Seventh National Monitoring Conference

Monitoring from the Summit to the Sea

April 25 - 29, 2010

Sheraton Denver Downtown

Denver, Colorado

Conference Program

National Water Quality Monitoring Council

2010

Monitoring From the Summit to the Sea

National Monitoring Conference

NWQMC National Water Quality Monitoring Council Working Together for Clean Water

United States Environmental Protection Agency

USGS science for a changing world

NALMS

NATIONAL WATER QUALITY MONITORING COUNCIL
Working Together for Clean Water
NWQMC

Welcome to the Seventh National Monitoring Conference!!

Dear Colleagues:

We are delighted to see you in Denver to explore water monitoring issues—from the summit to the sea! We look forward to this week's information exchange as water practitioners from all backgrounds—including governmental organizations, tribes, volunteers, academia, watershed and environmental groups, and the private sector—showcase new findings on the quality of the Nation's waters and highlight new innovations and cutting-edge tools in water-quality monitoring, assessment, and reporting. This year's program is rich in content and scope, including nearly 290 platform presentations, more than 170 technical posters, and 20 extended sessions, including workshops and short courses. Of special note, this year's conference features:

- National, regional, and state findings on lakes, groundwater, rivers and streams, and coastal systems
- Integrated land-to-sea assessments, including the National Monitoring Network for U.S. Coastal Waters
- Elements for a proposed long-term national groundwater monitoring network
- Management issues, including nutrient enrichment and criteria, effects of urbanization, and climate change
- Drinking water issues, including emerging contaminants such as pharmaceuticals
- Tools and networking for enhanced state and regional councils and volunteer monitoring programs
- Advancements in sensor technology and real-time monitoring in lakes, estuaries, rivers, and streams
- Bio-assessment and other statistical techniques and tools, including new approaches to trend analyses

The Conference Program provides a general overview of conference activities and contains:

- A summary on the **National Water Quality Monitoring Council**, its mission, membership, and selected accomplishments and priorities
- Recognition of **Conference Sponsors**
- Background on this year's recipients of the **Elizabeth J. Fellows**, **Vision**, and **YSI Foundation Awards**
- **Acknowledgments** to conference planners
- **Conference exhibitors**
- **Conference agenda**, listing times and locations for all sessions, posters, workshops, and short courses
- **Poster presentations**, categorized by water topic
- Biographies of conference **plenary speakers**
- **Index of abstracts and posters** as they relate to Council priorities, including state and regional councils, volunteer monitoring, monitoring for multiple objectives, assessment and statistical tools, sensors and real-time monitoring, National Monitoring Network for U.S. Coastal Waters, and data management and information dissemination.

All abstracts for platform and poster presentations have been provided to each attendee on a CD. PowerPoint presentations will be made available on the Council's website (http://acwi.gov/monitoring/) following the conference.

Sincerely yours,

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

Pixie A. Hamilton
Co-Chair, U.S. Geological Survey

Welcome volunteer monitors!

We welcome you to this 2010 conference and encourage your participation in the many presentations and workshops, particularly those highlighting the broad spectrum of volunteer monitoring activities.

Across the country – and indeed throughout the world – volunteer monitors watch over watersheds, often those that would otherwise go unmonitored. 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 relax. They do this to ensure safe drinking water. They do this for their community, their family, their children and grandchildren. They educate themselves, their community, and decision-makers. They recognize the importance of their role as watershed stewards. They make a difference.

Volunteer monitoring began in the 1970s. Many volunteer monitoring programs have been going strong for more than 20 years, providing an unparalleled long-term record of water quality. Volunteers conduct physical, chemical, and biological monitoring. They measure Secchi depth in lakes, identify benthic macroinvertebrates in streams, and monitor bacteria levels in beach waters. 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 such as examining water samples for toxic phytoplankton and 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.

As the volunteer monitoring movement has grown and matured, programs have increasingly emphasized data quality and documentation so that their data can be more widely shared and used. Among the challenges volunteer programs face in coming years is learning how best to manage and share their quality-assured data and results, how to maintain sustainable programs, and how to build strong partnerships with potential users of their data.

Talk to state agency staff about uses of volunteer monitoring data and you will probably hear about the state's biennial water quality assessment and impaired waters reporting under sections 305(b) and 303(d) of the Clean Water Act. And, indeed, in many states, quality-assured volunteer data are increasingly being used for these critical state needs. But volunteer organizations are quick to point out that state-level uses are just part of the equation. 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 is, in fact, key to understanding our waters.

We invite all conference participants to take advantage of workshops, presentations, and informal exchanges with the members of our vibrant volunteer monitoring community here at the conference.

For our waters,

The Volunteer Monitoring Conference Planning Sub-Committee

Table of Contents

National Water Quality Monitoring Council Selected Highlights 6
Sponsors 10
Elizabeth Jester Fellows Award 11
Vision Award 13
YSI Foundation "Minding the Planet" Award 14
Acknowledgments 15
Conference Information 16
Conference Exhibitors 17
2010 National Monitoring Conference-at-a-Glance 19
Plenary Agendas 23
Plenary Speakers 24
Field Trips 26
Extended Sessions 28
Concurrent Session Presentations 35
Poster Presentations 53
Abstracts (available only on conference CD) 60
An Index of Council Priorities and Related Conference Sessions (available only on conference CD) 224
Presenter Directory (available only on conference CD) 226

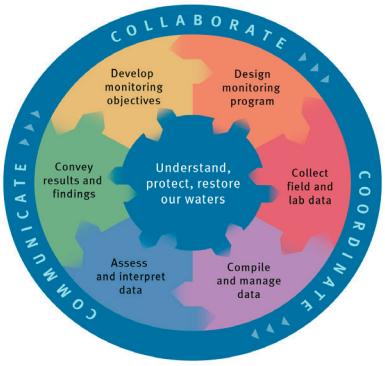
NATIONAL WATER QUALITY MONITORING COUNCIL

Working Together for Clean Water

NWQMC

Selected Council Highlights and New Products for Your Water Needs

The National Water Quality Monitoring Council (Council) provides a national forum for coordination of comparable and scientifically defensible methods and strategies to improve water quality monitoring, assessment and reporting, and promotes partnerships to foster collaboration, advance the science, and improve management within all elements of the water quality monitoring community. Vital to this role, the Council provides a voice for monitoring practitioners across the Nation and fosters increased understanding and stewardship of our water resources.



The Council was created in 1997 as a vehicle for bringing together diverse expertise needed to develop collaborative, comparable, and cost-effective approaches for monitoring and assessing our Nation's water quality (http://acwi.gov/monitoring). The approaches are fundamental to the successful management and sustainability of our waters, and are increasingly important because water issues are becoming more complex, resources are tighter, and the demand for high-quality water continues to grow in order to support a complex web of human activities and aquatic ecosystem needs.

Each year, thousands of government agencies, Tribes, academic researchers, volunteers, industry and other organizations dedicate significant resources to monitor, assess, protect, and restore our water resources and watersheds across the U.S. Despite such efforts, understanding the condition of the Nation's waters has been limited and fragmented by differences in monitoring designs, sampling and analytical methods. It has also been hampered by inconsistent metadata, data management, and information dissemination. Council goals are thereby set to improve data comparability and reliability; data management, assessment, sharing, and reporting; and collaboration. The goals are accomplished through its workgroups *Collaboration and Outreach, Water Information Strategies,* and *Methods and Data Comparability Board* and through its role with the National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries ("Network"). The Network was initiated by the Council in 2004 in response to a recommendation by the U.S. Commission on Ocean Policy, and provides critical information for national and regional management of coastal ecosystems and their tributaries.

Council goals pursued by its workgroups and the Network are increasingly achievable as technology and expertise advance in data collection and exchange, assessment, and reporting. As a result, the Council and its partners have made significant advances in its priorities, including data management and information dissemination; compatible web services; state and regional councils; volunteer monitoring; assessment and statistical tools; sensors and real-time monitoring; and integrated land-to-sea assessments through the Network. Multiple Council products and services are now available to help meet water needs across the Nation (described below).

The Council is representative of federal, state, interstate, tribal, local, and municipal governments; watershed and environmental groups; the volunteer monitoring community; universities; and the private sector, including the regulated community. Representatives generally serve 3 to 4 year terms.

The Council is co-chaired by the U.S. Geological Survey (USGS) and U.S. Environmental Protection Agency (EPA) and is chartered as a subgroup of the Advisory Committee on Water Information (ACWI) under the Federal Advisory Committee Act.

Council members are organized into work groups, including: Collaboration and Outreach, Water Information Strategies, and the Methods and Data Comparability Board. Workgroup participation is open to non-Council members.

The Council meets three times each year. The meetings are open to non-members through web seminars and teleconferencing. For information on upcoming meetings and topics, contact Pixie Hamilton, pahamilt@usgs.gov, (804) 261-2602 or Wendy Norton, wenorton@usgs.gov, (703) 648-6810.

