with the U.S. Geological Survey. For the past 10 years she has worked with the NAWQA Program with the Volatile Organic Compound (VOC) National Synthesis Team. She holds a masters degree in Geology and Geological Engineering from the South Dakota School of Mines and Technology.

Abstract

Ground water is used as a drinking-water supply for approximately half of the Nation's population. Untreated ground-water samples from about 2,400 domestic wells and 1,100 public wells were analyzed for 55 volatile organic compounds (VOCs) as part of the U.S. Geological Survey's National Water-Quality Assessment Program. Because domestic and public wells serve as drinking-water supplies, it is important to describe what the VOCs detected in these well samples may mean to human health. VOC concentrations were compared to Maximum Contaminant Levels (MCLs) and Health-Based Screening Levels (HBSLs) in a screening-level assessment to provide an initial perspective on the potential relevance of these concentrations to human health. VOC concentrations of potential human-health concern were defined as concentrations greater than MCLs or HBSLs; these concentrations occurred in about 1 percent of domestic-well samples and 2 percent of public-well samples. Fumigants accounted for about two-thirds of the VOC concentrations of potential human-health concern in domestic well samples. In public well samples, solvents accounted for about three-fourths of the VOC concentrations of potential human-health concern.

Evaluating the potential human-health relevance of VOC concentrations in domestic- and public-well samples is complex. NAWQA studies were not designed to evaluate the specific effects of VOCs on human health, and screening-level assessments are not a substitute for comprehensive risk assessments. Screening-level assessments, however, can provide an early indication of when concentrations approach levels of potential human-health concern and prioritize VOCs that may merit additional study or monitoring.

Preliminary Findings of Anthropogenic Organic Compounds in Source and Finished Waters of Community Water Systems

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Biographical Sketch of Author

Greg Delzer serves as the coordinator of the National Water-Quality Assessment Program's Source Water-Quality Assessments (SWQAs). SWQAs focus on characterizing the quality of major rivers and aquifers used as a source of supply as well as the associated finished water of some large and very large community water systems across the nation. Greg has served in this capacity for about 3 years and has been employed by U.S. Geological Survey for about 13 years.

Abstract

In 1991, the U.S. Geological Survey (USGS) began the National Water-Quality Assessment (NAWQA) Program to, in part, provide a nationally consistent description of current water-quality conditions for 50 of the largest and most important river basins and aquifers across the Nation. Beginning in 2001, the Program incorporated recommendations provided by the National Academy of Sciences, and others, and began its second decade of intensive assessment activities. These recommendations resulted in the implementation of a new assessment activity termed Source Water-Quality Assessments (SWQAs). SWQAs were implemented to focus on characterizing the quality of major rivers and aquifers used as a source of supply to some of the largest community water systems in these study areas. SWQAs are intended to complement existing drinking-water monitoring required by Federal, State, and local programs that focus primarily on post-treatment compliance monitoring. Through SWQAs, the NAWQA Program is increasing its emphasis on characterizing the water quality of rivers and aquifers that are major sources of drinking water and continues to collaborate with other agencies and organizations involved with supplying and managing drinking water.

The objectives of SWQAs are twofold: (1) to determine the occurrence and, for rivers, seasonal changes in concentrations of a broad list of anthropogenic organic compounds (AOCs) in rivers and aquifers that have some of the largest withdrawals for drinking-water supply in the United States, and (2) for compounds found to occur most frequently in source water, to characterize their detection frequencies and concentrations in both source and finished waters. This presentation will compare preliminary findings for about 270 AOCs in source water and the associated finished water at 9 surface-water intakes and 163 community water-supply wells. Results for regulated and several unregulated AOCs will be interpreted in a human-health context utilizing Health Based-Screening Levels.

Are Environmental Contaminant Concentrations in U.S. Waters Harmful to Fish-Eating Wildlife?

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Abstract
The Large River Monitoring Network (LRMN) of the USGS Biomonitoring of Environmental Status and Trends (BEST) Program has measured 29 organochlorine residues and 18 elemental contaminants in fish from large river basins throughout the U.S. including the Mississippi, Rio Grande, Columbia, Yukon, and Colorado. Many chemical contaminants bioaccumulate in the aquatic food chain, and birds and mammals may be exposed to high concentrations through the fish they consume. A screening-level risk assessment for piscivorous wildlife was conducted to utilize existing contaminant data from the LRMN. Exposure and subsequent hazard evaluation models were developed for three sizes of birds (belted kingfisher, osprey, bald eagle) and two mammals (mink, river otter). Toxicity reference values, derived from chemical specific effects on reproductive performance, growth, and survival in a species, consumption rates, and other species-specific metrics of exposure models were used to calculate hazard concentrations (HC) for each chemical and species combination. Concentrations of most contaminants measured by the LRMN did not exceed HCs, and risk associated with contaminant exposure was minimal in mammalian wildlife models. Concentrations of *p,p'*-DDE, endrin, PCBs, chromium, iron, mercury, selenium, and zinc exceeded HCs for small birds at most sites; these data were then compared to site-specific contaminant studies, if available, to confirm risks identified in the screening-level assessment. This approach provides an additional use of fish contaminant data which is rarely exploited.

Comparing Flow Variability in Urban Streams Across Environmental Settings

Elise M. Giddings[1], Dan L. Calhoun[2], and Lori A. Sprague[3]

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Elise Giddings has been a biologist with the U.S. Geological Survey since 1995, where she has worked for the National Water Quality Assessment (NAWQA) program in three different states. She spent 4 years managing biological data collection and analysis for the Great Salt Lake NAWQA, Utah. Most recently, she has been working in Raleigh, North Carolina focusing on urban land use change and its effects on stream ecosystems. Elise holds a M.S. degree in Water Resource Management and a B.S. in Biological Aspects of Conservation from the University of Wisconsin – Madison.

Dan Calhoun is a hydrologist with the U.S. Geological Survey in Atlanta, Georgia. Current work includes investigating the effects of urbanization on stream hydrology and ecology, and the effects of nutrient enrichment on streams.

Lori Sprague is a hydrologist in the Colorado Water Science Center within the U.S. Geological Survey's Water Resources Discipline. She is currently involved with the National Water-Quality Assessment Program of the USGS, where she is working on a variety of studies including an analysis of long-term trends in nutrient and suspended sediment concentrations in the Missouri River Basin and an examination of the effects of urbanization on water chemistry nationwide. She is also conducting research into the fate and transport of endocrine disruptors downstream from a wastewater treatment plant.

Abstract
Landscape transformation during urbanization affects streamflow variability which in turn affects instream biological communities. Climatic and topographic factors influence flow variability as watersheds become more urbanized. As part of the National Water-Quality Assessment Program, variability in streamflow patterns were assessed at 30 sites in each of 6 study areas across the Nation (near Raleigh, NC; Atlanta, GA; Milwaukee, WI; Dallas-Fort Worth, TX; Denver, CO; and Portland, OR). Submersible pressure transducers were installed to record continuous stream stage, which was converted to continuous cross-sectional area using a surveyed channel cross section. Metrics were calculated to represent magnitude, duration, and frequency of high and low streamflow conditions, and these metrics were compared with measures of urban intensity in the landscape. In all six study areas, as urbanization increased, the frequency of quickly rising streamflows increased (Spearman's rho 0.62 to 0.91), illustrating an increase in stream flashiness. The duration of high streamflow showed variable responses in the study areas. In study areas in the southern U.S. (Atlanta, Raleigh, Dallas-FtWorth) the median duration of high streamflow events and the duration of the longest high streamflow event showed a factor-ceiling effect, where streams high in urbanization had short duration events, while those low in urbanization had a range of event length. In the Denver study area, the median and maximum duration of high streamflow showed the opposite effect; the high urban sites had longer duration events, although the range of event lengths was much smaller than other study areas. The Portland and Milwaukee areas showed mixed results. Although each study area had significant hydrologic responses to urbanization, the strongest responses were seen in Atlanta, Raleigh, and Dallas-Ft. Worth. These areas lack confounding effects such as snow cover, hydrologic alterations or agricultural effects.

A Tale of Two Streams: Chemical and Physical Characteristics of Secondary Tributaries in an Arid Urban Watershed and Potential Impacts on a Main Stem River

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Phil Russell is the Environmental Analyst at the Littleton/Englewood Wastewater Treatment Plant (LEWWTP). He moved to the facility in 1992 from a private consulting business and the Denver Research Institute at the University of Denver. He is responsible for managing the facilities analytical laboratory, interacting with the State of Colorado in matters that might impact laboratory operations, taking an active role in the South Platte River urban watershed study, and developing, designing and implementing environmental related research projects.

Claudia Cossio is an environmental engineer from Bolivia. At the time of this project she was sponsored by Water for People on an internship provided by a John H. Ware fellowship grant which was facilitated by the Denver International Program (University of Denver). She worked at the LEWWTP to develop an understanding of analytical methodology, and watershed study development and implementation.

Abstract
Since 1998 South Platte Coalition for Urban River Evaluation (SPCURE) has studied the Denver, Colorado, urban watershed. The studies have focused on the main stem of the South Platte River. There has always been concern that the tributaries may impact the main stem but there have been limited resources to study the problem. In the Spring of 2004 an opportunity occurred because of a John H. Ware Fellowship program that sponsored a trainee from Bolivia. The trainee was scheduled to spend seven weeks observing and working with SPCURE. The trainee's goals were to learn techniques and methods for assessing water quality, and acquire field sampling design and implementation skills. This provided an opportunity for combined fellowship training and a tributary stream impact research project.

The trainee gained valuable insight into the process of designing and implementing a watershed field study, and knowledge about appropriate analytical procedures. The two streams that were selected for the study were selected because chemical analyses collected at the tributary mouths suggested that the two streams had different characteristics. Bear Creek (BC) originates from the western Rocky Mountains and Little Dry Creek (LDC) originates form the eastern plains.

Analytical variables measured included physical/chemical parameters, microbiology and a suite of metals. From this data it was observed that

1. the two streams are different in nature
2. the Mancos shale deposits to the east produced high Se levels in LDC
3. both streams had high non-human *E. coli* populations
4. the streams were impacted, but differently, by road de-icing

In conclusion, the chemical characteristics of relatively small tributary streams can vary significantly in spatial and temporal terms even for streams that are located in seemingly close proximity. During low flow conditions these streams have the potential to significantly impact the larger stream into which they flow.

An evaluation of aquatic communities in urbanized Mediterranean climate streams: a guide to more effective stream restoration in the Santa Clara Basin (San Jose, California)

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Alison Purcell is a doctoral candidate at the University of California, Berkeley in the Division of Organisms and Environment. The focus of her dissertation research is developing biological indicators to evaluate urban streams in the Santa Clara Basin (San Jose, California, USA). She has trained individuals from over 40 countries in conducting biological and habitat assessments of streams.

Jim Carter is an aquatic ecologist with the National Research Program, Water Resources Discipline of the U.S. Geological Survey. He studies the influence of physical and chemical factors on the composition and structure of benthic invertebrate assemblages in streams.

Michael Barbour serves as a technical consultant to the USEPA and state and tribal water quality agencies, and is a primary author of biocriteria guidance documents and the Rapid Bioassessment Protocols. He facilitates workshops and symposia on bioassessment and biocriteria strategies, and has presented papers at more than 100 such workshops. Currently, he directs a staff of 35 ecologists and toxicologists, who are involved in multiple projects across the nation.

Vincent Resh is a professor of Aquatic Ecology at the University of California, Berkeley. He has worked on biological assessment programs in West Africa, Southeast Asia, along with having conducted extensive research in North America, Europe, and Oceania for over 30 years. He has published over 250 books and articles on biological monitoring.

Abstract
Biological indicators that effectively characterize the impacts of urbanization on stream systems are needed to successfully manage and restore them. Biological metrics (n=72) were calculated based on benthic macroinvertebrate data from 85 sites along 14 streams in the Santa Clara Basin (San Jose, CA). These metrics were screened based on their relationship to a gradient of urbanization. The best performing metrics were assembled into potential multimetric biological indices with representation from three categories to reflect different components of the biological response of benthic macroinvertebrates (their community structure, their ecological function, and their use of habitat). Biological indicators were then developed for two additional regions of the United States (East - Baltimore, Maryland and Midwest - Cleveland, Ohio) to see if stressor-response relationships were comparable across regions. Quantile regression of the 95th quantile was used to characterize the upper boundary of the wedge-shaped scatter plots and to select the final biological indicators. Results of these analyses showed an agreement across regions in the relationship of the biological index to an urban gradient. This biological indicator can potentially be applicable on the national level to help set goals for restoration and management of urban streams.

Physical, Chemical, and Biological Characteristics of Streams in Urbanizing Areas Near Denver, Colorado

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Lori Sprague is a hydrologist in the Colorado Water Science Center within the U.S. Geological Survey's Water Resources Discipline. She is currently involved with the National Water-Quality Assessment Program of the USGS, where she is working on a variety of studies including an analysis of long-term trends in nutrient and suspended sediment concentrations in the Missouri River Basin and an examination of the effects of urbanization on water chemistry nationwide. She is also conducting research into the fate and transport of endocrine disruptors downstream from a wastewater treatment plant.

Robert Zuellig is an ecologist with the Colorado Water Science Center within the U.S. Geological Survey's Water Resources Discipline. His research has focused primarily on stream insect and fish communities and how they respond and recover from a variety of human induced stressors as well as aquatic insect taxonomy. He is involved with a variety of projects as part of the National Water-Quality Assessment Program and with Colorado State University. Currently, he is investigating how dissolved organic carbon, heavy metal pollution, and ultraviolet radiation interact to influence stream communities in the Rocky Mountain region.

Abstract

As part of the U.S Geological Survey's National Water-Quality Assessment (NAWQA) program, the physical, chemical, and biological characteristics of stream ecosystems in 28 basins along an urban land-use gradient in the metropolitan area of Denver, Colorado, were studied from 2002 through 2003. Study basins were chosen to minimize natural variability between basins due to factors such as geology, elevation, and climate and to maximize variability between basins due to the degree of urban development. Commonly-observed effects of urbanization on physical, chemical, and biological characteristics – increased flashiness, higher magnitude and more frequent peak flows, increased concentrations of chemicals, and changes in community structure – generally were not observed in these basins. None of the hydrologic, temperature, chemical, or biological measures were correlated strongly with urbanization, with the exception of some toxicity and concentration measures of polycyclic aromatic hydrocarbons (PAHs). Invertebrate, algae, and fish communities had the strongest association with water chemistry – specifically concentrations of nutrients and pesticides and the percentage of fine-grained suspended sediment. However, none of these water chemistry variables were strongly related to measures of urbanization. It is likely that water regulation associated with municipal and agricultural use in the study basins has led to a disconnect between the land surface and streams, resulting in in-stream physical, chemical, and biological characteristics that are to some degree independent of urbanization

Georgia Adopt A Stream Coastal Region Training Center at Savannah State University

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Joseph Richardson is a professor of marine sciences at Savannah State University in Savannah, Georgia. He also serves as the Director of the Georgia Adopt A Stream Coastal Region Training Center that serves the coastal zone counties of Georgia. In addition to this outreach project, his areas of research include water quality monitoring in estuarine habitats; finfish, invertebrate and sediment sampling for metals and organic pollutants; and the effects of controlled releases from upstream reservoirs on the salinity distribution in the Savannah River estuary.

Abstract

The Coastal Region Training Center (RTC) for the Georgia Adopt A Stream (AAS) Program was established at Savannah State University in 1996 to promote and serve Georgia AAS activities along the coast and in southeast Georgia. The Coastal RTC serves as a regional information and technical resource regarding non-point source pollution, coastal habitats and water quality, and it conducts water quality monitoring training workshops for Georgia AAS volunteer groups. The Center conducts visual, chemical, and biological monitoring training programs on the Savannah State University campus and in local communities throughout the Georgia coastal and southeastern region. The University campus provides both coastal freshwater stream and salt marsh tidal creek habitats for field training activities. Most of the RTC's training workshops, however, take place off-campus in local communities. Since 2000, the number of water quality training workshops has increased from 20 per year to more than 50 per year; and the number of workshop participants has increased from fewer than 200 to more than 1500 per year. Besides producing increased monitoring and data acquisition in the region, this increased activity and interest in water quality has enhanced education and local partnerships regarding water quality issues. Through its activities, the Coastal RTC has increased participation in volunteer water quality monitoring throughout its service area, and it has contributed to other water quality monitoring programs (eg. RiverKeeper Programs) by providing field and lab-based training. Support for the operation of the Coastal Region Training Center has been provided by grants from the Georgia Department of Natural Resources, Coastal Resources Division Coastal Management Program, and from the Georgia Sea Grant College Program.

The Importance of Professionally Training Citizen Monitors in Building, Promoting and Implementing a State-Wide Bioassessment Program in California

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Biographical Sketch of Author

Jim Harrington has been an aquatic biologist for more than 25 years and is currently a Staff Environmental Scientist for California Department of Fish and Game's Aquatic Bioassessment Laboratory (ABL). The ABL consists of researchers, field crews and invertebrate taxonomists utilizing various chemical and biological techniques to assess status, damage and monitor recovery of aquatic systems. For the past 12 years, Jim has volunteered with the Sustainable Land Stewardship Institute International to help citizens and professionals monitor the health of streams and rivers. He has written a widely-used methods manual and has conducted over 50 bioassessment workshops throughout the state.

Abstract

In 1993, the California Department of Fish and Game's (DFG) Hot Creek Hatchery was required to assess the effects of its discharge on the chemical, biological and physical condition of the receiving waters. As a result, DFG developed protocols for collecting biological and physical/habitat data for wadeable streams and rivers. At first it was difficult to get the state's water quality agencies to accept bioassessment in its water quality monitoring programs. The primary reason was that the state had invested a considerable amount of resources developing and implementing a sophisticated program based on chemical and toxicological endpoints. In response to this slow progress in acceptability of bioassessment, the Sustainable Land Stewardship Institute (SLSI) began a training program in 1996 with the intent to "empower citizens with the knowledge necessary to collect real data that will quantify the biological and physical health of western streams and rivers; and to encourage them to work with water resource agencies to restore and maintain the chemical, physical and biological integrity of western streams and rivers".

Using a 6 day workshop format and a comprehensive training manual, SLSI promoted the use of the California Stream Bioassessment Procedure (CSBP) developed by DFG as the only way to collect biological samples. Although a family level taxonomic effort was provided as an educational tool, workshops promoted the use of professional taxonomists for sample processing and a ridged QA/QC program. Workshops were also set up to mix citizen monitors, government biologists and water quality regulators together to facilitate communication. As a result, citizen monitoring groups trained by SLSI have flourished throughout the state, the state water quality agencies have incorporated bioassessment into its monitoring programs and citizen generated data was included in the development of water quality regulatory endpoints.

Evaluation of Volunteer-based Water Quality Monitoring Training for SCORE (South Carolina Oyster Restoration and Enhancement)

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Steven O'Shields is an environmental scientist with I.M. Systems Group, Inc. and has worked the last five years as a contractor to the National Oceanic and Atmospheric Administration's (NOAA) Coastal Services Center in Charleston, SC. Since October of 2002, Mr. O'Shields has worked within the Center's Landscape Characterization and Restoration Program and has provided support and leadership to a number of Center-supported projects, such as the South Carolina Oyster Restoration and Enhancement (SCORE) program.

Ms. Nancy Hadley is a biologist with the South Carolina Department of Natural Resources and an adjunct faculty member of the College of Charleston's graduate programs in Marine Biology and Environmental Studies. She runs the South Carolina Oyster Restoration and Enhancement program, a community-based restoration program which received the Coastal America Partnership award in 2004. Ms. Hadley was awarded the Theodore M. Sperry award for leadership in ecological restoration by the International Society for Ecological Restoration. She has been studying oyster reef ecology and implementing oyster restoration for ten years.

Abstract

In 2001, the South Carolina Department of Natural Resources (SCDNR) initiated the South Carolina Oyster Restoration and Enhancement (SCORE) program to actively engage local communities in the restoration of oyster habitat. Volunteers have logged over 12,000 hours of service building and monitoring oyster reefs. A major component of SCORE is volunteer-based water quality monitoring. Volunteers of all ages routinely measure water quality (salinity, pH, dissolved oxygen, water clarity, and temperature) at restoration sites after receiving on-site, hands-on training and materials from SCDNR staff. Volunteers enter data they collect into an on-line database on the SCORE Web site—where the data can be viewed real-time in both tabular and graphical formats. Data are checked for quality assurance on a quarterly basis. To enhance volunteer training and to further ensure quality data are reported by volunteers, SCDNR and the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center developed an e-learning application designed to teach volunteers about estuarine water quality and how it is measured under the SCORE program. The tutorial serves as a primer for on-site training, as well as a refresher course that can be accessed at anytime by anyone with an Internet connection. The on-line tutorial also is useful because it provides detailed background information on each water quality parameter measured under the SCORE program, something which cannot be fully covered during on-site training. The tutorial uses video, sound, and interactive elements to demonstrate how each water quality parameter is measured in the field and enables volunteers to practice procedural steps. Results of an evaluation that examined the effectiveness of the e-learning tutorial will be reported.

A Participatory, Multi-Stakeholder Approach to Curbing Urban Sprawl

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Abstract
The Community Links and Field Studies Program at Dunbarton High School was created in response to community concern over the loss to urban sprawl of the ecologically and culturally unique areas of the Pickering Airport Lands and Provincial Agricultural Reserve Lands. It is an Interdisciplinary Studies and Co-op program where students study environmental philosophy, the ecological impacts of different urban forms, and freshwater ecology. They then conduct water quality monitoring studies with the help of Citizens' Environment Watch (CEW), a non-profit organization based in Toronto, in the Rouge River and Duffins Creek immediately downstream of the next proposed areas for urbanization. Students then use their scientific data combined with knowledge of ecological sustainable urban design to engage Pickering citizens, politicians and businesses in a debate over how to make Pickering a sustainable community. To date students have conducted two public forums, each attended by over 50 members of the public including two mayors, representatives from local conservation agencies, NGOs, and media. This presentation will look at how a partnership between community activists, an environmental non-profit organization, and a high school has developed and run a unique community driven interdisciplinary studies program that is equal parts science and activism.

Comparable Biological Assessments from Different Methods and Analyses

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Biographical Sketches of Authors
David Herbst is a research biologist with the Sierra Nevada Aquatic Research Laboratory, of the University of California at Santa Barbara. His main research interests have been on the ecology and physiology of aquatic invertebrates and algae from streams, lakes and springs of the Sierra Nevada and Great Basin. Studies of streams have included bioassessment methods comparisons, developing regional biocriteria in California, examining introduced trout effects on native fishless streams of the Sierra, and sediment effects on benthos. The focus of his work on salt lakes has been physiological adaptation and how salinity regulates community structure and productivity.

Erik Silldorff is a senior scientist with the consulting firm Princeton Hydro, and directs the physical, chemical, and biological stream monitoring programs for various industrial, governmental, and non-profit clients to diagnose the sources of impacts and identifies remediation activities needed for ecological restoration. He also provides expert guidance and oversight to groups conducting stream monitoring studies. His research has included studies of the influence of exotic trout on stream invertebrate communities, and analyses of bioassessment data to establish indicators of biological integrity.

Abstract
Regionalized bioassessment programs of state and federal regulatory agencies, and other governmental and private groups often use different methods to collect and analyze stream invertebrate samples. While this has created concern and confusion over the comparability of these many disparate sources of data, studies have only recently begun to evaluate differences in performance between methods and reconcile the results produced from different programs. To obtain directly comparable data sets, we conducted concurrent sampling at 40 sites in the eastern Sierra Nevada of California using three bioassessment methodologies that differed at each stage, from field sample collection to laboratory processing and data analysis (California Stream Bioassessment Protocol, Region 5 US Forest Service, and Lahontan Regional Water Board methods). We used a performance-based methods system to compare precision, uniformity, discrimination, accuracy, and correlations among multimetric and predictive model output assessment scores. Reference and test sites were first identified using local and upstream watershed disturbance criteria, and invertebrate community measures and models were then developed to discriminate between these site classes. Differences in performance between methods were small, and the assessment scores were both highly correlated and distinguished reference from test sites with similar accuracy. An examination of the association of impaired biological integrity with environmental stress gradients showed that the method using most replication and sample counts provided the best resolution of stressor effect thresholds and signal to noise ratio. Despite slight differences in performance and stress detection, these results demonstrate that even substantially different methods of bioassessment yield very similar, effective discrimination of impaired biological condition. Moreover, this conclusion did not depend on the data analysis approach since both multimetric IBIs and multivariate RIVPACS predictive models were in close agreement. These results suggest that data from multiple sources can often be standardized and used in integrated assessments of stream biological integrity.

Pacific Northwest Side-by-Side Protocol Comparison Test

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Biographical Sketches of Lead Authors
Steve Lanigan is the team leader for the Aquatic and Riparian Effectiveness Monitoring Program. This program monitors in-channel, riparian, and upslope watershed attributes "west of the Cascades" in Washington, Oregon, and northern California to determine if the Northwest Forest Plan's Aquatic Conservation Strategy is maintaining or improving watershed conditions.

Brett Roper is the National Aquatic Ecologist, USDA Forest Service.

John Buffington is a research geomorphologist specializing in fluvial geomorphology, watershed processes, and interactions between physical and biological systems in mountain basins.

Abstract
Eleven state, tribal, and federal agencies participated during summer 2005 in a side-by-side comparison of protocols used to measure common in-stream physical attributes to help determine which protocols are best for determining status and trend of stream/watershed condition. This protocol comparison was sponsored by the Pacific Northwest Aquatic Monitoring Partnership as part of an ongoing effort to enable different agencies to be able to share data and determine best measurement techniques. Field sites were located in the John Day Basin, eastern Oregon, in mountain channels that provide critical habitat for threatened and endangered salmonids. Twelve streams were examined, representing a range of alluvial channel types (pool-riffle, plane-bed, and step-pool) and a range of channel/habitat complexity (simple, free-formed channels vs. complex wood-forced ones). Study sites had bankfull channel widths of 3-15 m, slopes of about 1-7%, and median substrate sizes of 9-154 mm. Channel features of interest included reach-average width, depth, gradient, sinuosity, substrate characteristics (median size, percent fines), wood characteristics (number, size), pool characteristics (residual depth, area of pools), and channel entrenchment. Field crews from the USDA Forest Service Rocky Mountain Research Station determined "true" channel characteristics using a dense array of cross sections spaced every half bankfull width over stream lengths of 40-80 bankfull widths. A total station was used for surveying channel cross sections

and the longitudinal profile of the stream bed, while Wolman pebble counts were used to sample substrate at each cross section. The sites were then inventoried by 1 to 3 field crews from 11 participating agencies using their measurement protocols. Preliminary results indicate that some monitoring group protocols performed better than others for particular attributes, no one monitoring group's protocols performed best for a majority of the attributes compared.

National Wadeable Stream Survey Comparability Study

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Abstract
We undertook a study comparing the Wadeable Stream Assessment (WSA) method with methods in Pennsylvania, Virginia, Tennessee, Iowa, Missouri, and Oklahoma. Comparability of state bioassessment programs allows the U.S. EPA Office of Water to assess the condition of the nation's waters using state results. Without comparable results, U.S. EPA must rely on standard bioassessment methods for all states. Approximately 20-40 sites in each state were sampled in 2005 using WSA and state methods side-by-side. Differences between the WSA method and state methods dictated that assessment comparability rather than data comparability was the focus of the study. Specifically, we focused on comparability of different benthic macroinvertebrate sampling methods with respect to assessments of stream conditions over larger geographic scales. We analyzed data from (1) duplicate samples collected using state methods at some sites, (2) side-by-side data collected using state methods and the WSA method, and (3) the reference samples (and criteria) used to calibrate the state data. We analyzed results for individual metrics (e.g., EPT taxa), but based calibration of data to support regional assessments on analysis of reference-based indicators (i.e., multimetric indices). Comparisons were based on the agreement among methods in standardized MMI scores and in designating stream condition into categories (i.e., poor, fair, and good). The differences in scores between WSA and state methods were then compared to differences in scores from duplicate samples collected with the same (state) method. These comparisons were done separately for high and low gradient streams. The ranges of scores obtained by each method were also compared to the human use index and to biological condition gradients provided by each state. Lastly, by comparing the reference criteria used by WSA and each state we standardized the assessment so that the departure from reference (which is critical to assessing degradation) is comparable across states.

Determining the Comparability of Six Bioassessment Methodologies in New England

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Abstract

During the summers of 2004 and 2005 the New England Interstate Water Pollution Control Commission (NEIWPCC) worked with the U.S. Environmental Protection Agency (USEPA), the Connecticut Department of Environmental Protection (CTDEP), the Maine Department of Environmental Protection (MEDEP), the New Hampshire Department of Environmental Services (NHDES), and the Vermont Department of Conservation (VTDEC) to collect side-by-side macroinvertebrate samples for the national Wadeable Streams Assessment (WSA) study. Methods comparability is a significant component of the national WSA study. The collection of benthic macroinvertebrates for the comparability study was chosen because macroinvertebrate assemblages are a good indicator of the overall water quality in a given water body. Six different methodologies were employed at approximately 43 sites over the two year period, including protocols utilized by the following organizations: CTDEP, MEDEP, NHDES, and VTDEC. Side-by-side samples were also collected using the following study specific protocols: WSA and the New England Wadeable Streams (NEWS) assessment. The protocols utilized range from riffle kick-net sampling to multi-habitat kick-net sampling to in-situ artificial substrate sampling. The data collected during this study, in combination with methods comparability data collected during the NEWS assessment (2001-2004) should provide a preliminary assessment of the comparability of the six bioassessment methodologies listed above. Preliminary results from this study will be available in the spring of 2006. Upon the completion of this study, if all or several of the bioassessment methodologies are deemed comparable, an extensive water quality dataset will be available to the New England states. This in turn could promote regional-scale monitoring efforts, enhancing the regions ability to monitor and protect water quality in New England.

Statistical Analysis of Probability Survey Data Using R Statistical Software

Anthony Olsen

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Biographical Sketch
Anthony R. Olsen is an environmental statistician at the U.S. Environmental Protection Agency, NHEERL, Western Ecology Division, Corvallis, Oregon. He received a PhD in statistics from Oregon State University in 1973. He is a Fellow of the American Statistical Association and is a recipient of the Distinguished Achievement Award from the American Statistical Association's Section on Statistics and the Environment and the distinguished statistical ecologist award of the International Association for Ecology. Dr. Olsen's research focuses on the development of large–scale ecological monitoring studies based on probability survey designs and statistical graphics for geographical data.

Description of Workshop
This workshop will demonstrate free software developed specifically for the statistical analysis of probability survey data. Statistical analysis examples of stream, lake, and estuary probability survey data will be completed using a survey analysis library for R Statistical Software. Both R and the library are free. Examples will be given for cumulative distribution functions (CDFs), percentiles, means, and categories. All necessary software and data will be provided. No knowledge of R required for the workshop. Participants can bring their own laptop, though this is optional.

BacteriALERT: A Cooperative Program for Water-quality Monitoring and Prediction of *Escherichia coli* Bacteria in the Chattahoochee River, Georgia

Stephen J. Lawrence

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Biographical Sketch of Author

Steve Lawrence is a hydrologist with the U.S. Geological Survey and the Water Quality Specialist for the USGS Georgia Water Science Center. Steve has been with the USGS for 20 years. During that time he has been project chief for a variety of water-quality studies in South Dakota, Nevada, and Georgia. His main research interests are aquatic biology/ecology, water chemistry, and bacterial indicators of water quality. Steve has a Masters Degree from Oklahoma State University.

Abstract

BacteriALERT is a cooperative program for monitoring the density of Escherichia coli bacteria (E. coli) and river turbidity at two sites on the Chattahoochee River near Atlanta, Georgia. Using regression equations developed from the monitoring data, E. coli densities are predicted and health risk estimations are delivered to river users in Metropolitan Atlanta, Georgia through the internet. Six different state, county, city, and non-governmental entities comprise the core of the BacteriALERT partnership.

BacteriALERT is designed to monitor and predict E. coli bacteria density at two sites on the Chattahoochee River within the National Park Service, Chattahoochee River National Recreation Area in Metropolitan Atlanta. Water samples are collected three times per week from the Chattahoochee River near Norcross, Georgia and at Vinings, Georgia and analyzed for E. coli density and turbidity levels. The most current bacteria and turbidity data can be viewed via a web page at http://ga.water.usgs.gov/bacteria. When the E. coli bacteria density exceeds the USEPA single-sample criterion for body-contact recreation (235 colonies per 100 milliliters (mL)), warning signs are posted at river access points within the CRNRA and a health-risk advisory is posted on the web page.

Currently, real-time continuous water-quality sondes record turbidity, water temperature, and specific conductance at both sites. Multivariate regression analysis shows that E. coli densities are dependent on flow regime (base flow, storm flow, and dam releases), turbidity, stream flow, and season (warm and cool), which account for 74 to 81 percent of the variability in E. coli densities at both sites. The results from this regression model will be posted to the BacteriALERT web site in real time. With this information, users of the Chattahoochee River within the Chattahoochee River National Recreation Area determine the potential health risk from river recreation in real time.

AquaSentinel: An Advanced Real-Time Biosensor System for Source Water Protection

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Biographical Sketches of Authors

Elias Greenbaum is a Corporate Fellow and Research Group Leader at Oak Ridge National Laboratory and a Professor of Biological Physics at The University of Tennessee. He received the B.S. degree in physics from Brooklyn College and Ph.D. in physics from Columbia University. Greenbaum's main areas of research are in the fields of photosynthesis, biosensors, molecular electronics and artificial sight. He was named 2000 Oak Ridge National Laboratory Scientist-of-the-Year. Greenbaum is a Fellow of the American Physical Society and American Association for the Advancement of Science. He holds 10 patents and is the author of more than 100 publications in peer-reviewed journals.

Miguel Rodriguez, Jr. is a Biotechnologist at Oak Ridge National Laboratory. He received a B.S. degree in industrial microbiology from the University of Puerto Rico-Mayaguez and an M.S. degree in life sciences from the University of Tennessee-Knoxville. He is a Biotechnologist in the Molecular Bioscience and Biotechnology Group of the Chemical Sciences Division. During his career development in ORNL, he has received the following awards: 2005 National Federal Laboratory Consortium Award for Excellence in Technology Transfer, 2002 Significant Event Award, UT-Battelle, LLC; 2000 Significant Event Award, UT-Battelle, LLC; and 1999 Technical Support Award, Lockheed Martin Energy Research Corporation.

Abstract

AquaSentinel is an automated and field-deployable real-time monitoring system for water protection that is based on the fluorescence induction properties of algae that grow naturally in source waters. BAE Systems (formerly United Defense) has acquired an exclusive commercial license from Oak Ridge National Laboratory for this technology in the United States. AquaSentinel uses microscopic algae as biosensors. Fluorescence induction curves are used as indicators of the health of the algae. We report photochemical yield analysis of chlorophyll fluorescence data collected for naturally-occurring algae from water samples collected from the Clinch River at Oak Ridge, Tennessee. The Clinch River is the main source of water supply for the City of Oak Ridge. We have evaluated the AquaSentinel technology at the 2004 health advisory levels designated by the EPA. We have demonstrated that AquaSentinel can be used by water facility managers as an early warning device for toxic agents at dose levels well below those which are lethal to humans. When combined with encrypted data telecommunication and a database-lookup library containing pertinent data for healthy algae, AquaSentinel provides a practical and effective approach under real-time world conditions to protection of sunlight-exposed primary drinking water supplies and regulation of water quality requirements.

Variability in Responses of Multi-Parameter Sensors in a Prototype Real-Time Early Warning System to Monitor Water Quality

By E.F. Vowinkel, R.J. Baker, and R.A. Esralew

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Ronald J. Baker, Ph.D., has been a hydrologist with the NJWSC of USGS for xx years. He is the project chief of the current water security project with the USEPA National Homeland Security Research Center (NHSRC) and past projects with USEPA Region 2 and the Division of Water Security. He has conducted studies to determine relations between land development and surface-water and ground-water quality in New Jersey, and on the fate and transport of organic contaminants in the subsurface.

Rachel A. Esralew has been a hydrologist with the NJWSC of USGS for 4 years. She manages and conducts real-time sampling, QA/QC, and database activities for the water security project with the USEPA/NHSRC and Region 2. She is involved in several studies related to nutrients in ground and surface water, and is conducting a study to develop ecological flow goals for surface water. She currently has a bachelors degree in Natural Resources Management from Rutgers University. She is now working toward her Masters degree in Environmental Geology at the University of Pennsylvania.

Abstract
A prototype early warning system to monitor changes in water quality resulting from an accidental or intentional spill is being developed as part of an ongoing investigation by the U.S. Geological Survey, the U.S. Environmental Protection Agency (USEPA), and Sandia National Laboratories. The investigation consists of three components: (1) field testing a network of real-time continuous sensors, (2) modeling to determine optimal locations of water-quality sensors in source waters and in distribution systems, and (3) developing real-time pattern-recognition algorithms for alert systems. An objective of the first study component is to determine whether the variability and rate of change in sensor responses in the source water and distribution system is larger than the variability in sensor responses during controlled experiments in which known concentrations of inorganic and organic contaminants were introduced to pipe loops at the USEPA Testing and Evaluation Facility. The results of the field testing also will be used to evaluate the reliability and maintenance requirements of the sensors (temperature, pH, specific conductance, oxidation-reduction potential, and chlorine residual) deployed in distribution systems and near the source-water intake. Preliminary results indicate that the variability in sensor responses in the distribution system generally are small over short time periods (15 minutes) but may be large over longer time periods (24 hours or more), especially in cases where the source of the water in the distribution system changes from ground water to surface water.

Real Time Monitoring – The Installation and Continuous Operation of Organic Carbon and Liquid Chromatography Analyzers at Remote Field Stations in the Sacramento – San Joaquin Delta

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David Gonzalez is a senior environmental scientist and supervisor of the MWQI Field Support Unit. He has over 16 years experience in designing, implementing, and managing field projects and studies for the California Department of Food and Agriculture and the Department of Water Resources and has authored and coauthored numerous reports and publications for these agencies.

Steven San Julian is an environmental scientist with 5 years experience with the Municipal Water Quality Investigations Program of the California Department of Water Resources. He has been instrumental in the design and development of sample delivery and filtration systems, analytical instrumentation operation and maintenance of the field stations, and the quality control/quality assurance of real-time data.
Arin Conner is an environmental scientist and has been with DWR since 1996 working as a water quality biologist and on drinking water quality projects with the MWQI program. Additionally, he has worked as a private consultant on endangered species field surveys, and water runoff and erosion simulation studies.

Jaclyn Pimental is an environmental scientist for the Department of Water Resources in the Office of Water Quality. She has 5 years experience with DWR conducting QA/QC data analysis and working on water quality monitoring studies.

Abstract
Historically, continuous monitoring of water quality has been limited to parameters such as temperature, electrical conductance, and turbidity. The growing availability of process analyzers has expanded the range of parameters that can be monitored and has increased the frequency of measurements. When combined with the Internet, process analyzers allow real-time access to high frequency water quality data that allows utilities, resource managers and researchers real-time access to a broad range of critical water quality parameters to improve operational decisions, track changes over time, and populate water quality models. The California Department of Water Resources has installed a series of organic carbon and anion analyzers to provide real-time monitoring of total and dissolved organic carbon and anions such as bromide, chloride, sulfate and nitrate at key points in the Sacramento-San Joaquin Delta and at the head-works of the California aqueduct on the State Water Project. These analyzers operate unattended at remote field stations for periods of up to two weeks between maintenance and service visits by DWR scientists. These analyzers perform continuous measurements using wet chemical oxidation (Sievers TOC 900), catalyzed combustion (Shimadzu TOC 4100), and Liquid Chromatography (Dionex DX-800). This project requires the installation at each site of a system of water delivery pumps, water filters, distribution valves, air compressors, air scrubbers, dataloggers, computers and other components needed to create and operate a field laboratory facility. The organic carbon data are recorded on dataloggers, telemetered to a central database via networked computers, and published on the Internet. Anion data are being transferred from the analyzer computer to a dedicated DWR network server. Focus will be given to the development and function of sample delivery systems, analytical instrumentation, data collection and dissemination, and QA/QC procedures and parameters.

Monitoring Environmental Stressors and Evaluating the Existing and Potential Designated Uses of Hardies Creek, Galesville, Wisconsin

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Daniel Helsel is water program supervisor for the State of Wisconsin's Department of Natural Resources in the western portion of State. Dan received his undergraduate degree from the University of Wisconsin-Madison and his Masters of Science degree from the University of New Hampshire-Durham. Dan, a Wisconsin Native, enjoys working with lake and stream volunteer monitoring groups and over the years has been involved with a number of state programs, including water quality monitoring and assessment, aquatic plant management and water/wetland regulation programs.

Kenneth Schreiber is a water quality specialist with the Wisconsin Department of Natural Resources (DNR). Since 2004, he has served as team leader of the state surface water quality monitoring program. Ken has worked with the Wisconsin DNR since 1977 in a variety of roles including water quality specialist, limnologist and planning analyst. He has functioned as a regional water quality biologist since 1990 and TMDL program coordinator since 2000. He is primarily involved in developing study designs, quality assurance procedures, sampling methods and policies related to the state water quality monitoring network.

Holly Eaton currently works full time for the Wisconsin Department of Natural Resources with duties as a wastewater specialist, writing Wisconsin Pollutant Discharge Elimination System permits for municipal and industrial wastewater dischargers and as a water quality biologist for a three county area. She is responsible for monitoring and assessing water bodies for 303d listing and Total Maximum Daily Load development. Holly is a member of the adjunct faculty at the Chippewa Valley Technical College, where she teaches general biology on a part time basis.

Jon Johnson is a science educator for the Galesville-Ettrick-Trempealeau school district. Jon has been teaching high school level science for nearly 10 years. Jon received his B.S. in natural resources from the University of Wisconsin-Stevens Point, a science education B.S. from the University of Wisconsin-Whitewater and a M.S. in Education from Walden University. For the past three years, Jon has offered an advanced environmental science class, providing students opportunities to collect, analyze and interpret physical, chemical and biological information from nearby Hardies Creek and at the same time, providing reliable data to the Wisconsin Department of Natural Resources.

Abstract

Hardies Creek is a medium sized stream (width = 3.5 m.) situated in the un-glaciated, driftless area in south-west Wisconsin. The entire 3.1 miles of the creek is currently listed as impaired on Wisconsin's 303d list because the creek is not meeting the designated use as a cold-water fishery. The Wisconsin Department of Natural Resources (WDNR) and the Galesville-Ettrick-Trempealeau High School (GET) have collected habitat and water quality information to characterize the watershed and in-stream stressors. Monitoring data was evaluated using guidelines for designating fish and aquatic life uses (WDNR 2004). Hardies Creek data was compared to two nearby reference streams to assist with the evaluation its potential use classification. This project highlights evolving approaches to stream use assessment and partnerships between local and state agencies.

The combined monitoring efforts of DNR staff and GET students have documented cold water temperatures (average summer temperature 13.4oC, maximum 20.1oC); well oxygenated water (August continuous dissolved oxygen average 9.9 ppm with a range of 11.51 to 9.07 ppm); good to fair stream habitat ratings and very good macroinvertebrate biotic index ratings (HBI values of 2.38 & 3.89). Visual inspections of the watershed found little indication of substantial non-point source runoff impacts. However, the fish community in Hardies Creek is limited with zero to four brook trout per 100-meter stations and only four other fish species present at very low densities. A more detailed review of the in-stream habitat data suggests that Hardies Creek may be limited in pool depth and area for adult trout survival and recruitment. Other factors like limited food resources or spawning habitat may also be affecting the fish community.

Water Quality Indicators and Monitoring Design to Support the Albemarle-Pamlico National Estuary Program: A Progress Report

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Dean Carpenter has served as Science Coordinator for the Albemarle-Pamlico National Estuary Program (APNEP) since late 2003. His main responsibilities are coordinating and administering APNEP's Science & Technology Program and providing staff support to APNEP's Science & Technical Advisory Committee. Dr. Carpenter previously served three years as project manager in the Water Environment Research Foundation's Watersheds & Ecosystem Management Group after ten years as environmental scientist with a U.S. Environmental Protection Agency's Office of Research & Development contractor, where his research focus was improving ecological risk assessment methods at regional scales in support of ecosystem-based management.

William Crowell has served as APNEP's Director since mid-2002. He works with the Program's citizen advisors and local, state and federal agencies, and others to implement the program's mission and Comprehensive Conservation and Management Plan (CCMP). Mr. Crowell previously served as the Senior Policy Analyst for the North Carolina Division of Coastal Management where he formulated coastal and ocean policies and regulations for the State. Prior to that he worked on cumulative coastal impacts analysis. He has also worked with the Nature Conservancy with wetland and endangered species monitoring, conservation planning and wetland research.

Abstract

APNEP's mission since its inception in 1987 is to identify, restore, and protect the significant resources within its 23,000 square-mile programmatic boundary encompassing northeastern North Carolina and southeastern Virginia. After a technical study of the A-P system, a management council produced its CCMP in 1994 whose objectives incorporated many principles of ecosystem-based management. In line with plan objectives, the program has supported both financially and in-kind the implementation of myriad resource management actions in the public and private sector to mitigate the impact of human activities.

Following programmatic reorganization in 2003, APNEP is attempting to bolster its capabilities at science & technical coordination. An anticipated benefit of this coordination is an improved capability to document change in natural resource condition. An important component in coordination has been the organization and support of a Science & Technical Advisory Committee (STAC). The STAC's first charge has been to recommend a set of indicators which collectively can help managers, scientists, policy makers, and other stakeholders track environmental conditions throughout the region. Following the STAC working with three new program bodies, namely a Policy Board, Management Advisory Committee, and Citizens Advisory Committee, their initial indicator recommendations are expected in 2006.

We will first document APNEP's evaluation and adoption of water quality indicators, including use of a regional ecosystem model to justify how these indicators fit with indicators for other natural resources to support an ecosystem-based assessment. We will then discuss progress at developing an integrated monitoring plan that proposes how the current water quality monitoring activities by federal, state, and localities within the region can be leveraged to produce data in support of a regional ecosystem-based assessment. We will conclude with anticipated future activities in water quality indicator development and in monitor planning and implementation.

Development of a Collaborative Multi-Jurisdictional Stream-Monitoring Network to Support Restoration of the Chesapeake Bay

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Steve Preston is a hydrologist with the U.S. Geological Survey, but serves as the monitoring coordinator for the U.S. Environmental Protection Agency sponsored Chesapeake Bay Program. Since 2000, he has worked with the Bay Program partner agencies to refine the monitoring networks that track progress toward restoration of the water quality and ecological health of the Chesapeake Bay. Steve started working for the U.S. Geological Survey in 1990 and has worked on a variety of watershed and water-quality studies in the Chesapeake Bay region.

John Brakebill is a geographer with the U.S. Geological Survey, Maryland Water Science Center. He began his career with the USGS in 1988, serving as the GIS/data base manager for the USGS National Water-Quality Assessment Program, evaluating the status, trends, and the natural and human conditions that affect water quality in the Potomac River watershed. John is currently developing GIS applications and data supporting regional and national water-quality surface-water transport models. This information is used to help determine the factors that affect the sources and transport of nutrients and sediment that drain into Chesapeake Bay.

Abstract

A new nontidal stream-monitoring program is being established in the Chesapeake Bay watershed to track progress toward nutrient and sediment load reductions that are necessary for achieving water-quality standards in the Bay. The Chesapeake Bay Program (CBP) and its nine partner agencies are working together to develop the network largely by integrating existing State and Federal (USGS and EPA) monitoring programs. To meet the management objectives of nontidal monitoring, a network of stations was identified at the boundaries of watershed units that have been selected for the implementation of specific management plans referred to as “tributary strategies”. At each of the sites, the monitoring plan calls for a USGS stream gage that will collect continuous discharge data, and water-quality samples collected by all participating agencies through a range of flow levels using compatible field protocols. A list of 188 candidate stations was initially developed that included 115 existing stations and locations where 73 new stations were recommended. To date, 50 of the 188 stations have been established by enhancing some sites, discontinuing others, and looking for efficiencies across and within State boundaries. Multiple sources of funding will be needed to fully implement the network. The CBP has been able to utilize existing ambient water-quality monitoring programs and stream gages to eliminate most of the network’s implementation costs. Additional funding was secured through the CBP and the USGS, and through States’ abilities to shift resources from other monitoring activities to the network. The cooperation of all the partner agencies has been critical to the network development effort and emphasizing the mutual benefit has been important in maintaining agency and jurisdictional support. Coordination is also a key component of the network development effort and the established CBP infrastructure has been critical in that role.

Water Quality Monitoring Among Local Agencies in the Red River of the North Basin

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Robert Hearne has been Assistant Professor in the Department of Agribusiness and Applied Economics, North Dakota State University since 2002, where teaches in Natural Resources Economics and Microeconomic Theory. Dr. Hearne's research focuses on water resources policy and the economic valuation of non-market environmental goods and services. His recent work has been published in *Forest Policy and Economics*, *Water Resources Research*, *Water Policy*, and the *Journal of Environmental Management*. Dr Hearne has international experience in Europe, Africa, South America and Central America.

Charles Fritz is responsible for general management and oversight of the International Water Institute and its Flood Damage and Natural Resources Research Center and the Center for Watershed Education. As the Institute Director, Mr. Fritz has developed international working partnerships with universities and colleges, state and federal agencies, and private organizations in the Red River Basin to develop, fund, and conduct applied research and watershed education projects.

Abstract
Water quality monitoring in the Red River of the North Basin is a joint effort of state and local agencies as well as a variety of volunteer organizations. This paper focuses on local water management institutions in the Red River of the North Basin in North Dakota, Minnesota, and Manitoba. As a complement to a much wider analysis of these water management agencies this paper presents analysis of those agencies that are currently engaged in decentralized water quality monitoring. Constraints to effective and reliable water quality monitoring among local groups will be identified.

Although water quality monitoring is conducted by a variety of institutional entities representing two nations and a number of local constituencies, similar goals are use to determine water quality standards. Existing State, Federal, and locally sponsored protocols do provide information on the aquatic health of the Red River. However due to the disparate constituencies and uncoordinated efforts further efforts are needed in order to standardize methods and improve data archival and retrieval.

Local efforts to monitor water quality include efforts by watershed districts, water boards, and soil and water conservation districts. An innovative program to include high schools in water quality monitoring, River Watch is gaining respect. However further training and coordination is needed.

Cooperative Agricultural Monitoring on California's Central Coast: An Integrated, Innovative Approach

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Karen Worcester is a staff environmental scientist for the Central Coast Water Board. She has been with the Board for fourteen years, where she has initiated several programs, including the Morro Bay National Monitoring Program, the Morro Bay National Estuary Program, the Central Coast Ambient Monitoring Program, and the new Cooperative Monitoring Program for Agriculture.

Alison Jones is an Environmental Scientist and is lead staff on development and management of the Conditional Waiver for Irrigated Agriculture for the Central Coast Water Board. She has been with the Board for thirteen years and has Master's degrees in Integrated Pest Management and Soil Science.

Dave Paradies is a software engineer and web designer who has provided support to the Central Coast Water Board and other water quality related efforts for the past decade. Dave also served as founding Director of the Morro Bay National Estuary Program and member of the AB 982 Public Advisory Group.

Abstract
The scenic central coast of California is the "salad bowl" of our state, where, because of the mild climate, intensive cropping schedule and relatively high crop value, applications of fertilizers and pesticides for some crops can be relatively high. High nutrient levels and in-stream toxicity have resulted in some areas. Like other Regional Boards in California, in past years the Central Coast Water Board waived any permitting requirements for irrigation discharges. However, in 1999, new legislation caused all waivers of waste discharge to expire on January 1, 2003. These have been replaced with conditioned waivers, which include a number of new requirements, including monitoring. The Central Coast Region initiated a Conditional Waiver Program for Agriculture that requires 15 hours of water quality education, farm plan development and implementation, management practice reporting, and monitoring. Growers were given the option of establishing a cooperative monitoring program as an alternative to individual, field scale monitoring. Virtually all participants have opted to participate in the cooperative approach. A new non-profit organization has been formed by industry members to implement the monitoring program and has successfully secured funding for the program.

The Cooperative Monitoring Program for Agriculture includes a 50-site network of trend monitoring sites, as well as a "follow-up" monitoring component for addressing problem areas. The monitoring program is designed to be integrated with the Central Coast Water Board's own Central Coast Ambient Monitoring Program (CCAMP) and other non-point sources monitoring efforts in the Region. Data collected by the program will be used to provide feedback to growers and to guide additional follow-up monitoring activities. It will also be used to assess long-term trends in water quality and the overall success of the program. The program is utilizing an innovative web delivery system that ensures that data is delivered in a format that is compatible with state monitoring programs and with CCAMP's own website generating software. A management practice tracking system is also being used to geographically track what types of agricultural practices are being implemented and where. Initial program findings indicate that high nutrient concentrations and toxicity are widespread in agricultural areas. We are analyzing water quality data in concert with management practice information to help us better work with growers to improve water quality.

A Regional Approach to Research/Monitoring in Southern California

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Chris Crompton has 28 years experience in environmental management, 21 of those years with the County of Orange. He currently serves as vice chair of the California Stormwater Quality Association (CASQA) and chair of the southern California Stormwater Monitoring COalition (SMC).

Abstract
The Stormwater Monitoring Coalition (SMC) was formed in February 2001 through a cooperative agreement between the following agencies:

- County of Orange
- County of Los Angeles
- County of San Diego
- Ventura County Watershed Protection District
- Riverside County Flood Control and Water Conservation District
- San Bernardino County Flood Control District
- City of Long Beach
- California Regional Water Quality Control Board, Los Angeles Region
- California Regional Water Quality Control Board, Santa Ana Region
- California Regional Water Quality Control Board, San Diego Region
- Southern California Coastal Waters Research Project (SCCWRP)

It was recognized at the time that both municipal dischargers and regulatory agencies were separately attempting to understand the water quality impacts of stormwater and urban runoff on receiving waters but finding that many of the scientific and technical tools for assessing these impacts were inadequately developed. The SMC was therefore formed to bring these entities together, set up a multi-disciplinary panel of stormwater research/monitoring experts to identify the deficiencies associated with stormwater quality monitoring methodologies and assessment tools, and create an agenda for future potential collaborative scientific and technical studies.

The initial work product of the SMC was a report entitled Stormwater Research Needs in Southern California (February 2002) that provided a detailed and ranked research/monitoring agenda for a five year period reflecting both stormwater and regulatory agency needs. The report has served as a roadmap for the implementation of additional projects by the SMC over the intervening 4+ year period. To date the following projects have been iniated/completed:

- Development of standardized sampling and analysis protocols
- Microbial source tracking method comparison
- Study of peak flow impacts and technical workshop
- Building a regionally consistent and integrated freshwater stream bioassessment monitoring program
- Development of a laboratory intercalibration program

New projects are in the planning phases including:

- Quantifying the effectiveness of site design/low impact development best management practices in Southern California
- Development of stormwater toxicity protocols

- Implementing a monitoring program to determine bacti reference watershed conditions
- Further developing the California Sustainable Watershed/Wetlands Information Manager (CalSWIM) website (www.calswim.org)

The presentation will cover the background of the formation of the SMC, the challenges of a managing a multi-agency program and the technical/scientific progress that has been made.

Southern California Laboratory Intercalibration Exercises: A Demonstration Regarding the Comparability of Monitoring Programs Using Multiple Laboratories

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Richard Gossett was employed at the Southern California Coastal Water Research Project from 1977 to 1991 performing research on the sources, fates, and effects of organic contaminants in wastewater effluent discharged into coastal waters. From 1991 to 1995 he was supersivor of the Trace Organics Section for the Orange County Sanitation Districts Envrionmental Sciences Laboratory. From 1995 to the present, he has been Owner and Laboratory Director of CRG Marine Laboratories, a commercial environmental laboratory located in Southern California.

Abstract

One challenge of collaborative, integrated regional monitoring is assuring the comparability of data when combining analytical results from multiple laboratories. This is a story of the process used in southern California to ensure that data generated from over 10 different laboratories could be combined with a high degree of confidence in comparability. Even though all of the laboratories were certified by the State of California and each had passed quality assurance requirements by the US EPA, most laboratories differed in methodology, protocols, and instrumentation. Concerns about comparability were verified after conducting laboratory intercalibration studies. Interlaboratory differences were less severe for traditional QA samples (i.e. certified reference materials), but became more severe using native sample matrix that many include potential interferences. For example, results from split field samples varied an order of magnitude for several of the most difficult constituents, including polynuclear aromatic or chlorinated hydrocarbons. As a result, the laboratories formed working groups, which focused on resolving interlaboratory variability including differences in extraction, clean-up, and instrumental analysis followed by iterative split sample intercalibrations. As a result, interlaboratory variability was reduced to levels that were no greater than within laboratory variability. Ultimately, the laboratory network produced a performance-based Quality Assurance Manual setting objectives for sensitivity, accuracy, and precision minimizing strict standardization and enabling each of the laboratories to maintain their own in-house practices and equipment. This process was repeated for stormwater runoff sample matrix (especially difficult), physical oceanography, and shoreline microbiology measurements.

Information Management in a Multi-Agency Cooperative Monitoring Program

Larry Cooper

Southern California Coastal Water Research Project (SCCWRP)

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Larry Cooper is an ichthyologist who specializes in creating computer tools for biologists and executing large scale environmental data management. He currently manages the Information Management Department at the Southern California Coastal Water Research Project.

Abstract
Large-scale collaborative monitoring projects involving multiple agencies present a number of logistic, organizational, and political challenges. One dominant challenge is data reporting and information management. Obtaining data that is both accurate and complete is often difficult because of the wide variety of information management approaches used by the varied experience of participating agencies. Some agencies use sophisticated, custom-designed data systems while others may simply use spreadsheets. SCCWRP has addressed the problem of consistent and accurate data reporting by developing consensus with the participating agencies in the form of standardized data transfer formats. Through a consensus-based approach, all participating agencies agree to express their data in a consistent format and use consistent data types for all reporting before any samples are collected. Therefore, agencies can share these data in any format, including ASCII delimited format, and are not required to purchase expensive software and hardware or train or hire new employees just to manage data. The resulting data files are then suitable to be shared between agencies, appended into a central database, or linked through a distributed data network. Improvements to this system have included distribution through data portals, QA/QC and error checking routines, and automated production of routine data analysis graphics. This process has now become the standard for sharing many different data types within southern California for a variety of different programs including those designed to assess shoreline microbiology, water quality, sediment quality, marine and freshwater invertebrate biology, fish biology, tissue concentration, water and sediment toxicity, hydrology, and habitat quality, to name just a few. Regardless, of the data type(s), the data are being compiled to make regional assessments of environmental condition and risks to public health.

Monitoring Implications of Using the Copper Biotic Ligand Model (BLM) and EPA's Updated Ambient Water Quality Criteria for Copper

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Lauren Wisniewski is an Environmental Engineer in the Office of Science and Technology (OST) within the U.S. Environmental Protection Agency's (EPA) Office of Water. Lauren co-chairs OST's Copper BLM Implementation Workgroup. Lauren received her B.S.E. in Civil Engineering from Duke University. She has completed graduate coursework and worked in the areas of watershed and water quality modeling, hydrology, technology policy, economics, GIS, and remote sensing. Lauren has worked at EPA for almost four years in a variety of areas, including the Water Quality Standards Program, the BASINS modeling framework, and EPA's Council for Environmental Regulatory Models (CREM).

Christina Jarvis is an Environmental Protection Specialist in the Office of Science and Technology (OST) within the U.S. Environmental Protection Agency's (EPA) Office of Water. Christina co-chairs OST's Copper BLM Implementation Workgroup, and works on various policy issues related to national water quality standards. Prior to joining OST in 2006, Christina worked in the EPA's Office of Pesticide Programs for five years on human health risk assessment issues. She holds a master's degree in ocean and coastal policy from the University of Delaware.

Abstract

The U.S. Environmental Protection Agency (EPA) Office of Science and Technology (OST) expects to release the final update of the ambient water quality criteria for copper in late 2006. The updated national criteria statement will include using the biotic ligand model (BLM) to calculate freshwater criteria based on site-specific water quality parameters. Unlike the previous criteria, which were based on an empirical relationship between copper toxicity and hardness, the BLM explicitly accounts for individual water quality variables and provides more accurate predictions of acute copper toxicity over a range of water chemistry parameters.

The BLM requires 11 input parameters, including pH, dissolved organic carbon (DOC), alkalinity, major cations (Ca, Mg, Na, and K), and major anions (SO_4 and Cl). EPA OST is developing guidance to address implementation issues such as BLM data requirements and monitoring implications. In developing this implementation information and training resources, OST is working with representatives from throughout the Office of Water, EPA Office of Research and Development, EPA Regions, and numerous States.

For more information on the draft ambient water quality criteria and the Copper BLM, visit www.epa.gov/waterscience/criteria/copper/ or contact Lauren Wisniewski (Wisniewsk.Lauren@epa.gov, phone: 202-566-0394) or Christina Jarvis (Jarvis.Christina@epa.gov, phone: 202-566-0537).

Characterizing and Interpreting Physical Habitat in the National Wadeable Stream Assessment

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Philip R. Kaufmann is a research physical scientist at the U.S. Environmental Protection Agency, Office of Research and Development, Western Ecology Division, Corvallis, Oregon. He received an MS in Limnology from Washington State University in 1977 and a PhD in hydrology/stream ecology from Oregon State University in 1987. Dr. Kaufmann's research focuses on developing quantitative approaches for assessing physical habitat structure and function in aquatic ecosystems. He is currently involved in the interpretation of the ecological condition of surface waters based on measurements of biological, chemical and physical indicators in large–scale aquatic monitoring studies.

Abstract

Effective environmental policy decisions require stream habitat information that is accurate, precise, and relevant. Ecological monitoring and assessment efforts such as the national Wadeable Streams Assessment (WSA) are designed to collect physical habitat information sufficiently comprehensive to facilitate interpreting biotic data. They do this by characterizing the major habitat features that may operate as controls or limiting factors on biotic assemblage composition under natural or anthropogenically disturbed circumstances. Two-person crews typically complete WSA habitat measurements in 1.5 to 3.5 hours of field time. The resultant field measurements quantify major dimensions of channel morphology and stream habitat, allowing calculation of measures or indices of stream size and gradient, substrate size and stability, habitat complexity and cover, riparian vegetation cover and structure, anthropogenic disturbances, and channel-riparian interaction. However, these physical habitat field methods can produce a bewildering array of raw data. We reduce the complexity of this data by calculating metrics that summarize stream reach habitat characteristics, also making an assessment of the repeatability of these metrics. Going beyond simple descriptions, large regional assessments usually require that we evaluate associations that implicate channel responses to basin-riparian disturbances, or biotic responses to habitat alteration. In large regions, human land use disturbances typically overlay wide ranges of natural geomorphic factors that control both habitat characteristics and biotic assemblages. I'll discuss a variety of approaches for estimating the degree to which streams deviate from "natural" or "reference" conditions, including use of historical information, best professional judgment, reference sites, impairment threshold criteria, and the use of process-based or empirical models to estimate reference condition.

Nutrient and Acidity Status of Wadeable Streams in the Contiguous United States—Results from EPA's Wadeable Streams Assessment

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Abstract
In 2004, the U.S. EPA completed the Wadeable Streams Assessment (WSA), an ecological assessment of wadeable streams throughout the U.S. based on physical, biological and chemical indicators. The WSA is the first national assessment conducted using a probability survey designed to estimate condition for the entire population of streams as depicted on the digitized version of 1:100,000 scale USGS maps. Water chemistry data is used to help characterize the condition of the nation's freshwater streams and identify potential stressors to the biological communities. Water samples were taken during baseflow conditions (May-October) from each of the 1,390 probability sites representative of 1,021,000 km of wadeable streams throughout the contiguous United States. An estimated 2% of the stream length was acidic (ANC <0 ueq/L). About half of that length, located in the Central and Northern Appalachians, were likely acidic due to acidic deposition. The remainder were acidic due to acid mine drainage or natural organic acids. Nutrient concentrations (total nitrogen and phosphorus) vary widely across the U.S. due to natural factors and anthropogenic additions. An estimated 33% of the stream length had total P > 50 ug/L and 20% had total P > 100 ug/L. In terms of total nitrogen, 19% of the nation□s stream length exceeded 1 mg/L and 2% exceeded 10 mg/L. We used two ecoregionally based approaches for determining nutrient criteria thresholds; EPA's Office of Water published nutrient criteria guidelines, and a percentile of reference sites approach. The two approaches were in close agreement in some ecoregions but varied widely in others. Results from the WSA will be used to report on the extent of current chemical condition and serve as a baseline for future broad scale regional assessments and trends.

Evaluating the Extent and Relative Risk of Aquatic Stressors in Wadeable Streams throughout the U.S.A.

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John Van Sickle is a Biological Statistician. He received his Ph.D. in Systems Science from Michigan State University (1975). His research interests include aquatic bioassessment, watershed-stream linkages, and multivariate statistical modeling.

John L. Stoddard is a freshwater ecologist. He has a Ph.D. in Biological Sciences from the University of California at Santa Barbara (1986). His research focuses on the science of ecological assessment, including indices of biological condition, and reference condition.

Steven G Paulsen is a senior aquatic ecologist. He received a PhD in limnology from the University of California-Davis in 1987. He received ORD's highest research award for communicating science in 2004 and is recipient of multiple agency awards for research excellence . Dr. Paulsen's research focuses on the development of large–scale aquatic monitoring studies based on biological, chemical and physical indicators of aquatic resource quality and probability survey designs.

Abstract
Aquatic stressors such as toxic chemicals, excess sediment, and non-native species threaten the biointegrity of stream ecosystems. The relative importance of a stressor depends both on the number of streams in which it is elevated, and on the severity of its effect when it is elevated. The Wadeable Streams Assessment (WSA), conducted by the U.S. Environmental Protection Agency, was designed to estimate the number of streams throughout the contiguous U.S.A. having elevated conditions for several individual stressors. We used "relative risk", a statistic widely employed in human health assessment, to assess the severity of each stressor's effect. Relative risk measures the strength and direction of the association between any stressor and any aquatic ecosystem response that can both be classified as being in either "least disturbed" condition or "most-disturbed" (degraded) condition for each sampled stream location. We present relative extent estimates for several stressors sampled by the WSA, as well as the relative risk of degraded aquatic macroinvertebrate condition for each stressor. We estimated relative risk and relative extent for individual ecoregions as well as for the lower 48 states as a whole.

Europe-wide Monitoring Obligations Under the EU Water Framework Directive

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Biographical Sketch of Author

Jos Timmerman is Program manager in the Department of International Policy Affairs within the Institute for Inland Water Management and Waste Water Treatment RIZA with expertise in the field of environmental information management. Since 2004 he is responsible for coordinating the International Water Assessment Centre (IWAC), a collaborating centre under the UNECE Water Convention. He is involved in the national and Europe wide implementation of the EU Water Framework Directive.

Abstract

The EU Member States (MS) have to comply with the EU Water Framework Directive (WFD) that has entered into force in 2000. The WFD requires the MS to reach a good ecological status of their waters by the year 2015. To be able to assess if this goal will be reached, the WFD obliges Member States to perform monitoring. These monitoring programmes are required to establish a coherent and comprehensive overview of water status within each river basin district. The monitoring programmes have to be operational at the latest by 22 December 2006. The WFD distinguishes between three types of monitoring: Operational monitoring, Surveillance monitoring, and Investigative monitoring. For each of these types of monitoring, requirements are defined in terms of frequencies, locations and parameters. The principle for monitoring is a tiered system; if the water has a good ecological status and no pressures are identified, then operational monitoring is required once in 16 years. Under normal conditions, operational monitoring is required once in three years. If specific problems occur, surveillance monitoring is needed at higher frequencies. Then, if the causes of a problem are unknown, investigative monitoring has to find these causes. This presentation will describe the principles of the EU-wide monitoring obligations under the EU Water Framework Directive.

Designing a National Water Quality Monitoring Network to support the Canadian Freshwater Quality Indicator

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Janine Murray is a Senior Environmental Monitoring Specialist with the National Water Quality Monitoring Office of Environment Canada. Janine has worked on environmental monitoring issues since 1992, firstly in northern ecosystems with the Northern Contaminants Program of Indian and Northern Affairs Canada and with the international Arctic Monitoring and Assessment Program in Norway. Since 2000, Janine has worked with Environment Canada on national coordination of water quality monitoring. Janine currently manages a national surveillance project on pesticides in water, working closely with water quality monitoring staff in each of EC's regional offices.

Abstract
Environment Canada, in partnership with Statistics Canada and Health Canada, is responsible for reporting annually on water quality for the National Freshwater Quality Indicator under the new Competitiveness and Environmental Sustainability Indicators (CESI) initiative. The freshwater quality chapter of the first CESI report, scheduled for completion in autumn 2005, is the first national report on water quality status for Canada. The national freshwater indicator is based on applications of the Water Quality Index (WQI) endorsed by the Canadian Council of Ministers of the Environment (CCME). The WQI is a tool allowing experts to translate large amounts of complex water quality data into a simple overall rating (e.g., good, fair, poor). Existing federal, provincial, territorial and joint long-term water quality data were used to calculate the indicator for the report, and spatial gaps in monitoring, as well as gaps in parameters monitored to address specific stressors/threats to water quality, were identified during its preparation. These gaps are being assessed to determine priorities for monitoring network expansion to enhance national reporting on the CESI Freshwater Quality Indicator. The immediate focus is on a core water quality monitoring network for aquatic life, the most sensitive and spatially-relevant water use. By 2009, other major water uses (e.g., source water for drinking, agriculture, and industry) will be incorporated into the indicator. A plan for generating the key data required to report on major water uses in Canada is outlined. Key elements include sustaining access to provincial network data; expanding existing and establishing new networks; negotiating new federal-provincial water quality agreements; collaborating with federal partners (e.g., Parks Canada, Indian and Northern Affairs Canada); and data gathering exercises with relevant agencies (e.g., provinces, municipalities) for other water uses. Biological measurements of aquatic ecosystem health will be incorporated into the indicator over the next four years.

Biological Assessment of Water Quality: Delivery of a National System in Australia

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Abstract
Easily used standardized methods of biological assessment are fundamental for adoption nationally. In 1992 biological criteria were adopted into national water quality guidelines and the Australian Prime Minister allocated Aus$10 M to a new National River Health Program (NRHP) which was created in 1994. The NRHPis run by Environment Australia, initially administered by the Land and Water Research and Development Corporation, with a non-government national coordinator, and developed through a lead agency in each state. Fundamental to development, ownership and adoption has been: a national steering committee of scientists and managers with contractual powers; a technical committee to oversee scientific aspects including adoption of standardized protocols for data collection and modeling; regular workshops and technology transfer activities; a parallel R&D program with 20 projects focusing on sampling, analysis, taxonomy, method sensitivity, diagnostics, alternative methods, and QA/QC. AUSRIVAS (the Australian River Assessment System) was developed through the NRHP for aquatic biological and habitat assessment. AUSRIVAS is an Internet based software program that runs predictive bioassessment models derived from complex analyses. The models are similar to the British RIVPACS approach and are based on Australian macroinvertebrate and environmental data from over 1500 reference sites. The program is run locally after down-loading from the Internet, but uses models stored on a central server. The manuals are also available on the Internet and updates to the program and models are immediately available to all users. Other advantages of this approach include: the ease of access and use of standardized site-specific outputs that are comparable nationwide and a standardized national taxonomic coding system. The methods have been adopted within: new national water quality guidelines; a range of indicator frameworks of environmental condition and industry performance; and as a standard method by Australia's National Association of Testing Authorities. AUSRIVAS was used to assess the biological condition of 6000 stream sites around Australia (1997-2000). The resulting data provided the basis for biological assessment in Australia’s National Land and Water Resources audit and for the national State of the Environment report.

Water Monitoring and Utilization: Surveillance, Struggle or Symbol?

Dennis de Kool

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Biographical Sketch of Author

Dennis de Kool studied Public Administration at Erasmus University Rotterdam. In 2000 he became civil servant at Dienst Justitiële Jeugdinrichtingen (DJI), the prison service agency of the Ministry of Justice. Since June 2002 he is Ph.D. student at Erasmus University Rotterdam. His research is focused on the utilization of information generated by monitors and the consequences for intergovernmental relationships in the Dutch public sector. His promotor is Prof. Dr V.J.J.M. Bekkers and his daily supervisor is Dr. V.M.F. Homburg. Dennis de Kool is a member of the research group Centre for Public Governance.

Abstract

In the Netherlands, as in many other countries, water management is a public task that involves a lot of different stakeholders, and water management is sometimes a rather fragmented activity. The progress of the water policy has been monitored in different ways. The annual Dutch report *Water in Focus (Water in Beeld* in Dutch*)* informs about progress within the management of the water. In this paper, the utilization of information from this monitor by the different stakeholders in the Dutch water management system will be analyzed. Most utilization studies employ a single perspective only, which results in a partial explanation of the utilization of information. From the literature about knowledge utilization however, it is possible to distinguish various forms of utilization. In the *instrumental* utilization approach, monitoring may result in direct actions to be undertaken in order to improve policy or to put new issues on the agenda of policy makers ("surveillance"). In the *political* utilization approach, information generated by monitors is seen as a powerful resource, which can be strategically used to protect specific positions and interests of the various stakeholders ("struggle"). In the *cultural* utilization approach, the emphasis lies on the creation of shared practices, which define and give meaning to policy actions ("symbol"). In order to get insight in the utilization of information in the Dutch water management system, I have investigated the ways in which the different stakeholders are using information from the monitor *Water in Focus*. In the current mode of monitoring rationalistic assumptions are dominant. My case study shows that a multiple perspective research method is a thoughtful approach to get insight in the complex reality of monitoring practices.

Stream Waders and the Maryland Biological Stream Survey: Comparing Volunteer and Professional Stream Quality Data

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Chris Millard currently heads the Data Management section of the Maryland DNR's Maryland Biological Stream Survey. Chris joined the DNR in 1996, following positions with the US Fish and Wildlife Service and US Geological Survey. His graduate training and professional experience have focused on freshwater aquatic ecology, with more recent forays into investigations of bioindicators and evaluating the efficacy electrofishing protocols. Chris holds a BS and MS degree from the State University of New York College of Environmental Science and Forestry.

Dan Boward directs the Stream Waders Program for the Maryland Department of Natural Resources' Monitoring and Non-Tidal Assessment Division. He has been involved in stream and river monitoring in Maryland at DNR and Maryland Department of the Environment for the past 20 years. He has a BS degree in Zoology from the University of Maryland and a MS in Environmental Science from Johns Hopkins University.

Abstract
Since 2000, the Maryland Department of Natural Resources (DNR) has trained and recruited volunteers to sample benthic macroinvertebrates in freshwater streams as part of the Maryland Stream Waders Program. Approximately 700 volunteers have sampled 2,877 sites statewide to help fill data gaps in areas not sampled by DNR professionals. Many aspects of Stream Waders are seamless with those of the Maryland Biological Stream Survey (MBSS), including field and laboratory methods, data analysis, and determination of stream quality using a Benthic Index of Biotic Integrity (BIBI). Family- and genus-level BIBIs were calculated for Stream Waders and MBSS samples, respectively. Data from Stream Waders and MBSS (1,336 sites) were compared at the statewide, watershed, reach, and site scale. Family-level BIBIs tended to rate the same site lower than genus BIBIs. Mean BIBIs agreed on impairment 73% of the time at the watershed scale and site pairs agreed on impairment 76% of the time at the reach scale. MBSS duplicate samples (same day, same site, same sampler) had a mean BIBI difference of 0.16 ($r = 0.82$) while repeat sampling by MBSS staff at sites previously sampled by Stream Waders volunteers (with at least three weeks between sampling) had a mean difference in BIBI of 0.03 ($r = 0.76$). Stream Waders data should be used to support those collected by the MBSS in watershed assessments.

Evaluation of Volunteer Data – The Lakes of Missouri Volunteer Program Review

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Dan Obrecht has been associated with the University of Missouri's limnology laboratory for over 15 years and currently serves as the lab's manager. He has been involved with the Lakes of Missouri Volunteer Program since its inception in 1992, when he and co-coordinator Meg Milanick designed the program with an eye towards generating quality data.