Council Workgroups

Methods and Data Comparability Board (Methods Board) – Provides a forum for evaluating and promoting methods that facilitate comparability among water-quality monitoring and analytical methods. A major focus currently is on quality control and data management of sensor data by an Aquatic Sensor Workgroup under the Methods Board. (**Contacts:** Dan Sullivan, djsulliv@usgs.gov, (608) 821-3869 and Gayle Rominger, grominger@ysi.com, (937) 767-7241)

Water Information Strategies Workgroup – Defines and promotes strategies for monitoring designs; data management, access, and exchange; data integration and analysis; and information reporting to address water needs. A major focus by WIS, along with the Methods Board, is to develop a system that guides scientists and managers with a range of statistical information, procedure references, and tools, and that assists in designing monitoring programs to meet specific objectives and converting data into information. (**Contacts:** Peter Tennant, ptennant@orsanco.org, (513) 231-7719, Mary Skopec, mary.skopec@dnr.iowa.gov, (319) 335-1579, Doug McLaughlin, douglas.mclaughlin@wmich.edu, (269)-276-3545, Leslie McGeorge, leslie.mcgeorge@dep.state.nj.us, (609) 292-1254, and Dan Sullivan, djsulliv@usgs.gov, (608) 821-3869)

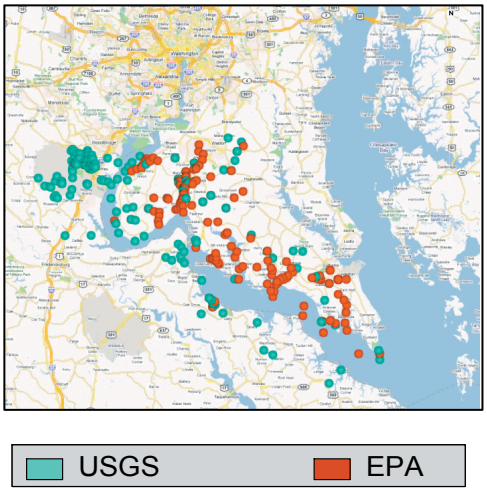
Collaboration and Outreach Workgroup – Works to build partnerships that foster collaboration and communication within the water-quality monitoring community. **(Contact:** Tracy Hancock, thancock@usgs.gov, (804) 261-2618)

Selected Highlights, Accomplishments, and Council Products for Your Water Needs

Compatible Web Services Available for Water Quality Exchange

Compatible web services and a shared data exchange, called the Water Quality Exchange (WQX), are now available that allow retrieval of data from multiple sources in common formats for direct use in mapping, statistical, and modeling applications. The ability to retrieve data in common formats simplifies the task of bringing together a wide range of information that can be used to describe the status and trends of water quality in our Nation's streams, groundwater and estuaries.

Chemical, physical, and biological data from the USGS National Water Information System (NWIS) (http://qwwebservices.usgs.gov) and data housed in the EPA Storage and Retrieval (STORET) (http://storetnwis.epa.gov/storetqw/portal.html#) are readily accessible online in a compatible format that employs data elements developed through the Council. Data collected by USGS and by states and tribes (submitted to EPA-STORET) thereby conform to a common nomenclature for biological and physical elements, chemical substances, chemical groups, sites, types, and sampling media. In total, over 150 million water-quality results are available from the two systems.



Application of the Water Quality Exchange (WQX) along the lower Potomac River yields a merged dataset that includes 161 USGS-NWIS and 169 EPA-STORET sites.

Efforts are ongoing for the continued development of simple web forms and querying capabilities on the Internet with user-friendly mapping tools, as well as access from a single, national, water-data portal (available in 2010).

The USGS/EPA activities began in 2003, resulting from an interagency *Agreement on the Management of Water Quality Data*, supported by the Advisory Committee on Water Information. USGS and EPA continue to work with data managers associated with other Federal agencies, including USDA's Agricultural Research Service (ARS) to integrate its STEWARDS data system, housing water, conservation and other land data, with the WQX.

Efforts also are ongoing with NOAA and the Integrated Ocean Observing System (IOOS), associated regional associations, and the Northeast Coastal and Ocean Data Partnership on extending the WQX and common web services to coastal data and improving capabilities beyond discrete data to include continuous and sensor data. (**Contacts:** Nate Booth, nlbooth@usgs.gov, (608) 821-3822 and Kristen Gunthardt, gunthardt.kristen@epa.gov, (202) 566-1194)

Guides for Sensors Are Now Available through a Council Supported Public/Private Partnership

Four products developed through the sensor partnership are now available, including: (1) a checklist for users related to calibration and record keeping to ensure that data are of known and documented quality; (2) a deployment guide to assist in siting and maintaining sensors in the field; (3) data elements (or metadata) for sensors; and, (4) a glossary of terms.

Freshwater sensor manufacturers have played an active role, along with governmental and non-governmental organizations, to develop guides for deploying sensors, with YSI co-chairing and funding much of the effort. Future efforts will extend the public/private partnership to the Alliance for Coastal Technologies to integrate sensor information with NEMI; develop data management capabilities for sensor data; and assess the relevance and utility of sensor data to meet management needs. Additional information can be found at http://watersensors.org. (**Contacts:** Dan Sullivan, djsulliv@usgs.gov, (608) 821-3869 and Gayle Rominger, grominger@ysi.com, (937) 767-7241)

National Environmental Methods Index Celebrates Its Tenth Year

The National Environmental Methods Index (NEMI) celebrates its 10th year in 2010 as an online resource of laboratory methods and field protocols, including more than 1,100 methods for chemical, biological and physical monitoring (http://www.nemi.gov). Recent improvements to NEMI include a user-friendly format for enhanced accessibility by stakeholders. "MethodsML" is being explored, which is an XML standard for analytical methods. Collaboration is ongoing with EPA's Forum on Environmental Management to leverage comparability among methods and laboratory services across the Nation. (**Contact:** Dan Sullivan, djsulliv@usgs.gov, (608) 821-3869)

Physical Habitat Data Are Included as National Data Elements

Approved data elements for physical habitat are available for streams, which expand the already available key data elements (or "core metadata") for chemical, microbiological, toxicity testing, and biological population/community data (http://acwi.gov/methods/pubs/wdqe_pubs/wqde_trno3.pdf). A Council priority is to continue to promote the use of all data elements among the water community to help facilitate comparisons and integration of data collected by multiple organizations. (**Contact:** Dan Sullivan, djsulliv@usgs.gov, (608) 821-3869)

Council Hosts Its 7th Biennial National Conference

A centerpiece forum for communication and collaboration among the monitoring community is the Council's biennial national conference. The 7th national conference in Denver explores many water monitoring issues—from the summit to the sea. More than 700 water practitioners from all backgrounds—including governmental organizations, tribes, volunteers, academia, watershed and environmental groups, and the private sector—showcase new findings on the quality of the Nation's waters and highlight new innovations and cutting-edge tools in water-quality monitoring, assessment, and reporting. (**Contacts**: Chuck Spooner, spooner.charles@epa.gov, (202)-566-1174, Jeff Schloss, jeff.schloss@unh.edu , (603) 862-3848 and Doug Glysson, gglysson@usgs.gov, (703) 648-5019)

White Paper is Released on Council Goals for Water Quality Statistics and Assessment Tools

A white paper, released at the 7th Council's biennial conference in Denver, describes the development of a system that will guide scientists and managers with a range of statistical information, procedure references, and tools, and will assist in designing and analyzing monitoring data to meet specific assessment and research objectives (http://acwi.gov/monitoring). (**Contacts:** Doug McLaughlin, douglas.mclaughlin@wmich.edu **,** (269)-276-3545, Leslie McGeorge, leslie.mcgeorge@dep.state.nj.us, (609) 292-1254, and Dan Sullivan, djsulliv@usgs.gov, (608) 821-3869)

Online Newsletter Released – *The National Water Monitoring News*

The first issue of the Council's bi-annual, online newsletter for the water monitoring community, released at the Council's 7th biennial conference in Denver, highlights activities of the national Council and those of state, regional, and tribal councils, watershed partnerships, and volunteer monitoring groups. Articles are included on monitoring success stories and other relevant topics on monitoring designs and assessments; related upcoming events, conferences, and links; and grant timelines (http://acwi.gov/monitoring). (**Contact:** Tracy Hancock, thancock@usgs.gov, 804-261-2618)

Council Hosts Web Seminars for State, Regional and Tribal Councils and Watershed Partnerships

The Council strives to support the creation and sustaining of partnerships among the water monitoring community, including state, regional, and tribal councils, as well as watershed groups and alliances, and currently interacts with more than 15 Councils and partnerships across the Nation. Through the development of a "How To Tool Kit" and hosting of web seminars, information is exchanged on success stories and challenges, support and funding, membership and operation, monitoring conferences, data and information exchange, leveraging resources, and building commonality in water management. Three web seminars have been hosted to date, which highlighted a presentation by Virginia's Monitoring Council on an online database tool and the integration of citizen monitoring data into the state assessment report, as well as presentations on new web technologies and social media tools for the water monitoring community. (**Contact:** Tracy Hancock, thancock@usgs.gov, 804-261-2618)

A citizen monitor with Alliance for Chesapeake Bay prepares to collect water samples near the U.S. Naval Academy, where submerged aquatic vegetation is being replanted. Some citizen data were used in Bay studies of these aquatic plants, which are vital to the Bay's health. (Photo by Bob Murphy, Alliance for Chesapeake Bay.)

Volunteer Monitoring Community Continues to Grow

The Council continues to support the volunteer monitoring community through web seminars, meetings, and conferences in which information is exchanged on volunteer efforts at local and national levels. The information exchange helps to better define the role of the volunteer community in state monitoring and assessment programs, and to share benefits and challenges associated with running a volunteer monitoring program. Planning for each national Council conference includes securing travel assistances for volunteer program coordinators; much appreciation is extended to YSI, Inc. for providing travel support to the Council's 7th biennial conference in Denver. (**Contact**: Linda Green, lgreen@uri.edu, (401) 874-2905)

Integrated Land-to-Sea Assessments Advance the National Monitoring Network Concepts

The National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries ("Network") provides information about the health of our oceans and coastal ecosystems and inland influences on coastal waters for improved resource management (http://acwi.gov/monitoring/network/index.html). This Network is, in reality, comprised of a "network of networks" and represents an integrated, multidisciplinary, and multi-organizational approach that leverages diverse sources of data and information; augments existing monitoring programs; and links observational capabilities. These networks include federal agencies, the Integrated Ocean Observing System (IOOS), and regional associations representing a broad community of users, including coastal and inland states, tribes, researchers, and non-governmental organizations.

Through Coastal Action Money provided in support of the Ocean Research Priorities plan, design concepts of the Network have been implemented since 2007 in three areas, including Lake Michigan, led by the Great Lakes Commission; Delaware Bay, led by the Delaware River Basin Commission; and San Francisco Bay, led by the San Francisco Estuary Institute. Activities are coordinated with IOOS regional associations, including the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA), Great Lakes Observing System (GLOS), and Central and Northern California Ocean Observing System (CenCOOS).

Activities in the three Network areas are successfully improving estimates of oceanic and land-based inputs of sediment, nutrients, and contaminants to U.S. coastal waters and estuaries, and improving assessments on the sources, amounts, timing, and severity of natural and anthropogenic stressors on coastal ecosystems. Findings are useful to compare responses of different estuarine and coastal waters to these stressors, which help to facilitate water-management decisions in other U.S. waters. In addition, the projects continue to provide added value in innovative technology and monitoring, such as in real-time monitoring with sensors and autonomous underwater vehicles (AUVs), which also is transferrable to other parts of the Nation.

More detailed information on land-to-sea assessments in the three Network areas and other U.S. coastal waters is available at http://acwi.gov/monitoring. (**Contacts:** Pixie Hamilton, pahamilt@usgs.gov, (804) 261-2602 and Tracy Hancock, thancock@usgs.gov, (804) 261-2618)

Additional information on Council activities can be obtained through the Council website, http://acwi.gov/monitoring/ and through the Council Co-Chairs, Chuck Spooner, USEPA, spooner.charles@epa.gov, (202) 566-1174 and Pixie Hamilton, USGS, pahamilt@usgs.gov, (804) 261-2602.

Sponsors

Thank You!

To our generous sponsors who have made the 2010 National Monitoring Conference a success!

Cosponsors

NWQMC National Water Quality Monitoring Council — Working Together for Clean Water

United States Environmental Protection Agency

USGS — science for a changing world

NALMS

YSI

Leading Sponsor

Water Environment Federation — the water quality people®

Sustaining Sponsors

Practical Stats — Statistics, down to earth

TETRA TECH

Contributing Sponsor

FLUID IMAGING TECHNOLOGIES — FlowCAM

Elizabeth Jester Fellows Award

Elizabeth Jester Fellows headed the Assessment and Watershed Protection Division in EPA's Office of Water until November 2000. She dedicated her career to natural resources management, environmental protection, and public service. She envisioned the creation of the National Water Quality Monitoring Council (NWQMC) and advocated for the development of a national framework for collecting, assessing, and communicating water quality monitoring information. In her memory, the NWQMC 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 his contributions to water quality monitoring, the National Water Quality Monitoring Council is pleased to present

the 2010 Elizabeth Jester Fellows Award to

Dr. Robert C. Ward
(Retired) Professor, Director
Colorado Water Resources Research Institute
Colorado State University
Fort Collins, Colorado

Dr. Robert C. Ward is dedicated to improving the state of the science of water quality monitoring through the delivery of quality education, development of coherent water monitoring systems, and promotion of the development of water quality information that the public and decision makers can understand, trust, and use to further improve water resources. Dr. Ward taught two generations of students in operations research, engineering design, and water quality monitoring during his 35-year tenure at Colorado State University (CSU) and through his "Short Course on Water Quality Monitoring Network Design." His seminal text on this topic and the monitoring network design he helped develop in New Zealand stand as testament to his work. His profession of goal-oriented monitoring was reflected in the Interim Task Force on Monitoring products,

as well as the National Water Quality Monitoring Council's (NWQMC) Framework for Water Quality Monitoring. Internationally he has served on the Scientific Organizing Committee for four Europe-wide conferences on water quality monitoring.

Dr. Ward represented academia on the NWQMC. He was a major contributor and editor of the September 2003 special report on "Seeking a Common Framework for Water Quality Monitoring," describing the Council's Framework for Water Quality Monitoring Programs that was published in the journal Water Resources IMPACT. He also chaired the Council's Water Information Strategies workgroup for its first eight years, on which his influence is still reflected.

In 2006, Dr. Ward received the University Council on Water Resources' (UCOWR) Warren A. Hall Medal in recognition of his distinctive scholarly accomplishments in the water resources field. UCOWR recognized Dr. Ward for his service as Director of the Colorado Water Resources Research Institute for fourteen years during which he also served as President of first UCOWR and then the National Institutes for Water Resources. He served as Interim Vice Chancellor for Academic Affairs of the CSU system and was designated a Life Member of the Colorado Water Congress. Nationally, he was a leader in the National Association of State Universities and Land-Grant Colleges (now known as the Association of Public and Land-Grant Universities).

Dr Ward was involved in American Water Resources Association (AWRA) for many years. He served as a Director for the Mountain District from 1995 to 1997. He also received the AWRA Icko Iben Award in 2006 for promotion of communication among disciplines concerned with water resource problems.

Dr. Ward provided the initial impetus to launch the Colorado Water Quality Monitoring Council (CWQMC). Based on his involvement in the NWQMC, he approached the Colorado Department of Public Health and Environment and the U.S. Geological Survey about starting a Colorado Chapter of the Council. Through his "behind the scene" support and guidance, a charter was written and the CWQMC was formed in 2000. This Council is still active today.

For nearly two decades, Dr. Ward served as an organizer and participant in the South Platte Forum. This forum provided an avenue for a timely, multi-disciplinary exchange of information and ideas important to resource management in the South Platte River Basin in Colorado. For his contributions, Dr. Ward received the 2006 Friend of the South Platte Forum Award.

Congratulations, Robert!

Vision Award

The Council's Vision Award was established to recognize an individual or group at the National Water Quality Monitoring Conference that has demonstrated extraordinary vision and leadership in the field of water quality monitoring on a local/regional level and has brought together scientists, managers, and communities to observe and understand the interconnectivity of physical, chemical, and biological aspects of the Earth's watersheds, estuaries, and oceans.

Mr. Terry Fleming

U.S. Environmental Protection Agency, Region 9

Terry Fleming has demonstrated strong leadership skills and dedication in the development and implementation of statewide monitoring strategies and programs for the state of California. Terry has consistently demonstrated an ability to encourage teamwork and collaboration among a diverse array of partners. As a result, California has produced a thorough, comprehensive monitoring strategy that successfully addresses the ten elements of the national program guidance for an effective monitoring program.

With Terry's leadership, the state's Surface Water Ambient Monitoring Program (SWAMP) developed and maintains the infrastructure (i.e., standard procedures, quality assurance and control, and consistent data formats) to ensure that data are comparable and of known, documented quality. The infrastructure provides the foundation for the design, implementation, and reporting of the SWAMP statewide and regional assessments. SWAMP is now collaborating with other Water Board programs to integrate water quality monitoring into the SWAMP structure. In addition, systems are now in place to provide public access to the data.

Terry and the SWAMP workgroup developed some key statewide monitoring priorities and plans for implementation. In 2007, the SWAMP embarked on a two-year effort to assess fish contamination in lakes and reservoirs statewide. The first year's results revealed significant contamination in sport fish throughout the State resulting in several new proposed 303d listings for impairment. The second year's results will be reported in spring 2010. In 2009, the program initiated 2-years of monitoring in coastal areas and will rotate to rivers and streams in 2011. Work on indicator development for the statewide aquatic life use survey of perennial streams has produced a robust statewide bioassessment program. The program supports development of biological objectives that allow the use of bioassessment information in a regulatory context to protect the state's stream resources. Terry's vision, drive and sense of humor have played an integral role in developing and implementing these statewide programs.

In addition to Terry's pivotal role in the SWAMP program, he is equally engaged in the CA Clean Beach Initiative, which coordinates beach monitoring and BMP implementation. Most recently, Terry joined the CA Water Quality Monitoring Council, representing EPA Region 9. He is bringing to the Council the same skills and knowledge that he willingly brings to SWAMP.

YSI Foundation "Minding the Planet" Award

The YSI Foundation, the philanthropic arm of YSI Incorporated, is allocated an annual amount of funds, based on financial results, for charitable giving to a multitude of causes. Since its inception in 1990, the Foundation has donated more than $2.8 million around the world; thereby practicing good corporate citizenship and demonstrating its commitment to its core values. The Foundation grants have funded a variety of projects, including university environmental science scholarships, high school scholarships, large scale restoration projects, a wetlands data center, science museum children programs, and equipment for fishermen who lost their livelihood in the December 2005 tsunami.

In 2006, the Foundation launched its new "Minding the Planet" grant program to specifically support environmental projects aimed at protecting and restoring water resources and natural habitats.

In 2008, in honor of our 60th Anniversary, at the National Water Quality Monitoring Conference in Atlantic City, YSI awarded a special $60,000 grant to Columbia Riverkeeper located in Hood River, Oregon for a water quality monitoring program used to train volunteers to collect water quality data on the Columbia River, the Pacific Northwest's longest river. This grant was for capacity building so that volunteers could monitor 100 sites total in backwaters and mainstem eddies for riparian restoration or protection in order to provide temporary cool-water refuges for juvenile salmonids and other native species. With more monitoring, volunteers soon identified and prioritized at least five restoration sites by 2009, one site per community.

In 2009, at the Coastal and Estuarine Research Foundation Conference in Portland, Oregon, the University of West Florida received a $25,000 grant from the YSI Foundation to synthesize water quality data and address issues of climate change. With this grant, a graduate student project was funded, which helped analyze nutrient and continuous dissolved oxygen data from five National Estuarine Research Reserves in the Eastern Gulf of Mexico and Florida Atlantic coast to determine the rate of primary production and net ecosystem metabolism. This work provided insights to help local and regional managers address water quality issues within their sensitive estuarine and coastal aquatic habitats.

The YSI Foundation, along with the employee-owners of YSI, are also pleased to have the opportunity to publicly acknowledge and applaud at this conference the very critical work that all of the hundreds of local volunteer monitoring organizations are doing to improve the quality of the nation's water.

Acknowledgments

The Council offers its gratitude to those who served on the 2010 Conference Planning Committee and its Subcommittees. 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. Listed below are the numerous individuals who participated in organizing the 2010 conference:

Conference Planning Committee Chairs

Charles Spooner, USEPA

Doug Glysson, USGS

Jeff Schloss, University of NH

Conference Planning Committee

Maggie Craig, Tetra Tech, Inc.