Anthony Thorpe has worked within the University of Missouri's Department of Fisheries and Wildlife Sciences since 1994. Among his previous research is the analysis of bacterial abundance relations in Missouri reservoirs. He has been coordinating the Lakes of Missouri Volunteer Program for the last 5 years.

J. Jones has taught Limnology and Water Quality courses at the University of Missouri for 30 years and is currently Chair of the Department of Fisheries and Wildlife Sciences. His research in reservoirs and streams addressed how nutrients and physical factors regulate algal biomass. Recent studies of nonpoint source inputs to Missouri reservoirs have quantified the opposite role croplands and forest cover have on nutrients and suspended solids in water bodies statewide.

Abstract
The Lakes of Missouri Volunteer Program (LMVP) was created in 1992 with the goal of monitoring lake trophic state while maintaining an educational/outreach component. Along with collecting the venerable Secchi transparency measurements, volunteers collect lake water samples that are processed for total phosphorus, total nitrogen, algal chlorophyll and suspended solids analyses. The processed samples are stored frozen and later analyzed at the University of Missouri's limnology laboratory; following the same methods used for research projects. In 1998 LMVP coordinators published a paper in the Journal of Lake and Reservoir Management entitled *Evaluation of Data Generated from Lake Samples Collected by Volunteers*. Three different analyses were used to gauge the quality of data generated with volunteer assistance, and results suggested that volunteer data were of high quality. The publication of that study along with the use of standard analytical methods prompted the state's regulating agency to consider the LMVP as a source of high quality data, which are currently used in the state's 305(b) report. The additional data collected in the years following the publication of the article will be analyzed for this presentation, and will focus on comparing LMVP and University research data. Comparisons will be made using annual data, long-term means and duplicate field samples. The precision of chlorophyll filter replicates will also be evaluated to gauge the quality of volunteer data.

Volunteer Water Quality Monitoring Data Enhancing Lake Chatuge Watershed Study

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Abstract
Lake Chatuge is a 7,000-acre reservoir straddling the North Carolina/Georgia state line. A decline in the ecological health of Lake Chatuge was observed in the 1990's. In 2001 the Hiwassee River Watershed Coalition (HRWC) received $216,000 from the Georgia legislature to determine the causes for the decline and to develop an action plan for improving the ecological condition. HRWC acquired professional water quality monitoring data from both the lake and its tributaries between April and November 2003 and partnered with the Tennessee Valley Authority for a computer model of the lake/watershed. Six months prior to the professional monitoring, a volunteer monitoring team was established in the Lake Chatuge watershed as part of the Volunteer Water Information Network (VWIN). VWIN is a program of the UNC-Asheville's Environmental Quality Institute (EQI). EQI provides technical assistance to organizations like HRWC through laboratory analysis of water samples, statistical analysis of water quality results, and written interpretation of the data. Network volunteers collect samples once a month from 217 sites along streams and rivers in the southern Appalachian region. Twelve sites, including six that would be monitored professionally as part of the Lake Chatuge study, were established on tributaries in October 2002 and have been monitored monthly ever since. Samples are collected on the third Saturday of every month and analyzed for 13 parameters including three metals (Cu, Zn, Pb). Overlapping the volunteer and professional data sets allowed a quality-assurance comparison of the VWIN data. Data collected through the HRWC program can be used to update and improve the Lake Chatuge water quality model. In addition, future volunteer monitoring data can be used to demonstrate improvements as the watershed action plan is implemented. Over the past three years, more than 40 individuals have been involved with the Lake Chatuge volunteer monitoring team!

QA/QC Assessment of Volunteer Monitoring in Rhode Island

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Abstract
As environmental concerns become more complex, volunteer monitoring data will be even more vital in developing workable solutions. This presentation confirms that lay monitoring can in fact provide reliable water quality data, that is comparable to professionally collected data. The presentation will include program background, project objectives and methods, and analysis of results, as well as implications for volunteer monitoring. Volunteer-collected data from the Cooperative Extension URI Watershed Watch Program provide decision-makers with extensive water quality information on RI's water resources. Lay monitoring was rigorously assessed in order to justify inclusion in the 305(b) Report. Program staff conducted field QA/QC visits to 21 lay-monitored public lakes, observing all monitoring activities performed by the volunteers. Staff and volunteer each collected a set of water samples following the usual Watershed Watch protocol (discrete samples collected at 1 and 5 m). Two sets of samples were taken by staff following a protocol approved by USEPA for a Clean Lakes assessment (integrated epilimnetic and mid-hypolimnetic samples). Field analyses included Secchi depth, water temperature, dissolved oxygen, and chl-a processing. Laboratory analyses included pH, alkalinity, TP, chl-a, Ca, Mg, Na, and Cl. Comparisons were made between samples collected by the volunteers and staff, and between Watershed Watch protocol-collected and Clean Lakes protocol-collected samples. The results indicated that volunteers collected data which were as representative of lake water quality as were data collected by staff following the Clean Lakes protocol. This comparative study also resulted in a number of minor modifications to the volunteer monitoring protocols in order to improve the representativeness of the data, and to improve QA/QC overall. Staff versus volunteer assessments have become an element of the overall QA program, with regular controlled tests being conducted during sample collections events. This emphasis on ensuring generation of credible, comparable data has resulted in increased confidence in the widespread use of URI Watershed Watch data.

Watershed Stewardship: GPS Habitat and Bioassessment Surveys

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Biographical Sketches of Authors

Aspen Madrone is a native Californian, who has conducted ecological monitoring on both coasts for the past 10 years. She received a B. S. in Aquatic Ecology from the Evergreen State College, then worked for the Washington State Department of Ecology assessing the health of streams for 3 years. She continues her watershed monitoring efforts assisting volunteers in Contra Costa County.

Abby Fateman is a Planner for the Contra Costa County Community Development Department, working in the Conservation Programs Division. She first joined the department in 2001 to work with the Contra Costa Watershed Forum (CCWF) to develop and implement the Creek GPS Data Collection program. Currently she is involved in a number of natural resource conservation projects. She has a B.A. from Wesleyan University in Connecticut and a M.S. in Natural Resources from the University of Michigan.

Abstract

In Contra Costa County volunteers are working with local agencies, resource managers and regulators to monitor and improve the health of local creeks and watersheds that drain to the San Francisco Bay and Delta regions. The Contra Costa Watershed Forum's Citizen Watershed Monitoring and Assessment program mobilizes existing volunteer organizations to implement a coordinated countywide citizen-based watershed monitoring program. Volunteers are trained to collect physical habitat data with global positioning systems (GPS) and bioassessment data using the California Stream Bioassessment Procedure. Volunteers and other stakeholders utilize this data to identify and prioritize future water quality improvement projects.

GPS Creek Surveys document vegetation (type, invasive species), human disturbances (outfalls, bridges, dams), and channel conditions (substrate, canopy cover, bank composition). The data can be presented graphically on a map as well as analyzed to quantify habitat conditions.

Bioassessment Surveys utilize benthic macroinvertebrates (bugs) to screen for water quality problems. Monitoring the diversity and abundance of aquatic bugs helps determine the biological integrity and overall health of watersheds. Bioassessment surveys provide volunteers and regulators a cost-effective method to monitor water quality, identify possible pollutant sources, and target restoration and pollution prevention actions.

The volunteer collection efforts augment the on-going work by agencies to characterize and monitor watersheds. The baseline data, as well as annual monitoring by Citizen Watershed Monitoring and Assessment program provides resource managers and regulators data needed to address habitat restoration and pollution reduction strategies in Contra Costa County. This program empowers citizens to be effective watershed stewards by providing skills, resources, and facilitating relationships with agency staff to cooperatively monitor and address water quality issues. Watershed stewards turn education into action with tangible, scientific data to make well-informed decisions to improve water quality at the watershed scale.

Great Lakes Aquatic Gap: A regional approach to identify gaps in species and habitat conservation for Great Lakes streams

Jana Stewart[1], James E. McKenna, Jr. [2], Steve Aichele[3], and Dora Passino-Reader[4]

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Jana Stewart is a geographer with the USGS WI Water Science Center and is the Principal Investigator for the USGS Great Lakes Aquatic Gap (GLGAP) project along with GIS specialist for the Western Lake Michigan Drainages NAWQA. In addition to overall coordination of the GLGAP project, Jana is leading the WI GLGAP study, with work focused on GIS processing of habitat characteristics and temperature modeling. James McKenna is an ecologist with the USGS Tunison Laboratory of Aquatic Sciences and is a Co-PI for the GLGAP project, leading the coastal pilot and NY riverine component, as well as leading the fish modeling effort. Steve Aichele is a geographer with the USGS MI Water Science Center and is a Co-PI for the GL GAP project, leading the MI riverine component and GIS method development. Dora Passino-Reader is a Research Fisheries Biologist, who recently retired from the USGS Great Lakes Science Center. Dora has coordinated MI GLGAP fish modeling for the riverine component as well as the Central Database and has continues to be involved in the project since her retirement

Abstract
The Great Lakes Aquatic Gap project uses a regional approach to characterize the habitat of stream reaches, predict fish species distributions, and identify gaps in species distributions, data collection, and conservation of fish species and their habitats over a large geographic area using a geographic information system (GIS). Habitat characteristics consist of attributes that describe stream network position and connectivity, land cover, geology, and climate for channel, riparian, and watershed features. Summer water temperature and stream flows were modeled from GIS-derived habitat characteristics and climate data. Fish species occurrence and abundance data were compiled from existing sources, in collaboration with universities, non-government organizations, states, Tribes, and other federal agencies. Habitat characteristics and fish species data are linked to stream segments and stored in a Central Database for developing maps of fish species distribution and habitat, and for developing species-habitat models to predict fish species distributions. Classification and regression tree (CART) and artificial neural network (ANN) techniques were used to successfully estimate fish species distribution and abundance in un-sampled streams with 70 – 90 percent accuracy. Project results can be used by scientists, resource managers, and decision-makers at a local and regional scale for fish species and habitat conservation (eg. identify species at risk and conservation priority areas), monitoring (eg. document changes in species distribution, assess bio-monitoring and stocking programs, track spread of invasive species, manage point-source discharges, and develop aquatic life use designations), planning (eg. assess habitat suitability, identify stream restoration opportunities, prioritize dam removal and stream crossing improvement, and develop decision support systems for land use planning). Great Lakes Aquatic Gap studies are currently underway in New York, Michigan, Ohio, and Wisconsin with similar work being conducted in Illinois through collaboration with a US EPA STAR project on Ecological Classification for Streams in IL, MI, and WI.

An Overview of the National Park Service's Vital Signs Water Quality Monitoring Program: A National Framework for Land Management Agencies

By Gary Rosenlieb and Barry Long

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Biographical Sketches of the Authors

Gary Rosenlieb is a hydrologist and has been the water quality program leader for the National Park Service (NPS) since 1990. He and three other water quality and contaminant specialists are responsible for developing national technical guidelines for the implementation of the sevicewide Vital Signs Water Quality Monitoring Program. In addition, Gary also develops national policy for the NPS for Clean Water Act compliance and provides technical assistance to numerous National Park Units for the interpretation of water quality data and information.

Barry Long is a hydrologist with the National Park Service, Water Resources Division. He is a water quality specialist and part of a team working on the Vital Signs Water Quality Monitoring Program. Since 1998, he has served as co-chair of the NPS-USGS Water Quality Partnership Program. Also since the mid-1990's, Barry has served as a member and NPS representative on the National Water Quality Monitoring Council.

Abstract

Vital signs monitoring is a key component in the National Park Service's strategy to provide scientific data and information needed for management decision-making and education and also contributes information needed to understand and to measure performance regarding the condition of watersheds, landscapes, and marine resources, and biological communities. Under the program, 270 park units have been organized into 32 ecoregion-based networks that share funding and a core professional staff to conduct long-term ecological monitoring. A key component of the program is water quality monitoring which is closely aligned with the requirements of the Clean Water Act by focusing monitoring on state-identified quality impaired waters on 303d lists. Servicewide, about 138,000 miles of streams and about 5,000,000 acres of lakes, reservoirs, or marine areas in 118 parks have been identified as exceeding standards on the state lists. Monitoring emphasis is also directed towards establishing long-term status and trends in park-managed Outstanding National Resource waters which are afforded the highest degree of protection under the Clean Water Act. This presentation will provide and overview of the NPS's approach to establishing a national monitoring program in a federal land management agency, including monitoring design at the network level, development of protocols, and quality assurance and quality control guidelines.

Moving the National Water-Quality Assessment Habitat Data Through Time

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Biographical Sketches of Author

Jeffrey Steuer has served as a hydrologist and project manager in the Wisconsin Water Center since 1989. He has an undergraduate degree in Ocean Engineering and advanced degree in Hydraulic Engineering. Jeffrey has spent his career working on projects that have ranged from rainfall-runoff and contaminant transport modeling to monitoring and assessing the effects of urban stormwater. He has been involved with the National Water-Quality Assessment Program since 2003.

Abstract

Traditionally, the National Water-Quality Assessment (NAWQA) Program has related biological data to habitat data collected from streams during base-flow conditions. Past studies have shown that stream biology may be related to channel morphology and hydraulic characteristics that are reflective of frequent low-magnitude floods. The U.S. Geological Survey utilized a 1-dimensional hydraulic model (HEC-RAS) and continuous stream stage data to calculate channel morphology and hydraulic characteristics from habitat data collected in fall 2004. At Rio Creek, a 56 km^2 basin located in northeastern Wisconsin, a habitat survey conducted on August 31, 2004 measured a water surface slope, mean reach velocity and depth of 0.0019, 4 cm/s, and 0.37 m respectively. The hydraulic simulation over the interval March 18, 2004 to November 9, 2004 identified eight flow events in which the bottom shear stress (reach median) was 7 times greater than during the above habitat survey. Additionally, during these eight events shear stress computed at each of the 11 transects was found to be greater than the 0.95 dyne/cm^2 threshold found to be significant in defining refugia for an invertebrate population. Conversely under the lowest flow condition the wetted perimeter (reach mean) was reduced by nearly 50 percent from that measured during the habitat survey (9.13 m). It is anticipated that analyses of these, along with additional geomorphic and hydraulic variables, as they change over time may improve our understanding of algal, invertebrate, and fish assemblages in the 90 streams that are a part of an ongoing NAWQA study on urbanization effects on aquatic biota.

Statistical Analysis of Probability Survey Data Using R Statistical Software

Facilitator
Anthony Olsen

Biographical Sketch
Anthony R. Olsen is an environmental statistician at the U.S. Environmental Protection Agency, NHEERL, Western Ecology Division, Corvallis, Oregon. He received a PhD in statistics from Oregon State University in 1973. He is a Fellow of the American Statistical Association and is a recipient of the Distinguished Achievement Award from the American Statistical Association's Section on Statistics and the Environment and the distinguished statistical ecologist award of the International Association for Ecology. Dr. Olsen's research focuses on the development of large–scale ecological monitoring studies based on probability survey designs and statistical graphics for geographical data.

Description of Workshop
This workshop will demonstrate free software developed specifically for the statistical analysis of probability survey data. Statistical analysis examples of stream, lake, and estuary probability survey data will be completed using a survey analysis library for R Statistical Software. Both R and the library are free. Examples will be given for cumulative distribution functions (CDFs), percentiles, means, and categories. All necessary software and data will be provided. No knowledge of R required for the workshop. Participants can bring their own laptop, though this is optional.

Collaborative Monitoring in the Great Lakes: Revisiting the Lake Michigan Mass Balance Project

John Hummer[1], Charles A. Peters[2], Steve Westenbroek[2], Gary Kohlhepp[3]

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John Hummer is a Senior Program Specialist with the Great Lakes Commission, Environmental Quality Program. He specializes in and coordinates projects addressing ecosystem monitoring and Great Lakes Areas of Concern. John has been with the Commission for five years. Prior to that he served with Michigan State University Extension as program director for a small watershed in northern Michigan. John has served as co-coordinator of the Lake Michigan Monitoring Coordination Council, the Lake Michigan Tributary Monitoring Project, and the Marsh Monitoring Program in partnership with Bird Studies Canada for U.S. and binational Areas of Concern.

Charlie Peters has been involved in water quality monitoring studies with the U.S. Geological Survey for 27 years and has authored over 40 water quality reports. He is past co-chair of the National Methods and Data Comparability Board, past member of the National Water Quality Monitoring Council, and current co-chair of the Lake Michigan Monitoring Coordination Council. Charlie currently directs the research in the USGS Wisconsin Water Science Center. Together with USGS colleague Steve Westenbroek and Gary Kohlhepp of the Michigan Department of Environmental Quality, he has coordinated sampling design and monitoring parameters for the Lake Michigan Tributary Monitoring Project.

Abstract
Many organizations devote enormous amounts of time, energy, and money to monitor, protect, manage and restore the Lake Michigan basin. Critical differences in monitoring objectives, data analysis, and data management make it difficult to share monitoring information and results. Yet, it is important that monitoring organizations collaborate to share data effectively and efficiently. The Lake Michigan Monitoring Coordination Council provides a regional forum to coordinate and support scientifically defensible monitoring methods and strategies in the Lake Michigan basin.

The Tributary Workgroup of the Council coordinated state and federal surface water monitoring programs to monitor key tributaries to Lake Michigan for the sampling seasons 2005-06. This intensive monitoring event serves to validate forecasting and update results from the Lake Michigan Mass Balance (LMMB) project. In 1994-95, the LMMB project modeled cross-media loadings and processes throughout the lake for several pollutants. As one component of the project, water samples were collected from 11 major tributaries to Lake Michigan. Objectives included identifying relative loading rates of pollutants from these tributaries, and comparing loading rates to other media, such as air and sediments.

In the 2005-06 sampling season, the Michigan Department of Environmental Quality, U.S. Geological Survey-MI, and the U.S. Geological Survey-WI revisited select Lake Michigan tributaries studied during the LMMB project with the goal of characterizing present-day water column contaminant concentrations and loadings. Sampling parameters included total mercury, methyl mercury, PCBs, and a suite of nutrients. Sensitivity and error analyses will be performed in order to understand the uncertainty associated with loads calculated from a reduced level of effort relative to the original mass balance work.

Several issues were addressed and overcome throughout this project, including a minimal budget, coordination among multiple agencies, study design, anticipated data use and quality assurance protocols. This presentation will highlight several lessons learned throughout this project.

Collaboration on EMAP Stream Condition Assessments in EPA Region 8

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Biographical Sketches of Authors

Thomas Johnson is an environmental scientist in the Water Quality Unit of the Ecosystems Protection Office in U.S. EPA Region 8. He has worked on ecological assessment issues related to the EMAP and R-EMAP programs since 1999. He has been with U.S. EPA Region 8 since 1991 and has worked in a number of water quality programs and projects, including NPDES permitting, ecological assessments of the Upper Missouri Basin and Northern Great Plains, and general monitoring issues. He has BS in Microbiology from Kansas State University and an MS in Environmental Science from Oklahoma State University.

Karl A. Hermann is a Senior Analyst with U.S. EPA Region 8. His primary responsibility is Coordinator for Water Quality Monitoring and Assessment Team. He is also the coordinator of Region 8 efforts in the EMAP-West study. He makes extensive use of GIS, remote sensing, and GPS technologies in his work involving monitoring, landscape analysis, assessment, and reporting. He has been at EPA since 1996 and has previous experience with the University of Tennessee as a U.S. Department of Interior cooperator, ManTech Environmental Inc. as an EPA contractor, Pacific-Sierra Research Inc. as a Department of Defense consultant, the State of North Carolina as a state employee, and has operated his own small GIS consulting company. He has an MS in Resource Economics from Colorado State University and worked on a PhD in Forestry at North Carolina State University.

Abstract

Staff from six western states, the U.S. Geological Survey, the U.S. Environmental Protection Agency (USEPA) Region 8, and the USEPA Office of Research and Development (ORD) are collaborating on assessments of ecological stream condition in EPA Region 8. The assessments are part of the USEPA Environmental Monitoring and Assessment Program's (EMAP) Western Study involving 12 Western States. The collaborative assessment approach in Region 8 is unique within the EMAP Western Study. The six Region 8 States, Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming are currently conducting assessments with USGS and USEPA, which will be published in a single volume with separate assessment chapters by ecoregional, state, and basin reporting units. The development of multi-metric indicators for macroinvertebrates, aquatic vertebrate, and periphyton assemblages are being done on an ecoregional basis. Predictive modeling of macroinvertebrate taxa is being performed on a statewide basis. The extent of stressors (habitat, chemistry, and landscape) will be reported and associations with ecological condition will be explored. Benefits of the collaborative approach include the sharing of reference site data and evaluation, cross training in assessment methods, and consistency of the assessment approach and reporting.

A Collaborative Approach to Assessing Watershed Conditions in Coastal National Parks

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Kristen Keteles is a research scientist at Texas A&M University hired through the Cooperative Ecosystem Study Unit to coordinate the Coastal Watershed Condition Assessments conducted through the National Park Service Water Resources Division. Previously, Dr. Keteles was an assistant professor of biology and coordinator of the environmental science program at the University of Central Arkansas. She also worked in the Superfund Basic Research Program at Dartmouth College and in the Counter Terrorism Forensic Science Research Unit at the FBI. Her research interests focus on the availability of environmental contaminants, particularly toxic metals, to aquatic organisms.

Cliff McCreedy has more than 20 years experience in developing environmental protection and natural resource policies and programs in the executive branch, Congress, and nonprofit sector. As Marine Program Leader for the National Park Service he coordinates ocean resource assessment and management programs for the National Park System and jointly with the National Oceanic and Atmospheric Administration and U.S. Geological Survey. Cliff was the chief executive for Oceanwatch prior to joining the Park Service. He also managed legislative programs on water quality, toxics and enforcement at the U.S. Environmental Protection Agency.

Abstract
The National Park Service (NPS) Water Resources Division (WRD) has initiated assessments of coastal water resources in 52 coastal and island Parks through the Natural Resource Challenge Watershed Condition Assessment Program. Reports from these assessments are characterizing the relative health or status of Great Lake, estuarine and marine resources in the National Park System and are revealing ecological stressors that may cause impairment. This presentation will describe the program and explore ways to strengthen partnerships among various stakeholders to produce robust and cost-effective monitoring approaches at coastal Parks. Assessing coastal water quality and habitat condition in the Parks provides a platform for cooperative monitoring and watershed management partnerships. For example, dissolved oxygen concentrations were found to be unexpectedly low in estuarine waters at Cumberland Island National Seashore during the summer, which encouraged increased monitoring for hypoxia by the State of Georgia. NPS is developing the next phase of the program to investigate resource problems and fill information gaps by forming monitoring partnerships with states, federal agencies, academia, local watershed groups and programs such as the National Coastal Assessment.

A Multi-scale Collaborative Approach For Linking Terrestrial and Aquatic Long-Term Monitoring: Lessons Learned in the Delaware River Basin and Proposed New Directions

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Pete Murdoch is a Research Hydrologist with the Watershed Research Group of the US Geological Survey in Troy, New York. Since 1982 he has lead research projects on watershed processes, and the effects of acid rain and climate change on aquatic systems. In the mid-1990s he served as the DOI representative to the White House Committee on Environmental and Natural Resources (CENR). In 2004-06, Pete served as the DOI representative to an interagency committee that oversees the North American Carbon Program. He now leads a multi-agency study on the effects of permafrost thawing in the Yukon River Basin

Abstract
The Collaborative Environmental Monitoring and Research Initiative (CEMRI) integrated the existing monitoring and research programs of the US Geological Survey, the US Forest Service, and the National Park Service in the Delaware River Basin to address multi-scale environmental issues that could not be assessed by individual programs. Using a tiered monitoring structure of intensive research sites, condition-gradient surveys, probability surveys, and remote sensing and inventories the participating agencies collaborated to assess soil and stream acidification, landscape fragmentation and associated river degradation, the causes and effects of forest pest and invasive species invasion, and terrestrial and aquatic carbon budgets. The collaborative study revealed a correlation between soil calcium availability and forest health in the Catskill Mountains, and a decline in streamwater calcium concentrations over the past 50 years. At the regional scale, the study provided an integrated stream and soil chemistry survey in the upper Delaware basin that identified a band of low-calcium streams and soils extending from the western Pocono Mountains in Pennsylvania to the eastern Catskills in New York. Detailed aerial photo interpretation by USFS, when combined with stream and macro-invertebrate surveys by USGS, revealed a strong correlation between watershed disturbance (urbanization and forest fragmentation) and stream habitat, fauna, and water-quality decline. The combination of intensively and extensively collected data, and the integration of the forest-, soil-, and water-sampling programs created a regional monitoring system for tracking changes in terrestrial and aquatic ecosystems in the upper Delaware River Basin that was not attainable by the individual monitoring programs. Further development of this multi-scale, collaborative approach will occur with the application of the CEMRI design in the Yukon River Basin in 2007 to study the effects of melting permafrost on water, energy, and carbon dynamics.

Regression Model for National Assessment of Nitrate in Ground Water

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Bernard T. Nolan is a ground-water specialist for the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS). He has worked in the area of nutrient data synthesis and interpretation since 1995. He assesses aquifer vulnerability to contamination through modeling and spatial analysis of water-quality data, soil and aquifer properties, and land-use characteristics.

Kerie J. Hitt is a Geographic Information Systems specialist with the NAWQA Program in Reston, Virginia, and provides technical support for national studies of nutrients in ground water. She develops and applies ancillary spatial data on factors that influence water quality. Ms. Hitt joined the USGS in 1981 and has been with the NAWQA Program since 1991.

Abstract

Nitrate is considered the most widespread contaminant in ground water, which has both environmental and human-health implications. Recent studies have linked elevated nitrate concentrations in community wells to diseases, such as bladder and ovarian cancers and non-Hodgkin's lymphoma. The scope of the ground-water nitrate problem is underscored by the fact that 130 million people in the United States consume ground water. Of these, 40 million consume water from private or "domestic" wells, which commonly are shallow and are not monitored routinely. These wells are more susceptible to chemicals applied at the land surface because contaminants have relatively little distance to travel to reach ground water.

Obtaining samples from wells is the most reliable way to identify areas with contaminated ground water; however, monitoring is expensive, and it is impractical to measure nitrate everywhere. A model can be used to predict concentrations in unsampled areas, but the model predictions are only as good as the data upon which the predictions are based. To address these concerns, we use an integrated approach to monitoring and prediction. We developed a national regression model based on measured nitrate data collected from more than 2,000 wells, plus continuous spatial coverages that represent nitrogen inputs, soils, and geology. By understanding and quantifying factors that control nitrate in the environment, we can reliably predict nitrate occurrence in unsampled areas. In turn, prediction errors can indicate where more data are needed to refine our understanding.

The regression model indicates that nitrogen loading and aquifer susceptibility factors significantly influence nitrate concentration in ground water. Areas with high N application, high water input, well-drained soils, fractured rocks or those with high effective porosity, and lack of attenuation mechanisms have the highest predicted nitrate concentration. Model errors indicate that predictions generally agree with the measured nitrate data. The model is being used to predict nitrate concentration in unsampled ground waters of the U.S.

Using Logistic Regression to Assess Regional Ground-Water Vulnerability: High Plains Aquifer

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Biographical Sketch of Author

Jason Gurdak is a hydrologist in the Colorado Water Science Center of the U.S. Geological Survey with experience in field and modeling investigations of watershed and aquifer contaminant hydrology for the National Water Quality Assessment (NAWQA) Program. He is currently with the NAWQA High Plains Regional Ground Water (HPGW) study. As part of the HPGW study, he has developed models to assess regional ground-water vulnerability to nitrate contamination and has investigated unsaturated-zone water- and chemical-flux response to land use and climate variability.

Abstract

Interest in predicting nonpoint-source contamination in ground water has increased because of widespread detections of nitrate and consequent implications for human and aquatic health and resource sustainability. As part of the U.S. Geological Survey's National Water-Quality Assessment Program, a novel ground-water vulnerability assessment was developed to predict the occurrence probability of elevated nitrate (> 4 mg/L) concentrations in recently (< 50 -years) recharged ground water of the High Plains regional aquifer (451,000 km^2). This empirically based assessment coupled particle-tracking simulations and multivariate logistic regression within a geographic information system (GIS) framework, thereby incorporating site-specific estimated hydrogeologic parameters, ground-water flow regime, and data from a network of 336 ground-water quality monitoring wells. The results of the logistic regression model indicate the probability of detecting nitrate > 4 mg/L is best explained by the extent of non-irrigated and irrigated agricultural lands, organic content of the soil, depth to the regional water table, and clay content of the unsaturated zone. Since statistical relationships were developed between monitoring well-specific nitrate concentrations and GIS-based explanatory variables, it was possible to interpolate the vulnerability predictions spatially across the entire regional aquifer using a GIS map-algebra technique. This spatial distribution is presented as a vulnerability map. Validation using an independent subset of wells ($R^2 = 0.823$) suggests the model is a reasonably good predictor in areas currently lacking monitoring wells. Predicted vulnerability corroborated the conceptual model that elevated nitrate is directly related to nitrogen loading at land surface, and inversely related to denitrification in the soil zone and impedances to downward advective chemical movement through the unsaturated zone. The nitrate vulnerability model and map offer a predictive tool for water resource managers to identify likely areas of non-point source contamination and evaluate the impact of anthropogenic activity on nitrate distribution in ground water.

Empirical Modeling of Nitrate Loading and Crop Yield for Corn-Soybean Rotations in Iowa

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Biographical Sketches of Authors

Rob Malone is a research engineer with the National Soil Tilth Laboratory in Ames, IA. The authors are developing tools and methods to quantify the effect of agricultural management on water quality and crop production that will facilitate agricultural decision-making.

Abstract

Crop yield and nitrate nitrogen losses through subsurface drainage are affected by multiple climatic and management variables, however the interactive affect of these variables is not well understood. Simple equations that predict nitrate loading and crop yield as a function of important variables may improve our understanding of agricultural systems. Therefore, we developed multivariate polynomial regression equations to predict crop yield, nitrate concentration, drainage volume, and nitrate loading from a corn and soybean rotation in response to rainfall amount, N source, N rate, and timing of N application in northeastern Iowa. The regression equations described over 90% nitrate loading, 90% drainage, 80% yield, and 60% nitrate concentration variation. The regression equations were then used to analyze nitrate leaching and crop yield under a variety of N management and climate scenarios. The regression equations improve our understanding of variable interactions on nitrate leaching, offer a simple method to quantify potential N losses from Midwestern corn-soybean rotations, and are a step toward development of easy to use N management tools.

Using Logistic Regression to Ppredict the Probability of Occurrence of Volatile Organic Compounds in Ground Water

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Biographical Sketch of Author
Michael Moran is a hydrologist for the U.S. Geological Survey who works on analyzing and interpreting ground water quality data for the National Water-Quality Assessment (NAWQA) Program. His work includes analyzing and interpreting data on VOCs in ground water, designing national-scale ambient ground water monitoring programs, and developing statistical models to predict the probability of occurrence of VOCs in ground water. Michael holds a Ph.D. in geological engineering from the South Dakota School of Mines & Technology and is a member of the American Institute of Professional Geologists, the Association of Engineering Geologists, and the National Ground Water Association.

Abstract
Volatile organic compounds (VOCs) in ground water sampled by the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program have been analyzed using logistic regression. Using logistic regression, the occurrence of VOCs in ground water has been associated with one or more independent, or explanatory, variables. In addition, equations relating the probability of occurrence of VOCs to one or more explanatory variables have been developed.

Some advantages of applying logistic regression to VOC occurrence in ground water include: 1) identification of explanatory variables associated with occurrence that may aid in understanding their sources, transport, and fate, and 2) prediction of the probability of occurrence of VOCs in ground water relative to one or more explanatory variables. Some limitations of logistic regression include the inability to: 1) identify specific sources or transport mechanisms, 2) extrapolate the probability of occurrence beyond the sample point.

In some cases, the NAWQA Program has successfully applied logistic regression in predicting the occurrence of VOCs in ground water at a national scale. However, it may not be possible to extrapolate the probability of occurrence beyond the sample point for: 1) data with limited spatial distributions, 2) data from highly specific sampling approaches, and 3) some types of explanatory variables. For example, although the occurrence of three solvents was related to dissolved oxygen, it was not possible to extrapolate the probability of occurrence because of the unknown content of dissolved oxygen in ground water beyond the sample point. It may be possible, for some types of explanatory variables, to estimate values or conditions beyond the sample point. Probabilities of occurrence beyond the sample point also could be generated based on the probabilities at each sample point.

Overview of the National Nutrient Criteria Program

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Dr. Amy Parker serves as the National Nutrient Coordinator for the US Environmental Protection Agency's Office of Science and Technology in the Office of Water. Her current work includes coordinating the Nutrient Criteria Program, participating on EPA's Hypoxia Team, and providing technical support for numeric nutrient criteria development and standards adoption. Dr. Parker received her PhD from the University of Georgia where her dissertation topic was "The Role of Iron in the Biogeochemical Cycling of Phosphorus in Georgia Piedmont Impoundments". Her specific work included nutrient fate and transport, and biogeochemical cycling of nutrients in rivers and lakes.

Abstract

The National Nutrient Program began as a part of the 1998 Clean Water Action Plan. The goal of the program is to reduce cultural eutrophication, i.e. eutrophication that results from human activity. We are working to achieve that goal by partnering with states, authorized tribes, and territories to identify and adopt appropriate numeric nutrient criteria into State/Tribal/Territorial water quality standards and implement those standards in their water quality programs. To that end, USEPA Headquarters developed waterbody specific technical guidance addressing lakes and reservoirs, rivers and streams, estuaries and coastal waters, and wetlands. USEPA has also release 26 criteria recommendation documents identifying 304(a) criteria for the 14 nutrient ecoregions across the country. These 304(a) criteria were issued as reference condition values covering approximately 95% of US freshwaters to provide a starting point for States/Tribes/Territories to begin developing more locally appropriate criteria. USEPA is currently working with state and academic partners to develop 304(a) criteria recommendations for estuaries, wetlands and near-shore coastal waters to provide examples that will States/Tribes/Territories as they move to developing nutrient criteria for these waterbody types. USEPA is also providing scientific and technical assistance to States/Tribes/Territories for nutrient criteria development and standards implementation using N-STEPS (Nutrient Scientific Technical Exchange Partnership and Support), a website of information about the Nutrient Program, and a technical support request system, T-REQS (Technical REQuestS) for States/Tribes/Territories and EPA Regions.

States/Tribes/Territories have submitted plans for developing numeric nutrient criteria and standards adoption in response to this program. USEPA views submission of a nutrient criteria development plan as a commitment by States/Tribes/Territories to adopt numeric nutrient standards for their waters. According to the plans submitted and the schedules for standards adoption, 21 States/Tribes/Territories of the 56 entities that we track will adopt numeric nutrient standards for their priority waters by 2008, showing a good faith effort in reducing cultural eutrophication in our Nation's waters.

Nutrient-Biota Interactions in Agriculturally Dominated Landscapes: Lessons from the U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program

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Biographical Sketch
Mark D. Munn is a stream ecologist with the USGS Washington Water Science Center and has worked on a variety of projects ranging from benthic ecology to contaminants in fish. Since 1992 he has worked for the USGS National Water-Quality Assessment (NAWQA) Program, and is presently the National Team Leader for the Effects of Nutrients on Stream Ecosystems team which is part of NAWQA.

Nutrient (nitrogen and phosphorus) enrichment is a leading cause of water quality impairment in the United States, with agricultural activities a major source of nutrients to surface waters. In 2001, the U.S. Geological Survey's National Water-Quality Assessment Program began a study on the effects of nutrient enrichment on stream ecosystems. Eight agriculturally influenced study units were selected; study activities began at five study units in 2001 and at three study units in 2005. Thirty independent, wadeable stream sites distributed along a gradient of nutrient conditions were selected in each study unit. Sites were selected using geodata, predicted nutrient loads and measured nutrient concentrations, habitat, and stream size. Data collected during a single period include nitrogen and phosphorus, biological communities (algae and invertebrates), algal chlorophyll *a*, primary production and respiration, and stream habitat. Riparian and land-use data were obtained using GIS procedures. Additional data to be collected at the 2005 study units include streamflow and seasonal changes in nutrients and biota. Although nutrient and chlorophyll *a* concentrations often are used in developing nutrient criteria, preliminary results from this study indicate a number of issues that need to be considered in agricultural streams: (1) nutrients and chlorophyll *a* often are weakly correlated; (2) biota may reflect nutrient concentrations from an earlier time; (3) physical habitat is a limiting factor for biological communities; (4) nutrient concentrations in many streams exceed biological requirements; and (5) macrophytes may have a greater effect on some streams than do algae. Furthermore, the relation between nutrients and a biological measure may be expressed as a threshold-response curve with threshold concentrations typically less than those measured in agricultural streams. Streams in agriculturally dominated landscapes provide unique opportunities and challenges that must be adequately addressed to establish accurate nutrient enrichment criteria.

Response of Benthic Algal and Invertebrate Communities to Nutrient Enrichment in Agricultural Streams: Implications for Establishing Nutrient Criteria

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Robert W. Black is an aquatic ecologist with the Washington Water Science Center of the US Geological Survey in Tacoma, WA. He is currently the project chief of the National Water Quality Assessment (NAWQA) Program activities in the State of Washington. He has published and presented numerous papers in the area of community ecology, water quality modeling, habitat restoration, ecotoxicology and biomonitoring methods development. For the last 16 years, he has been an active member in the Ecological Society of America, American Fisheries Society and North American Benthological Society.

Patrick Moran is a biologist with the Washington Water Science Center of the US Geological Survey in Tacoma, WA. Mr. Moran holds a M.S. degree in toxicology from Oregon State University and manages and provides technical review and/or support on a number of water quality related projects in Washington State. In addition, Mr. Moran serves as the biologist for the Washington State portion of the USGS National Water Quality Assessment (NAWQA) Program. His particular research interest focuses on applied or in-situ approaches to monitoring contaminant impacts on fish physiology and aquatic communities.

Abstract

As part of the USGS National Water Quality Assessment Programs Nutrient Effects study, benthic algae and invertebrate communities were used to examine nutrient enrichment in the Central Columbia Plateau-Yakima River (Washington) and Central Nebraska (Nebraska) study regions. In each region, 28-29 independent sites were selected to represent a gradient of nutrient conditions. The study was carried out at low-flow conditions in 2003. Data collected included nutrients, benthic and seston chlorophyll-*a*, benthic algal and invertebrate communities, stream and riparian habitat, and basin-scale land use. Based on multivariate ordination methods, algal and invertebrate communities were significantly different between regions. These differences were due to different combinations of explanatory variables including nutrients for each study region. Explanatory variables identified during the ordination analysis were incorporated into significant predictive models using nonparametric multiplicative regression. The most significant models used nutrient data in combination with other explanatory variables to predict algae metric scores. Those models predicting benthic and seston chlorophyll-*a* concentrations were statistically less significant. The results of this study suggest that algal and invertebrate communities from different agricultural settings respond to different combinations of nutrients and other explanatory variables. These findings suggest that predictive tools used to help establish nutrient criteria may need to be done on a regional scale. The study also suggests that more ecologically realistic statistical modeling tools can be used to relate biological response variables to predictor variables including nutrients. The presented modeling approach could be used to help establish regional nutrient criteria.

The Use of Calculated Stream Metabolism in Understanding Nutrients in Agricultural Streams

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Jill Frankforter has been a hydrologist with the U.S. Geological Survey, Nebraska Water Science Center since 1992. Within an educational background in biology and aquatic ecology, she is the ecologist for the National Water-Quality Assessment Program's Central Nebraska Basins study unit, and has been involved in the implementation of the Program's study of the effects on nutrient enrichment on stream ecosystems. In addition, she has been the water-quality specialist for the Nebraska Water Science Center since 1999, and has worked on a variety of water-quality related projects.

Holly Weyers is a fisheries ecologist with the U.S. Geological Survey, Delaware Water Science Center. She has been the ecologist for the National Water-Quality Assessment Program's Potomac River Basin and Delmarva Peninsula study unit since 2001. She has been involved in the development and implementation of sampling methods, personnel training, and data interpretation associated with stream metabolism estimates conducted as part the Program's study on the effects of nutrient enrichment on stream ecosystems. In addition, she is currently responsible for continuous, real-time water-quality assessments being conducted on selected streams with the State of Delaware.

Abstract

The development of nutrient criteria for rivers and streams has largely focused on measures of nitrogen, phosphorus, sestonic and periphytic chlorophyll *a*, and turbidity. The relation between concentrations of nutrient species and chlorophyll *a* in nutrient-enriched streams is variable and is influenced by natural and anthropogenic factors. The photosynthetic rate, or primary productivity, is often more sensitive and responsive to variable nutrient levels than is algal biomass (measured as chlorophyll *a*), but the need to normalize data for differences between sites and the analytical difficulty in estimating productivity has limited the use of production in assessments of nutrient enrichment.

The U.S. Geological Survey's National Water-Quality Assessment Program study of the effects of nutrient enrichment on stream ecosystems is intended to expand existing knowledge of the interrelations among nutrient conditions, algal communities, habitat, and stream metabolism. A key objective is to determine the extent to which these relations can be regionalized. Sampling is occurring at approximately 130 sites representing 8 distinct U.S. Environmental Protection Agency aggregated nutrients ecoregions across the Nation. Some of the previously documented difficulties with estimating whole-stream metabolism that are being addressed during this study include: estimation of reaeration; seasonal variability in metabolic processes; the influence of macrophytic metabolism; the quantification of changes in antecedent streamflow; and the analytical difficulty associated with estimates of productivity. Estimates of gross primary production, 24-hour community respiration, and net daily metabolism (net primary productivity) were generated using software developed for the study. These estimates were compared to the biotic community, water-quality, and habitat data to determine which factors are most strongly related to the nutrient conditions within and among selected nutrient ecoregions. These results may then be used in the development of regional nutrient criteria for streams.

Statewide Monitoring of Mercury in Surface Water, Precipitation, and Fish in Indiana

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Martin ("Marty") Risch has been a hydrologist with the USGS Indiana Water Science Center since 1990. Since 2000, he has operated a state-wide monitoring program for atmospheric deposition of mercury and is currently involved in a study of mercury in Indiana's streams. In 2002 he completed a study of mercury in the Grand Calumet River and Lake Michigan in northwestern Indiana. Marty is the incoming chairman of the National Atmospheric Deposition Program network operations committee. He was chief of the ground-water program at the Indiana Department of Environmental Management prior to joining the USGS.

Nancy T. Baker is a hydrologist with the USGS Indiana Water Science Center. She has been the Center's Geographic Information Specialist (GIS) since 1991. She has provided GIS support on a variety of projects ranging from bathymetric mapping to spatial analysis of water-quality data.

Abstract

The U.S. Geological Survey in cooperation with the Indiana Department of Environmental Management has operated statewide monitoring networks for assessing mercury concentrations and loads in surface water since 2002 and mercury concentrations and deposition from precipitation since 2001. In addition, the Indiana Department of Environmental Management has maintained annual fish sampling for mercury since 1993 in support of health-risk fish-consumption advisories. The data from these three programs include a group of samples from 2002 through 2005 with information about mercury deposition, mercury loads, and mercury in fish. The mercury-monitoring data were used to assess if there were any spatial patterns or clusters related to mercury-source inventories and environmental features in Indiana. Mercury-source inventories included stationary emissions to the air and discharges to surface water from wastewater treatment. Environmental features included land cover and land use. The monitoring data and source inventories were organized by watershed and mapped with the environmental features. Watersheds were identified where mercury in fish and mercury loads spatially coincided with mercury sources or certain land cover and land use. These spatial relations were used to evaluate advantages and limitations of the existing locations for mercury monitoring and to identify optimal locations for mercury monitoring.

Mercury Monitoring in California Sport fish: Past, present, and future

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Dr. Davis is Program Manager for the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP). He has worked on contaminant issues in the San Francisco Estuary since 1986. He received his Ph.D. in Ecology at the University of California, Davis in 1997. Dr. Davis is also the principal investigator of the Fish Mercury Project, a $4.5 million project to examine mercury in fish in the Bay-Delta watershed, to increase public awareness of fish contamination issues, and to monitor changes in mercury concentrations from CALFED restoration and remediation projects.

Dr. Grenier has been working in the tidal marshes of the San Francisco Bay estuary since 1999. She received her Ph.D. from the Environmental Science, Policy and Management Department at UC Berkeley, focusing on conservation biology and specializing in tidal marsh animal ecology. Her previous research has included tidal marsh food web structure and the relationship of song sparrow fitness and behavior to tidal marsh sub-habitats. Currently, she continues to study wetlands ecology and the bioaccumulation of contaminants in estuarine food webs, particularly mercury in tidal marsh animals. Dr. Grenier is in charge of monitoring biota in the South Bay Salt Ponds for the South Baylands Mercury Project.

Aroon Melwani received his B.S. in Oceanography with Marine Biology from the University Of Southampton, England in 1998 and his M.S. in Marine Science from Moss Landing Marine Laboratories in 2004. Aroon performed his Master's research on factors influencing benthic infauna at shallow hydrothermal vents and deep-sea cold seeps in California and Mexico. Aroon joined the staff of SFEI in 2004, primarily working on tasks associated with the California Sediment Quality Guidelines and other Contaminant Monitoring and Research.

Abstract
The Fish Mercury Project (FMP), funded by the California Bay-Delta Authority, and the Surface Water Ambient Monitoring Program (SWAMP), funded by the California State Water Resources Control Board, are combining to provide a historic review of sport fish mercury monitoring in California, conduct extensive sampling over the next three years, and develop a long-term strategy for monitoring mercury and other pollutants in sport fish in the future. Extensive gold mining in the Sierra Nevada and mercury mining in the Coast Range of northern California created a legacy of mercury contamination across much of the state.

Historic and recent monitoring supports several general findings. 1) We have a significant mercury problem in the watershed. Several species have mercury concentrations that commonly exceed a 0.3 ppm threshold for human health concern, and frequently exceed the threshold by 3-fold or more. Consumption advisories driven by mercury concentrations are in place for many water bodies in northern California. 2) Significant spatial variation exists in the watershed, including some locations with unexpectedly low mercury. 3) Mercury in the food web appears to have changed little over the long term.

The FMP, in coordination with other efforts, is conducting extensive sampling of mercury in sport fish in the Central Valley in 2005 – 2007. This project also will develop consumption advice for mercury-

impacted water bodies in the Valley and will include a significant risk communication component. Meanwhile, the SWAMP is developing a statewide monitoring strategy for pollutants in sport fish. A preliminary vision of this strategy is of a hybrid monitoring design, with a combination of 1) randomized sampling to allow inferences about areas that have not been sampled and to provide representative statistics on impairment and 2) targeted sampling in support of long-term trend analysis, local assessment of specific management actions, and advisory development.

Mercury in Northeastern North America: A Synthesis of Existing Databases

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Abstract
In late 2000, a group of scientists formed the Northeastern Ecosystem Research Cooperative (NERC) through support from the Northeastern State Research Cooperative (NSRC), a program of the USDA Forest Service, Northeastern Research Station. A main focus of NERC is to encourage joint research projects, the development of ecological networks, sharing of data and results, and participation in the analysis and synthesis of regional environmental issues. NERC was also formed to foster communication among researchers, resource managers, and policy-makers to facilitate science-based policy decisions. One of the NERC projects funded by the NSRC was the compilation and interpretation of mercury (Hg) databases from northeastern North America. We assembled a group of scientists, science managers, and others representing state, provincial and federal governments, universities, cooperative groups, and non-profit organizations. Workshops were organized in the fall of 2001, 2002 and 2003 in greater Portland, Maine, USA. The study region included New York, eastern Ontario, New England, Quebec, and the Canadian Atlantic Provinces (Figure 1). Compilation of Hg databases represented largely freshwater ecosystems and did not include the Great Lakes. Over 70 scientists and policy-makers from the Northeast participated in the initial workshop thereby forming the NERC Hg consortium. Ten workgroups were assembled based on environmental media and analytical approaches. These included Hg in air and precipitation, freshwater sediments, surface waters, plankton, macroinvertebrates, herpetofauna, fish, birds, and mammals. Another group worked on model development. Group leaders were responsible for assembling relevant databases, delegating interpretation and analytical efforts, and organizing manuscripts for peer-review and publication. The subsequent analyses from these workgroups form the 21 original manuscripts in this special issue—Biogeographical patterns of environmental mercury in northeastern North America. The issue is available on-line at: http://www.briloon.org/mercury/index.htm.

A Framework for Monitoring the Response to Changing Mercury Releases

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Biographical Sketch of Lead Author
Michael Murray, Ph.D., is a staff scientist with the National Wildlife Federation, working on scientific and science-policy aspects of mercury and other toxic chemicals in the environment.

Abstract
Mercury is the most common cause of fish consumption advisories in the U.S., and is recognized as a global pollutant. The metal has been the subject of regulatory and voluntary reduction programs for more than a decade in the U.S., including recent promulgation of rules affecting some of the larger source sectors (e.g., coal-fired electric utilities and mercury cell chlor-alkali plants). While there is reasonable certainty about the overall trends in mercury emissions in the U.S. (with an overall downward trend estimated for 1990 – 1999) and to a lesser extent globally, numerous questions remain about how mercury levels in the environment respond to these changes in anthropogenic releases. In response to these challenges, the Society of Environmental Toxicology and Chemistry (SETAC) organized a workshop in September 2003 involving 32 mercury researchers from the U.S., Canada, and Europe. The workshop charge included deliberations in four workgroups (airsheds and watersheds, in-lake chemistry, aquatic biota, and wildlife) to identify suitable chemical and biological indicators for mercury and proposing a network framework to monitor changes in environmental mercury levels in response to changes in emissions (with a focus on North America). Participants utilized a number of cross-cutting criteria for identifying suitable indicators of mercury contamination (including comparable across ecosystems, relatively simple to interpret, and easily sampled and processed and/or already measured as part of existing efforts). A framework involving approximately 10 ecoregions in the U.S. and mercury indicator sampling at both cluster sites and intensive sites (where more involved monitoring would be conducted to help address mechanistic questions) was proposed, with sampling frequencies ranging from weekly (e.g., wet deposition) to annually (e.g., piscivorous fish and wildlife). The development of the framework, which has been outlined (Mason et al., ES&T, 39(1):14A-22A) and will be published in book form (SETAC, 2006) will be discussed.

Texas' Contributions to The National Wadeable Streams Assessment And Future Direction Of The State's Biological Monitoring Program

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Biographical Sketches of Authors

Anne Rogers is an aquatic scientist in the Surface Water Quality Monitoring Program at the Texas Commission on Environmental Quality. She joined the agency in 1992 and specializes in aquatic habitat assessment and assisting in developing the state's biological monitoring program. Anne co-coordinated the agency's participation in the Environmental Protection Agency's National Wadeable Stream Assessment Project and has participated in several large-scale biological monitoring projects in Texas. Anne serves on the Interagency Biological Monitoring Workgroup with the Texas Parks and Wildlife Department, the Texas Invasive Species Council, and the EPA's Tiered Aquatic Life Use for Texas workgroup.

Bill Harrison has been with the Texas Commission on Environmental Quality since 1989. Bill spent four years in the Tyler Office as an environmental investigator and regional biologist. In 1993, he transferred to the TCEQ central office in Austin, and joined the Surface Water Quality Monitoring Team. As a member of the team, Bill has specialized in biological assessments, primarily of benthic macroinvertebrate and fish assemblages. Bill's primary interest is developing methods to allow the use of fish and benthic data to evaluate the effects of pollution and habitat modification on the integrity of instream fish and benthic macroinvertebrate assemblages.

Abstract

For the past 20 years, biological monitoring in Texas has been primarily conducted on water bodies of concern for possible impairment using a targeted approach. In the late 1980s, a statewide biological survey of reference conditions in each of Texas' 12 Level III ecoregions was conducted. In 2004, the EPA requested participation by all states in a national probabilistic survey of biological resources called the NWSA. Because this type of approach is of great interest to the TCEQ, the agency decided to take on this project with existing resources rather than to participate as a grantee.

Due to the enormous size of the state and the diversity within each Level II ecoregion, this project required participation by several entities both within and outside the TCEQ. The TCEQ's SWQM Program coordinated the project with agency personnel in the central office in Austin and with biologists in the TCEQ regional offices, the United States Geological Survey in Austin, Texas, and the Central Plains Center for BioAssessment in Lawrence, Kansas. Due to scale issues with monitoring a state as large as Texas, and based on our past experience with the statewide ecoregion monitoring project, discussions had been ongoing about forming a "virtual" biological monitoring team which could work cooperatively with our regional offices, river authorities, and possible contracted entities in conducting strategic biological assessments to cover the entire state. The NWSA set the stage for future developments in large-scale approaches to monitoring such varied and often difficult to reach waters in the state. The WSA provided a first test for this new "team" and provided the agency with a successful experience with which to move forward in developing a statewide probabilistic approach to biological monitoring.

Validation of a Multimetric Index Using Probabilistic Monitoring Data

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Biographical Sketches of Authors

Larry Willis and Jason Hill coordinate the Virginia DEQ Probabilistic Monitoring Program (ProbMon) and with coauthors George Devlin and Warren Smigo perform most of the design, data analysis and report writing for the program. Larry is a Regional Monitoring Coordinator, Jason is a Regional TMDL Program Coordinator, George is a Regional Biologist and Warren is the biomonitoring coordinator for Virginia.

Abstract

In 2000, EPA contracted TetraTech to develop a multi-metric macroinvertebrate index for the Commonwealth of Virginia. This index contains eight core metrics that are collectively known as the Stream Condition Index (SCI). TetraTech developed the SCI using Virginia's existing biomonitoring database, which mainly consisted of upstream control sites for use with the Rapid Bioassessment Protocols. Reference sites located in the piedmont ecoregions and headwater streams were limited. Using the probabilistic database (n=215) with data collected from 2001-2004, Virginia has validated the SCI using this spatially diverse (ecoregionally and stream size) data set. This probabilistic data set allowed Virginia to fill the data gaps and the test proposed reference condition by stream size, ecoregion, river basin, regional office, sampling technique and best standard values. The random data has the unique ability to help policy makers preview the amount of streams that will be impaired to help determine assessment guidelines.

A Comparison of Biological Methods for Macroinvertebrate Collection in Missouri Streams

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Biographical Sketch of Author

Shane Dunnaway is a resource staff scientist for the Missouri Department of Conservation (MDC). He has spent the last two years, with resource scientist Matt Combes and resource staff scientist Bill Mabee, implementing Missouri's portion of the WSA project. Before coming to MDC in July 2004, Shane received his Master's degree in Biology from Missouri State University in August 2003 and has worked on several field crews sampling fish, macroinvertebrates and water chemistry mostly in Missouri's Ozark streams.

Abstract

The EPA initiated the Wadeable Streams Assessment (WSA) program to assess the condition of wadeable streams throughout the United States, as well as Guam and Puerto Rico, based on physical, biological and chemical features, with a goal of helping water quality agencies understand stream conditions over time. Sample site selection was determined from a probability-based design used to select a random sample of streams in regions sharing ecological characteristics across thirty-four states. (This had previously been done in Western states between 2000 and 2004.) As a cooperator in this assessment, The Missouri Department of Conservation (MDC) sampled twenty-four sites in Missouri between 27 July and 9 November, 2004. At each site, macroinvertebrates were collected using both the WSA method and Missouri's state method. In addition, all sites sampled prior to September 15 were re-sampled between September 15 and October 15 using only the Missouri method (according to Missouri's SOP). Benthic macroinvertebrate communities have long been used as a bio-monitoring tool to help assess the ecological condition of water bodies. The focus of this presentation is to compare the WSA macroinvertebrate collection method with Missouri's macroinvertebrate collection method. Both the WSA and Missouri collections were processed at MDC's Resource Science Center Aquatic Macroinvertebrate ID/wet-lab. Macroinvertebrate identifications have been completed and data analysis is nearly complete. Initial findings show that the results produced by the WSA collection method are significantly different from the results produced by the Missouri method, with the WSA method generally underestimating the condition of the stream relative to Missouri's method.

Comparability of Macroinvertebrate Collection Methods in Oklahoma's Low Gradient Streams

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Biographical Sketches of Authors

Monty Porter has been with the OWRB since December of 1997. As Streams/Rivers Monitoring Coordinator, he manages all activities related to stream and river monitoring for the OWRB including fixed station monitoring for trends and status, special studies, biological monitoring programs, and stream gaging. He also represents the Board on several state and regional workgroups and committees with activities related to standards development, use assessment analysis, interstate monitoring coordination, and development of standardized field procedures. Monty received a BS in Biology from the University of Central Oklahoma (UCO) in 1994 and an MS in Biology from UCO in 2005.

Jason Childress has been with the OWRB since May of 2004. As the Biological Monitoring Team Leader, he coordinates the probabilistic monitoring program as well as other biological monitoring in support of other programs. Jason is an active member of the American Fisheries Society and has provided technical expertise in the revision of Oklahoma's wadeable RBP. Jason received a BS in Environmental Health Science and Biology from East Central University in Ada, Oklahoma and a MS in Fisheries and Aquatic Sciences from the University of Florida.

Abstract

Oklahoma has a broad diversity of aquatic habitats with twelve Level III and forty-seven Level IV Omernick Ecoregions currently designated. With this diversity, a variety of habitat conditions are present in the state's lotic waters, and additionally a variety of low-gradient streams may be found throughout the state. As would be expected, this assortment of habitat leads to a high diversity of aquatic organisms. Adequately characterizing the benthic community can be difficult. In 1999 (updated 2006), Oklahoma water quality monitoring agencies developed a rapid bioassessment protocol (RBP) that could be used across the state to make comparable assessments in similar waterbodies. The protocol targeted the richest habitats for macroinvertebrates and used various measures of the both in-stream and riparian characteristics to quantify habitat. In 2004, Oklahoma participated in the USEPA's National Wadeable Streams Assessment. In addition to monitoring at nineteen randomly targeted and ten non-random reference sites, Oklahoma collected data for both a habitat and benthic macroinvertebrate methods comparability study using protocols from both the USEPA Western Environmental Monitoring Assessment Program (W-EMAP) and Oklahoma's RBP. The study showed a low level of comparability between Oklahoma's RBP methodology and W-EMAP methodology. Looking at the community structure and taxa composition of the paired samples may help elucidate the causes of low comparability. Furthermore, several factors including unforeseen environmental conditions and an inadequate temporal coverage, may have confounded comparability results. One of the more positive outcomes of any comparability study is the potential ability to amass various data sets to use in a single analysis. This is beneficial on multiple scales including state, regional, and national studies, and a repeat of this study in areas such as low gradient streams would be beneficial.

The SWAMP Advisor - a New Tool for Producing Consistent and Comprehensive Quality Assurance Project Plans (QAPPs)

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Biographical Sketches of Authors
Dr. Keith is president of Instant Reference Sources, Inc. and has 40 years experience as an environmental chemist. He has worked for U.S. EPA, Radian International, and has taught environmental QA/QC courses in Asia, Australia, Europe, South America and throughout the United States and Canada. He is currently developing expert systems for the U.S. EPA's Water Security Division and California's State Water Resources Control Board.

Dr. Katznelson has over 30 years of experience in performing, interpreting, and assuring quality of field and laboratory analyses of chemical, biological, toxicological, and bacteriological water quality characteristics. She has also been involved in preparing and teaching a number of specialized courses in ecology and in environmental monitoring. She is currently implementing her experience in the development of distance learning tools and expert-system educational materials.

Ms. van Buuren is manager of the Quality Assurance (QA) Research Group at Moss Landing Marine Laboratories (MLML). She is the QA Officer for the SWAMP and CBDA Mercury Studies programs. She has designed and taught QA courses for the Northwest Environmental Training Center, the Washington State Department of Ecology, and for project/program-specific applications in the classroom, laboratory and field.

Abstract
An expert software system named the SWAMP Advisor is being developed for the State of California's Surface Water Ambient Monitoring Program (SWAMP). This new software will lead users through the complex planning and decision-making process involved with preparing effective Monitoring Plans and Quality Assurance Project Plans (QAPPs). While doing so, it will educate the user as to the importance and usage of the QAPP contents that it requests - in fact, the SWAMP Advisor is a very effective training tool for distance learning. The end result is a draft QAPP produced in less time and is immediately ready, with minor edits, for submission to program administrators.

The SWAMP Advisor utilizes pop-up definitions, dual screen panels, and a unique, three-tiered system of information delivery. The three degrees of information delivery are at: 1) an executive level, 2) a detailed information level, and 3) a research level, with links to documents and web sites from the State of California and United States Environmental Protection Agency (EPA). It also enables development of multiple "study questions" (lines of inquiry) and it incorporates all twenty-four elements described in the EPA document "Guidance for Quality Assurance Project Plans" (EPA QA/G-5). These 24 elements have been augmented with materials needed to address the State of California's SWAMP requirements. After implementation of this software within SWAMP, it may be modified for use by other California programs or even by other States and organizations.

Continuous Nitrate Concentration Data From a Small Agricultural Ditch In Indiana: Relationship To Stream Flow And Inferences To Biological Processes Affecting Nitrogen Cycling

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Biographical Sketch of Author
Tim Lathrop is a hydrologist with the USGS Indiana Water Science Center. Primarily, Tim has been involved with data collection and analysis for the National Water Quality Assessment project. He has played various roles with both the Agricultural Chemicals: Sources, Transport, and Fate (ACT) and the Effects of Nutrient Enrichment on Stream Ecosystems (NEET) topical teams. Additionally, Tim led data collection and analysis for Indiana's Source Water Quality Assessment study and for a nutrient and chlorophyll analysis study teamed with the Indiana Department of Environmental Management.

Abstract
Typical surface-water quality sampling regimes collect samples for nutrient analysis on a daily, weekly, monthly, or less frequent basis. Nutrient concentrations, specifically nitrate, can vary hourly in streams, however as a result of changes in stream flow (runoff) and biological process. The U.S. Geological Survey worked with YSI, Inc. to collect continuous nitrate data in water in a small agricultural ditch in east central Indiana during 2004 using an in-situ nutrient analyzer. Concurrent water samples were collected and analyzed for nitrate by an off-site laboratory to assess the accuracy of the continuous nitrate data. Nitrate concentrations during the study period rose with increased ditch flow, which reflected contributions from nitrate sources in the watershed. In addition, nitrate concentrations in the ditch fluctuate diurnally during lower flow conditions. The diurnal nitrate concentration changes were small, less than one milligram per liter; however, the pattern was consistent throughout the study period, being highest during the day and the lowest at nighttime. In-stream photosynthesis and respiration can produce diurnal fluctuations of dissolved oxygen. Specifically, photosynthesis during the day produces higher dissolved oxygen levels, while nighttime respiration consumes oxygen. If in-stream biological processes dominate a system, then nitrate fluctuations should inversely follow the dissolved oxygen diurnal changes. However, the small diurnal nitrate changes found in this stream appear to be the opposite of what would be expected of an in-stream process dominated system. These small changes in nitrate concentrations in the ditch suggest that benthic processes dominate nitrogen cycling in this ditch during low flows.

Use of Trace-Level Cyanide Method to Determine Attenuation of Discharged Cyanide in Lower South San Francisco Bay

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Biographical Sketches of Authors
Peter Schafer has been employed as a Biologist for the City of San Jose for the past 11 years. He works in the Watershed Investigations group which conducts fieldwork in Lower South San Francisco Bay (LSB) and reviews and analyzes technical issues concerning the San Jose/Santa Clara Water Pollution Control Plant's discharge to LSB. He has 15 years of toxicity testing experience including study of the toxic effects of cyanide on fish.

Alo Kauravlla is a Research Microbiologist with the City of San Jose Environmental Services Department Laboratory. She has over 13 years experience, working on a variety of projects involving the design and implementation of research activities for optimization of analytical methods for water and wastewater at the City's Laboratory and providing scientific consultation on water quality and regulatory issues. Together with co-author Peter Schafer, she provided support to the Bay Area Clean Water Agencies' effort to develop an attenuation factor and associated compliance strategy for San Francisco Bay area shallow-water dischargers.

Abstract
The City of San Jose Environmental Services Department Laboratory developed a low-level (trace) method for the determination of total cyanide in 2004 to achieve the detection limit of less than 0.5 ppb needed to evaluate compliance with the EPA's cyanide criterion of 1 ppb for saltwater. The standard method used for monitoring of cyanide (SM 4500-CN B, C & E) for NPDES permit compliance was modified to measure total cyanide levels in the San Jose/Santa Clara Water Pollution Control Plant's (Plant) discharge and in the receiving water. Modifications included increased distillation time and concentration factor, use of a 10 cm cell for color determination, and use of nitrogen as the carrier gas. These modifications resulted in a method detection limit of 0.06 ppb for Bay water and practical quantitation limits of 0.3 and 1.0 ppb for Bay water and final effluent, respectively.

Holding time experiments indicated that the standard method retention time was acceptable. A preliminary evaluation of approved sample preservation techniques using sodium hydroxide as a preservative demonstrated an increase in the measured cyanide concentration when compared to samples that were unpreserved and analyzed immediately upon collection.

The trace cyanide method was used to track total cyanide concentrations from the Plant's discharge to 13 receiving water locations from July 2003 to September 2004. Total cyanide concentrations in the receiving water did attenuate with increasing distance downstream of the Plant. Mean cyanide concentrations decreased from 2.9 ppb in the Plant's discharge to 1.6 ppb at the mouth of Artesian Slough. Eight LSB stations had a mean cyanide concentration of 0.3 ppb during the study, and no single measurement for these stations (n=112) exceeded the EPA cyanide criterion of 1.0 ppb.

Median "Attenuation Factors" for two successive Coyote Creek stations nearest the Plant were 2.24 and 4.50.

Identifying Greener Analytical Methods in NEMI for More Environmentally Friendly Monitoring

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Biographical Sketches of Authors
Dr. Young has worked at the ACS Green Chemistry Institute (GCI) since 2004, where she focuses on the development and promotion of research resources to aid chemists and engineers in implementing green chemistry and engineering. Her other past research experiences include laboratory research on green chemistry/polymers at the University of North Carolina at Chapel Hill (1995-2000) followed by industrial polymer research for water-based ink jet inks at DuPont (2000-2004). Jennifer works under the direction of Dr. Anastas, the Director of GCI, who has served as Assistant Director for the Environment in the White House Office of Science and Technology Policy and as the Chief of the Industrial Chemistry Branch at the EPA.

Dr. Keith is president of Instant Reference Sources, Inc. and has 40 years experience as an environmental chemist. He has worked for U.S. EPA, Radian International, and has taught environmental sampling and analysis courses in Australia, Europe, Hong Kong, Taiwan, South America and throughout the United States and Canada. He is a past co-chair of the NEMI Workgroup and a member of the Methods and Data Comparability Board.

Abstract
The ACS Green Chemistry Institute (GCI) has initiated a new project to actively define, identify, and promote analytical chemistry methods that use fewer harmful solvents, use safer chemicals, and prevent waste. GCI has led the efforts with the Methods and Data Comparability Board (MDCB) to define metrics and rules to rate the "greenness" of analytical methods and is applying these rules to the over 800 methods in the National Environmental Methods Index (NEMI; www.nemi.gov).

Green Chemistry strives for the prevention of the use and/or generation of hazardous chemicals. GCI is a non-profit organization, founded in 1997 and allied with the American Chemical Society in 2001, whose mission is to advance the implementation of green chemistry principles into all aspects of the chemical enterprise. Of the 12 Principles of Green Chemistry*, the following abbreviated principles may be most applicable to identifying "greener" analytical methods: prevent waste, design safer chemicals and products, use safer solvents and reaction conditions, increase energy efficiency, avoid chemical derivatives, analyze in real time to prevent pollution, and minimize the potential for accidents (*reference: Anastas, P. T. and Warner, J. C. *Green Chemistry: Theory and Practice*, Oxford University Press: New York, 2000). In addition, the aspects of an analytical method that have the most affect on whether the method is "greener", and that will be the focus of the selection criteria (business rules) for identifying "greener" methods, include: sample preparation, reagents, solvents, preservatives, energy, and waste.

GCI is extracting specific data including chemical use and waste generation from all of the full analytical methods currently in NEMI. After applying "greenness" rating rules to this data, the "greenness" rating information is put back into NEMI. As a result, when multiple methods in NEMI are evaluated, the methods' performance criteria and "greenness" ratings can be easily identified and compared. Other applications and future directions of the project may include the development of a teaching module, evaluation and rating of other types of analytical methods, identification of areas in which greener methods are needed, and guidance on how to make an analytical method greener.

Data Management and Databases: Capturing, Storing, and Managing Data for Success in Monitoring Programs

Trainers
Lynette Seigley, Water Resources Board of California
Revital Katznelson, California State Water Resources Control Board
Kristine Stepenuck, University of Wisconsin Extension and Wisconsin Department of Natural Resources

Biographical Sketches
Lynette received her B.A. in geology from the College of Wooster, Ohio and her M.S. in geology from the University of Iowa. Since 1987, she has worked as a research geologist for the Iowa Department of Natural Resources on a variety of projects addressing the impacts of nonpoint source pollution on surface water and groundwater. Since January 2000 she has been working on the state's water monitoring program to collect data on Iowa's resources to assess water quality and trends over time. She also assists in training volunteers across Iowa as part of IOWATER, Iowa's volunteer water monitoring program.

Dr. Revital Katznelson has many years of experience in environmental research, including collection, documentation, quality assurance, and interpretation of monitoring data. In recent years she has developed and implemented a Data Quality Management system that can be used by small monitoring groups for data capture and documentation, as well as for communication of what the data represent in the environment. She has also been involved in preparing and teaching a number of specialized courses in ecology and in environmental monitoring. She is currently implementing her experience in the development of distance learning tools and expert-system educational materials.

Kristine Stepenuck received her B.S. in Water Resources Management from the University of New Hampshire and her M.S. in Natural Resources from the University of Wisconsin-Stevens Point. Since 2001 she has been the coordinator of Wisconsin's volunteer stream monitoring program. She also serves as a staff member on a USDA funded project with the University of Rhode Island Cooperative Extension which is designed to help increase coordination and communication among volunteer water quality monitoring programs across the nation.

Short Course Description
Revital Katznelson from the State Water Resources Board of California, and Lynette Seigley from the Iowa Department of Natural Resources and the IOWATER Volunteer Water Monitoring Program will lead this short course which is designed to build participants' knowledge about data capture, storage and management for any monitoring program.

Katznelson will discuss scale, limitations, advantages, and requirements of several database options - from paper copies to Excel spreadsheets, to Access, Oracle and online databases.

Seigley will lead participants through the steps followed to plan and implement the IOWATER Program's online database and will share lessons learned during the development process. She will demonstrate this online database for participants, focusing on its storage and display features; These features include storage of monitoring data, digital images, and for Geographic Information System data to be delivered to an individual's desktop through AcrIMS, an Internet mapping system.

Data Capture, Quality Management, and Storage Tools for Citizen Monitoring Groups

Revital Katznelson

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Biographical Sketch of Author

Dr. Katznelson has many years of experience in environmental research, including collection, documentation, quality assurance, and interpretation of monitoring data. In recent years she has developed and implemented a Data Quality Management (DQM) system with data capture and validation tools for field operators, trainers, and technical leaders of monitoring projects. In 2004 she created a template DQM file for transfer of field measurement data collected by a watershed group into STORET, working in close collaboration with the developers of the STORET Interface Module (SIM).

Abstract

Most agencies provide adequate support, including appropriate tools and committed expertise, for the processes of generating, documenting, managing, and using monitoring data. These resources are essential to enable the four major functions of any data management system, namely: (1) documentation and quality assessment, (2) data storage & sharing, (3) data retrieval, and (4) data interpretation and presentation. On the other hand, Citizen Monitoring Groups often operate at a local scale, with limited resources and with little Information Technology (IT) savvy or support. Many groups retain and store their data and/or metadata on hardcopy data sheets, and use electronic formats only for the data items that are needed to generate graphs and reports. However there are several data capture and management systems available to groups. These systems are based on computers and software found in most households, and require minimal resources and expertise. Electronic options for small-scale operations include spreadsheets (e.g., MS Excel) and desktop-scale databases (e.g., MS Access). Large databases residing on an Oracle platform can be used by agencies but usually not by small groups. This paper presents a matrix that shows the scale, limitations, and requirements of each option and discusses how they relate to the four basic functions of a data management system. The advantages and disadvantages of each option in relation to web based data presentation and data exchange systems are discussed as well.

ACWA (Alaska Clean Water Action) Program and Web-based Tool for Managing Alaska's Waters

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Biographical Sketches of Authors
Dianne Denson is an Analyst/Programmer with the Division of Water within the Alaska Department of Environmental Conservation (DEC). She has training in Environmental Sciences as well as in computer programming. She served as the project development manager for the ACWA project and was responsible for the migration of data from the previous ACWA 'manual' systems into the new database. Dianne is also the key contact for Alaska DEC's STORET (STOrage & RETrieval), a water quality database designed and maintained by EPA.

Jeff Hock is the Acting Program Manager for the Division of Water's Water Quality Assessment & Monitoring Program within the Alaska Department of Environmental Conservation. He has training in Engineering and Environmental Sciences and, since 2002, has facilitated and sponsored the workgroup planning, design and implementation of ACWA across three State resource agencies. Mr. Hock has almost 30 years of Alaska experience with field project planning, design and implementation; laboratory and field analysis; data management; water quality interpretation and assessment; and program management.

Abstract
This presentation describes the Alaska Clean Water Actions (ACWA) program and the new web-based tool for managing Alaska's waters.

The ACWA program and tool allow the State to focus limited resources on managing the highest priority waterbodies. ACWA agencies develop comprehensive information about Water Quality, Quantity & Aquatic Habitat to better understand what is needed for healthy waters.

Three State agencies -- Environmental Conservation (Quality), Natural Resources (Quantity), Fish & Game (Habitat) were designated the coordinating agencies for developing and implementing the ACWA process. These agencies:

- **a) Prioritize** waterbodies to direct funding and actions where they are most needed,
- **b) Coordinate** the state's water resource programs to eliminate redundancies,
- **c) Identify** gaps in the program, and adequately address them.

The ACWA web-based tool consists of three key functions:

- **a)** Nomination – allows the public or agency personnel to nominate waterbodies for monitoring, at-risk, or recovery,
- **b)** Analysis, Scoring and Ranking – provides a means for State agency personnel to
  1. asses the waterbody information to determine how sufficient and credible it is,
  2. analyze the information available for a nominated waterbody,
  3. rank the waterbody using selected quantity, quality, and habitat criteria.
- **c)** Actions – captures actions assigned to waterbodies for recovery, protection, and/or monitoring.

The ACWA application also provides reports that agency personnel can use to actively track and manage waterbodies. This presentation will describe how ACWA works and the how it was developed.

Integrating Historical and Real-Time Monitoring Data into an Internet-Based Watershed Information System for the Bear River Basin

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Biographical sketches

David is a Professor in Civil and Environmental Engineering and a researcher at the Utah Water Research Laboratory at Utah State University, a land grant Carnegie I research university. He has over 20 years of experience in many facets of Environmental Engineering, of which over 10 years have been spent specifically in the area of watershed water quality management. His expertise includes surface and ground water quality modeling, monitoring, and decision support. He has developed or supported development of a number of tools for managing, analyzing, and communicating water quality monitoring data for researchers, regulators, consultants and stakeholders. Jeff has worked for the past five years at the Utah Water Research Laboratory at Utah State University in the areas of surface water quality, watershed management, and decision support. Trained in Environmental Engineering with an emphasis in surface water quality, he is working to create stand alone and Internet based tools for managing, analyzing, and disseminating water quality and watershed related data. Mr. Horsburgh's professional experience includes projects providing technical support for development of Total Maximum Daily Loads, water quality data management and analysis, surface water quality model selection and development, information dissemination to stakeholders, and integrated watershed management planning.

Abstract

As part of an EPA Targeted Watersheds Grant effort, Utah State University is developing an Internet-based Watershed Information System (WIS) for the Tri-State Bear River Basin in Utah, Idaho, and Wyoming. One objective of the WIS is to provide unprecedented access to data and information to stakeholders and water quality managers in a watershed where information and data sharing has been hampered by state, jurisdictional, and administrative boundaries. As part of this project, there is a major ongoing effort to compile and make available via the WIS all existing and historic water quality, streamflow, and climate monitoring data relevant to the watershed. In addition, the Internet-based WIS will provide users with a central location to access real time data being generated by several monitoring organizations in the watershed. This presentation will focus on the technology being developed at Utah State University to address the challenge of sharing both historical and real time data over the Internet.