Philip Forsberg, NALMS

Linda Green, University of RI

Pixie Hamilton, USGS

Tracy Hancock, USGS

Jim Laine, WV DEP

Barry Long, National Park Service

Kim Martz, USGS

Wendy Norton, USGS

Gayle Rominger, YSI

Gary Rowe, USGS

Mary Skopec, IA DNR

Dan Sullivan, USGS

Cathy Tate, USGS

David Tucker, City of San Jose, CA

Sarah Unz, NALMS

Local Planning Committee

Daniel Beley, CO DPHE

Joan Carlson, US Forest Service

Karl Hermann, USEPA

Barry Long, National Park Service

Dave Mueller, USGS

Gary Rowe, USGS

Cathy Tate, USGS

Katie Walton-Day, USGS

Robert Ward, Professor Emeritus, CSU

Awards Committee

Val Connor, CA SWRCB

Pixie Hamilton, USGS

Tracy Hancock, USGS

Gary Kohlhepp, MDNRE

Wendy Norton, USGS

Tony Olsen, USEPA

Chris Piehler, LA DEQ

Charles Spooner, USEPA

David Tucker, City of San Jose, CA

Volunteer Monitoring Planning Committee

Danielle Donkersloot, NJ DEP

Linda Green, University of RI

Barb Horn, CO Division of Wildlife

Alice Mayio, USEPA

Conference Information

Registration

Conference registration is located on the Concourse Level of the Plaza Building.

Hours:

Sunday, April 25	5:00 pm – 7:00 pm
Monday, April 26	7:00 am – 5:30 pm
Tuesday, April 27	7:00 am – 5:30 pm
Wednesday, April 28	7:00 am – 5:30 pm
Thursday, April 29	7:00 am – 12:00 pm

Meal Functions

All meals listed below are provided to all full conference registrants on Monday, Tuesday, Wednesday & Thursday. Daily registrants receive all meals on the day that they attend the conference.

Continental Breakfast

Monday, April 26	7:30 am – 8:00 am	Governors Square Foyer
Available to morning Extended Session participants only.		
Tuesday, April 27	7:00 am – 8:00 am	Exhibit Hall
Wednesday, April 28	7:00 am – 8:00 am	Exhibit Hall
Thursday, April 29	7:00 am – 8:00 am	Ballroom

Morning Break

Monday, April 26	10:30 am – 10:45 am	Exhibit Hall
Tuesday, April 27	9:30 am – 10:00 am	Exhibit Hall
Wednesday, April 28	9:30 am – 10:00 am	Exhibit Hall
Thursday, April 29	9:30 am – 10:00 am	Ballroom

Lunch

Monday, April 26	12:30 pm – 1:30 pm	Exhibit Hall
Tuesday, April 27	11:30 am – 1:00 pm	Exhibit Hall
Wednesday, April 28	11:30 am – 1:00 pm	Exhibit Hall
Thursday, April 29	11:30 am – 1:30 pm	Ballroom

Afternoon Break

Monday, April 26	3:00 pm – 3:30 pm	Exhibit Hall
Tuesday, April 27	2:30 pm – 3:30 pm	Exhibit Hall
Wednesday, April 28	2:30 pm – 3:30 pm	Plaza Foyer

Exhibit & Poster Receptions

Monday, April 26	5:00 pm – 7:00 pm	Exhibit Hall
Tuesday, April 27	5:00 pm – 7:00 pm	Exhibit Hall

Conference Exhibitors

Abraxis LLC
54 Steamwhistle Dr.
Warminster, PA 18974-1450
info@abraxiskits.com
www.abraxiskits.com
215.357.3911

ACZ Laboratories, Inc.
2773 Downhill Dr.
Steamboat Springs, CO 80487
sales@acz.com
www.acz.com
800.334.5493

Agilent Technologies
2553 Thunderbird Ln.
Evergreen, CO 80439
contact_us@agilent.com
www.agilent.com
303.662.4268

Aqualytical
11760 Commonwealth Dr.
Louisville, KY 40299
www.ciagent.com
866.242-4368

Aquatic Informatics
Ste. 1100 – 570 Granville St.
Vancouver, BC V6C 3P1
Canada
info@aquaticinformatics.com
www.aquaticinformatics.com
877.870. 2782

bbe Moldaenke GmbH
Wildrosenweg 3
24119 Kiel-Kronshagen
Germany
bbe@bbe-moldaenke.de
www.bbe-moldaenke.de
+49 0431 380 40 0

Blue Water Satellite
440 E. Poe Rd., Ste. 203
Bowling Green, OH 43402
www.bluewatersatellite.com
419.728.0060

Campbell Scientific, Inc.
815 W. 1800 N.
Logan, UT 84321
info@campbellsci.com
www.campbellsci.com
435.753.2342

Carnet Technology
6097 Oakley Palestine Rd.
Terry, MS 39170
www.carnettechnology.com
601.857.8641

Charm Sciences, Inc.
659 Andover St.
Lawrence, MA 01843
info@charm.com
www.charm.com
978.687.9200

ChemWare
900 Ridgefield Dr., Ste. 150
Raleigh, NC 27609
info@chemware.com
www.chemware.com
919.855.8716

Clean Lakes, Inc.
PO Box 3548
Coeur d'Alene, ID 83816
info@cleanlake.com
www.cleanlake.com
208.665.1475

EcoAnalysts, Inc.
1420 S. Blaine St., Ste. 14
Moscow, ID 83843-2876
info@ecoanalysts.com
www.ecoanalysts.com
208.882.2588

Energy Laboratories, Inc.
PO Box 30916
Billings, MT 59107
eli@energylab.com
www.energylab.com
800.735.4489

EnviroTech Instruments / Green Eyes
1517 Technology Dr., Ste. 101
Chesapeake, VA 23320
mail@envirotechinstruments.com
www.envirotechinstruments.com
757.549.8474

Fluid Imaging Technologies, Inc.
65 Forest Falls Dr.
Yarmouth, ME 04096
info@fluidimaging.com
www.fluidimaging.com
207.846.6100

Forston Labs
4098 Trouble Trail
Fort Collins, CO 80524
info@forstonlabs.com
www.forstonlabs.com
800.301.1259

FTS
1065 Henry Eng Place
Victoria, BC V9B 6B2
Canada
sales@ftsinc.com
www.ftsinc.com
800.548.4264

Geotech Environmental Equipment
2650 E. 40th Ave.
Denver, CO 80205
www.geotechenv.com
800-833-7958

GFS Chemicals, Inc.
PO Box 245
Powell, OH 43065
sales@gfschemicals.com
www.gfschemicals.com
877.534.0795

Greenspan Analytical
c/o Goyen Valve Corp.
1195 Airport Rd.
Lakewood, NJ 08701
www.goyen.com
732.364.7800

Hach Hydromet
PO Box 389
Loveland, CO 80539
sales@hachenvironmental.com
www.hydrolab.com
800.949.3766

IDEXX
1 IDEXX Dr.
Westbrook, ME 04092
water@idexx.com
idexx.com
800.321.0207

In-Situ Inc.
221 E. Lincoln Ave.
Fort Collins, CO 80524-2533
www.in-situ.com
800.446.7488

LaMotte Company
PO Box 329
802 Washington Ave.
Chestertown, MD 21620
www.lamotte.com
800.344.3100

National Water Quality Monitoring Council
acwi.gov/monitoring/

North American Lake Management Society
PO Box 5443
Madison, WI 53705-0443
info@nalms.org
www.nalms.org
608.233.2836

Pine Environmental Services
7332 S. Alton Way
Bldg. 13, Ste. E
Centennial, CO 80112
sales@pine-environmental.com
www.pine-environmental.com
303.741.3800

Practical Stats
9278 Lark Sparrow Dr.
Highlands Ranch, CO 80126-5232
ask@practicalstats.com
www.practicalstats.com
303.870.4921

Satlantic Inc.
3481 N. Marginal Rd.
Halifax, NS B3K 5X8
Canada
info@satlantic.com
www.satlantic.com
902.492.4780

Sequoia Scientific, Inc.
2700 Richards Rd., Ste. 107
Bellevue, WA 98005-4200
info@sequoiasci.com
www.sequoiasci.com
866.212.2226

Solinst Canada Ltd.
35 Todd Rd.
Georgetown, ON L7G 4R8
Canada
instruments@solinst.com
www.solinst.com
800.664.2023

Technical Associates
7051 Eton Ave.
Canoga Park, CA 91303
tagold@nwc.net
www.tech-associates.com
818.883.7043

Teledyne Isco, Inc.
4700 Superior St.
Lincoln, NE 68504
iscoinfo@teledyne.com
www.isco.com
402.464.0231

Tetra Tech
400 Red Brook Blvd., Ste. 200
Owings Mills, MD 21117
jeffrey.white@tetratech.com
www.tetratech.com
410.356.8993

Thermo Scientific
166 Cummings Center
Attn. Sokhom Bin
Beverly, MA 01915
www.thermo.com
800.636.6162

Turner Designs
845 W. Maude Ave.
Sunnyvale, CA 94085
sales@turnerdesigns.com
www.turnerdesigns.com
877.316.8049

US Geological Survey
Hydrologic Instrumentation Facility
Building 2101
Stennis Space Center, MS 39529
mhbrooks@usgs.gov
wwwhif.er.usgs.gov
228.688.2607

US Geological Survey
National Water-Quality Assessment Program (NAWQA)
413 National Center
Reston, VA 20192
nawqa_whq@usgs.gov
water.usgs.gov/nawqa/
703.648.5716

US Environmental Protection Agency
Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
spooner.charles@epa.gov
www.epa.gov/ow/
202.566.1174

WET Labs, Inc.
PO Box 518
620 Applegate St.
Philomath, OR 97370
sales@wetlabs.com
www.wetlabs.com
541.929.5650

YSI, Inc.
1725 Brannum Ln.
Yellow Springs, OH 45387
environmental@ysi.com
www.ysi.com
800.765.4974

2010 National Monitoring Conference-at-a-Glance

Sunday, April 25

7:30 am – 5:00 pm	**Field Trip 1**: Mining and the Treatment of Mine Drainage
8:00 am – 5:00 pm	**Field Trip 2**: Demonstration and Training in the National Wetland Condition Assessment Field Methods
1:00 pm – 5:00 pm	**Field Trip 3**: Field Demonstration of Methods for Water-Quality Sampling & Monitoring – Part 1 of the "Monitoring Framework"

Monday, April 26

7:30 – 8:00	Breakfast for Workshop Participants – Governors Square Foyer								
8:00 – 10:30	**Extended Session 1** Cancelled		**Extended Session 2** Plenary Seminar for Continuous Real-Time Monitoring: Direct Measures and Surrogates Rm. 14	**Extended Session 3** Using NHD and State GIS Information to Improve National Aquatic Resource Survey Designs Rm. 11		**Extended Session 4** Guidelines for Design, Sampling, Analysis, and Interpretation for Cyanobacterial Toxin and Taste-And-Odor Studies in Lakes and Reservoirs Rm. 10		**Extended Session 5** Building a Case for Causes of Biological Impairment Rm. 12	
10:45 – 12:30	**Opening Plenary and Award Presentations** – Plaza Ballroom F								
12:30 – 1:30	Lunch – Exhibit Hall (Plaza Ballrooms A-E)								
	A1	**A2**	**A3**	**A4**	**A5**	**A6**	**Extended Session 6**	**Extended Session 7**	**Field Trip 4**
1:30 – 3:00 **Concurrent Session A**	Continuous Real-Time Monitoring: Operation and Data Evaluation Rm. 14	Indices of Biotic Integrity for Wetlands Rm. 17	Developing Nutrient Criteria 1 Rm. 15	Lessons Learned from National Assessments Rm. 11	Strategies for Growing a Volunteer Monitoring Program Rm. 12	Monitoring and Assessing Groundwater Vulnerability 1 Rm. 16	Building Successful State, Regional, and Tribal Water Monitoring Councils, Part 1 Rm. 9	Man vs. Stats, Part 1 Rm. 10	Tour of the USGS National Water-Quality Lab - Part 2 of the "Monitoring Framework"
3:00 – 3:30	Break – Refreshments in Exhibit Hall (Plaza Ballrooms A-E)								
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**Extended Session 6**	**Extended Session 7**	**Field Trip 4**
3:30 – 5:00 **Concurrent Session B**	Evaluation and Application of New Technologies for Real-time Monitoring Rm. 14	Developing New Biological Assessment Tools Rm. 17	Developing Nutrient Criteria 2 Rm. 15	Monitoring the Effects of Development on Hydrology and Water Quality Rm. 12	Modeling Ecological Conditions Rm. 11	Monitoring and Assessing Groundwater Vulnerability 2 Rm. 16	Building Successful State, Regional, and Tribal Water Monitoring Councils, Part 2 Rm. 9	Man vs. Stats, Part 2 Rm. 10	Tour of the USGS National Water-Quality Lab - Part 2 of the "Monitoring Framework"
5:00 – 7:00	***Exhibit and Poster Reception*** – **Exhibit Hall** (Plaza Ballrooms A-E and Plaza Foyer)								

Tuesday, April 27

7:00 – 8:00	Breakfast – Exhibit Hall (Plaza Ballrooms A-E)							
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**Extended Session 8**	**Extended Session 9**
8:00 – 9:30 **Concurrent Session C**	Monitoring Stressors and Impacts to Lakes and Reservoirs Rm. 17	Monitoring for Stormwater Management Effectiveness Rm. 16	Interpreting Water Quality Data Rm. 14	Downstream Impacts from Mined Lands 1 Rm. 15	National Monitoring Network: Monitoring Water Quality from Inland to Coastal Ecosystems Rm. 12	PAHs and Coal-Tar-Based Pavement Sealcoat: Stormwater Management, Toxicology, and Public Policy Rm. 11	Sensors Basics: Tools to Enhance the Quality and Comparability of Sensors Data for Continuous Real-Time Monitoring, Part 1 Rm. 10	Emerging Applications of the Biological Condition Gradient (BCG) Rm. 9
9:30 – 10:00	Break – Refreshments in Exhibit Hall (Plaza Ballrooms A-E)							
	D1	**D2**	**D3**	**D4**	**D5**	**D6**	**Extended Session 8**	**Extended Session 9**
10:00 – 11:30 **Concurrent Session D**	Wetlands Condition Monitoring and Assessment Rm. 17	New Tools and Approaches in Data Analysis and Reporting Rm. 11	Elements of a Long-Term National Ground-Water Monitoring Network and a State-Scale Example Rm. 16	Downstream Impacts from Mined Lands 2 Rm. 15	Effective Communication Leads to Action Rm. 12	Pharmaceuticals and Other Emerging Contaminants Above and Below the Water's Surface Rm. 14	Sensors Basics: Tools to Enhance the Quality and Comparability of Sensors Data for Continuous Real-Time Monitoring, Part 2 Rm. 10	Biological Condition Gradient (BCG) Development and Calibration at State, Regional, and National Levels Rm. 9
11:30 – 1:00	Lunch – Exhibit Hall (Plaza Ballrooms A-E)							
	E1	**E2**	**E3**	**E4**	**E5**	**E6**	**Extended Session 10**	**Extended Session 9**
1:00 – 2:30 **Concurrent Session E**	Continuous Real-Time Monitoring: Applications in Lakes and Estuaries Rm. 14	Monitoring BMP Effectiveness Rm. 16	Integrating Probabilistic and Targeted Monitoring Rm. 11	Modeling at a Regional Scale Rm. 12	Volunteers and State Agencies: Collaborating for Better Decisions Rm. 17	Contaminant Effects on Aquatic Ecosystem Health 1 Rm. 15	Emerging New Approaches to Water Quality Trend Analysis, Part 1 Rm. 10	Using Stressor-Response Relationships to Address Hydrological and Nutrient Issues Rm. 9
2:30 – 3:30	Exhibit and Poster Viewing – Exhibit Hall (Plaza Ballrooms A-E)							
	F1	**F2**	**F3**	**F4**	**F5**	**F6**	**Extended Session 10**	**Extended Session 9**
3:30 – 5:00 **Concurrent Session F**	Continuous Real-Time Monitoring: Applications in Rivers and Streams Rm. 14	Regional Scale Wetlands Monitoring and Assessment Rm. 16	Water Quality Exchanges Improve Data Access and Sharing Rm. 11	Using Probabilistic Monitoring to Support State and Tribal Programs Rm. 12	Innovation and Longevity in Volunteer Monitoring Programs Rm. 17	Contaminant Effects on Aquatic Ecosystem Health 2 Rm. 15	Emerging New Approaches to Water Quality Trend Analysis, Part 2 Rm. 10	Using the BCG and Stressor-Response Information in an Urbanizing Setting Rm. 9
5:00 – 7:00	***Exhibit and Poster Reception*** – **Exhibit Hall** (Plaza Ballrooms A-E and Plaza Foyer)							

Wednesday, April 28

7:00 – 8:00	Breakfast – Exhibit Hall (Plaza Ballrooms A-E)							
	G1	**G2**	**G3**	**G4**	**G5**	**G6**	**Extended Session 11** Data Flow through the Monitoring Framework, Part 3 – USGS Data from the Lab to the Public Rm. 9	
8:00 – 9:30 **Concurrent Session G**	Continuous Real-Time Monitoring: Regulatory Perspectives Rm. 14	Biological Monitoring with Volunteers Rm. 17	Watershed Scale Protection and Restoration Assessments Rm. 11	Examining Nutrient Processing at Multiple Scales Rm. 16	Results and Importance of Comparability Studies Rm. 12	Evaluating Contaminant Trends in Surface-Water Quality: Streams and Rivers Rm. 15		
9:30 – 10:00	Break – Refreshments in Exhibit Hall (Plaza Ballrooms A-E)							
	H1	**H2**	**H3**	**H4**	**H5**	**H6**	**Extended Session 12** Science-Based Environmental Report Cards and Indicators from the Watershed to the National Scale Rm. 2	**Extended Session 2** Closing Interactive Panel Discussion for Continuous Real-Time Monitoring Rm. 10
10:00 – 11:30 **Concurrent Session H**	Statewide Bioassessment Rm. 16	Your Stream Overfloweth: Case studies in Monitoring Stormwater Quality Rm. 14	Using Data Sharing as a Pathway to Collaboration Rm. 11	Monitoring Network Design: Implementing Large Scale Solutions Rm. 12	Harmful Algal Blooms and Cyantoxins: How (Blue) Green is my Water? Rm. 17	Evaluating Contaminant Trends in Lakes and Reservoirs using Sediment Cores Rm. 15		
11:30 – 1:00	Lunch – Exhibit Hall (Plaza Ballrooms A-E)							
	I1	**I2**	**I3**	**I4**	**I5**	**I6**	**Extended Session 13** Is Your Monitoring Program Producing Measurable Results and How Do You Know?, Part 1 Rm. 9	**Extended Session 14** The National Lakes Assessment – Just How Good are the Nation's Lakes and Reservoirs, Part 1 Rm. 10
1:00 – 2:30 **Concurrent Session I**	Biological Assessments - Survey Design and Sampling Considerations Rm. 16	Tracking What Flows Downhill: Microbial Source Tracking Rm. 12	21st Century Technical Tools for Water Quality Assessments Rm. 14	Integrated Land-to-Sea Assessments Based on Multiple Networks Rm. 11	Contaminants in Groundwater Rm. 15	Prioritization of Chemicals for New Methods Development Rm. 17		
2:30 – 3:30	Break – Plaza Foyer							
	J1	**J2**	**J3**	**J4**	**J5**	**J6**	**Extended Session 13** Is Your Monitoring Program Producing Measurable Results and How Do You Know?, Part 2 Rm. 9	**Extended Session 14** The National Lakes Assessment – Just How Good are the Nation's Lakes and Reservoirs, Part 2 Rm. 10
3:30 – 5:00 **Concurrent Session J**	Coastal and Estuarine Assessments Rm. 12	Developme nt of Reference Condition for Different Purposes and at Different Scales Rm. 16	Integrating Water Quality Indicators to Support Monitoring and Assessment Decisions Rm. 17	Overcoming Barriers to Monitoring Collaboration and Partnerships Rm. 11	Evaluating Contaminant Trends in Groundwater Quality Rm. 15	Endocrine Disrupting Compounds - Identification, Sources, and Effects Rm. 14		
5:15 – 6:30	Methods Board Meeting – Room 17							
5:15 – 6:45	Volunteer Monitoring Meeting – Room 10							
6:00 – 9:00	USGS Continuous Water Quality Committee – Room 9							