Web-based Data Sharing for Small Watersheds

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Biographical Sketch of Author
Lisa Walling has a Bachelor's degree in Biology from Stanford University, and is currently a graduate student at the Goldman School of Public Policy, U.C. Berkeley. She worked as a summer intern for the City of Palo Alto to design and construct this web-based tool. She is interested in California marine and water policy, and science policy.

Abstract
With the help of USGS and others, the City of Palo Alto and the San Francisquito Watershed Council have developed a web-based tool for sharing water quality data among employees, volunteer streamkeepers, and interested community members. To view the site, please follow this link: <http://www.cityofpaloalto.org/cleanbay/creeks/>. The website contains data about four small watersheds in the Palo Alto, California area: San Francisquito, Matadero, Adobe, and Barron. To access graphs and tables of water quality and observation-based data, the user clicks through a series of progressively more detailed maps. In addition, still pictures and "virtual tours" (360° views) show sampling locations visually. Several issues constrained the design and utility of this website, such as resource limitations, the absence of quality control for certain types of data, and perceived needs for interpretation of the data before making it publicly available. In the future, The City of Palo Alto and the San Francisquito Watershed Council plan to expand the functionality of this website to include secure, real-time data sharing among streamkeepers and employees.

Displaying Water Quality Data on Internet Maps

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Sandy Williamson is team leader of the (NAWQA) National Data Team, composed of people across the country maintaining and developing new data base and mapping tools on the web. He has worked for the USGS for 30 years, previously in Austin, Texas, and Sacramento, California, doing flood studies, regional ground water modeling and water quality studies. He has a M.S. in Civil Engineering-Water Resources from California State University, Sacramento (1981), and a B.S. in Applied Geomorphology from Western Washington State University (1976). His interests are in web-based presentations of scientific studies, data, and mapping, risk in environmental decision making, and effective use of statistics.

Nate Booth is an information technology specialist with the U.S. Geological Survey. Since 1999 he has managed development of the National Water Quality Assessment (NAWQA) Data Warehouse system including database infrastructure, analytical applications and web products. Since 1997, he has co-developed the capacities of the USGS Middleton Data Center to include a robust array of enterprise software and hardware that run various state and national analytical information systems. His main interest is in leveraging commercial information management tools and methodologies to improve scientific research capacity and efficiency. He has a B.S. in Civil Engineering from University of Wisconsin (1998).

Abstract

The U.S. Geological Survey has linked its mapping resources (http://nationalmap.gov) to its national water quality data (http://water.usgs.gov/nawqa/data). This allows selection from about 600 chemical constituents and maps the results over variable scales and areas, along with real-time selection among dozens of background maps. The application brings much GIS functionality to a web browser and can be operated with very little or no training. Data can be searched and exported to Excel or Google Earth. Map data points can be clicked to see site information and more.

The NAWQA (National Water Quality Assessment) program began in 1991. In 1999 NAWQA developed a data warehouse (DW) adding public access and internet mapping over the years of development. The DW currently contains and links the following data from 45 study units:

- Chemical concentrations in water, sediment, and aquatic organism tissues
- Biological data on stream habitat and community data on fish, algae, and invertebrates
- Site, well, and network information associated with thousands of descriptive variables derived from spatial analysis, like land use, soils, population density, etc.
- Daily streamflow and temperature information for repeated sampling sites

These data were collected at about 7,600 stream sites and 8,100 wells selected to be indicative of various land uses. In addition to about 48,000 nutrient samples, 30,000 pesticide samples were collected from the water as well as 2,600 samples from sediment and tissue, which were analyzed for hydrophobic compounds. Most pesticide, sediment, and tissue samples were analyzed for over 40 different compounds. At many of the same stream sites, the ecological data listed above were collected. Collectively, they represent over 10 million records in the DW.

Oklahoma's Beneficial Use Monitoring Program (BUMP) – Results, Lessons Learned, and Future Directions

Bill Cauthron, Julie Chambers, and Monty Porter

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Biographical Sketches of Authors
Mr. Cauthron works for the Oklahoma Water Resources Board where he serves as the Water Quality Monitoring Program Coordinator in the agency's Water Quality Division. He oversees the operation of the Monitoring & Assessment Section. Bill has worked for the Water Resources Board since 1987 and during his tenure has assisted with streams technical studies, conducted Clean Lakes Studies and overseen the Agencies Lake Water Quality Assessment Program. He received his Bachelor of Science in Biology from East Central University and his Masters in Public Health from the University of Oklahoma Health Sciences Center.

Julie Chambers has worked at the Oklahoma Water Resources Board since 1999 in the Water Quality Division. As the Lakes Monitoring Coordinator for the Board, she manages all activities related to the statewide lakes monitoring and assessment program which assesses the health of approximately 130 of the state's largest lakes and reservoirs. Julie also serves on several state technical workgroups related to assessment of lakes and field protocol development. Julie graduated from the University of Central Oklahoma in 1995 with a BS in Biology.

Monty Porter has been with the OWRB since December of 1997. As Streams/Rivers Monitoring Coordinator, he manages all activities related to stream and river monitoring for the OWRB including fixed station monitoring for trends and status, special studies, biological monitoring programs, and stream gaging. He also represents the Board on several state and regional workgroups and committees with activities related to standards development, use assessment analysis, interstate monitoring coordination, and development of standardized field procedures. Monty received a BS in Biology from the University of Central Oklahoma (UCO) in 1994 and an MS in Biology from UCO in 2005.

Abstract
This past year marked the seventh year of Oklahoma's Beneficial Use Monitoring Program (BUMP). The BUMP is Oklahoma's statewide water quality monitoring program, which assesses the state's many lotic and lentic resources. The data collected is compared to water quality standards using Oklahoma's Use Support Assessment Protocols (USAP) to determine if the beneficial use(s) assigned to the waterbody are being met. Results are compiled into the yearly BUMP Report to the Oklahoma Legislature and are included in Oklahoma's Integrated Water Quality Assessment Report. Furthermore, adequate data has been collected to begin assessing trends across the state. The lakes component of BUMP continues to monitor approximately 130 of the larger lakes and reservoirs across the state. Currently 65 lakes and reservoirs are sampled quarterly on a biannual basis. At multiple sites on each lake, nutrient and minerals samples are collected at the lake surface and vertical profiles for made for various *in-situ* parameters. Chlorophyll-a samples are collected to assist in determining productivity and lake trophic status using Carlson's TSI. Additionally, the program annually monitors 100 stations on various rivers and streams throughout the state. Data are collected 8-12 times per year and include nutrients, chlorophyll-a, minerals, *in-situ* data, bacteria, and instantaneous flow and stage. Toxicants data are also collected on an irregular basis. In addition, biological samples are collected at each station over time. The program continues to adapt, diversify and grow. The broad-based nature of the program has allowed the program to be integrated into various short-term projects with more specific goals. In addition, the monitoring strategy is continually tweaked to meet ever-evolving management needs and fluctuating fiscal circumstances.

Lock ‘um in a Room, Hawaii’s Attempt to Achieve Comparability

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Linda Koch is an environmental specialist with the Hawaii State Department of Health, Environmental Planning Office. With an extensive water chemistry and biology background, she has served as the State’s Bioassessment/303d Listing coordinator since 2003. In addition to conducting bioassessment protocols in the field, she is working on developing Biocriteria for the unique Hawaiian environment for inclusion into the State’s Water Quality Standards.

Katie Kamelamela is a Hawaiian Internship Program (HIP) Intern with University of Hawaii at Manoa, currently pursuing Bachelors in Botany and Hawaiian Studies. She has been working with the Hawaii State Department of Health, Environmental Planning Office since 2004. Projects outstanding include designing and operating a temperature monitoring network as well as leading a volunteer water quality monitoring campaign for Kaelepulu, Oahu. Interests include integrating cultural knowledge and science in education, ethnobotany of native Hawaiian plants and cultural/traditional lifestyles.

Abstract

Multiple interests (under multiple institutional frameworks) share responsibility for protecting Hawaii stream ecosystems. These differences in interest, framework, and responsibility have generated a multitude of ecosystem monitoring and assessment techniques.

As overall efforts expand, comparability among and integration of these techniques deserves greater attention. Additionally, many complex ecological and bureaucratic processes interact to create issues and roadblocks. Some examples include invasive species, altered habitat, dewatering of surface streams, changing land use, as well as, water quality standards rigidity and differing weighted metrics within protocols.

This paper touches on the various protocols now used in Hawaii, problems inherent, and plans of data integration and quality control for the future. Hawaii seems ready for a consolidation of efforts by creating a collaborative council for monitoring and assessment.

Data-Driven Decision-making: Enhanced use of Data Quality Objectives in New Hampshire's Comprehensive Water Monitoring Strategy

Paul Currier

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Biographical Sketch of the Author

Paul Currier is the Administrator of the Watershed Management Bureau at the New Hampshire Department of Environmental Services. He is a registered professional civil engineer and geologist with training in hydrology. Programs under his supervision include statewide surface water monitoring, beach and shellfish monitoring, instream flow protection, TMDL water quality modeling, and Nonpoint Source Programs. He is the Region I state representative to the National Water Quality Monitoring Council and a principal author of the New Hampshire Water Monitoring Strategy.

Abstract

Too often public water management decisions are made without clearly framing the issue and without a good understanding of the problem, even if pertinent monitoring data already exist. During strategic planning to develop a watershed approach and a comprehensive statewide monitoring strategy, the New Hampshire Department of Environmental Services developed a data-driven decision making process for water management issues based on EPA guidance for Data Quality Objectives. This process, now incorporated into the New Hampshire Water Monitoring Strategy, is used to communicate an issue, identify the needed monitoring data, and describe how the data will be analyzed to address the issue. Data-driven decision making has three underlying principles: water quality management decisions should be data-driven and framed on a watershed basis; the purpose for collecting data should be clearly understood, and data should be accessible and interoperable with documented metadata. Virtually all monitoring projects have Quality Assurance Project Plans (QAPPs), so the QAPP is a good place to record the results of a data-driven decision making process for project design. This process has been incorporated into guidance for New Hampshire watershed approach pilot grants under the 319 nonpoint source program, and is now the basis for water quality assessments under 305(b) and 303(d). We are implementing the process for all surface water monitoring programs, even those with a long prior history, and are reaching out to other monitoring organizations to encourage their involvement as well.

Navajo Nation EPA Water Quality Standards and Water Quality Sampling

Eric Rich

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Eric Rich is a Senior Hydrologist in the Water Quality Program within the Navajo Nation Environmental Protection Agency (NNEPA). Since 1999 he has been overseeing Navajo Nation surface water quality sampling activities and has also been implementing the water quality standards program. For the past 16 years Mr. Rich has worked as a hydrologist and geologist in both regulatory and consulting capacities.

Abstract

The Navajo Nation is the largest Native American community in the United States and with a landmass of 17,627,262 acres, it is approximately the size of West Virginia. Surface waters of the Navajo Nation are located in the San Juan, Rio Grande, Little Colorado River, Lower Colorado River, and Upper Colorado River Basins. There are 31 watersheds within the Navajo Nation in these basins. Surface waters range from mountain lakes and streams to ephemeral desert washes. There are approximately 39,000 miles of streams, mostly intermittent or ephemeral, and 17,000 acres of lakes/ponds on the Navajo Nation. The NNEPA Water Quality Program samples surface waters in these watersheds annually. Historically surface water was the primary source for drinking water in the Navajo Nation (now the primary drinking water source is ground water). Surface water currently is a dependable water source for farming and livestock production, and plays a significant role in Navajo culture. The goal of surface water sampling activities is to obtain water quality data and compare it to the Navajo Nation Surface Water Quality Standards to determine designated use support. Impacts to surface water quality result from coal mining, energy production, roads, trash dumping, grazing, agriculture, uranium mining/milling and other sources. This presentation will focus on the relationship between water quality standards and water quality sampling.

Screening-Level Assessments of Public Water Supply Well Vulnerability to Natural Contaminants

By Stephen Hinkle[1], Mary Ann Thomas[2], Craig Brown[3], Kathy McCarthy[1], Sandra Eberts[2], Leon Kauffman[4], Michael Rosen[5], and Brian Katz[6]

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Biographical Sketches of Authors
All eight authors are hydrologists with the USGS. They have worked on numerous water-quality and water-quantity projects at local, regional and national scales, focusing on topics such as anthropogenic and natural contaminant source and fate, flow and transport modeling, ground-water age-dating, nutrient cycling, and many other topics. The authors are part of a larger team of USGS National Water-Quality Assessment Program hydrologists currently studying factors affecting the transport of natural and anthropogenic contaminants to public water supply wells at multiple scales.

Abstract
Geochemical data and ground-water flow models (particle tracking) were used to identify process-based variables for use in quantitative screening-level vulnerability assessments for uranium and arsenic in public water supply wells. These results, from eight USGS National Water-Quality Assessment Program study areas in principal aquifers, demonstrate an approach that can be undertaken with existing tools and data and applied to these or other natural contaminants. Such assessments may be useful for prioritizing locations and types of more refined vulnerability assessments.

Principal components analysis suggests that uranium is associated with oxidizing water, and arsenic with both oxidizing and reducing water. These statistical relations are consistent with the geochemistry of these elements: uranium generally is mobilized under oxidizing conditions but attenuated under reducing conditions, whereas arsenic can be mobilized under both oxidizing and reducing conditions.
Spearman correlation analysis of variables from particle-tracking simulations indicates that uranium is positively correlated with variables that represent (1) overall ground water time-of-travel (TOT), (2) TOT through oxidizing regions, and (3) water fluxes to wells from oxidizing regions. Uranium also is inversely correlated with variables representing TOT through reducing regions. TOT may be an important variable because many geochemical reactions are kinetically limited. Arsenic was positively correlated with variables representing overall TOT, but correlations with redox TOT variables were ambiguous in the combined (eight aquifer) dataset, likely resulting from the presence of both oxidizing and reducing arsenic mobilization processes.

Classification tree analysis (a nonparametric method in which data are partitioned recursively into increasingly homogeneous subsets, similar to dichotomous classification keys) on arsenic concentrations yielded a quantitative categorical model using two TOT variables and a variable representing solid-phase arsenic concentrations. The classification tree model accuracy on the learning data subset was 70%, and on the testing data subset, 79%, demonstrating the usefulness of TOT variables in vulnerability assessments.

Probability of Detecting Atrazine/Desethyl-atrazine and Elevated Concentrations of Nitrate in Ground Water in Colorado

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From 1991 through 1999, Michael served as a hydrologist with the U.S. Geological Survey in their Boise, Idaho office. Michael's primary topics of interest included developing models that predict the probability of ground-water contamination by agricultural chemicals using multivariate statistical techniques, and using ground-water age dating and geochemistry to quantify the impacts of agricultural activities to ground-water quality. Since 1999, Michael has been working in the Pueblo, Colorado USGS office where he has continued to develop models predicting the probability of ground-water contamination, and assessing the trends of nitrate in ground water in the United States.

Abstract

Draft Federal regulations may require that each State develop a State Pesticide Management Plan for the herbicides atrazine, alachlor, metolachlor, and simazine. Maps were developed that the State of Colorado could use to predict the probability of detecting atrazine and desethyl-atrazine (a breakdown product of atrazine) in ground water in Colorado. These maps can be incorporated into the State Pesticide Management Plan and can help provide a sound hydrogeologic basis for atrazine management in Colorado. Maps showing the probability of detecting elevated nitrite plus nitrate as nitrogen (nitrate) concentrations in ground water in Colorado also were developed because nitrate is a contaminant of concern in many areas of Colorado.

Maps showing the probability of detecting atrazine and(or) desethyl-atrazine (atrazine/DEA) at or greater than concentrations of 0.1 microgram per liter and nitrate concentrations in ground water greater than 5 milligrams per liter were developed as follows: (1) Ground-water quality data were overlaid with anthropogenic and hydrogeologic data using a geographic information system to produce a data set in which each well had corresponding data on atrazine use, fertilizer use, geology, hydrogeomorphic regions, land cover, precipitation, soils, and well construction. These data then were downloaded to a statistical software package for analysis by logistic regression. (2) Relations between concentrations of atrazine/DEA and nitrate in ground water and atrazine use, fertilizer use, geology, hydrogeomorphic regions, land cover, precipitation, soils, and well-construction data were evaluated, and several preliminary multivariate models were constructed. (3) The multivariate models that best predicted the presence of atrazine/DEA and elevated concentrations of nitrate in ground water were selected. (4) The accuracy of the multivariate models was confirmed by validating the models with an independent set of ground-water quality data. (5) The multivariate models were entered into a geographic information system and the probability maps were constructed.

Development and Application of a Regression Model for Estimating the Occurrence of Atrazine in Shallow Ground Water Beneath Agricultural Areas of the United States

By Paul E. Stackelberg[1], Robert J. Gilliom[2], David M. Wolock[3], and Kerie J. Hitt[4]

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Paul Stackelberg has been a hydrologist with the USGS since 1988. His research interests include evaluating relations between natural and anthropogenic factors and ground-water quality, and the fate of pharmaceuticals and other compounds in streams and drinking-water supplies.

Robert Gilliom has been a hydrologist with the USGS since 1978. His research interests are focused on water-quality assessments, ranging from statistical methods for data analysis, to regional and national assessments of nutrients, trace elements, and pesticides. Currently he directs the Pesticide National Synthesis Project of the National Water Quality Assessment Program.

David Wolock is a research hydrologist with the USGS. Since 2001, he has served as the team leader of NAWQA's Hydrologic Systems Team. The Hydrologic Systems Team helps plan and implement modeling studies in NAWQA. His main area of interest is natural and human effects on the water balance at broad spatial scales.

Kerie J. Hitt joined the USGS in 1981 and has been a Geographic Information Systems (GIS) specialist with the National Water-Quality Assessment Program since 1991. She provides technical support for national studies, primarily of nutrients in ground water. She develops and applies ancillary spatial data on factors that influence water quality.

Abstract

Results from 52 ground-water studies throughout the United States were used to examine relations between the occurrence of atrazine in shallow ground water in agricultural settings and explanatory variables that describe the natural setting, agricultural-management practices, and the type and amount of development in each area. The explanatory variables that were found to be correlated with atrazine occurrence were soil infiltration rates, presence of artificial drainage (tile drains or trenches), available water-holding capacity of soils, soil permeability, amount of study area using ground for irrigation source (as percentage of total area), amount of agricultural land (as percentage of total area), and intensity of atrazine use. Ordinary least-squares regression equations that used one or more of these explanatory variables describe as much as 58 percent of the variation in atrazine-detection frequencies. Application of a multivariate equation to unmonitored agricultural areas across the conterminous United States illustrates that atrazine use alone is insufficient for estimating the occurrence of atrazine in shallow ground water; rather, areas in which soil characteristics and agricultural-management practices favor the movement of water from land surface to the water table and that also have intensive atrazine use are the most vulnerable to atrazine contamination.

Development of Spatial Probability Models to Estimate Ground-Water Vulnerability to Nitrate Contamination in the Mid-Atlantic Region

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Earl Greene is a staff scientist with the U.S. Geological Survey in the Office of the Chief Scientist for Hydrology where he provides support to the Chief Scientist and the Associate Director for Water on various National Research Program and Headquarters issues. His research interests are in fractured rock hydrology and development of regional-scale statistical models. Additionally, he serves as coordinator for the WEBB (Water, Energy, and Biogeochemical Budgets) Program, Hydrologic Networks and Analysis Program, and Climate Change Science for the Water Resources Discipline.

Andrew LaMotte is with the U.S. Geological Survey's Maryland, Delaware, Washington D.C. Water Science Center located in Baltimore, Maryland. Since 1994 he has been involved in a variety of projects and programs lending his geographic and cartographic expertise through the use of Geographic Information Systems. Mrs. Cullinan has supported the project with her expertise in application of statistical principles and models to environmental data

Abstract

The U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency's Regional Vulnerability Assessment Program, has developed a set of statistical probability modeling tools to support regional-scale, ground-water quality and vulnerability assessments. These statistical tools have been used to explore and characterize the relation between ground-water quality and geographic factors in the Mid-Atlantic Region. Available water-quality data obtained from U.S. Geological Survey National Water-Quality Assessment Program studies were used in association with geographic data (land cover, geology, soils, and others) to develop logistic-regression equations that use explanatory variables to predict the presence of a selected water-quality parameter (nitrate as nitrogen) exceeding a specified management concentration threshold. Additional statistical procedures (PRESS Statistic) modified by the U.S. Geological Survey were used to compare the observed values to model-predicted values at each sample point. Statistical procedures to determine the confidence of the model predictions and estimate the uncertainty of the probability values were developed and applied. Spatial probability models at multiple thresholds were applied to produce maps showing the likelihood of elevated concentrations of nitrate as nitrogen in the Mid-Atlantic Region. These maps can be used to identify areas that are currently at risk and help identify areas where ground water has been affected by human activities. This information is being used by regional and local resource managers to protect water supplies and identify land-use planning solutions and monitoring programs in these vulnerable areas.

Addressing California's Nutrient Issues

Dena McCann

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Nutrients are very complex and can lead to the impairment of beneficial uses of our water. Unlike most toxic substances, too little nutrients can be just as problematic as too much nutrients. A summary of the 2002-303(d) list identifies 268 California water bodies that do not meet water quality standards because of nutrients. Nutrients are now the second largest cause for listing waters, and the listing numbers are expected to grow with the release of the 2006 303(d) list document. Therefore, it has become imperative that California develops an approach for addressing nutrient problems in these waters. With an understanding that California waters vary from region to region (e.g. temperature, flow, effluent dominated, use designation), a single statewide objective cannot be supported. Through a joint effort with U.S. EPA Region 9, Tetra Tech, and the State Water Resources Control Board and the nine Regional Water Quality Control Boards, an effort is underway to move forward using selected biological responses (benthic algal density, chlorophyll a, etc.) in addition to nutrient concentrations (various nitrogen and phosphorus species). The linked biological responses and concentrations can then become incorporated into a tiered approach to better evaluate nutrient impacts. Modeling, empirical data analysis, review of the scientific literature, and technical nutrient experts are all being utilized to provide guidance for nutrient TMDL use, which in-turn can help provide further data necessary for statewide nutrient policy recommendations.

Algal Metric Approaches for Assessing Trophic Condition and Organic Enrichment in U.S. Streams and Rivers

Stephen D. Porter[1], Norman E. Spahr[1], David K. Mueller[1], Mark D. Munn[2], and Neil M. Dubrovsky[3]

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Stephen Porter is an aquatic ecologist with the USGS who was the National Water-Quality Assessment (NAWQA) algae protocol author and regional biologist for the NAWQA Program, a contributor to NAWQA nutrient and ecological national-synthesis activities, and a contributor to the EPA Nutrient Criteria Technical Guidance Manual for streams and rivers. He has been active in algal-nutrient research throughout his 30 year career with state and federal agencies and as an environmental consultant. Norman Spahr is a senior hydrologist with the USGS and project chief of the Upper Colorado River NAWQA Program. David Mueller is a senior hydrologist with the USGS who has been actively involved with the NAWQA National Nutrient Synthesis Team over the past 15 years. He currently is water-quality specialist for the USGS Central Region. Mark Munn is an aquatic ecologist with the USGS who currently serves as the NAWQA Nutrient Enrichment Effects Team (NEET) leader. Neil Dubrovsky is a senior hydrologist with the USGS who leads the NAWQA National Nutrient Synthesis Team.

Abstract
Algal-community metrics (water-quality indicators) were calculated for periphyton samples collected from 976 streams and rivers sampled by the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program during 1993-2001. Algal-metric scores were compared with nutrient concentrations from discrete samples collected on or near the same date of periphyton sampling and with modeled nutrient concentrations representing average conditions during various time periods prior to periphyton sampling. Algal-metric correlations with discrete and modeled nutrient concentrations were similar in most instances. Algal metrics with significant positive national and regional correlations with nitrogen and phosphorus concentrations include indicators of trophic status and indicators of tolerance to organic enrichment, low dissolved-oxygen concentrations, and moderate to high specific conductance. The relative abundance of algal taxa capable of fixing atmospheric nitrogen was negatively correlated with dissolved and total nitrogen concentrations, and generally was largest in streams draining undeveloped, forested basins. Algal indicators of eutrophic condition and tolerance were relatively higher in urban streams than those draining other developed basins, and non-linear, threshold responses were observed at very low percentages of urbanization. Algal-metric scores increased with stream size, possibly responding to cumulative nutrient enrichment from urban and agricultural activities. Nationally, algal indicators of eutrophic condition and tolerance were largest in streams draining the Mississippi River basin, coastal New England, and California, with relatively lower metric scores observed in the Pacific Northwest, Rocky Mountain, Ozark, and Appalachian regions. Algal biomass (biovolume) did not differ significantly among geographic regions or land-use classifications and was only weakly associated with nitrate concentrations. Although excessive amounts of algal biomass are an important consideration for establishing nutrient criteria, indicators of algal biomass (e.g. chlorophyll a) appear to be site specific and may be controlled by antecedent hydrologic disturbance, shading, and biological interactions more than by land-use practices or ambient nutrient concentrations

Impacts of Nutrients on the Biological Integrity of Wadeable Streams in Wisconsin

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Biographical Sketch of Lead Author

Dale M. Robertson is a research hydrologist with the Wisconsin Science Center of the U.S. Geological Survey. He has been a member of the U.S. EPA's Region V Regional Technical Assistance Group for Nutrient Criteria since 1998. His research interests include regionalization techniques, determining how different sampling strategies affect estimated water quality, and examining the influence of environmental factors, watershed management strategies, and in-lake management alternatives on the water quality of rivers and lakes.

Abstract

Excessive nutrient (phosphorus and nitrogen) loss from watersheds is frequently associated with stream impairments. Therefore, standards and regulations are being proposed to reduce these losses. More confidence in the environmental benefits of these standards is possible with a better understanding of the biotic response to different nutrient concentrations. To help provide this understanding, water-quality and biotic data (benthic and suspended chlorophyll, diatoms, macroinvertebrates, and fish) were collected in 240 wadeable streams in Wisconsin.

Variability in reference or background conditions and the response in most nutrient concentrations to anthropogenic factors are best described by regionalizing streams into two categories: those in areas with soils having a high clay content and those in the rest of the state. Streams in clay areas had lower reference nitrogen and suspended chlorophyll concentrations and more dramatic responses in all water-quality constituents to anthropogenic effects. However, the response of most biotic indices to changes in nutrient concentrations was similar throughout the state, regardless of soil type.

Most biological indices had a wedge-shaped response to changes in nutrient concentrations. At low concentrations, indices ranged from good to poor, but at high concentrations, they primarily indicated poor conditions. The wedge-shaped distribution and results of redundancy analyses suggest that at low nutrient concentrations, non-nutrient factors often limit the health of biological communities, whereas at high nutrient concentrations, nutrients and other correlated characteristics may be predominant factors. Therefore, specific biological indices alone may not be good indicators of nutrient impairment.

Thresholds were identified where relatively small changes in nutrient concentrations result in large changes in biological communities. Thresholds in phosphorus concentrations ranged from ~0.04 mg/L for benthic chlorophyll, to ~0.06-0.07 mg/L for suspended chlorophyll, diatoms, and fish, to ~0.09 for macroinvertebrates. Thresholds in nitrogen concentrations ranged from ~0.5 mg/L for fish to ~0.9 to 1.2 mg/L for chlorophyll, diatoms, and macroinvertebrates.

Control of Nitrogen Cycling Processes in the Upper Mississippi River (UMR)

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William Richardson is a research aquatic scientist in the Aquatic Sciences Branch (ASB) at the Upper Midwest Environmental Sciences Sciences Center (UMESC), with background in large river food web ecology and biogeochemical cycling of nitrogen. Current research focuses on hydrogeomorphic controls of nitrogen cycling in large flood plain rivers, effects of river management on nitrogen dynamics, and the role of river margin wetlands in controlling nitrogen, phosphorus, and sediment flux to the Mississippi River. New research will determine the effect of nutrients on river productivity, including source, fate and trophic transfer of nitrogen and carbon in river food webs.

Eric Strauss is an Assistant Professor of Biology at Fort Hays State University where he teaches and conducts research in limnology, biogeochemistry and microbiology. Recently, he has conducted research on controls of nitrogen cycling in large flood plain rivers, effects of river management on nitrogen dynamics, and the role of river margin wetlands in controlling nitrogen, phosphorus, and sediment flux to the Mississippi River. He is a recognized expert on the controls of nitrification is rivers and streams.

Lynn Bartsch is a research aquatic scientist in the ASB of the UMESC, with background and experience in large river food web ecology and biogeochemical cycling of nitrogen. Current research focuses on hydrogeomorphic controls of nitrogen cycling in large flood plain rivers, effects of river management on nitrogen dynamics, and the role of river margin wetlands in controlling nitrogen, phosphorus, and sediment flux to the Mississippi River. He has a particular interest in nitrogen fixation in aquatic systems.

Jennifer Cavanaugh a research aquatic biologist in the ASB of the UMESC, with background and experience in stream ecology and ecology of aquatic insects and algae. Current research focuses on hydrogeomorphic controls of nitrogen cycling in large flood plain rivers, effects of river management on nitrogen dynamics, and the role of river margin wetlands in controlling nitrogen, phosphorus, and sediment flux to the Mississippi River.

Abstract
Large flood plain rivers provide significant logistic challenges for assessment of processes driving spatial and temporal variation in concentrations and loads of nutrients, and development of nutrient criteria. Nitrogen (N) concentrations can vary significantly across flood plains and seasons in a single river reach. For example, in Navigation Pool 8 of the UMR, NO3- concentrations range from undetectable in backwater lakes in summer, to 6 to 8 mg L-1 in channels during floods. Current loads of total N in the UMR range from ~15 x10 3 t . month-1 (spr) to ~1 x103 t . month-1 (winter), with NO3- making up ~95 % of the total load. A five year study of N-cycling processes was conducted in Navigation Pool 8 (2000 - 2004) to evaluate causes of such variation. Flood plain backwaters and impounded areas had the highest rates of denitrification potential (10.9 and 7.6 µg N . cm-2 . hr -1, respectively); side and main channels exhibited the lowest rates (2.2 and 1.6 µg N . cm-2 . hr -1, respectively). Nitrification rates were also highest in backwaters and impounded areas (1.1 and 1.4 µg N . cm-2 . hr -1, respectively), and lowest in main and side channels (0.3 and 0.6 µg N . cm-2 . hr -1, respectively). Denitrification removes ~ 6900 tons of nitrate-N annually from Pool 8, representing ~ 7 % of the total NO3- load. Much of the NO3- removal is offset by nitrification, which contributes ~7 tons N/yr in navigation Pool 8. Variation in NO3-

concentration in the UMR depends on 1) spatial variation of factors promoting microbially-mediated N production and removal that vary at local scales (sediment carbon and oxygen concentrations); 2) hydrologic factors that vary at reach (channel morphology) and basin (river discharge) scales; and 3) upstream sources and transport dynamics that vary regionally.

Mercury cycling and bioaccumulation in streams in Oregon, Wisconsin, and Florida

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Biographical sketch of author

Mark Brigham coordinates mercury studies for the U.S. Geological Survey's National Water-Quality Assessment Program. Prior to his current position he worked on: studies related to mercury cycling in waters of Minnesota; assessments of trace elements in streambed sediments; assessment of suspended sediment sources in streams using fallout radioisotopes; and the National Water-Quality Assessment Program's study of the Red River of the North Basin. Brigham has a BA in Chemistry and an MS in Civil Engineering, both from the University of Minnesota.

Abstract

During 2002-2004, the U.S. Geological Survey conducted detailed studies of mercury cycling and bioaccumulation in a total of eight streams in Oregon, Wisconsin, and Florida. Each study stream receives mercury predominantly from atmospheric deposition to the watersheds, with subsequent transport to the streams from runoff. The percentage of total mercury entering the stream basins via wet deposition that exits the basins via runoff varied from 4.4 to 48 percent, with a mean of 20 percent. Benthic mercury methylation was active in organic-rich streambed sediment, whereas demethylation of methylmercury dominated in sandy, inorganic sediment. Benthic sediment methylation of mercury is probably not an important source of methylmercury to the streams; if it were a dominant process, then low-discharge conditions would have accompanied high aqueous methylmercury concentrations. Instead, in most of the streams, aqueous concentrations of total mercury, methylmercury, and dissolved organic carbon (DOC) were positively correlated with discharge at the time of sampling, suggesting that transport of mercury-DOC complexes controls both total mercury and methylmercury concentrations. Mean aqueous methylmercury concentrations were strongly correlated with mercury concentrations in tissue of forage fish and predator fish. We hypothesize that watershed inputs of methylmercury—particularly from wetlands in riparian and upstream areas—are more important than in-channel methylation as a driver of methylmercury bioaccumulation in fish in many stream ecosystems.

EMMMA: A Web-based System for Environmental Mercury Mapping, Modeling, and Analysis

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Biographical Sketches of Authors

Steve Wente is an aquatic biologist. He received B.S. degrees in Wildlife Biology and Natural Resource Mgmt., M.S. in Biology from Ball State University, and Ph.D. from Purdue University. He has worked on issues related to the biological assessment of water quality at Indiana's Department of Environmental Mgmt. and USGS's Minnesota Water Science Center and National Center. The National Descriptive Model of Mercury in Fish that is deployed on EMMMA was originally developed as part of his doctoral research and is central to his current research with the USGS.

Paul Hearn is a senior scientist and project manager with USGS's Eastern Geographic Science Center, with a background in geology, geochemistry, and the application of GIS technologies to hazard mitigation, human health, and natural resource management. In his 30 years with USGS, he has worked as a research geologist, represented the USGS in the negotiation of science agreements with various foreign countries and managed a variety of technical programs in the former USSR, Central America, and in the U.S.

David Donato has been a quantitative professional with the U.S. Department of the Interior for more than 29 years, the last 20 of which have been with the USGS. He has worked as a statistician and an operations research analyst and is currently a computer scientist assigned to the USGS Eastern Geographic Science Center (EGSC) in Reston, Virginia. Formally educated in mathematics, statistics, and computational science, he specializes in algorithm design and software development for computer modeling and stochastic simulation, for general scientific computation, and for computational economics. David has extensive experience in deploying models and other software on the Internet. Currently he manages the EGSC High-Performance Computing Cluster (Beowulf); continues development of the Environmental Mercury Mapping, Modeling, and Analysis system; and conducts research into parallel algorithms for image processing and geographic modeling and analysis.

John Aguinaldo is a user-interface and web application developer employed by Harris Technical Services Corporation on contract at the USGS National Center in Reston. He has been developing internet applications for various companies around the country since 1997. John specializes in GIS web development, particularly user-interface usability design and developing fat-client web applications utilizing Javascript, AJaX, CSS2+, and DOM2+.

Abstract

Large and complex data sets of mercury concentrations in various environmental media and associated ancillary data have been generated by many Federal, State, Tribal, and local agencies. To facilitate efficient and effective use of these data in managing and mitigating human and wildlife exposure to mercury, the U.S. Geological Survey and the National Institute of Environmental Health Sciences have developed a website for visualizing and studying the distribution of mercury in our environment. The Environmental Mercury Mapping, Modeling, and Analysis (EMMMA) website (http://emmma.usgs.gov) provides health and environmental researchers, managers, and other decision-makers the ability to: interactively view and access a nationwide collection of environmental mercury data (fish tissue, atmospheric emissions and deposition, stream sediments, soils, and coal) and mercury-related data (mine

locations); interactively view and access predictions of the National Descriptive Model of Mercury in Fish (NDMMF) at 4,976 sites and 6,829 sampling events (events are unique combinations of site and sampling date) across the United States; and use interactive mapping and graphing capabilities to visualize spatial and temporal trends and study relationships between mercury and other variables.

Reconnaissance Survey of Mercury in Water, Sediment, and Fish from U.S. Streams

By Barbara C. Scudder[1], Lia S. Chasar[2], Nancy J. Bauch[3], Dennis A. Wentz[4], Mark E. Brigham[5], David P. Krabbenhoft[1], Patrick J. Moran[6], and William G. Brumbaugh[7]

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Barbara Scudder's expertise is in the effects of water quality on stream biota, with emphasis on trace elements, bioaccumulation, and toxicity; she also studies community ecology of benthic algae, invertebrates, and fish. She received a B.A. in Aquatic Biology in 1979 from the University of California, Santa Barbara and a M.S. in Marine Science in 1984 from California State University, Hayward (Moss Landing Marine Laboratories). At the USGS, as the lead study unit biologist for the Western Lake Michigan Drainages study unit of NAWQA, she is involved in multi-year biological research efforts on water quality using aquatic biota.

Lia Chasar received her Ph.D. in Biological and Chemical Oceanography in 2001 from Florida State University. Her research focuses on understanding the links between biogeochemical processes and trophic dynamics in aquatic ecosystems; she specializes in using natural tracers and population dynamics to evaluate the ways in which environmental disturbances (nutrient and contaminant loading, water management, climate shifts) influence the flow of energy (as carbon, nitrogen and sulfur) through these systems. She has been with the USGS NAWQA Georgia-Florida Coastal Plains study unit since 2001, and is an Assistant Professor in Environmental Sciences at Florida A & M University in Tallahassee, Florida.

Nancy Bauch has been a Hydrologist with the U.S. Geological Survey Colorado Water Science Center since 1994 and has performed investigations of water quality and fish contaminants in Colorado and the Nation. Nancy received B.S. degrees in Forestry and Geology from Virginia Tech in 1979 and 1982 and a M.S. in Environmental Science, Water Resources concentration, from Indiana University in 1993.

Dennis Wentz is a hydrologist in the Water Resources Discipline of the US Geological Survey, with training and experience in trace-element geochemistry, limnology, water-quality of large river basins, and mercury in stream ecosystems. From 1991 to 2004, he served as Chief of the National Water-Quality Assessment (NAWQA) in the Willamette Basin, Oregon. Since 2005, he has been coordinator for the NAWQA Program in the western United States.

David Krabbenhoft received his Ph.D. in 1988 from the University of Wisconsin-Madison in geochemistry and hydrogeology, and that same year started his career with the USGS at the Wisconsin Water Science Center. Dave's first project with USGS was an examination of mercury in Wisconsin lakes and the topic has consumed his professional life. In 1994, Dave established the USGS's Mercury Research Laboratory, which is a state-of-the-art facility strictly dedicated to the analysis of mercury, with low-level speciation. In 2006, Dave will serve as the Co-Host for the 8th International Conference on Mercury as a Global Pollutant in Madison, Wisconsin.

Patrick Moran is a biologist with the Washington Water Science Center of the US Geological Survey in Tacoma, WA. Mr. Moran holds a M.S. degree in Toxicology from Oregon State University and manages and provides technical review and/or support on a number of water quality related projects in Washington State. In addition, Mr. Moran serves as the Biologist for the Washington State portion of the USGS National Water Quality Assessment Program. His particular research interest focuses on applied or *in situ* approaches to monitoring contaminant impacts on fish physiology and aquatic communities.

William G. Brumbaugh, Ph.D., Environmental Research Chemist, has worked at the U.S. Geological Survey's Columbia Environmental Research Center since 1978. His primary research interest is the development of analytical methods for assessing the cycling and bioavailability of toxic trace elements in water, sediment, and biota. He was a co- principal investigator of the former USFWS National Contaminant Biomonitoring Program and of the USGS National Water Quality Assessment Program's national mercury monitoring pilot project. He holds two patents for passive sampling devices for trace metals, and has authored or co-authored over 50 publications in peer-reviewed scientific journals.

Abstract

The U.S. Geological Survey (USGS) examined mercury occurrence in water, streambed sediment, and fish from stream sites that spanned a range of land-use/land-cover conditions and environmental loadings of mercury across the US. This work was a collaborative effort between the USGS National Water-Quality Assessment and Toxic Substances Hydrology programs together with researchers from states, tribes, and other USGS programs. Land-use/land-cover included mining, urban, agricultural, and minimally-disturbed settings that represented forested, grassland, and wetland land cover. Minimally-disturbed sites were selected to represent expected high and low rates of mercury methylation, based on wetland abundance. Approximately 300 sites were sampled once at low flow during the period of 1998 through 2005. Stream water and streambed sediment were analyzed for total mercury (THg), methylmercury (MeHg), and ancillary characteristics thought to affect methylation. Predator fish (largemouth bass, *Micropterus salmoides*) were targeted for collection, and skin-off fish fillets were analyzed for THg. In areas where largemouth bass were not available, alternate predator fish were selected. Mercury concentrations in unfiltered water ranged from <0.01 to 2.91 ng/L MeHg and 0.27 to 446 ng/L THg; concentrations in streambed sediment (dry weight basis) ranged from <0.10 to 47.1 ng/g MeHg and 1.33 to 6510 ng/g THg. Maximum bioaccumulation factors ranged from 5.1×10^6 to 7.9×10^6 for MeHg in water to THg in fish and from 4.52×10^3 to 8.1×10^3 for MeHg in sediment to THg in fish. Concentrations of THg in fish ranged from 0.01 to 1.95 ug/g (wet weight basis); the highest concentrations in fish among all sampled sites occurred in tannic, blackwater coastal-plain streams of the eastern US and western mining affected sites. Several blackwater coastal-plain streams had MeHg concentrations that were similar to those of mining-affected sites, even though THg concentrations were much lower. This difference in the ratios of MeHg to THg highlights the importance of methylation as a controlling factor in the bioaccumulation of mercury in fish.

Modeling Mercury in Stream Ecosystems

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Biographical Sketch of Author

Robert Ambrose is an environmental engineer with over 30 years of experience at EPA developing, applying, and supporting environmental fate and surface water quality models. He has participated in the mercury modeling field for the past 12 years, contributing to the Mercury Report to Congress, the Everglades restoration program, several mercury TMDLs, the Ecological Risk Assessment Support Center, and the Clean Air Mercury Rule.

Abstract

Mercury is a classic multimedia pollutant. Natural and anthropogenic emissions are driven by a complicated set of transport and transformation reactions operating on a variety of scales in the atmosphere, landscape, surface water, and biota. In the past 15 years, surface water mercury model development has focused on lake ecosystems. Relatively less effort has been devoted to developing mercury models specifically adapted to riverine ecosystems. Lakes typically have medium to long residence times (months to years) and experience relatively quiescent, stable conditions. By contrast, riverine systems typically have short residence times (hours to weeks); they can experience large fluctuations in flow, depth, and velocity on a seasonal as well as a short term basis. Rivers are intimately connected to their drainage basins from which they receive both pollutant loads and dilution water.

Given our present understanding of environmental mercury transport, this presentation summarizes important components of a robust riverine mercury modeling system, from the upland watershed through the flood plains, riparian wetlands, the drainage network, and the underlying sediments. The important hydrological, transport, and transformation processes that should be included in riverine mercury models are highlighted, along with the key solids and mercury variables. Data needs to support these models are itemized, and example applications are presented to clarify model development issues. Finally, a collaborative monitoring, process science, and model development program is recommended.

The Development of an Internet Database for WV Save Our Streams Volunteer Monitors

Tim Craddock

WV Save Our Streams Program Coordinator

Abstract

The presentation briefly discusses the planning, development and the implementation of WV Save Our Streams Internet database, the "Volunteer Access Database", or VAD for short. The idea of this database initially began in 2002, however, I (the WV Save Our Streams Program Coordinator) lacked the time, but more importantly the expertise to develop a system that any volunteers would use and that is similar enough to the current program structure as not to be to intimidating. In the summer of 2005 WV Save Our Streams searched for an intern through the Governor's program. This person must have a basic understanding of basic stream ecology, but more importantly, a wide knowledge of computer skills related to building an Internet database. WV Save Our Streams was lucky enough to find such a West Virginian. Robert (Bobby) Williams is a sophomore at Georgetown University pursuing a degree in science and technology and international affairs. Within a time period of three months, Bobby was able to build the system by familiarizing himself with the program, and was able to interpret my ideas for the database structure.

The VAD is now on the Internet at: http://www.wvdep.org/dwwm/wvsos/vad/index.htm.

Biographical sketch

Tim Craddock is an Environmental Resource Specialist III employed by the WV Department of Environmental Protection (WV DEP), and coordinator of the WV Save Our Streams Program, a position he has held for the past six years. Tim has a bachelors of science with a marine science focus from WV State University and Old Dominion University, and masters in environmental science from Marshall University Graduate College. Tim has worked in the environmental field both as a volunteer and under the employ of federal and state agencies for more than 15 years. Accomplishments include the development of outreach and education materials focusing on polluted coalmine drainage; constructed and enhanced a wetland adjacent to a high school in Cabell County WV; assisted with the development of small scale passive wetland treatment systems to affect acid mine drainage in Putnam County WV; and more recently expanded the WV Save Our Streams Program by developing beginning, intermediate and advanced training levels. Acted as project team leader with the Federal Emergency Management Agency (FEMA) during disaster relief and environmental assessments following hurricane Marilyn in the Virgin Islands, and after several floods throughout the Midwest and West Virginia.

Westchester County's Online Volunteer Monitoring Database

Susan E. Darling

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Biographical Sketch of Author

Susan Darling is an environmental planner with the Westchester County Department of Planning. She is currently the program manager of the Westchester County Citizens' Volunteer Monitoring Program.

Abstract

The Westchester County Citizens' Volunteer Monitoring Program (WCCVMP) was established in 2002 by the Westchester County Department of Planning (WCDP) through Safe Drinking Water Act funding distributed by the New York State Department of Environmental Conservation. The goals of the program are to create a historical baseline of water quality information throughout Westchester County, connect communities to their water resources through education and hands-on involvement, and allow public access to water quality information for educational purposes. Each year, approximately 80 volunteers undertake weekly monitoring of the biological, chemical, and physical characteristics of streams throughout Westchester County. The WCDP worked with the Westchester County Department of Information Technology (WC DoIT) to create an interactive online Oracle database to manage, store, and provide access to all monitoring data collected by WCCVMP volunteers. In addition, partnerships have been developed with other organizations outside of Westchester County so that they can enter and store data in the database. This database has several unique features including Quality Assurance/Quality Control tools to prevent data entry errors. It is password protected and all volunteers are provided user ID's and passwords to upload data collected during monitoring events. WCDP has found it important to work closely with both the WC DoIT and volunteers in order to get feedback and continually improve database design and functionality. Due to a lack of confidence with computers and the Internet, several volunteers have had difficulty with uploading data into the database. As a result, the data entry process was simplified through the development of a series of user-friendly data entry forms and training sessions were created to teach volunteers how to upload their data. The database and data entry processes have proven to be the most dynamic aspect of the WCCVMP.

Open Source Citizen Volunteer Water Monitoring Database

Andrew Alm

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Biographical Sketch of Author
Andy Alm has worked with organizations around the world to introduce the use of computer networks for internal and external communications since 1991. He serves as special advisor for knowledge management on the Commission on Education and Communication of IUCN, the World Conservation Union, and has an education and professional background as an environmental writer and editor.

Abstract
The Environmental Alliance for Senior Involvement (EASI) is distributing an open-source environmental-monitoring web database application as a cost-effective (free) tool for any individual or group to use to record their monitoring results and the procedures and protocols they use.

In 1997, in cooperation with the Pennsylvania Department of Environmental Protection, EASI launched an online citizen water-monitoring database that allows volunteers to record results via the web from chemical testing, habitat analysis, macro-invertebrate inventories and ground observations collected using specific EPA-approved quality protocols and procedures. That first database application averaged more than 1,000 monitoring events recorded per month by volunteers in 2004.

Based on the demand from citizen water-monitoring groups to be able to include a greater variety of monitoring results and protocols, EASI and PaDEP decided to re-engineer the database application using only open-source, freely licensed components, and to make the new version freely available. The National Park Service contributed to the effort, and put the new database to work for volunteer water and wildlife monitoring along the Appalachian Trail.

The new application flexibly supports any monitoring parameters and associated protocol metadata, along with associated quality-assurance validation rules for each parameter and the physical characteristics of monitoring sites. It provides for flexible reporting and charting of data, as well as data export for other applications. It installs in minutes on most commercial web-hosting services, or on any personal computer, as part of a free content-management system for a complete web site.

In-stream Monitoring Database

Gretchen Peterson[1] and Richard Brocksmith[2]

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Biographical Sketches of Authors
Gretchen Peterson is a principal natural resources scientist and GIS analyst at PetersonGIS. She began work on the habitat database in 2003, spending the following two and a half years designing, implementing, and populating the database. She has been a consultant for five years.

Richard Brocksmith is the lead entity coordinator for salmon habitat recovery at the Hood Canal Coordinating Council. He received his B.S. from Oklahoma State University in Zoology and his M.S. from the University of Washington in fish biology. In addition to implementing habitat protection and conservation projects, he has been working with local, regional, state, tribal, and federal partners to develop integrated monitoring plans for aquatic habitats.

Abstract
Imagine this scenario: you are a researcher who wants to know how a particular stream's gravel composition has changed over time. Even if you know which agencies and/or groups have gathered the data for your stream, and you know who to ask for it, once you receive it, you will find that it may come in many different formats (Excel, Word, Access, paper) and be recorded differently depending on the year and protocol in which it was taken.

The habitat conditions database that will be presented today seeks to solve many of the problems associated with this scenario. It integrates data from two different stream monitoring protocols, from three agencies, for five counties in Washington State. It is designed to hold historic and future monitoring data, regardless of protocol. If new monitoring techniques or measurements are implemented in future surveys, they can be added to the database. All the data are spatially enabled and can be exported to a GIS for visual and spatial analyses.

The presentation will begin with an overview of the database's current data and structure, and then proceed to an in-depth look at the database's output capabilities. Database diagrams, maps, and issues-encountered will be shared.

Assessing the Biological Quality of the Nation's Streams with an Indicator of Taxonomic Completeness

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Charles Hawkins is Professor of Aquatic Ecology in the Department of Aquatic, Watershed, and Earth Resources at Utah State University and Director of the Western Center for Monitoring and Assessment of Freshwater Ecosystems. His main research activities involve development and testing of biological indicators, classification of reference conditions, modeling effects of natural factors on the distribution of aquatic biota, and use of taxon-specific responses to different stressors to diagnose causes of biological impairment.

Lester Yuan is an environmental engineer in the U.S. EPA. His primary research interests include using taxon-level statistical models to identify likely causes of impairment and refining indicators of stream biological condition.

John Van Sickle is a Biological Statistician with the Western Ecology Division of the U.S. Environmental Protection Agency's National Health and Environmental Effects Research Laboratory in Corvallis, Oregon. He earned M.S. degrees in mathematics and statistics from Michigan State University and Oregon State University, respectively, and received his Ph.D. in Systems Science from Michigan State University. His research interests include aquatic bioassessment, watershed-stream linkages, and multivariate statistical modeling.

Alan Herlihy is a senior research Associate Professor at Oregon State University in the Department of Fisheries and Wildlife. He received his undergraduate degree in chemistry from Northwestern University, and a M.S. and Ph.D. in Environmental Sciences from the University of Virginia. Current research projects focus on developing survey design methodology, assessment approaches, and ecological indicators for assessing surface water ecological condition.

Daren Carlisle is an invertebrate ecologist with the National Water-Quality Assessment Program. His current duties include integrating and aggregating ecological data collected by the Program over the past 14 years. His training is in aquatic ecology, statistics, and ecotoxicology. He has been employed with the Interior Department for 5 years.

Abstract
RIVPACS-type predictive models are used to measure the taxonomic completeness of biotic assemblages inhabiting aquatic ecosystems. The index, O/E, represents the proportion of the native taxa expected (E) in a sample that were observed (O), i.e., they provide a measure of biodiversity loss. RIVPACS models are used routinely to assess the biological condition of streams in Great Britain and Australia and have been developed for several states in the US. In this talk, we describe the application of predictive models

to the invertebrate samples collected in support of the national Wadeable Stream Assessment (WSA). We developed a single nation-wide model as well as a series of regional models from data collected at reference-quality sites. These models predicted the expected taxonomic composition at a site based on empirical relationships between observed assemblage composition and environmental variables that characterized site geography (latitude, longitude, elevation), geology (dominant watershed geology), climate (precipitation and temperature), and stream size (watershed area). Application of the models to the WSA data set allowed us to quantify the variation in biodiversity loss among the nation's streams. In general, this assessment showed that while some streams remain in reference condition, many streams have experienced significant loss of native taxa, some severely so, and the occurrence frequencies of several hundred taxa are substantially different from expected. We discuss these results in the context of both data quality and model accuracy and precision.

Comparability of Biological Assessments Derived from National-, Regional-, State-, and Provincial-Scale Predictive Models

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Biographical Sketches of Authors

Peter Ode is a research ecologist at the California Department of Fish and Game's Aquatic Bioassessment Laboratory. Since joining the ABL in 1995, he has been involved in developing and refining the use of bioassessment in California's water resource programs. His chief research interests include the relationship between landuse activities and stream invertebrate assemblages, and improving techniques for associating biotic condition with specific anthropogenic stressors.

Charles Hawkins is Professor of Aquatic Ecology in the Department of Aquatic, Watershed, and Earth Resources at Utah State University and Director of the Western Center for Monitoring and Assessment of Freshwater Ecosystems. His main research activities involve development and testing of biological indicators, classification of reference conditions, modeling effects of natural factors on the distribution of aquatic biota, and use of taxon-specific responses to different stressors to diagnose causes of biological impairment.

Alan Herlihy is a senior research Associate Professor at Oregon State University in the Department of Fisheries and Wildlife. He received his undergraduate degree in chemistry from Northwestern University, and a M.S. and Ph.D. in Environmental Sciences from the University of Virginia. Current research projects focus on developing survey design methodology, assessment approaches, and ecological indicators for assessing surface water ecological condition.

John Van Sickle is a Biological Statistician with the Western Ecology Division of the U.S. Environmental Protection Agency's National Health and Environmental Effects Research Laboratory in Corvallis, Oregon. He earned M.S. degrees in mathematics and statistics from Michigan State University and Oregon State University, respectively, and received his Ph.D. in Systems Science from Michigan State University. His research interests include aquatic bioassessment, watershed-stream linkages, and multivariate statistical modeling.

Abstract

Predictive models are increasingly used by water resource managers to assess the biological condition of aquatic ecosystems. These models predict the taxonomic composition expected at a site under reference conditions. Comparison of the observed taxa with those expected is a measure of the biological condition at the site, most frequently expressed as a ratio of the observed number of taxa to the expected number of taxa (O/E). These site-specific assessments can be aggregated to estimate the proportion of waters in different condition classes. Model performance (accuracy and precision) is a function of several factors including the level of taxonomic resolution used and availability of predictor variables, both of which can vary across data sets. Recent modeling efforts that used data from several sources allowed us to compare assessments of the same California streams derived from models developed to cover 5 increasingly large

areas: separate models for each of 3 climatic provinces within California, a single California-wide model, separate models for 5 climatic regions in the western US, a single western US model, and a nation-wide model. All models were developed from a combination of data provided by the EPA (EMAP-W and WSA), Utah State University, USGS, US Forest Service, and several states. In this talk, we discuss the degree to which regional assessments derived from models for the 4 largest coverages agreed with assessments derived from models for the 3 CA climatic provinces and the reasons for observed differences.

Using Biomonitoring Data to Assess Possible Causes of Biological Impairment: Combining Predictive Models and Taxon Tolerance Values

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Biographical Sketches of Authors

Daren Carlisle is an invertebrate ecologist with the U.S. Geological Survey's National Water-Quality Assessment Program. Currently, Daren is integrating and aggregating ecological data collected by the Program over the past 14 years. He is trained in aquatic ecology, statistics, and ecotoxicology and has been employed with the Department of the Interior for 5 years.

Charles Hawkins is Professor of Aquatic Ecology in the Department of Aquatic, Watershed, and Earth Resources at Utah State University, and Director of the Western Center for Monitoring and Assessment of Freshwater Ecosystems. His main research activities involve development and testing of biological indicators, classification of reference conditions, modeling effects of natural factors on the distribution of aquatic biota, and use of taxon-specific responses to different stressors to diagnose causes of biological impairment.

Abstract

Predictive models such as RIVPACS (River Prediction and Classification System) are used in biological assessments to predict the assemblage composition expected (E) in the absence of human perturbation at specific sites. Comparison of observed (O) assemblage composition with E provides a simple, intuitive measure (O/E) of biological impairment. If taxon tolerance values are available for specific stressors, E can be weighted to estimate the expected mean tolerance values at a site, which can then be compared with observed mean tolerance values. These stressor-specific O/E values should provide insight regarding the likely cause of biological impairment at a site. We developed a predictive model for stream invertebrates from data collected at 310 reference sites in the eastern United States, and applied the model to approximately 700 non-reference stream sites. We then used nationally derived genus- and family-level tolerance values for specific conductance, nutrients, temperature, suspended sediment, and percent-fine substrates to weight the O/E values estimated at each site. Of the 700 non-reference sites, 27 sites were selected that represented a gradient in amount of upstream watershed urbanization. We used data from these sites to explore the potential use of stressor-specific O/E values in detecting the causes of biological degradation across this gradient. Road density in each watershed was used to quantify differences among sites in watershed urbanization. Regressions of stressor-specific O/E values on road density showed that all tolerance-weighted O/E values except temperature were positively correlated with basin road density. At moderate to high road densities, O/E values for specific conductance, nutrients, and fine sediments exceeded thresholds set by model error. Our results are consistent with independent analyses of chemical and physical habitat in the study area that show these stressors increase with urbanization.

Biological Assessment of Water Quality: Delivery of a National System in Australia

Richard Norris

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Abstract
Easily used standardized methods of biological assessment are fundamental for adoption nationally. In 1992 biological criteria were adopted into national water quality guidelines and the Australian Prime Minister allocated Aus$10 M to a new National River Health Program (NRHP) which was created in 1994. The NRHPis run by Environment Australia, initially administered by the Land and Water Research and Development Corporation, with a non-government national coordinator, and developed through a lead agency in each state. Fundamental to development, ownership and adoption has been: a national steering committee of scientists and managers with contractual powers; a technical committee to oversee scientific aspects including adoption of standardized protocols for data collection and modeling; regular workshops and technology transfer activities; a parallel R&D program with 20 projects focusing on sampling, analysis, taxonomy, method sensitivity, diagnostics, alternative methods, and QA/QC. AUSRIVAS (the Australian River Assessment System) was developed through the NRHP for aquatic biological and habitat assessment. AUSRIVAS is an Internet based software program that runs predictive bioassessment models derived from complex analyses. The models are similar to the British RIVPACS approach and are based on Australian macroinvertebrate and environmental data from over 1500 reference sites. The program is run locally after down-loading from the Internet, but uses models stored on a central server. The manuals are also available on the Internet and updates to the program and models are immediately available to all users. Other advantages of this approach include: the ease of access and use of standardized site-specific outputs that are comparable nationwide and a standardized national taxonomic coding system. The methods have been adopted within: new national water quality guidelines; a range of indicator frameworks of environmental condition and industry performance; and as a standard method by Australia's National Association of Testing Authorities. AUSRIVAS was used to assess the biological condition of 6000 stream sites around Australia (1997-2000). The resulting data provided the basis for biological assessment in Australia’s National Land and Water Resources audit and for the national State of the Environment report.

Developing Habitat Condition Metrics

Trainer
Phil Kaufmann, U.S. Environmental Protection Agency

Biographical Sketch
Philip R. Kaufmann is a research physical scientist at the U.S. Environmental Protection Agency, Office of Research and Development, Western Ecology Division, Corvallis, Oregon. He received an MS in Limnology from Washington State University in 1977 and a PhD in hydrology/stream ecology from Oregon State University in 1987. Dr. Kaufmann's research focuses on developing quantitative approaches for assessing physical habitat structure and function in aquatic ecosystems. He is currently involved in the interpretation of the ecological condition of surface waters based on measurements of biological, chemical and physical indicators in large–scale aquatic monitoring studies.

Short Course Description
Phil Kaufmann from EPA's Western Ecology Division will lead this interactive session demonstrating the development of habitat quality metrics based on the quantitative habitat assessment methods.

Monitoring of Transboundary Waters in Europe: Lessons Learned from the UNECE Pilot Projects

John Chilton[1] and Jos Timmerman[2]

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Biographical Sketches of Authors
John Chilton is a principal hydrogeologist with the Groundwater Management Programme of the British Geological Survey. He trained as a geologist and has worked in the Survey for over 30 years in both groundwater resources and groundwater quality, and both in the UK and overseas. His recent experience in groundwater quality has been in the impact of agriculture (both nitrate and pesticides) and in the design of groundwater quality monitoring programmes. In the latter, he has been involved extensively in work with WHO, UNEP and the EU and with the UNECE on transboundary issues.

Jos Timmerman is Program manager in the Department of International Policy Affairs within the Institute for Inland Water Management and Waste Water Treatment RIZA with expertise in the field of environmental information management. Since 2004 he is responsible for coordinating the International Water Assessment Centre (IWAC), a collaborating centre under the UNECE Water Convention. He has developed a methodology for the specification of information needs and applied this methodology in several national and international projects for the development of monitoring networks.

Abstract
The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes was established in 1992 and came into force in 1996. To support the convention, guidelines for the monitoring of transboundary rivers, lakes and groundwater have been prepared. Following the adoption of the guidelines for rivers, a series of pilot projects was established with the objective of demonstrating the implementation of the guidelines and supporting countries in their use, and to take account of any lessons learnt for their review and revision.

Work on these pilot projects commenced in 1997, and was divided into three phases. Firstly an inception phase included the establishment and organisation of the project. Secondly, the main work of the project was undertaken, identifying the functions and uses of water in the transboundary river basin, carrying out inventories and surveys to describe water quality and reviewing existing institutional and legislative settings. Finally, an analysis of the information needs arising from the functions and issues and an evaluation of the present monitoring to meet these needs was undertaken.

Lessons from the pilot projects are drawn out with respect to a) project preparation, b) project implementation, c) transboundary monitoring and assessment and d) revision of the guidelines. At the time of initiating the river pilot projects there was little experience of such projects in Central and Eastern Europe. Further, the European Water Framework Directive came into force during the lifetime of the projects, and has to be increasingly taken into account by countries in the UNECE region in their monitoring programmes.

Global Water Watch, a Worldwide Network of Community-Based Water Monitoring Groups

William G. Deutsch

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Biographical Sketch of Author
William Deutsch is a Research Fellow in the Department of Fisheries and Allied Aquacultures at Auburn University. He has worked on watershed projects of the International Center for Aquaculture and Aquatic Environments for 16 years, and has made about 40 international trips to 20 countries. He directs Global Water Watch, an affiliation of international, community-based water monitoring groups, and has also been the program manager for Alabama Water Watch since it began in 1992.

Abstract
Global Water Watch (GWW) is a community-based water monitoring (CBWM) network coordinated from Auburn University, Alabama, USA. The primary goals of the GWW program are to provide training workshops, technical backstopping and data management to a variety of citizen groups which are interested in assessing and protecting watershed health and drinking water sources. GWW is an outgrowth of the Alabama Water Watch program and has had activities in the Philippines, Ecuador, Thailand, China, Brazil and Mexico. Water data and other information about groups are entered, analyzed and retrieved via a customized, online database. Monitoring groups implement one or more of four data-to-action strategies: 1) environmental education, to raise public awareness of water issues and develop classroom curricula, 2) restoration and protection, to prevent pollution and develop watershed management plans, 3) advocacy, to improve water policies and enforcement of environmental laws and 4) spread, to strengthen and expand the CBWM network. A book entitled, *Community-Based Water Monitoring, Global Experiences for Practical Programs in Watershed Management*, synthesizes GWW activities over a 14-year period and documents lessons learned and a model for CBWM planning and evaluation.

Improving Binational Coordination of Monitoring In The Great Lakes

Melanie A. Neilson[1] and Paul J. Horvatin[2]

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Biographical Sketch

1) As Head of the Great Lakes Studies section, Melanie is responsible for Great Lakes monitoring programs for water and sediment quality, precipitation chemistry, and contaminants in fish. She received her B.Sc. in Biochemistry from McMaster University in 1977 and has been with Environment Canada ever since. Fondly dubbed "the Monitoring Queen", Melanie has been involved in developing several bi-national monitoring programs, including many of the Lake plans for the Great Lakes International Surveillance Plan (GLISP), the Niagara River Upstream/Downstream program, and the Integrated Atmospheric Deposition Network (IADN). She has published over 25 scientific papers, contributed to numerous reports, and given presentations at conferences, workshops and public meetings.

2) Paul is Program Manager for the Monitoring, Indicators and Reporting Branch with responsibilities for indicator development and monitoring programs for USEPA in the Great Lakes including: open lakes monitoring, Integrated Atmospheric Deposition Network (IADN), contaminated fish monitoring, and biological monitoring (phytoplankton, zooplankton and benthic). He also serves as the U.S. Co-Chair for the State of the Lakes Ecosystem Conference (SOLEC) which is a bi-national effort to report on the chemical, physical and biological condition of the Great Lakes using a system of indicators. He received a B.Sc. in Biology from the University of Illinois-Urbana in 1975 and M.Sc. in Environmental Engineering from the University of Illinois-Urbana in 1977.

Abstract

The Great Lakes Water Quality Agreement requires that Canada and the U.S. work together to develop and implement a surveillance and monitoring program on the Great Lakes. The sheer size of the Great Lakes, the breadth of environmental issues, and the number of agencies involved in studying and managing the lakes present a challenge in meeting this expectation. It's recognized that monitoring collaboration and coordination need to be maximized in order to promote data comparability, enhance data utility, extend resources, and deliver efficient and timely reporting on environmental change and progress. In order to improve the binational coordination of Great Lakes monitoring, two initiatives have recently been launched. A binational, basin-wide inventory of monitoring programs has been developed on the internet to raise awareness of ongoing activities, encourage collaboration, and assist in identifying monitoring gaps. Also, a Canada-U.S. Cooperative Monitoring Steering Committee has been established to encourage participation, build partnerships, and solicit resources and support to deliver monitoring programs that are specifically designed to address knowledge gaps in each lake, on a rotational cycle. The successes and challenges of these initiatives will be discussed.

The JA JAN Coalition a Binational Collaborative Network for Water Quality Monitoring in the U.S.-Mexico Border Region

Hiram Sarabia

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Hiram Sarabia researches applications of emerging technologies in environmental monitoring and risk assessment for the University of California at San Diego's Superfund Basic Research Program and is a founding member of the JA JAN Coalition. Hiram Sarabia has nearly 10 years of research and professional experience in the field of water quality monitoring and was director of the San Diego Coastkeeper's Binational Water Quality Monitoring Program for the U.S-Mexico border region for five years. Mr. Sarabia is defending a Master's Thesis with emphasis in Coastal Pollution from the University of San Diego Marine and Environmental Studies Graduate Program in the spring of 2006.

Abstract
The United States and Mexico share three major watersheds along their border region: the Tijuana River, Colorado River and Rio Grande watersheds. According to the U.S. EPA Border 2012 program, over the last decades this region has experienced rapid and unplanned growth that has resulted in the deterioration of natural resources and environmental health. Explosive population growth, combined with jurisdictional, legal, economic, language and cultural differences make dealing with watershed issues and promoting sustainability along the U.S-Mexico border particularly challenging. Moreover, the ability of government agencies monitor natural resources at regional scales is limited and work conducted by trained community groups operating in accordance to established QA/QC guidelines is providing an increasingly valuable source of additional information. A multidisciplinary binational network of environmental organizations, academics and citizens called JA JAN ('good water' in the regions' PaiPai language) has been working in the Tijuana River Watershed and California-Baja California region dealing with the borders' many drinking water, coastal water and inland watershed challenges and is producing reliable data and tangible results for government agencies and impacted communities on both sides of the border. This effort could serve as a community-level networking model for strengthening community capacity to monitor and manage water resources in other areas of the border region and developing countries.

Occurrence of Anthropogenic Organic Compounds in Ground Water and Finished Water of Community Water Systems

By Jessica A. Hopple

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Biographical Sketch of Author

Jessica Hopple, a hydrologist in the New Jersey Water Science Center of the U.S Geological Survey, received her B.S. and M.S. degrees in chemistry from George Mason University, Fairfax, Virginia. Employed by the USGS since 1978, Jessica is a member of the Source Water-Quality Assessment project of the National Water-Quality Assessment Program. She currently is writing a report characterizing the quality of water in major aquifers used as a source of supply and of the associated finished water from several large community water systems across the Nation.

Abstract

As part of the National Water-Quality Assessment (NAWQA) Program, the U.S Geological Survey (USGS) is conducting Source Water-Quality Assessments (SWQAs) to characterize the occurrence and concentrations of anthropogenic organic compounds in ground water withdrawn from selected aquifers used by Community Water Systems. SWQAs are intended to complement existing drinking-water monitoring required by Federal, State, and local programs, which focus primarily on post-treatment compliance monitoring. In the first year, samples of source water collected from about 15 production wells in each of 13 study areas across the United States were analyzed for about 270 anthropogenic organic compounds that included pesticides, pesticide degradates, polycyclic aromatic hydrocarbons, volatile organic compounds, and selected emerging contaminants. Detection frequencies and concentrations from the results of these initial analyses were used to select a subset of the wells for sampling during the second year of the study. During the second year, samples of source water from 86 wells and of the corresponding finished drinking water in 12 study areas were analyzed.

The second year of sampling focuses on comparing concentrations of compounds in source water to concentrations in finished drinking water. The results will enable NAWQA researchers to ascertain which compounds detected in source water are likely to be entering the communities' distributions systems and the concentrations at which they are likely to occur. Preliminary results from the second year of sampling indicate that the five most frequently detected compounds in source water were atrazine, deethylatrazine, metolachlor ethane sulfonic acid, metolachlor oxanilic acid, and trichloromethane (chloroform). The five most frequently detected compounds in finished drinking water were atrazine, bromodichloromethane, deethylatrazine, metolachlor ethane sulfonic acid, and trichloromethane.

Chemical Markers of Human Waste Contamination in Source Waters: A Simplified Analytical Approach

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Abstract
Giving public water authorities a tool to monitor and measure levels of human waste contamination of waters simply and rapidly would enhance public protection. Most of the methods used today detect this contamination by quantifying microbes that occur in feces in high enough densities such that they can be measured easily. However, most of these microbes, for example E. coli, are not a specific marker for any one host species. As an alternative, chemicals shed in feces might be used to detect human fecal contamination of environmental waters. One definitive chemical marker of fecal contamination is the compound urobilin. Urobilin is one of the final by-products of hemoglobin breakdown, it is excreted in both the urine and feces, and is specific to mammals. Source waters from 21 sites in New England, Nevada, and Michigan were extracted using hydrophilic-lipophilic balance (HLB) cartridges and then analyzed by high performance liquid chromatography-electrospray-mass spectrometry (HPLC-ES-MS). As a marker of human waste, urobilin was detected in many of the source waters at concentrations ranging from not detectable to 300 ng/L. Besides urobilin, azithromycin, an antibiotic widely prescribed for human-use only in the US, was also detected in many of these waters, with concentrations ranging from not detectable to 77 ng/L. This methodology, using both urobilin and azithromycin (or any other human-use pharmaceutical) could be used to give public water authorities a rapid (24 hrs) and definitive method for measuring human waste contamination. NOTICE: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

Occurrence of Radium-224, Radium-226, and Radium-228 in Aquifers Used Primarily for Drinking Water in the United States: Retrospective Survey of Results from 1987 to 2004

Zoltan Szabo[1], Eric Jacobsen[1], Jeffrey M. Fischer[1], Thomas F. Kraemer[2], and Vincent T. dePaul[1]

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Biographical Sketch of Authors
Zoltan Szabo has been a research hydrologist with the U.S. Geological Survey for 22 years. He received his MSc in geochemistry from Ohio State University. He has been investigating the occurrence and mobility of radium, radon, and uranium, and has been leading the effort to define the occurrence of short-lived radium-224 in ground water in the Nation, currently as part of the NAWQA program. He has helped design, test and implement "ultra-clean" ground-water sampling protocols for trace elements and mercury. He has investigated arsenic in soils of differing land uses. He is also investigating wastewater, pharmaceutical compounds, and mercury occurrence in ground water.

Eric Jacobsen has been a hydrologist with the U.S. Geological Survey for 21 years. He received his BSc in geology from the State University of New York at Binghamton. He has investigated the mobility of trace elements and nutrients from land-applied biosolids in acidic soils and ground waters and has worked on designing sampling programs for radionuclide, wastewater, and pharmaceutical compound occurrence. He is working on several water-quality issues for the NAWQA program.

Jeffrey Fischer has been a hydrologist with the U.S. Geological Survey for 25 years. He studied radionuclide transport and biodegradation as part of his work on low-level disposal issues. He has been heading the Delaware River NAWQA program for the last 5 years.

Thomas Kraemer has been a research hydrologist with the U.S. Geological Survey for 29 years. He received his Ph. D. from the University of Miami, Rosenstiel School of Marine and Atmospheric Sciences. He leads the "Radionuclides in ground water" research project investigating naturally occurring radionuclides in rock, water and gas in a wide variety of locations, including impact craters, permafrost regions, sabkhas (salt flats), lakes and major river basins, oil and gas deposits, and ground waters. He has developed or modified new techniques for the analysis of naturally occurring radionuclides.

Vincent dePaul has been a hydrologist with the U.S. Geological Survey for 14 years. He received his BSc degrees in Geography and Geosciences at the College of New Jersey. He has worked in the Atlantic Coastal Plain characterizing the occurrence of radium in ground water, the occurrence of salt-water intrusion, and regional-scale water level declines.

Abstract
Radium, a human carcinogen, poses a risk through ingestion of drinking water containing it. The U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) for combined radium (radium-226 (Ra-226) plus radium-228 (Ra-228)) is 5 pCi/L (picocuries per liter). The concentration of short-lived (half-life, 3.64 days) radium-224 (Ra-224) is not considered for the combined radium MCL, but the alpha-particle emissions from it are detected by gross alpha-particle activity measurement, which has a 15-pCi/L MCL. Occurrence data for radium has been limited by high cost of analysis, and by use of gross alpha-particle activity as a surrogate for occurrence. Also, existing analytical techniques had not been refined to adequately characterize the concentration of Ra-224. The U.S. Geological Survey National Water Quality Assessment (NAWQA) program, in cooperation with the USEPA, is evaluating

occurrence data for uranium, radon, and isotopes of radium in water from aquifers that are major sources of drinking water. An issue of concern is whether the highest concentrations of radium are distributed throughout the Nation or are clustered in a few broad physiographic provinces.

Of the about 750 untreated filtered samples collected from 33 NAWQA study units and analyzed for both Ra-226 and Ra-228 concentrations, about half were from domestic supply wells. Eight samples (1.1 percent), all from the Coastal Plain or Appalachian physiographic provinces, contain concentrations of combined radium greater than the MCL (maximum concentration, 12.4 pCi/L). Of the 53 samples with combined radium concentrations greater than 2 pCi/L, 41 (77 percent) were from those two provinces. The distribution of Ra-224 concentrations was similar to that of the other Ra isotopes, but the sample with the maximum concentration, 10.6 pCi/L, and about 20 percent of samples with concentrations greater than 2 pCi/L were from alluvial aquifers in the western United States. The highest concentrations of Ra in ground water were found mostly, but not exclusively, in the Coastal Plain and Appalachian physiographic provinces.

Monitoring Synthetic Musk Compounds in Municipal Wastewater and Estimating Biota Exposure in the Receiving Waters

Lantis I. Osemwengie

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Biographical Sketch of Author

Dr. Lantis Osemwengie is a research chemist in the Environmental Sciences Division within the U.S. Environmental Protection Agency's Office of Research and Development with training and experience in environmental chemistry. He has authored several peer-reviewed journal articles that present new chemical analysis methods for determining ultra-trace levels of organic chemical contaminants in surface water, biota, and biosolids. He is also a member of the American Chemical Society board of councilors, representing the Southern Nevada Local Section.

Abstract

Synthetic musk compounds are consumer chemicals manufactured as fragrance materials and consumed in very large quantities worldwide. Due to their high usage and release, they have become ubiquitous in the environment. The U.S. EPA (Las Vegas) developed surface water monitoring methodology and conducted a 1-year monthly monitoring of synthetic musk compounds in water and biota from Lake Mead (Nevada) as well as from combined sewage effluent streams feeding Lake Mead. Evaluation of data obtained from the analyses of combined effluent streams from three municipal sewage treatment plants (STPs), from lake water, and from whole carp (*Cyprinus carpio*) showed a relationship between values from the source (STPs effluent) and those from the receiving waters (Lake Mead). Presented here is the overview of the chemistry, the monitoring methodology, and the statistical evaluation of concentrations obtained from the analysis of a suite of these compounds in different environmental compartments.

SPARROW: A Hybrid Statistical-Deterministic Approach to Modeling Surface-Water Quality

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Biographical Sketches of Authors
Richard Smith received B.S. and M.S. degrees in biology from the University of Richmond and a PhD in Environmental Engineering from Johns Hopkins University. His research career with the U.S. Geological Survey spans more than 30 years and includes investigations into many aspects of water quality and related topics in ecology, public health, statistics, and modeling. He has been a co-developer of the SPARROW water quality model currently in wide use by the USGS. His peer-reviewed publications have appeared in numerous journals including *Science, Nature, Environment, American Journal of Tropical Medicine and Hygiene, Ecological Modeling,* and *Water Resources Research*.

Richard Alexander is a Research Hydrologist with the NAWQA program, and has been with the USGS for 25 years. He also coordinates and instructs in the USGS National Training Center's course on statistical methods and data analysis and has served as a visiting scientist with the National Institute of Water and Atmospheric Research in New Zealand. He received a B.A. from the University of North Carolina-Charlotte in 1979 and a M.S. in Water Resources Administration from the University of Arizona in 1982. His current research focuses on the development and use of modeling techniques to assess the sources and transport of contaminants in surface waters and their relation to biogeochemical and anthropogenic characteristics of watersheds.

Gregory Schwarz received a B.A. from Syracuse University and M.A. and Ph.D. degrees in economics from the University of Chicago. He worked as a resource economics consultant and taught economics at the University of Maryland Baltimore County. In 1991, he joined the the Branch of Systems Analysis in the Water Resources Division of the USGS, and in 1998 became associated with the National Water Quality Assessment Program. His current research interests include the development of statistical models for estimating water quality flux and trend, national-scale empirical models of water quality (SPARROW), and quantifying the socioeconomic impacts of climate change.

Abstract
Faced with tightening budget constraints on monitoring, water-resource managers are increasingly using water-quality models to quantify the effects of pollution sources on un-monitored waters and to predict the effectiveness of alternative pollution-control strategies to achieve efficient designs. Unlike more highly complex, short time-step, deterministic models commonly used in intensive river and lake studies, the SPARROW modeling approach (SPAtially Referenced Regression on Watershed attributes) uses models that are statistically calibrated on the basis of data from conventional fixed-station monitoring networks. The SPARROW approach addresses growing concerns in the scientific community about whether sufficient high-frequency monitoring data, ancillary input data, and knowledge of biogeochemical processes exist to reliably support calibration and use of highly complex deterministic models and to properly quantify their error bounds, especially at large spatial scales. SPARROW calibration is based on a nonlinear regression equation incorporating a few fundamental mechanistic components including explicit surface-water flow paths, non-conservative transport processes, and mass-balance constraints on long-term mean conditions. The model infrastructure consists of a spatially detailed stream-reach network with DEM-delineated watersheds. Pollutant sources and climatic and hydrogeologic properties that affect contaminant transport are spatially referenced to the reach network. The separation of land and water components in the model allows for separate empirical estimation of the

rates of pollutant delivery to streams from point and diffuse sources and subsequent downstream pollutant transport. Model coefficients have physically meaningful interpretations and may be compared with experimentally derived values from the literature. The SPARROW calibration algorithm provides formal estimates of the error bounds of model parameters and predictions. SPARROW models have been used successfully in several recent applications in the areas of chemical and biological water-quality assessment and management.

New England SPARROW Model And Example Applications of Model Results

Richard B. Moore[1] and Laura J. Blake[2]

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Biographical Sketches of Authors
Richard B. Moore attended the University of New Hampshire, and has obtained a Bachelor of Science degree in Hydrology and a Master of Science degree in Geology. In 1979, Richard began working for the U.S. Geological Survey where has since conducted numerous projects, including, most recently the New England Spatial Regression on Watershed Attributes (NE SPARROW) project.

Laura J. Blake is an Environmental Analyst at the New England Interstate, Water Pollution Control Commission and is their coordinator for the New England SPARROW Model.

Abstract
The U.S. Geological Survey, in cooperation with the New England Interstate Water Pollution Control Commission and the U.S. Environmental Protection Agency (USEPA), has developed SPARROW (SPAtially Referenced Regressions On Watershed Attributes) models to assist in regional water-quality management activities in New England (NE). The NE SPARROW models relate available monitoring data on nitrogen (N) and phosphorus (P) (nutrient) stream loads to pollution sources and watershed characteristics. These statistical relations are then used to estimate nutrient loads in unmonitored streams.

Catchment characteristics were computed for approximately 42,000 stream reaches and used as model input. Independent variables included point-source data derived from USEPA's Permit Compliance System, and non-point source data derived from land-cover and atmospheric-deposition datasets. Reach and catchment physical characteristics included streamflow, time-of-travel, stream density, percent wetlands, slope of the land surface, and soil permeability. The catchment delineation method, developed for this project, has subsequently been applied to the entire conterminous United States, as part of NHDPlus, an enhanced National Hydrography Dataset.

The NE SPARROW models for total N and total P have R-squared values of 0.95 and 0.94, respectively. Significant sources of N include wastewater discharges, atmospheric deposition, agricultural area, and developed land area. Significant sources of P include wastewater discharges, forested area, agricultural area, and developed land area.

SPARROW model results provide estimates and confidence intervals of nutrient loads, area-weighted yields of nutrients, sources of nutrients, and the downstream movement of nutrients. This information can be useful for determining (1) regional nutrient criteria options, (2) source and magnitude of nutrient loads in streams, (3) downstream (including estuarine) effects, and (4) appropriate monitoring strategies. SPARROW model results are being used to help assess nitrogen loadings to Long Island Sound, an impaired coastal waterway. The SPARROW model results provide estimates of nutrient loadings by upstream source, watershed, and state.

Regional Scale Point-Source Nutrient Load Estimation in Support of SPARROW Nutrient Modeling

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Gerard McMahon is a geographer in the U.S. Geological Survey National Water Quality Assessment Program whose research interests include regional nutrient modeling, studies of the water quality effects of urbanization, and the development and use of ecoregion frameworks. Since 1999 he has worked on regional implementations of the SPARROW model.

Larinda Tervelt is a biologist for the U.S. Environmental Protection Agency. Her interest is in nutrient enrichment and the national strategy to reduce the frequency, duration, size and degree of oxygen depletion of the hypoxic zone of the northern Gulf of Mexico. She has worked on this effort since 1995 from the Gulf of Mexico Program Office at Stennis Space Center in Mississippi and has recently moved to Atlanta.

William (Mike) Donehoo is an Environmental Engineer in the U.S. Environmental Protection Agency's Region 4 office. He has served as a Clean Water Act permit writer, enforcement officer, and for over twenty years as regional manager of EPA's Permit Compliance System (PCS) database. He has earned national recognition for his expertise in extracting data from PCS and preparing it for use in other systems and projects.

Abstract

One of the greatest challenges in developing regional-scale nutrient water-quality models is the estimation of nutrient inputs. Regional SPARROW (SPAtially Referenced Regressions On Watershed attributes) models require development of either mass-based nutrient input estimates (e.g., total annual nutrient mass associated with fertilizers or point sources) or area-based proxy measures of nutrient inputs (e.g., areas of agricultural or urban land). Researchers at USGS and US EPA, in conjunction with the U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program, are estimating annual nitrogen and phosphorus inputs associated with approximately 4,000 point-source dischargers in the southeastern United States, with the intent us using the input estimates in the calibration and application of a regional SPARROW model. The study includes basins draining to the southern Atlantic, Gulf Coast, and the Tennessee River.

Site information, including latitude and longitude and monitored effluent data, are compiled into a project database from both state and USEPA databases, including the USEPA Region 4 Permit Compliance System (PCS) database. For sites with a complete effluent monitoring record, flow and effluent-concentration data are used to develop estimates of annual point source nitrogen and phosphorus flux. When flow data exist but concentration data are missing or incomplete, typical pollutant concentrations (TPC) of total nitrogen and total phosphorus are used to estimate flux. Dischargers are classified by both the magnitude of discharged flow and type of discharger, indicated by the Standard Industrial Classification (SIC). TPC values are estimated using several approaches, including use of observed distributions of concentrations in the project database, summarized by state, flow classification, and SIC, and a national review of SIC-based discharges conducted by U.S. EPA. Annual point-source nutrient input estimates are allocated to specific river reaches for use in the SPARROW model.

Effect of Stream-Network Resolution and Monitoring-Site Density on the Calibration of a Nutrient SPARROW Model for the Southeastern United States

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Anne Hoos is a hydrologist in the U.S. Geological Survey National Water Quality Assessment Program, where she has conducted monitoring and statistical modeling investigations of nutrient transport in surface water. She has worked since 2002 on SPARROW model documentation and model applications in the Southeast. Gerard McMahon is a geographer in the U.S. Geological Survey National Water Quality Assessment Program whose research interests include regional nutrient modeling, studies of the water quality effects of urbanization, and the development and use of ecoregion frameworks. Since 1999 he has worked on regional implementations of the SPARROW model.

Abstract
The U.S. Geological Survey's National Water-Quality Assessment Program is compiling surface-water-quality data and estimates of nutrient sources (agricultural, atmospheric, urban runoff, and wastewater) from Federal, State, and local water-resource agencies throughout the Southeastern United States to estimate rates of nitrogen and phosphorus transport in surface water and to estimate which sources and watersheds contribute the highest nutrient loads. The SPARROW (SPAtially-Referenced Regression On Watershed attributes) water-quality model is used to quantify the sources of nutrients and the transport of these nutrients to downstream water bodies and coastal areas, providing information that can assist water-resource managers in selecting nutrient control strategies.

The modeling objectives include investigation of the effect of stream-network resolution and monitoring-site density on model calibration and performance. Two separate SPARROW models, one built from the RF1 reach network (Reach File Version 1.0, 1:250,000-scale hydrography) and one built from the NHD reach network (National Hydrography Dataset, 1:100,000-scale hydrography), were calibrated. The smaller calibration set for the RF1-based model was developed from the 600-site calibration set for the NHD-based model as the subset (400) of the monitoring sites that intersected the coarser RF1 network. Aspects of model calibration under investigation include sensitivity to network resolution and monitoring-site selection of: (1) prediction accuracy; (2) allocation of nutrient-mass attenuation to overland and instream transport; (3) standard error associated with model estimation of overland and instream nutrient attenuation; and (4) predicted loads and load distribution among stream size classes.

Evaluation of Ground-Water-Quality Trends Design as Part of the USGS National Water Quality Assessment Program

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Michael Rosen has been a Research Hydrologist at the US Geological Survey since 2001. Before this he worked at the Institute of Geological and Nuclear Sciences in New Zealand, the Division of Water Resources, CSIRO, and Curtin University of Technology, Western Australia, and at the Limnological Research Center, University of Minnesota. Michael received his degrees in geology from Haverford College (BS), the University of Rochester (MS), and the University of Texas at Austin (PhD). His research in the past has covered the fields of hydrochemistry, chemical limnology, sedimentary geochemistry, paleolimnology, ecology, geothermal and Antarctic research, and hydrogeology.

Abstract

Chemical analyses of nutrients, pesticides and volatile organic compounds in ground water sampled by the U.S. Geological Survey (USGS) National Water-Quality Assessment Program (NAWQA; http://water.usgs.gov/nawqa) since 1988 are being evaluated to determine if the concentrations and detection frequencies of selected analytes have changed significantly over time. Trends are being evaluated in 16 principal aquifers within the United States. Networks of about 30 wells each are resampled approximately 10 years apart to determine decadal-scale changes. Also, a subset (5 wells) of these trend network wells are sampled biennially throughout the decadal cycle and quarterly (4 times) in a single year to evaluate short-term seasonal variations that could complicate long-term trends analysis. Small-scale studies of local flow systems also provide information on trends by the analysis of chemical transport of ground water to various receptors. Evaluation of the data is ongoing and is being done on national, regional and local scales. An evaluation of the quarterly sampling data indicates that quarterly sampling for only one year is inadequate to quantify seasonal variations in ground-water quality. Reasons include variability in chemical concentrations due to year-to-year variations in climate, irrigation, and cropping patterns, unidirectional variations in concentrations caused by long-term trends, and random noise caused by analytical precision and sampling. If water-quality data are combined with continuous water-level data from the same well, some inferences about seasonal variations can be made at a local scale; however, these inferences may not be valid for an entire well network. Comparison with another national ground-water-quality dataset from New Zealand indicates that a minimum of three years of quarterly data are needed before definitive seasonal variations can be determined. NAWQA is in the process of evaluating the trend-network study design in order to enhance the long-term ability to detect trends in ground-water quality.

Trends in Pesticide Detections and Concentrations in Ground Water of the United States, 1993-2003

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Laura Bexfield is a hydrologist in the New Mexico Water Science Center within the U.S. Geological Survey. She has a Master's Degree in hydrology and specializes in ground-water chemistry. Mrs. Bexfield has been involved in the National Water-Quality Assessment (NAWQA) Program since joining the USGS in 1993, and currently works on NAWQA projects at both the national and local levels. She also has been involved with multiple studies characterizing aquifer systems in New Mexico through the use of ground-water chemistry, environmental tracers, and ground-water-flow modeling.

Abstract

Pesticide data for ground water sampled in many regions of the United States between 1993 and 2003 by the U.S. Geological Survey (USGS) National Water-Quality Assessment Program (NAWQA; http://water.usgs.gov/nawqa) were evaluated for trends in detection frequency and concentration. The data analysis evaluated samples collected from a total of 445 wells located in 12 networks characterizing shallow ground water in agricultural areas and 6 networks characterizing the drinking-water resource in areas of variable land use. The well networks were sampled about eight years apart, once during 1993-95 and once during 2001-03. The networks provide a broad overview of conditions across a wide range of hydrogeologic settings and in major agricultural areas that vary in dominant crop type and pesticide use.

Of more than 100 pesticide compounds analyzed (mostly herbicides, insecticides, and selected degradates), only 8 compounds were detected in ground water from at least 10 wells during both sampling events. These compounds were the triazine herbicides atrazine, simazine, and prometon; the acetanilide herbicides alachlor and metolachlor; the urea herbicides diuron and tebuthiuron; and an atrazine degradate, desethyl-atrazine (DEA). Most detections of these compounds were at concentrations less than 0.5 micrograms per liter. Changes in concentrations between sampling events typically were less than 0.2 micrograms per liter.

Preliminary data analysis for wells with detections during both sampling events indicated that concentrations of atrazine, prometon, and simazine had decreased on a national scale between sampling events, whereas concentrations of DEA had increased. More detailed analysis incorporated information on the variability of pesticide concentrations associated with field and laboratory procedures (as assessed through field replicates) and changes in laboratory performance (as assessed through laboratory spikes). The more detailed analysis indicated that no national trends in concentrations between sampling events could be identified with confidence for these compounds. Detailed analysis of pesticide trends also is being conducted at the network scale by USGS NAWQA investigators.

Trends in Shallow Ground-Water Quality of the Delmarva Peninsula, Delaware, Maryland, and Virginia: Results from Local-Scale and Regional Study

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Linda M. Debrewer is a hydrologist with the U.S. Geological Survey. Since 2000, she has been the ground-water specialist for the Potomac River Basin and Delmarva Peninsula National Water-Quality Assessment (NAWQA) study unit. Her research includes spatial and temporal trends in ground-water chemistry in Coastal Plain and carbonate aquifer systems.

Judith M. Denver has been a hydrologist with the U.S. Geological Survey since 1980. She is currently the chief of the Potomac River Basin and Delmarva Peninsula NAWQA study unit. Her research includes analysis of the effects of land use and hydrogeology on ground-water and stream chemistry.

Abstract
Multiple studies of spatial and temporal trends in nitrate and selected pesticide concentrations were conducted from the late 1980s through 2001 in the surficial unconfined aquifer of the Delmarva Peninsula, Delaware, Maryland, and Virginia. The surficial aquifer is generally sandy and permeable with well-oxygenated ground water. Samples were collected from 60 shallow wells (less than 100 feet below land surface) located throughout the Peninsula and along three flow paths located in agricultural areas. The median nitrate concentration in water from the surficial aquifer is about 5 milligrams per liter as nitrogen. There was no apparent change in nitrate from 1988 to 2001 in the shallower parts of the surficial aquifer or in water from the flow paths. Higher nitrate concentrations have migrated into deeper, older parts of the flow systems over time at two of the flow-path sites, however, and nitrate concentrations increased by an average of 2 milligrams per liter between 1988 and 2001 in the deeper part of the surficial aquifer used for domestic supply where dissolved oxygen concentrations are greater than 1 milligram per liter. These increases in nitrate concentrations with depth in the surficial aquifer are attributed to changes in nitrogen application over time.

Concentrations of selected herbicides and degradation products are related to land-use patterns and hydrologic conditions. Metolachlor, alachlor, and atrazine are the most commonly detected herbicides, occurring primarily in the form of degradation products. Regionally, pesticide concentrations tend to be higher beneath well-drained agricultural areas and are present in oxidizing environments throughout the surficial aquifer. Temporal trends in pesticide concentrations are not evident on the regional scale; however, higher concentrations of atrazine and metolachlor have migrated farther along one of the flow paths over time.

Ground-Water Quality Trends of the South Platte River Alluvial Aquifer, Colorado

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Suzanne Paschke is a Research Hydrologist with the U.S. Geological Survey (USGS) and Ground-Water Specialist for the South Platte River basin study unit of the USGS National Water-Quality Assessment (NAWQA) Program. Dr. Paschke has over twenty years experience evaluating and modeling ground-water systems and water-quality. Ms. Mashburn is a Hydrologist with the USGS specializing in water-quality sampling and assessment, and Ms. Flynn is a Hydrologist with the USGS providing expertise in geographical information systems and database management. Mr. Bruce is a Supervisory Hydrologist with the USGS and Project Manager for the South Platte River basin study unit of the NAWQA Program.

Abstract
Temporal trends in ground-water quality of the South Platte River alluvial aquifer in Colorado and Nebraska were investigated by the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS). The South Platte River alluvial aquifer is composed of unconsolidated upper Pleistocene to upper Holocene sand and gravel valley-fill and terrace deposits along the South Platte River and its tributaries. The alluvial aquifer is vulnerable to the effects of overlying land use because of its high hydraulic conductivity and the direct connection between the land surface and the water table. From 1992 to 1995, the USGS NAWQA Program installed and sampled 30 monitoring wells in the South Platte alluvial aquifer from Brighton, Colorado, to North Platte, Nebraska, to examine the effects of irrigated corn agriculture on ground-water quality. An additional 15 wells were installed and sampled along two ground-water flow paths near Greeley, Colorado, in the early 1990s. Both NAWQA networks were resampled from 2002 to 2005 to examine decadal changes in ground-water quality, and some of the NAWQA wells were sampled annually and quarterly by State and local agencies during the 10-year period. Water-quality results indicate a statistically significant increase in ground-water nitrate concentrations and statistically significant decreases in ground-water atrazine and prometon concentrations from 1992 to 2005. Flow-path-study results indicate travel times from upland recharge areas to discharge areas along the South Platte River range from approximately 20 to 25 years. Ongoing analyses of land-use and agricultural practices over the past decade are designed to provide explanations for the observed changes in ground-water quality.

Wet Deposition of Mercury in the U.S. and Canada, 1996-2004: Results from the NADP Mercury Deposition Network

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David Gay is an Environmental Scientist in the Center for Atmospheric Sciences, within the Illinois State Water Survey, a research arm of the Illinois Department of Natural Resources at the University of Illinois. His training is in air pollution and climatology. Since 2004, he has served as the Assistant Coordinator for Toxics, operating the Mercury Deposition Network of the National Atmospheric Deposition Program. His research specialty is the interaction of air pollutants and climate.

Abstract
The Mercury Deposition Network (MDN) is part of the National Atmospheric Deposition Program (NADP), and operates approximately 90 mercury wet-deposition sites surrounding the United States and Canada. Wet deposition is thought to be the dominant input of mercury to water bodies. Annual summaries from weekly observations are reported for the years 1996-2004. The mean mercury concentration is 12.9 ng/L (median = 9.4 ng/L). Wet deposition of mercury depends on both the concentration in the rain and the total rainfall amount. Wet deposition is highest in the southeastern U.S. The mean mercury deposition per week is 200 ng/m^2 week (median = 98 ng/m^2 wk). Annual averages are 9.3 ug/m^2 yr and the median is 8.5 ug/m^2 yr. For MDN sites east of the Rockies, mercury deposition is strongly seasonal with summertime depositions averaging about 6 times wintertime depositions. In addition, the number of observations is great enough for trends to be determined. Negative trends in both concentration and deposition are present, but are small.

Mercury Concentration in Fish from Streams/Rivers Throughout the Western United States

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Spencer Peterson and John Van Sickle are Senior Research Ecologist and Biological Statistician, respectively, at the U.S. Environmental Protection Agency, National Health and Ecological Effects Research Laboratory, Western Ecology Division. Peterson received a B.S. in biology from Sioux Falls University and a M.S. and Ph.D. in fisheries science and aquatic ecology, respectively, from the University of North Dakota. His current research is focused on mercury in fish tissue as it relates to regional assessments of streams and lakes. Van Sickle received M.S.degrees in mathematics and statistics from Michigan State University and Oregon State University, respectively, and a Ph.D. in Systems Science from Michigan State University. His research interests include aquatic bioassessment, watershed-stream linkages, and multivariate statistical modeling.

Alan Herlihy and Robert Hughes are both Senior Research Associate Professors at Oregon State University in the Department of Fisheries and Wildlife. Herlihy received his undergraduate degree in chemistry from Northwestern University, and a M.S. and Ph.D. in environmental sciences from the University of Virginia. His current research projects focus on developing survey design methodology, assessment approaches, and ecological indicators for assessing surface water ecological condition. Hughes received his A.B. in Psychology and Biology and M.S. in Resource Planning & Conservation from the University of Michigan, and his Ph.D. in Fisheries from Oregon State University. His current research interests include explaining regional patterns in aquatic ecosystems and developing ecological indicators for assessing surface water condition.

Abstract
We collected 2 707 fish from 626 stream/river sites in 12 western USA states using a probability design to assess the spatial extent of whole fish mercury (Hg) concentrations. In all large (> 120 mm) fish, Hg concentrations (mean $\mu g \cdot g^{-1}$; SD) in both piscivores (0.260; 0.241) and non-piscivores (0.090; 0.101) exceeded the wet weight detection limit of 0.0024 $\mu g \cdot g^{-1}$. Hg levels were most strongly related to fish length and trophic guild rather than environmental factors tested. We constructed a model to predict filet Hg concentrations from whole fish Hg concentrations. Salmonidae, the most commonly occurring family, exceeded 0.1 μg $Hg \cdot g^{-1}$ (deemed protective for fish-eating mammals) in 11.1% of assessed stream length and exceeded the filet equivalent of 0.3 μg $Hg \cdot g^{-1}$ (USEPA human consumption advisory level) in 2.3% of assessed stream length. Piscivores were found at fewer sites, but their Hg concentrations exceeded 0.1 $\mu g \cdot g^{-1}$ in 93% of assessed stream length, and the 0.3 μg $Hg \cdot g^{-1}$ filet equivalent concentration in 56.8% of assessed stream length. Our findings, coupled with those of others, suggest long range atmospheric transport is a key factor relative to Hg in fish across the western USA.

The Roles of Biogeochemistry and Aquatic Biota in Mercury Cycling in Stream Ecosystems

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Lia Chasar received her Ph.D. in Biological and Chemical Oceanography in 2001 from Florida State University. Her research focuses on understanding the links between biogeochemical processes and trophic dynamics in aquatic ecosystems; she specializes in using natural tracers and population dynamics to evaluate the ways in which environmental disturbances (nutrient and contaminant loading, water management, climate shifts) influence the flow of energy (as carbon, nitrogen and sulfur) through these systems. She has been with the USGS NAWQA Georgia-Florida Coastal Plains study since 2001, and is an Assistant Professor in Environmental Sciences at Florida A & M University in Tallahassee, Florida.

Barbara Scudder's expertise is in the effects of water quality on stream biota, with emphasis on trace elements, bioaccumulation, and toxicity; she also studies community ecology of benthic algae, invertebrates, and fish. She received a B.A. in Aquatic Biology in 1979 from the University of California - Santa Barbara and a M.S. in Marine Science in 1984 from California State University - Hayward (Moss Landing Marine Laboratories). At the USGS, as the lead biologist for the Western Lake Michigan Drainages NAWQA study, she is involved in multi-year biological research efforts on water quality using aquatic biota.

Robin Stewart is a Research Hydrologist with the USGS National Research Program in Menlo Park California. Robin's research focuses on understanding transport, fate and bioaccumulation of trace metals, elements and organic contaminants in aquatic systems. She has studied a range of contaminants including trace elements (metals, Se, Hg) and organochlorine pesticides (PCBs, DDT), in a variety of aquatic systems including lakes and reservoirs, wetlands, estuaries and rivers.

Amanda Bell received her B.S. in watershed management in 2002, and M.S. in natural resource management in 2005, from University of Wisconsin in Stevens Point. She is a Hydrologist with a biological emphasis with the USGS NAWQA Program and has been with the USGS since 2001. Her current projects evaluate mercury in riverine biota, especially periphyton, and the effects of urbanization on biological communities in rivers.

Abstract

Although recent advances have been made toward understanding the geochemistry of mercury (Hg) in freshwater ecosystems, abiotic and biotic mechanisms responsible for uptake, assimilation, and biomagnification of Hg by aquatic biota remain poorly characterized in lotic systems. The U.S. Geological Survey is conducting multi-year, interdisciplinary (geochemistry, microbial ecology, biology), process-oriented studies in stream systems across the U.S. Geological Survey to address this knowledge gap. Hg in surface water, streambed sediment, and biota, as well as other environmental parameters (including stream discharge, pH, water temperature, dissolved organic carbon, sulfide/sulfate), were sampled intensively across eight diverse stream systems from 2002-2004: surface water 18 times per year; bed sediment, periphyton, invertebrates and forage fish twice per year; and apex predators, such as

largemouth bass and cutthroat and rainbow trout, once per year. Streams were selected to represent a range in diversity of watershed characteristics such as land use and land cover, Hg loading, water chemistry (e.g., pH=2.94-8.4, DOC=0.06-77.0 mg/L), and temperature regime; and were located in the Willamette Basin in Oregon, the Western Lake Michigan Drainages in Wisconsin, and the Georgia-Florida Coastal Plain Drainages in Florida. Preliminary examination of data collected to date illustrates a strong correlation between Hg bioaccumulation and the concentration and complexity of DOC ($r^2_{DOCvsSUVA}$ for forage fish=0.83; $r^2_{DOCvsSUVA}$ for predators=0.95), as well as system-specific differences in net Hg-methylation and the efficiency of uptake and trophic transfer of Hg. In addition to promoting an improved understanding of the factors controlling bioaccumulation of Hg in aquatic ecosystems, intensive multi-year studies such as this serve as valuable management resources. The development of heuristic ecosystem models and other management tools (eg, total maximum daily loads; bioaccumulation factors) benefit greatly from larger sample sizes and more frequent and comprehensive sampling than are typical of routine state and regional monitoring efforts.

Mercury in Ground Water, Soils, and Septage, New Jersey Coastal Plain

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Julia L. Barringer is a research hydrologist with the U.S. Geological Survey. She received her Ph.D. in geology/geochemistry from the University of Pennsylvania, relating trace-element chemistry of meta-igneous rocks to tectonic setting. Since 1984, she has studied the effects of acid rain on a Coastal Plain watershed, has investigated arsenic in soils of differing land uses, and has determined arsenic sources to a New Jersey Highlands watershed. She continues to investigate sources of mercury to Coastal Plain ground water and the processes that mobilize mercury in ground water and surface water.

Zoltan Szabo is a research hydrologist with the U.S. Geological Survey. He received his MSc in geology/geochemistry from Ohio State University evaluating the potential of strontium isotopes as ground-water flow tracers. He has been investigating the occurrence and mobility of radon and radium since 1985 and has been the National leader in defining the occurrence of short-lived radium-224 in ground water. He helped design, test and implement "ultra-clean" ground-water sampling protocols for trace elements and mercury. He has investigated arsenic in soils of differing land uses. He is currently investigating wastewater, pharmaceutical compounds, and mercury in ground water.

Abstract

Investigations by health departments of eight counties in southern New Jersey, the N.J. Department of Environmental Protection, and the U.S. Geological Survey (USGS), have shown that mercury concentrations in water tapped by about 600 domestic wells exceed the maximum contaminant level (MCL) of 2 micrograms per liter. The wells are finished in the areally extensive unconfined Kirkwood-Cohansey aquifer system of New Jersey's Coastal Plain. Background concentrations of mercury in water from this system are < 0.01 micrograms per liter. Evidence of contributions from point sources (landfills, hazardous-waste sites) is lacking. During 1996-2003, the USGS collected water samples from 203 domestic, irrigation, observation, and production wells using ultraclean techniques; septage, leach-field effluent, soils, and aquifer sediments also were sampled. Elevated concentrations of ammonium, boron, chloride, nitrate, sodium, and presence of surfactants in domestic-well water indicate that septic-system effluent affects water quality in unsewered residential areas. Neither septage nor effluent appears to be a major mercury source. Detections of hydrogen sulfide in ground water at a residential area indicate localized reducing conditions. Undetectable sulfate concentrations in water from other residential areas indicate that reducing conditions, perhaps conducive to mercury methylation, may be common locally. Volatile organic compounds (VOCs), mostly chlorinated solvents, also are found in ground water at the affected areas, but statistically significant associations between presence of mercury and VOCs were few for the areas evaluated. In several paired samples, mercury concentrations were lower in filtered water than in unfiltered water, probably indicating that some mercury is associated with particles or colloids. The source of colloids may be soils, which, when undisturbed, contain higher concentrations of mercury than do disturbed soils and aquifer sediments. Disturbance during residential development and septic-system effluent may mobilize mercury from soils to ground water; concentrated sources of mercury have yet to be found.

Connection before Protection

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Abstract
Before you learned to use chemical test kits…..before you decided where to cast your fishing line…..before you waded into a creek just for the experience…..something happened to awaken you to the value of clean, functioning streams, rivers and lakes.

Chances are this essential "something" that took place has been a player in your decision to be a water quality professional. Or if you are a volunteer, this "something" has helped you to place a priority on environmental protection. It is important to share this critical connection to the natural world with others, so that we can work together to protect.

This presentation will look at activities and experiences that lead people to become stewards of their local resources. Included are many scenes of people actively engaged in outdoor activities – the kind of activities that get people involved, that touch the folks who are busy, who seem to be focused on everything but their environment, and the folks who may be out of touch with most anything that does not impact them at this minute in their little corner of the world. This presentation will also touch on the importance of leaving the office for the creek; the value of field experiences; and the differences in lifestyles and relationships to nature.

The goal of this presentation is to remind the participants of when they first became believers in stewardship, and to emphasize the importance of connecting the general public with the resources we work daily to protect.

How to Get the Public Active in Water Quality Issues

Ginger North

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Ginger is the Stream Watch Coordinator for the Delaware Nature Society. Previously she was Stream Watch Assistant Coordinator, the Technical Monitoring Assistant in the Natural Resource Conservation Department, and a Naturalist in the Education Department all for the Delaware Nature Society.

She received a Masters of Science degree in Genetics from the University of Delaware, and Bachelor of Science degree in Biology/Marine Biology from the University of Long Island. She taught biology laboratories for four years at the University of Delaware. She also has an extensive background in Quality Control, both in clinical microbiology laboratory and in a hospital endocrinology laboratory.

Abstract

Those of us in academia, non-profit volunteer monitoring groups, or state, national, and other regulatory entities are constantly made aware of how critical water quality issues are. How do we present the data and issues in a way that encourages the public to take action? Join us for a presentation that shows Delaware Stream Watch's perspective on how to empower citizens to take action. Delaware Stream Watch is a grassroots volunteer waterway protection program focusing on citizen monitoring, education, and advocacy. Founded in 1985 as a partnership between the Delaware Nature Society and the Division of Water Resources of the Delaware Department of Natural Resources and Environmental Control (DNREC), it is one of the oldest statewide volunteer water quality monitoring programs in the nation, and one of the few joint efforts between a state agency and a non-profit environmental organization. When we think of citizen action we often automatically turn towards data collection, Delaware Stream Watch will present ways the public can improve water quality by applying the concept of watershed stewardship to their own backyards.

Breaking the Code: Training Volunteers to Convert Data to Information

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Biographical Sketch of Author
Candie Wilderman is a Professor of Environmental Sciences at Dickinson College, in Carlisle PA. She is also the Founder and Science Director of the Alliance for Aquatic Resource Monitoring (ALLARM), a project of the Environmental Studies Department which provides programmatic and technical assistance to watershed groups. Her teaching and research interests include: community-based research, watershed assessment and management, water quality, and aquatic ecology.

Abstract
As the volunteer monitoring movement continues to move forward, the issue of data analysis is emerging as the new frontier. Volunteer monitoring groups have learned to define their goals, design their studies, and collect and measure a wide array of indicators. But then, how are the data to be analyzed? Who can interpret the maze of numbers, pulling useful information from the data – information that can inform action decisions? Is it feasible for volunteers to engage in meaningful data analysis?

This presentation will first focus on the importance of volunteers engaging in this difficult process in terms of the sense of ownership, increased understanding, and empowerment for action that comes out of this involvement. It will also discuss the special contribution of volunteers in terms of utilizing local knowledge for sound interpretation of cause and effect.

A two-phase model for training volunteers to interpret data will be presented. The first phase is an analysis of a "virtual" watershed case study to teach statistical and graphical interpretation skills and to lead volunteers to discover how patterns in water chemistry may reflect geology and land use patterns. The second phase is the analysis and interpretation of their own actual data; during this phase participants' knowledge of local practices is used to identify the causes of the patterns and to inform action plans. Our own effectiveness in training watershed groups to turn their data into useful information will be assessed.

Data Tell Part of the Story – Actions Write the Rest

Brian Soenen

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Biographical Sketch of Author

Brian earned his bachelor's degree in Biology from the University of Northern Iowa in 2000. Over the past four years, Brian has been serving fellow Iowans through the DNR's IOWATER program. As the coordinator of this volunteer water quality monitoring program, Brian strives to help Iowa's citizens volunteer to protect and improve their water resources.

Abstract

To protect and improve Iowa's water quality…

The first few words of the IOWATER program's mission statement are perhaps the most powerful. While data collection, acceptance, usage, and analysis are all important for water monitoring programs, in a world of quality assurance project plans, 305(b) reports, and 303(d) lists, the actions needed to accomplish this mission can sometimes get overlooked. Volunteer monitoring programs can help the general public to understand their watersheds, which in turn, may empower and inspire them to take action. While IOWATER data have been used by government agencies to list a small stream on the state's 303(d) list, identify and prioritize an unsewered community that illegally dumps raw sewage into a nearby stream, and influence permit decisions regarding stream channelization, it was the actions taken by the volunteer monitors themselves that protected and improved Iowa's water quality. Their knowledge, observations, and data from their sites helped give them the courage to speak up and question current conditions that impacted their streams. When volunteers are educated, they are more likely to become involved; when they become involved, they are more likely to understand; and when they understand, they are more likely they are to make a difference.

In water monitoring, data only tell part of the story; they can provide a baseline for water quality, identify trends, and locate "hot spots" that might require further monitoring. However, as one volunteer commented, "I don't care if the stream is on some government list; I just want them to stop dumping waste in our stream." And while state officials debate about how to resolve the problem, this particular volunteer has been taking action – teaching watershed residents about their stream, inviting them down to touch the water, and helping them to understand the problem.

Integrated Indicators of Contaminant Response in Resident Species: Making a New Generation of Indicators Feasible for Management

Susan Anderson

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Abstract
Currently used indicators of contaminant effects in sediment and wetlands are out of date and should be improved to keep pace with decades of scientific advancement. It is little wonder that managers are reticent to incorporate piecemeal approaches into ecological risk assessment; yet, there have been few opportunities for scientists to develop integrated approaches and then to have them critiqued by managers. The Pacific Estuarine Ecosystem Indicator Research (PEEIR) consortium advocates the development of an integrated portfolio of contaminant exposure and effects responses using indicator species that are selected for various habitat types. We developed a portfolio of techniques for salt marshes that are integrated using fish (mudsucker, Gillichthys mirabilis), invertebrate (shore crab, Pachygrapsus crassipes) and plant (cordgrass, Spartina foliosa and pickleweed Salicornia virginica), indicator species. We performed sediment and tissue chemical analyses and analyzed biomarker responses in these species at five marshes in Northern and Southern California. A comparison to toxicity test responses and benthic population surveys was performed at a more limited number of stations. While the widely used Sediment Quality Triad approach is a useful screening tool, we found that this approach does not predict the range of effects in resident species. Specifically, we noted reproductive impairment in shore crabs and/or ovarian tumors and endocrine disruption in mudsucker fish at two sites, where toxicity was either relatively low or nonexistent. We have also developed toxicity identification procedures that can be used to predict what chemicals cause endocrine disruption and other reproductive harm in fish. While multiple indicators are usually included in a portfolio, even a single indicator can be useful for very specific management questions. Our Resident Species Portfolio approach is a first step in making monitoring of Bay species more practical, and hence minimizing extrapolations inherent in ecological risk assessment of contaminated sediments. Numerous emerging contaminants are being discovered, such as Personal Care Products and flame retardants; techniques are needed to prioritize the contaminants that cause the greatest harm to aquatic life and to help focus regulatory action. Through highly integrated research and improved cooperation between research and management, it will be feasible to create a new paradigm for determining when and how contaminants impair the quality of our estuarine habitat. This research has been supported by the EPA Science to Achieve Results (STAR) Estuarine and Great Lakes (EaGLe) program through funding to the Pacific Estuarine Ecosystem Indicator Research (PEEIR) Consortium, an integrated team of over 30 Principal Investigators. Pacific EcoRisk performed the toxicity testing cited above in collaboration with PEEIR.

Using Simulation to Evaluate the Comparability of Different Bioassessment Methods

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Biographical Sketches
Yong Cao is a senior research scientist at Western Center for Monitoring and Assessment of Freshwater Ecosystems, Utah State University. His research has been focused on community aquatic ecology, development and testing of biological indicators, assemblage data quality control, and data comparability in bioassessment.

Charles Hawkins is Professor of Aquatic Ecology in the Department of Aquatic, Watershed, and Earth Resources at Utah State University and Director of the Western Center for Monitoring and Assessment of Freshwater Ecosystems. His main research activities involve development and testing of biological indicators, classification of reference conditions, modeling effects of natural factors on the distribution of aquatic biota, and use of taxon-specific responses to different stressors to diagnose causes of biological impairment.

Brett Roper is the Forest Service's National Aquatic Ecologist and is an adjunct professor at Utah State University. Brett's research interest range from salmonid viability to the effect on mentoring. Currently much of his effort is focused on understanding how sources of variability in measuring an attribute affects a manager ability to make informed decisions.

Jeffrey Kershner is the Director of the USGS Northern Rocky Mountain Science Center at Bozeman, Montana. His research efforts have focused on understanding the relationship between land management actions and stream characteristics and the distribution of biota within those streams.

Abstract
Issues of method comparability limit our ability to aggregate biological assessments into region-wide assessments. A key constraint in determining the comparability of biological indicators is associated with how methods are calibrated, which usually involves the degree to which indicators distinguish between reference and degraded sites. However, the true accuracies of different methods are largely unknown because the real degree of impairment at degraded sites is usually unknown and the data sets used to calibrate indicators vary in how degraded test sites are. Simulations provide a way to track known biological responses to stress and thus the comparability of different indicators. We used a set of macroinvertebrate samples collected from streams in the Upper Colombia Basin (1998-2002) to develop seven different multimetric indices, which differed in how they accounted for natural biological variability, and four RIVPACS-type predictive models, which differed in the biological and predictor data used. We then applied a simulation model to biological samples collected from thirteen reference-quality sites. Environmental tolerance values were used to predict how each taxon responded to stress. The seven multimetric indices all decreased linearly from low to intermediate levels of stress and then leveled off at higher stress levels. O/E values for all four RIVPACS-type models decreased linearly over the entire range of simulated stress. The comparability of these two types of indicators thus appears to vary with stress level. The assessments of individual sites also varied considerably among methods, however the proportion of test sites inferred as impaired within the region differed much less among methods.

Quantifying Tolerance Indicator Values for Common Stream Fish Species of the United States

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Biographical Sketches of Authors

Michael Meador, an ecologist with the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program, Ecological National Synthesis, within the U.S. Geological Survey's Office of Water Quality, has training and experience as a fisheries biologist. He is an American Fisheries Society Certified Fisheries Scientist, with experience in the implementation and interpretation of aquatic ecological investigations and environmental impact assessments. Mike has been involved in ecological studies within the NAWQA Program since 1991, including the development of national fish and habitat data collection methods and fish taxonomic quality-assurance procedures, and continues to coordinate national fish sample collection activities.

Daren Carlisle is an ecologist with the U.S. Geological Survey's National Water-Quality Assessment NAWQA Program, Ecological National Synthesis, within the U.S. Geological Survey's Office of Water Quality. Currently, he is integrating and aggregating ecological data collected by the Program over the past 14 years. Daren is trained in aquatic ecology, statistics, and ecotoxicology. He has been employed with the Department of Interior for 5 years.

Abstract

Fish species tolerance to environmental disturbance is often used as a means to assess ecosystem conditions; however, its use may be problematic because tolerance classifications often are based on subjective judgment. We analyzed fish and physicochemical data from 773 stream sites collected as part of the U.S. Geological Survey's National Water-Quality Assessment Program to calculate tolerance indicator values (TIVs) for 10 physicochemical water-quality variables. We calculated TIVs as predictors of physicochemical variables using weighted averaging inference models. Fish abundance-weighted averages for ammonia, chloride, dissolved oxygen, nitrate plus nitrite, pH, phosphorus, specific conductance, sulfate, suspended sediment, and water temperature were calculated for 105 common fish species of the United States. Tolerance indicator values (ranging from 1 representing low tolerance to 10 representing high tolerance) were subsequently created by transforming weighted averages into 10 ordinal ranks based on percentiles of weighted averages across all species. Principal components analysis indicated that the distinction between tolerant and intolerant classifications (from U.S. Environmental Protection Agency Rapid Bioassessment Protocols) was determined largely by chloride, specific conductance, suspended sediment, and total phosphorus distributions. Factors such as dissolved oxygen, pH, and water temperature may be relatively unimportant in distinguishing between tolerant and intolerant classifications, but may help to segregate species classified as moderately tolerant. Mean TIVs for fish assemblages (average TIVs across all species at a site) were significantly ($P < 0.05$) correlated with road density in New England. To our knowledge, this is the first empirically based understanding of fish species tolerance for stream fishes of the United States.

Relation Between Urbanization and Relative Toxicity of Semipermeable Membrane Device Extracts from the Lake Tahoe Basin and Truckee River Watershed, Nevada and California, 2002-2004

Timothy G. Rowe[1], Michael R. Rosen[1], and Steven L. Goodbred[2]

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Tim Rowe, a Hydrologist with U. S. Geological Survey (USGS) in Carson City, Nevada, is currently the Biologist for the National Water Quality Assessment (NAWQA) program, Nevada Basin and Range (NVBR) Study Unit. Tim also serves as the USGS Lake Tahoe Liaison. Tim has been with USGS for over 26 years has worked on many water studies in California, Alaska, and Nevada. Prior to USGS, Tim worked in Fisheries Biology with U.S. Fish and Wildlife Service, U.S. Forest Service, and California Department of Fish and Game.

Dr. Michael Rosen, a Research Hydrologist with USGS, is currently the NAWQA NVBR Study Unit Chief in Carson City, Nevada. Prior to USGS, Michael was employed at the Institute of Geological and Nuclear Sciences in Taupo, New Zealand as the Ground Water Program Leader. He also worked in the Division of Water Resources CSIRO in Perth, Western Australia; Curtin University of Technology, Perth, Western Australia; and at the Limnological Research Center at the University of Minnesota.

Steve Goodbred, a Fish and Wildlife Biologist with USGS, Biological Resources Discipline (BRD), is currently is a Regional BRD Biologist for NAWQA in Sacramento, California. Prior to USGS Steve worked for the National Biological Service and US Fish and Wildlife Service at various locations in the United States.

Abstract

Rapid growth in urban areas of the United States has caused concern about the effects on water quality of streams and aquatic ecosystems. One technique to assess the effects of urbanization on stream-water quality is to sample organic contaminants associated with urban landscapes. Samples for organic contaminant analyses can be collected by deployment of passive samplers, such as semipermeable membrane devices (SPMDs). SPMDs use a lipid (triolein) to mimic contaminant accumulation in fatty tissue of aquatic organisms. These devices concentrate many organic compounds that may be present in low concentrations in the water column including polycyclic-aromatic hydrocarbons (PAH), certain pesticides, and many other hydrophobic organic contaminants.

Possible effects of urbanization on stream-water quality in the Lake Tahoe Basin and Truckee River watershed of Nevada and California were examined using toxicity tests on organic compounds extracted from SPMDs. These SPMDs were deployed during the summer baseflow and spring snowmelt runoff periods in 2002, 2003 and 2004 in the Lake Tahoe Basin and along the main stem and tributaries of the Truckee River upstream, within, and downstream of the Reno/Sparks urban area.

The SPMD Pyrene Index test indicated higher relative toxicity in urban areas within Reno/Sparks as compared to less urbanized areas in the Lake Tahoe Basin. However, low levels of relative toxicity were found at all sites in the Lake Tahoe Basin. The correlation ($R2 = 0.33$) between the Pyrene Index and percent urbanization in the Basin shows that the Pyrene Index test can be used as an indicator of the effects of urbanization in the Lake Tahoe and Truckee River watersheds.

Developing O/E (Observed-to-Expected) Models for Assessing Biological Condition

Trainer:
Charles Hawkins, Utah State University

Biographical Sketch
Charles Hawkins is Professor of Aquatic Ecology in the Department of Aquatic, Watershed, and Earth Resources at Utah State University and Director of the Western Center for Monitoring and Assessment of Freshwater Ecosystems. His main research activities involve development and testing of biological indicators, classification of reference conditions, modeling effects of natural factors on the distribution of aquatic biota, and use of taxon-specific responses to different stressors to diagnose causes of biological impairment.

Short Course Description
Chuck Hawkins from the Western Center for Monitoring and Assessment of Freshwater Ecosystems at Utah State University will explain the concepts underlying biological assessments that use taxonomic completeness as a measure of biological integrity. Taxonomic completeness is the proportion of expected taxa that are observed in a sample (O/E). A model is used to make site-specific predictions of the expected taxa. He will provide examples of O/E assessments based on the Western Streams and Wadeable Streams Assessment data sets.

A Graphical Presentation of Water Quality Data In Time And Space

Peter Stoks

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Abstract

The Dutch Association of Rhine Water works RIWA operates a monitoring network in the Dutch part of the Rhine basin. The purpose of this network is to assess compliance with specific standards and to determine trends over time. Annual reports are produced to underline demands regarding measures towards an improved water quality. In order to attain a more readily visualized presentation of water quality data, especially for decision makers who appear not to have a thorough experience in water quality issues we have developed a graphical presentation in which a two-dimensional array combines sampling locations and selected water quality variables, and a color represents a trend in compliance ratio over time for a given variable at a given site. The compliance ratio for each variable of interest (r max) is determined as the ratio between the maximum value of that variable and its quality standard, in three intervals (r max <0.5, r max 0.5-1.0 and r max >1.0 A five-year dataseries (annual frequencies >10) for each variable is converted to quarterly averages, to reduce skewness and auto-correlation, and the resulting data are subjected to a trend analysis according to a modified linear regression model. This yields either a decreasing trend (worsening, at least for most variables), an increasing trend (improving) or no trend (stable). For each combination of variable and site the trend in r max can be presented as follows. A 'good' status (blue in the graphical presentation): r max <0.5 and not worsening over the five years' interval, or r max 0.5-1.0 and improving over time A 'bad' status (red): r max >1.0 and not improving, or r max 0.5-1.0 and worsening. All other combinations are 'moderate', and are colored yellow in the graphical presentation. It should be emphasized that this graphical presentation serves illustrative purposes only.

Designing a National Water Quality Monitoring Network to Support the Canadian Freshwater Quality Indicator

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[1] Environment Canada, National Water Research Institute, National Water Quality Monitoring Office

Abstract
Environment Canada, in partnership with Statistics Canada and Health Canada, is responsible for reporting annually on water quality for the National Freshwater Quality Indicator under the new Competitiveness and Environmental Sustainability Indicators (CESI) initiative. The freshwater quality chapter of the first CESI report, scheduled for completion in autumn 2005, is the first national report on water quality status for Canada. The national freshwater indicator is based on applications of the Water Quality Index (WQI) endorsed by the Canadian Council of Ministers of the Environment (CCME). The WQI is a tool allowing experts to translate large amounts of complex water quality data into a simple overall rating (e.g., good, fair, poor). Existing federal, provincial, territorial and joint long-term water quality data were used to calculate the indicator for the report, and spatial gaps in monitoring, as well as gaps in parameters monitored to address specific stressors/threats to water quality, were identified during its preparation. These gaps are being assessed to determine priorities for monitoring network expansion to enhance national reporting on the CESI Freshwater Quality Indicator. The immediate focus is on a core water quality monitoring network for aquatic life, the most sensitive and spatially-relevant water use. By 2009, other major water uses (e.g., source water for drinking, agriculture, and industry) will be incorporated into the indicator. A plan for generating the key data required to report on major water uses in Canada is outlined. Key elements include sustaining access to provincial network data; expanding existing and establishing new networks; negotiating new federal-provincial water quality agreements; collaborating with federal partners (e.g., Parks Canada, Indian and Northern Affairs Canada); and data gathering exercises with relevant agencies (e.g., provinces, municipalities) for other water uses. Biological measurements of aquatic ecosystem health will be incorporated into the indicator over the next four years.

Coastal Watershed Assessment: A Template for Assessing Water Quality Conditions at the Watershed Level

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Anitra Pawley is the coordinator and principal author of the Point Reyes National Seashore and Golden Gate National Recreation Area Coastal Watershed Assessment. She was the P.I. of the Bay Delta Ecological Scorecard and continues to assist in the process of improving upon and updating the San Francisco Bay Index at The Bay Institute. Her recent projects include a regional level indicators consortium and a review of wetland indicators for the Bay region (Pacific Estuarine Ecological Research Program). She has worked on environmental assessment and indicators research in the San Francisco Bay Delta Ecosystem for nearly ten years through her work with CALFED and the Bay Institute.

Abstract

The National Park Service (NPS) has initiated a Coastal Watershed Assessment Program to assist parks in the synthesis of pertinent information to support long-term park planning and management needs. Point Reyes National Seashore and Golden Gate National Recreation Area manage more than 150,000 acres and 125 miles of the California coast, including four state Areas of Special Biological Significance, and are contiguous to the Gulf of the Farallones National Marine Sanctuary. As part of this assessment, we have developed a methodology to assess and portray watershed condition, using a standardized set of analyses and a reporting structure. We are currently testing this methodology using watershed examples that range from riverine to estuarine and from highly pristine to highly impacted. The framework approach allows for comparisons across watersheds using stressor factors, categories of pollutants, summaries of hydrologic and geomorphic condition and biotic parameters such as salmon populations. It provides a simple but powerful visual display of condition that is suitable for managers and the public.

The analysis uses existing archival data, so its lessons are germane to any program that wishes to assess condition without a predetermined probabilistic sampling design. We discuss the problems inherent in any condition assessment using existing data sources and methods to portray results so that the results portray condition relative to sampling limitations. We also discuss how the template can be updated to provide a measure of water quality improvements over time and the role that professional judgment can play in such an approach, given the limitations of data inherent in watershed assessments. Please see our accompanying poster presentation (Ketcham et. al. 2006).

LakeSuperiorStreams.org: Making Stormwater and Stream Data Come Alive for Citizens, Students, Teachers, Contractors, Resource Agencies, Decision-Makers and Scientists

Richard Axler[1], Cynthia Hagley[2], George Host[1] and Jesse Schomberg[2]

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Biographical Sketches of Authors

Richard Axler is a Senior Research Associate at the Natural Resources Research Institute (NRRI), U. of Minnesota-Duluth and on the Graduate Faculty in Water Resources Science and Integrated Biological Sciences. He has a PhD in Ecology/Limnology from the U. of California - Davis (1979). Since 1988 at NRRI, he has done research on northern Minnesota lakes and streams, alternative septic system performance, and using real-time data from lakes and streams for formal, informal and community education.

Cynthia Hagley is a Professor of Extension and Water Quality Extension Educator with Minnesota Sea Grant at the U. of Minnesota-Duluth. She has an M.S. in Ecology/Limnology from the U. of California - Davis (1989). Her many projects have focused on shoreland education, protection and restoration, educating stakeholders and decision makers on the links between land use and habitat and water quality (NEMO), and using real-time data from lakes and streams for formal, informal and community education.

George Host is a Senior Research Associate at the Natural Resources Research Institute (NRRI), U. of Minnesota-Duluth and on the Graduate Faculty in Water Resources Science and Integrated Biological Sciences. He has a PhD in Forest Ecology from Michigan State University (1987). Since 1989 at NRRI, he has done research on landscape/forest ecology, interactions between landscapes and water quality and community structure, biostatistics and modeling, and using real-time data from lakes and streams for formal, informal and community education.

Jesse Schomberg is an Assistant Extension Professor with Minnesota Sea Grant at the U. of Minnesota-Duluth. He has an M.S. in Stream Ecology from Idaho State University (1999). His research has focused on stormwater and hydrologic simulation modeling, impervious surface analysis, and land use-water quality connections. He coordinates the NEMO (Nonpoint Education for Municipal Officials) program for Sea Grant and works to educate local governments on the connections between land use and water resources.

Abstract

Urbanization and rural development are placing pressure on western Lake Superior streams and nearshore zones. Stormwater runoff and overflows of partially treated domestic wastewater threaten public health via pathogens and fish-Hg. Increased flows, temperature, sediments, nutrients and organic matter represent ecological health risks. Stream and coastal zone degradation represents a significant social and economic impact to a region whose economy and character are tied to its pristine natural state. This project uses web-based delivery of real-time stream monitoring data to address issues of sustainability in critical Minnesota watersheds at the headwaters of the Great Lakes. The website delivers intensive real-time values of flow, temperature, turbidity and conductivity in conventional formats and via a unique data animation tool from sensors in three urban trout streams, the St. Louis River discharge to Lake Superior, and two Northshore Lake Superior tributaries. *Lakesuperiorstreams.org* (LSS) incorporates interpretive information, curricula, case studies and a site design toolkit to educate contractors, consultants,

developers, students, teachers, homeowners, agencies, decision-makers and scientists. It also serves as a data/report reference library for regional streams and promotes event-based volunteer monitoring. LSS led to collaboration with the Minnesota Pollution Control Agency (MPCA) to create MNbeaches.org and the tools were adapted to display Lake Superior Beach Monitoring fecals/E. coli data via animation and mapping utilities. A Regional Stormwater Protection Team of 22 organizations was also created to deliver common educational messages, collaborate on projects and provide tools and training via a variety of formats with the LSS website as a central focus. LSS has now expanded to include data and ancillary information from two *Impaired* tributaries to Lake Superior including a stream restoration initiative. The website averages >200,000 requests/mo and ~ 35,000 page requests/mo. LSS is a partnership between the University, City of Duluth, MPCA and the Western Lake Superior Sanitary District.

Monitoring Perchlorate in Shallow Ground Water in the Central United States

Stephen J. Kalkhoff[1], Lynne S. Fahlquist[2], W. Andrew Jackson[3], Sarah J. Stetson[4], Richard B. Wanty[5], and Gregory L. Linder[6]

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Biographical Sketches of Authors
Stephen Kalkhoff is the project manager and the lead scientist of the USGS Eastern Iowa Basins National Water-Quality Assessment study. He along with Richard Wanty and Gregory Linder are principal investigators on the USGS Central Region Integrated Science (CRISP) perchlorate project.

Lynne Fahlquist worked on NAWQA projects studying the Edwards (South-Central Texas) and High Plains (High Plains Ground Water) aquifers. She is currently working on a NAWQA topical study of Transport of Anthropogenic and Natural Compounds (TANC) to Public Supply wells in the Edwards aquifer.

Andrew Jackson is a faculty member in the Department of Civil Engineering at Texas Tech University. Dr. Jackson's general field of expertise is related to the remediation and fate of compounds in the surface and subsurface. For the past 6 years he has focused on the occurrence of natural perchlorate in the environment

Sarah Stetson is currently working on her PhD degree at the Colorado School of Mines. Her dissertation topic is the development of methods for analyzing mercury stable isotopes in geologic materials and application to the biogeochemical cycling of mercury in the environment.

Richard Wanty is a research chemist with USGS involved in projects investigating the geochemistry of mined or unmined mineral deposits and natural background geochemistry. He is currently working to develop geoenvironmental models of mineral deposits nationwide.

Gregory Linder works with USGS/BRD at their Columbia Environmental Research Center (CERC), where he is primarily focused on environmental assessment and monitoring projects that support Department of Interior and other federal government natural resource management agencies.

Abstract
Perchlorate has been documented as a contaminant in ground water near areas where ammonium perchlorate is produced and used in solid-fuel rockets, fireworks, and other explosives. Recently, perchlorate has been found in areas where there are no apparent anthropogenic sources and where agricultural activities (fertilizers and irrigation) are prevalent. Because of the recent findings, there was a need to sample shallow ground water in other parts of the central United States where row-crop agriculture is present. In 2004, the U.S. Geological Survey (USGS) established an initial monitoring program to supplement the work of Texas Tech University researchers in the southern High Plains of Texas and New Mexico. Perchlorate samples were collected from about 150 shallow wells that were sampled as part of the U.S. Geological Survey's National Water-Quality Assessment Program (NAWQA)

or as part of cooperative projects with State and local agencies in Iowa, Nebraska, Colorado, and Texas. Samples were collected concurrently with other water-quality studies to leverage sampling resources and to increase the amount of chemical data available for each well sample. A dataset was compiled for analysis that covers parts of the central United States and that includes information from both Texas Tech University and the USGS. Samples were analyzed by Texas Tech and the USGS using newly developed ion chromatographic techniques that provide detection levels of 0.5 micrograms per liter, which is almost an order of magnitude lower than U.S. Environmental Protection Agency Method 314. About 43 percent of sampled wells contained water with detectable concentrations of perchlorate. Perchlorate was found throughout the study area, however, the rate of detection and perchlorate concentrations tended to be greater in the southern high plains than in the northern high plains. The wide spatial distribution of perchlorate in agricultural areas suggests that farming may contribute to the occurrence of perchlorate in ground water. Data suggests that natural sources also contribute to its occurrence in shallow ground water.

Occurrence of Anthropogenic Organic Compounds in Surface Water and Finished Water of Community Water Systems

By James A. Kingsbury

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Biographical Sketch of Author
James Kingsbury is a hydrologist in the Tennessee Water Science Center of the U.S. Geological Survey. He currently is working with the National Water-Quality Assessment Program's Source Water-Quality Assessments (SWQAs). SWQAs focus on characterizing the quality of major rivers and aquifers used as a source of water supply as well as the associated finished water of selected community water systems across the Nation.

Abstract
Nine surface-water sites located near drinking-water intakes across the United States were sampled monthly to characterize the occurrence and concentrations of anthropogenic organic compounds in the source water used by community water systems (CWSs). These sites were sampled as part of the Source-Water Quality Assessments (SWQAs) component of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program. SWQAs are intended to complement existing drinking-water monitoring required by Federal, State, and local programs, which focus primarily on post-treatment compliance monitoring. During the first year of activities (2002-2003), source-water samples were analyzed for about 270 anthropogenic organic compounds that included pesticides, pesticide degradates, polycyclic aromatic hydrocarbons, volatile organic compounds, and selected emerging contaminants. During the second year of SWQA activities (2004-2005), samples of both source water and the corresponding finished water were analyzed for a subset of the original analytes. These nine sites are located within NAWQA study areas across the Nation and represent the first set of SWQA's for surface water.

Results from the first year of source-water sampling indicate that about one-half of the 270 compounds analyzed were detected at least once, but only about 40 compounds were detected in 10 percent or more of the samples collected. Concentrations of these compounds generally were low; median concentrations of the most frequently detected compounds typically were less than 0.1 microgram per liter. Results from the second year of sampling, including data for these anthropogenic organic compounds in source water and finished water samples, are forthcoming and will be used to characterize the extent to which compounds detected in source water also are detected in finished water.

Concentrations of Organic Compounds in Wastewater at Five Sites in New York State, 2003-04

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Abstract
Across the United States, there is a rapidly growing awareness of the occurrence and the toxicological impacts of natural and synthetic trace compounds, known as emerging Contaminants (ECs) in the environment. Wastewater treatment plants (WWTPs) have been identified as a key collection point for ECs in the water cycle and potentially an ideal location at which to treat to remove them, thereby mitigating their release into the environment. Little is known about the nature, variability, transport and fate of ECs in typical wastewaters and treatment facilities in the United States. Furthermore few studies have been performed to monitor or understand the capability of conventional or innovative wastewater treatment processes to remove or reduce the concentrations of a wide variety of ECs at wastewater facilities. This study was designed to provide baseline information on this topic.

Wastewaters appear to contain a wide range of ECs. Over 55 of the 63 target contaminants were detected in the five different wastewaters examined during the course of this study, 44 of them frequently. The median cumulative concentrations of EC in the wastewaters ranged from between 120 µg/L to just over 500 µg/L. The raw wastewater characteristics were not as variable as anticipated.

Conventional wastewater treatment processes were effective in removing significant amounts of the ECs. Results indicated that the type of technology operated and the mode of operation both had an impact on the removal capability of the plants.

Over half of the frequently detected ECs were reduced by 95 percent or more in samples collected at Plants which operated an activated sludge process. Less than 10 percent of the ECs were reduced by 95 percent or more at Plant D, which uses a trickling filter treatment process

Furthermore, focused pilot studies indicated that increased removals of ECs were closely associated with increased SRTs in the activated sludge process. The most significant impact of SRT appeared to occur as the sludge age increased above 5 days. While removals continued to improve as the SRT increased above 10 days the benefits were less marked.

Perchlorate Monitoring in the Llagas Groundwater Subbasin

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Don Smallbeck is a Vice President, Senior Principal and Senior Project Manager at MACTEC Engineering and Consulting, Inc. with over 20 years of experience in the environmental engineering and remediation industry. He received his B.A. and M.S. at North Dakota State University in Bacteriology and Environmental Microbiology. He continues to work as an applied environmental microbiologist, as he has since 1980, in addition to his Project Management responsibilities and is recognized as an expert for implementation of in situ bioremediation techniques, having performed over 100 site closures.

Richard McClure is a Senior Associate at Olin Corporation with nearly 20 years of professional groundwater experience and is currently the project manger for a large-scale perchlorate investigation in Morgan Hill, California. Mr. McClure has extensive groundwater expertise and has managed over 50 environmental projects with Olin Corporation.

Abstract

Olin Corporation has been monitoring perchlorate in groundwater of the Llagas Subbasin since 2003 after it was discovered beneath the site of its previously operated safety flare manufacturing facility in Morgan Hill, California. Over the course of the following year, Olin collected samples from over 1,500 privately owned supply wells south of the site and began providing bottled water to approximately 400 owners with wells impacted by perchlorate above the action level. Detections were observed in supply wells up to 10 miles downgradient (south) and generally less than 400 feet below ground surface.

The current cleanup and abatement order (CAO) requires that Olin characterize the groundwater subbasin, making this investigation of an almost unprecedented scale. Challenges associated with this investigation include: a very large scale of investigation, relative unknowns associated with an 'emergent' chemical, the potential for multiple undocumented sources, absence of a maximum contaminant level (MCL), interaction with thousands of private well owners, and a complex alluvial-fan dominated lithology.

Olin currently samples approximately 800 privately owned supply wells on a quarterly basis to conduct a trend analysis of perchlorate concentrations. Dedicated monitoring wells have been and continued to be installed and depth-discrete sample results will be compared to sample results from privately owned supply wells to assess whether supply wells can continue to be used to sufficiently monitor groundwater quality, as has been done for previous nitrate investigations. The previous understanding of this subbasin derived from decades of monitoring nitrate concentrations, elevated from historical agricultural land use, and recent investigations including the analysis of stable isotopes and age-dating will be incorporated into this current investigation to improve our understanding of groundwater flow characteristics in the Llagas Subbasin.

Biologically Based Urban Response Models for the South Atlantic Gulf and Tennessee River Basins

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Tom Cuffney is a research ecologist in the U.S. Geological Survey's Water Resources Discipline. He joined the Survey in 1990 and has worked for the National Water-Quality Assessment (NAWQA) Program for the past 16 years. He has made many contributions to NAWQA including program design (urban stream studies), sampling protocols (invertebrates), and data analysis methods and tools (IDAS, ADAS, GRAN). From 1999-2001 he led the effort to evaluate land-use gradients as a mechanism for understanding the effects of urbanization on streams. Tom has a Ph.D. in Entomology/Aquatic Ecology from the University of Georgia and a M.S. in Biology from Idaho State University.

Elise Giddings has been a biologist with the U.S. Geological Survey since 1995, where she has worked for the National Water Quality Assessment (NAWQA) in three different states. She spent 4 years managing biological data collection and analysis for the Great Salt Lake NAWQA, Utah. Most recently, she has been working in Raleigh, North Carolina focusing on urban land use change and its effects on stream ecosystems. Elise holds a M.S. degree in Water Resource Management and a B.S. in Biological Aspects of Conservation from the University of Wisconsin – Madison.

Brian Gregory is an ecologist at the U.S. Geological Survey's Georgia Water Science Center. He has worked for the National Water-Quality Assessment (NAWQA) Program since joining the Survey in 1999. Brian is currently involved in conducting studies on urban and agricultural streams as part of the NAWQA Program's EUSE (Effects of Urbanization on Stream Ecosystems) and NEET (Effects of Nutrients on Agricultural Streams) programs. Brian holds a M.S. degree in Conservation Ecology and a B.S. in Environmental Microbiology from the University of Georgia.

Abstract

U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program personnel are investigating the effects of urbanization on streams across the United States by examining biological, chemical, and physical changes along gradients of urban intensity defined by a multimetric urban intensity index (UII). Biological-response models were derived by using invertebrate assemblages to quantify ecological distances among sites and then relating these distances to the UII using linear regression. Response models were derived for Birmingham, AL (BIR); Atlanta, GA (ATL); and the urban corridor along I-40 from Raleigh to Winston-Salem, NC (RAL) based on richest habitat (RTH), qualitative multi-habitat (QMH), or QQ (RTH + QMH) invertebrate samples.

Models based on quantitative single habitat (RTH) samples did not perform as well as models based on qualitative multi-habitat (QMH and QQ) samples. In ATL, the RTH model explained only 31% of the invertebrate response whereas the QQ model explained 69%. In all, the urban response models based on QQ samples were able to explain 69% (ATL), 78% (RAL), and 83% (BIR) of the variation in biological responses.

Response models (ATL, BIR, and RAL) were used to predict responses at 294 NAWQA Program sites in the South Atlantic gulf and Tennessee River basins. The applicability of each model was assessed based on the deviation of predicted from actual values for site score and UII. Sites with widely different natural environmental characteristics tended to have fewer taxa in common with the underlying response model and deviated more from expected results. For example, response models developed from small basins performed poorly when applied to large rivers. There was, however, considerable correspondence among the three models derived from small streams. The applicability of these biologically based models of urbanization to small streams indicates that a general model of urban effects can be developed for this area.

Estimating Pesticide Concentrations in U.S. Streams from Watershed Characteristics and Pesticide Properties

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Charles Crawford has been a hydrologist with the U.S. Geological Survey since 1978. He is presently Surface Water Status and Trends Coordinator for the National Water Quality Assessment (NAWQA) Program. From 2000 to 2005 he was a member of the NAWQA Pesticide National Synthesis Project Team. Prior to the Pesticide Synthesis project, he was Chief of the NAWQA White River Basin Study for 10 years. Dr. Crawford has worked on a variety of water-quality modeling and monitoring projects and is a co-author of the U.S. Geological Survey LOADEST program for estimating constituent loads in streams and rivers.

Robert Gilliom has also been a hydrologist with the U.S. Geological Survey since 1978. He has directed the Pesticide National Synthesis Project of the National Water Quality Assessment Program since 1990. Prior to the Pesticide Synthesis project, he served as project chief for the USGS San Joaquin Valley Studies from 1984-1989, was with the Systems Analysis Group during 1981-1984, and was a member of the Puget Sound Earth Science Application Project during 1978-1981. Research and publications have focused on water-quality assessments, ranging from statistical methods for data analysis to regional and national assessments of nutrients, trace elements, and pesticides.

Abstract
Assessment of the risk of pesticides in water to humans and aquatic life requires evaluation of the potential effects of exposure. Ideally, pesticide concentrations in streams would be measured frequently to characterize exposure of aquatic life, and, should the stream be a source of drinking water, exposure to humans. High sampling costs, however, makes adequate monitoring possible for only a small number of streams. Empirical regression models have been developed by the USGS, in cooperation with the USEPA, to provide a tool for estimating the occurrence of pesticide concentrations in unmonitored watersheds. Separate models were developed to estimate the annual mean and nine selected percentile concentrations of atrazine (from the 5th to the 95th). The models were developed from monitoring data collected at more than 100 streams throughout the United States by the USGS as part of the National Water-Quality Assessment Program. Pesticide use in a watershed was the most significant explanatory variable, but several hydrologic and soil parameters were useful in explaining the variability in observed atrazine concentrations. The atrazine models have been extended to other pesticides by an adjustment factor that incorporates pesticide properties. Predicted concentrations were nearly always within an order of magnitude of the measured concentrations, and the predicted percentile concentrations reasonably matched the actual distribution of the percentiles in most cases. The models have been used by the USGS for assessing stream quality in areas lacking monitoring data. The models have also been used by the USEPA for designing a monitoring program for ecological risk assessment by identifying streams likely to have atrazine concentrations that exceed a level of concern. The USEPA is also evaluating use of the models as part of its approach to human-health risk assessments for potential human exposure to pesticides through drinking water sources.

Regression Models for Explaining and Predicting Concentrations of Organochlorine Pesticides in Whole Fish from U.S. Streams

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Lisa Nowell (chemist), Naomi Nakagaki and Gail Thelin (geographers) are members of the Pesticide National Synthesis Project team of the U.S. Geological Survey's (USGS) National Water Quality Assessment (NAWQA) Program. Lisa Nowell's role has included national-scale analysis of organochlorine pesticides in stream sediment and fish. Her training is in environmental chemistry and ecology, and she previously worked at the U.S. Food and Drug Administration and the Swiss Federal Institute of Aquatic Science and Technology (EAWAG). For the NAWQA Program, Naomi Nakagaki has provided environmental characteristics of watersheds for NAWQA surface-water sites, and developed national spatial datasets of agricultural pesticide use. Gail Thelin has developed methods to estimate current and historical county pesticide use data and other characteristics of agricultural land use. Prior to joining the NAWQA Program, Gail was a remote sensing specialist at NASA-Ames Research Center.

Charles Crawford (USGS hydrologist) is presently Surface Water Status and Trends Coordinator for the NAWQA Program. He previously was a member of the NAWQA Pesticide National Synthesis Project team and Chief of the NAWQA White River Basin Study, and he has worked on a variety of USGS water-quality monitoring and modeling projects. David Wolock (USGS research hydrologist) is the leader of NAWQA's Hydrologic Systems Team, which helps plan and implement modeling studies in NAWQA.

Abstract

Regression models were developed for estimating organochlorine pesticide concentrations in whole fish from U.S. streams on the basis of fish lipid content and watershed characteristics. Organochlorine pesticides were measured in composite whole-fish samples collected at about 650 stream sites nationwide during 1992–2001, as part of the U.S. Geological Survey's National Water Quality Assessment (NAWQA) Program. The sampled sites include a wide variety of environmental and land use settings. Pesticide compounds that were measured and modeled were: p,p'-DDT and its degradates; major components of technical chlordane; and dieldrin. The most important explanatory variables in the different models include (1) fish lipid content (for all pesticides); (2) the estimated, historical, agricultural pesticide use intensity in the watershed (for DDT compounds and dieldrin); (3) a score representing past use for termite control in the watershed (for chlordane compounds and dieldrin); (4) population density in the watershed (for DDT and chlordane compounds), and (5) percentage of forested land in the watershed (for chlordane compounds and dieldrin), where past pesticide use was expected to be minimal. Tobit regression methods were used because 20 to 70 percent (for different pesticides) of pesticide concentration values in the model-development data were reported as less than a detection threshold, resulting in censored data. The models explain 50 to 70 percent of the variability in the different pesticide concentrations measured in whole fish. The models were used to predict pesticide concentrations in whole fish in unmonitored streams throughout the U.S. For example, the highest predicted dieldrin concentrations are in Corn Belt streams, where past agricultural use of aldrin and dieldrin was highest. For 99 percent of U.S. river miles, the probability of whole-fish dieldrin concentrations exceeding the New York wildlife criterion (for adverse effects other than cancer, assuming 6.2 percent fish lipid) is less than 25 percent.

Use of WARP to Design a Monitoring Program to Identify Waters Potentially at Risk from Pesticides

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Nelson Thurman is a senior environmental scientist in the Office of Pesticide Programs at the Environmental Protection Agency, specializing in pesticide risk assessments and characterization of the fate and effects of pesticides in the environment. In addition, Nelson has worked on developing tools to better integrate modeling and monitoring in exposure assessments and on using GIS tools to characterize the spatial dimension of pesticide exposure in the environment. Prior to joining EPA in 1996, Nelson held jobs as research project leader, laboratory director, and field scientist on a variety of soil, environmental, and hydrologic issues.

Abstract

As one of the conditions for re-registration of the herbicide atrazine under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), EPA required a monitoring program to determine whether atrazine concentrations in water exceed a magnitude and duration that would cause adverse impacts to the aquatic community. The program is intended to answer the questions:

(1) What fraction of waters exceed effects-based thresholds for atrazine? and

(2) Where are those waters that exceed effects-based atrazine thresholds?

Watersheds expected to be most vulnerable to atrazine loading in flowing water bodies were identified using the WARP model. The vulnerability ranking based on the WARP model was compared to existing monitoring to evaluate how effectively it separated stations with high atrazine detections from those with no reported detections. EPA then used a random tessellated sampling design to identify a subset of the most vulnerable watersheds for monitoring. This will allow EPA, states, tribes, and interested parties to make inferences to the larger population of watersheds vulnerable to atrazine runoff. The extent to which exceedances occur will be quantified in terms of the fraction of watersheds having flowing water bodies that exceed the effects-based threshold with a specified level of confidence. The monitoring study results will help EPA identify watersheds with similar characteristics that are also likely to be of concern. This presentation will illustrate how WARP can be used as a vulnerability assessment tool to help focus additional monitoring and to aid in risk management actions.

Skokomish River Fecal Coliform TMDL Attainment Monitoring in Washington State

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Dr. George Onwumere is a senior research scientist in the Environmental Assessment Program within the Washington State Department of Ecology. He has more than 13 years of experience in environmental monitoring research. Prior to recruitment at Ecology, he worked for the Quinault Indian Nation as a water resource manager in charge of the tribal water program and as a co-op researcher for a joint applied research project between the Civil Engineering Department at the University of British Columbia in Vancouver, Canada, and the British Columbia Ministry of Transportation and Highways in Victoria, Canada.