Thursday, April 29

7:00 – 8:00	Breakfast – Plaza Ballroom ABC							
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**Extended Session 15**	**Extended Session 16**
8:00 – 9:30 **Concurrent Session K**	Water Quality Monitoring in Coastal and Marine Environments Rm. 12	Geospatial Assessments of Water Quality Rm. 16	Modeling of Nutrient Transport and Loadings Rm. 14	Monitoring Partnerships: Promoting Water Resource Stewardship and Protection Rm. 11	Transport and Distribution of Mercury through Aquatic Ecosystems Rm. 15	Agrochemical Monitoring Rm. 17	Working with Watershed Tools and Data to Get (and Show) Results, Part 1 Rm. 9	National Aquatic Resource Surveys: Transferring Technical Tools and Approaches, Part 1 Rm. 10
9:30 – 10:00	Break – Plaza Ballroom ABC							
	L1	**L2**	**L3**	**L4**	**L5**	**L6**	**Extended Session 15**	**Extended Session 16**
10:00 – 11:30 **Concurrent Session L**	Monitoring Hydrology: A Critical Consideration for the Interpretation of Water Quality and Biological Assessment Data Rm. 12	Climate Change: Monitoring Impacts on Water Quality and Quantity Rm. 15	Linking Sources and Stressors to Water Quality Rm. 17	Unique Collaborative Approaches for Successful Outcomes Rm. 11	Biomagnification of Mercury through Food Webs Rm. 16	Contaminant Threats to Drinking Water Rm. 14	Working with Watershed Tools and Data to Get (and Show) Results, Part 2 Rm. 9	National Aquatic Resource Surveys: Transferring Technical Tools and Approaches, Part 2 Rm. 10
11:30 – 1:30	**Closing Plenary Luncheon** – Plaza Ballroom ABC							
1:45 – 5:00	Monitoring and Assessment Partnership, a meeting of US EPA, States, and Tribes interested in enhancing the National Aquatic Resource Surveys – Rm. 14							
1:45 – 5:00	USGS National Water Quality Meeting: The Field – Rm. 11, The Data – Rm. 12, The Labs – Rm. 16, The Future – Rm. 17							
2:00 – 3:30	**Field Trip 5**: Tour of EPA Region 8 Office Green Building and Green Operations							

Plenary Agendas

Opening Plenary and Award Presentations

Monday, April 26, Plaza Ballroom F

10:45 am **Welcome to the 2010 National Monitoring Conference**
Pixie Hamilton, U.S. Geological Survey, NWQMC Co-Chair

10:50 am **Welcome to Denver**
Martha E. Rudolph, Executive Director, Colorado Department of Public Health and Environment

11:00 am **Introduction of Anne Castle**
Pixie Hamilton

11:05 am **The National Perspective**
Anne J. Castle, Assistant Secretary for Water and Science, U.S. Department of the Interior

11:30 am **Introduction of Tracy Mehan**
Charles Spooner, U.S. Environmental Protection Agency, NWQMC Co-Chair

11:35 am ***Flying Blind No More: Data and Monitoring as Indispensable Tools of Water Management***
G. Tracy Mehan III, Principal, The Cadmus Group and Former Assistant Administrator for Water, U.S. Environmental Protection Agency

12:00 pm **Presentation of the YSI Foundation Minding the Planet Grant**
Gayle Rominger, YSI

12:05 pm **Presentation of the Vision Award**
Val Connor, California State Water Resources Control Board

12:10 pm **Presentation of the Elizabeth Jester Fellows Award**
Charles Spooner

12:15 pm **Charge to Conference Participants**
Charles Spooner

Closing Plenary and Luncheon

Thursday, April 29, Plaza Ballroom ABC

11:30 am **Luncheon**

12:15 pm **Welcome to Closing Luncheon**
Pixie Hamilton, U.S. Geological Survey, NWQMC Co-Chair

12:20 pm **Introduction of Thomas Tidwell**
Sherry Hazelhurst, U.S. Forest Service

12:25 pm ***Water Delivery from Forests in an Era of Climate Change: Landscape-Scale Conservation***
Thomas L. Tidwell, Chief, U.S. Forest Service

12:50 pm **Introduction of Robert Hirsch**
Pixie Hamilton

12:55 pm ***Water Monitoring for a Changing World***
Robert M. Hirsch, Research Hydrologist and Former Associate Director for Water, U.S. Geological Survey

1:20 pm **Conference Closing & Invitation to 2012 Conference**
Charles Spooner, U.S. Environmental Protection Agency, NWQMC Co-Chair

Plenary Speakers

Anne J. Castle

Assistant Secretary for Water and Science, Department of Interior Washington, D.C.

Since June 2009, Anne Castle has served as the Assistant Secretary for Water and Science in the Department of Interior where she oversees water and science policy and has responsibility for the Bureau of Reclamation and the U.S. Geological Survey. As a partner in the Denver, Colorado office of Holland &Hart LLP from 1981 to 2009, Castle had an extensive practice that included litigation and multi-party negotiations involving water issues, water related transactions, and advice on water policy and strategy. Her clients included a wide assortment of water users. While at Holland & Hart she was elected to chair the firm's management committee and served in that position from 2001 to 2004. Castle has served on the South Platte River Basin Task Force; as chair and elected member of the Board of Directors, Genesee Water and Sanitation District; and as a member of the Colorado Ground Water Commission.

Castle has been listed in Best Lawyers in America for water law in 2007 and 2008. The Women's Vision Foundation selected her for its prestigious Woman of Vision award in 2008, recognizing positive, enlightened leadership and active promotion of the advancement of women within the law firm and in the community. She is featured in the November 2008 issue of Law Practice magazine in its leadership profile series.

G. Tracy Mehan, III

Principal, The Cadmus Group, Inc., Arlington, Virginia

G. Tracy Mehan, III, is Principal with The Cadmus Group, Inc., an environmental consulting firm, since 2004. Mehan served as Assistant Administrator for Water at the U.S. Environmental Protection Agency from 2001 to 2003. In that capacity he directed both the Clean Water and Safe Drinking Water Acts programs including permitting, infrastructure finance, wetlands regulation, standards and watershed management. During his tenure, he developed new policies and guidance on watershed-based permitting and water quality trading, and promoted expanded ambient water quality monitoring and innovative approaches to meeting the challenge of the infrastructure financing gap. He served as Environmental Stewardship Counselor to the 2004 G-8 Summit Planning Organization (2004).

Mehan also served as director of the Michigan Office of the Great Lakes (1993-2001), as Associate Deputy Administrator of EPA in 1992, and as director of the Missouri Department of Natural Resources from 1989 to 1992. In that capacity he managed the state's environmental, parks, historic preservation, geology and other programs. He represented the State of Missouri in all negotiations over the management of the Missouri River, as well as matters pertaining to water diversions including tribal reserved water rights potentially impacting main stem flows downstream.

Mehan is a graduate of Saint Louis University and its School of Law, and currently is an Adjunct Professor in Environmental Law at George Mason University School of Law. Presently, Mehan serves on the Water Science and Technology Board and the Committee on the Mississippi River and the Clean Water Act for the National Research Council of the National Academies. He has also served as an independent expert judge for the Municipal Water Conservation Achievement Award Program (2006) sponsored by The U.S. Conference of Mayors and its Urban Water Council. Mehan is a former board member for the Great Lakes Protection Fund and currently serves on the Boards of Directors of the Potomac Conservancy, the Great Lakes Observing System and the Clean Water America Alliance.

Thomas L. Tidwell

Chief, Forest Service, Washington, D.C.

Tom Tidwell grew up in Boise, Idaho, and graduated from Washington State University. He has spent 32 years with the Forest Service in a variety of positions. He began his Forest Service career on the Boise National Forest in fire, and has since worked on eight different national forests, in three regions. He has worked at all levels of the agency in a variety of positions, including District Ranger, Forest Supervisor, and Legislative Affairs Specialist in the Washington Office, where he worked on the planning rule, the 2001 roadless rule and the Secure Rural Schools County Payments Act. Tom served as the Deputy Regional Forester for the Pacific Southwest Region, with primary responsibility for fire and aviation management, recreation, engineering, state and private forestry and tribal relations. Under Tom's leadership, there was a significant increase in the Region's effectiveness to reduce hazardous fuels, and improved cooperation with CALFIRE on wildland fire suppression. Prior to this assignment, Tidwell served as the Regional Forester for the Northern Region, with responsibility for the national forests and grasslands in northern Idaho, Montana, North Dakota and portions of South Dakota. As the Regional Forester, Tom encouraged and supported community-based collaboration to find resolution on how and where to use active management to restore forest health and address wildfire threat to communities, and to provide protection for the values of unroaded landscapes. Tom's field experience includes working from the rural areas of Nevada and Idaho all the way to the urban Forests in California and the Wasatch-Cache National Forest in Utah, where he served as Forest Supervisor during the 2002 Winter Olympics.

Tom has extensive fire experience, beginning as a firefighter, and accumulating nineteen years as an agency administrator responsible for fire suppression decisions. Tom is married to Kim, and they have one daughter, MacKenzie.

Dr. Robert M. Hirsch

USGS Research Hydrologist, Reston, Virginia

Robert M. Hirsch currently serves as a Research Hydrologist at the USGS. From 1994 to 2008, he served as the Chief Hydrologist of the U.S. Geological Survey (USGS), responsible for all USGS water monitoring, assessment, and research programs. During his USGS tenure, Hirsch has played an instrumental role in developing several major USGS water quality and quantity programs, including: 1) the National Water Quality Assessment (NAWQA) Program: 2) the National Streamflow Information Program (NSIP); and 3) the National Water Information System Web (NWISWeb). Hirsch is a Fellow of the American Association for the Advancement of Science and an active member of the American Geophysical Union and the American Water Resources Association. Since 2003 he has served as the co-chair of the Subcommittee on Water Availability and Quality of the Committee on Environment and Natural Resources of the National Science and Technology Council, and in this role he has been instrumental in developing interagency priorities for water science and technology.

Hirsch earned a Ph.D. from the Johns Hopkins University Department of Geography and Environmental Engineering. He is co-author of the textbook "Statistical Methods in Water Resources," and has received numerous honors, including the 2006 American Water Resources Association's William C. Ackermann Medal for Excellence in Water Management, and rank of Meritorious Senior Executive by the President of the United States. Hirsch is a recipient of the USGS "Eugene M. Shoemaker Award for Lifetime Achievement in Communications."

He began his USGS career in 1976 as a hydrologist and has conducted research on water supply, water quality, pollutant transport, and flood frequency analysis. Since returning to a research position he has focused his efforts on methods for better documenting and understanding long-term changes in water quantity and quality in rivers. He is exploring century-scale trends in flooding nationwide and nutrient transport trends over several decades in rivers tributary to the Chesapeake Bay and the Gulf of Mexico.

Field Trips

Field trip attendees should meet in the Plaza Lobby of the Sheraton 15 minutes before your field trip is scheduled to depart.

Field Trip 1 – Mining and the Treatment of Mine Drainage

Sunday, April 25| 7:30 am – 5:00 pm | Price: $65

Note: Blizzard conditions in the mountains could cause cancellation of this trip.

This trip presents glimpses of the beginning and the end of mining operations and contains a mine tour sandwiched between tours of two water treatment facilities. We begin with a tour of the Breckenridge, Wellington-Oro Mine water treatment plant (that utilizes biologically augmented sulfide precipitation) followed by an underground tour of the Country Boy mine and museum. Lunch at a restaurant in Dillon, Colorado (bring your own cash). On the way back to Denver we will tour the Argo tunnel treatment plant as an example of another mine drainage treatment technique (traditional hydrated-lime iron precipitation). A visit to the Idaho Springs visitor center will occur, time pending. Bus time will include discussions of the history of mining in Colorado and techniques used to help identify locations for remediation of mining activity.

Additional Information: Participants should dress in layers prepared for cold weather outside and underground. Field gear is best as one could get dirty during the underground mine tour. Travel over a high mountain pass (elevation approx. 11,500 feet). Weather may be cold, snowy.

Field Trip 2 – Demonstration and Training in the National Wetland Condition Assessment Field Methods

Sunday, April 25 | 8:00 am – 5:00 pm | Price: No fee to attendees, but registration is required.

Learn about wetlands and help finalize field methods for the 2011 National Wetland Condition Assessment (NWCA). EPA invites states, tribes, and other interested parties to participate in a field-based, interactive workshop to demonstrate the proposed field methods for the 2011 NWCA. Participants will be transported to a nearby wetland site and trained by expert EPA and state wetland ecologists on the draft NWCA field methods. Participants will have the opportunity to implement all components of the field manual, including: establishing the assessment area and vegetation plots, identifying plant species, excavating soil pits and collecting soil samples, pore water samples, and algae samples. EPA will then solicit feedback on the overall usability of the methods and use the input to help finalize the field methods before the 2011 survey.

Additional Information: Participants must be dressed for the field. Some walking will be required, mostly on paved trails.

Field Trip 3 – Field Demonstration of Methods for Water-Quality Sampling & Monitoring

Sunday, April 25| 1:00 pm – 5:00 pm | Price: $20

Part 1 of the "Monitoring Framework"

This field trip is the first part of a tour through the NWQMC "Monitoring Framework," using USGS procedures to provide an example of the life-history of water-quality data from "collecting field data" through "conveying results and findings." On this afternoon field trip, USGS staff will demonstrate methods for stream-sample collection, sample processing, and continuous monitoring at the "Super Gage" on Clear Creek at Golden, on the west side of the Denver area.

Additional Information: Participants must be dressed for the field. Some walking will be required, mostly on paved trails.

Field Trip 4 – Tour of the USGS National Water-Quality Lab

Monday, April 26| 1:30 pm – 5:00 pm | Price: $20

Part 2 of the "Monitoring Framework"

This field trip is the second part of a tour through the NWQMC "Monitoring Framework." This half-day trip will be to the USGS National Water-Quality Laboratory (NWQL) at the Denver Federal Center. The NWQL combines a national research facility and production lab that produces state-of-the-art, low-level environmental chemistry analyses. The tour will include all aspects of the analytical process, from when the sample arrives at the lab, through various analytical methods, to data review and reporting. We'll also have a chance to meet with the Research & Development staff to discuss their work on new analytic methods.

Additional Information: Participants will need a picture ID, such as a driver's license, for entry to the Federal Center.

Field Trip 5 – Tour of EPA Region 8 Office Green Building and Green Operations

Thursday, April 29| 2:00 pm – 3:30 pm | Price: No fee to attendees, but registration is required.

We are pleased to invite you to visit our EPA Region 8 Office building at 1595 Wynkoop Street, which stands as a tangible example of our mission "to protect human health and the environment." We have developed a one hour tour program that will introduce you to the design features, green products, innovative technologies and business practices that make this building a model of sustainability.

EPA Region 8 is working to decrease its impact on the natural environment by working in a high performance, green building and paying close attention to the environmental impact of our daily activities. The building Region 8 Headquarters occupies achieved the gold rating under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) and was designed and constructed in a more environmentally friendly way than a traditional building. Features that help decrease environmental impact include:

- Extensive use of daylight to reduce need for artificial light
- A vegetated green roof to control storm water and decrease urban heat island effect
- Waterless urinals and low-flow plumbing fixtures to decrease water use
- High recycled content materials throughout the building help preserve resources

Region 8's Environmental Management System helps us improve our environmental performance by quantifying the impact of our operations (e.g., electricity, water, material consumption and transportation) and taking actions to reduce those impacts.

Additional Information:

- Bring a government-issued picture ID (i.e., a driver's license) with you on the day of the tour. You will be asked to show this ID as you enter the lobby.
- Arrive 15 minutes before the start of your tour. No Earlier. Unless arranged in advance. Our security screening process is similar to screening at the airport. You will be asked to walk through a magnetometer (removing metal objects from your pockets) and your coats, bags, etc. will be x-rayed. We regret that we do not have facilities to check coats or bags.
- You will be provided with a visitor badge after you pass through security. Please wear this at all times while you are in the building.
- Photography is not allowed in the building. We have a library of building photos that are available.

Extended Sessions

Most extended sessions carry a registration fee. You may register for one of these great sessions at the Registration Desk. **Seating is limited, so register early!**

Extended Session 1 – Cancelled

Extended Session 2 – Plenary Seminar for Continuous Real-Time Monitoring: Direct Measures and Surrogates

Monday, April 26 | 8:00 – 10:30 am | $20 to attend this plenary and the closing session on Wednesday, April 28 | Room 14

Organized by Andy Ziegler, USGS

Speakers will introduce sessions for the continuous real-time monitoring session track of the conference – monitor operation and data evaluation, sensor basics, evaluation and application of real time nitrogen sensors, continuous monitor applications in lakes and estuaries, continuous monitor applications in rivers and streams, status of the NWQMC sensor workgroup, and regulatory perspectives. Andy Ziegler (USGS) will present an overview of worldwide real-time water quality monitoring and networks. Stewart Rounds (USGS) will present a history of long-term continuous water-quality monitoring in Oregon. Mario Tamburri (Alliance for Coastal Technologies) will present on tools required for coastal monitoring and ocean observing. Heather Powell (NEON, Inc.) will present an overview of the current design of the NEON water-quality network to define baseline water conditions in reference watersheds in the US. Future directions will be offered by each of the speakers as an introduction to the technical and closing sessions.

Closing Interactive Panel Discussion for Continuous Real-Time Monitoring

Wednesday, April 28 | 10:00 – 11:30 am | $20 to attend the plenary session on Monday, April 26 and this closing session | Room 10

Organized by Andy Ziegler, USGS

Andy Ziegler (USGS) will moderate a panel discussion to summarize future directions in continuous real-time water quality monitoring. The panel will be composed of the moderators from each of the continuous real-time water-quality monitoring technical sessions. Session moderators include Reed Green (USGS), Ken Hyer (USGS), Janice Fulford (USGS), Dan Sullivan (USGS), Rob Ellison (YSI), and Chuck Spooner (EPA).

The following questions, introduced in the plenary seminar and discussed during the conference, will be the focus for this session:

- Where do we need to go? (What isn't getting done that is needed for instruments, protocols, databases, etc.?)
- Why aren't we there? (What are the technological and other impediments?)
- How do we fill these gaps to get where we need to go?