Abstract

Washington State is required, under Section 303(d) of the federal Clean Water Act and U.S. Environmental Protection Agency (EPA) implementing regulations, to (1) develop and implement Total Maximum Daily Loads (TMDLs) for water quality-impaired surface waters, and (2) evaluate the effectiveness of the water clean-up plans following implementation of water quality restoration activities.

The Skokomish River drains an area of about 247 square miles before discharging into Annas Bay in southern Hood Canal near Potlatch, Washington. Bacterial contamination was found in the lower Skokomish River and its marine receiving water that threatened beneficial uses such as freshwater and marine recreation, domestic water supply, and shellfish harvest. The Washington State Department of Health has listed the Annas Bay commercial shellfish harvest area as threatened by bacterial contamination for 9 of the last 10 years. To support these designated uses, the TMDL recommended that most streams in the lower Skokomish River basin have fecal coliform levels well below Class AA freshwater criteria (i.e. 50 colony-forming units per 100 milliliters of water) in order to protect the marine waters and their beneficial uses. To achieve this reduction, the approved TMDL set geometric mean value (GMV) target levels at established compliance points with the ultimate goal of meeting Class AA water standards and protecting beneficial uses. Several cleanup efforts were implemented which prompted this study.

The objectives of the study are to (1) evaluate attainment of bacteria target concentrations and percent reductions, and (2) determine if Class AA water standards are being met at the four compliance stations identified in the TMDL study. Preliminary results indicate improvement in water quality and possible compliance with the TMDL targets set for the Skokomish River system.

Volunteer/State Partnerships Inspire Grassroots Action

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Cheryl Snyder works as a biologist in the Pennsylvania Department of Environmental Protection's (DEP) Bureau of Watershed Management and is DEP's Citizens' Volunteer Monitoring Coordinator. She coordinates various activities for this statewide program and provides assistance to volunteer monitors in water quality sampling, biological monitoring, habitat assessment, streamside physical monitoring and watershed assessment project monitoring as well as helping volunteers develop study designs for their monitoring programs. Cheryl has worked in a number of water programs for DEP over the last 20 years.

Abstract

Grassroots groups have been active in Pennsylvania for many years. As volunteer monitoring groups developed, the monitors wanted to use their time and effort to achieve worthwhile goals. However, these groups don't always have the necessary resources to do everything they would like to do. On the other hand, state agencies have been facing cutbacks in staff and money, and they also can't do everything they would like to do.

This sets the stage for volunteer/state partnerships. These partnerships enable the volunteer monitors to have access to equipment and expertise from professionals while working to meet project goals. The state agencies get help from volunteers to work on projects that would otherwise never happen. This discussion will focus on a volunteer bacteriological monitoring project partnership in Pennsylvania. The volunteers were inspired to do more in their watersheds after taking part in the project. They took it upon themselves to move beyond the initial project goals, and the changes they initiated will be discussed. The volunteers were truly inspired to take grassroots action that resulted in benefits to their watersheds.

Volunteer Monitoring for Bacteria in San Francisco Bay Area Creeks

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Amy Wagner is a marine biologist in the U.S. Environmental Protection Agency Region 9 Laboratory with training and experience in marine ecology and toxicology. She has a masters of Science in Marine Science from Moss Landing Marine Laboratories. She is currently editing the West Coast chronic toxicity testing manual and has collaborated on the development of a Hawaiian sea urchin fertilization toxicity test method. Since 1998, Amy has served as the USEPA Region 9 Volunteer Monitoring Coordinator. As the coordinator, she has provided technical assistance, established an equipment loan program, and coordinated laboratory analyses for citizen monitoring groups.

Andy Lincoff is an environmental engineer with in the U.S. Environmental Protection Agency Region 9 Laboratory. As an expert in ecological and human health risk assessment, he was the remedial project manager for the cleanup of the United Heckathorne Superfund site in Richmond, CA. As lead microbiologist at the Region 9 Laboratory, he conducts bacterial analyses of drinking water and ambient water samples and conducts laboratory audits of drinking water labs for drinking water certification. Andy has participated in the National Study of Chemical Residues in Fish Tissues, mercury TMDLs, and atmospheric mercury analyses.

Abstract
The U.S. Environmental Protection Agency collaborates with volunteer monitoring organizations because it builds stewardship, increases water quality monitoring, and produces results. The EPA Region 9 Laboratory supports San Francisco Bay Area volunteer monitoring groups through training, loaning sampling equipment, and providing bacterial analyses. Over the past seven years, the EPA Region 9 Lab has performed over 1500 analyses for citizen monitoring groups for total coliforms, *E. coli*, and *Enterococcus*. During dry and rainy seasons, volunteers can collect weekly samples for five weeks from up to ten sites per creek or watershed. The results have been used to identify leaking sewage lines, septic tanks and drinking water lines. Bacterial data have allowed volunteers to work closely with local governments to mitigate these problems and communicate analytical results to the public.

Surfrider Foundation's Blue Water Task Force Program - Volunteer Monitoring that Leads to Change

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Rick Wilson is Coastal Management Coordinator with Surfrider Foundation, a non-profit organization working to protect the oceans, waves and beaches. He directs Surfrider's volunteer water quality monitoring programs, provides guidance on water quality policies and technical assistance to chapters on water quality issues. Prior to joining Surfrider Foundation in 2002, he worked for over 30 years as a Professional Chemical Engineer in industry and environmental consulting.

Abstract

The Blue Water Task Force (BWTF) is the Surfrider Foundation's water quality monitoring, education and advocacy program. It has been utilized by our Chapters and members since the early 1990s to alert citizens and officials in their communities about water quality problems and to work toward solutions. BWTF has demonstrated success by raising public awareness of coastal water pollution levels and precipitating the establishment of state and local government water quality monitoring programs in many communities where the program has been implemented.

BWTF was established with the following objectives:

- to provide concerned citizens with the opportunity for hands-on involvement with an environmental problem solving effort
- to gather coastal water samples on a regular basis to determine pollution patterns in the near shore environment
- to raise public awareness regarding the extent and severity of coastal water pollution
- to use the data collected to bring polluters into compliance
- to develop a model program that could influence national legislation and enforcement.

BWTF has directly influenced the enactment or establishment of:

- The AB 411 water quality program in California in 1999
- The federal BEACH Act in 2000
- Oregon's Beach Monitoring Program in 2002-2003

The program continues to grow and evolve. We recently started a program in Puerto Rico, we have rapidly expanding programs in Oregon and Washington, and we have been working closely with the Dept. of Health in Hawaii to review their ocean water quality testing procedures and standards. Approximately 20 of Surfrider's 60 chapters along the West, East and Gulf coasts currently participate in the program. Our chapters implement the program in various ways; using chapter activists, community volunteers and school groups. Testing methods have evolved from a simple Millipore test kit to EPA-approved methods developed by IDEXX for e*nterococci* and *E. coli*.

The Sacramento San Joaquin River Delta Mercury TMDL: Reducing Methylmercury in Fish and Water

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Michelle Wood and Janis Cooke are environmental scientists in the Mercury TMDL Unit. Chris Foe is a senior environmental scientist in the TMDL/Watershed Program. Ms. Wood received a BS in physical geography and minor in geology from Louisiana State University and an MS in geosciences from the University of Arizona, with emphases in flood hydrology and climate change. Dr. Cooke received a BS in biochemistry from Michigan State University and a doctorate in environmental toxicology from the University of California (UC), Davis. Dr. Foe received a BS in physics from UC Berkeley, an MS in aquatic biology from San Diego State University, and a doctorate in estuarine ecology from UC Davis. His emphasis has been on determining the effect of contaminants on aquatic resources in the Sacramento-San Joaquin Delta Estuary and its tributary watersheds. The authors along with other Mercury TMDL Unit staff combine their areas of expertise to conduct water, sediment and fish sampling and develop TMDLs with control programs for Central Valley waterways impaired by mercury.

Abstract

Fish methylmercury concentrations in the Sacramento San Joaquin River Delta exceed safe levels for consumption by humans and wildlife. The Delta mercury Total Maximum Daily Load program addresses both methyl and total mercury to address this impairment. The program focuses on methylmercury because statistically significant, positive correlations have been found between methylmercury levels in water and fish tissue in the Delta. The program also addresses total mercury because methylmercury production is a function of the total mercury content of sediment and because the mercury control program for San Francisco Bay is expected to assign a total mercury load reduction to water leaving the Delta. TMDL elements include: (a) development of fish tissue methylmercury targets, (b) calculation of the mathematical linkage between water and fish methylmercury levels, (c) quantification of methyl and total mercury sources and necessary reductions, and (d) development of a control program. The Delta is divided into eight regions based on hydrologic characteristics and mixing of the source waters. A hydrology-based methylmercury TMDL was developed as it more accurately reflects concentrations and sources of methylmercury and the extent of fish impairment. The linkage analysis predicts that reducing the annual average aqueous (unfiltered) methylmercury concentration to 0.06 ng/l will result in safe fish tissue levels. Reductions in aqueous methylmercury needed to meet the 0.06 ng/l safe level vary by subregion and range between 0 and 80%. Methylmercury allocations for the sources in each Delta region are proposed in terms of the existing assimilative capacity of the different Delta regions. Total mercury reductions are proposed for the largest sources of highly contaminated sediment. This presentation describes the methylmercury TMDL for the Delta, focusing on monitoring and data evaluation strategies needed to assess the progress of the mercury control programs in a region with immense spatial and inter-annual variability.

Guadalupe River Watershed Mercury TMDL

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Ms. Austin is an environmental engineer in the TMDL and Planning Division of the California Regional Water Quality Control Board, San Francisco Bay Region (California Environmental Protection Agency). Inspired by Love Canal and Three Mile Island, Ms. Austin obtained a B.S. in Political Economy of Natural Resources (1984) and an M.S. in Environmental Engineering (1991) from UC Berkeley. Previous to joining the Water Board, Ms. Austin worked in the private sector as a hazardous waste site clean-up engineer. Since 2001, she has been co-chair of the Guadalupe Mercury Work Group and fascinated by the New Almaden gold-rush legacy.

Abstract

The New Almaden mercury-mining district, located in the headwaters of the Guadalupe River Watershed, was the largest mercury producer in North America. Over 90% of production occurred prior to 1910, in an era when mine wastes were disposed of in creeks for storms to wash downstream.

The lesson learned in this TMDL was the value of a local watershed steward: staff and board of the Santa Clara Valley Water District without whose funding and oversight of a watershed-wide monitoring program the TMDL would not take into account—and no one would be testing innovative measures to address—the phenomenal methylmercury production and bioaccumulation.

Like most deep-water bodies, reservoirs downstream of the mining district become thermally stratified in the warm dry season (May through October). The resulting anoxic conditions allow naturally occurring sulfate reducing bacteria to convert inorganic mercury to methylmercury. In Guadalupe and Almaden reservoirs, the concentration of methylmercury in the hypolimnion is pronounced—greater than 10 ng/L.

Fish mercury concentrations are also elevated, particularly in Guadalupe Creek and Reservoir where they are as high as 0.83 mg/kg average total mercury, wet weight in age-1 largemouth bass (90 mm), and 6.1 mg/kg in adult (420 mm).

In contrast, in the reference reservoir (Lexington) located outside of the mining district, the dry season hypolimnion methylmercury concentration reaches 3.0 ng/L. Mercury concentrations in largemouth bass in Lexington Reservoir were 0.09 mg/kg in age-1 (89 mm) and 0.6 mg/kg in adult (410 mm).

The TMDL numeric targets are fish tissue methylmercury concentrations protective of human health and wildlife. Control actions range from hazardous waste clean-ups (excavate mine waste) and annual maintenance (remove sediments in storm drains, maintain vegetation for erosion control), to innovation: adapt engineering approaches used to control nutrients in reservoirs to control mercury methylation (e.g., hypolimnetic oxygenation to maintain oxic conditions).

Use of Multi-Media Monitoring to Develop a Statewide Mercury TMDL

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Bruce Monson is a Research Scientist in the Environmental Analysis and Outcomes Division of the Minnesota Pollution Control Agency. He analyzes and interprets mercury data from lakes and rivers, as well as oversees mercury research projects. Prior to joining the MPCA in 2002, he worked for several environmental consulting firms and environmental advocacy organizations.

Howard Markus is a Research Scientist in the Environmental Analysis and Outcomes Division of the Minnesota Pollution Control Agency. He is coordinator of the 303(d) Impaired Waters listing and project manager of the Minnesota mercury TMDL. Prior to joining the MPCA in 1990, he worked for the Missouri Department of Natural Resources.

Abstract

The Minnesota Pollution Control Agency (MPCA) has drafted a statewide mercury TMDL to address the 1239 impairments caused by mercury contamination, mostly due to fish consumption advisories. To develop a mercury reduction target, the MPCA relied on (1) routine fish mercury monitoring in lakes and rivers, which provided the basis for a needed reduction factor to remove the impairments, and provided the basis for dividing the state into two regions, with separate specific TMDL goals; (2) mercury wet deposition monitoring, which provided the basis for concluding mercury deposition is essentially uniform across the state; and, (3) intensive sediment core collections, which provided a measure of total mercury deposition through 1990. These various mercury monitoring programs have been compiled into the context of a TMDL and together they have provided the essential pieces that allowed the MPCA to take the unprecedented step of a statewide TMDL. This presentation will give an overview of Minnesota's draft mercury TMDL, as well as describe the mercury monitoring program. The TMDL, once approved by the US EPA, will be the impetus for future multi-media monitoring to assess implementation of the TMDL. The need for implementation monitoring is expected to drive new approaches to long term monitoring of mercury deposition.

Mercury Emission Trends and Biota Response in Florida: A Case Study

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Dr. Curtis D. Pollman is currently Chief Scientist and CEO with Frontier Geosciences. Prior to joining Frontier, Dr. Pollman served as Principal Scientist with Tetra Tech. His principal areas of expertise are aquatic geochemistry and geochemical modeling. He has been intimately involved in atmospheric deposition studies and the relationship between atmospheric deposition and surface water chemistry beginning with his doctoral work on the nutrient dynamics of Lake Apopka in the late 1970's. More recently, Dr. Pollman's research has expanded to include atmospheric deposition of mercury, and elucidating the biogeochemical mechanisms that control how mercury cycles through aquatic food chains.

Abstract
In 1989 monitoring found Hg in largemouth bass of the Florida Everglades in excess of 2 ppm – well above national and international guidelines. In response, the FDoH recommended limits for consumption at 0.5 mg/kg and issued advisories for over 1 million acres of fresh waters in Florida. Since the mid-1990's, however, consistent declines in mercury concentrations in bass throughout Florida have been reported, including declines in portions of the Everglades of 60 to 80%. Declines in Hg in wading birds in the Everglades have been reported as well. Because atmospheric deposition is the major source of Hg to the Everglades, one hypothesis that seeks to explain the observed biota Hg concentration trends links the biota declines to declines in local emissions of Hg. This study examines whether this hypothesis is supported by the extant data or whether the apparent trends in biota may be more appropriately related to other factors or perturbations. (1) Are the reported trends in different biota robust and self-consistent? (2) Are there concomitant trends in local emissions of Hg? And (3) Has there been a significant change in atmospheric deposition fluxes of mercury?

These results indicate that large reductions in emissions (ca. 93% relative to peak emissions) occurred after 1991. Second, we statistically analyzed wet deposition fluxes for mercury from November 1993 through December 2002 for samples collected in Everglades National Park to determine whether these trends, if any, can be related to changes in the atmospheric signal, or are related to changes in rainfall patterns. Although wet deposition monitoring began well after the largest fraction of the reductions in local emissions occurred, the wet deposition signal showed a significant decline nonetheless (ca. 25%; $p=0.0413$), one that agrees reasonably well with the emissions declines during the same period. Third, we compare the biota trends to examine whether the time scale and magnitude of changes in largemouth bass Hg observed in the Everglades are consistent with predicted changes produced by the changing deposition trajectory. These results suggest that the biota changes are indeed consistent with the estimated declines

in local emissions and deposition, although additional analyses to test other hypotheses should be conducted before more definitive conclusions are reached.

Water Quality Monitoring in Michigan, 1996-2006: A Decade of Program Evolution

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Gary Kohlhepp received a B.S. degree in Biology from Xavier University in Cincinnati and a Masters degree in Aquatic Biology from the University of Notre Dame. From 1991-95, Mr. Kohlhepp worked on Lakewide Management Plans for the U.S. Environmental Protection Agency, Region 5. Since 1996, Mr. Kohlhepp has worked for the Water Bureau, Michigan Department of Environmental Quality. His primary responsibilities include: implementation and oversight of a comprehensive surface water quality monitoring program for the State; reporting on environmental indicators; and serving as a liaison between the MDEQ and other federal, state, local agencies with water quality monitoring responsibilities.

Abstract
In 1996, the Michigan Department of Environmental Quality (MDEQ) initiated a review of its water quality monitoring activities and needs. This review culminated in the development of a comprehensive monitoring strategy in 1997, which identified monitoring priorities for fish and wildlife contaminants, river and lake water, sediments, biological integrity, beaches, stream flow, and volunteer monitoring. Michigan voters approved the Clean Michigan Initiative in 1998, a state bond which allocated an additional $3 million per year for water quality monitoring. This funding led to the implementation of the projects identified in the 1997 monitoring strategy. As required by EPA, and consistent with their guidance, Michigan's monitoring strategy was updated in April 2005. When this process began in 1996, the overall monitoring program design was based on 4 goals: 1) assess current water quality and standards attainment; 2) measure temporal and spatial trends; 3) evaluate program effectiveness; and 4) detect emerging problems. During the ensuing decade, these goals and the basic design of MDEQ's monitoring program has changed very little. However, the monitoring program has evolved substantially over this period to meet new objectives/requirements, to increase the types of waters assessed, and to improve implementation efficiency. For example, probabilistic sampling designs have been recently incorporated in some program areas to better assess statewide water quality conditions. Partnerships with universities and local governments have been expanded substantially to more effectively evaluate emerging contaminants and issues of local concern. Specific steps have been taken to improve integration with state water quality protection programs and ensure that programmatic needs are addressed. This presentation will describe the evolution of MDEQ's monitoring program over the past decade, including programmatic challenges, lessons learned, and long-term funding mechanisms.

A Cooperative State and USGS Statewide Water Quality Monitoring Network: Accomplishments and Lessons Learned After 15 Years

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Chris Mebane has served since 2003 as a liaison between the U.S. Geological Survey and NOAA Fisheries, working mostly with ecotoxicology issues related to water quality criteria, discharges, and effects of nutrient enrichment. Previous related work included positions with the Idaho Department of Environmental Quality working with water quality standards, monitoring and assessment, and service with NOAA supporting marine and coastal monitoring and assessment projects. Mark Hardy is a chemist and currently serves the water quality specialist for the USGS Idaho Water Science Center. Mark has worked with many monitoring studies with the USGS in Idaho, Oregon, and Pennsylvania. Dorene MacCoy is a biologist and has conducted integrated monitoring studies with USGS in Idaho, Washington, and California.

Don Essig has served since 2003 as the Water Quality Standards Manager for the Idaho Department of Environmental Quality. Don has worked with a variety of water quality standards issues including temperature, metals, human health criteria for pathogens and toxic substances, and sediment. Previously Don worked on developing TMDLs and TMDL methods development. Other positions related to water quality monitoring and assessment included consulting work with Hydrometrics, Inc. in Helena, Montana, the Montana Department of Natural Resources and Conservation, and as a staff scientist with the University of Montana.

Abstract

In 1989, the U.S. Geological Survey (USGS) and the Idaho Department of Environmental Quality (IDEQ) began a cooperative statewide water quality monitoring program (SWQMP). The program was implemented in support of Idaho's antidegradation policy. Antidegradation goals include maintaining "high quality" waters that have better quality than that required by numeric criteria, as well as protecting existing aquatic life and recreational beneficial uses of waters. The objective of the SWQMP was to provide water-quality managers with a coordinated statewide program to detect trends that could indicate if water quality was changing. The network consists of 56 sites distributed across the major river basins of Idaho. Sites were intended to serve as either integrator or reference sites. Integrator sites were intended to reflect the cumulative influences of upstream management practices, land uses, and effluent controls; whereas reference sites were intended to provide comparisons from streams that are relatively unaltered from their natural states. Sites have been sampled on a rotation, with 5 integrator sites sampled annually and the rest biennially or triennially. Initially, analyses focused on conventional physical and chemical parameters that could be compared to criteria lookup tables. However, this approach to evaluating aquatic life uses is inadequate. As protocols were established for evaluating biological conditions of water, by 1996 chemical sampling was reduced in favor of biological monitoring of macroinvertebrate and fish assemblages.

Challenges to maintaining and making best use of this broadscale, long-term monitoring program include, (1) natural variability that complicates trend detection, (2) effects of local management practices may be imperceptible at integrator sites, (3) personnel turnover that may shift priorities and directions, and (4) updated sampling and analysis methods that can affect data comparability. Interpretive reports by T.R. Maret and others (WRIR 01-4145) and by M.A. Hardy and others (SIR 2005-5033) are available at http://id.water.usgs.gov/public/reports.html.

Can You Teach A Long-Term Benthic Monitoring Program New Tricks? Assessement and Redesign to Address Different Scales.

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Marc Vayssières is an environmental scientist in the Environmental Monitoring Program within the Interagency Monitoring Program. He has a PhD in Ecology and began working for the California Department of Water Resources in 1998. Send correspondence regarding this presentation to him at marcv@water.ca.gov

Karen Gehrts is also an environmental scientist with the Department of Water Resources. She begun working for the Environmental Monitoring Program in 2000 and assumed management of the benthic monitoring program in 2001.

Cindy Messer is currently a Senior Environmental Scientist in the Municipal Water Quality Investigations Program within the Office of Water Quality. She began working for the California Department of Water Resources in 1997. Her area of interest is in the ecology of invasive freshwater and estuarine invertebrates.

Abstract

Within the California Interagency Ecological Program (IEP), the Environmental Monitoring Program (http://www.iep.water.ca.gov/emp/) has been monitoring water quality, phytoplankton, zooplankton and benthic macro-invertebrates in the Upper-San Francisco Estuary since the mid-1970's. The EMP Benthic monitoring component has recently been reviewed and the question was raised of the large scale and small scale representativity of its sampling design. To address this question, we conducted an estuary wide survey to determine if there were benthic macro-invertebrate communities that were not sampled by the current design. We also surveyed 64-hectares neighborhoods around six of our long term monitoring stations to assess the degree to which these stations characterize the communities found at that smaller spatial scale. The results of these surveys are presented with the lessons learned and the implications for the interpretation of a long-term monitoring program's historic data and the overhaul of its sampling design.

Optimization of a Large-scale Water Quality Monitoring Network in South Florida

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Patricia Burke has been with the South Florida Water Management District for over ten years. She currently applies her knowledge and experience in the design, development and implementation of comprehensive monitoring networks to support the Comprehensive Everglades Restoration Plan.

Carlton Hunt has over 30 years of experience in estuarine and coastal ecosystems. He has managed projects involving the transport, fate, effects, and bioaccumulation of contaminants and water quality impacts of nutrients in a diverse set coastal systems. His knowledge of field and laboratory requirements is used to formulate monitoring and assessment strategies and to develop state-of-the-art sample collection methods that address relevant environmental and regulatory issues.

Steve Rust is a Senior Research Leader in Battelle's Columbus, OH office where he applies statistical theory and methodology to research problems related to information systems, engineered systems, human health, and the environment. He currently manages a Battelle-funded effort to develop standard bioinformatic analysis procedures and tools to be applied by Battelle scientists when analyzing genomic, transcriptomic, proteomic, and metabolomic data.

Jennifer Field is Principal Research Scientist in Battelle's West Palm Beach, FL office where she applies her biological and statistics background to ecological issues associated with essential fish habitat assessments, threatened and endangered species assessments, and environmental impact statements.

Abstract

The South Florida Water Management District (District) is continuously challenged with providing the resources needed to provide substantial and diverse water quality information. With over 1500 monitoring sites over a 16-county area, the District water quality monitoring network spans a wide variety of ecosystems over a large geographic area. The network consists of individual monitoring projects driven by multiple mandates and objectives and the monitoring must be accomplished with limited resources under the constraint of changing priorities. The environmental restoration of South Florida will undoubtedly increase monitoring commitments and associated costs in the future. To ensure that present and future monitoring will efficiently generate high quality, scientifically defensible data, an optimization of seventeen individual water quality monitoring projects was conducted. This optimization not only incorporated statistical analyses, but also gave equal weight to the need and relevance of each monitoring program as it related to the District's mission and priorities. The optimization method incorporated the EPA's Data Quality Objectives (DQO) approach in evaluating individual projects and relied on rigorous interactions with data end users to develop appropriate statistical tests and identify project specific optimization opportunities. Our presentation will highlight the optimization process and detail results from water quality projects that span the range of challenges associated with a comprehensive optimization of a diverse monitoring network.

Effect of taxonomic resolution on the performance characteristics of a new macroinvertebrate field sampling protocol for large rivers

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Biographical Sketches of Authors

Karen Blocksom is a statistician in the National Exposure Research Laboratory (NERL) within the U.S. Environmental Protection Agency's Office of Research and Development (ORD). She has training and experience in both aquatic ecology and applied statistics. Since 1998, Karen's research has focused on issues related to the development and application of biological indicators and bioassessment methods.

Joseph Flotemersch is a research ecologist in U.S. EPA's NERL with training in aquatic biology, fisheries, wildlife biology, and forest science. His primary area of research is in large river ecology and assessment, but he is also interested in floodplain river ecology and the comparison of field sampling methods.

The performance characteristics of a sampling protocol provide critical information about its utility for diverse bioassessment applications. The taxonomic resolution used to estimate performance can affect such comparisons. Specifically, identification of organisms to family level should result in estimates of precision and sensitivity that differ from those calculated at the genus and species levels. Recently, U.S. EPA developed a new macroinvertebrate field sampling protocol for large rivers with an accompanying laboratory protocol, and a study was conducted to assess the performance characteristics of this protocol. Initially, estimates and evaluations of performance were measured for data at the lowest possible taxon level. However, many states use family- or genus-level data for bioassessment due to cost or other resource constraints. Using assemblage metrics, we re-evaluated precision and sensitivity of the field and laboratory components of the protocol at the family and genus levels in order to determine the effect of taxonomic resolution on these attributes. We anticipated greater precision (lower variability) in metric values at the family level, with fewer anticipated errors in taxonomic identification, and reduced sensitivity to a disturbance gradient. Variability largely followed the expected pattern with respect to taxonomic resolution, but when considered relative to metric value range, the pattern either was reversed or was no longer obvious. The relationship between sensitivity and taxonomic resolution was more complicated and varied depending on the metric. This study provides an indication of the types of tradeoffs that can be expected for varying levels of taxonomic resolution applied to the same protocol. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

A National Autecology List for Benthic Macroinvertebrates

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Biographical Sketch
Erik W. Leppo is a staff scientist/programmer at Tetra Tech, Inc.'s Center for Ecological Studies in Owings Mills, Maryland. His experience includes database development and management of large datasets.

Abstract
A national autecology list for benthic macroinvertebrates emerged as a product of the National Wadeable Streams Assessment (WSA). A master taxa list for benthic macroinvertebrates was needed for analysis that covered the entire nation and included such information as phylogenetic names, functional feeding groups, tolerance values, and habits. At the foundation of any analysis of benthic macroinvertebrates is a fully populated master taxa list with autecology information. Without a complete and accurate list any analysis is flawed. For the WSA project this list was compiled from the list used for the Western Environmental Monitoring and Assessment Program (EMAP), several eastern bioassessment programs, and the organisms collected for the WSA project. These various lists were compiled and synthesized to a single list. The merging of these various lists required support from a wide range of areas of expertise (entomologist, biologists, statisticians, and database managers). The development of the list also required the condensing of information from multiple sources to a single attribute to be used in the list. Many lessons were learned during the development of this tool but it is now a reference tool that can be useful for states, tribes, or agencies across the country.

Enhancing the Credibility of Taxonomic Data: the National Wadeable Streams Assessment

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James (Sam) Stribling is a Director in Tetra Tech's Center for Ecological Sciences in Owings Mills, Maryland. He has been involved with development and application of biological indicators for decision-making related to water resources management for over 20 years, 15 of which have been with Tetra Tech. Most recently, he has been active in development of method performance characteristics for biological monitoring, approaches for evaluating protocol comparability, and design of monitoring programs for counties and watershed management groups.

Kristen Pavlik has been a scientist with Tetra Tech in Owings Mills for 7 years. She recently coordinated the laboratory processing associated with the National Wadeable Streams Assessment (WSA), comprising approximately 750 samples, which were processed through multiple laboratories. She also worked with EMAP to train all of the State and Cooperator field teams for this intensive effort. She has performed field sampling and laboratory work for monitoring programs across the country, and is currently coordinating the Nutrient Scientific Technical Exchange Partnership and Support (N-STEPS) for the USEPA. Susan Holdsworth is in the USEPA Office of Wetlands, Oceans, and Watersheds, and is the Program Manager for the National Wadeable Streams Project, as well as upcoming Agency initiatives for broad scale assessments of the nation's waters. Susan has been with OWOW for 8 years.

Abstract
The identities of organisms contained within samples are the primary data used in biological monitoring and assessment. Although there are other potential error sources in the assessment process, the central function of taxonomic identifications and data impels the need to document and report associated uncertainty. This second phase of the National Wadeable Streams Assessment (WSA) encompassed all states of the eastern US, as far west as New Mexico in the south, Iowa and Kansas centrally, and Minnesota in the north, and resulted in a total of 749 benthic macroinvertebrate samples. All samples were laboratory subsampled to approximately 500 organisms, and sent to taxonomists for identification and enumeration; primary identifications were performed among at least 26 taxonomists in 11 laboratories. For each taxonomist, approximately 10% of the samples were randomly-selected for re-identification by an independent taxonomist in a separate laboratory (total n = 72), and the two sets of results directly compared. Taxonomists were provided with standard hierarchical target levels (by major group) which were primarily genus; and with counting/non-counting "rules", such as avoiding empty mollusk shells and non-headed worm fragments. The sample-based comparison results were summarized as percent taxonomic disagreement (PTD) and percent difference in enumeration (PDE), with mean values of approximately 24% and 2%, respectively. Following initial results, interactions between the primary and re-identification taxonomists (via detailed reconciliation conference calls), coupled with very specific corrective actions, resulted in improved consistency; so far, a second round of comparisons demonstrated mean PTD of 13% and PDE of 1%, both below the project measurement quality objectives. Detailed results provided direction on developing approaches to dealing with problematic taxa, differential expertise among multiple taxonomists, and data entry and recording errors. The process resulted in improved consistency of data among multiple laboratories and taxonomists.

How often are we wrong? A Bayesian assessment of taxonomic identifications for the National Wadeable Streams Assessment

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Lester Yuan is an environmental engineer in the Office of Research and Development of the U.S. EPA. His primary research interests include using taxon-level statistical models to identify likely causes of impairment and refining indicators of stream biological condition.

Jeroen Gerritsen has more than 28 years of experience in aquatic environmental sciences (13 years with Tetra Tech), including basic and applied research, teaching, environmental assessment, and project management. Dr. Gerritsen has ongoing research interests in developing cost-effective sampling designs and data analysis methods for long-term environmental monitoring, research, and assessment.

James (Sam) Stribling is a Director in Tetra Tech's Center for Ecological Sciences in Owings Mills, Maryland. He has been involved with development and application of biological indicators for decision-making related to water resources management for over 20 years, 15 of which have been with Tetra Tech. Most recently, he has been active in development of method performance characteristics for biological monitoring, approaches for evaluating protocol comparability, and design of monitoring programs for counties and watershed management groups.

Abstract
Biological assessment using RIVPACS-type models to predict which taxa should occur in a waterbody are highly dependent on reliable and consistent identification of the organisms in the monitoring database. Large-scale or long-term biological monitoring programs must achieve consistent identification among many different taxonomists (as well as with a single taxonomist over time), yet error is inevitable when we consider that taxonomists must identify some 50 genera in each sample from a pool of more than 500 genera in a region, many of which are rare in the sample collection. Macroinvertebrates collected from the Eastern U.S. phase of the National Wadeable Streams Assessment were identified by 26 different taxonomists in 11 different laboratories. Ten percent of all samples were re-identified by a single QC taxonomist. Using the QC data and some simplifying assumptions, we estimated error rates of identifying taxa, both false positive (taxon identified, but not actually present) and false negative (taxon not identified, but present). Using a Bayesian approach common in medical diagnostics, we estimated the posterior probabilities of taxa being present when identified, and absent when not identified. This analysis combined estimates of true and false positive identification rates with estimates of the overall occurrence frequency of different taxa to arrive at a prediction of the probability of a taxon actually being present in a sample when it was observed by the primary taxonomist. Results were quite encouraging for the use of these data for models requiring accurate presence-absence data. Posterior probabilities of correct identification were very high for most taxa, even many rare taxa. The analysis identified only a small number of genera that were consistently misidentified, leading to unacceptably high false-positive rates. For most of these genera, aggregating to a higher taxonomic level (family) or combining similar genera into composite genera groups reduced the error rate to acceptable levels.

Wetlands Biological Assessments: The 1 – 2 – 3 Approach

Facilitators
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John Mack, Ohio Environmental Protection Agency, Division of Surface Water

Biographical Sketches
Chris Faulkner is an aquatic biologist with the US Environmental Protection Agency. He has worked on ambient water quality monitoring and assessment for 15 years.

John J. Mack is a wetland ecologist and botanist with the Ohio Environmental Protection Agency. He received a B.S. in Interdisciplinary Studies from Miami University in Oxford, Ohio, an M.S. in Environmental Science from Indiana University, Bloomington, Indiana, a Juris Doctor from Cleveland State University, Cleveland, Ohio, and an M.S. in Evolution, ecology, and Organismal Biology from Ohio State University, Columbus, Ohio. His work at Ohio EPA includes developing and applying biological indicators to access wetland condition including the development of a Vegetation Index of Biotic Integrity for Ohio wetlands. He also has done research on the history of prairie peninsula in Ohio and the florisitcs and ecology of Ohio prairie and savannah.

Description of Workshop
Wetlands play a vital role in water quality management programs. As is true with all waterbodies, the biological community of a wetland reflects the cumulative response to a host of chemical, physical, and biological stressors. The most meaningful way to measure biological condition is to directly examine one or more biological assemblages such as macroinvertebrates or vascular plants. This biological assessment data will then be used to evaluate ambient water quality conditions as well as determine success of wetland mitigation and restoration efforts.

EPA advocates Wetland assessment at three different tiers. This course will introduce the 1 – 2 - 3 assessment approach as well as focus on the selection of assessment metrics for integration into a final index. This course will introduce biological assessment and criteria methods for wetlands and their many applications to State and Tribal wetland programs. Course material will be taken from EPA's Methods for Evaluating Wetland Condition as well as case studies and examples from states. Recommended for anyone interested in conducting biological assessments and deriving biocriteria for wetlands. Participants attending the field component should wear comfortable shoes and clothes that can get dirty.

Effects of Organic Carbon Distribution on Redox Chemistry in a Glacial Aquifer, Woodbury, Connecticut

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Craig Brown is a hydrologist with the U.S. Geological Survey. His research interests include aquifer geochemistry, geochemical modeling, and processes associated with the transport of natural contaminants and other trace elements.

Pete McMahon is a hydrologist with the U.S. Geological Survey. His research interests include the geochemistry of aquifer systems, temporal variability in ground-water recharge chemistry, and application of isotope techniques in hydrologic studies.

Jeff Starn has been a hydrologist with the Federal government for over twenty years. He has worked overseas with the Peace Corps, with the USEPA in Region IV, and with the USGS in the Kentucky and Connecticut Water Science Centers. His current interests include probabilistic ground-water modeling and using combined watershed and ground-water models to help better understand hydrologic processes in glacial/crystalline rock aquifer systems.

Abstract

Glacial aquifers in much of the northeastern United States consist of stratified glacial valley-fill deposits of limited lateral extent. Ground water in these aquifers is typically young (< 10 years old), and rates of flow are typically high (hydraulic conductivity values range from 1.5 meters per day in tills to 46 meters per day in sand and gravels). Consequently, redox conditions are generally considered to be oxic throughout the aquifer. In reality, localized reducing conditions can result from dissolved organic carbon (DOC) that is leached from natural organic matter or from anthropogenic sources. A study of ground-water flow and geochemistry in the contributing area to a community supply well in Woodbury, Connecticut, identified organic carbon sources that include: (1) DOC leached from surface water in the summer and fall months, (2) natural sedimentary organic matter (>1 percent) in some sediments, and (3) contaminant point sources (septic leach fields, leaking storage tanks, or spills). The leaching of DOC from these sources can result in localized reducing zones that affect the movement of contaminants for tens to hundreds of feet downgradient. Older ground water derived from adjacent or underlying till and fractured bedrock also tends to have reducing redox chemistry that may or may not be affected by organic carbon.

High concentrations of DOC generally are associated with low concentrations of oxygen and nitrate, and high concentrations of dissolved manganese, iron, and sulfide. Naturally occurring trace elements, including arsenic, in sediments and rocks can be mobilized by reductive dissolution coupled to oxidation of organic carbon. Locally high concentrations of nitrate (from 3 mg/L to 19 mg/L as N) and DOC (from 0.5 to 89 mg/L) were observed in wells downgradient of several septic leachfields. Transport of nitrate leached from septic leach fields is limited by denitrification coupled to oxidation of organic carbon; nitrate in at least one sample near a leach field was enriched in ^{15}N, apparently as a result of biological fractionation. This effect of organic carbon on ground-water redox chemistry generally is spatially limited in these glacial aquifers, but can be important on a local scale.

Optimizing a Monitoring Network Using Water Quality and Environmental Factors in the Glacial Aquifer System, United States

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Terri L. Arnold is the GIS Specialist for the U.S. Geological Survey, National Water-Quality Assessment (NAWQA) Program's Upper Illinois River Basin Study Unit. She received her BS in Geography from the University of Illinois. Her responsibilities include spatial and geostatistical analysis and mapping of water samples and environmental data.

Kelly L. Warner is a hydrologist with the U.S. Geological Survey, NAWQA Program. She received a BA from Knox College and an MS from Northern Illinois University, both in Geology. She currently leads an effort to synthesize data to assess the regional ground-water quality for the glacial, Cambrian-Ordovician, and New England crystalline aquifer systems.

Abstract

A framework for developing a monitoring network for comparison of ground-water quality across the glacial aquifer system was developed based on two primary characteristics of the system: intrinsic susceptibility and vulnerability. Intrinsic susceptibility, a measure of how easily water enters and moves through aquifer material, is represented by the spatial distribution and physical setting of fine- or coarse-grained material at the land surface. Vulnerability, a function of intrinsic susceptibility and the proximity and characteristics of contaminants, includes natural and anthropogenic sources. The framework divides this aquifer system into areas with similar environmental factors for which ground-water quality can be compared. Water-quality data collected between 1991 and 2001 and various related environmental factors were used to optimize the selection and addition of sampling sites for a monitoring network in the glacial aquifer system within the framework context.

As part of the U.S. Geological Survey's National Water-Quality Assessment Program, ground-water-quality data were collected at over 1,700 domestic, public, and monitoring wells from representative parts of the glacial aquifer system. Sites with similar water quality, based on major ions and alkalinity, were categorized into five groups using cluster analysis (a statistical method that groups data to maximize between-group variability and minimize within-group variability). Regression-tree analysis identified 17 environmental factors that contribute to the spatial variability of water quality in the glacial aquifer system based on the five water-quality groups. All of the identified factors were related to how long water is in contact with the aquifer materials and indicated a statistically significant relation to the framework characteristics used to design the monitoring network for the glacial aquifer system. Understanding water-quality differences in the glacial aquifer system and knowing environmental factors that affect the spatial variability in water quality will help optimize the ground-water quality monitoring network as new sites are added.

Estimation of Stream-Valley Aquifer Withdrawals, 2000

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Pierre Sargent received his Master's degree in water resources management from the University of Wisconsin, Madison. He has been compiling and analyzing water use data at the U.S. Geological Survey's Louisiana Water Science Center in Baton Rouge since 1999.

Molly Maupin is a Hydrologist with the U.S. Geological Survey Water Science Center in Boise, Idaho. She has worked on the National Water Quality Assessment Program for almost 15 years in various capacities. She provided support for NWIS databases, and analysis of water use, environmental, and GIS information to the Upper Snake River Basin study unit during the high-intensity phase between 1991 and 2001. She has been the water-use specialist for Idaho since 1990 and serves as the Western Region Water Use Specialist for the National Water Use Leadership Team and is a liaison to the NAWQA National Leadership Team.

Steve Hinkle received his Master's degree in hydrology from the University of Arizona in 1990 and has been working for the U.S. Geological Survey since then.

Abstract

Assessments by the U.S. Geological Survey National Water-Quality Assessment Program indicate that while many of our Nation's waters are suitable for most uses, contamination continues to affect our rivers and ground water. Especially vulnerable is ground water withdrawn from stream-valley aquifers. Stream-valley aquifers are long but narrow sand and gravel deposits beneath floodplains and terraces of streams that are in hydraulic connection with associated streams. Water use from stream-valley aquifers has been included in previous national water-use compilations, but not explicitly identified as originating from stream-valley aquifers. As a means of gaining a better understanding of the importance of this resource from a water-use perspective, stream-valley aquifer withdrawals were determined for calendar year 2000. Withdrawals were determined for irrigation, public supply, and self-supplied industrial categories, which typically comprise over 90 percent of all ground-water withdrawals.

Twenty-four states were selected for the determination of stream-valley aquifer withdrawals. The states were selected by generally excluding areas covered by Quaternary continental glaciation, Atlantic coastal plain aquifer systems, the High Plains aquifer, and western basin-fill aquifers. In these areas, withdrawals from stream-valley aquifers typically cannot be differentiated from withdrawals from underlying alluvial sediments.

Site-specific water-use data provides the best opportunity to extract stream-valley aquifer pumpage. In addition to annual pumpage and location data, information on well depth, state and national aquifer codes, lithology, watershed classification, and standard industrial classification code is useful. GIS coverages of geology, aquifers, southern extent of Quaternary continental glaciation, watersheds, and rivers are combined with the site-specific water use data in order to determine stream-valley aquifer withdrawals.

The results of the analysis indicate that stream-valley aquifer withdrawals (over 1,400 Mgal/d) are comparable to withdrawals from the 10 most productive principal aquifers in the United States.

Comparison of the Vulnerability of Domestic Wells and Public Wells to Volatile Organic Compounds

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Abstract

Occurrence of volatile organic compounds (VOCs) in ground water supplies sampled by the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program indicates that domestic well samples had fewer compounds, lower detection frequencies, and smaller concentrations than public well samples. Chloroform, MTBE, and perchloroethene were the most frequently detected VOCs in samples from both well types. VOCs in domestic well samples represented compounds with multiple uses. VOCs in public well samples were predominantly solvents, the gasoline oxygenate MTBE, and trihalomethanes.

About one percent of domestic well samples and two percent of public well samples had VOC concentrations greater than the U.S. Environmental Protection Agency's Maximum Contaminant Levels (MCLs). Concentrations of 1,1-dichloroethene, trichloroethene, and perchloroethene were greater than MCLs in both well types. Additional VOCs with concentrations greater than MCLs in domestic wells included dibromochloropropane, 1,2-dichloropropane, and ethylene dibromide; whereas methylene chloride and vinyl chloride were additionally greater in public wells.

Factors associated with an increased likelihood of detecting VOCs in both well types included increased aquifer recharge, increased soil permeability, and proximity to hazardous waste facilities. For public wells, MTBE occurrence was associated with local use of this oxygenate in gasoline.

Findings indicate that water from public wells has greater vulnerability to VOC contamination than domestic wells despite deeper median depth of sampled public wells (303 feet) than domestic wells (104 feet). Larger withdrawal rates, proximity to developed areas, larger capture zones, and greater drawdown explain, in part, why VOC occurrence in pubic well samples was greater than in domestic well samples. Young, recently recharged ground water can be intercepted by both well types. Public wells may also intercept VOCs from multiple land uses and point sources because of their large contributing areas; and from ground water flowing along deeper, longer flow paths.

Nutrients in Ground Water from Private, Public-Supply, and Monitoring Wells Open to the Glacial Aquifer System, United States

Kelly L. Warner and Terri L. Arnold

Abstract
Nutrient concentrations in ground water in the glacial aquifer system of the United States were investigated by comparing concentrations in private, public-supply, and monitoring wells. The water-quality data were collected as part of the U.S. Geological Survey's National Water-Quality Assessment program from 469 private wells, 99 public-supply wells, and 1,116 shallow monitoring wells (generally less that 100 feet deep) across the glacial aquifer system.

The median nitrate concentrations (measured as dissolved nitrate and nitrite) in ground water from the private and public-supply wells considered here are 0.1 mg/L, and 0.2 mg/L, respectively. These concentrations differ appreciably from the median concentration for the monitoring wells (1.2 mg/L); sample concentrations from monitoring wells reflect recently recharged ground water, whereas sample concentrations from the other well types reflect older water, possibly explaining this difference. Comparison of ground-water concentrations from private, public-supply, and monitoring wells at nitrate screening levels of 1, 4, and 10 mg/L, respectively, indicates increasing differences by well type with higher screening levels. Preliminary analysis of phosphate and ammonia concentrations indicates no significant variation among well types. In addition to water-quality differences among well types, there is a range of physical (well depth, casing diameter, surficial material, and others) and water-quality differences in water from private, public-supply, and municipal wells. Comparison of median nutrient concentrations among areas of similar hydrochemistry shows a statistical difference by hydrochemical area. Hydrochemical areas have similar water quality based on major ions and alkalinity and determined by cluster analysis. Five hydrochemical areas were defined across the aquifer system in this analysis.

Can We Distinguish Regional From Local Variations in Trace Element Concentration in the Glacial Aquifer System?

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Abstract
Variability is large in ground water trace element concentrations in the glacial aquifer system of the northern United States, in both local and regional scales. Ground-water sampling, from 1992 through 2003, of the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey, determined trace element concentrations in 847 wells in the glacial aquifer system. Concentrations of antimony, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, strontium, thallium, uranium, and zinc vary as much within NAWQA study units (local scale; ranging in size from few thousand to tens of thousands of square miles) as over the entire glacial aquifer system. The glacial aquifer system includes areas from most of New England, through the Midwest, and portions of the Pacific Northwest and Alaska. The sampled wells are from both land-use surveys and water-supply well networks.

Relations between trace elements in ground water and glacial or bedrock geology, are difficult to determine, in part, because of the large variability in mineral content and bulk trace element chemistry of the geologic units. Patterns of trace element detections in glacial aquifer ground water were examined using techniques suitable for dataset with zero to 80 percent non-detections. During the time period of sampling, the analytical techniques changed and, in general, improved sensitivity. Multiple reporting limits complicate comparing detections and concentrations. Regression on Order Statistics was used to characterize the medians and other quantiles of the trace element concentrations. Quantiles of dissolved iron concentrations are similar for selected study units and the entire data set. Other trace elements that show similar variability between study-unit scale and the extent of the glacial aquifer are: barium, lead, cadmium, copper, and zinc. Characterization of this variability is a step in determining the regional probability of these trace elements exceeding drinking-water or other human health standards.

Natural and Human Factors Affecting Shallow Ground-water Quality at Local and Regional Scales in the North Atlantic Coastal Plain, New York through North Carolina

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Jim Tesoriero is a research hydrologist with the Oregon Water Science Center within the USGS. Since 1994, he has focused on the fate and transport of agricultural contaminants in ground-water systems for the NAWQA program.

Paul Stackelberg has been a hydrologist with the USGS since 1988. His research interests include evaluating relations between natural and anthropogenic factors and ground-water quality, and the occurrence and fate of pharmaceuticals and other compounds in streams and drinking-water supplies.

Abstract
Effects of soil properties, hydrogeologic conditions, land use, and other potential natural and human influences on the quality of shallow, unconfined ground water were examined at the local and regional scales in the North Atlantic Coastal Plain, from Long Island, New York through North Carolina. The Coastal Plain includes a variety of land uses (including forest, agriculture, and densely populated urban areas) and hydrogeologic conditions. Unconfined ground water commonly occurs within 20 to 30 feet of the land surface, and typically moves along relatively short flow paths to local streams within a few decades. Ground water in the surficial unconfined aquifer represents a significant source of flow to local streams and a source of drinking water in many areas. Surficial sediments in many areas are well-weathered siliciclastic sands and gravels, and ground-water quality in much of the surficial aquifer reflects the influence of relatively recent local land use.

Ground-water quality within the surficial aquifer system in the Coastal Plain was examined along individual local flow paths in selected land-use and hydrogeologic settings, and at the regional scale in several hundred wells. Local-scale studies illustrate specific natural and human factors that influence ground water and generate different water chemistry in different settings. Nitrate, calcium, and magnesium, for example, are typically important ions in oxygen-rich ground water affected by fertilizer or manure applications, although nitrate may not occur under reducing conditions. Pesticide concentrations are typically highest in recharge areas where applied, although pesticides may occur throughout the flow system. Such local information supports the interpretation and understanding of related patterns observed in water chemistry and water quality at the regional scale. Insights on the interacting natural and human influences on shallow unconfined ground water in the Coastal Plain provided by these complementary approaches can be useful for watershed management and similar applications.

Trends in Ground-Water Withdrawals for Irrigation and Public-Supply Uses Across The United States

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Molly A. Maupin is a Hydrologist with the U.S. Geological Survey Water Science Center in Boise, Idaho. She has worked on the National Water Quality Assessment Program (NAWQA) since 1991 in various capacities. She provided support for the National Water Information System (NWIS) databases, water-use analysis, and environmental and GIS information to the Upper Snake River Basin study unit. She has been the water-use specialist in Idaho since 1990 and serves as the Western Region Water-Use Specialist for the National Water-Use Information Program. She is also a liaison to the NAWQA National Leadership Team for water-use information.

Abstract
Ground water has increasingly become a major source of water supply across the United States. In 2000, about 83,300 Mgal/d (million gallons per day) was obtained from fresh ground-water sources, and accounted for nearly 25 percent of the total (surface and ground) freshwater withdrawals. Ground water provided nearly 42 percent of the total water withdrawn for irrigation and 37 percent of total water withdrawn for public supply. The High Plains aquifer, underlying parts of 8 states, was the most intensively used aquifer in the United States providing 17,500 Mgal/d--mostly for irrigation (97 percent). Other aquifers that supplied large amounts of irrigation water in 2000 include the Central Valley aquifer system and the Mississippi River Valley alluvial aquifer. The largest producers of water for public supply in 2000 were the glacial sand and gravel aquifers, the California Coastal Basin aquifers, and the Floridan aquifer system.

Total ground-water withdrawals in the United States increased from 34,000 to 83,300 Mgal/d between 1950 and 2000. Ground-water withdrawals for irrigation and public-supply (including self-supplied domestic) increased 145 percent between 1950 and 2000. Ground-water withdrawals from the High Plains aquifer increased from 4,600 to 17,500 Mgal/d between 1980 and 2000. Withdrawals from the Floridan aquifer system increased more than 500 percent between 1950 and 2000. Increased population and crop irrigation between 1950 and 2000 has increased the reliance on ground-water resources throughout the United States. These withdrawals, however, have caused declines in ground-water levels, saltwater intrusion, and a host of water-quality issues related to runoff, septic-tank discharge, and nutrients associated with agricultural production and urban land-use practices. An understanding of trends in water demand and the effects that withdrawals have on ground-water quantity and quality is important in managing our water resources to meet the Nation's future water needs.

Using a Modified Probability Approach for Determining the Contributing Area to a Public Supply Well In Karst Terrain

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Abstract
Demand for safe drinking water is leading water managers, purveyors, and scientists to improve assessments of contributing areas to public supply wells so that these wells can be adequately monitored and protected. This study addresses the transport of anthropogenic and natural contaminants to a supply well in the karst Upper Floridan aquifer near Tampa, Florida, and is part of the U.S. Geological Survey's National Water Quality Assessment Program. Because karst features in the study area are mappable at land surface, but can only be approximated below land surface, a ground-water flow model was calibrated using parameter estimation techniques to optimize hydraulic and recharge parameters. The model explicitly incorporates karst features using multiplication arrays that increase hydraulic conductance and recharge and decrease porosity where karst features are identified. An initial contributing area was generated from this model. The greatest uncertainty in the contributing area is a consequence of the spatial uncertainty of the karst features; thus, a probabilistic method was developed based on Langevin (2003) to distribute karst features spatially. Distributional information characterizing karst features such as fracture lineament, diameter, orientation, density, and length was used to generate 1000 realizations of karst features in the modeled area. These results were collated and used to generate a karst probability field. The features were, once again, incorporated into the model using multiplication arrays--increasing hydraulic conductance, and recharge values and decreasing porosity. The ground-water transport process was run using a range of probabilities characterizing the spatial karst information to generate potential contributing areas. This method provides estimates of the most probable contributing area to a public supply well and allows water managers to incorporate risk tolerance into their decision-making process regarding monitoring well placement in areas where the extent and spatial distribution of karst features is relatively unknown. Langevin, C.D., 2003, Stochastic ground water simulation with a fracture zone continuum model: Ground Water, v. 41, no.5, p. 587-601. 1. Hydrologist, National Water Quality Assessment Program, Transport of Anthropogenic and Natural Contaminants to Supply Wells, Georgia-Florida Coastal Plain, Center for Aquatic Studies, U.S. Geological Survey, 2010 Levy Ave., Tallahassee, Florida 32310, (850) 942-9500 ext. 3030, crandall@usgs.gov

Spatial Distribution of Dissolved Solids in Basin-Fill Aquifers and Major River Systems in The Southwestern United States

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David Anning has been a hydrologist with the U.S. Geological Survey Arizona Water Science Center since 1991, and has performed investigations of water use, water availability, and water quality in Arizona and in the Southwestern United States. David attended the University of Arizona where he received a B.S. in Geosciences in 1991 and an M.S. in Hydrology in 2002.

Steven Gerner is a hydrologic technician with the U.S. Geological Survey. He has worked in the Utah Water Science Center since 1991 collecting hydrologic, water quality and biological data as well as performing water-quality investigations throughout Utah.

Abstract
In many areas of the Southwestern United States, high concentrations of dissolved solids in ground and surface water limit the water's suitability for certain uses. In response to this water-quality issue, the U.S. Geological Survey's National Water-Quality Assessment Program began a study in 2004 to characterize dissolved solids in basin-fill aquifers and major river systems in the region.

The spatial distribution of dissolved-solids concentrations in basin-fill aquifers was characterized by synthesizing information from available maps and reports. Concentrations less than 500 milligrams per liter were found throughout the region; concentrations greater than 10,000 milligrams per liter were found in topographically low areas of the basin-fill aquifers. Ground-water concentrations were affected by natural and anthropogenic factors including the quality of water recharging the aquifer, type and solubility of minerals in the basin fill, hydrogeologic flow systems, evapotranspiration, and land-use practices.

For major river systems, the spatial distribution of dissolved-solids concentrations, loads, and yields were characterized on the basis of chemical and physical data for 420 stream sites. The data were collected between 1974 and 2003 as part of many U.S. Geological Survey surface-water-quality and discharge-monitoring programs. Based on data for the 420 sites, median daily dissolved-solids concentrations in rivers and their tributaries ranged from 22 to 13,819 milligrams per liter; median annual loads ranged from 60 to 7.86 million tons per year; and median annual yields ranged from less than 1 to 7,507 tons per square mile per year. The dissolved-solids concentrations, loads, and yields in the surface water differed throughout the region in response to natural and anthropogenic factors including geology, streamflow characteristics, evapotranspiration, ground-water discharge, water use and reuse, and land-use practices.

Reactive Transport of Nitrate in a Heterogeneous Alluvial Fan Aquifer, San Joaquin Valley, California.

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Christopher T. Green is a hydrologist with the US Geological Survey. Since 2002, he has worked with the National Water Quality Assessment program, collaborating with researchers in the Hydrologic Systems Team and Agricultural Chemical Transport topical study. His experience includes laboratory and field methods for characterizing denitrification in the unsaturated and saturated subsurface, and numerical modeling for the study of percolation and reactive solute transport.

Steven P. Phillips has been a Hydrologist with the U.S. Geological Survey for 20 years. His primary experience and interests involve using simulation models to better understand hydrologic systems and developing tools to help manage these systems. Most of his career has been spent addressing irrigation-driven management issues in the San Joaquin Valley, and artificial recharge, land subsidence, and public water supply issues in Antelope Valley, California.

Abstract
Fate of nitrate in an alluvial fan aquifer in the San Joaquin Valley, California, was investigated with combined laboratory analyses, field measurements, geostatistics, and flow and reactive transport modeling. Groundwater wells and lysimeters were installed to monitor hydrology and chemistry along a 1-km transect that extends upgradient from the Merced River. Sediment core samples from above and below the water table were analyzed for organic matter, nutrients, inorganic chemistry, and microbial parameters. Curve fitting of denitrification enzyme assays (DEA's) provided estimates of microbial biomass and growth coefficients in sediment cores. DEA biomass was similar to values obtained with the most probable number technique and varied by orders of magnitude between cores. At the aquifer scale, estimates of groundwater age and excess nitrogen gas implied zero-order decay rates of 0–0.8 mg/L/yr, which suggests that the large volume of groundwater exceeding nitrate drinking-water standards will continue to expand under current agricultural practices and hydrogeologic conditions. To quantify the fate and transport of nitrate, the field and laboratory measurements served as input for geostatistical realizations of sediment properties and simulations of reactive transport. Analyses of sediment cores, well logs, and previous interpretations of the local geology were used to generate (1) transition probability models of hydrofacies distributions within Holocene alluvium and pre-Holocene fans, and (2) maps of the boundaries between the stratigraphic sequences. Multiple 3-D realizations were created and ranked based on lateral and vertical bulk-flow properties. For realizations representing a range of geological conditions, flow was calculated with boundary conditions interpolated from a regional groundwater model. Results highlight the importance of distinguishing between aquifer- and core-scale estimates of reaction rates and kinetic parameters in heterogeneous systems.

Framework of Possible Factors that Affect Water Quality in Basin-Fill Aquifers of the Southwestern United States

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Tim McKinney is a physical scientist in the Utah Water Science Center of the U.S. Geological Survey and has assisted with the National Water Quality Assessment Program's Great Salt Lake Basins study since 2001. Currently, he is using geographic information systems to analyze data sets at a regional scale.

Abstract

Ground water is an important source of water to many cities and agricultural communities in the basins of the arid and semiarid southwestern United States and the quality of this resource, now and in the future, is of concern. The U.S. Geological Survey's National Water-Quality Assessment Program is studying the water quality of the basin-fill aquifers in the Southwest and the issues that affect water quality across the region. Principal aquifers included in the regional analysis are the Basin and Range basin-fill aquifers in Nevada, Utah, Arizona, and California, the Rio Grande aquifer system in New Mexico and Colorado, and the southern Coastal Basins and Central Valley aquifer systems in California. These principal aquifers consist primarily of unconsolidated sediment, have similar land- and water-use practices (although to varying degrees), and face many of the same water-quality issues.

As a first step in this regional analysis, an explanatory framework is being developed and will be used to assess similarities and differences in ground-water quality in the region. The framework is based on the physical characteristics of the basins, such as climate and topography; and the vulnerability of the aquifers to contamination, which is related to population density and type of land use. The framework variables will be distributed across the region by using a geographic information system. Overlaying these variables on maps will show areas with similar and dissimilar physical, susceptibility, and vulnerability characteristics.

Water-quality data sets from the area will be compiled to statistically test the relation between selected constituent concentration or detection probabilities to framework variables. This data and the initial framework will be used to assess hypotheses explaining water quality in the aquifers. Where water quality cannot be adequately modeled by the framework, more study will be needed to determine which factors affect the water quality.

New Jersey's Ambient Ground Water Quality Monitoring Network: Status of Land Use Impacts to Shallow Ground Water Quality Michael E.

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Raymond Bousenberry is a senior environmental specialist in the Bureau of Water Resources within the N.J. Department of Environmental Protection's New Jersey Geological Survey. He has training and experience in marine biology and environmental sciences. Mr. Bousenberry has been involved with the N.J. Ambient Ground Water Quality Monitoring Network since 2001, supporting the network into full implementation. He continues to coordinate the maintenance of the network, preparing wells for sampling, while supporting data collection, and evaluation activities.

Jacob Gibs is the Water Quality Specialist at the United States Geological Survey (USGS) in West Trenton, NJ and has been involved in the Ambient Ground Water Quality Monitoring Network since its inception.

Abstract
During the first NWQMC National Monitoring Conference Reno, Nevada (1998) the conceptual design for a new ground-water monitoring network in New Jersey was presented. Since that time, all of the network wells have been installed and sampled at least once. Water quality data from the 150 well, New Jersey, Ambient Ground-Water Quality Monitoring Network (AGWQMN) yields information about the quality of shallow ground water in agricultural, urban and undeveloped land use areas. The major goals of this NJDEP/USGS cooperative network are to evaluate the status and trends of shallow ground-water quality as a function of land use related non-point source pollution. Network wells are screened just below the water table and are sampled 30 per year on a 5-year cycle. The first cycle was completed and the second started in 2004. The New Jersey Geological Survey (NJGS) manages the network design, well installation, well maintenance and data interpretation and reporting. The NJDEP Bureau of Fresh Water and Biological Monitoring and the USGS collect the well-water samples, and the USGS laboratory in Denver, Colorado analyzes them. Chemical and physical parameters analyzed at each well include: field parameters such as pH, SC, DO, T and alkalinity; major ions, trace elements, gross-alpha particle activity, volatile organic compounds, and pesticides. Total dissolved solids concentrations, as well as the concentration, frequency, and variety of trace elements, nutrients, volatile organic hydrocarbons (VOC) and pesticides are found at significantly higher levels in wells located in agricultural and urban areas than from wells in undeveloped areas. Shallow ground water in agricultural land use areas have the highest frequency of pesticide detection's, highest median nitrate concentrations (maximum up to 56 mg/L in this network) and gross alpha particle activity. These concentrations are likely related to the application of agricultural chemicals. In Urban areas, there are generally lower dissolved oxygen and higher total dissolved solids, dissolved iron, chloride, and VOC (such as MTBE) concentrations found in the ground water.

Design Considerations for Assessing Ground-Water Quality in Regional Aquifer Systems: The High Plains Aquifer

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Abstract
Regional assessments of ground-water quality are challenging due to spatial and temporal variability in the factors that control water-quality conditions. Spatial variation in land-use, hydrogeology, climate, and even economics can have significant influence on source loading and transport of chemical constituents to the water table. Vertical heterogeneity of aquifer materials and variations in saturated- and unsaturated-zone thickness control recharge rates and effect the distribution of chemicals and chemical processes that influence ground-water quality within the aquifer. Additionally, large-scale ground-water pumping causes mixing of aquifer water with varying ages and chemical quality that complicate regional interpretations.

The High Plains Regional Ground-Water Quality Study is an example of a large regional ground-water-quality assessment; covering about 174,000 square miles in parts of 8 western states. To assess the water-quality within this aquifer this study employed an areally and vertically nested sampling design that integrated multi-scale studies into a holistic assessment of ground-water quality for the entire system. A phased approach, consistently applied to aquifer sub-regions, allowed aggregation of results into a regional assessment while at the same time providing local understanding of the factors affecting spatial and temporal variation in ground-water quality. Vertically-nested studies provided an assessment of the processes affecting the timing of chemical transport from the land surface to the water table, chemical reactions occurring within the system, the effects of pumping on aquifer mixing, and the interaction between the High Plains aquifer and underlying bedrock units. This poster describes the design and implementation of the High Plains Regional Ground-Water Study and provides a template that is transferable to other regional ground-water quality assessments.

Salt Marsh Ecosystem Health at Ft. Pulaski National Monument Near Savannah, Georgia

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Kenneth S. Sajwan is a Professor and Director of the Environmental Sciences Program at Savannah State University. His teaching responsibilities include courses in ecotoxicology, environmental impact assessment, limnology, and hazardous waste management at the undergraduate level and analytical techniques in seawater, sediments and soils at the graduate level. His area of research specialization includes biogeochemistry of trace elements, waste management, and water quality.

Sivapatham Paramasivam is an assistant professor of environmental sciences at Savannah State University in Savannah, Georgia. In addition to teaching, he is involved solid waste management research, and monitoring surface and wastewater for trace elements and heavy metals. He is currently involved in monitoring emission flux of various greenhouse gases from soils amended with sewage sludge and treated wastewater.

Abstract
Fort Pulaski National Monument, located 12 miles east of Savannah, GA, is comprised of two islands, Cockspur and McQueens, which include extensive salt marsh ecosystems, and are situated near the mouth of the Savannah River. The administration at Ft. Pulaski sought to evaluate the ecological health of the marsh ecosystems by acquiring baseline chemical data from water, sediment, shellfish and finfish collected from the Monument's 5,356 acre estuarine habitat. As the potential for the deepening of the Savannah River Harbor increases, the Fort Pulaski National Monument staff desired to evaluate the present levels of a variety of chemical pollutants, including heavy metals and organic compounds, in marsh/estuarine sediments, oyster and finfish tissues. Beginning during the autumn of 2000, faculty and students of Savannah State University's Marine Sciences and Environmental Sciences Programs collected water, sediment, and oyster samples from 6 sites selected in consultation with Ft. Pulaski staff. The following year, 3 additional sites were sampled; and presently small finfish are being sampled. In future years, the partners anticipate collecting/sampling larger (pan-sized) finfish for analysis. Sediment and oyster samples were analyzed for heavy metals and organic compounds including polychlorinated biphenyls (PCB's), poly aromatic hydrocarbons (PAH's), and alkylphenols (AP's). In sediment samples, PCB's, PAH's and AP's were detected from various locations but concentrations were relatively low. Copper, Lead and Chromium concentrations were generally low in sediments. Oyster meat samples from the various sampling sites within the marsh ecosystem also revealed variable concentrations of PCB's, PAH's, and heavy metals including Lead and Arsenic. At the present stage of this project, the concentrations of metals and organic compounds have suggested a healthy marsh ecosystem at Ft. Pulaski National Monument.

Relations Between Species Traits and Trace Element Bioaccumulation in Riverine Fishes

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Lawrence "Rod" Deweese is a fish and wildlife biologist with the Contaminant Biology Program of the U.S. Geological Survey's biology discipline. Since 1992 he has provided biological support to the USGS NAWQA program in the central U.S., and has participated in the development and coordination of research projects focusing on contaminant-related effects to aquatic organisms in the Nation's streams and rivers.

Neil Dubrovsky is the Chief of the Nutrients and Trace Elements National Synthesis team of the U.S. Geological Survey's NAWQA program. He has been with the USGS for 20 years, studying ground-water chemistry and designing and supervising large-scale multidisciplinary water-quality investigations.

Abstract
Concentrations of trace elements were determined in liver tissue from 51 species of riverine fishes collected during the period 1992-2000 as part of the U.S. Geological Survey's National Water-Quality Assessment Program. Tissue trace element concentrations were used as indicators of trace element occurrence at 538 sites in 45 river basins across the conterminous United States, Alaska, and Hawaii. Relations between tissue trace element concentrations and fish species traits were examined to determine the extent to which trait-based characteristics accounted for relative differences among taxa in trace element bioaccumulation. Species traits that potentially could contribute to increased exposure of waterborne or dietary trace elements were determined for each taxon, and included 1) fluvial habitat preference, 2) reproductive-related migratory behavior, 3) stream size preference, 4) tolerance to physical-chemical stressors, 5) trophic ecology, 6) relative adult body size, and 7) benthic habitat preference. Discriminant analysis indicated that differences in trace element concentrations among taxa were strongly related to taxon-specific trait characteristics. Differences in standardized concentrations of tissue trace elements were examined among trait-defined groups. Results showed that bioaccumulation was greatest for taxa that are primarily detritus feeders, occurring predominantly in large rivers, preferring depositional habitats, having relatively large adult body size, exhibiting non-migratory behavior, and preferring benthic rather than open-water habitats. Bioaccumulation rankings were used to classify taxa according to their trait-based bioaccumulation potential. These results underscore the importance of accounting for species-specific differences in behavioral and physiological traits when comparing patterns of trace element bioaccumulation among multiple taxa. Moreover, determining linkages between species traits and contaminant exposure may help identify species most at risk.

Uranium and ^{222}radon in Ground Water from Glacial and Bedrock Aquifers in the Northern United States

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William T. Morrow is a hydrologist in the USGS IL Water Science Center who has been involved in radionuclides studies in the Midwest glacial aquifers

Abstract
Regional occurrence and distribution patterns of uranium and ^{222}radon were analyzed using data from 1,200 monitoring, public, and domestic drinking-water wells in glacial and bedrock aquifers throughout the northern United States. These data, collected as part of the U.S. Geological Survey National Water Quality Assessment Program, show that uranium and ^{222}radon concentrations vary by source of aquifer materials and exceed drinking-water standards in localized areas.

Uranium concentrations greater than 1 microgram per liter (µg/L) were measured in 36 percent of 1,200 ground-water samples. Only 28 samples (2.5 percent) were above the U.S. Environmental Protection Agency's (USEPA) Maximum Contaminant Level of 30 µg/L; 82 percent of these samples were from monitoring wells in glacial aquifers in the western United States, and 18 percent were from domestic wells in the crystalline bedrock aquifers of New England and New Jersey. Uranium concentrations were highest in wells in glacial aquifers that are within sediments derived from predominantly Cretaceous deposits found in north central United States, the glacial aquifers in the Columbia Lava Plateau, and the crystalline bedrock aquifers of New England, New Jersey, and New York. High uranium concentrations also correlated with chemical constituents related to agricultural land use raising the issue that some of the uranium may be related to the use of recycled irrigation waters in the north central United States

^{222}Radon concentrations exceeded the proposed USEPA drinking-water 2nd-option standard of 300 picocuries per liter (pCi/L) in 60 percent of nearly 1,200 ground-water samples. Ground water in bedrock and glacial aquifers in the Northeast, however, had ^{222}radon concentrations exceeding the USEPA drinking-water 1^{rst}-option standard of 4,000 pCi/L. The highest concentration, 215,000 pCi/L, was from a domestic well in an intrusive igneous granite pluton in New Hampshire. ^{222}Radon correlated positively with uranium, lead, and gross alpha in wells in the crystalline bedrock aquifers.

Agricultural Pesticides in Shallow Ground-Water Flow Systems: A Contrast Between Systems

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Hank Johnson is a hydrologist with the USGS in Portland, Oregon. His interest is in subsurface transport and transformation of anthropogenic contaminants. Since joining the NAWQA program in 1999, he has been studying the distribution, transport, and fate of nutrients and pesticides in irrigated agricultural systems of Central Washington.

Mark Sandstrom is a research chemist in the USGS National Water Quality Laboratory, specializing in the development and application of methods for determination of currently used pesticides and pesticide degradates in water. He has been involved with the NAWQA Program since the 1980's, supporting the development of sampling methods, analytical methods, and quality-assurance samples required for low-concentration pesticide studies.

Abstract
The U.S. Geological Survey, as part of its National Water-Quality Assessment Program, studied the occurrence of pesticides in ground water in relation to environmental setting, agricultural management practices, and depth to water. In 2003-2004, flow-path transects of ground-water wells were installed in different agricultural settings—Maryland, Nebraska, California, and Washington—to investigate the presence and fate of agricultural chemicals in shallow ground water. Maximum depths to ground water were about 10 m in Maryland, 21 m in Nebraska, 7 m in California, and 13 m in Washington. Corn was grown at all sites. However, the Maryland and Nebraska transects are located in areas of corn-soybean crop rotation and soybeans were grown in Maryland during 2004. The California and Washington transects are in heterogeneous settings containing surface-water irrigation of orchards, vineyards, and alfalfa in addition to corn.

Twice during 2004, water samples from each monitoring well were analyzed for pesticide concentrations: once following application of pesticides and once in late summer-early fall around harvest time. Pesticides were detected in ground-water samples from all four agricultural areas.

Atrazine, metolachlor, alachlor, and metabolites of these herbicides were the primary pesticides detected in ground-water samples. These herbicides were currently or recently used on corn fields in the four study areas. Atrazine and its metabolites typically were detected in the same ground-water samples. In contrast, excluding Maryland, metabolites of metolachlor and alachlor (both acetanilide herbicides) primarily were detected without the parent product. In Maryland, measurable concentrations of metolachlor parent product were detected with its metabolites. Two metabolite forms of the acetanilide herbicide were commonly detected in ground-water samples—ethanesulfonic acid (ESA) and oxanilic acid (OA). Initial

degradation of the acetanilide herbicides seems to favor the production of the OA metabolite form; however, the relative fraction of ESA increases over time.

The Occurrence of Volatile Organic Compounds in Aquifers of the United States

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Janet Carter has been a hydrologist with the U.S. Geological Survey for the past 15 years and has authored more than 30 publications. She has B.S. and M.S. degrees in Geological Engineering from the South Dakota School of Mines and Technology.

Abstract
Water samples from 3,498 wells comprising a variety of water uses and tapping 36 aquifers in the United States were collected during 1985-2001 by the U.S. Geological Survey's (USGS) National Water Quality Assessment (NAWQA) Program and analyzed for 55 volatile organic compounds (VOCs). Results reported here are from single well samples and are reported at an assessment level of either 0.2 or 0.02 microgram per liter (µg/L).

One or more VOCs were detected in almost 20 percent of the water samples at an assessment level of 0.2µg/L, and in slightly more than 50 percent for the subset of 1,687 samples analyzed at the lower assessment level of 0.02µg/L. The five most frequently detected VOCs were chloroform, perchloroethene (PCE), methyl *tert*-butyl ether (MTBE), trichloroethene (TCE), and toluene. Forty-two VOCs were detected at least once at an assessment level of 0.2µg/L; however, concentrations typically were low. For example, 90 percent of the total VOC concentrations in samples were less than 1 µg/L.

Compounds in each of seven VOC groups—fumigants, gasoline hydrocarbons, gasoline oxygenates, organic synthesis compounds, refrigerants, solvents, and trihalomethanes (THMs)—were detected. THMs, which are chlorination byproducts, and solvents were the most frequently detected groups.

VOCs were detected throughout the United States, with most of the largest detection frequencies in California, Nevada, Florida, and the Northeast and Mid-Atlantic States. In some cases, detections were geographically widespread: examples are the THMs and solvents. In a few cases, a VOC had a regional or local occurrence pattern that is related to areas of known use: examples include the gasoline oxygenate MTBE and the fumigants ethylene dibromide (EDB) and dibromochloropropane (DBCP).

The frequent and widespread occurrence of VOCs demonstrates the physical-chemical behavior of VOC sources and the vulnerability of many of the aquifers to low-level VOC contamination. The low-level contamination also indicates a potential for contamination by other contaminants that have similar physical-chemical properties to those of VOCs.

Real-Time Monitoring and Regression Analysis for Specific Conductance and Sodium-Adsorption Ratios in an Area of Coalbed Natural Gas in the Powder River Basin, Montana and Wyoming

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Kirk Miller is a supervisory hydrologist in the Wyoming Science Center within the U.S. Geological Survey's Water Resources Discipline. Since 2004, he has supervised the Hydrologic Data Section, which monitors stream quantity, ground-water quantity, and water quality in Wyoming. Special study work has included flood and drought assessments of Wyoming streams and streamflow in Antarctica.

Abstract

The coalbed natural gas in the Powder River Basin in southeastern Montana and northeastern Wyoming is an important resource for the United States. Most water that is produced during coalbed natural gas development in northeastern Wyoming is discharged into constructed reservoirs or into surface drainages, where it may infiltrate into the ground, become part of the streamflow, or evaporate. Concerns exist that coalbed waters may affect stream water for irrigation use by increasing specific conductance and sodium-adsorption ratios (SAR). The U.S. Geological Survey, in cooperation with the Wyoming Department of Environmental Quality, has installed real-time instruments for specific conductance and collects biweekly water-quality samples at four sites in the Powder River watershed.

The salinity in the Powder River watershed is classified as medium to very high, and the sodium hazard is classified as low to very high for irrigation water use. Daily mean specific conductance on the Powder River ranged from 953 to 7,100 microsiemens per centimeter (µSm/cm) at 25 degrees Celsius upstream at Sussex, Wyoming and from 492 to 5,920 µSm/cm downstream at Moorhead, Montana during the 2001-2004 irrigation seasons. Median SAR values in samples collected from the four sites ranged from 1.2 to 5.1. Specific conductance and SAR values generally were smaller at sites on the tributaries of Crazy Woman Creek and Clear Creek.

Regression equations for specific conductance and SAR were statistically significant (*p*-values <0.001) at the four sites. The strongest relation (R-squared=0.92) was at the Powder River at Sussex, Wyoming. Relations on Crazy Woman Creek near Arvada, Wyoming (R-squared=0.91) and Clear Creek near Arvada, Wyoming (R-squared=0.83) also were strong. The relation between specific conductance and SAR was weakest (R-squared=0.65) at the Powder River at Moorhead, Montana, which has a larger and more diverse contributing area. Real-time data for specific conductance and predicted SAR values can be used to assess the suitability of the water for irrigation and can be found at URL: http://waterdata.usgs.gov/nwis.

Small Scale Water Monitoring Networks for USACE Construction Projects

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John Esparza is the Section Chief of the USACE Sacramento District's Environmental Chemistry Section. In this capacity Mr. Esparza is responsible for the supervision of scientists, engineers and technicians performing environmental compliance monitoring of dredging operations and construction activities. Mr. Esparza currently serves as the Sacramento District's Quality Assurance Officer (QAO) for environmental restoration projects. He has also managed storm water monitoring programs for industrial facilities and construction projects.

Abstract
USACE construction projects along waterways often require the establishment of water monitoring networks to limit environmental impacts and ensure regulatory compliance. Networks generally consist of stations surrounding the location of the work being performed. Monitoring is performed during project activities that may potentially impact water quality. Monitoring results provide feedback on the effectiveness of methods used to limit impacts. If impairment of water quality is observed then a project is stopped until impacts are evaluated and the problem is corrected. Data collected is available to the regulating agency (State Water Resources Control Board) but the short duration of monitoring and variable site conditions limit the interest of other agencies in the data.

Two projects that have required the use of monitoring stations are at the Folsom Dam in Folsom, CA and the Napa River Flood Protection Project in Napa, CA. The Folsom Dam work includes water pumping to obtain access for maintenance and the creation of a new spillway. Folsom Dam work has required monitoring stations to capture potential water impairing activities. Potential contaminants of concern at the Folsom Dam site include increased turbidity and disturbance of sediment containing mercury from historical gold mining activities. The Napa Flood Protection Project involves large amounts of earthwork along an impaired water body (Clean Water Act 303d listed for turbidity and suspended solids). Timely monitoring feedback is used to determine the effectiveness of storm water Best Management Practices.

Small monitoring networks are vital to ensure regulatory compliance and to minimize environmental impacts. Each network must be tailored for a project and altered based on construction activities and contaminants of concern. Some future goals are to better inform other agencies and the general public of the water quality work being performed and to find effective methods for sharing the data being collected.

Using Long-Term Monitoring and Special Studies to Evaluate Trends and Address Problems at Twelve USACE Managed Reservoirs in California

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Abstract

The U.S. Army Corps of Engineers Sacramento District monitors the water quality at 12 reservoirs throughout Central and Northern California. Sampling is performed twice annually at each of the reservoirs with additional studies/samples focusing on specific areas of concern. Water Quality data has been collected at some of the reservoirs using various methods for nearly 30 years. Initially the monitoring program was implemented to compare findings against water quality guidelines for recreational use and to monitor basic environmental health within the reservoirs. The current iteration of the monitoring program includes examining the physical and chemical characteristics of the water, phytoplankton species counts and fish tissue analysis. Increasingly the monitoring program looks at impacts on the reservoirs from upstream and historic activities in the watersheds. In situations where existing monitoring data is inadequate special studies are being used to model and evaluate problem areas and determine if any corrective actions can be pursued. Special studies currently underway include monitoring the impacts of urbanization and mercury in fish due to historical gold mining in California. Construction upstream and a potential reduction in reservoir water clarity has created a public perception that the Martis Creek Lake in Truckee, CA has been impacted by nutrient loading. A monitoring network is to be implemented next year and the turbidity and nutrient data collected will be used to model trends. Several of the USACE managed reservoirs in California have been included in fish consumption advisories issued by the state of California. In response the USACE has increased fish tissue testing at the impacted reservoirs. The future goals of the USACE reservoir monitoring program are to improve sharing of data between agencies working in the watersheds, continue to evaluate the usability if historical data, and evaluate results from special studies.

Using a Spatially Balanced, Random Sampling Design to Assist Informed Management Decisions

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Abstract
The San Francisco Estuary Regional Monitoring Program for Trace Substances (RMP) is the primary source for long-term contaminant monitoring information for the Estuary. The RMP is an innovative and collaborative program implemented by the scientific community, the San Francisco Bay Regional Water Quality Control Board, and the regulated discharger community. The RMP includes a Status and Trends component that evaluates spatial and long-term temporal contaminant trends in water, sediment, and tissue throughout the Estuary. Additional special studies address specific scientific questions relating to water quality and beneficial uses.

The Status and Trends sampling design was changed in 2002 employing the Generalized Random Tessellation Stratified design (GRTS) utilized by the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) for monitoring the condition of the nation's coasts and large estuaries. Each year, the Status and Trends program sequentially samples randomly selected water and sediment stations for trace contaminants and other water quality indicators accumulating increased spatial resolution of the Estuary over time. This design will provide environmental managers and regulators statistically defensible information about the spatial and temporal distribution of regulated and emerging contaminants in the Estuary.

The new Status and Trends monitoring design is well suited to address some of the new, more focused, RMP management questions developed in 2005, by Bay Area scientists, environmental regulators, and the regulated community. A few of the management questions the new random sampling design will address include: What are the spatial and temporal patterns of contamination in the Estuary and it's sub-regions; How does contamination in the various Estuary regions compare to each other, and to specific water and sediment effects thresholds; What are possible pathways of contamination to the Estuary; Is contamination in the shallow reaches of the Estuary different from the deeper channels?

Perspective on the Role of Analytical Methods Development and Environmental Knowledge of Organic Contaminants

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Abstract
The focus of the Organic Geochemistry Research Group of the U.S. Geological Survey is to assess the effects of agricultural nonpoint-source pollution on surface and ground water and the environmental effects of emerging contaminants and how they affect the Nation's water. The goals of this multidisciplinary group are to develop, automate, and simplify analytical methods for pesticides, antibiotics, and their degradation products in soil and water.

During the 1980s, methods were developed to analyze triazine and chloroacetanilide herbicides in surface and ground water by gas chromatography/mass spectrometry in which a sample mixture is vaporized and separated into individual organic compounds. These compounds then are ionized as they elute from the gas chromatograph and fragment in a vacuum by means of electron impact ionization. Each compound has a unique spectrum, providing identification.

During the 1990s, liquid chromatography/mass spectrometer (LC/MS) equipped with a diode array detector was used to measure concentrations of acetamide and triazine herbicides. Results showed that acetamide and triazine degradation products were detected more frequently in surface and ground water than the parent herbicides. A method for analysis of the extensively used herbicide glyphosate and its degradate, aminomethylphosphonic acid, also was developed.

Recently, methods were developed using LC/MS/MS to analyze isoxaflutole and its degradates in water and antibiotics in natural water, liquid waste from confined animal feeding operations, and water discharged from wastewater treatment facilities. This research focused on the types of antibiotics used and their fate and transport in the hydrogeologic system. Development of analytical methods and collection of environmental data are essential for learning more about the occurrence, fate, and transport of pesticides, antibiotics, and their degradation products in water-quality studies.

Herbicide Transport and Transformations in the Unsaturated Zone of Two Small Agricultural Basins with Corn and Soybean Row Crops

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Jason R. Vogel is a hydrologist in the Nebraska Water Science Center of the USGS. Since 2002, he has served as Lead Scientist of the NAWQA Program, ACT Study of the Maple Creek Basin in Nebraska. The authors are working on a national study of the fate and transport of pesticides in the unsaturated zone of five agricultural basins with varying environmental settings and agricultural management practices.

Abstract
Herbicides are among the most significant nonpoint-source pollutants, especially in agricultural row-crop settings. In the United States, herbicides were applied to 95% of all fields in corn production and 97% of all fields in soybean production in 2003 and 2004, respectively. The United States Geological Survey (USGS) has conducted a study on herbicides in the unsaturated zone under corn and soybean fields in two predominantly agricultural basins: Morgan Creek (Maryland) and Maple Creek (Nebraska). In 2004, the Morgan Creek fields were in soybeans and the Maple Creek fields were in corn. The Maple Creek fields were irrigated, whereas those in Morgan Creek were not. Similarities and differences in agricultural management practices, climatic conditions, and natural features, such as soil types and geology, will be discussed.

The occurrence of herbicides and their metabolites in the unsaturated zone of these basins reflect application practices over the past number of years. The most frequently detected herbicides and metabolites were the pre-emergent triazines and acetanilides, specifically atrazine, metolachlor, acetochlor, and alachlor and their metabolites. The temporal and spatial trends of herbicide concentrations and other chemical constituents will be related to the physical and hydrologic properties of the unsaturated zone.

Parent triazine and acetanilide herbicides were only detected at relatively low concentrations in the unsaturated zone water of the Morgan Creek basin at depths greater than 4 meters and only in an upland recharge area with sandier soils, probably because these compounds had not been applied for several years. At the Maple Creek sites, where triazine and acetanilide herbicides were recently applied, parent compounds of atrazine, metalochlor, acetochlor, and alachlor were detected, typically at concentrations higher than their metabolites. The Maple Creek site is influenced by focused recharge, macropore flow, and a capillary fringe created by a soil transition zone from loess to sand.

Dissolved Copper Trends in Lower South San Francisco Bay

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Peter Schafer has been employed as a Biologist for the City of San Jose for the past 11 years. He currently works in the Watershed Investigations group, which conducts fieldwork in Lower South San Francisco Bay (LSB) and reviews and analyzes technical issues concerning the San Jose/Santa Clara Water Pollution Control Plant's discharge to LSB. He has 15 years of toxicity testing experience including a 1998 copper Water-Effect Ratio study which led to the establishment of a copper site-specific objective of 6.9 ppb in LSB.

Abstract

The City of San Jose (City) monitored dissolved copper concentrations in Lower South San Francisco Bay (LSSFB) from 1997 to 2005. This work was initially in support of the effort to establish Site-Specific Objectives for dissolved copper in LSSFB. Subsequent monitoring was used to compare copper concentrations to established LSSFB Copper Action Plan trigger levels during the dry season (June-November). The City monitored copper monthly during wet and dry seasons at 10 LSSFB stations. One station each in Coyote Creek and the Guadalupe River were added in 1997 to characterize LSSFB tributary concentrations.

Following nine years of year-round copper sampling, the City re-evaluated its monitoring program to answer specific management questions, resulting in the following conclusions:

(1) Dry season dissolved copper concentrations in LSSFB are significantly higher than wet season values.
(2) Tributary station dissolved copper concentrations differ significantly from LSSFB stations in both wet and dry seasons.
(3) Tributary stations show either no seasonal trend or an inverse non-significant trend compared to seasonal trends in LSSFB.
(4) Mean dry season dissolved copper concentrations in LSSFB remain at 1998 levels of 3.2 mg/L.
(5) RMP results were virtually identical to City results with respect to mean dry season concentrations in LSSFB.

The City concluded that its intensive copper monitoring effort may be a more valuable tool than the RMP for detecting fine-scale trends in LSSFB. However, the annual RMP sampling may satisfy the City's current copper monitoring requirements, as is currently proposed for the North San Francisco Bay Regions, and would be a more cost-effective approach to copper trigger monitoring in LSSFB.

Development of Spatial Probability Models to Estimate Ground-Water Vulnerability to Nitrate Contamination in the Mid-Atlantic Region

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Abstract
The U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency's Regional Vulnerability Assessment Program, has developed a set of statistical probability modeling tools to support regional-scale, ground-water quality and vulnerability assessments. These statistical tools have been used to explore and characterize the relation between ground-water quality and geographic factors in the Mid-Atlantic Region. Available water-quality data obtained from U.S. Geological Survey National Water-Quality Assessment Program studies were used in association with geographic data (land cover, geology, soils, and others) to develop logistic-regression equations that use explanatory variables to predict the presence of a selected water-quality parameter (nitrate as nitrogen) exceeding a specified management concentration threshold. Additional statistical procedures (PRESS Statistic) modified by the U.S. Geological Survey were used to compare the observed values to model-predicted values at each sample point. Statistical procedures to determine the confidence of the model predictions and estimate the uncertainty of the probability values were developed and applied. Spatial probability models at multiple thresholds were applied to produce maps showing the likelihood of elevated concentrations of nitrate as nitrogen in the Mid-Atlantic Region. These maps can be used to identify areas that are currently at risk and help identify areas where ground water has been affected by human activities. This information is being used by regional and local resource managers to protect water supplies and identify land-use planning solutions and monitoring programs in these vulnerable areas.

Comparison of Anthropogenic Organic Compounds in the Source Water and Finished Water for the City of Atlanta, October 2002 – May 2005

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Biographical Sketches of Authors

Melinda Dalton is a hydrologist with the Georgia Water Science Center within the U.S. Geological Survey (USGS). She has participated in various studies, including water-quality and ecological assessments.

Elizabeth Frick is a hydrologist with the Georgia Water Science Center within the U.S. Geological Survey (USGS). She has primarily studied regional water-quality issues in ground- and surface-waters related to nutrients, pesticides, microbial indicators, and emerging contaminants.

Abstract

As part of the Source Water-Quality Assessment (SWQA)—one of several study components within the U.S. Geological Survey's National Water-Quality Assessment Program—the source water and finished water for the City of Atlanta were analyzed for the presence of more than 270 anthropogenic organic compounds (AOCs) representing a diverse group of extensively used chemicals. During the first phase of the study, 17 source-water samples were collected at the City of Atlanta drinking-water intake. In the second phase of the study, 15 paired samples were collected from the drinking-water intake and finished water from the Chattahoochee Water Treatment Plant (CWTP). The relative concentrations of anthropogenic organic compounds in source water versus finished water at the CWTP will be illustrated in this poster.

There were no exceedences of Federal drinking-water standards or health advisories in source- or finished-water samples, although such standards or advisories have not been established for most of these compounds. Concentrations of AOCs detected in source-water samples for the City of Atlanta generally were low. For most AOCs with available drinking-water standards or health advisories, maximum concentrations measured in source-water samples ranged from 10 to 100,000 times less than available standards and advisories.

Fewer AOCs were detected in finished water from the CWTP than in source water, and concentrations in finished water generally were less than concentrations in source water by one to three orders of magnitude, with the notable exception of total trihalomethanes (THMs). THMs are common disinfection by-products when surface water is chlorinated to protect against bacterial contamination. Concentrations of THMs detected in finished water generally were low and compare well with the CWTP's consumer confidence reports. For all other AOCs with available drinking-water standards or health advisories, the maximum concentrations measured in finished-water samples ranged from 100 to 100,000 times less than available standards and advisories.

A National Assessment of PBDEs in Lake Fish Tissue

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Abstract
The U.S. Environmental Protection Agency (EPA) has conducted a national freshwater fish contamination survey to estimate the national distribution of selected, persistent, bioaccumulative and toxic chemicals in fish tissue for lakes and reservoirs of the contiguous United States. Polybrominated diphenyl ethers (PBDEs), a subgroup of brominated chemicals that are used as flame retardants, were included in the survey because recent studies have shown that PBDE levels are increasing over time in human tissues and breast milk. The increasing levels are of concern because PBDEs have been associated with endocrine disruption, reproductive and developmental toxicity, neurotoxicity, and cancer in rodent studies. Samples collected from two statistical subsets of National Lake Fish Tissue Study (NLFTS) sites were analyzed for PBDEs. This data set consists of 352 fish samples from 166 statistically selected lakes and reservoirs in the lower 48 states. Two types of fish samples were collected from each lake or reservoir: predator composites and bottom dweller composites. The PBDE data set contains 195 predator samples and 157 bottom dweller samples. The concentrations of 46 PBDE congeners were determined down to the ng/kg level (wet weight) using Draft EPA Method 1614 (August 2003), a high-resolution gas chromatography, high-resolution mass spectrometry procedure being developed by EPA. The results from this survey provide the first national estimates of mean concentrations of PBDEs in lake fish and define a national baseline to track progress of pollution control activities.

Establishment of Baseline Water-Quality and Sediment-Chemistry Data at Sentinel Sampling Sites on Lake Powell for Future Monitoring of Organic and Inorganic Contaminants

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Bob Hart is a supervisory hydrologist with the Arizona Water Science Center, Water Resources Discipline of the U.S. Geological Survey. Mr. Hart has worked extensively in water resources studies in northern Arizona, including the Grand Canyon National Park and Lake Powell..

Howard Taylor is a research chemist and project chief with the National Research Program, Water Resources Discipline of the U.S. Geological Survey. Dr. Taylor has performed international research on the water quality of rivers and lakes with a focus on trace element chemistry. He has worked extensively in National Parks in the western United States..

Abstract
The U.S. Geological Survey is currently (2005) collecting and analyzing water from marinas and high-use side canyons of Lake Powell for the presence of hydrocarbon and trace-element contaminants. Hydrocarbons, including volatile organic compounds (VOCs); semivolatile organic compounds (SVOCs), which include polycyclic aromatic hydrocarbons (PAHs); and selected trace elements may be directly linked to the emissions of unburned fuel from personal watercraft or other fuel powered watercraft on Lake Powell. Houseboat use and camping practices can also discharge organic and inorganic contaminants into the lake and beach areas. Because of high visitor use related to recreational activities on Lake Powell, the Glen Canyon National Recreation Area is concerned about the occurrence, distribution, and persistence of organic and inorganic constituents in Lake Powell. These compounds can pose potential health risks to both humans and aquatic life and can be found in the water column, stored in sediments, and accumulated in biological tissue. Recent studies by the USGS have evaluated selected high-use side canyon waters in Lake Powell for the presence of VOCs, selected SVOCs, trace elements, and emerging contaminants, including pharmaceuticals. PAHs, organochlorine pesticides, and trace elements have been evaluated in sediments of the Colorado River inflow area near Hite, Utah. The results of these baseline studies are now being used to establish sites on Lake Powell for long-term monitoring of organic and inorganic contaminants in both water and sediment. Similar monitoring plans also will be implemented at other national recreation areas, including Lakes Mead and Mohave in Arizona and Nevada.

The National Stream Quality Accounting Network (NASQAN II) Program: A Case Study of Water Quality in the Lower Rio Grande Basin.

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Rebecca Lambert is employed by the U.S. Geological Survey as a hydrologist in the Texas Water Science Center, San Antonio, Texas office. Since 2001, she has served as Rio Grande Basin Coordinator for the U.S. Geological Survey's National Stream Quality Accounting Network II (NASQAN II) program. The NASQAN program has focused on monitoring the water quality of four of the Nation's largest rivers, the Mississippi, the Columbia, the Colorado, and the Rio Grande. She also conducts ground-water, surface-water, and water-quality investigations in south-central Texas.

Abstract

Since 1995, the U.S. Geological Survey National Stream Quality Accounting Network (NASQAN II) has focused on monitoring the water quality of the Nation's largest rivers. The NASQAN II program is designed to characterize the variability of chemical and sediment concentrations and transport in relation to flow by quantifying a mass flux for selected constituents. The lower Rio Grande Basin is in an arid to semiarid region of the United States and Mexico. Many tributaries to the Rio Grande are intermittent streams, and flow in the river is controlled by numerous reservoirs throughout the basin. Nine sites are monitored for water quality in the lower Rio Grande Basin downstream from the confluence of the Rio Conchos and Rio Grande. Samples are collected six to eight times per year at these sites and are analyzed for a variety of constituents including major ions, trace elements, nutrient and carbon species, pesticides, and suspended sediment. Sampling indicates that high salinities are common throughout the basin and dissolved solids concentrations exceed the USEPA Secondary Drinking Water Regulation (SDWR) of 500 milligrams per liter (mg/L) at all sites. Chloride and sulfate concentrations also exceed SDWRs of 250 mg/L at five sites. Elevated concentrations of aluminum, arsenic, manganese, uranium, and zinc have been detected in one or more samples. The concentration of aluminum exceeded the SDWR of 0.05 mg/L at the Arroyo Colorado site. Arsenic concentrations exceeded the USEPA maximum contaminant level (MCL) of 10 micrograms per liter at three sites. The majority of these elements are typically transported in association with suspended sediment. Pesticides have been detected at all sites with atrazine, diazinon, and metoachlor the most frequently detected. The sites with the greatest number of pesticide detections and greatest frequency of detections are in areas that are highly urbanized or have agricultural land use.

Mercury Biomagnification from the Base of the Food Chain in Guadalupe River Watershed, San Jose, CA

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Brent Topping is an analytical chemist with the U.S.G.S. in Menlo Park. He and his project chief, Jim Kuwabara, have typically focused their efforts on understanding the role of benthic flux in regulating the concentrations of solutes within lakes and estuaries. Extensive information and published reports can be found at their project website (http://wwwrcamnl.wr.usgs.gov/solute_transport/).

Abstract
Mercury bioaccumulation at the base of the food chain is a critical process that influences mercury biomagnification in top predators, including fish consumed by humans. The Guadalupe River watershed encompasses the former New Almaden mercury mines, once the largest mercury producer in North America. Five reservoirs within the watershed were selected for study to provide measurements and characterization of mercury bioaccumulation starting at the base of the food web. The phytoplankton and zooplankton mercury concentrations are operationally defined by filter size, so particulate mercury is a potential contributor. The proportion of mercury which is methylmercury increases up the food chain, but total mercury values are used here for simplicity. Using system-wide averages, the initial transfer of total mercury from the water column to phytoplankton exhibited a biomagnification factor in the range of 20000. In comparison, all subsequent transfers (phytoplankton to zooplankton to small fish to piscivorous fish) were in the range of 5. These bioaccumulation factors, consistent with previous studies in other lakes, indicate that mercury accumulation is heavily weighted at the food web base. A lack of correlation between phytoplankton density and zooplankton density indicated that the planktonic communities were at disequilibrium during our only sampling event. Improved temporal resolution could result in significantly different biomagnification factors. Taxonomic investigations of each reservoir revealed major differences between them despite their close proximity. In an unintended result, this study was the first known to report the presence in the South San Francisco Bay region of the invasive zooplankton species *Daphnia lumholtzi* (of concern for ecological disruption in the Great Lakes and other water bodies due its ability to avoid predation) and the toxin-producing blue-green alga *Cylindrospermopsis raciborski* (the cause of human poisoning incidents in Australia and Brazil).

Monitoring Mercury Contamination in the Carson River System, Nevada

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Karen Thomas is a physical scientist with the U.S. Geological Survey in Carson City, Nevada. In 1988 she received a Bachelor of Science in Soil Science from California Polytechnic Sate University, San Luis Obispo. Karen began working for the U.S. Geological Survey in 1988 and is currently project chief for the Carson River mercury superfund project, is in charge of the data management for the Nevada Basin and Range (NVBR) Study Unit as part of the National Water Quality Assessment (NAWQA) Program, and participates in other ongoing water-quality investigations.

Carl Thodal has been a hydrologist at the U.S. Geological Survey Nevada Water Science Center in Carson City since 1984. He received his Master of Science in Hydrology/Hydrogeology from the University of Nevada, Reno in 1986 and his Bachelor of Science in Environmental Studies from the University of Maine, Fort Kent in 1978.

Abstract

Mercury amalgamation, used to recover gold and silver from ore mined near Virginia City, Nevada, released about 7,500 tons of elemental mercury to the Carson River System during the late 1800's. Contaminated mill tailings have since been redistributed throughout the lower Carson River System. Lahontan Reservoir has received and retained most of these sediments since its construction in 1915. The U.S. Environmental Protection Agency (USEPA) listed a portion of the Carson River system on the "Superfund" National Priorities List in 1990. In 1997, the U.S. Geological Survey, in cooperation with USEPA, began monitoring streamflow and concentrations of mercury, methylmercury, and suspended sediment upstream and downstream from Lahontan Reservoir.

Concentrations of mercury and methylmercury in unfiltered samples upstream from Lahontan Reservoir ranged from 33.9 to 21,600 and from 0.66 to 21.8 nanograms per liter (ng/L) and concentrations in filtered samples ranged from 9.01 to 102 and 0.14 to 5.36 (ng/L), respectively. Downstream from the reservoir, unfiltered concentrations ranged from 57.3 to 587 and from 0.1 to 2.73 ng/L, respectively and filtered concentrations ranged from 3.61 to 24.2 and 0.04 to 1.08 ng/L, respectively. Suspended-sediment concentrations upstream from Lahontan Reservoir ranged from 1 to 3,400 milligrams per liter (mg/L), whereas downstream from the reservoir the range was 6 to 61 mg/L.

For samples collected upstream and downstream from Lahontan Reservoir, unfiltered mercury concentrations generally are more than an order of magnitude greater than filtered concentrations. Concentrations of unfiltered mercury and suspended sediment are moderately correlated upstream ($r^2 = 0.75$) and poorly correlated downstream ($r^2 = 0.45$) from Lahontan Reservoir. Concentrations of unfiltered mercury and suspended sediment are moderately correlated with streamflow ($r^2 = 0.70$ and $r^2 = 0.58$, respectively) upstream from the reservoir. These correlations indicate that mercury is transported with suspended sediment, especially during high flow.

Mercury transport to San Francisco Bay through the Sacramento-San Joaquin River Delta

Nicole David, Lester J. McKee, Jon E. Leatherbarrow

Biosketch of Author

Nicole David graduated from the Free University of Berlin, Germany in 1996 with a M.S. in Marine Ecology. Her master's research focused on marine and freshwater ecosystems and the intensive human use of coastal waters. She joined the staff of the San Francisco Estuary Institute in 2000, where she is currently involved in Sources Pathways and Loadings Projects, as well as the Grassland Bypass Program, and the Regional Monitoring Program.

Abstract

San Francisco Bay is currently listed as impaired on the Clean Water Act 303(d) list for mercury due primarily to elevated concentrations in sport fish and the issuance of current fish consumption advisories. The large magnitude of sediment and runoff entering San Francisco Bay through the Sacramento-San Joaquin River Delta makes these major rivers important transport pathways for mercury and other particle-associated contaminants. Historic gold and mercury mining in the Sierra Nevada and Coast Range Mountains as well as expanding urbanization in the Central Valley of California are ongoing sources of mercury to the Bay. Between January 2002 and January 2005, water samples were collected at a downstream location of the Sacramento River to quantify mercury concentrations and loads in surface runoff associated with large storm events and re-suspension of river sediments. Mercury concentrations ranged from 3.2 to 14 ng/L and showed a strong correlation ($r^2 = 0.8$) to suspended sediment concentrations. The collection of continuous turbidity measurements by U.S. Geological Survey at the study location allowed for extrapolation of the suspended sediment record to estimate daily average total mercury loads. For the first two years of monitoring in water years (WYs) 2002 and 2003, daily mercury loads ranged from 3 to 1800 g, while annual mercury loads were approximately 58 ± 20 kg in WY 2002 and 97 ± 20 kg in WY 2003. Preliminary load estimates for WYs 2004 and 2005 reflect annual mercury loads of similar magnitudes. Results from this study have helped refine current estimates of mercury loads to the Bay from the Sacramento-San Joaquin River system. In the context of other significant transport pathways and numerical models, these refined estimates will further assist in understanding the long-term fate of mercury and recovery of impaired waters of the Bay.

Water and Air – Mercury In Idaho

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Marti Bridges is currently the TMDL Program Manager for the Idaho Department of Environmental Quality, a position she has held since September, 2001. She oversees the development and implementation of TMDLs for increasingly complex media, most recently mercury. Bridges has spent nearly three decades working in the areas of water quality and water policy both in the non-profit sector and for federal agencies including the Natural Resources Conservation Service, US Forest Service and Bureau of Land Management.

Don Essig is currently the Water Quality Standards Program Manager for the Idaho Department of Environmental Quality, a position he has held since September, 2003. Mr. Essig has been with DEQ since September 1995, managing Idaho's TMDL program and working on interstate temperature issues before taking on water quality standards. His career has revolved around environmental issues, but has ranged from university research, to forest management, to environmental consulting, and now environmental regulation. For three years he and three partners ran an analytical chemistry business.

Abstract

This poster paper traces the path to Idaho's adoption of a fish tissue methylmercury water quality standard, and how that standard has translated into recent monitoring efforts, source assessments, and the development of TMDLs.

In the mid 1990's Idaho issued its first fish consumption advisory for mercury, for Brownlee Reservoir. At the time this was viewed as an anomaly, attributable to historic mining and natural cinnabar deposits. Since then the Idaho Fish Consumption Program arose as a cooperative effort among sister state agencies to gather data and inform the public about further fish tissue contamination. There was no specific funding so sampling was opportunistic. Although the coverage of data was limited, nearly everywhere data was obtained an unacceptable risk to human health was identified – principally from methylmercury and for pregnant women and children. A picture of widespread contamination emerged. Fish consumption advisories for mercury in Idaho now stand at eight and rising.

Idaho began rulemaking in 2003 to update its water quality criteria for mercury, and in 2005 adopted EPA's recommended fish tissue criterion for methylmercury. During this process DEQ learned of several major sources of airborne mercury to the south of Idaho. Work also began on development of two mercury TMDLs in southern Idaho. More recently, a proposal to build the first coal-fired power plan in Idaho brought mercury to both the public and legislative eye.

Over the past year Idaho has been monitoring a variety of media – fish, water, soil and air – in attempt to better understand the importance of various sources of mercury. Idaho is gearing up for a major, probabilistic sampling of fish tissue to document the extent of mercury contamination. Idaho has also secured location of a new National Mercury Deposition Site within its borders.

Monitoring Mercury Bioaccumulation in Fish during Everglades Restoration

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Biographical Sketch

David Evans is a research chemist and leader of the Forecasting and Related Research Team at the Center for Coastal Fisheries and Habitat Research (CCFHR) with an interest in the use of chemical substances in tracing ecological processes. He is responsible for the trace metal analytical facility at CCFHR. Over the past decade, he has worked on mercury problems at the Lavaca Bay, TX superfund site and more recently in south Florida, and in North Carolina wetlands and offshore waters. He has an interest in understanding why some fish have especially high mercury concentrations and seeks to determine the role of mercury sources, trophic structure, and fish bioenergetics in determining this. Modeling for the purpose of prediction is a central element of this pursuit which has been furthered by recent training in Ecopath/Ecosim/Ecotracer modeling. From 1985 to 1993 he worked on NOAA's National Status and Trends Program, Benthic Surveillance Project monitoring trace metals in fish tissues and sediments along the Atlantic and Gulf of Mexico Coasts.

Abstract

Mercury bioaccumulation in fish is a concern throughout the Everglades and adjacent areas of south Florida. NOAA and the Florida Fish and Wildlife Research Institute are cooperating in a regional monitoring program to monitor changes in mercury bioaccumulation as the Comprehensive Everglades Restoration Plan (CERP) proceeds with major hydrologic modifications in the area. A broad array of ecological changes are anticipated to accompany these modifications which may further alter mercury concentration patterns. Monitoring of mercury in fish is underway throughout the freshwater and coastal areas as part of the Monitoring and Assessment Plan (MAP) of CERP's REstoration COordination & VERification (RECOVER) program to establish spatial patterns and trends in mercury concentrations in fish. Annual sampling will permit identification of trends over time that can be assessed with respect to CERP restoration activities as they are implemented. Twenty-two regions have been identified with multiple sampling sites per region. Two species of fish are targeted for sampling in each region. A baseline database of existing mercury concentrations has been developed against which to measure changes over time. Monitoring results will be employed to inform managers through a process of adaptive management of restoration activities that may be altering mercury bioaccumulation in fish.

The Fish Mercury Project: Involving Stakeholders in Monitoring and Risk Communication in the Sacramento-San Joaquin Delta Watershed

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Abstract
Fish contamination is a serious environmental and public health concern in California's Sacramento-San Joaquin Delta watershed. Mercury accumulates in fish at levels that may pose health risks to the consumers of these fish. The Fish Mercury Project, funded by the California Bay-Delta Authority, is a collaborative, three-year effort to monitor mercury in fish in the watershed. One major goal of the project is to: protect human health by characterizing mercury contamination in fish, develop safe consumption guidelines for the public, and reduce human exposure to mercury in fish through risk communication based on environmental justice principles. The information gained from the Fish Mercury Project will shed light on the spatial and temporal trends of mercury in fish from the watershed and facilitate the protection of public health. The project has undertaken an innovative approach by directly involving a diverse group of stakeholders in the planning of the fish monitoring activities. A Steering Committee, which includes representatives from state and federal agencies, as well as tribal, environmental justice, angler, environmental advocacy, and community-based groups was established to enhance stakeholder involvement and ensure that the project addresses the concerns of the populations that may be impacted by local fish contamination. By involving stakeholders with intimate knowledge of local fishing patterns, the monitoring site locations and fish species sampled can best reflect community concerns. In addition to Steering Committee meetings, information about fishing activities and community concerns about fish contamination is gained through key informant interviews, focus groups with anglers, and site visits to potential sampling locations. This stakeholder process and the exchange of cultural and scientific information is one small step towards addressing environmental injustices faced by communities who may be consuming contaminated fish.

Caspian and Forster's Terns as Indicators of Mercury and Other Priority Pollutant Exposure in San Francisco Bay

Terrence L. Adelsbach[1], Collin A. Eagles-Smith[1], Joshua T. Ackerman[2], Steven E. Schwarzbach[3]

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Biographical Sketches of Authors
Terrence Adelsbach has been fish and wildlife biologist with the U.S. Fish and Wildlife Service, for 7 years. Primary field of study is in the effects of Hg and PCB's on aspects of avian ecology such as foraging and reproduction. Studies to date include assessment of effects of Hg and TEQ's on hatchability and reproductive success in three species of terns in San Francisco Bay.

Collin Eagles-Smith has been a fish and wildlife biologist with the U.S. Fish and Wildlife Service for 4 years and has more than 5 years experience in food web ecology, specializing in ecological applications of stable isotopes, and mercury bioaccumulation in complex aquatic/marine ecosystems of California, including: Clear Lake, Cache Creek, Eagle Lake, and the San Francisco Bay and Delta.

Joshua Ackerman is currently a wildlife biologist with the US Geological Survey, Biological Resources Discipline. His primary field of study is avian ecology focusing on waterfowl, seabirds, and shorebirds of California's Central Valley, Sacramento-San Joaquin River Delta, and the San Francisco Bay.

Steven Schwarzbach is currently the Center Director for the USGS, Biological Resources Discipline, Western Ecological Research Center in Sacramento California. He supervises research scientists involved in research on a variety of topics including contaminants, fire, invasive species, avian ecology, global climate change, wetland restoration and amphibian declines.

Abstract
San Francisco Bay (SFBay) is considered an impaired waterbody under Section 303(d) of the Clean Water Act due to mercury and polychlorinated biphenyl (PCB) contamination, and recent data suggests that polybrominated fire retardants (PBDE) are a concern as well. Shallow water piscivorous tern species, such as Caspian and Forster's Terns, are the primary wildlife taxonomic group at risk from these contaminants in SFBay. Variation in mercury levels among tern species breeding in SFBay may be related to variation in foraging habitats. We found that >75% of Caspian and Forster's Tern eggs had mercury concentrations above the accepted 0.5 ppm (ww) Lowest Observed Adverse Effects Level (LOAEL) on reproduction. Moreover, 25% of Forster's Tern eggs and 40-50% of Caspian Tern eggs were above 1 ppm fww, with maximum concentrations reaching >3 ppm (fww). Such high mercury concentrations in eggs suggest that tern reproduction in SFBay is being adversely affected.

Maximum mercury and PCB concentrations occurred in Forster's Tern eggs and PBDE concentrations were the highest ever recorded in biotic tissue, suggesting that Forster's Terns may be at greatest risk for population level effects. Contaminant concentrations in forage fish in conjunction with carbon and nitrogen isotope ratios in fish and bird eggs suggests that breeding Forster's Terns have limited home ranges during the breeding season and this may increase the ecological risk of contaminant hot spots that occur within SFBay. Recent radio telemetry data collected during the pre-breeding and breeding phases supports this conclusion. Together, these results suggest that entire breeding colonies may be at risk to localized hot spots and contaminants could have population level impacts on terns in the SFBay. Thus, Forster's Tern eggs should be a key component of any regional monitoring program.

Time Series Study of Mercury in San Francisco Bay

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Abstract
Because of past and present industrial activities, mercury is a persistent contaminant in San Francisco Bay, and in following with the Clean Water Act, the Bay has been placed on a list of impaired water bodies due to concerns regarding the consumption of mercury-contaminated fish. Although concentration of mercury in fish in the Bay show no evidence of a trend, time series analysis of mercury concentrations in water and sediment for the period 1993-2001 show declining trends for certain areas for the Bay. However, these trends may be due to annual variation in hydrology and long-term sedimentological processes within the Bay, rather than indicating a decline of mercury in the system overall. Resolving this uncertainty has implications for considering to what degree the system is at steady state, which in turn has implications for mass balance models of the Bay. In addition, identifying the factors related to these long-term temporal trends in mercury allows for a better understanding in how to properly assess the effectiveness of water quality protection efforts in this system.

Use of a National Descriptive Model of Mercury in Fish in Site-specific Applications

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Biographical Sketch of Author
Steve Wente is an aquatic biologist. He received B.S. degrees in Wildlife Biology and Natural Resource Mgmt., an M.S. in Biology from Ball State University, and Ph.D. from Purdue University. He has worked on issues related to the biological assessment of water quality at Indiana's Department of Environmental Mgmt. and the USGS's Minnesota Water Science Center and National Center. The National Descriptive Model of Mercury in Fish used in this research was originally developed as part of his doctoral research and is central to his current research with the USGS.

Abstract
Fish-tissue mercury monitoring programs commonly serve multiple purposes, including identification of contaminated sites, assessment of temporal trends, and development of fish consumption advisories. Scientists and resource managers have considered the National Descriptive Model of Mercury in Fish (NDMMF) (http://emmma.usgs.gov/) to be useful for national or regional scale estimation of spatial and temporal trends, but are reluctant to use NDMMF predictions for applications requiring accurate interpretations at a site-specific scale. The accuracy of the NDMMF was tested in site-specific applications using a data set consisting of 193 composite fish samples collected from 14 sites in the St. Croix River Basin of Minnesota and Wisconsin in 2004. At each site, approximately 14 samples were collected from a wide range of species, tissue types (whole fish and skin-on and skin-off fillets), and lengths of fish from both game and non-game species. At many sites, observed fish-tissue mercury concentrations varied by factors of more than 10 (total range: 7.3 to 830 µg/kg). The fit of the NDMMF predictions to observed fish-tissue mercury concentrations, measured as R^2 values calculated separately for each site's data set, ranged from 0.75 to 0.96 at the 14 sites, indicating the NDMMF can estimate fish-tissue mercury concentrations across a wide range of species, tissue types, and fish lengths accurately.

Mercury in Stream Water, Streambed Sediment, and Fish of the Willamette Basin, Oregon, in Relation to Mercury Sources

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Lia Chasar is a Research Hydrologist in the Water Resources Discipline of the US Geological Survey and an Assistant Professor of Environmental Sciences at Florida A&M University. She has been with the Georgia-Florida Coastal Plains NAWQA study since 2001. Her previous and current research includes community ecology of freshwater, estuarine, nearshore, and marine ecosystems; carbon cycling in wetlands; natural abundance radio- and stable isotope tracers in freshwater and coastal ecosystems; nutrient dynamics and biogeochemical cycling of carbon, nitrogen, and sulfur; and bioaccumulation of contaminants, particularly mercury, in riverine and coastal ecosystems.

Abstract

Sources of mercury (Hg) to Willamette Basin streams include atmospheric deposition, urban areas, historic cinnabar and gold mining, and geothermal springs. During summer low flow, 2002, the U.S. Geological Survey measured Hg levels in surface water, streambed sediment, and fish from 16 small Willamette Basin streams potentially impacted by these sources. Water from three geothermal springs also was analyzed. On average, total mercury (THg) in both springs and streams comprised 2/3 dissolved and 1/3 particulate Hg. THg concentrations in streams draining forested areas were 0.42-0.94 ng/L and should reflect inputs from background atmospheric deposition. In geothermal springs, THg concentrations ranged from 14 to 2,000 ng/L, but stream concentrations decreased to 0.4-4.0 ng/L within a few miles of these sources. The highest THg concentrations in streams were measured below an abandoned cinnabar mine (5.9 ng/L) and in an urbanized area (4.5 ng/L). Methylmercury (MeHg) was detected in streams below abandoned cinnabar mines and in urban streams, but total concentrations (dissolved plus particulate) were low (typically <0.15 ng/L). In streambed sediment, the highest THg concentrations occurred downstream from cinnabar mines. The median THg concentration in bed sediment from streams not contaminated by mine tailings was 49 ng/g, with two of the three highest values downstream from geothermal springs. The highest MeHg concentrations in streambed sediment were found below a geothermal spring and an abandoned cinnabar mine (5.3 and 4.7 ng/g, respectively). Hg concentrations in 1-2 year old cutthroat and rainbow trout collected from 15 streams were 0.015-0.17 ug/g (wet weight); levels were positively correlated with THg in stream water and MeHg in streambed sediment. Although 2-3 year old trout were collected from only three streams, Hg concentrations exceeded the U.S. Environmental Protection Agency criterion (0.30 ug/g, wet weight) in fish from two of these streams (below historic cinnabar and gold mining).

Characterization Of Mercury Concentrations In Suspended Sediment Loads In Guadalupe River And Coyote Creek, San Jose, California: Can TMDL Targets Be Met?

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Over the past 11 years, Dr. McKee has accumulated a wide variety of experience at the intersection of environmental chemistry, hydrology, and geomorphology. In 2000, he joined San Francisco Estuary Institute (SFEI) as the Director of the Watershed Program where he has led the development of conceptual models, testable hypotheses, and field studies that been critical in the development of Bay Area TMDLs. Several recent contributions have included the development of stormwater conveyance Hg and PCB mass budgets, a review of BMPs applied in the Bay Area, and estimates of efficiency of BMPs to reduce Hg and PCB loads.

Abstract

San Francisco Bay is listed on the Clean Water Act 303(d) list as a water body impaired by mercury. A mercury TMDL for San Francisco Bay was developed by the Regional Water Quality Control Board. The TMDL contains specific recommendations for the Guadalupe River due to mercury loads from the historic New Almaden Mining District including: “Quantitatively demonstrate that the mercury concentration of suspended sediment that best represents sediment discharged from the watershed to San Francisco Bay is below the suspended sediment target”. The question is: Can this TMDL mercury target (0.2 mg/kg) be reasonably met?

The Sources Pathways and Loadings Workgroup (SPLWG) of the Regional Monitoring Program for Trace Substances has been monitoring stormwater in Guadalupe River since 2002. Guadalupe River suspended sediment load exceeds the mercury sediment target by 10 times during “normal years” and even more during very wet years when mercury enriched sediments are mobilized from the historic Mining District. To help determine if the sediment target is reasonable, the SPLWG carried out a small pilot study on Coyote Creek at the USGS gage at Hwy 237 - a large neighboring watershed where mercury is mainly derived from atmospheric deposition and urban runoff. During water year 2005, a total of seven water samples were collected during floods. The sediment concentrations for Coyote Creek averaged approximately 0.2 mg/kg. Based in interpretation of this data, we suggest that Coyote Creek meets the Bay TMDL sediment mercury target. The data support a hypothesis that other Bay Area watersheds dominated by urban and atmospheric sources can be managed to meet the target. It is presently difficult to predict if watersheds contaminated by mining wastes such as the Guadalupe River can be remediated and managed to meet the target but this is the focus of ongoing planning studies.

Mercury Monitoring in the San Jose/Santa Clara Water Pollution Control Plant

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James Downing is a biologist in the Watershed Protection Division of the City of San Jose's Environmental Services Department. James has a background in marine ecology, marine pollution, and watershed protection. Most recently, James has managed the City of San Jose's South Bay Monitoring Program and Mercury Fate and Transport Study, and serves as the Santa Clara Basin Watershed Management Initiative's liaison to the Guadalupe River Watershed Mercury TMDL workgroup.

Sujoy Roy is an environmental engineer with experience of modeling of the fate, transport, and ecological risk of chemicals in the aquatic environment, with a focus on trace metals, nutrients and organic compounds. His recent work involves the modeling of mercury and contaminants of drinking water concern in California waters.

Thomas Grieb is chief scientist in Tetra Tech's Research and Development Division. Dr. Grieb's primary research interests include the behavior of mercury and other trace metals in the aquatic environment and the application of statistical methods to characterize uncertainty in estimates of human health and ecological risks.

Abstract

We present the interim results of a multi-year study of the fate and transport of mercury within the San Jose/Santa Clara Water Pollution Control Plant (WPCP). Since freshwater inputs to the Lower South San Francisco Bay are dominated by WPCP effluent for part of the year, and small amounts of dissolved and methylmercury may impact fish and wildlife, processes of removal, dissolution, and methylation in wastewater treatment are of particular interest. Influent total mercury concentrations at the WPCP range from 100-500 ng/l. Effluent concentrations range from about 2-5 ng/l, with the greatest reductions at steps where solids are removed. Total mercury is reduced by more than 98%. Dissolved mercury is reduced by approximately 50%, and methylmercury by about 97%. There was no evidence of mercury methylation in any stage of the wastewater treatment process. Total mercury is removed at each step where solids are removed, and the greatest reduction in dissolved and methylmercury occurs at the secondary process step. Total and methylmercury concentrations in sludge are consistent with removal from the aqueous samples, supporting the finding that the great majority of mercury is captured in solids.

Trends in Water Quality and Nutrient Sources and In-stream Nutrient Loads in the Southeastern United States

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Abstract
Water-quality data from U.S. Geological Survey (USGS) surface-water sampling sites in the Southeastern United States for the period 1973-2005 are being assessed for trends in concentrations of nutrients, sediment and major constituents, and nutrient transport. The study objectives include assessing water-quality trends for individual stations; characterizing regional patterns in the trends; defining the association of trends in agricultural nutrient sources, atmospheric inputs, urban land use, population, and trends in water-quality; evaluating nutrient loads; testing trends for specific time periods using regression load models; and providing input to a regional SPARROW (SPAtially Referenced Regressions On Watershed) attributes model. The study area includes river basins draining to the southern Atlantic, Gulf Coast, and the Tennessee River. This study is one of several major river basin (MRB) studies of the National Water-Quality Assessment (NAWQA) Program, which include the review of a common time period to assess national water-quality trends. Sampling sites with sufficient water-quality data and continuous streamflow record (approximately 100 sites) are being examined for all apparent monotonic trends using the seasonal Kendall trend test or Tobit regression. The constituents being examined include major ions, nutrients, and sediment concentrations. The seasonal Kendall trend test adjusts for seasonal variability by comparing seasonally grouped constituent concentrations adjusted for the effects of streamflow with LOWESS (LOcally WEighted Sum of Squares) smoothed curves. The Tobit test is appropriate for examining records that include reporting limits. Spatial patterns in trends for multiple stations are being analyzed in reference to regional landscape variables. The associations of trends in agricultural nutrient sources (annual variation of cropping and fertilizer use) with trends in water quality are being tested using principal components and multiple-regression analysis.

Fate and Transport of Water within the Unsaturated Zone in Five Agricultural Areas of the United States

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Lawrence Fisher is a hydrologist in the Oregon Water Science Center of the United States Geological Survey (USGS) with a B.S in Chemistry and a M.A. in Environmental Science and Engineering. He has been working with the USGS National Water Quality Assessment (NAWQA) program since 2002 helping conduct groundwater and unsaturated zone investigations in agricultural settings. His current research involves the transport and fate of water and nutrients within the unsaturated zone.

Rick Healy is a research hydrologist with the Unsaturated Zone Field Studies Project in the National Research Program of the United States Geological Survey (USGS) at the Denver Federal Center. His areas of expertise involve water flow and contaminant transport in the unsaturated zone. Rick's work has involved evaluating methods for estimating groundwater recharge and determining time of travel of water within the unsaturated zone.

Abstract

The movement of water through the unsaturated zone at five agricultural settings in the United States – California, Indiana, Maryland, Nebraska, and Washington – was investigated under the National Water Quality Assessment (NAWQA) program. Objectives of the study were to calculate water budgets for each site, estimate rates of groundwater recharge, and determine time of water travel through the unsaturated zone. This information is crucial to understanding the fate and transport of agricultural chemicals within agricultural ecosystems. Comparison of results from different settings provides some indication of how site specific hydrogeology, climate, and agricultural management practices influence the fate of water within the unsaturated zone. The maximum vadose zone thickness was about 7 m in California, 10 m in Maryland, 21 m in Nebraska, and 5 m in Washington. The Indiana study site has tile drains that maintain the vadose zone thickness at about 1 m during wet periods, but thickness increases to about 3 m during dry periods. Saturated hydraulic conductivity ranged from ~5E-8 cm/second in Indiana and Maryland to ~3E-4 in Washington. Total precipitation during 2004 was about 110 cm in Indiana and about 100 cm in Maryland, with no irrigation. Total water inputs for the same year in California (~150cm) and Washington (~90 cm) were ~80% irrigation water. Hydrology at each site was characterized using chemical and physical analyses of sediment cores, in-situ measurement of soil-moisture content and matric potential, monitoring of meteorological parameters, measurement of water-table elevations, and conservative tracer tests. Recharge was calculated using two approaches that incorporate the specifics of each site: water-table fluctuation and unsaturated-zone water balance. Evapotranspiration was calculated using the Priestley-Taylor and FAO Penman-Montieth methods. Time of water travel within the unsaturated zone was estimated from bromide tracer tests conducted at each site and from groundwater level response to water inputs.

Whole Stream Responses to Nitrate Loading in Three Streams Draining Agricultural Landscapes in Washington, Maryland, and Nebraska

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Biographical Sketch
Mr. Duff is a biologist with the US Geological Survey. His research interests focus on nitrogen, phosphorus, and carbon cycling in streams and near-stream groundwater. He uses a wide range of techniques to measure nutrient dynamics in streams ranging from small scale microbial process studies to whole-stream nutrient enrichments.

Abstract
Whole-stream bromide injections were conducted in three streams draining orchard/dairy and row crop to quantify upstream-downstream discharge, groundwater input, effective storage area (As/A), and nitrate mass balance. Stream discharge ranged from 135-440 L/s, sediment organic matter from 2-24 g/kg AFDM, and stream water nitrate from 0.6-3.2 mg N/L. Nitrate load increased along all three reaches by 18–157 mg/s. Groundwater accounted for 5-18% of the discharge gain but an insignificant proportion of nitrate export from the reaches. The highest rates of nitrification (0.44 ug N/cm^2/h) and denitrification (1.62 ug N/cm^2/h) among streams were associated with the highest stream water nitrate concentrations, highest water temperature, highest content of sediment N and C, and relatively high As/A (0.11). Though the absolute rates of N loss predicted from the denitrification assays were high compared with pristine streams, as a proportion of nitrate transported the relative nitrate loss was low. These preliminary results suggest that even when sediments are conducive for denitrification, surface water interaction with the biota is insufficient to cause a high level of nitrate removal in low gradient agricultural streams.

Random nutrient concentration v. targeted nutrient concentration... is there a difference?

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Dr. Nelson is the monitoring and assessment program manager for the Idaho Department of Environmental Quality. Since joining the agency in 2003, she has been working on expanding the State's ambient monitoring strategy to include probabilistic monitoring on lakes, reservoirs and rivers as well as coordinating and directing monitoring efforts in Idaho for wadeable streams. She received her doctoral degree in 2003 from the University of Nebraska-Lincoln

Abstract

Idaho Department of Environmental Quality (IDEQ) has developed a bioassessment program focused on monitoring biological and physical habitat parameters and has collected data from over 5000 stations throughout the state. Recent EPA directives, to develop numeric nutrient criteria, have IDEQ considering the addition of water chemistry samples to the current protocols. Analysis of nutrient levels is an important and vital aspect to monitoring water quality since increased levels of nutrients can have severe effects throughout the aquatic community of a water body. Nutrient concentrations were examined to compare a single point-in-time water chemistry sample with the overall biological assessment of individual sites. Overall one-hundred four sites were evaluated for nutrient concentrations and statistical tests were compiled.

Each of the six IDEQ regions sampled approximately 17 sites where 8-10 sites were selected randomly and the remaining 7 to 9 sites were selected from among targeted sites typically done for assessment purposes. Results were evaluated based upon Aggregate Level III Eco-regions found in the EPA's recommended nutrient criteria, random selection versus targeted site selection, and Strahler order. Comparative analysis of sites selected randomly versus those targeted by regional staff showed a tendency of the target sites to have lower mean and median values for all parameters measured except chlorophyll a and turbidity. This is different from the expected results where targeted sites would show higher median and mean values for all parameters. Overall, 44% of the random sites and 33% of the targeted sites in the Xeric West Eco-region exceeded the total phosphorus criterion. The Forested Mountain Eco-region showed 11% of random sites and 4% of targeted sites exceeding the chlorophyll a criterion. Results of other nutrients and the comparison of chemical to biological assessments will be presented.

Supporting nutrient criteria development nationwide: Web application & Technical REQuest System (T-REQS)

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Biographical Sketch of Presenter

Jeroen Gerritsen has more than 28 years of experience in aquatic environmental sciences, including basic and applied research, teaching, and assessment. His technical abilities include biological assessment, statistical design and analysis, systems ecology and modeling, ecological risk assessment, limnology, wetlands ecology, estuarine ecology, and stream ecology. He served as a member of a scientific workgroup to prepare guidance for developing nutrient criteria for lakes and reservoirs for US EPA's Office of Water. He was the principal author of two chapters: *Characterizing Reference Conditions* and *Data Analysis*. Jeroen currently serves as a technical expert on T-REQS for lakes, streams, and statistics.

Abstract

EPA's Health & Ecological Criteria Division (HECD) has provided technical guidance to the States and Tribes for developing quantitative nutrient criteria for their water resources for several years. As more States and Tribes begin developing and refining numeric nutrient criteria, there is a need for providing continued technical support in answering questions, addressing issues, and creating a central mechanism for documenting and distributing consistent and standardized information. The Nutrient Scientific Technical Exchange Partnership & Support (N-STEPS) has been created to fill that role.

N-STEPS will provide support to EPA Regional nutrient coordinators, States, and authorized Tribes on any range of technical issues related to the effects of nutrients on aquatic biological communities, the assessment and management of nitrogen and phosphorus, and development of nutrient criteria. A major tool of N-STEPS is the Technical REQuest System (T-REQS). T-REQS will provide timely and helpful expert advice on topics such as cause-response relationships, sampling design, data collection, data evaluation, statistical analysis, classification of ecosystems, and implementation of numerical nutrient criteria. N-STEPS will coordinate with existing EPA programs, other federal agencies and academicians to provide the necessary expertise to assist States and Tribes in the different stages of their programs. It is not intended to replace the assistance that is currently being provided by these organizations, but rather to provide easy access to additional resources for state specific nutrient related assistance. In addition to the question-and-answer tracking format of T-REQS, the website will include a variety of valuable technical resources, including links to useful literature (guidance documents, other peer reviewed literature, white papers, and fact sheets); a discussion board where states can talk about similar issues or problems; and a news page, where state or tribal advances in or stories related to nutrient criteria are posted.

Determination of Trends in Nutrient and Sediment Concentrations and Loads in Major River Basins, South-Central United States

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Richard Rebich currently serves as the Acting Studies Section Chief and Water-Quality Specialist for the U.S. Geological Survey (USGS) Mississippi Water Science Center in Jackson, MS. Mr. Rebich has been involved in numerous surface water-quality projects including the Mississippi Delta Management Systems Evaluation Areas project and the Reforestation Monitoring project located in northwestern Mississippi. Both of these studies involved field-scale monitoring of agricultural BMPs installed to reduce pollutants such as sediment and nutrients in storm runoff. Mr. Rebich recently operated a bacteria lab that was used to process samples collected from estuary tributary streams in the aftermath of Hurricane Katrina.

Dennis Demcheck currently serves as project chief of the USGS Acadian-Pontchartrain National Water-Quality Assessment Project in Louisiana. Dennis has extensive experience with water-quality issues in and around Lake Pontchartrain, the Verret Basin, and the Calcasieu around Lake Charles as part of the USGS Louisiana Water Science Center. Dennis was also heavily involved in water-quality sampling activities in and around Lake Pontchartrain in the aftermath of Hurricane Katrina.

Abstract

Since the early 1970's, the U.S Geological Survey (USGS) has collected water-quality information from major river basins throughout the United States as part of three thrust programs: the Hydrologic Benchmark Network (HBN), the National Stream Quality Accounting Network (NASQAN), and the National Water-Quality Assessment (NAWQA) Program. In addition, other long-term water-quality monitoring stations operate as part of local USGS cooperative efforts, and State agencies have collected water-quality data as part of regulatory efforts.

The USGS will collate data from all of these sources in an effort to investigate trends in water quality for eight major river basins in the United States. The USGS Mississippi and Louisiana Water Science Centers will help in this effort by investigating trends in nutrient and suspended-sediment concentrations and loads for rivers in South-Central United States, which includes three hydrologic regions: Lower Mississippi, Arkansas-White-Red, and Texas-Gulf. States included in the drainage area for this effort are Oklahoma, Texas, Arkansas, Louisiana, and parts of Mississippi, Colorado, Nebraska, Missouri, Kentucky, and Tennessee. The study period is from 1980 to present.

This effort will help resource managers understand changes in loads of nutrients and sediments to the northwestern Gulf of Mexico. Nutrients of interest include nitrogen and phosphorus species. Both spatial and temporal trends will be investigated. Once trends have been identified, sources of nutrients (point and nonpoint) will be identified and evaluated to help explain those trends.

Causes of Increased Total Dissolved Solids and Conductivity Levels in Urban Streams in Georgia

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Biographical Sketch

Ted is Total Maximum Daily Load Implementation Coordinator for the Georgia Environmental Protection Division (GAEPD). Current responsibilities include development, coordination, and implementation of plans to restore impaired waters. Previously, he was engaged in river basin planning and nonpoint source pollution assessment and management. He conducts personal research on stream morphology and watershed ecology. Prior to EPD, he worked for local planning agencies, a private consultant, and the Florida Department of Environmental Regulation. He was graduated from the University of South Florida, holds a Master of City and Regional Planning from Florida State University, where he pursued further study in environmental planning and urban stormwater assessment.

Abstract

Study objective were to identify the major causes and likely sources of increased conductivity (EC) and related total dissolved solids (TDS) concentrations in urban streams. Using a Standard Methods formula for calculating TDS as a surrogate for EC, calculations of TDS were derived from the summation of estimated and measured constituent concentrations compiled for a comprehensive GAEPD study of five clusters of comparable urban and control streams in different ecoregions of Georgia. Estimates of unmeasured constituents in the formula for control streams were derived from a comprehensive USGS study of State background water quality, while urban stream estimates were derived from Georgia and comparable studies. The resultant calculated TDS concentrations for Georgia study streams were validated and evaluated.

The **measured** 114.8 mg/l mean TDS concentration for five Georgia urban streams was significantly higher than the **measured** control stream mean of 51.8 mg/l. The **calculated** urban stream mean of 85.6 mg/l was substantially higher (not tested) than the **calculated** 31.3 mg/l control stream mean. Calculated TDS concentrations for each of the five urban streams were substantially higher than their corresponding control stream. Differences between measured and calculated concentrations were attributed to unmeasured organic carbon and other ions found in "blackwater" streams.

Over 93 % of the calculated 54.3 mg/l mean difference between urban and control streams was accounted for by the carbonate portion of total alkalinity (23.6 mg/l), calcium (15.7 mg/l), sulfate (6.1 mg/l), and chloride (5.2 mg/l) ions. While other components of the difference such as nitrate, sodium, and magnesium were significantly in urban streams, their portion of the difference was relatively small.

Since differential weathering due to lithological variation and evaporative concentration were unlikely causes, elevated TDS concentrations in urban streams are most likely due to the increased supply, solubility, and more efficient transport of soluble ionic constituents. Major likely causes of elevated TDS are: 1) increased alkalinity and calcium concentrations from the weathering, efficient delivery, and accelerated dissolution of calcium carbonate found in the increased expanses of impervious surfaces and wastewater leakage; 2) increased sulfate resulting from increased deposition and more efficient delivery and wastewater leakage; and 3) elevated chloride concentrations resulting from varied sources.

Effects of Altered Storm Water Discharge on Water Quality in the Vernon River Estuary, GA

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Biographical Sketch of Author

Joseph P. Richardson is a professor of marine sciences at Savannah State University in Savannah, Georgia. In addition, he has conducted environmental and coastal water quality monitoring and research since 1998 through his consulting agency Coastal Environmental Analysis. Through university related teaching, research and outreach activities and through consulting services, he has worked with many local, state and federal agencies and private organizations on water quality issues affecting coastal Georgia.

Abstract

During periods of high rainfall, portions of Savannah, GA, flood. As a result, a series of storm water drainage canals have been constructed, maintained and expanded. During summer 2002, a storm water pumping station became operational at the southern end of Savannah's Casey Canal where it empties into the upper reach of the Vernon River Estuary. The pumping station is capable of moving storm water into the estuary at an increased flow rate (up to three times faster, from 600 cfs to 1800 cfs), and producing relatively short, high volume pulses of storm water in the estuary. It is estimated that the water volume that took 2 weeks to empty from the canal previously can be discharged in 1-2 days. Downstream, the Town of Vernonburg has an active Water Quality Committee, and since 1998, has sponsored an ongoing weekly water quality monitoring program. As estuarine water quality problems are determined, the Vernonburg committee meets with and discusses these issues with representatives of Savannah, Chatham County, Health Department, and others to seek resolutions. One study currently underway involves the production of a vertical stratification of low salinity water overlying estuarine water in the estuary following large rain events and subsequent pumping of storm water into the estuary. Salinity stratification in Georgia estuaries is not normal because of the high tidal range and subsequent mixing of coastal rivers, marshes and tidal creeks. Low dissolved oxygen concentrations in Georgia estuarine waters during warm months are normal, and the possible trapping of salt water below an artificially produced halocline is of concern and is being investigated. Past fish kills in the upper reaches of the estuary have been attributed to pulses of low salinity, low oxygen-containing water draining into the estuary at volumes and rates that produced rapid anoxic conditions.

NAWQA Addresses Urban Water-Quality Issues Through Multiple Studies

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Abstract
A major thrust in the National Water-Quality Assessment (NAWQA) Program is to understand relations between urban land use and water quality. Specifically, the goal is to describe biological, chemical, and physical characteristics of urban water resources over time, and relate those characteristics to natural processes and human activities that control the movement and quality of water within and among urban watersheds. The intended outcome is an improved scientific basis for decision makers to protect urban waters in varying geographic and environmental settings across the Nation, and to manage and prioritize competing demands, such as for safe drinking water, aquatic ecosystem health, native and endangered species preservation, and recreation in urban areas. NAWQA doesn't address urban issues with one network. Rather, the Program uses a collection of networks and studies that are each designed with specific questions, but that together help to accomplish the overall goal (http://water.usgs.gov/nawqa). The largest urban component investigates the effects of urbanization on stream ecosystems in up to 11 metropolitan areas. These studies define the magnitude and pattern of response in stream hydrology, habitat, water chemistry, and biological communities as watersheds are urbanized. The studies are proposed on a rotational schedule through 2012, including in Birmingham, Alabama; Boston, Massachusetts; and Salt Lake City, Utah in 2000; Raleigh, North Carolina; Atlanta, Georgia; and Denver, Colorado in 2003; Dallas/Fort Worth, Texas; Milwaukee, Wisconsin; and Portland, Oregon in 2004; and Seattle, Washington and Sacramento, California in 2007. Other NAWQA Program studies with an urban focus consist of (1) local and regional-scale vulnerability assessments of public-supply wells affected by contamination from multiple sources, including urban; (2) national- and regional-scale assessments of pesticides, nutrients, and VOCs in urban streams and shallow ground water; and (3) sediment-core analyses used to evaluate trends of persistent urban contaminants, such as DDT, PCBs, chlordane, and PAHs, in reservoirs and lakes in 42 metropolitan areas.

Effects of Urbanization on Stream Stage and Temperature during Winter and Summer Storms within the Piedmont of North Carolina, 2002-2003

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Robin Brightbill is a biologist for the U.S. Geological Survey's Water Resources Discipline. She joined the Survey in 1988 and has served as a biologist on several National Water Quality Assessment (NAWQA) study basins in multiple aquatic community assessments, worked with the U.S. Environmental Protection Agency Region III regarding nutrient criteria, with the U.S. Corps of Engineers on fish community surveys in New York and Pennsylvania, with the Department of Defense at Fort Indiantown Gap Military Base in Pennsylvania on aquatic invertebrate and fish surveys, and within the Pennsylvania Water Science Center on various types of water quality projects. She is currently involved in several national NAWQA studies dealing with the effects of urbanization on stream communities.

Tom Cuffney (Ph.D) is a research ecologist in the U.S. Geological Survey's Water Resources Discipline. He joined the Survey in 1990 and has worked for the National Water-Quality Assessment (NAWQA) Program for the past 16 years. He has made many contributions to NAWQA including program design (urban stream studies), sampling protocols (invertebrates), and data analysis methods and tools (IDAS, ADAS, GRAN). From 1999-2001 he led the effort to evaluate land-use gradients as a mechanism for understanding the effects of urbanization on streams. His primary research interest is the effect of land-use changes on stream communities and the environmental factors that cause these changes.

Abstract
As part of the U.S. Geological Survey National Water-Quality Assessment Program and to determine possible effects of urban intensity on stream stage and temperature, 30 sites were monitored between 2002 and 2003 along the rapidly urbanizing I-40 corridor from Raleigh to Winston-Salem, North Carolina. Using a multimetric urban intensity index (UII), ranging from 0 (minimum urbanization) to 100 (maximum urbanization), 6 sites with an UII greater than 80 and 7 with an UII less than 20 were chosen for study. The sites were compared seasonally, winter and summer, to determine how urbanization could affect stability (the flashiness of the stage and temperature fluctuations) of in-stream habitat for animals and plant life.

Using graphics to determine storm duration (rise and fall until the stage begins to level off) high UII site storms lasted 59 hours or less, while storms at low UII sites lasted 114 hours or less for both summer and winter seasons (not drainage area adjusted). Non-storm temperatures showed diurnal water temperature fluctuations in summer were greater (1 to 10 degrees Celsius) at the high UII sites than at the low UII sites (0.2 to 2.5 degrees Celsius). Over winter these diurnal fluctuations were similar for both the high UII (1 to 5 degrees) and low UII sites (1 to 3 degrees). Water temperatures were more stable at lower UII index sites than at sites with a higher UII index.

Because stormflow duration in highly urbanized streams is shorter than in streams with less urban intensity, highly urbanized streams may scour more frequently and provide a less stable in-stream habitat for animals and plants. Diurnal temperature fluctuations are more constant in both seasons at low UII index sites than at the high UII index sites possibly causing stress to the animals and plants in the stream reach.

Nutrients and Biological Communities of Ozark Streams, 1993-2005

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James Petersen is a hydrologist with the U.S. Geological Survey (USGS) and is chief of the Ozark Plateaus study unit of the National Water Quality Assessment (NAWQA) program. He has been a Ozark Plateaus NAWQA study unit team member since 1992. Mr. Petersen has been involved in a number of studies of the water quality and ecology of Ozark streams.

Jerri Davis and Suzanne Femmer also are hydrologists with the USGS, specializing in water quality and aquatic ecology, respectively. They have been members of the Ozark Plateaus NAWQA study unit team since 1992. Prior to 1992, and since 1992, Ms. Davis and Ms. Femmer have conducted several studies related to water quality and ecology of Ozark streams.

Billy Justus is an aquatic ecologist with the USGS. He has been a member of the Ozark Plateaus NAWQA study unit team since 1999. Prior to that time, he was the biologist for the Mississippi Embayment NAWQA study unit. He has conducted several water quality and biological studies in Arkansas, Missouri, and Mississippi.

Abstract
The Ozark Plateaus area of Arkansas, Oklahoma, and Missouri is an area experiencing rapid agricultural and human population growth. Parts of the Ozarks produce large amounts of poultry and include counties with some of the fastest growing human populations in the United States. These increases in poultry and human populations have lead to perceived problems associated with nutrients. Since 1993 the U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) program has, along with other USGS programs, studied the water quality and biological communities of more than 100 Ozark streams. Nutrient (nitrogen and phosphorus) concentrations are greater in streams in agricultural areas and downstream from wastewater treatment plants than in streams in forested areas. These differences in nutrient concentrations generally correspond with differences in fish and periphyton (algae attached to a substrate) communities. For example, relative abundances of stonerollers (algae-eating minnows) often are greatest in streams with greater concentrations of nutrients. Some fish community metrics (percent generalistic feeders and percent rock spawners, for example) were correlated with nutrient concentrations and land use in a study of fish communities of north-central Arkansas. Periphyton communities also differ between Ozark streams in agricultural basins and forested basins. Biovolume (a measure of the amount of periphyton) of blue-green algae in streams in agricultural basins generally was about double the biovolume of blue-green algae in streams in forested basins. The taxonomic composition of periphyton communities (the mix of species and other taxa) also appeared to be affected by land use.

Environmental Monitoring Network in the St. Joseph River Watershed

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In order of authorship, the authors serve as soil scientist, support scientist, unit research leader, hydraulic engineer, and soil scientist at the National Soil Erosion Research Laboratory with one of the primary projects being the Conservation Effects Assessment Project (CEAP). The group forms an interdisciplinary team with varied backgrounds and areas of expertise. The scientists are part of a national effort to estimate the environmental benefits produced by participants in the USDA conservation programs at the watershed scale.

Abstract
The USDA Agricultural Research Service (ARS), in conjunction with many other interested stakeholders, are taking part in the Source Water Protection Initiative (SWPI) and the Conservation Effects Assessment Project (CEAP) in the St Joseph River Watershed in Northeastern Indiana. SWPI and CEAP are programs to assess the environmental benefits of current conservation practices and to develop and document the effects of new Best Management Practices (BMPs). The research involves a variety of crop and soil types that undergo different agricultural and water management practices with studies conducted from field to watershed scale. Characterizing water quality in runoff from different site conditions and agricultural treatments will help identify which land management systems are most effective at protecting and conserving water resources. In order to characterize relationships between water quality, weather, site conditions, and land use, a network of automated, real-time monitoring systems have been installed within the Cedar Creek subbasin, the largest tributary of the St Joseph River. Profile soil moisture and temperature, rainfall, air temperature and humidity, windspeed and direction, and solar radiation are transmitted every 60 minutes via radio telemetry from several remote sites to a base station computer at a centralized laboratory. These data are analyzed in conjunction with stream flow and water chemistry data in response to rainfall events. The data serve as input for calibration and validation of the Soil and Water Assessment Tool model which is used to assess the effects of conservation practices on water quality. Current monitoring network upgrades include bringing the automated water quality samplers on-line for stream flow data transmission and sampler collection status. Data from the environmental network is automatically posted to the internet on a password protected website. ARS research scientists, cooperators and private landowners can access the site to view, analyze and share data.

Occurrence of Volatile Organic Compounds in Selected Urban Streams in the United States, 1995-2003

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David Bender is a hydrologist with the U.S. Geological Survey. His work includes analyzing and interpreting volatile organic compound surface water quality data and quality assurance and quality control data for the National Water-Quality Assessment Program. David has a Masters Degree in Civil Engineering from the South Dakota School of Mines & Technology.

Abstract
The U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program sampled 37 urban streams throughout the United States for volatile organic compounds (VOCs) from 1995 to 2003. These urban streams were selected to (1) characterize stream water quality from areas draining predominantly residential and commercial land uses and (2) determine which natural and human factors affect stream quality. Initial interpretation of the VOC data set is focused on determining which VOCs commonly are found, the range of concentrations, and the temporal distribution.

The 37 urban streams sampled had drainage areas that ranged from 23 to 13,000 square kilometers with a median of 71 square kilometers. The urban streams are located in 8 major surface-water regions within the conterminous United States, Alaska, and Hawaii and are located in 9 statistically distinct climatic settings. The urban streams were sampled for VOCs monthly for about 1 year with some storm samples collected at selected sites. A total of 869 samples (410 in the summer and 459 in the winter) were collected from 1995 to 2003 and were analyzed for about 85 individual VOCs. A median of 5 VOCs in the summer and 7 VOCs in the winter were detected. Overall, the five most frequently detected VOCs at concentrations equal to or greater than 0.02 microgram per liter were toluene, chloroform, trichloroethene, perchloroethene, and methyl *tert*-butyl ether (MTBE). These five VOCs represent four VOC use groups: gasoline hydrocarbons, disinfection by-products, solvents, and gasoline oxygenates.

Analysis of the Effects of Road Salt on Water Quality in the Northern United States

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John Mullaney is a hydrologist in the USGS Connecticut Water Science Center. Over the last 20 years he has worked on a variety of projects that relate land use to ground-water and surface water quality.

David Lorenz is a hydrologist with the US Geological Survey, specializing in surface water and water-quality studies. Since 1991, he has been involved with local, regional, and national aspects of the National Water-Quality Assessment Program of the USGS.

Mr. Arntson earned a Bachelor of Civil Engineering degree from the University of Minnesota. He has been a hydrologist with the U. S. Geological Survey in Minnesota for 30 years and has worked on a variety of hydraulic and hydrologic studies from step-backwater models to watershed system models.

Abstract
Data collected from 1993-2004 by the U.S. Geological Survey National Water Quality Assessment Program (NAWQA) in northern glaciated parts of the United States were analyzed for relations among concentrations of road-salt related chemicals in ground water and surface water and ancillary factors including land use, hydrology and climate.

Significant variables for predicting the natural log of chloride concentrations in shallow ground water include the mean annual frequency of one inch or greater snowfall, the percentage of road area in a 500-meter buffer around the well, and the ground-water recharge rate. Variables that are significant in predicting maximum chloride concentrations in surface water include road density, potential evapotranspiration, and the percentage of total runoff from overland flow.

Typical chloride concentrations in ground water and surface water in selected forested areas in the study area were less than 10 milligrams per liter (mg/L). The maximum concentration of chloride in shallow ground water underlying urban areas was 800 mg/L and the median concentration was 38 mg/L . Chloride concentrations were as large as 4,300 mg/L in surface water in 27 selected urbanized basins averaging 51 square miles. The median of the maximum concentrations in samples from the 27 basins was 190 mg/L.

Yields of chloride from the selected surface-water basins were typically less than 10 tons per square mile per year in forested basins and greater than 50 tons per square mile per year from urban basins.

Estimating and Projecting Impervious Cover in the Southeastern United States

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Jim Harrison is an Environmental Scientist and water quality monitoring coordinator for EPA Region 4. His interests include incorporation of landscape data and predictive models into water quality monitoring systems, development of biological, sediment and other criteria, and melding of watershed and ecoregional frameworks.

Linda Exum is a Geographer whose research interests include analysis of land use and land cover change, use of geographic information systems for image analysis, network analysis and aerial photo interpretation, and map and graphic display of geographic information.

Sandra Bird is an Environmental Engineer whose research interests include air transport of pesticides, estimation and projection of impervious area, and collaboration with canines (four-footed olfactory sensors) to identify sources of indoor air pollution.

Christine Perkins is a geographic information systems analyst.

Abstract
Urban/suburban land constitutes the fastest growing land use class in the Southeastern United States. Predominant development practices increase impervious surface--areas preventing infiltration of water into the underlying soil. Uncontrolled increase of impervious areas (roads, buildings, parking) can cause detrimental hydrologic changes, stream channel erosion, habitat degradation and severe impairment of aquatic communities. Development practices that reduce impervious area and include preventative strategies to protect water quality are more effective and less costly than remedial restoration efforts. The extensive hydrological alteration of watersheds associated with increased impervious cover is very difficult to control and correct. Complete identification and eventual prevention of urban water quality problems pose significant monitoring, “smart growth” and water quality management challenges.

Simple and reliable methods to estimate and project impervious cover can help identify areas where a watershed is at risk of changing rapidly from a system with relatively pristine streams to one with significant symptoms of degradation. We provide a multiple data source (MDS) estimation of imperviousness in the Southeastern U.S. In this study, a method for estimating and projecting impervious cover for 12/14 digit hydrologic units over a large area was developed and tested. These methods were applied throughout EPA Region 4’s eight southeastern states to provide a screening tool to guide monitoring and educational efforts. These estimates demonstrate an inexpensive method to determine impervious cover with known accuracy at the watershed and sub-watershed scales, and characterize imperviousness changes over time. Additionally, this report estimates future impervious cover in the Southeastern U.S. using the MDS technique. These estimates can guide in-situ monitoring to confirm problems, aid listing of impaired waters under Section 303(d) of the Clean Water Act and total maximum daily load (TMDL) development, provide reliable information to enable sound local planning and land-use decisions, and promote protection and restoration of urban streams.

Development of Spatial Probability Models to Estimate Ground-Water Vulnerability to Nitrate Contamination in the Mid-Atlantic Region

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Earl Greene is a staff scientist with the U.S. Geological Survey in the Office of the Chief Scientist for Hydrology where he provides support to the Chief Scientist and the Associate Director for Water on various National Research Program and Headquarters issues. His research interests are in fractured rock hydrology and development of regional-scale statistical models. Additionally, he serves as coordinator for the WEBB (Water, Energy, and Biogeochemical Budgets) Program, Hydrologic Networks and Analysis Program, and Climate Change Science for the Water Resources Discipline.

Andrew LaMotte is with the U.S. Geological Survey's Maryland, Delaware, Washington D.C. Water Science Center located in Baltimore, Maryland. Since 1994 he has been involved in a variety of projects and programs lending his geographic and cartographic expertise through the use of Geographic Information Systems. Mrs. Cullinan has supported the project with her expertise in application of statistical principles and models to environmental data

Abstract

The U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency's Regional Vulnerability Assessment Program, has developed a set of statistical probability modeling tools to support regional-scale, ground-water quality and vulnerability assessments. These statistical tools have been used to explore and characterize the relation between ground-water quality and geographic factors in the Mid-Atlantic Region. Available water-quality data obtained from U.S. Geological Survey National Water-Quality Assessment Program studies were used in association with geographic data (land cover, geology, soils, and others) to develop logistic-regression equations that use explanatory variables to predict the presence of a selected water-quality parameter (nitrate as nitrogen) exceeding a specified management concentration threshold. Additional statistical procedures (PRESS Statistic) modified by the U.S. Geological Survey were used to compare the observed values to model-predicted values at each sample point. Statistical procedures to determine the confidence of the model predictions and estimate the uncertainty of the probability values were developed and applied. Spatial probability models at multiple thresholds were applied to produce maps showing the likelihood of elevated concentrations of nitrate as nitrogen in the Mid-Atlantic Region. These maps can be used to identify areas that are currently at risk and help identify areas where ground water has been affected by human activities. This information is being used by regional and local resource managers to protect water supplies and identify land-use planning solutions and monitoring programs in these vulnerable areas.

Urban Hydrology Monitoring Programs in the Atlanta Metropolitan Area, Georgia

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Brian Hughes is a hydrologist at the USGS Water Science Center in Atlanta and has a background in geology, water quality, and ecological studies. He is currently the chief of the urban studies and watershed studies sections. His current projects include a NAWQA program in the Apalachicola-Chattahoochee-Flint River Basin, urban monitoring programs in the Atlanta Metropolitan Area, research on instream flows required to support aquatic ecosystems, and monitoring amphibian populations in relation to water-quality conditions.

Abstract

Metropolitan Atlanta is the most rapidly growing urban area in the southeastern United States, with a population that increased by 2 million between 1970 and 2000 and with a predicted additional increase of 2.3 million people by 2030. As population has increased, the historically agricultural and forested lands of the upper Piedmont have been converted to urban and suburban land uses. Growth in Atlanta has followed the major transportation corridors and infrastructural development, resulting in a sprawling metropolitan region that currently encompasses 16 counties. Increased urbanization with its concomitant stormwater runoff, water withdrawals, and wastewater discharges has produced an overall decline in water quality throughout the region.

In response to the needs of cooperators, the U.S. Geological Survey (USGS) is conducting several urban water quality and quantity monitoring programs in the Atlanta Region. The cooperators include Federal, State, county, and municipal governments, as well as multi-jurisdictional groups. The studies were initiated to (1) meet monitoring requirements for water supply and wastewater permits, (2) meet monitoring for stormwater runoff programs, and (3) provide data in support of state-mandated water-resources planning. The USGS interest in these studies is to determine the hydrologic and geochemical responses of watersheds to urbanization. The goals of the projects vary, but have several themes in common, including:

- Determine the effects of development on hydrologic conditions in urban watersheds.
- Assess baseline water-quality conditions in urban, urbanizing, and relatively undeveloped watersheds.
- Compare streamflow and water-quality conditions in watersheds with differing levels of development and different types of land uses.
- Compare watersheds with different types and levels of implementation of stormwater controls and best-management practices.
- Assess the effectiveness of wastewater infrastructure improvements on water quality.

These projects will provide information that will be useful for designing urban water-quality monitoring programs in other parts of the Nation.

Development of an Urban Hydrological Model Linking Denitrification Potential to Urban Wetland Restoration

Michael Mak[1], Christopher C. Obropta, Ph.D.[1], Beth Ravit, Ph.D.[1], Peter L. Kallin, Ph.D. [1], Joan G. Ehrenfeld, Ph.D. [1], Eric F. Vowinkel, Ph.D.[2]

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Michael Mak is a Masters of Science Candidate in the Bioresource Engineering Graduate Program at Rutgers University. Michael received a B.S. in Bioresource Engineering from Rutgers, the State University of New Jersey in 2004. In addition to developing an Urban Wetland Model for Teaneck Creek, Michael is conducting research to determine an ideal soil compaction value for the optimization of pollutant removal efficiency and lifespan of a stormwater Best Management Practice (BMP) such as the bioretention system.

Christopher C. Obropta, Ph.D., P.E is the Assistant Extension Specialist in Water Resources with Rutgers Cooperative Research & Extension, and an Assistant Professor with the Department of Environmental Sciences at Cook College, Rutgers University. Dr. Obropta has a background in watershed management, water quality modeling, hydrologic and hydraulic modeling, and coastal engineering. His specific experience includes watershed restoration, onsite wastewater treatment system design and management, wasteload allocations and TMDL studies, stormwater management, and wetland design. In addition to serving on numerous University, State and National Water Committees, he was awarded the 2003 NJDEP Environmental Excellence Award for Environmental Stewardship.

Dr. Ravit has a Ph.D. in Environmental Science from Rutgers University, where she is an Assistant Research Professor and a member of the department of Biochemistry & Microbiology. Dr. Ravit is also the Director of the Rutgers Environmental Research Clinic, whose function is to fund graduate research, which supports scientific studies that are relevant to environmental issues in the State of New Jersey. Her specific research interests include anaerobic wetland processes and restoration, particularly with respect to microbial functional activities. Dr. Ravit is the recipient of numerous grants supporting her research and restoration work, including the prestigious USEPA STAR Fellowship.

Peter L. Kallin, Ph.D., PWS, is the Senior Project Manager of the Water Resources Program at Rutgers University with Rutgers Cooperative Research & Extension. Dr. Kallin has a broad educational background with specific experience in physical oceanography, surface and groundwater hydrology, water quality modeling, contaminant fate and transport modeling, wetlands ecology and biogeochemistry, risk-based corrective action (RBCA), environmental impact assessment, and watershed management and restoration. Certified as a Professional Wetlands Scientist (PWS) by the Society of Wetlands Scientists, he designed and implemented numerous stormwater and wastewater treatment wetland projects, as well as other wetland and watershed restoration projects.

Dr. Joan G. Ehrenfeld, Ph.D., is a Professor in the Department of Ecology, Evolution, and Natural Resources at Rutgers University, where she has been studying plant communities and soils of wetlands throughout New Jersey. Her research is centered on the overlap between ecosystems ecology and plant ecology. Dr. Ehrenfeld is pursuing various research that explores the interrelationships between plants (specifically root biology and mycorrhizae) and soil (including soil processes such as decomposition and nitrogen cycling, soil structure, and the biology of soil organisms). Dr. Ehrenfeld is the current Director of the New Jersey Water Resources Research Institute (NJWRRI).

Eric Vowinkel, Ph.D., is an adjunct professor at the School of Public Health and the Environmental and Occupational Health Sciences Institute (EOHSI) at the University of Medicine and Dentistry of New Jersey (UMDNJ). He serves as the Chair of the Water Subcommittee on the Cook College Executive Dean's Advisory Council on the Environment. He received his Ph.D. from the Department of Environmental Sciences at Rutgers University in 1997.

Abstract
The urban wetlands of Teaneck Creek are located in the upper reaches of the New Jersey Meadowlands within the Hackensack River Watershed. Owned by Bergen County Parks and leased by the Teaneck Creek Conservancy, this 46-acre property represents significant open space in the NJDEP WMA5 watershed, which is characterized by 95 percent urban land use. The hydrologic conditions of this formerly riparian wetland system are characterized by human alterations including (1) the addition of a floodgate, which shifted the habitat from estuarine to freshwater, (2) the construction of berms, which have disconnected the natural flow of water between the wetlands and surrounding streams, (3) and the deposition of debris from construction of the New Jersey Turnpike. Concentrated urban land use upstream from the wetlands presents a significant challenge in reducing nutrient loadings from ground-water and surface-waters, as well as inputs from discharging storm drains.

(#61- continued) The collection of empirical data will be used to calibrate and verify a model that links the wetland water compartments with sediment nitrogen cycling processes. System denitrification potential will be evaluated via sampling of dry and saturated sediment cores from areas that are potential candidates for flooding post-restoration. This analysis will determine system denitrification potential under pre- and post-restoration conditions. The water budget (Urban Wetland Model) will be utilized to evaluate possible impacts of breaking the berm and restoring some natural water flow into the wetlands area. Restoring the natural water flow may be a critical factor for increasing wetland denitrification of anthropogenically produced nitrogen inputs from surface-water, ground water, and atmospheric sources. The effects of the restoration activities on the flow regime in this urban wetland with respect to the hydrology, water quality, sediment porewater N species, surrounding community, and denitrification potential before, during and after restoration will be evaluated.

National Water Quality Surveillance for Waterborne Pathogens and Related Indicators in Canadian Agricultural Waters

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Abstract
The National Agri-Environmental Standards Initiative (NAESI) began in 2004 to develop, field-test and recommend science-based environmental performance standards for Canadian agriculture. The intent is to develop a national suite of non-regulatory environmental standards specifying desired levels of environmental quality, or ecological condition, as nationally-consistent benchmarks for agricultural practices, management and policy. NAESI standards themes include biodiversity, pesticides, air and water quality. Under water quality, standards will be developed for nutrients, sediments, instream flow needs and waterborne pathogens. Given the paucity of effects-based water quality standards and limitations in pathogen monitoring, the NAESI Pathogens research project is focused on the development of credible, reliable and cost-effective indicators of waterborne pathogens. Initially, an analysis of current indicators used in determining occurrence, quantity, source, and relative risks of waterborne pathogens to human and non-human receptors was undertaken. Canada's first national waterborne pathogen surveillance program is now underway to detect and quantify a broad suite of relevant agriculturally-derived protozoan, bacterial and viral pathogens along with various water quality indicators (microbial, chemical, and physical). In addition, any impacts (e.g., incidence of waterborne disease outbreaks, shellfish contamination, wildlife and livestock illness and death, and crop contamination from irrigation) will also be explored. A network of Canadian experimental agricultural watersheds posing high pathogen risk to water quality and water uses is being used. These include watersheds both with and without Intensive Livestock Operations of bovine, avian or porcine origin. The national surveillance data will then be examined using correlative analyses to explore the best indicators, or combinations thereof, for various agricultural pathogen source scenarios. Recommendations of relevant standards (indicator suites) will be made in 2008 for further testing and application as national water quality performance benchmarks in agricultural waters. The program design and initial efforts underway on pathogen surveillance and indicator development are described.

Anthropogenic Impacts to Fish Assemblages in Northern New Jersey Streams

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John Vile is a research scientist for Water Monitoring & Standards within the New Jersey Department of Environmental Protection. He is certified as an Associate Fisheries Professional by the American Fisheries Society specializing in aquatic ecological investigations. Currently he is in charge of overseeing the New Jersey Fish IBI Program. In addition, Mr. Vile has spent several years working as a fisheries biologist in the Midwest and Pacific Northwest. He has a B.S. in Biology from Rutgers University and a M.S. in Biology from East Stroudsburg University.

John Abatemarco is an environmental specialist in the NJDEP's Division of Water Monitoring & Standards with training and experience as a fisheries biologist. Since 2004 he has worked with the Bureau's Fish Index of Biotic Integrity program.

Leslie McGeorge is the Administrator for Water Monitoring & Standards, where she directs NJ's ambient water quality monitoring, standards and assessment program. Previously, she served as Assistant Commissioner for Environmental Planning and Science, and as a Research Scientist, Assistant Director, Deputy Director and Director in the Division of Science, Research and Technology. She sits on the National Water Quality Monitoring Council, co-chairs the NJ Water Monitoring Council, and represents NJ on ASIWPCA's Monitoring, Standards and Assessment Task Force. She has a B.S. in Biology (Lafayette College) and a M.S. in Public Health, Environmental Chemistry and Biology (University of North Carolina).

Abstract

The New Jersey Fish Index of Biotic Integrity (IBI) has been used to assess the health and condition of fish assemblages and to identify potential stressors from high gradient streams in New Jersey. Since the initiation of the program in 2000, a number of impacted waters have been identified. Seventy-six percent of urban streams sampled have been impacted or have suspected impacts as a result of human activities. The most common urban stressor to the aquatic community is loss or degradation of natural habitat. Bank erosion and siltation have eliminated overhead cover, bank vegetation, riparian buffer, and suitable substrate in many urban streams. The effects of such habitat alterations are evident in the fish community, as benthic insectivores, which require clean substrate, have exhibited a decreasing trend in response to urbanization. Trophic imbalance is often evident in urban waters, as specialized feeders such as insectivorous cyprinids are replaced by generalists. In addition, data from the 2005 season indicates external deformities in fish are more common in urban settings, likely a result of environmental stress or input of contaminants.

Controlling Cumulative Impacts from Impervious Surfaces: Relationship Between California State Law and NPDES Requirements

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Abstract
Cumulative changes in impervious surfaces pose a number of potentially significant threats to watersheds, particularly to water quality and from potential erosion. Where water bodies are already considered impaired, cumulative impacts present serious concerns. Although data on impervious surface changes could be easily compiled for each new development, local governments do not currently require this information from new developments. Without an adequate analysis of impervious surface changes, the local governments cannot verify that they have avoided significant environmental impacts. New requirements under the Clean Water Act and Porter-Cologne Act address some impacts of impervious surfaces; however, these new requirements do not address all the potentially significant cumulative impacts, as is required under the California Environmental Quality Act. Changes in CEQA Guidelines require this cumulative impact analysis. This presentation will discuss an analysis prepared by the Committee for Green Foothills focusing on Santa Clara County, but the monitoring requirements under discussion are relevant throughout the Bay Area and California. The presentation also discusses mitigation that could be required as a result of adequate monitoring.

Diurnal nutrient fluctuations in the Lake Okeechobee watershed, Florida

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Molly S. Wood is a Hydrologist in the Florida Integrated Science Center, U.S. Geological Survey, in Orlando, FL. She has approximately 7 years experience in the water resources field, including assisting with Remedial Investigations/Feasibility Studies at CERCLA sites, statistical modeling of surface water-quality data, hydrologic data collection and analysis, and design of groundwater remediation systems. She began working for the U.S. Geological Survey in 2002 and is currently Project Manager of a long-term nutrient load monitoring program in the Lake Okeechobee watershed as part of the Comprehensive Everglades Restoration Plan. She is a registered Professional Engineer in Florida.

Abstract

Lake Okeechobee is the heart of South Florida's water supply and flood control system and is a major source of water for the Everglades. Agricultural development and canal construction in the watershed have resulted in more efficient delivery of stormwater to the lake, increased nutrient inputs, and a concomitant decline in ecosystem health. The U.S. Geological Survey is operating a 10-year (2003 – 2013) water-quality and streamflow monitoring program at 18 sites to assess the effects of future restoration efforts in the watershed.

Many streams in the Lake Okeechobee watershed have substantial amounts of aquatic vegetation growth, likely due to high nutrient concentrations combined with low flow. In-stream nutrient concentrations might vary due to diurnal changes in vegetation growth and associated nutrient uptake. As a result, water-quality data from the monitoring program may be biased if samples are collected only during daytime hours. To test this hypothesis, water samples were collected hourly for 24 hours from a monitoring site with substantial aquatic vegetation, Williamson Ditch, on March 15-16, 2005. Samples were analyzed for phosphorus species, nitrogen species, and total suspended solids. In addition, a continuous water quality monitor was deployed to measure dissolved oxygen concentration, water temperature, pH, turbidity, and specific conductance.

Statistical analysis (t-test on transformed data, $\alpha=0.05$) showed that phosphorus and total suspended solids concentrations were lower during daytime hours than nighttime hours. Dissolved ammonia concentrations were higher during daytime hours; however, this may be due to a change in equipment cleaning techniques in the latter part of the sampling event. Total nitrite plus nitrate did not exhibit a diurnal trend. Total organic plus ammonia nitrogen data could not be used due to holding time exceedance at the laboratory. Streamflow did not change significantly during the study. Dissolved oxygen, pH, and turbidity were lower and specific conductance was higher during daytime hours.

Assessment of Native Stream Biodiversity and the Influence of Invasive Species in Tierra Del Fuego, Chile

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Michelle Moorman is a master's candidate in Marine Science at North Carolina State University. She has worked as a hydrologic technician for the U.S. Geological Survey's National Water Quality Assessment Program since 2001. In 2005, Mrs. Moorman was the recipient of a Wildlife Conservation Society Research Fellowship that allowed her to go to the "end of the world" in search of fish.

Christopher B. Anderson is a doctoral candidate in the University of Georgia's Institute of Ecology where he has been studying the impact of the North American Beaver on riparian communities in the Cape Horn Biosphere Reserve. His work was funded by Fulbright and Boren Fellowships as well as a NSF Doctoral Dissertation Improvement Grant.

Paul Szejner is an undergraduate student at the University Austral de Chile in the Department of Forestry with an emphasis in forest ecology. His undergraduate thesis will focus on understanding the dynamics of pine forest in Guatemala by using dendrochronology techniques. He spent February of 2006 collecting data with Mrs. Moorman and is happy that he finally caught his first big trout.

Rina Charlin has worked with the Omora Foundation for the past 4 years and has a profound knowledge of native and introduced plants of Chile. In recent years, her expertise in plants has taken her to the Cape Horn Biosphere Reserve and the Southern Ice Field in Chile.

Abstract
The Cape Horn Biosphere Reserve (CHBR) was recently designated as one of the world's last remaining pristine wilderness areas. However, at the same time invasive species can be found along its fringes. Since 2004 we have been assessing aquatic biodiversity and the effects of introduced species to provide physical, chemical, biological, and ecological information to guide management, conservation, and future research activities in the area. Streams in this area contained relatively diverse (mean taxa richness = 12 in natural sites) and largely endemic aquatic macroinvertebrate fauna (e.g., Trichoptera *Monocosmoecus hyadesi* and *Rheochorema magellanicum* and Plecoptera *Notoperla fuegiana*), but freshwater fish species were rather species-poor and lacked endemics (*Galaxias maculatus*, *Aplochiton zebra*, and *A. tenatius*). The introduced North American beaver (*Castor canadensis*) were found in nearly all the watersheds of the study area, except for the extreme western and southwestern portion of the archipelago. Their impoundments reduced the richness and diversity of benthos, but increases invertebrate biomass and the abundance of *G. maculatus*. Two trout species (*Salvelinus fontinalis* and *Oncorhynchus mykiss*) were also found throughout Navarino and Hoste Islands in areas previously settled by humans, indicating that the presence of trout is related to human inhabitation. An increase in the abundance and biomass of trout is negatively related to the abundance and biomass of native fish species, but less so then in other areas of Tierra del Fuego where brown trout (*Salmo trutta)* are present and have severely impacted the native fish communities. Prevention of the introduction of highly invasive brown trout is necessary in order to

preserve the native fish communities. In conclusion, our findings illustrate that the invasion of exotic species on the fringes of the Cape Horn Biosphere Reserve is fundamentally altering the pristine nature of its aquatic ecosystems, and their control should be a high priority.

Using Environmental Monitoring and Assessment Program Data for Describing Condition of Inner Columbia River Basin Streams

Lillian Herger, Gretchen Hayslip, and Peter Leinenbach

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Biographical Sketches of Authors

Lillian Herger is a fisheries scientist with the Environmental Protection Agency, Region 10. She is a member of the Region's Environmental Monitoring and Assessment team, which develops methods for evaluating aquatic ecosystem condition. Gretchen Hayslip is an aquatic biologist with EPA Region 10. She is the lead for the Western EMAP program in Region 10 and has been the Regional Water Monitoring Coordinator for the past 15 years. Peter Leinenbach is an aquatic and landscape ecologist with the Environmental Protection Agency, Region 10. He is a member of the Region's Environmental Monitoring and Assessment team.

Abstract

The objectives of EPA's National Strategic Plan include protecting the quality of rivers and streams by using monitoring data to assess the condition these waters at different scales (e.g. national, statewide and basin). Also, the States and EPA monitor individual stream reaches to identify water quality problems and develop pollution control measures such as discharge permits and Total Maximum Daily Loads (TMDLs). Because State monitoring programs are under-funded, problem stream reaches in need of permits or TMDLs typically receive high priority rather than state-wide or basin-scale assessments. In fact, not all states have a monitoring program designed to assess the entire State and even fewer have a monitoring program designed to assess basin conditions. The primary reporting mechanism for state water quality is the Integrated Report (IR), which is designed for reporting on a stream segment level. The IR is a list of the segments for which the State has data and has made an assessment but is not designed to assess the condition of entire basins.

The Environmental Monitoring and Assessment Program (EMAP) was developed by EPA to assess the condition of the nation's ecological resources using a statistical design that generates assessments that describe the length of the stream and river resource in good, fair and poor condition. In 2000, Western EMAP began a five-year effort to monitoring and assessment of the ecological condition of rivers and streams across the western U.S. Taking a subset of the data from this large project we assess the ecological condition of the wadeable streams of the inner Columbia River basin of Washington, Oregon and Idaho. We present a comparison of these results with data from State Integrated Reports.

The Water Quality Monitoring Programs of the Oklahoma Water Resources Board (OWRB)

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Biographical Sketch of Author

Mr. Cauthron works for the Oklahoma Water Resources Board where he serves as the Water Quality Monitoring Program Coordinator in the agency's Water Quality Division. He oversees the operation of the Monitoring & Assessment Section. Bill has worked for the Water Resources Board since 1987 and during his tenure has assisted with streams technical studies, conducted Clean Lakes Studies and overseen the Agencies Lake Water Quality Assessment Program. He received his Bachelor of Science in Biology from East Central University and his Masters in Public Health from the University of Oklahoma Health Sciences Center.

Abstract

The Oklahoma Water Resources Board (OWRB) Monitoring Section has developed a far-reaching monitoring strategy over the past decade. Programs address a variety of surface water and groundwater resources in the state and integrate both professional and volunteer monitoring. The projects have involved a variety of cooperators, funding sources and methods of data collection. With a very professional, well-trained staff as well as many capital and logistical resources, the OWRB has the capacity to support very diverse programs. The Beneficial Use Monitoring Program (BUMP) is the cornerstone program. Using state funds, the BUMP monitors both lentic and lotic waterbodies across the state and gathers a wide variety of data for an assortment of uses including general water quality assessments, trend analysis, and estimation of loads. In addition, the OWRB recently began a statewide, long-term probabilistic monitoring program that will monitor over multiple 5-year periods and make both statewide and regional estimates of condition. Along with long-term monitoring programs, an integral part of the agency's monitoring strategy is short-duration, project-specific monitoring programs. These projects have various objectives including: 1) data collection for total maximum daily load development, 2) groundwater monitoring at compliance test wells associated with confined animal feeding operations, 3) regional assessments of biological condition, 4) monitoring of areas impacted by oil and gas production, 5) groundwater/surface water interaction studies, 6) regional stream gaging, and 7) monitoring upstream and downstream of sewage treatment plants receiving state Clean Water State Revolving Fund monies. Additionally, the agency has a long-standing, well developed volunteer program. Around the state, groups monitor a variety of parameters on streams, rivers, and lakes.

Coastal Watershed Assessment Point Reyes National Seashore and Golden Gate National Recreation Area

Brannon Ketcham[1], Anitra Pawley, PhD[2], Darren Fong[3], Kristen Keteles, PhD[4]

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[3] Aquatic Ecologist, Golden Gate National Recreation Area, Fort Chronkite Bldg 1061, Sausilito, CA
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Biographical Sketches of Authors
Brannon Ketcham has been the park Hydrologist and Water Resource Program Manager at Point Reyes National Seashore since 2000. This includes oversight of park monitoring and management efforts associated with watershed protection, water quality monitoring, fisheries management and monitoring, and wetland restoration.

Anitra Pawley is the coordinator and principal author of the Point Reyes National Seashore and Golden Gate National Recreation Area Coastal Watershed Assessment. She has worked on environmental assessment and indicators research in the San Francisco Bay Delta Ecosystem for nearly ten years through her work with CALFED and the Bay Institute.

Darren Fong has been the aquatic ecologist at Golden Gate National Recreation Area since 1995 responsible for a variety of monitoring, management and restoration efforts associated with salmonids, amphibians, reptiles, and aquatic invertebrates. Prior to his work at GGNRA, Darren worked for the US Fish and Wildlife Service in Sacramento.

Kristen Keteles has been the Coastal Watershed Condition Assessment Coordinator since 2004. Prior to joining the NPS program she was a professor at Arkansas State University, with a focus in aquatic ecology.

Abstract
The National Park Service (NPS) has initiated a Coastal Watershed Assessment Program to assist parks in the synthesis of pertinent information to support long-term park planning and management needs. Point Reyes National Seashore and Golden Gate National Recreation Area manage more than 150,000 acres and 125 miles of the California coast, including four state Areas of Special Biological Significance, and are contiguous to the Gulf of the Farallones National Marine Sanctuary. The poster will provide an overview of the NPS coastal watershed assessment process and present findings associated with these specific park units. All elements of the assessment will be presented, including: a synthesis of impacts and stressors on these complex and unique coastal watersheds; discussion of the influence of park watersheds on the coastal and nearshore habitats and conditions; evaluation of what we can presently determine about marine influences and effects on coastal park resources; and identification and evaluation of indicator species which integrate conditions within multiple habitat areas. Data gaps and future directions for research will also be discussed.

San Francisco Bay Area Network Water Quality Monitoring Protocol

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Biographical Sketches of Authors

Brannon Ketcham has been the park Hydrologist and Water Resource Program Manager at Point Reyes National Seashore since 2000. This includes oversight of park monitoring and management efforts associated with watershed protection, water quality monitoring, fisheries management and monitoring, and wetland restoration.

Mary Cooprider worked as the San Francisco Bay Area Network Water Quality Specialist from 2002-2005, and developed the monitoring protocol. Mary is now a Biologist/Environmental Scientist at LSA Associates, Inc. in Point Richmond California.

Rob Carson is the San Francisco Bay Area Network Water Quality Specialist in charge of program implementation. Rob has experience in ecological and long-term monitoring through the Black Rock Research Forest in Cornwall, New York.

Abstract

The San Francisco Bay Area Network (SFAN) comprises eight National Park Service Units including Golden Gate National Recreation Area, John Muir National Historic Site, Pinnacles National Monument, and Point Reyes National Seashore. Through the National Park Service Inventory and Monitoring (I&M) Program, staff have developed and are in the process of implementing a peer-reviewed water quality monitoring protocol for the suite of SFAN park units. A Quality Assurance Plan (QAPP) and sampling protocols have been prepared to ensure data collection, management, and reporting quality. The water quality data are managed within a National Park Service (NPS) database for archival purposes, with regular uploads to the EPA STORET database. The monitoring protocols were developed over a two year period to meet park, network, and national water quality monitoring and management needs. The protocol narrative articulates these multiple goals and scales, and provides a peer-reviewed monitoring approach. The objective of this poster is to summarize the application of national monitoring program objectives at the network and park scale.

Water Quality Status and Issues in Nepal

Keshari Bajracharya

His Majesty's Government , Ministry of Environment , Science and Technology P.O.Box 406 or 3526 Baber Mahal, Kathmandu, Nepal 16/359 Nagbahal, Lalitpur Nepal Kathmandu, Ba, 1428

Abstract

Extensive Surface Water pollution in Nepal is currently regarded as the most serious environmental issue in Nepal aside from the deforestation issue. Although Nepal is rich in water resources, majority of the people are yet share the benefits in terms of improved water quality. Rivers are not only of immense religious significance that serve as the cradle of human existence, it is a pre-requisite for better future as well. The rivers are being contaminated by various reasons including people's negligence. Discharge of domestic sewage dumping of solid waste and industrial effluents are the most visible causes of contamination along the urban area of the rivers. The drinking water supply in Kathmandu Valley and in most of the rural area are usually inadequate in terms of overall coverage, quantity of water and of course poor water quality, which is below WHO Standards. Water supplies are intermittent with access to only a few house each day. As an alternative to the piped water supply system, people used traditional water sources such as spring, pond, stream open dug well and shallow tube well. But these sources being unprotected, the quality of water is usually poor. Thus these inadequate water facilities consumed by the poor and low coverage of improved sanitation facilities together not only cause health problems but also lead to the another cause of the contamination of surface water. Water borne epidemics such as occasional cholera breakouts are therefore endemic. Since water quality problems have attained a prominent role for the growing population of both in urban and rural area, the monitoring of water resources contamination is the primary basis for environmental protection. Only by knowing the condition of water quality it is possible to take the appropriate measures to protect these scarce resources.

New York City's Harbor Survey Program
Water Quality Monitoring in an Urban Watershed

Beau Ranheim, Naji Yao, Markus Koelbl, William Lopez, Daniel Marcktell, Andrew Owens, Yin Ren

NYC Dept. of Environmental Protection, Marine Sciences Section Wards Island, NY 10035

Biographical Sketch of Authors
Beau Ranheim is a marine biologist in the Marine Sciences Section within the NYC Dept of Environmental Protection(NYCDEP). Mr. Ranheim has worked at the DEP for the Harbor Survey Program since 1992 and has been the Section Chief since 2000.

Abstract
The City of New York has been monitoring water quality in New York Harbor since 1909. The Survey was begun as a response to quality of life complaints about the waterways surrounding Manhattan Island. The Survey has continued without interruption to the present.

The Survey started as a Summer only sampling of twelve (12) stations on a monthly basis, has evolved into a year-round program that monitors thirty-five (35) open water stations, at up to a weekly frequency.

This long term database allow us to show trends and observe the impact that infrastructure improvements have made on the water quality in the Harbor. Currently the Survey is exploring new technology , such as real time remote monitoring and PCR based bacteria determination.

An Overview of the California Monitoring and Assessment Program (CMAP) for Perennial Streams

[1]Melenee Emanuel, [1]Emilie Reyes

California State Water Resources Control Board 1001 I Street, 15 Floor, Sacramento, CA, 95814

Abstract

The State Water Board's Nonpoint Source (NPS) and Surface Water Ambient Monitoring Program (SWAMP), in cooperation with the US Environmental Protection Agency (USEPA) and the California Department of Fish and Game initiated the California Monitoring and Assessment Program (CMAP) in 2004. This program builds on USEPA's Environmental Monitoring and Assessment Program (EMAP), and will be used to (a) provide a framework for producing valid assessments of condition for perennial streams in California and (b) develop tools to facilitate these assessments. As part of this program, historic EMAP data will be analyzed to produce assessments of the condition of streams in different areas of the state including southern coastal and northern coastal California. In addition, a monitoring study will be continued in order to assess aquatic life beneficial use protection in streams. The study uses a probabilistic monitoring design and incorporates a core suite of indicators. Results from CMAP will provide information to help address questions applying to statewide status, trends, and extent and types of nonpoint source impairments.

Sediment Quality Indicators for the Delaware Estuary

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Abstract
Estuaries are variable and dynamic habitats that are difficult to assess. Sediment characterization is an important component of the assessment of estuarine environmental health. Ecological indicators have the laudable goal of integrating environmental response to multiple stressors by cost effective measurements of exposure and effects. Indicators are useful in assessing trends or as first tier screening tools prior to more rigorous and costly sampling efforts. We synthesized and compared data for the Delaware Estuary from the National Coastal Assessment Program, the National Status and Trends Program, Delaware River Basin Commission program studies, and permit compliance monitoring activities. Sediment chemistry, acute and chronic sediment toxicity and benthic infauna assemblage studies and sediment quality criteria were compared to published benchmarks, effects ranges, and bioassessment guidance in an integrated approach to sediment quality characterization

EPA's National Study of Chemical Residues in Lake Fish Tissue

[1]Leanne Stahl, [2]Blaine Snyder, [2]Jennifer Pitt

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Abstract
The Office of Water is conducting the largest national freshwater fish contamination survey undertaken by EPA. The National Study of Chemical Residues in Lake Fish Tissue (or the National Lake Fish Tissue Study) includes the largest set of chemicals studied in fish, and it is the first national fish contamination survey to have sampling sites statistically selected. Agencies in 47 states and three tribes, along with two other federal agencies, collaborated with EPA for four years to collect fish from 500 lakes and reservoirs in the lower 48 states. Sampling teams applied consistent methods nationwide to collect samples of predator and bottom-dwelling species from each lake. EPA is analyzing the fish tissue for 268 persistent, bioaccumulative, and toxic chemicals, including mercury, arsenic, PCBs, dioxins and furans, and pesticides. Preliminary results for the four year data set show that mercury was detected in predator species at all 486 sites where predator samples were collected, whereas PCBs and dioxins/furans were detected in predator samples at 99% and 80% of these sites, respectively. When completed in 2006, this study will provide the first national estimates of mean concentrations of the 268 target chemicals in fish. It will also provide a national baseline for assessing progress of pollution control activities that limit release of these chemicals into the environment.

Working Together to Determine the Status of Maryland's Forgotten Bays

Carol Cain

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Biographical Sketch of Author
Carol Cain has been employed as the Technical Coordinator for the Maryland Coastal Bays Program since 2000 and is responsible for tracking efforts to implement the Comprehensive Conservation & Management Plan for the Maryland Coastal Bays watershed. This National Estuary Program is a cooperative effort between local, State and Federal entities to bring together scientists, policy makers and local stakeholders to define and address environmental issues and conflicts.

Abstract
Volunteer water quality data collected by local citizens has been incorporated into the first Maryland State of the Coastal Bays Report (2004). This report, prepared by the Maryland Dept. of Natural Resources, University of Maryland-IAN, and the Maryland Coastal Bays Program is a public friendly document that conveys current status and trends of water quality and living resources.

This report details the positive developments conducted by Program partners to improve water quality, protect fish and wildlife, improve recreation & navigation and enhance community and economic development.

Water quality is collaboratively studied by volunteers, university programs, State departments and by the USGS and National Park Service. Collectively, indicators have been chosen and thresholds established for stream health, estuarine water quality, sediment quality, harmful algae, habitat and living resources. By determining the frequency and area each agency or group monitors, gaps can be identified and resources are used more prudently by all cooperators.

MCBP volunteer water quality monitors do their part by measuring near shore areas as opposed to open water sites which are covered by State and Federal biologists. Monthly observations of pH, temperature, salinity, and site conditions are recorded, and samples are collected to analyze organic and inorganic nitrogen and phosphorus and chlorophyll.

Five years of data were analyzed to produce the Maryland Coastal Bays Volunteer Water Quality Monitoring Report 1997-2002. Other volunteer opportunities include annual reptile searches, spawning horseshoe crab surveys, and stream benthic macroinvertebrate sampling. These activities, in addition to clean-ups, newsletters and other outreach products and events help MCBP to keep the community abreast of current conditions and engaged in finding local solutions to local problems.

BioSITE: Students Investigating Their Environment

[1]Sandra Derby, [2]Robert Zaccheo

[1]Children's Discovery Museum 180 Woz Way San Jose, CA, 95110
[2]Pioneer High School

Abstract
Participants in the engaging workshop, led by our student scientists, will be shown how to implement a full year of environmental science programming focused on watershed monitoring. Children's Discovery Museum of San Jose has been doing just that since 1993. Our unique partnership with San Jose Unified School District has evolved to include more that 1,000 students and our central program is facilitated by the students of Pioneer High School. These Pioneer High School students will share their experiences as science mentors, demonstrate authentic methods of field study, and provide unique insights as to the importance of serving the community as well as the natural world in which we all live. Sharing: Students will share with participants their unique experiences of being science mentors to elementary students in the full year of field science. In pictures and words, our program is introduced to participants through the eyes of our most invaluable environmentalists of the future- our BioSITE students. Activities: Participants will create their own watershed model and discuss the importance of a healthy watershed. Environmental issues such as non-point source pollution, erosion factors, and restoration efforts are brought to focus by this favorite activity. Participants will be shown how to conduct water quality tests using authentic water quality variable test kits. Student facilitators will share the research data they have collected and point out the importance of monitoring and analyzing results. Participants will receive a new Environmental Science High School Service Learning Program Curriculum that will provide them with multiple guidelines that can help interested educators create a program like Pioneer's BioSITE

Resources Available for Volunteer Monitoring Programs

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[2]URI CE
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[4]UNH CE

Abstract
Volunteer monitoring can be a tremendous asset to water quality protection efforts. A variety of resources are available to assist in developing new programs or expanding existing programs. This poster will introduce two Cooperative Extension efforts Cooperative State Research Education Extension Service (CSREES) Volunteer Water Quality Monitoring National Facilitation Project Guide for Growing CSREES Volunteer Monitoring Programs, and the tools of the New England Regional Monitoring Collaborative (NERMC), which is affiliated with the New England Water Program. The Guide for Growing incorporates extensive references and links to materials from Cooperative Extension and other programs, to provide a comprehensive document to help support volunteer monitoring efforts. Guide modules include: " Why Volunteer Water Quality Monitoring Makes Sense for CSREES; “How to use the Guide to Growing CSREES Volunteer Monitoring Programs; " Designing Your Monitoring Strategy: Basic Questions and Resources to Help Guide You; " Training Volunteer Water Quality Monitors Effectively; " Assuring Quality Data; " Volunteer Management and Program Support; " Outreach Tools; and " Finding Support and Funding for Local Efforts. The NERMC resources focus on specific monitoring methods to facilitate watershed-based monitoring. NERMC offers basic training materials (videos and manuals) and workshops designed to train watershed monitoring groups to carry out four types of assessments: 1) Watershed Natural Resources Inventory, 2) Habitat Assessments, 3) Benthic Macroinvertebrate Assessment, 4) On-site Nonpoint Source Pollution Evaluation (Following the Flow) By integrating these resources with local institutional supports (state agency, university or non-profit service providers) volunteer monitoring can provide citizens and communities with tools to improve their knowledge of the status and factors affecting their local water quality. This knowledge engages stakeholders in programs related to changes needed at the farm, home/camp and community level to ensure lake water quality protection.

The Nuts and Bolts of a Volunteer Monitoring Day

Janet Cohen

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Abstract
Your volunteers are trained, your monitoring program and QAPP are in place and your equipment is purchased. Now you're faced with the logistics of how to successfully get volunteers and equipment out of the door, down to the river and back again having collected good data. Preparation for a successful Monitoring Day starts weeks before the day itself and involves many steps and the involvement of staff and volunteers. The Nuts and Bolts of a Volunteer Monitoring Day will illustrate how imperative it is to be highly organized and professional on Monitoring Day, so that your volunteers can collect their samples and data with as few problems as possible. The model used in this workshop builds on the success of the South Yuba River Citizens League's (SYRCL) successful volunteer river monitoring program, which is widely viewed as a model program in California. Janet Cohen, SYRCL's former Executive Director and initiator of the program will present a tried and true template for how to run a problem-free monitoring event. Lists of essential tasks, volunteer jobs and an organizational timeline will be part of a kit that participants will receive at the workshop.

Introducing NHDPlus!

Thomas Dewald[1]

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Abstract
NHDPlus is a suite of geospatial data products that incorporates many of the best features of the National Hydrography Dataset (NHD) and the National Elevation Dataset (NED). NHDPlus is the outcome of a multi-agency effort aimed at developing NHD stream flow volume and velocity estimates to support pollution fate-and-transport models, such as the EPA/OW Riverspill and USGS SPARROW models. NHDPlus includes a stream network (based on the 1:100,000-scale NHD) with improved networking, naming, and value-added attributes, such as stream order. NHDPlus also includes elevation-derived catchments (drainage areas) for each NHD reach, a flow direction grid, a flow accumulation grid, and National Land Cover Dataset attributes assigned to the catchments.

Geographic Targeting for Watershed Restoration

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Abstract
The Tennessee Valley Authority (TVA) develops detailed nonpoint pollutant source (NPS) inventories to identify, quantify, and prioritize contributors to environmental problems in watersheds. These land-use and land-activity GIS databases provide the means to effectively prioritize and target watershed restoration funds and, thus, achieve the greatest level of pollutant reduction for the least amount of funding. The comprehensive data details, such as eroding road and stream banks, livestock sites, illegal dumps, and suspect septic systems extracted from stereo photographs provides the first step in determining the cause of a pollution problem in the watershed. Data analysis transforms a dispersed, area-wide concern into a defined, site-specific problem by identifying sub-watersheds that are the greatest contributors to the pollution problem. Then, the specific sites that contribute the greatest pollutant loads in each priority sub-watershed can be determined. This basic form of geographical targeting is the most efficient and cost-effective approach to watershed improvement. While providing a foundation for focusing efforts on priority impacted watersheds and identifying most-effective abatement measures for meeting TMDLs, these NPS assessments also serve as documentation of nonpoint sources to support application for water quality improvement grants and to provide the stimulus for agencies, industries, interest groups, and landowners to work toward a common goal. Based on data from a recently completed watershed restoration project, this poster presentation will illustrate the NPS inventory and assessment process through photographs, maps, charts, and pollutant loading reports.

New NHD Tools for the Evaluation of Watershed Condition and Management Performance

William Cooter, Peter Ilieve. Tim Bondelid, Mark Bruhn, Kevin Pickren, Eric Solano, and Sunil Rao

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Biographical Sketches of Authors

William Cooter, Peter Ilieve, and Tim Bondelid direct RTI International's water quality program, providing support for major monitoring, assessment, and analysis programs for EPA's Office of Water, including support for EPA's TMDL program under the Clean Water Act and source water protection initiatives under the Safe Drinking Water Act. Mark Bruhn and Kevin Pickren are GIS specialists with expertise in georeferencing and geospatial analysis techniques using the National Hydrography Dataset (NHD). Eric Solano and Sunil Rao are experts in the application of Oracle and Oracle Spatial systems that provide a wide range of integrated database and geospatial analysis tools. RTI's water quality program has created most of the EPA data layers georeferenced to the NHD, and RTI is on the cutting edge in the development of special value-added features that will be a part of the new NHDPlus.

Abstract

The National Hydrography Dataset (NHD) supports a set of value added tools providing a robust analytical infrastructure for the flexible integration of monitoring and assessment information using both standard and custom, watershed units. This new system, called NHDPlus, represents a joint effort on the part of the EPA and the USGS to provide a consistent national platform that can facilitate the sharing of information on measures of watershed condition and management program performance. Examples are provided on applying this NHD-based platform using enhanced upstream-downstream analysis techniques and other tools for the rapid integration of data related to conventional GIS vector layers (point, line or polygon data) as well as raster data such as the National Land Cover Data (NLCD). NHDPlus is built around a set of small catchment polygons related to the drainage areas of individual flow paths in the NHD. These catchments are aggregated to define the standard units (e.g., HUC12 subwatersheds, HUC10 watersheds, or HUC8 subbasins) for the Watershed Boundary Dataset (WBD).

Catchments can also be flexibly aggregated to define custom watershed units geared to the needs of specific management programs. In our examples we show how criteria such as time of travel or shifts in land cover patterns can help define watershed-based analysis envelopes for monitoring sites, regulated facilities, urbanized areas, public lands, tribal lands, transportation corridors, and other management units or areas of investigation. These focused analysis envelopes can be applied to integrate monitoring data and water quality standards assessment data to support a wide range of water quality programs conducted by federal, state (including tribal groups), or local management authorities.

Evaluating Watershed Condition and Management Performance with the NHDPlus Toolkit

[1] Mellony Hoskinson, [1]Tim Bondelid, [1] Randy Dodd , [1]Mark Bruhn

[1]Environment, Health and Safety Division, RTI International, PO Box 12194, Research Triangle Park, NC, 27709

Abstract
The National Hydrography Dataset (NHD) provides a set of value added tools to support the flexible integration of monitoring and assessment information for custom, or standard, watershed units. This new system, called NHDPlus represents a joint effort on the part of the EPA and the USGS, and offers a consistent national platform to share information on indicators of watershed condition and management program performance measures. Examples are provided on applying this NHD-based platform using enhanced upstream-downstream analysis techniques and new tools for the rapid integration of data related to conventional GIS vector layers (point, line or polygon data) as well as raster data such as the National Land Cover Data (NLCD). These NHDPlus tools can be applied to integrate available monitoring information for the standard polygons in the Watershed Boundary Dataset (e.g., HUC12 subwatersheds, HIC10 watersheds, or HUC8 subbasins). NHDPlus is built around a set of small catchment polygons related to the drainage areas of individual flow paths in the NHD. These catchments are aggregated to define the standard units for the Watershed Boundary Dataset (WBD); and catchments can also be flexibly aggravated to define custom watershed units geared to the needs of specific management programs. Examples are provided on how criteria such as time-of travel or shifts in land cover patterns can define watershed-based analysis envelopes for urbanized areas,, military bases, tribal lands, transportation corridors, the ecoregions used in EPA's nutrients database criterion initiative, or sensitive areas such as National Parks. These focused analysis envelopes can be applied to help integrate monitoring data and water quality standards attainment conclusions from the National Assessment Database to develop outcome-based performance measures for numerous EPA and state water quality-based programs.

Arkansas Monitoring Data Assessment Program (AMDAP) Using the Segment Evaluation Spreadsheet (SEGEVAL.XLS)

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Abstract

The data analysis needed to prepare the Integrated Report for 305(b) and 303(d) requirements entails a very large number of repetitive mathematical calculations and logical comparisons. Performing the calculations by hand has a higher probability of error than an electronic system. Performing logical comparisons in person has a higher probability of variability of application of the acceptance criteria. The Arkansas Monitoring Data Assessment Program (AMDAP) Team developed an Excel Segment Evaluation Spreadsheet (SEGEVAL.XLS) tool capable of making an automated, electronic analysis of monitoring data. The initial tool has been updated to reflect changes to the water quality standards and assessment methodology. Use of this tool will result in an annual reduction of between 3,174 and 7,268 man-hours related directly to analyzing data and an additional 15,870-36,340 man hours in streamlining the process for preparing its Integrated Report and 303(d) list of impaired waters. That translates into a savings of $477,000 to $1,092,000 on each report. The cost benefit for use of the Cross-Reference file in answering Water Quality Standards questions has not been estimated. After technology transfer to the State, the State has endorsed the use of the tool in preparation of its 2004 Integrated Report and contributed feedback for the continued improvement of the program. The tool is transferable to other states for an overall water quality enhancement at both the state and federal level. Other benefits include 1) a program quality improvement from a more detailed understanding by all parties involved of how monitoring data uses the standard to determine waters that are impaired and 2) creation of a Program Data Resource in the form of a cross-reference file for answering water quality standards questions on a particular water segment on a case by case basis.

Spatial Scale and the Proximity Factor for Water Quality- Landscape Correlations

Ronald B. Zelt[1], Brian S. Fredrick[1], and Amy L. Zoller[1]

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Biographical Sketch of Author

Ronald Zelt, P.HWQ., is a supervisory hydrologist in the Nebraska Water Science Center within the U.S. Geological Survey. Since 2002, he has served as project manager of the Central Nebraska study unit of the National Water-Quality Assessment Program, and section manager overseeing collaborative studies with U.S. Environmental Protection Agency and Nebraska Department of Environmental Quality. With graduate degrees in both watershed science and geography, Ron has worked on a variety of projects during 19 years with USGS that included duty stations at Cheyenne, Wyoming, and Lawrence, Kansas.

Abstract

Linkages between water-quality conditions and landscape characteristics may be strongest at landscape scales smaller than the entire drainage area. This study examined the scale-dependency of relations between trends in flow-adjusted nutrient concentrations (FACs) in Missouri River Basin streams and a selected set of landscape characteristics pertaining to nutrient loadings for several spatial scales, chiefly focused on total drainage area and the 10 percent of drainage area nearest to each trends site. The proximal 10 percent subset was determined from elevation model-derived flow paths of overland runoff for each of 35 trends sites. Also, 10 sites were selected randomly for analyses including the 3-, 6-, 14-, and 18-percent proximity subsets.

Nutrient trends were the slope coefficients for time in constituent-specific, site-specific, multiple-linear regressions of nutrient concentration with time as one of the model terms. For six of the selected landscape characteristics, available time-series data were analyzed by rank-based regression to yield temporal trend slope coefficients as the landscape variable.

To test scale-dependency of pairs of nutrient and landscape variables, Pearson's correlation coefficient (R) was computed for two comparisons, yielding coefficients R_{XZ} and R_{YZ}, where **Y** is the vector of values for a landscape variable characterizing the entire drainage area, **X** is a similar vector for the same variable characterizing the 10-percent proximity subset, and **Z** are the trend slopes for one nutrient species. The difference between these two dependent correlations (H_0: □$_{xz}$ = □$_{yz}$) was tested using the Hotelling-Williams procedure.

For the 10 sites selected for multi-scale study, correlations were examined between trend slopes and landscape characteristics of the proximal i percent of the drainage area, where i = 3, 6, 10, 14, 18, and 100. The series of X_iZ rank correlations (Kendall's □$_i$) were computed and graphed versus spatial scale (i) to explore the scale dependency of correlation strength.

An American/Canadian Partnership – Sharing Data for the Gulf of Maine

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Biographical Sketch of the Author
Deb Soule has worked at the New Hampshire Department of Environmental Services for 16 years in various programs such as GIS development, source water protection, public water supply monitoring and compliance, and database management. For the last 6 years she has worked as a business systems analyst for the Watershed Management Bureau. Since December 2004, she has served on the Gulf of Maine Ocean Data Partnership Executive Committee and is the chair of the Technical Committee.

Abstract
How do you find data related to the Gulf of Maine? The Gulf of Maine Ocean Data Partnership (GoMODP) is making progress on simplifying the answer to that question.

The GoMODP is comprised of 21 organizations that collect and manage environmental data within the Gulf of Maine and its watershed. Members include federal, state, provincial, university and research organizations in the US and Canada. The goal of the partnership is to make each partner's long term datasets discoverable, accessible, and eventually interoperable through tools available on the internet. The partnership intends to use standards and protocols already in use by the various disciplines represented wherever possible.

To fulfill that goal, partners have filled out detailed surveys regarding their data. This information, which is available to all partners, has greatly assisted in developing a strategy for achieving interoperability between the partners. Discovery metadata training and assistance have been provided to partners to aid in establishing a common set of practices in the publishing of data through a number of interoperable standards based discovery web portals: Geospatial One-Stop, NASA's Global Change Master Directory (GCMD), and the Canadian GeoConnections Discovery Portal. In addition a dedicated GoMODP discovery portal for the partnership's data sets has also been established by GCMD. The next phase of GoMODP development will be through a series of end-user oriented pilot projects whereby the partners are expecting to gain practical experience regarding the use of interoperable data access techniques like web services.

Achieving true data discoverability, accessibility, and interoperability without making the task overwhelming for the individual partners is challenging for such a diverse set of organizations. To reach this goal, the GoMODP develops a yearly work plan administered by a governing board and technical committee. The GoMODP continues to add members and hold annual meetings.

RésEau: Building Canadian Water Connections

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Chris Lochner is a Water Quality Information Specialist and Scientist with the National Water Quality Monitoring Office of Environment Canada. He is a geochemist with specialization in radio-isotopes. He began his government career in 2003 and has been involved in several water-related information initiatives that have included mostly the federal government, provinces and NGOs. Aside from a three year hiatus to work as a professional musician, Chris spent much of his pre-government career, working as a consultant with World Bank and Asian Development Bank projects in China with a company called Chreod Ltd.

Abstract

Water information and expertise in Canada is extremely horizontal in nature and stakeholders span a wide range of government departments, jurisdictions and communities. Bringing water information together across these stakeholders in a credible, accurate and dynamic manner is a key challenge to the growing need for improved access to environmental information. As one of the largest single providers and users of on-line services and information to Canadians, the federal government has an important leadership role in stimulating the continued and future growth of client-centered information, tools and services. RésEau aims to demonstrate this role for Environment Canada and internationally. RésEau is a demonstration project that will develop multi-jurisdictional partnerships, content and tools required to share, discover, access and use water-based data and information on the Web. A key cornerstone of RésEau is that the data and information being shared is best managed and delivered directly from the source using web services rather than a central data warehouse. This eliminates the need for redundancy and ensures the utmost currency of the data being shared. Some examples of data and information provided include surface and groundwater quality and quantity, public health, and aquatic biodiversity. Under Environment Canada leadership, RésEau will create a web portal that will: demonstrate sharing, discovery, access and use of accessible water quality, quantity and use data over a distributed, interoperable network (based on web-services); address common end-user requirements associated with specific target audiences (e.g. water policy makers, water resource managers, water science community, industry, youth and Canadians); implement shared tools and applications; and promote the implementation of open standards, web services and principles to integrate water data and information across certain jurisdictions.

Facilitating the Exchange and Reporting of Monitoring Data

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Abstract

The Regional Monitoring Program for Trace Substances (RMP) is the primary source for long-term contaminant monitoring data for the San Francisco Estuary and provides high quality, scientific information for formulating technically sound policies. To facilitate the exchange and use of monitoring data, the RMP's information management system incorporates standardized data storage procedures that are consistent with a statewide standard, a web-based tool for accessing results, and a variety of graphical methods and reports for presenting synthesized results to different audiences. This information management system is the foundation for participants in the monitoring program to draw inferences, develop reports, and communicate complex scientific information to the public.

The San Francisco Bay Regional Water Quality Control Board uses data collected by the RMP for regulatory purposes, such as evaluating 303(d) listing of water bodies, establishing background contaminant conditions used in National Pollutant Discharge Elimination System permits, and modeling for estimating Total Maximum Daily Loads and ecosystem recovery times. In addition, long-term monitoring data are used to evaluate whether the cumulative range of management actions taken at the individual watershed level, by setting permit conditions, and developing new policies have been successful in reducing contaminant loads, mitigating impacts to the Estuary, or restoring ecosystem support functions.

The integrity of the RMP data is evaluated by a rigorous QA/QC verification and validation process before results are made available to water quality managers, decision-makers, scientists, and the public. By maintaining an integrated data management and information system, the RMP is able to provide the

scientific data needed for addressing important environmental management questions. Its comparability with the statewide water quality database and integration into the State's newly adopted Monitoring Strategy make it a valuable tool for developing local and regional indicators for assessing the effectiveness of regulatory and management efforts to protect the Estuary's beneficial uses.

New Tools for Importing, Sharing, and Visualizing Biological Monitoring Data using the Ecological Data Analysis System (EDAS)

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Jeffrey White is a scientist at Tetra Tech, Inc.'s Center for Ecological Studies in Owings Mills, Maryland. His experience includes project management and technical lead of projects requiring development relation databases, web based decision support systems, and web applications. He developed the first versions of EDAS, Tetra Tech's bioassessment database and data analysis tool for use with MS-Access.

Erik W. Leppo is a staff scientist/programmer at Tetra Tech, Inc.'s Center for Ecological Studies in Owings Mills, Maryland. His experience includes database development and management of large datasets.

Ben Jessup is a scientist at Tetra Tech, Inc.'s Center for Ecological Studies in Owings Mills, Maryland. His experience includes biological and ecological criteria development, ecosystem assessment, statistical analysis, environmental data management, and biological modeling. He specializes in aquatic ecosystem analysis for development of biological indices.

John Zastrow is a scientist at the Fairfax, Virginia Office of Tetra Tech, Inc. He leads the geospatial development group and manages projects relating water quality data management and assessment. He has recently completed several software development projects that provide semi-automated assessment of water quality using state-level impairment rules.

Abstract
Tetra Tech developed a data management and analysis system, *Ecological Data Application System* (EDAS), specifically for the development and interpretation of indices of biological and physical habitat condition. EDAS is an analysis application developed using Microsoft Access that calculates biological metrics used for monitoring and assessment, and facilitates the integration and statistical analysis of aquatic ecological data (i.e., biological, chemical, physical, geographical). Analytical features include calculation of all metrics in EPA's Rapid Bioassessment Protocols (1999), a "starter" taxonomic database including biological attributes, and linkage of taxonomy to ITIS (the U.S. standard for taxonomic nomenclature). State, federal, and local agencies are using EDAS for biocriteria development, routine biological assessment, and innovative data management and querying. Recently there has been a need to provide web based tools for managing and analyzing biological monitoring data. In response, Tetra Tech is in the process of developing an upgraded version of EDAS. This new version will allow users to share (import or export) biological data from multiple sources or organizations. Additional features in development include web based tools for data entry, biological metric and habitat calculations, and reporting.

Flood-Tracking Chart for the Chattahoochee River near Metropolitan Atlanta, Georgia

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Jacob LaFontaine is a civil engineer in the Georgia Water Science Center, in Atlanta, Georgia. Jacob has been working on the City of Atlanta Water-Quantity/Water-Quality Monitoring Program since 2003.

Brian McCallum is Assistant Director of the Georgia Water Science Center, in Atlanta, Georgia. He oversees the long-term hydrologic data collection activities for the USGS in Georgia. He studied civil engineering at the University of Nebraska-Lincoln.

Timothy Stamey is a recently-retired hydrologist in the Georgia Water Science Center, in Atlanta, Georgia. He held many positions with the USGS during his 32 years of service, including Surface-Water Specialist, Data Chief, Records Section Chief, Flood Specialist, and Project Chief for several types of interpretive studies.

Caryl J. Wipperfurth is a cartographer in the Georgia Water Science Center, in Atlanta, Georgia. Caryl has worked in the Atlanta office for 12 years. Prior to that, she worked with the USGS in Madison, Wisconsin, and Rolla, Missouri. Caryl's work includes water-related reports for the USGS for Georgia and the United States, the Center for Disease Control, and the Middle East (including Palestinian, Jordanian, and Israeli areas).

Abstract
The U.S. Geological Survey (USGS) operates a hydrologic monitoring network in the Chattahoochee River Basin, with support from the City of Atlanta, as well as Federal, State, and local agencies. Using data collected from this network, the USGS has compiled a flood-tracking chart for the Chattahoochee River near Metropolitan Atlanta. The Flood-Tracking Chart supplements the USGS real-time hydrologic data network by providing local citizens and emergency management officials with a useful tool to track and compare floods in the Chattahoochee River Basin near Metropolitan Atlanta.

The Flood-Tracking Chart is intended for emergency management officials who make decisions on road closures and evacuations, as well as property owners living within water’s reach. Valuable information concerning precautions to take when dealing with a flood, as well as contact information for Federal, State, and local emergency management agencies is also provided on the chart.

The Flood-Tracking Chart summarizes historical water-level peaks for 16 of the 35 real-time gages operating in this part of the hydrologic data network. This chart includes the portion of the real-time network that extends from the Chattahoochee River at Buford Dam, near Buford, Ga to the Chattahoochee River near Fairburn, Ga. The National Weather Service (NWS) uses 10 of the 16 gages and has established flood-stage levels for the gages. Flood warnings and predictions for the gages used by the NWS are available on the World Wide Web at *http://www.srh.noaa.gov/serfc*. These warnings and predictions are based on water-level and discharge data provided by the USGS. These data are available on the World Wide Web at *http://ga.water.usgs.gov*.

Proactive Water Quality Monitoring with Actionable Data in Drinking Water Distribution Systems

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Abstract
The WaterNOW Data Management Service provides drinking water utilities with a fully integrated data visualization and reporting solution, centered on a web-based, internet browser driven user interface. Collecting and consolidating data from various sources such our WaterPOINT 870, other field measurements, internal and external laboratories (LIMS) or SCADA/PLC is done via automated or semi-automated processes and via intuitive and logical entry routines. Location oriented visualization and reporting allows the water quality manager to direct and manage resources and pin-point corrective action in a timely fashion. The understanding of water health and the health of water distribution is visualized by way of colored gradients, indicating well published concerns like water aging, ground water intrusion and infrastructure wear and tear. Reviewing the history, understanding a trend and responding to a need are made available by a click of a button. Location based data management incorporates an encompassing sample handling procedure protecting the chain of custody from the time a sample is taken, measurements are performed up to the moment when laboratory results are returned for data consolidation. Time/Date stamp are complemented by GPS Longitude/Latitude, Location and Operator Name, providing the stringent framework tying results to a physical location. WaterNOW eliminates the need of purchasing costly hardware and software by deploying its service from a secure web-server supported by redundancy reinforced power and data transmission. The monthly per user seat based service allows you to access and manage your own data at any time, schedule standard reporting to key personnel and file required compliance reports with the State and Federal EPA.

Use of Colilert, Colilert-18 and Enterolert for the Determination of *E.coli*, fecal coliforms and enterococci in Waste Waters.

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Gil Dichter is the World Wide Technical Support Manager, Environmental for IDEXX Laboratories.

Gil received his B.A. in Chemistry from Brooklyn College in New York and his MBA in Management from Marist College in New York.

He has over 15 years experience in the Pharmaceutical and Clinical Industry and for the past 17 years is employed in water microbiology.

Gil is the Chair of ASTM D19-24 Methods for Water Microbiology and is also a member of Standard Methods for Water and Wastewater Microbiology section 9000 and a member of the Methods and Data Comparability Board.

He is a member of the following organizations:

- American Society of Microbiology (ASM)
- American Water Works Association (AWWA)
- Water Environment Federation (WEF)
- American Society of Testing Materials (ASTM)
- American Chemical Society (ACS)
- Society for Applied Microbiology (SFAM)

Abstract
Waste Water Facilities are required to test the final effluent in order to be in compliance with their NPDES permit which permits them to discharge the effluent into a specific body of water. Presently several states allow the use of Colilert and Colilert-18 for the detection of E.coli in the final effluent. On August 16th, 2005, US EPA proposed in the Federal Register to add E.coli and enterococci for testing wastewater prior to the discharge into a body of water and also included Colilert and Enterolert as proposed methods. Colilert, Colilert-18 and Enterolert and Quanti-Tray are a proven method and will be an important analytical tool for the testing of these parameters. Colilert is based on Defined Substrate Technology and detects coliforms and E.coli simultaneously using two nutrient indicators ONPG and MUG, which will turn yellow for the presence of coliforms and yellow and fluorescence for the presence of E.coli. With Enterolert, a blue fluorescence will be observed for the presence of enterococci. Colilert or Enterolert with the Quanti-Tray yields quantitative results within 18-24 hours and is a fast, easy and reliable proven procedure. Studies will be presented to support this technology as an analytical tool for the detection of these parameters in wastewaters.

A Case Study for Comparison of NAWQA and EMAP Protocols for Benthic Macroinvertebrates and Habitat

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Dave Peterson is a hydrologist with the Wyoming Water Science Center of the U.S. Geological Survey. In recent years, he has served as project chief and biologist on the Yellowstone River Basin NAWQA study and the western pilot EMAP study in Wyoming. Dave has worked on numerous biological and water-quality projects with the USGS since receiving his B.S. degree in Water Resources (ind.) from the University of Wisconsin – Madison.

Peter Wright is a hydrologist with the U.S. Geological Survey in Billings, Montana. He has coordinated and participated in the collection of ecological and water-quality data for several monitoring programs in Montana and Wyoming including the Yellowstone NAWQA and EMAP Western Pilot. He has worked for the U.S. Geological Survey since 1992. He received his B.S. degree in Environmental Science from Allegheny College.

Jeremy Zumberge is supervisor of the water quality monitoring program at the Wyoming Department of Environmental Quality, and lives in Sheridan, Wyoming. He has a B.S. in Environmental Studies from Bemidji State University (Minnesota) and a M.S. in Water Resources Science from the University of Minnesota.

Abstract
Benthic macroinvertebrate communities and habitat measurements are compared for data collected following protocols established by the USGS NAWQA program and by the USEPA EMAP Western Pilot. Samples and measurements at 12 sites were collected by the same personnel for both protocols, in a side-by-side fashion at streams in Wyoming, Montana, and Colorado.

Benthic macroinvertebrate community structure was compared between the data sets using individual metrics and multivariate analysis. Differences in total taxa richness and Ephemeroptera taxa richness between the data sets were significant at the $p < 0.05$ level after removal of ambiguous taxa. Differences in other metrics generally were not significant, such as richness of Plecoptera and Trichoptera, tolerant taxa, functional feeding groups, diversity, and dominance. Scores calculated for a multi-metric index, the Wyoming Stream Integrity Index, were not significantly different between the data sets. Some differences in community structure between the two data sets could be attributed to differences in subsampling and taxonomic identification procedures. Subsampling procedures appeared to have greater effect on individual metrics, whereas reconciliation of the taxa lists resulted in decreased differences between data sets in multivariate analysis. Procedures are discussed to minimize differences and maximize the comparability and potential cross-utilization of the NAWQA and EMAP macroinvertebrate data sets.

Habitat features such as thalweg depth and bankfull height were measured using NAWQA and EMAP protocols for a stream reach defined for this study as the length of 20 wetted channel widths. Differences between the protocols in measuring bank angle and substrate, for example, sometimes resulted in significant differences in the results.

A Comparison of Stream Biological Assessment Results Obtained Using Different Sampling Protocols in Midwestern Agricultural Streams

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Biological Sketch of Author
Since joining the IDNR in 1990, Tom has been involved with a variety of surface water monitoring and assessment projects throughout Iowa. One of his primary duties is coordinating the development and implementation of stream biological assessment criteria. Other projects and responsibilities include the probabilistic (REMAP) survey of Iowa's perennial rivers and streams, stressor identification for stream biological impairments, hydropower project evaluation of water quality impacts, and Stream and Watershed Integrated Management (S.W.I.M.) training workshops.

Abstract
Among other variables, benthic macroinvertebrate data are influenced by selection of sampling gear, technique, and locations from which samples are drawn. The National Wadeable Streams Assessment (WSA) study initiated by the U.S. Environmental Protection Agency offers a unique opportunity to compare results obtained from various sampling strategies across different regions, landscapes, and disturbance regimes. During the July-October 2004 WSA index period, thirty-eight stream sites located throughout Iowa's agriculturally dominated landscapes were sampled for benthic macroinvertebrates using both the State methodology and the WSA methodology. The State methodology combines standard (richest targeted) habitat and multi-habitat sampling, while the WSA methodology features kick net sampling at evenly spaced channel transects. Differences in sampling procedures and taxonomic analysis endpoints yielded substantial differences in the benthic macroinvertebrate data available to assess stream biological conditions. For example, State samples produced greater richness and proportional abundances of EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa compared with WSA samples, which were typically dominated by Chironomidae taxa. Differences in sample composition and taxonomic endpoints yielded from the two protocols can ultimately impact the degree to which bioassessment conclusions agree or disagree, and how well each methodology is able to discern a gradient in biological condition and responses to ecosystem stressors.

A Comparison of Benthic Macroinvertebrate Assemblages Collected in New Mexico and Texas Reference Streams Using Selected Methods from State and Federal Agencies

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Bruce Moring is a senior biologist in the Investigations and Research section within the Texas Water Science Center of the U.S. Geological Survey (USGS). He has served as the Project Chief for the Trinity River Basin Study Unit of the USGS's National Water Quality Assessment program since 2000, and has experience and interest working with aquatic insects and fish assemblages in streams across Texas. Bruce joined the USGS in 1992, and he has worked on more than 20 projects since joining the agency.

Abstract
Benthic macroinvertebrates were collected from reference streams in New Mexico using two methods. At each reference stream in New Mexico, a benthic macroinvertebrate sample was collected using the U.S. Geological Survey's National Water Quality Assessment (NAWQA) Program's Richest Targeted Habitat method. Concurrently, a benthic macroinvertebrate sample was collected using the United States Environmental Protection Agency's Wadeable Streams Assessment (WSA) method. In Texas, in addition to benthic macroinvertebrates collected using the NAWQA and WSA methods, an additional benthic sample was collected using the Texas Commission on Environmental Quality's (TCEQ) standard method for the collection of benthic macroinvertebrates. The efficacy and ease of application for each method was compared in the field. The NAWQA and TCEQ methods were similar in effort per site. The WSA method was more labor intensive per site. Taxa composition and the relative abundance of selected taxa for each site varied among sample types. Benthic metric scores were calculated for each site using data from each method and compared. Differences in scores from each method probably resulted from the targeted habitat types for each method. Differences in stream flow, time of year, and the availability of skilled and trained field personnel can influence results depending on the method employed.

Components of Variability in Long Term Regional Monitoring Program Data

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Biological Sketch

Donald Yee is SFEI's QA Officer. Dr. Yee has worked on various projects for the RMP, such as studies on atmospheric deposition of trace metals, and organic contaminants to the estuary and surrounding watersheds, and a survey in SF Estuary waters of VOCs, dioxins, and other priority pollutants not yet regularly monitored by RMP. He is presently the principal investigator of a CalFed grant evaluating mercury cycling in the Petaluma Marsh. Dr. Yee has also conducted investigations of loads of PCBs and other organic contaminants from point source dischargers.

Abstract

The Regional Monitoring Program for Trace Substances (RMP) conducts monitoring and research on the San Francisco Bay to develop a better understanding of the distribution and impacts of contaminants in Bay. A major component of the RMP is the annual monitoring of San Francisco Bay sediment, water, and bivalves under its Status and Trends program. Samples are analyzed for a suite of inorganic and organic contaminants and ancillary parameters. Laboratories reporting data from RMP sample analyses are also required to submit quality control (QC) data, including results of blanks, replicates, spikes, and reference samples. For a majority trace elements and organic contaminants, concentrations in blank samples are seldom detected or are small relative to quantities measured in field samples. Most measurements done for the RMP are also highly reproducible, as demonstrated through laboratory performance on replicate analyses of field and reference samples. Recoveries of spikes and reference materials were also generally within targets and certified acceptance ranges for most analytes. However, in some cases, blank contamination, poor precision or recovery, matrix interferences and other analytical problems for some analytes required data qualifiers and censoring (i.e. results not reported) of those analytes in some analytical batches. Potential analytical variability as evident from QC data reported for the RMP will be evaluated against temporal and spatial variability resulting from system characteristics and the sampling program design. Implications for data interpretation in the context of RMP objectives (evaluation of status and trends relative to regulatory criteria and effects threshholds) will be discussed.

Discrete versus continuous: A comparison of water quality monitoring frequencies

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Biographical Sketch of Author
Nelia White is a graduate student in geography at San Francisco State University, studying GIS and natural resources. Since August 2000, she has worked as a student intern for the Surface Water Ambient Monitoring Program (SWAMP) at the San Francisco Bay Regional Water Quality Control Board. Her work with SWAMP includes fieldwork and data analysis for pathogen indicators and basic water quality field parameters.

Abstract
Basic water quality field parameters fluctuate in interrelated diel cycles in response to the interplay of physical, chemical, biological, and anthropogenic influences. Efforts to characterize field parameters with daily, or less frequent, discrete monitoring may misrepresent water quality. Discrete measurements are less effective than continuous at capturing the magnitude and pattern of irregular episodic events whose influence may have a disproportionate effect on water quality. This study compares discrete and continuous datasets of temperature, dissolved oxygen, pH, and specific conductance measured at 43 sites on streams in the San Francisco Bay Area for the Surface Water Ambient Monitoring Program (SWAMP) between 2001 and 2003. Using benchmarks to evaluate the data, this study found notable instances of exceedances missed by discrete measurements. Even if a discrete measurement represents the median of the continuous distribution, it cannot represent the range. The comparison also points out the extent of disagreement between the two datasets due to environmental variation, sampling protocol, and equipment. To eliminate that variability, discrete sampling at 7 AM, 10 AM, and 3 PM is simulated by examining subsets of continuous monitoring records at one site. The resultant graphs are compared to evaluate how the data would be interpreted differently at different sampling times and frequencies.

Achieving Comparability for a Statewide Program through Careful Selection of Quality Assurance and Quality Control Systems

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Beverly H. van Buuren is manager of the Quality Assurance (QA) Research Group at Moss Landing Marine Laboratories (MLML). The QA Research Group consists of six full-time staff members that are currently focused on two large-scale programs: the State of California's Surface Water Ambient Monitoring Program (SWAMP), and the CALFED/California Bay-Delta Authority (CBDA) Mercury Speciation Monitoring and Research Studies. Ms. van Buuren is the QA Officer for both programs, and has designed and taught QA courses for the Northwest Environmental Training Center, the Washington State Department of Ecology, and for project/program-specific applications in the classroom, laboratory and field.

Abstract

The Surface Water Ambient Monitoring Program (SWAMP) was formed in support of Federal Directive AB 982, which mandates that each state develop a comprehensive surface water quality monitoring program. In California, the implementation of such a program is particularly challenging due to diverse geography, disparate monitoring methods, varied regional data uses, and customary budget restraints. During initial planning, The SWAMP Quality Assurance (QA) Team, in cooperation with stakeholders, carefully prioritized the implementation of quality systems that provide a framework for state-wide data comparability. This framework includes the statement of program data quality objectives (DQOs), the creation of key quality documents that support these DQOs, and the ongoing assessment of program contract laboratories and their data.

To help answer state-wide water monitoring questions and to support environmental decision-making, it is essential to leverage data from many programs. The SWAMP QA Program developed an umbrella approach to help focus on data and metadata comparability from generation to storage. Some of the quality control (QC) systems that are being used to improve comparability are:

- technical focus groups to address measurement quality objectives (MQOs) and standardization of methods
- involvement of programs and organizations (including Federal) outside SWAMP
- boiler-plate QA/QC language for contracts, audits for laboratories, field work and Regional Board implementation
- formal reviews of quality assurance project plans (QAPPs) prior to sample collection
- transparency of QC systems through standard operating procedures (SOPs)
- special research studies for issues such as holding times or sample container types
- tracking of comparability through corrective action systems
- use of control charts at the programmatic level

A flexible working system has allowed SWAMP to implement these systems in steps and over time. The result is a QA program that promotes comparability and produces data that is useful for environmental decision-making.

The Analysis of Turbidity Data – Establishing the Link Between Sample Characteristics and Measurement Technologies

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Biographical Sketch of the Authors
Michael Sadar is a Senior Application Scientist for Hach Company. He has over 18 years experience in the research, development of turbidity, particle analysis, and imaging technologies and their application for the monitoring of fluids. He is a key consultant when applying the technology of turbidity for the monitoring of environmental waters. He has authored several papers on the science of turbidity and its applications, and currently serves on several ASTM and Standard Methods sub-committees related to turbidity and suspended sediments measurement. Mr. Sadar received his Bachelor of Science degree in analytical chemistry from Colorado State University in 1988.

G. Douglass Glysson has over 35 years of service with the USGS as a hydrologist working at all levels of the Water Resources Division and has served as supervisor and technical manager. Mr. Glysson received a M.S. in Engineering Administration from The George Washington University and a B.S. in Civil Engineering from the California State University, Sacramento. He currently serves as the Chair of ASTM International's Committee on Water and Secretary of the Board of Registration for the American Institute of Hydrology. Mr. Glysson has authored over 35 books, reports, papers, and standards on sediment data collection, analysis, and transport.

Abstract
Turbidity is recognized as a key indicator of water quality. There are many types of turbidity measurement technologies in use, and different technologies can deliver different results for waters with similar suspended-sediment concentrations. Differentiating technological features include: type of light source, type of and number of detector(s), detector angle(s), and path length[1]. Recently, the ASTM high-level turbidity workgroup worked with the USGS to develop a set of traceable reporting units for turbidity technologies[2]. A specific unit represents a unique type of technology, although no numerical conversions between technologies have been promoted[1]. In October 2005, this ASTM high-level task group on turbidity conducted an on-site round robin study.[3] The study had three goals: 1) to identify which technologies consistently generate different versus similar results; 2) to determine the optimum range of measurement for each technology type; and 3) determine the impact that sample preparation had on the analytical results. The round robin involved a total of 21 laboratories that analyzed 28 samples. Samples were of three types: standards (run as unknowns), environmental, and USGS QC suspended-sediment samples. The round robin results showed that many of the turbidity technologies would produce different results. For example on one environmental sample from Kansas, the average NTU reading was 1640 NTU and the FNU meters averaged 1045 FNU. However, a few technologies did consistently produce similar results across the spectrum of samples. This confirms that measurement traceability is valuable when recording turbidity measurements. The optimum measurement range for each technology tested was also identified. Test results show that better agreement among a larger group of technologies was achieved at turbidities below 500 turbidity units. Lastly, the study provided information on key sample preparation techniques that, if practiced with consistency, improved the precision of measurements, with the exception of those samples with high sand concentrations.

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Interstate assessment: Cross-calibration of the Biological Condition Gradient among state monitoring programs in New England

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Jeroen Gerritsen has more than 28 years of experience in aquatic environmental sciences, including basic and applied research, teaching, and assessment. His technical abilities include biological assessment, statistical design and analysis, systems ecology and modeling, ecological risk assessment, limnology, wetlands ecology, estuarine ecology, and stream ecology. He served as a member of a scientific workgroup to prepare guidance for developing nutrient criteria for lakes and reservoirs for US EPA's Office of Water. He was the principal author of two chapters: *Characterizing Reference Conditions* and *Data Analysis*. Current projects include the statistical analysis of biological data for developing TMDLs for impaired streams throughout West Virginia; development of nonlinear decision support models for tiered biological assessment; and data analysis for EPA's National Wadeable Stream Assessment.

Abstract

Multi-state and regional biological assessments are plagued with the issue of incompatibility among state and federal sampling and analysis methods. As part of the New England Wadeable Streams project, USEPA Region 1 and CT, VT, NH, and ME collaborated on a monitoring program using a single regional sampling method side-by-side with each state method. The purpose was to compare the collected benthic stream samples in terms of both sample content and assessment results, where assessment was based on the Biological Condition Gradient (BCG) of the tiered aquatic life use methodology. The EPA regional method sampled from quadrats randomly located in the sampling reach, targeting habitats in proportion to their occurrence throughout the reach. State sampling methods were kick-net samples from targeted riffles and artificial substrates (rock baskets) in riffles. There were distinct taxonomic differences among methods because state methods were restricted to the riffle habitat while the EPA method included all habitats encountered in a reach. Development of the BCG yielded a more consistent assessment than was apparent from the taxonomic differences among methods. The BCG is therefore considered a more universally applicable model for regional assessment of multiple data sets than other approaches, although its initial development is labor intensive.

Four Ways to Get Biased Estimates of Pollutant Loads

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Pete Richards is Senior Research Scientist in the National Center for Water Quality Research (NCWQR, former the Water Quality Lab). The NCWQR operates a research-scale river monitoring program on seven major rivers in Ohio, three smaller rivers in Ohio, and the River Raisin in Michigan. This program has obtained nutrient and sediment samples at frequencies of one to three samples per day for as much as 30 years. The resulting datasets (http://www.wql-data.heidelberg.edu) are widely used for many purposes. One important use is for exploring the interplay between sampling frequency and pattern and success in detecting trends or obtaining accurate and precise pollutant load estimates. Dr. Richards has primary responsibility for interpreting these data, and has worked extensively in the areas of load estimation and trend detection over the last 27 years.

Abstract

Pollutant load estimation often involves combining relatively abundant flow data with relatively scarce concentration data, and integrating the two to obtain an annual load estimate. This is often done using a rating curve, i.e. a regression relationship between flow and concentration (usually both log transformed), to estimate concentrations for days not sampled. The estimated log-concentrations are then back-transformed, multiplied by the flows, and summed to obtain the annual load estimate. This widely used approach can be subject to severe bias of several forms.

ONE form of bias is back-transformation bias. This has been widely discussed in the literature and several approaches to bias correction have been identified.

A SECOND form of bias is important when the correlation between concentration and flow is weak. With decreasing correlation, the regression line rotates toward the horizontal. While the mean concentration is still correctly predicted, the high concentrations are underpredicted and the low concentrations overpredicted. Back-transformation increases the severity of underprediction in the high concentrations, which tend to correspond to the high flows that dominate the loads. Consequently, the most important contributors to the total load are most severely underestimated.

The THIRD form of bias comes from model mis-specification. In some rivers we have studied, the relationship between concentration and flow which characterizes the winter months is different from the one that characterizes the summer. Failure to treat the two time periods separately leads to serious underprediction of the log-concentrations that correspond to high flows, again creating a low bias in the final load estimate.

The FOURTH form of bias results from the simple, but fallacious, practice of calculating an average load as the product of average concentration and average flow. When these are correlated, the resulting load is biased, low if the correlation is positive and high if the correlation is negative.

Site Evaluation and Field Sampling Coordination for National Scale Surveys: Supporting the Probability Design Network

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Jennifer Pitt is employed as an environmental scientist at the Baltimore, MD office of Tetra Tech, Inc. She served as the primary field task coordinator for both the U. S. EPA's National Study of Chemical Residues in Lake Fish Tissue and the U. S. EPA's Wadeable Streams Assessment project. She is now involved in the data analyses, data management, and report writing for both of these national projects.

Ellen Tarquinio has been working for the EPA in the Monitoring Branch since February 2004. Prior to this, she worked for the New York State Department of Environmental Conservation. Other work experience includes research on lobster settlement patterns for the University of Maine, and coral reef assessments with the Center for Marine Resource Management. Ellen graduated with honors from the University of Pennsylvania in 2002.

Abstract

Field sampling for national-scale projects requires close coordination among all of the collaborators, especially when sampling sites are randomly chosen as they are with a probabilistic survey design. Lessons learned from various national-scale projects have helped us to develop an efficient, comprehensive way of organizing and coordinating such a large-scale field sampling effort. A stepwise process to enhance efficiency and minimize false starts includes: mapping procedures to determine access and feasibility, land owner determination, obtaining land owner permission and required permits, site reconnaissance by experienced personnel, and on-site decisions for sampling efficacy. We have found it is crucial to have a central coordinator to oversee all aspects of the field work, from site reconnaissance to sample shipping. A central coordinator will have the big picture in mind at all times, and should be able to delegate work to others while making sure that nothing is slipping through the cracks. Field crew leaders of all collaborators maintain contact with the central coordinator, who disseminates information regarding the disposition of sites, site replacements, field schedules, and alternate plans. The central coordinator maintains complete documentation, and provides a conduit for status reports and planning updates among the full team.

Optical Dissolved Oxygen Sensors Maximize Accuracy, Minimize Downtime

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Rob Mooney is the Surface Water Market Manager for In-Situ Inc., a manufacturer of water quality monitoring equipment. He has over 15 years of experience in the water quality industry, most recently specializing in new product development for Surface Water monitoring applications. Rob began his career as an environmental chemist with O'Brien and Gere Engineers, and he holds a BS in Biochemistry from the State University of New York.

Tony Arnerich is a Senior Chemist for In-Situ Inc., a manufacturer of water quality monitoring equipment. He has over 20 years experience in the analytical equipment industry, and has been with In-Situ as a chemist since 1998. He has contributed in the capacities of research, product design and manufacturing of product lines ranging from mass spectrometry, laboratory robotics, and water quality instrumentation. Tony earned the Bachelor's degree in chemistry from the University of California at Berkeley.

Abstract

There are generally three methods of measuring dissolved oxygen in surface waters: Winkler titration; membrane covered electrochemical sensors; and newly developed optical-based sensors. The optical technology for measuring Dissolved Oxygen (DO) levels in water is quickly becoming well accepted due to its many advantages over membrane sensors, and its close correlation to Winkler titrations. This poster will present a comparison of the various strengths and weaknesses of the current methods, with a focus on accuracy over long-term deployments and reduction in operating costs. Comparative data from impartial studies and evaluations will be presented.

Optical DO sensors rely on lifetime-based fluorescence technology to accurately measure DO levels in-situ. Lifetime-based measurements involve selected substances that can act as dynamic fluorescence quenchers. If a platinum porphyrin complex (lumiphore) is illuminated with a blue LED, it is excited and emits back a red luminescent light with a lifetime that is inversely proportional to dissolved oxygen concentration. Optical sensors are especially accurate below 2 ppm—a range in which most membrane sensors routinely give poor results. When monitoring anoxia in open bodies of water, achieving accurate readings below 2 ppm allows researchers to reliably characterize nutrient-related hypoxic zones. Optical DO sensors do not consume oxygen as part of an electrochemical reaction, and do not require sample flow for accurate readings.

This new optical sensing technology has been proven in multiple field studies to give accurate data over long deployment periods—with minimal maintenance and calibration requirements. Maintenance and material costs are drastically reduced, and site visits are minimized. Data is especially accurate in anoxic conditions with accuracy in normal DO ranges as good or better than traditional membrane sensors. Additionally, sensor response time is faster, and potential for user error is all but eliminated. The methodology has recently been recommended for interim EPA approval.

Achieving Comparability for a Statewide Program through Careful Selection of Quality Assurance and Quality Control Systems

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Beverly H. van Buuren is manager of the Quality Assurance (QA) Research Group at Moss Landing Marine Laboratories (MLML). The QA Research Group consists of six full-time staff members that are currently focused on two large-scale programs: the State of California's Surface Water Ambient Monitoring Program (SWAMP), and the CALFED/California Bay-Delta Authority (CBDA) Mercury Speciation Monitoring and Research Studies. Ms. van Buuren is the QA Officer for both programs, and has designed and taught QA courses for the Northwest Environmental Training Center, the Washington State Department of Ecology, and for project/program-specific applications in the classroom, laboratory and field.

Abstract

The Surface Water Ambient Monitoring Program (SWAMP) was formed in support of Federal Directive AB 982, which mandates that each state develop a comprehensive surface water quality monitoring program. In California, the implementation of such a program is particularly challenging due to diverse geography, disparate monitoring methods, varied regional data uses, and customary budget restraints. During initial planning, The SWAMP Quality Assurance (QA) Team, in cooperation with stakeholders, carefully prioritized the implementation of quality systems that provide a framework for state-wide data comparability. This framework includes the statement of program data quality objectives (DQOs), the creation of key quality documents that support these DQOs, and the ongoing assessment of program contract laboratories and their data.

To help answer state-wide water monitoring questions and to support environmental decision-making, it is essential to leverage data from many programs. The SWAMP QA Program developed an umbrella approach to help focus on data and metadata comparability from generation to storage. Some of the quality control (QC) systems that are being used to improve comparability are:

- technical focus groups to address measurement quality objectives (MQOs) and standardization of methods
- involvement of programs and organizations (including Federal) outside SWAMP
- boiler-plate QA/QC language for contracts, audits for laboratories, field work and Regional Board implementation
- formal reviews of quality assurance project plans (QAPPs) prior to sample collection
- transparency of QC systems through standard operating procedures (SOPs)
- special research studies for issues such as holding times or sample container types
- tracking of comparability through corrective action systems
- use of control charts at the programmatic level

A flexible working system has allowed SWAMP to implement these systems in steps and over time. The result is a QA program that promotes comparability and produces data that is useful for environmental decision-making.

Importance of field QC Samples in Designing Monitoring Programs and Interpreting Data for Trace Elements in Aquatic Organisms

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Lawrence "Rod" DeWeese is a fish and wildlife biologist with the Contaminant Biology Program of the U.S. Geological Survey's biology discipline. Since 1992 he has provided biological support to the USGS National Water Quality Assessment (NAWQA) Program in the central U.S. and also participated in the development and coordination of research projects focusing on contaminant-related effects to aquatic organisms in the Nation's streams and rivers.

Terry Short is an ecologist with the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program. Since 1991, he has served as the Regional Biologist for the western region of the NAWQA program and has participated in the design, implementation and interpretation of aquatic ecological and contaminant studies in streams and rivers throughout the western U.S., Alaska, and Hawaii.

Neil Dubrovsky is the Chief of the Nutrients and Trace Elements National Synthesis team of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program. He has been with the Geological Survey for 20 years, studying ground-water chemistry and designing and supervising large-scale multidisciplinary water-quality investigations.

Abstract
Concentrations of trace elements were determined in composite samples of liver tissue from 52 species of riverine fishes and soft tissue of the Asian clam (Corbicula fluminea). Tissue samples were collected during the period 1992-2000 as part of the U.S. Geological Survey's National Water-Quality Assessment Program. Tissue trace-element concentrations were used as indicators of trace-element occurrence and distribution at over 500 sites in over 40 river basins across the conterminous United States, Alaska, and Hawaii. Either common carp (Cyprinus carpio), white sucker (Catostomus commersonii) or the Asian clam were collected at many of the sites and at a subset of these, two or three replicate samples were collected to estimate the variability of trace-element concentrations within sites. Variation of trace metals in replicates of Asian clam tissue was generally lower than in fish livers, possibly because fish are more mobile, therefore might have more variable exposures to trace metals. Variation of trace metals in replicates of Asian clam tissue was generally smaller for collections made at the same site and time, than for samples collected at the same site but at different times. Variation of trace metals in tissue samples of Asian clams collected at the same site and time was generally lower for three replicates than for two replicates. Programs that monitor trace elements in aquatic biota could benefit from the use of replicates to estimate the variation within sites. This type of information would be needed to conduct statistical treatment of this type of monitoring data. For example, the ability to detect significant differences attributed to either spatial or temporal variation would be diminished if within-site variation was large.

Watershed Stewardship Utilizing GPS Habitat and Bioassessment Surveys

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Abstract

In Contra Costa County multiple groups are working to improve the health of local creeks and watersheds. The Citizen Watershed Monitoring and Assessment program coordinates existing volunteer groups to support a cohesive countywide citizen-based watershed monitoring program. Volunteers are trained to collect physical habitat data with global positioning systems (GPS) and bioassessment data. Volunteers and other stakeholders utilize this data to prioritize future water quality improvement projects. GPS Creek Surveys gather data on vegetation (type, %, invasive species), human disturbances (outfalls, bridges, dams), and channel conditions (substrate, canopy cover, bank composition) all linked to an exact location in order to spatially view and analyze existing habitat conditions. Bioassessment Surveys utilize benthic macroinvertebrates (bugs) to screen for water quality problems. Monitoring the diversity and abundance of aquatic bugs helps determine the biological integrity and overall health of watersheds. Bioassessment surveys provide volunteers and regulators a cost effective method to measure the ability of a water body to support and sustain life. The volunteer collection efforts augment the characterization of watersheds by providing baseline data in order to help prioritize nonpoint source pollution reduction strategies to improve water quality in the San Francisco Bay and Delta regions. This program empowers citizens to be effective watershed stewards by providing skills and tools to diagnose water quality problems. Watershed stewards turn education into action with tangible, scientific data to make well-informed decisions to improve water quality at the watershed scale.

Environmental Monitoring Program Benthic Special Studies

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Abstract

The Environmental Monitoring Program (EMP) was created over 30 years ago to conduct mandated biological, physical and chemical monitoring in the upper San Francisco Estuary (estuary). The main objectives of the EMP are to provide information on the potential impacts of river inflows and the diversion of water, and to provide long-term environmental data for research and analysis. The purpose of this poster is to inform the community about the first of many steps that the EMP is taking to enhance the quality of its benthic monitoring element. We are currently pursuing three special studies, as well as an in-depth program element review. A small scale spatial variability study was conducted between April and July of 2005 to assess the small scale spatial variability of benthic organisms at EMP monitoring stations and to develop recommendations for the possible redesign of the benthic monitoring element of the EMP. A pilot study measuring benthic biomass was also conducted to develop a reliable and efficient protocol to determine the biomass of the benthic samples. This is extremely important because abundance and biomass often do not track together in a population and this data can be used to evaluate the function of the benthic community in the ecosystem and how these functions may affect at risk species. Lastly, a Benthos Bio Guide is being developed in tandem with the benthic biomass study. The Bio Guide will serve as a single, comprehensive resource for researchers and resource managers interested in the taxonomy and life-history information for benthic species in the estuary. The objective of these analyses is to assess how effectively the current benthic sampling regime reflects the composition of benthos in the estuary.

Relations of Hydrologic and Physical Characteristics to Aquatic Assemblages in Low-Gradient Streams in Agricultural Settings in North-Central and Northeastern U.S.

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Jennifer L. Hogan is currently a Fisheries Management Specialist with the NOAA National Marine Fisheries Service in Juneau, Alaska where she assists with managing groundfish collections in the Aleutian Islands and Bering Sea. Prior to joining NOAA, Jennifer served as an ecologist for the U.S. Geological Survey's Illinois Water Science Center from 2003-06 and Texas Water Science Center from 2000-03 where she assisted with the collection, analysis, and verification of biological data for the National Water Quality Assessment (NAWQA) Program's Upper and Lower Illinois River Basins (UIRB/LIRB) and Trinity River Basin (TRIN) and South-Central Texas Basin (SCTX), respectively.

Julie Hambrook Berkman is an ecologist with the U.S. Geological Survey's Ohio Water Science Center. Since 1992 she has worked on a variety of projects assessing environmental characteristics that influence aquatic communities and water quality in our nation's rivers. Her investigations have focused on hydrologic disturbance of the benthic community in response to storms, linkages between nutrients and algal community composition and biomass, and responses of the algal community along land use gradients. She has contributed to the national protocols and to a summary of algal research in the NAWQA Program.

Jonathan G. Kennen is an aquatic ecologist with the U.S. Geological Survey's New Jersey Water Science Center (NJWSC). Since 1995, he has served as lead biologist for the Long Island-New Jersey (LINJ) study unit of the NAWQA Program and as the biological specialist for the NJWSC. Jonathan is involved with many ongoing cooperative research projects aimed at evaluating the effects of urbanization and hydrologic alteration on aquatic ecosystems. Jonathan is currently the Lead Scientist for the NAWQA Program's northeast Major River Basins where he administers a series of projects looking at trends in ecology and water-quality.

Karen Riva-Murray has been an aquatic ecologist with the U.S. Geological Survey's New York Water Science Center since 1991. As lead biologist for the Hudson River Basin (HDSN) and Delaware River Basin (DELR) NAWQA Program studies, her research interests include mercury cycling and bioaccumulation in streams, effects of urbanization on stream ecosystems, occurrence and distribution of contaminants in aquatic biota, ecological effects of landscape fragmentation, and responses of aquatic assemblages to hydrologic alteration and land use change.

Abstract

A multidisciplinary study was conducted to evaluate the effects of hydrology, landscape, and land use on aquatic assemblages in low-gradient, agricultural areas across the northeastern and north-central United States. Hydrologic variables representing five components of streamflow (timing, magnitude, duration, frequency, rate of change) were calculated for 86 sites from The Nature Conservancy's Indicators of Hydrologic Alteration-software program. Using a non-redundant subset of 75 hydrologic variables generated from daily mean streamflow values, cluster analysis produced five major hydrologic classes that varied in landscape, land use, water quality, and algal- and macroinvertebrate-assemblage structure. Sites within the same hydrologic class often were close spatially and had similar land use and geology. In addition, location (east to west) and land use were shown to be highly predictive of streamflow. Differences among the five classes were explained by high- and low-flow predictability, evapotranspiration rates, percent of clay or silt substrates, and road density. Sites in agricultural classes differed greatly, for example, Midwestern agricultural streams were more flashy and had less variable flow than other agricultural classes. Sites within urban classes generally had unpredictable but frequent flooding, short duration of high-flow pulses, and sustained periods of low-flow. Macroinvertebrate-assemblage structure varied among hydrologic classes. The richness of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa was lowest for classes within urban settings. Attributes such as flow predictability, flood predictability, frequency of low-flow pulses, duration of high-flow pulses, and flow per unit area were highly predictive of the structure of aquatic assemblages. A combination of natural (location, geology) and anthropogenic (land use) factors that contribute to these hydrologic processes will be considered in improving the management of agricultural and urban streams in the northeastern and north-central United States.

Validation of a Multimetric Index Using Probabilistic Monitoring Data.

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Larry Willis and Jason Hill coordinate the Virginia DEQ Probabilistic Monitoring Program (ProbMon) and with coauthors George Devlin and Warren Smigo perform most of the design, data analysis and report writing for the program. Larry is a Regional Monitoring Coordinator, Jason is a Regional TMDL Program Coordinator, George is a Regional Biologist and Warren is the biomonitoring coordinator for Virginia.

Abstract

In 2000, EPA contracted Tetra Tech to develop a multi-metric macroinvertebrate index for the Commonwealth of Virginia. This index contains eight core metrics that are collectively known as the Stream Condition Index (SCI). Tetra Tech developed the SCI using Virginia's existing biomonitoring database, which mainly consisted of upstream control sites for use with the Rapid Bioassessment Protocols. Reference sites located in the piedmont ecoregions and headwater streams were limited. Using the probabilistic database (n=215) with data collected from 2001-2004, Virginia has validated the SCI using this spatially diverse (ecoregionally and stream size) data set. This probabilistic data set allowed Virginia to fill the data gaps and the test proposed reference condition by stream size, ecoregion, river basin, regional office, sampling technique and best standard values. The random data has the unique ability to help policy makers preview the amount of streams that will be impaired to help determine assessment guidelines.

The effects of fine sediment accumulation on macroinvertebrate distributions below urban dams

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Steve Fend is a freshwater biologist with the National Research Program, Water Resources Discipline of the U.S. Geological Survey. His area of interest is the application of benthic invertebrate measures to water quality studies.

Jim Carter is an aquatic ecologist with the National Research Program, Water Resources Discipline of the U.S. Geological Survey. He studies the influence of physical and chemical factors on the composition and structure of benthic invertebrate assemblages in streams.

Min Choy is a graduate student at the Yale School of Forestry and Environmental Studies, focusing on water science, policy, and management. She is currently working on a sediment analysis of a small New England dam planned for removal.

Alison Purcell is a doctoral candidate at the University of California, Berkeley in the Division of Organisms and Environment. The focus of her dissertation research is developing indicators to evaluate urban streams in the Santa Clara Basin (San Jose, California, USA). She has trained individuals from over 40 countries in conducting biological and habitat assessments of streams.

Abstract

Of the many effects of reservoirs on stream habitats, accumulation of fine sediments below dams has received remarkably little attention. A prior survey of Santa Clara Valley stream macroinvertebrates indicated that dams have a negative effect on the species composition of downstream sites. Visual habitat observations indicated that fine sediments tended to accumulate downstream of each dam, particularly within the first kilometer. To test whether fine sediment accumulation was influencing macroinvertebrate distributions, six separate streams were sampled for both macroinvertebrates and fine sediment. Three streams had sites located below bottom-release dams and three sites were located on streams without major reservoirs. We used a sealed Hess-type sampler to simultaneously collect macroinvertebrates and a sample of fine bed sediments. Additionally, we tested the ability of in situ turbidity measurements (within the sampling device) to rapidly estimate the amount of fine sediment present in the sampled area. Macroinvertebrate assemblage data were summarized by calculating density, biomass, and commonly used bioassessment metrics. In general, metrics and densities of sensitive taxa were negatively related to fine sediment estimates. The estimated turbidity of the suspended material was correlated with measured fine sediment weight, indicating that rapid field measurements may provide a reasonable estimate of fine sediment for ecological studies. Future studies will include developing both a longitudinal as well as temporal description of fine sediment distribution.

The effects of intra-annual variability on interpreting long-term trends in macroinvertebrate-based bioassessments

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Paul Weissich recently received is M.S. in biology from CSU East Bay. His thesis identified the seasonal effects of dams on lotic macroinvertebrate assemblages.

Abstract
The principal goal of most water-quality monitoring programs is differentiating impaired sites from non-impaired sites. In large-scale water-quality programs this goal tends to be approached within a spatial framework, and determining whether macroinvertebrate distributions vary spatially is emphasized. However, many programs have the less explicitly stated goal of determining whether macroinvertebrate assemblage structure changes over time as well: that is, whether the quality of a site improves or degrades from year-to-year. However, meeting these goals (i.e., determining both the spatial and temporal condition of macroinvertebrate assemblages) with a single study design is problematic. Sampling on an annual or even longer interval is common in large-scale programs. These sampling regimes often lead to sampling periods that extend over several months. Extended sampling periods potentially influence the assessment because of phenological change in the benthic assemblage. To address the question of these effects on long-term variability in common metrics, we collected benthic invertebrates on two temporal scales: biweekly at 6 sites and annually at 8 sites. Within-site, biweekly samples were grouped into 6-week periods (N = 4 collections per period). Annual samples were evaluated for a period of 4 years. The coefficient of variation (CV) in a regional IBI was often greater within a year than among years. For example, within-site, within-group CVs of IBIs based on 6-week sampling periods ranged from 0.7 to 72.7. Among-year annual CVs ranged from 4.7 to 24.4. Therefore, high short-term temporal variability will likely confound the interpretation of long-term variability when evaluating annual or greater changes in benthic assemblage structure. Understanding the magnitude of both short- and long-term temporal variability in metrics derived from lotic macroinvertebrate assemblages is necessary for the design and analysis of long-term water quality assessments.

Probabilistic Monitoring in Oklahoma

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Monty Porter has been with the OWRB since December of 1997. As Streams/Rivers Monitoring Coordinator, he manages all activities related to stream and river monitoring for the OWRB including fixed station monitoring for trends and status, special studies, biological monitoring programs, and stream gaging. He also represents the Board on several state and regional workgroups and committees with activities related to standards development, use assessment analysis, interstate monitoring coordination, and development of standardized field procedures. Monty received a BS in Biology from the University of Central Oklahoma (UCO) in 1994 and an MS in Biology from UCO in 2005.

Jason Childress has been with the OWRB since May of 2004. As the Biological Monitoring Team Leader, he coordinates the probabilistic monitoring program as well as other biological monitoring in support of other programs. Jason is an active member of the American Fisheries Society and has provided technical expertise in the revision of Oklahoma's wadeable RBP. Jason received a BS in Environmental Health Science and Biology from East Central University in Ada, Oklahoma and a MS in Fisheries and Aquatic Sciences from the University of Florida.

Abstract

In the early 2000's, several of Oklahoma's water quality monitoring agencies determined that the inclusion of a probabilistic design in Oklahoma's overall monitoring strategy was a necessity. In 2003, the Oklahoma Water Resources Board (OWRB) took the lead in developing a strategy and securing funding for the program. The top priority was to initiate a statewide probabilistic monitoring program, and a monitoring plan developed by the Oklahoma Conservation Commission (OCC) and the USEPA NHEERL Ecology Group in Corvallis, Oregon, was used as the framework. The initial plan was built around a 5-year monitoring plan using Oklahoma's eleven planning basins as the structural framework and was eventually reworked to include both statewide and various regional estimates. Funding for years 1-3 have been secured through both a CWA 104(b)3 Cooperative Grant from USEPA Region VI and a Regional Environmental Monitoring Assessment Program (R-EMAP) grant from the USEPA Office of Research and Development (ORD). The first year of the study was successfully completed in 2005. The second priority was to develop regional or project specific probabilistic programs. To date, two such programs have been initiated. In 2004, Oklahoma participated in the USEPA's National Wadeable Streams Assessment (NWSA). In addition to monitoring at 19 randomly targeted and 10 non-random reference sites, Oklahoma collected data for both a habitat and benthic macroinvertebrate methods comparability study. Moreover, in 2005, the OWRB received a CWA 104(b)3 Cooperative Grant from USEPA Region VI for a two-year project in Oklahoma's Illinois River scenic river watershed. Using a probabilistic design including over 50 stations, the project's goal is to make watershed estimates of aquatic health using measures of the fish, macroinvertebrate, and algal communities as well as intensive surveys of habitat. The study will provide valuable information about the relationships between periphyton biomass/algal cover and nutrients in Ozarkian streams.

Application of the Reference Condition Approach to Assessing Aquatic Ecosystem Health in Canada's National Parks

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Abstract

The reference condition approach for assessing ecosystem health is based on developing predictive relationships between the biological condition of sites and habitat attributes. In assessing aquatic ecosystems, this approach has been used to establish models linking benthic invertebrate community composition with physio-chemical descriptors. These models allow for a prediction of expected species occurring at any site that is then used to assess the sites' health. The development of these models requires the collection of data of a large array of reference sites that represent the different "normal" conditions in a region. Such models have been established for the Fraser River catchment in British Columbia, the nearshore of the Laurentian Great Lakes, and the Moose River catchment in Northern Ontario. These databases have formed the basis of the Canadian Aquatic Biomonitoring Network (CABIN). A current initiative in Ontario, in collaboration with the Ontario Ministry of Environment and the Ontario Mining Association, is developing a reference database for the Boreal Shield Ecozone. In Atlantic Canada, a database is being established with community groups and three National Parks (Terra Nova, Fundy, and Kejimkujik). In all cases, a standard set of Environment Canada sampling protocols is being used and data are managed by the National Water Research Institute (NWRI). The sampling methods are straightforward and can be easily employed after a short training course. Centralized data management and model development by NWRI scientists allows users of all levels of expertise to apply the approach. Participation by National Parks offers two advantages; to the CABIN program, access to high quality sites that are likely some of the best reference sites in the country, and to Parks Canada, a standardized and rigorous approach to assessing stream health and diversity.

Uranium and 222radon in ground water from glacial and bedrock aquifers in the northern United States

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Abstract
Regional occurrence and distribution patterns of uranium and 222radon were analyzed using data from 1,200 monitoring, public, and domestic drinking-water wells in glacial and bedrock aquifers throughout the northern United States. These data, collected as part of the U.S. Geological Survey National Water Quality Assessment Program, show that uranium and 222radon concentrations vary by source of aquifer materials and exceed drinking-water standards in localized areas. Uranium concentrations greater than 1 microgram per liter (µg/L) were measured in 36 percent of 1,200 ground-water samples. Only 28 samples (2.5 percent) were above the U.S. Environmental Protection Agency's (USEPA) Maximum Contaminant Level of 30 µg/L; 82 percent of these samples were from monitoring wells in glacial aquifers in the western United States, and 18 percent were from domestic wells in the crystalline bedrock aquifers of New England and New Jersey. Uranium concentrations were highest in wells in glacial aquifers that are within sediments derived from predominantly Cretaceous deposits found in north central United States, the glacial aquifers in the Columbia Lava Plateau, and the crystalline bedrock aquifers of New England and New Jersey. High uranium concentrations also correlated with chemical constituents related to agricultural land use raising the issue that some of the uranium may be related to the use of recycled irrigation waters in the north central United States. 222Radon concentrations exceeded the proposed USEPA drinking-water second-option standard of 300 picocuries per liter (pCi/L) in 60 percent of nearly 1,200 ground-water samples. Ground water in bedrock and glacial aquifers in the Northeast, however, had 222radon concentrations exceeding the USEPA drinking-water first-option standard of 4,000 pCi/L. The highest concentration, 215,000 pCi/L, was from a domestic well in an intrusive igneous granite pluton in New Hampshire. 222Radon correlated positively with uranium, lead, and gross alpha in wells in the crystalline bedrock aquifers.

An Assessment of the Chemical, Habitat and Biological Condition of Wadeable Streams in the Lower Columbia Region of Oregon.

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Mike Mulvey is an environmental specialist in the Watershed Assessment Section within the Laboratory Division of the Oregon Department of Environmental Quality (DEQ) with training and experience in aquatic ecology. He has been the coordinator of DEQ's monitoring under the Oregon Plan for Salmon and Watersheds since 1998. Mike has been with the State of Oregon in a variety of monitoring and analytical programs for the last 19 years.

Aaron Borisenko is an environmental specialist in the Watershed Assessment Section within the Laboratory Division of the Oregon Department of Environmental Quality with training and experience in aquatic vertebrate ecology. He has been in charge of field operations of DEQ's Oregon Plan monitoring since 1998. Aaron has been with DEQ in a variety of water monitoring and analytical programs for the last 12 years.

Abstract
We conducted a two-year study of the biological, chemical and habitat quality of first through third order, wadeable streams in the Oregon portion of the Lower Columbia basin. We surveyed 54 randomly selected streams and 17 non-random reference streams in 2003 and 2004 during June, July, August and September using the US EPA Environmental Monitoring and Assessment Program wadeable streams protocol. This region includes the spawning and fresh water rearing habitat of several anadromous salmonids that are listed or being considered for listing as threatened under the Endangered Species Act. It also contains Portland, Oregon's largest city.

We found that the most extensive stressors in wadeable streams were high levels of fine sediment, high turbidity, and warm water temperatures. These stressors impair 30 to 40% of the wadeable stream miles. Water temperature, fine sediment, phosphorus and turbidity were on average significantly higher across the region relative to high-quality reference sites. Although we found stream habitat simplification and alteration were less extensive (<10%), when present these stressors were significant risk factors to the biological integrity of the aquatic vertebrate and macroinvertebrate communities. Habitat simplification and alteration were indicated by decreased amounts of large woody debris habitat, increased proportion of glide habitat, and reduced stream shade relative to reference sites.

We also compared our findings to the 2002 303d List of Water Quality Limited Streams which was compiled using non-randomly selected data. Overall, the 303d List greatly underestimated both the extent and the types of impairment present relative to the probabilistic stream assessment data.

An Assessment of the Chemical, Habitat and Biological Condition of Wadeable Stream Habitat of Threatened Oregon Coastal Coho Salmon

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Abstract

We conducted a six-year study of the biological, chemical and habitat quality of first through third order, wadeable Coho salmon habitat streams in the Oregon Coastal Coho Evolutionarily Significant Unit (ESU). Oregon Coastal Coho are listed as threatened under the Endangered Species Act. We surveyed 129 randomly selected streams and 29 reference streams between 1998 and 2003 during June, July, August and September using the US EPA Environmental Monitoring and Assessment Program wadeable streams protocol.

We found that the most extensive stressors were warm water temperatures, high levels of total solids, high phosphorus and high levels of fine sediment. These stressors impair approximately 40 to 50% of Coho habitat wadeable stream miles. Although low dissolved oxygen, non-native vertebrate species and pH standard violations were not extensive (<10% of stream miles), these stressors were a highly significant risk factor to the biological integrity of aquatic vertebrates and macroinvertebrates when present. Relative to high quality reference sites, Coho habitat streams tended to have higher fine sediment, higher phosphorus, and lower dissolved oxygen. Streams on publicly owned state and federal forests tended to be in the best condition while streams in agricultural areas were in the worst condition. Streams in privately owned forested areas were of intermediate condition.

We also compared our findings to the 2002 303d List of Water Quality Limited Streams which was compiled using non-randomly selected data. Overall, the 303d List greatly underestimated both the extent and the types of impairment present relative to the probabilistic stream assessment data.

Effects of Climate and Hydrology on Biological Traits of Macroinvertebrate Communities in the Central United States

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Jeffrey Mabe is an ecologist with the Texas Water Science Center within the U.S. Geological Survey's Water Resources Discipline. Since 2002 he has served as an ecologist for the National Water Quality Assessment program in the Trinity River drainage. His present research involves investigating the influence of nutrient conditions on nuisance algae growth and stream communities in Central Texas.

Robert Zuellig is an ecologist with the Colorado Water Science Center within the U.S. Geological Survey's Water Resources Discipline. His research has focused primarily on stream insect and fish communities and how they respond and recover from a variety of human induced stressors as well as aquatic insect taxonomy. He is involved with a variety of projects as part of the National Water Quality Assessment Program and with Colorado State University. Currently, he is investigating how dissolved organic carbon, heavy metal pollution and ultraviolet radiation interact to influence stream communities in the Rocky Mountain Region.

Scott Mize is a hydrologist and aquatic ecologist in the Louisiana Water Science Center within the U.S. Geological Survey located in Baton Rouge, Louisiana. Since 2000, he has served as the study unit ecologist, responsible for ecological field studies and data collection for the National Water Quality Program in the Acadian-Pontchartrain Drainages in southern Louisiana. Before working in Louisiana, Scott assisted in ecological field studies in the Upper Colorado River Basin in western Colorado.

Abstract
Water resource development in stream ecosystems or their associated aquifers can often result in reduced flow conditions, especially when combined with drought. Water resource managers are increasingly confronted with the task of delivering water for consumptive uses while also providing adequate stream flow for the maintenance of stream ecosystem functions. As a consequence managers are in need of tools to assist in identifying ecological impacts related to stream flow reduction. Benthic macroinvertebrate surveys are used as an efficient method for assessing aquatic life use impairments in lotic ecosystems, but most traditional invertebrate community metrics were developed to address issues related to water quality and may not be ideal for identifying changes related to flow alteration. We tested the hypotheses that biological traits of invertebrate communities would be related to flow conditions. Specifically, we used analysis of covariance to quantify the relative importance of climate and flow conditions vs. geographic setting on macroinvertebrats biological traits.

For this analysis we selected 106 stream and river reaches from the US Geological Survey's National Water Quality Assessment Program that had both benthic macroinvertebrate data and a continuous hydrologic record. The sites were distributed across 9 states in the central region of the United States and varied in basin size, landuse, and degree of flow modification.

The Indicators of Hydrologic Alteration software was used to evaluate the hydrologic data and help develop metrics that describe the average annual flow conditions. Climatic data were included in the data set to evaluate conditions related to natural flow reductions during dry spells.

A set of 54 macroinvertebrate biological and functional traits developed by the U.S. Geological Survey and Colorado State University was used to assess community differences. Traits covered six general categories: morphology, behavior, modes of resource acquisition, habitat preference, mobility, and life-history.

Low Cost Wireless Remote Monitoring Advancements

Stephen Cone

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Biographical Sketch of Author
Stephen Cone is a Business Development Manager for American Innovations since 2003. He has been involved in the implementation of wireless communications for monitoring equipment located in remote areas in various industries, including water & wastewater, oil & gas, railroad, and many others. He lives in Austin, TX, and travels throughout the US. He is a graduate of Texas A&M University with a degree in Industrial Distribution.

Abstract
Monitoring equipment located in remote or geographically dispersed areas can be a challenging and potentially expensive endeavor. The oldest way to check on remote equipment, still widely used today, is to hop in a truck and drive out to each location to check on it personally. While that can get the job done, it is often an inefficient use of personnel's time, and often does not tell the owner anything about the equipment the other 23 hours and 50 minutes that the equipment is not monitored.

Over the past two decades wireless communications has been implemented for monitoring various types of equipment in remote areas. Radios have been the most often used type of communication, and for certain situations can make the most sense. But radio communications does have its limitations, including distance, line of sight issues, and cost of implementation if towers and repeaters are needed. Not to mention the cost of the monitoring software (SCADA) and its integration with the radios.

Today there are new types of equipment monitors available which can help overcome these obstacles, principally using cellular and satellite communications. Advantages of these types of monitors include:

- The elimination of obstacles such as distance and line of sight
- No need for AC power to run the monitors if solar panels can be used
- 24/7 monitoring with notifications of alarm conditions
- Typically low front end cost
- Low ongoing communication fees
- Presentation of data via the web

Many owners of remote equipment haven't been made aware of such monitoring abilities, or aren't aware of the low costs required to utilize such monitors. But more and more types of monitoring equipment are being developed each year, and it's becoming easier than ever for owners to have full-time monitoring.

Event Monitoring Water Quality of Micro-Watersheds in Southern Alberta Utilizing Real Time ROM Communications

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Lawrence Schinkel is a Senior Monitoring Technologist with Alberta Agriculture, Food & Rural Development (AAFRD). He graduated in 1984 from the Lethbridge Community College in Agriculture with an irrigation major. Lawrence has served as a planning technologist, later moving into the water measurement field. He has been involved with water quality evaluation projects since the mid 1990s and has assisted in setting up instrumentation to collect hydrology monitoring stations since then. He is responsible for the AAFRD Flow Measurement Demonstration and Testing Facility.

Wally Chinn graduated in 1973 from the University of Manitoba with a B.Sc. In Agricultural Engineering and has been employed with the Irrigation Branch of AAFRD in Lethbridge, Alberta Canada in various professional and management capacities for more than 30 years. Currently, as Head of the Irrigation Development Section, project focus is on irrigation demand and risk management modelling for assessments of irrigation growth impacts, climate change adaptation potentials and water-sharing strategies during times of shortage.

Wayne Jamieson is the Manager of Business Development for ROM communications Inc. Wayne is an engineering technologist specializing in telecommunication and instrumentation systems. He has been involved in numerous remote monitoring projects in the water and environmental sector, as well as many oil industry monitoring projects globally. Breaking new ground and providing unique solutions has always been Wayne's design approach. Affordable wireless technology for remote monitoring has been his main focus in the last few years, with complete special system design and "turn-key" deployment.

Abstract

Technology has provided the necessary tools to measure water and monitor the events instantly. Up until a few years ago, field visits were required to effectively acquire data from water quality monitoring sampling stations. The data had to make it from a laptop or palm device to a computer without loss. Monitoring of events was sporadic in trying, for example, to collect samples from surface runoff events. Special research projects across Alberta are now equipped with these water quality monitoring facilities, as components in assessing and quantifying hydrological runoff in agricultural areas.

Emerging technologies such as real time web-based data access (such as provided by ROM Communications) has allowed monitoring via the internet with alarms to pagers, computers and cell phones. Up until approximately 5 years ago, the technology was very expensive or non-existent. Instrumentation has evolved from daily manually-observed staff gauge readings, to paper recorders, then to electronic data loggers, and in the early 1980's to ultrasonic water level sensors. Now, real time instrumentation provides almost instantaneous information regularly updated for viewing and archiving data through the internet. The water-sampling technology has changed from manual grab sampling to automated continuously available sampling with alarm notification potentials of every 15 minutes. The water quality samples need to be transported to the analysis laboratory within 24 hours so timing is critical. Notwithstanding the growing pains of such components as programming, cellular phone network limitations, alarm limits and the like, the rewards of instant access to specific and detailed data information are the main benefits.

Evaluation of Blood as a Surrogate for the Monitoring of Mercury in Largemouth and Smallmouth Bass Muscle Tissue

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William G. Brumbaugh, Ph.D., Environmental Chemistry, has conducted research at the U.S. Geological Survey's Columbia Environmental Research Center since 1978. His primary research interest is the development of analytical methods for assessing the cycling and bioavailability of toxic trace elements in water, sediment, and biota. He was a co-investigator of the former USFWS National Contaminant Biomonitoring Program and of the USGS National Water Quality Assessment Program's national mercury monitoring pilot project. He holds two patents for passive sampling devices for trace metals, and has authored or co-authored over 50 publications in peer-reviewed scientific journals.

Christopher J. Schmitt, M.S., Fisheries Biology, has conducted research at the U.S. Geological Survey's Columbia Environmental Research Center since 1978. His research is focused on the design and implementation of monitoring studies and programs; validation of biomarkers and bioindicators for use in environmental monitoring; and the investigation of mining-related impacts on aquatic and terrestrial biota. He coordinated the fish component of the USFWS National Contaminant Biomonitoring Program and contributed to the design and implementation of the USGS Biomonitoring of Environmental Status and Trends program. He has authored or co-authored more than 120 peer-reviewed reports, journal articles, and book chapters.

Donald E. Tillitt, Ph.D., Environmental Toxicology, is Chief of the Biochemistry & Physiology Branch at the USGS Columbia Environmental Research Center. His areas of expertise include effects of nutrition and xenobiotics on the development of larval fish and the health of adult fish. His current focus is on early life stage toxicity in fish, reproductive toxicology in fishes, in vitro bioassay development, biochemical mechanisms of toxicity, and monitoring of fish health in the environment.

Abstract

The USEPA water quality criteria for methylmercury is currently expressed as a fish tissue residue because water concentrations are usually extremely low and the prediction of fish tissue concentrations based upon bioaccumulation factors is not always accurate. Fish sampling has consequently become the primary means of monitoring mercury (Hg) in the environment. Large fish are often monitored the most intensively because they usually have the greatest concentrations and pose the greatest risk for human consumption. However, the practice of sacrificing large numbers of mature, recreationally-important fish is becoming increasingly unpopular, prompting investigations of non-lethal sampling approaches. Accordingly, we conducted a preliminary investigation of blood sampling as a minimally-invasive approach for monitoring and estimating Hg concentrations in fish tissue. We sampled whole blood (0.5 ml) and axial muscle ("skin-off" fillet) from adult fish that included 41 largemouth bass (LMB) collected from three rivers in northeastern Florida and 62 smallmouth bass (SMB) from four streams in the Ozarks

region of southern Missouri. All samples were freeze-dried and analyzed for total Hg by combustion-amalgamation atomic absorption spectrophotometry (EPA method 7473). Blood-Hg concentrations were strongly correlated with fillet-Hg concentrations; Pearson r values were 0.96 for Florida LMB and 0.93 for Ozark SMB ($p < 0.0001$ for both). Blood-Hg concentrations were more than ten-fold lower than fillet concentrations (dry weight basis), but method precision was similar (2.4% RSD for blood; 2.2% RSD for fillet). Regression analysis of LMB and SMB data combined indicated that a blood-Hg concentration of 0.015 ± 0.005 µg/mL (mean ± range) was associated with the EPA human health criteria fillet-Hg concentration of 0.30 µg/g wet wt. These results indicate that blood sampling shows promise for monitoring and for estimating Hg in fish tissue, but additional assessments are needed for different species of fish, waterbodies, and geographic regions.

Evaluating Nitrate Sources in Nested Agricultural Sub-basins Using Nitrate Stable Isotopes

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Moon Kim is a hydrologist with the Indiana Water Science Center and has worked on various aspects of the National Water-Quality Assessment (NAWQA) Program including data collection and analysis since 1994. He is currently the Geographical Information System and National Water Information System specialist for the NAWQA program in Indiana.

Cecily Chang is a native Californian who joined the USGS in 1980. She is part of the National Research Program and has published papers about nutrient and trace metal interactions in Lake Tahoe, the San Francisco Bay, and the application of stable nitrate isotopes to determine sources and transformations of nitrate in forested watersheds, the Mississippi River Basin, and rivers draining areas with multiple land uses.

Abstract
According to the U.S. Environmental Protection Agency nutrient enrichment is the second leading cause of impairment in streams in the United States. To provide environmental managers with nutrient source and transport information, the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program conducted a multi-component study in Sugar Creek Basin, Indiana, in which nutrients, major ions, and pesticides were analyzed. Land use at Sugar Creek (246 square km basin) is dominated by row crop agriculture, primarily corn and soybeans. The soils are largely heavy clay of glacial till origin, and require tile drains to move excess water and make the land farmable. Samples were collected most intensively from Leary-Weber Ditch, a 6.2.square km basin is nested within Sugar Creek Basin. Water samples were collected in 2003 and 2004 from major environmental compartments involved with the movement of nutrients into the ditch, (precipitation, tile drain, and overland flow). As one component of the study, stable isotopes of nitrate (N-15 and O-18) were used to examine nitrate sources and transport, and possible transformations of nitrate. Storm samples were collected bracketing four distinct periods of the agricultural cycle: pre-application of fertilizer, post-application of fertilizer, growing season, and post-harvest. Nutrient samples (dissolved nitrate, dissolved ammonia, orthophosphate, and total phosphorus) were also collected between storm events during baseflow conditions. Preliminary water-quality data indicate that tile drains are the primary pathway for nitrate movement to the ditch and little interaction occurs between the ground water and surface water interface. Nitrate stable isotopes will enable us to determine the relative contribution of nitrate sources, such as fertilizer, soils, and atmospheric deposition to tile drains, Leary-Weber Ditch and Sugar Creek. Initial results indicate that stable isotope analysis can track changes in these sources throughout a storm and over a growing season.

The Sensitivity of Whole-Stream Metabolism Calculations to Measurement Errors

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Jerad Bales is a hydrologist with the USGS and conducts research and investigations in rivers, reservoirs, estuaries, and coastal systems to address effects of management actions on flow and water-quality. He has participated in and provided consultation on hydrodynamic and water-quality modeling projects in more than a dozen states, served on numerous interagency review panels, and is currently working with NOAA on a flood forecasting – flood mitigation project in India. Bales has authored or co-authored more than 100 articles and technical reports, and was primarily responsible for the river network monitoring design of the proposed National Monitoring Network.

Mark Nardi is a geographer with the USGS, working primarily with the USGS Potomac Delmarva National Water Quality Assessment Program. In addition to providing computer programming support for a variety of applications, Nardi's primary interests are in application of waveform-resolving LIDAR and hyper-spectral techniques to map vegetation communities in Coastal Plain environments. He also supports mapping efforts of the Delaware Geological Survey through a USGS Mapping Partnership Office. Prior to coming to the USGS in 1999, Nardi worked for the Kent Conservation District in the area of stream restoration.

Abstract
Nutrients long have been identified as an important water-quality issue. The relation between nutrients and primary productivity in streams and rivers, unlike lakes and reservoirs, is poorly understood because of the variety of physical, chemical, and biological processes in these systems.

The U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program is conducting field studies in a variety of settings at more than 200 sites across the Nation to investigate the effects of nutrient enrichment on stream ecology. Determination of the interrelations among nutrient conditions, algal communities, and stream metabolism is an important component of these studies. Methods for calculating metabolism from *in situ* data are fairly well known, although there is no standard set of procedures for all aspects of the calculations. In order to rapidly calculate and archive stream metabolism at the large number of study sites, the Stream Metabolism Program software was developed. Data used to compute metabolism include a time series of *in situ* dissolved-oxygen, temperature, and photosynthetically active radiation, depth, wetted area, stream slope, reach travel time, discharge, and the reaeration rate coefficient, which can be computed using empirical relations or entered directly from field measurements.

The Stream Metabolism Program was applied using data from stream sites in Nebraska, Maryland, Georgia, and Washington, and the effects of errors in the various measured values on calculated stream metabolism was investigated. The sensitivity of metabolism calculations to measurement errors was dependent on the magnitude of the diel dissolved-oxygen fluctuation. Metabolism calculations also were sensitive to errors in reach travel time and the reaeration rate coefficient. These results can be used to better plan field metabolism experiments, and to give guidance on the uncertainty that might be expected in metabolism estimates as a function of field measures and parameter estimation.

The Use of Geo-Informatics and Remote Sensing Techniques for the Assessment of Oil and Gas Pipeline Spills

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Mr. Subijoy Dutta is a registered professional engineer (P.E.) in several States. He has recently authored a book, "Environmental Treatment Technologies for Hazardous and Medical Wastes – Remedial Scope and Efficacy", published in March 2002 by Tata McGraw Hill Company. Mr. Dutta has over 15 years of experience in Remedial Investigations, Feasibility Studies (RI/FS), Remedial Design, and Remedial Actions (RD/RA) pertaining to the RCRA and CERCLA regulations. He also provides expertise in the treatment, storage and disposal aspects of medical waste.

Abstract
This paper addresses remote sensing system applications for oil and gas pipeline security assessment. A variety of advanced technologies are available to enhance planning, design, management, operation, and maintenance of oil and gas pipeline systems. Aerial and satellite remote sensing integrated with GIS represents is one area that can be leveraged to assist pipeline risk assessment in assuring the safety of pipeline facilities. Industrial and scientific advances in airborne and satellite remote sensing systems and data processing techniques are evaluated for application opportunities to more effectively meet oil and gas pipeline mapping, safety and security needs. Hyper-spectral sensor data analysis is used to detect and characterize oil and gas leaks in the environment from remote sensing platforms. Automated change detection within a defined sector is another example of analysis capability that will assist in detection of unauthorized intrusion events onto oil and gas pipeline right of ways. Pipelines often cover thousands of miles and are located in remote areas that are difficult and expensive to monitor. In one case study satellite imagery and target identification analysis is used to detect unauthorized intrusion onto a pipeline right-of-way in a remote area of Canada.

Technological advances in handheld computers and the impact on data collection and processing.

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Sandra Kinnaman is a Hydrologist in the U.S. Geological Survey, Florida Integrated Science Center, Orlando, FL. She came to the USGS in 2000 from working as an environmental consultant. During her time at the USGS she has been involved with an evapotranspiration study relating to the Greater Everglades Ecosystem Restoration in addition to authoring the semi-annual publication of the potentiometric surface map of the Upper Floridan Aquifer since September 2001. In 2003 she was tasked with overseeing the data collection and quality assurance of ground water and rainfall data collected by the Hydrologic Records Section within the central Florida region.

Abstract

Recent advances in handheld field computer technology have had great impact on data collection techniques and data processing. Data collection, quality assurance (QA), and data input to databases, such as the U.S. Geological Survey's (USGS) National Water Information System (NWIS), become almost seamless.

An example is an application developed by the USGS called Multi Optional Network Key Entry System (MONKES). MONKES is a series of programs for ground-water data entry and processing using handheld computers. MONKES1 is a ground-water levels program designed to input and process ground-water level measurements. MONKES2 is designed to input site information for site schedules.

The USGS, Altamonte Springs, Florida office is currently using MONKES1 for the data collection and data transfer of water levels routinely measured in approximately 35 observation wells throughout central Florida. The time savings achieved by using the MONKES1 program on a small scale is 2-3 hours per month. It is the goal of the Altamonte Springs office to expand its use of MONKES1. Each May and September approximately 650 water levels are measured in 1 week, in 36 counties throughout central Florida and southeast Georgia. The water levels are used to generate potentiometric-surface maps of the Upper Floridan Aquifer following the dry and wet seasons. The current QA procedure is to check each measurement and then manually enter the data into NWIS. The process takes 1-2 hours per county, or 40-45 hours per map. Data processed in MONKES1 are automatically checked for mathematical errors and are compiled into an output file that can be loaded as a multi-well batch file into NWIS. The use of MONKES1 with the semi-annual potentiometric-surface map is expected to reduce the QA/data input portion to about 15 minutes per county, or less than 10 hours per map.

The advances in handheld computer technology can reduce data processing time from days or weeks to hours by eliminating redundancy while increasing accuracy and efficiency.

Improvement of water quality monitoring by onsite and automatic monitoring

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Abstract
All actors of water management have to face with the design of water quality monitoring programme. When, where and how make samples and measurement? The answers must consider the economical aspect and the quality of information required. In complement to the classical methodology of sampling and laboratory analysis, the use of on site alternative measurements and remote sensing devices can be a way of improvement. This approach is the heart of the on-site and automatic measurement (OSAM) procedure, which is coupled with grab or integrated sampling and laboratory analysis. On site measurement of temperature and dissolved oxygen is often carried out while sampling, because of the rapid variation of this parameters with conservation and transportation. These measurements are completed with conductivity and UV spectrum acquisition, this last giving estimation of suspended solids, nitrate and organic carbon concentration by spectrum deconvolution. Automatic measurement of these parameters is possible with a compact water quality monitoring system, coupled with an autosampler and a rain gauge. This device is located for example in the downstream control point, and sends remote results either by internet or phone. In case of alarm or at any time, remote actions can be made for measurement or sampling. The main advantages of the OSAM procedure are the following : - Optimization of sampling and analysis by quickly checking the relevance of location of control points and monitoring frequency; - Limitation of experimental errors due to samples aging; - Exploitation of trends in results evolution for early warning in vulnerable area. An application for the design of the Magog river quality monitoring programme, in the area of Sherbrooke, Southern Québec, Canada, will be presented. The use of the OSAM procedure has led to the reduction of number of critical control points and to the proposal of a simple and versatile monitoring programme.

Towards a new procedure for wastewater discharge survey

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Abstract

The evaluation of the impact of a wastewater (even treated) discharge in a natural water body is often based on the analysis of specific or aggregate parameters carried out on a grab or integrated sample. Physico-chemical and biological parameters such as total phosphorus, suspended solids, organic matter (COD, BOD or TOC), fecal coliforms or biotic index are determined in lab. These analyses are often expensive and the delay for results is important. It means that real-time accident detection is not possible and the survey of discharge in a river monitoring is thus often neglected. The procedure proposed can be applied on site. It is namely based on the exploitation of UV spectra, used as a fingerprint for water quality characterisation, and on inhibition test. This study will present the general procedure, integrating biological and physico-chemical techniques. Thanks to the exploitation of UV spectrum of water sample given by a field portable system, it is possible to get information on: - the discrimination between anthropic and natural organic matter, - the calculation of an index associated to the impact degree of a discharge on a natural water, - the estimation of specific (nitrate) and aggregate parameters (TSS, TOC). An application of the procedure on several wastewater discharge types in river will be presented. Depending on the treatment type and efficiency, and on the hydrological characteristics of the river, the impact can be from very weak to important.

Use of *In-Situ* Amendments to Reduce Ecological Risk from Metals Contaminated Sediments

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David is an environmental chemist with Neptune and Company at their Los Alamos office, where he has worked since 2000. He has directed and supported the design, implementation, and interpretation of technology evaluations since 1988 with the US EPA, DOE, NASA and private industry. His interests include quality assurance, analytical method development, chemical modeling, and utilization of innovative remediation technology.

Greg McDermott is an ecologist and ecological risk assessor for Neptune and Company in Fairfax Station, VA. Greg's efforts focus primarily on assisting clients with evaluation of risk posed by contaminated soils and sediments. Mr. McDermott has provided ecological expertise to a variety of state and federal agencies, including DOE, and DoD (multiple U.S. Navy facilities across the U.S). Mr. McDermott has 18 years of experience in managing environmental problems, including application of the Data Quality Objectives process to environmental data collection, data interpretation and information management; technical research; and report writing and environmental policy and guidance support.

Dean Neptune is a Principal with Neptune and Company, Inc and served as President for over 15 years. Dr. Neptune has over 35 years of experience in the environmental field with the US EPA, DoD and private industry.

Abstract
Two pilot demonstration projects have been conducted to assess the efficacy of using wastewater treatment biosolids and/or calcium phosphate (apatite) to reduce ecological risk from metals contamination in sediment via *in-situ* sequestration. Five 100 ft^2 experimental plots were constructed at two locations. Mattawoman Creek adjacent to the site of a former zinc recovery furnace at Indian Head Naval District Washington Indian Head, Maryland was the site of the first location. Chopawamsic Creek was the site of the second location where only apatite was used. Chopawamsic Creek is across the Potomac from Indian Head and is located at Marine Corps Base Quantico (MCB Quantico) in Quantico, Virginia. Using the Data Quality Objectives process, an experimental design was developed that entailed five plots for each location. At each site three 100 ft^2 contaminated test plots were established with two uncontaminated control plots of similar size established upstream of the contaminated test plots. Two of the contaminated plots and one of the uncontaminated plots were then amended, via mechanical mixing, with biosolids and/or apatite. After four months, sediment from all plots was resampled for analysis of pore water orthophosphate and metal concentrations. Laboratory bioassays were conducted to evaluate acute and chronic toxicity of the post-amendment sediments to the amphipod *Hyalella azteca*. Bioaccumulation of the metal of interest (zinc or lead) into the oligochaete, *Lumbriculus variegates,* was also measured in a 28-day bioassay. Improvements in pore water metal concentrations as well as amphipod growth and oligochaete bioaccumulation was observed at both locations. There was no evidence that either amendment increase the concentration of ortho-phosphate. These demonstration projects indicate *in-situ* application of these amendments can significantly reduce the toxicity of metal contaminated sediments.

What's in a CUP of British Columbia Surface Water?

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Coreen Hamilton is an analytical chemist at Axys Analytical Services Ltd. She has been involved in the application of organic analyses to environmental monitoring for over twenty years. She has been responsible for the implementation of many routine procedures in the Axys labs as well as a variety of analytical method development projects.

Abstract
In fall 2003, Environment Canada initiated a pilot study to identify and quantify levels of Current Use Pesticides (CUP) in aquatic environments across Canada. In British Columbia, surface water was collected from areas with primarily urban, agricultural, or mixed urban and agricultural activity, as well as from areas considered undisturbed (limited anthropogenic activity). Sampling sites were located in two regions of the province: the Okanagan Basin and the Lower Fraser Valley. Analytical techniques developed at AXYS Analytical Laboratories required minimal sample volumes (1 L), thus enabling use of a simple sample collection method. The AXYS methods employ gas chromatography with high resolution mass spectrometric detection and routinely achieve nanogram per litre detection limits for up to 46 CUP. Samples collected from agricultural areas had as many as 43 CUP with concentrations ranging from 0.001 ng/L (multiple pesticides) to 12,500 ng/L (diazinon). Although concentrations were not as high as the levels measured at the agricultural sites, the urban sites had up to 34 CUP detected (ranging from 0.002 to 90 ng/L), and the undisturbed sites had as many as 18 CUP (ranging from 0.001 to 0.972 ng/L). Our findings show that Current Use Pesticides are routinely found in the surface waters of British Columbia.

Linear Regression of Water Quality Data with Nondetects - A New Method

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Dennis Helsel is a research geologist with the USGS and author of the textbook *Nondetects And Data Analysis: Statistics for Censored Environmental Data*, published by Wiley (2005). For years his research has focused on practical methods for interpreting environmental data. In 2003 he received the Distinguished Achievement Award from the American Statistical Association's Section on Statistics and the Environment, for both his research and training courses on applied statistics.

Abstract

Water quality data often contain nondetect values, concentrations below one or more detection/reporting limits. These values make it difficult to apply standard regression methods. Substituting artificial values such as one-half the detection limit for nondetects prior to regression causes documented problems such as large biases, or incorrect decisions of whether regression slopes are significant. A new method to estimate a central line based on the Theil-Sen slope estimator, related to Kendall's tau correlation coefficient, is presented here. This method computes the median of all pairwise slopes between points in the dataset, including points whose values are nondetects. The method allows censoring in both the X and Y variables, unlike maximum likelihood estimation (MLE), the standard parametric procedure for censored regression. MLE allows only the Y variable to contain nondetects. The new method is similar to a previously-published nonparametric method by Akritas, but can be computed using commercially-available software for survival analysis, and so is more accessible to most water-quality scientists than is Akritas' method.

Real-Time Monitoring of Organic Carbon and Selected Anions in the Sacramento/San Joaquin River Delta System

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David Gonzalez is a senior environmental scientist and supervisor of the MWQI Field Support Unit. He has over 16 years experience in designing, implementing, and managing field projects and studies for the California Department of Food and Agriculture and the Department of Water Resources and has authored and coauthored numerous reports and publications for these agencies.

Steven San Julian is an environmental scientist with 5 years experience with the Municipal Water Quality Investigations Program of the California Department of Water Resources. He has been instrumental in the design and development of sample delivery and filtration systems, analytical instrumentation operation and maintenance of the field stations, and the quality control/quality assurance of real-time data.

Arin Conner is an environmental scientist and has been with the Department of Water Resources since 1996 working as a water quality biologist and on drinking water quality projects with the MWQI program. Additionally, he has worked as a private consultant on endangered species surveys, and water runoff and erosion studies.

Jaclyn Pimental is an environmental scientist for the Department of Water Resources in the Office of Water Quality. She has 5 years experience with DWR working on quality control/quality assurance and water quality monitoring.

Abstract

Historically, continuous monitoring of water quality has been limited to parameters such as temperature, electrical conductance, and turbidity. The growing availability of process analyzers has expanded the range of parameters that can be monitored and has increased the frequency of measurements. When combined with the Internet, process analyzers allow real-time access to high frequency water quality data that allows utilities, resource managers and researchers real-time access to a broad range of critical water quality parameters to improve operational decisions, track changes over time, and populate water quality models. The California Department of Water Resources has installed a network of organic carbon and anion analyzers to provide real-time monitoring of total and dissolved organic carbon and anions such as bromide, chloride, and nitrate at key points in the Sacramento-San Joaquin Delta and at the head-works of the California aqueduct on the State Water Project. These analyzers perform continuous measurements using wet chemical oxidation (Sievers TOC 900), catalyzed combustion (Shimadzu TOC 4100), and liquid chromatography (Dionex DX-800). The organic carbon and anion data are recorded on dataloggers, telemetered to a central database via networked computers, and published on the Internet. Focus will be given to the development and function of sample delivery systems, analytical instrumentation operation, data collection and dissemination, QA/QC procedures and data, and a brief look at system reliability and estimated operating costs.

Characterization of Streamflow Requirements for Habitat Restoration, Upper Salmon River Basin, Idaho

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Terry Maret is a Biologist for U.S. Geological Survey, Idaho Water Science Center in Boise, Idaho. He is an American Fisheries Society Certified Fisheries Scientist, specializing in riverine habitat studies and aquatic ecological investigations. Since 1992, he has been the lead biologist in two National Water Quality Assessment Programs including the upper Snake River and Northern Rockies study units. Prior to joining the U.S. Geological Survey, he worked for the Nebraska Department of Environmental Control and Idaho Department of Environmental Quality on a variety of surface water programs. Throughout his career he has been involved with developing biomonitoring programs for both state and federal agencies. For the past 3 years he has been evaluating instream flow needs for ESA-listed fish species in the upper Salmon River Basin of Idaho.

Abstract

Historically, the upper Salmon River Basin in central Idaho provided migration corridors and significant habitat for Chinook salmon, steelhead trout, and bull trout. Human development has modified the original streamflow conditions in many streams of this basin. Habitat and streamflow information were collected for the Physical Habitat Simulation (PHABSIM) model, a widely applied method to determine relations between habitat and discharge requirements for fish species and life stages. Continuous streamflow data were collected upstream from all diversions to characterize the natural hydrograph. In addition, natural summer streamflows were estimated for each study site using regression equations derived from watershed characteristics. PHABSIM results are presented for target species over a range of summer streamflows for juvenile, adult, and spawning life stages at study sites. Adult fish passage and discharge relations are evaluated at specific transects identified as a potential low-streamflow passage barriers. Continuous summer water temperature data for selected study sites are summarized and compared to temperature requirements of targeted fish species. Model results can be used by resource managers to guide habitat restoration efforts in the evaluation of potential fish habitat and passage improvements by increasing streamflow.

Regional-scale sources, transport, and sinks of dissolved solids in water resources of the Southwestern United Sates

By David W. Anning[1], Nancy J. Bauch[2], and Steven J. Gerner[3]

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David Anning has been a hydrologist with the U.S. Geological Survey Arizona Water Science Center since 1991, and has performed investigations of water use, water availability, and water quality in Arizona and in the Southwestern United States. David attended the University of Arizona where he received a B.S. in Geosciences in 1991 and an M.S. in Hydrology in 2002.

Nancy Bauch has been a hydrologist with the U.S. Geological Survey Colorado Water Science Center since 1994 and has performed investigations of water quality and fish contaminants in Colorado and the Nation. Nancy received B.S. degrees in Forestry and Geology from Virginia Tech in 1979 and 1982 and a M.S. in Environmental Science, Water Resources concentration, from Indiana University in 1993.

Steven Gerner is a hydrologic technician with the U.S. Geological Survey. He has worked in the Utah Water Science Center since 1991 collecting hydrologic, water quality and biological data as well as performing water-quality investigations throughout Utah.

Abstract

The U.S. Geological Survey's National Water-Quality Assessment Program has launched a regional study to understand the sources, transport, and sinks of dissolved solids in water resources of the Southwestern United States by using a spatially referenced regression model of dissolved-solids transport on watershed attributes (SPARROW). The model is based on a stream-reach network and relates annual loads of dissolved solids in a given reach to the catchment characteristics of that reach as well as of contributing upstream reaches. Monitored stream-load data and associated catchment characteristics for 315 reaches are being used to calibrate the model. Predictions from the calibrated model provide estimates of (1) loading to reaches from natural and human sources within reach catchments, (2) transport of instream loads from upstream to downstream reaches, and (3) losses from stream reaches that are delivered to sinks. The amount of dissolved solids delivered to each reach is determined by the characteristics of potential sources, such as the total area of irrigated land and the area of geologic units. Loading rates from different types of sources vary spatially with catchment characteristics that affect land-to-water transport, such as annual runoff, air temperature, soil permeability, drainage density, and vegetation types. Instream loads delivered to each reach from upstream reaches and from reach-catchment sources are transferred to downstream reaches, minus any losses to sinks along each reach. Reach losses of dissolved-solids loads occur as a result of streamflow infiltration or diversions. Identification of major source and sink areas in the Southwest was determined through a spatial analysis of total deliveries from all catchment sources and total losses for each reach.

Nitrate in Ground Water: Using a model to simulate the probability of Nitrate Contamination of Shallow Ground Water in the Conterminous United States

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Kerie J. Hitt is a Geographic Information Systems (GIS) specialist with the National Water-Quality Assessment (NAWQA) Program in Reston, Virginia, and provides technical support for national studies of nutrients in ground water. She develops and applies ancillary spatial data on factors that influence water quality. Ms. Hitt joined USGS in 1981 and has been with the NAWQA Program since 1991.

Bernard T. Nolan is a ground-water specialist for the National Water Quality Assessment (NAWQA) Program. He has worked in the area of nutrient data synthesis and interpretation since 1995. He assesses aquifer vulnerability to contamination through modeling and spatial analysis of water-quality data, soil and aquifer properties, and land-use characteristics.

Abstract
The U.S. Geological Survey has collected information on nitrate and other water-quality constituents in 51 major river basins and ground-water systems across the Nation. Ancillary information on hydrology, land and chemical use, and natural features also has been compiled to help explain observed water quality and why some areas are at higher risk for contamination than other areas.

To estimate nitrate occurrence at unmonitored sites, a logistic regression model of the probability of nitrate contamination of shallow ground water (typically 5 meters deep or less) was developed. This approach relates the probability that nitrate concentration exceeds a certain threshold (4 milligrams/liter as nitrogen) to the natural and human factors that influence nitrate concentrations. The outcome predicted by the model—the probability of nitrate contamination—is made by associating nitrate measurements with known nitrogen input sources, land use, and soil and aquifer characteristics, which together control the amount of nitrate applied to the land surface and transported to ground water. The model was calibrated using measured nitrate concentrations in 1,280 wells sampled in 20 study areas during 1992–95. The model results were validated by comparing model predictions to additional nitrate data measured in 736 different wells sampled in 16 other study areas during 1996–99. The model correctly simulated nitrate status in 75 percent of the wells used for validation, indicating that the model fits the data well.

The six variables (depicted in maps) that most influence the probability of nitrate contamination of shallow ground water are nitrogen fertilizer applications, agricultural land use, population density, well-drained soils, depth to seasonally high water table, and unconsolidated sand and gravel aquifers. A national map of the probability of nitrate contamination highlights areas where intense agricultural activity and high aquifer susceptibility coincide, such as the upper Midwest and the irrigated West.

Modeling the Fate of Particle-Associated Contaminants in San Francisco Bay, CA

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Abstract
Understanding the long-term fate of contaminants in San Francisco Bay is one of the primary objectives of the Regional Monitoring Program for Trace Substances (RMP). Many contaminants of interest are known to associate with sediment particles and follow sediment transport pathways. These sediment transport pathways are currently not well understood, thus prompting the RMP, in collaboration with the USGS, to include a sediment transport component. Conceptual models developed from these monitoring activities aid in the development of numerical transport models of varying complexity. Currently, contaminant modeling efforts are focused on polychlorinated biphenyls (PCBs), which are of high regulatory priority in San Francisco Bay and the subject of a TMDL. A spatially explicit multi-box mass budget model of PCBs was developed to improve understanding of their long-term fate in the Bay. The model is capable of accounting for external inputs from various transport pathways: runoff from the Central Valley via the Sacramento-San Joaquin River Delta, runoff from local Bay Area tributaries, atmospheric deposition, and municipal wastewater effluent. Model results will greatly improve our understanding of the fate of PCBs, and sediment associated contaminants in general, in the Bay and help evaluate current and potential contaminant management strategies.

Optimization of Water Quality Monitoring in Biscayne Bay, Florida

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Carlton Hunt is a Research Leader in Battelle's Duxbury, MA office where he applies his chemical oceanographic and ecological background to estuarine and coastal assessment, monitoring, and remediation projects. He currently provides support to the South Florida Water Management District, Massachusetts Water Resources Authority, US Army Corps of Engineers, and US EPA.

Steve Rust is a Senior Research Leader in Battelle's Columbus, OH office where he applies statistical theory and methodology to research problems related to information systems, engineered systems, human health, and the environment. He currently manages a Battelle-funded effort to develop standard bioinformatic analysis procedures and tools to be applied by Battelle scientists when analyzing genomic, transcriptomic, proteomic, and metabolomic data and supports the National Institute of Child Health and Human Development in probability-based sampling and convenience sampling designs.

Jennifer Field is Principal Research Scientist in Battelle's West Palm Beach, FL office where she applies her biological and statistics background to ecological issues associated with essential fish habitat assessments, threatened and endangered species assessments, and environmental impact statements. She currently supports the South Florida Water Management District, US EPA and the US Army Corps of Engineers.

Fred Todt is Research Scientist Battelle's Houston, TX office where he applies statistical theory to experimental design, response surface methodology, and nonlinear regression techniques. He provides develops statistical algorithms in support of the pipeline safety and the airline industries.

Abstract

With over 1,500 water quality monitoring sites that span a wide variety of ecosystems, the South Florida Water Management District is continuously challenged with providing the resources needed to accommodate diverse water quality data needs. The monitoring is driven by a diverse set of mandates and objectives, which must be accomplished under the constraint of priority initiatives supported by limited resources. Optimizations of seventeen water quality monitoring projects, including two monitoring programs concurrently conducted in Biscayne Bay, were conducted with a goal of reducing operating costs and improving service, while ensuring that future monitoring complies with regulatory requirements and generation of high quality, scientifically defensible data. The optimization approach incorporated the EPA's Data Quality Objectives, statistical models, and power analysis for trend detection using Monte Carlo simulation and Seasonal Kendall Tau Test for Trend. Data from the two Biscayne Bay monitoring programs were evaluated for comparability, parameters on which to base the optimization, data driven definitions of geographic domains in the bay, redundancy among the stations, and the ability of alternative monitoring designs to detect change. The findings demonstrate the utility of the approach as an environmental monitoring optimization tool.

Predicting Sediment and Nutrient Loads in Tropical Watersheds in Puerto Rico

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Edwin Martinez earned a BS degree in agronomy from the University of Puerto Rico and actually he is doing a MS in Soil Sciences at the same university. He worked as a summer research assistant in the Biological and Environmental Engineering Department at Cornell University, in the Soil Sciences Department at University of Massachusetts and in the Agricultural and Biosystems Engineering Department at the University of Puerto Rico. He is interested in soil and water quality and natural resources conservation.

Dr. Pérez earned a PhD in Agricultural and Environmental Engineering from Pennsylvania State University. He has been responsible for placing advance undergraduate students of Mechanical Technology in Agriculture in summer internships. He is a Professor of Soil and Water Management, Hydrologic Modeling to Watershed, Fundamental and Application of GIS in Agriculture and Natural Resources, and Agricultural Waste Management at the Department of Agricultural and Biosystems Engineering in the University of Puerto Rico.

Abstract

Water is essential to support life. Sediment and nutrient concentrations in streams are precursors or indicators of stream impairment. According to recent estimates by USEPA (2001), about 40% of the monitored national water supplies do not meet quality standards to support designated uses. A similar situation is observed in Puerto Rico. The 2002 water quality inventory of Puerto Rico reports that 67% of the monitored river miles were impaired (JCA, 2002). In this study water quality parameters were sampled during the 2004-2005 water year in four sub watersheds (Río Limón, Río Grande de Arecibo, Río Caonillas and Río Jauca) of the Río Grande de Arecibo watershed, located in the central part of Puerto Rico. The objective of this thesis research was to determine sediment and nutrient loads and to propose mathematical relationships to relate sediment and nutrient loads to physiographic and orographic properties of the sub watersheds. Sampled variables include pH, temperature, conductivity, salinity, water velocity, total suspended sediment, chlorophyll a, total Kjeldahl nitrogen (TKN), total phosphorus (TP) and dissolved phosphorus (DP). Sediment loads and yields from storm events range from 3,352.08 tons/event, 35.77 tons/km^2 (Río Limon) to 33.06 tons/event, 1.87 tons/km^2 (Río Jauca). Nutrient concentrations range, from 6.49 to 1.11 mg/l of TKN, 1.82 to .05 mg/l of TP and .24 to .05 mg/l of DP. Median values of Chlorophyll a, ranges from 6.48 to 3.36 mg/l. Mathematical expressions are presented and use to predict sediment and nutrient loads from these watersheds.

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