Extended Session 3 – Using NHD and State GIS Information to Improve National Aquatic Resource Survey Designs

Monday, April 26 | 8:00 – 10:30 am | $20 | Room 11

Organized by Tony Olsen, US EPA

The objective of this workshop is to develop approaches for integrating GIS data layers (e.g., NHD) used by states and the National Aquatic Resource Surveys in their probability monitoring designs. Integrating these sample frames will not only improve the quality of the information used for the survey designs but also further the long-term goal of integrating state and NARS survey designs. The Wadeable Streams Assessment, National Lake Assessment, National Rivers and Streams Assessment and National Coastal Assessment survey designs relied mainly on NHD-Plus for the sample frames. Concurrently, many state probability survey designs used either NHD-Plus or a derivative of NHD as their sample frames. In several instances, state sample frames have been integrated into the NARS sample frames, most recently for the National Coastal Assessment. When state and NARS designs are implemented, site evaluations are conducted providing information that can be used to improve the sample frames (e.g., whether a lake is actually a lake or a stream site has flowing water). This workshop will discuss how sample frames are currently constructed by states and NARS staff. Then participants will identify procedures that will improve integration of state and NARS sample frames and incorporate site evaluation information into NHD.

Extended Session 4 – Guidelines for Design, Sampling, Analysis, and Interpretation for Cyanobacterial Toxin and Taste-And-Odor Studies in Lakes and Reservoirs

Monday, April 26 | 8:00 – 10:30 am | $20 | Room 10

Organized by Jennifer Graham and Keith Loftin, USGS

Cyanobacteria cause a multitude of water-quality concerns, including the potential to produce toxins and taste-and-odor compounds. Toxins and taste-and-odor compounds may cause significant economic and public health concerns and are of particular interest in lakes, reservoirs, and rivers that are used for drinking-water supply, recreation, or aquaculture. Federal and state agencies, resource managers, drinking-water treatment-facility operators, lake associations, and local officials increasingly are faced with decisions about managing cyanobacterial blooms that affect local economies and public awareness, exposure, and health. Many different approaches have been used in the design, sample collection, and analysis of studies addressing cyanobacterial toxins and taste-and-odor compounds and consistent, reliable guidance is not readily available. The purpose of this session is to provide guidance for the design, sample collection, sample analysis, and interpretation for studies of cyanobacteria and associated toxins and taste-and-odor compounds. The session will combine lecture and discussion, and provide numerous examples based on experience and real data.

Extended Session 5 – Building a Case for Causes of Biological Impairment

Monday, April 26 | 8:00 – 10:30 am | $20 | Room 12

Organized by Susan Cormier, US EPA

This short course will explore the arguments used to develop a case for or against possible causes of biological impairments. Participants will be introduced to the philosophical and scientific foundations of causation and the four broad types of environmental assessments. They will gain a working knowledge of planning, analysis, and synthesis used in causal assessment described by the U.S. EPA Stressor Identification process and the resources available at www.epa.gov/caddis. In particular, students will become familiar with refutation, diagnosis, and weight of evidence as a means for identifying probable causes of biological impairment. Diverse and multiple causes will be discussed such as temperature, conductivity, toxicity, sediment, and eutrophication. Examples will be drawn from case studies of streams and watersheds from around the United States.

Extended Session 6 – Building Successful State, Regional, and Tribal Water Monitoring Councils

Monday, April 26 | 1:30 – 5:00 pm | Room 9

Organized by Tracy Hancock, USGS, John Hummer, Great Lakes Commission, & Abby Markowitz, Condatus Consulting

This session is a facilitated, interactive panel discussion, focusing on forming, building, and sustaining successful water monitoring councils, whether at the State, Regional, or Tribal level. Panelists will contribute case study examples from various types of councils as well as alternatives to formal monitoring councils (e.g., partnerships and alliances). We will explore various ways stakeholders organize to share water monitoring information (e.g., an annual or water quality issue-oriented meeting). In addition to case study presentations, the session will include substantial time for questions and discussion among all the participants. We look forward to your suggestions as to how the National Water Quality Monitoring Council might assist with the formation and growth of monitoring councils, such as facilitating communication and collaboration among councils in various phases of development and discussion.

Extended Session 7 – Man vs. Stats

Monday, April 26 | 1:30 – 5:00 pm | $20 | Room 10

Organized by Dennis Helsel, Practical Stats

Data can be dangerous – not like the textbook cases presented back in your college course. Dangers such as skewness, outliers and nondetect values lurk, ready to strike. This workshop will teach basic survival skills for analysis of environmental data. Survival skills include when to transform data and why, how to handle outliers, and advantages of newer nonparametric and permutation tests for scientific data analysis. Common pitfalls of traditional methods will be discussed. Danger signs in regression will be taught so you can spot them in the field. Attending this workshop will clear up misconceptions, point to further resources, and get you heading in the right direction.

Extended Session 8 – Sensors Basics: Tools to Enhance the Quality and Comparability of Sensors Data for Continuous Real-Time Monitoring

Tuesday, April 27 | 8:00 – 11:30 am | $20 | Room 10

Organized by Dan Sullivan, USGS

Users of water-quality sensors will learn basic concepts in data quality and be introduced to tools that have been developed to promote the generation of field measurements of known and documented quality. Participants will take part in an interactive discussion to compile and examine different aspects of data quality, including data usability, reliability, validity, and measurement quality. This will be followed by a demonstration of simple hands-on activities that trigger discussion of the sources of measurement error and other aspects of data quality. This session will also include perspectives from sensor manufacturers on what they emphasize is necessary to achieve a high level of data quality and what quality assurance activities are needed in field monitoring. Last but not least, participants will also learn how to enhance the representativeness of their data when they deploy their sensors.

Extended Session 9 – Defining the Relationship between Disturbance, Stressors and Biological Condition at State, Regional and National Levels

Series of four 90-minute sessions | $20 for one or all four sessions

Emerging Applications of the Biological Condition Gradient (BCG)

Tuesday, April 27 | 8:00 – 9:30 am | Room 9

Facilitated by Susan Jackson, US EPA

In this session, we examine how the BCG framework can be used to understand and enhance protection of aquatic resources. Emerging applications of the BCG in water quality management are presented including discussion of collaboration among states in the North East, establishing biological thresholds protective of aquatic life use, and strengthening implementation of state antidegradation policies. Potential for application of the BCG framework in the EU is also discussed.

Presentations:

- Emerging Applications of the Biological Condition Gradient (BCG): Moving Beyond BCG 101!, Susan Davies, ME
- The Northeast Managers' Pilot Project, Kerry Strout, New England Interstate Water Pollution Control Commission
- Use of the BCG to help characterize the quality of reference sites, Jackson, Passmore, Hammer, Laidlaw, Davis, Yuan
- The Application of Tiered Aquatic Life Use (TALU) Principles in Developing a Biotic Index for Pennsylvania's Antidegradation Program, Brian Chalfant, PA
- Comparison of the Biological Condition Gradient and the Water Framework Directive, Wayne Davis, US EPA and Christian Feld, University of Duisberg-Essen, Germany

Biological Condition Gradient (BCG) Development and Calibration at State, Regional, and National Levels

Tuesday, April 27 | 10:00 – 11:30 am | Room 9

Facilitated by Ellen Tarquinio, US EPA and Dave Courtemanch, ME

In this session, we will examine the development and calibration of the biological condition gradient model at different spatial scales and the implications for cross-jurisdicational collaboration. Key opportunities and issues will be identified and discussed including different perspectives on solutions and paths forward. Application of the BCG as a framework for interpretation of national surveys will be explored. Analysis of results of different BCG modeling and calibration exercises will be presented. A multiscaled BCG model for estuaries but with potential application to inland systems will be presented.

Presentations:

- Exploring the possibilities for developing and using the BCG at the state/national/regional scale, Ellen Tarquinio, US EPA and Dave Courtemanch, ME
- Biological Assessment: How far can we generalize a quantitative BCG model?, Jeroen Gerritsen, Tetra Tech , Inc.
- Development of Estuarine BCG – a model for multi-scale BCG (individual habitat and habitat mosaic), Giancarlo Cicchetti, US EPA
- Development of BCG at the national scale- while we do have experience with BCG at state and regional scales, let's begin the discussion about where we go from here and explore the potential and the issues related to applying the BCG at a national scale, Chris Yoder, MBI
- Panel Discussion

Using Stressor-Response Relationships to Address Hydrological and Nutrient Issues
Tuesday, April 27 | 1:00 – 2:30 pm | Room 9

Facilitated by Susan Jackson, US EPA and Dave Courtemanch, ME

In this session, we examine the possibilities and issues in using the BCG framework and stressor-response relationships to prevent or mitigate the impacts of altered hydrology and nutrient enrichment. Current applications of stressor-response relationships in State water quality programs are discussed as well as the management application of a scientific model relating the hydrogical regime to biological condition. Using nutrient criteria as an example, an examination of the issues and opportunities in using response-stressor relationships in criteria development will be presented, kicking off a discussion session with the panel of speakers.

Presentations:

- Introduction to the session: issues and opportunities, Susan Jackson and Dave Courtemanch
- Relating biological condition and hydrology in Ohio, Chris Yoder, MBI
- Developing the relationship between hydrological regime (flow) and biological condition, Eloise Kendy, The Nature Conservancy
- Maine's Freshwater Nutrient Criteria, Tom Danielson, ME
- Using stressor-response relationships to derive candidate nutrient criteria, Lester Yuan, US EPA
- Open Discussion of Issues and Opportunities

Using the Biological Condition Gradient (BCG) and Stressor-Response Information in an Urbanizing Setting
Tuesday, April 27 | 3:30 – 5:00 pm | Room 9

Facilitated by Gerard McMahon, USGS

In this session, we examine how the BCG framework can be used to understand and manage water quality in urbanizing stream ecosystems. Data from a gradient-based USGS study of the "Effects of Urbanization on Stream Ecosystems" are used to assess the relation between urbanization, reach scale stressors, and algae, invertebrate, and fish communities, using both correlation/regression approaches and a Bayes Net Approach. The Bayes Net approach is used to explicitly assess the network of relations between watershed and reach scale stressors, macroinvertebrates, and BCG tiers. Management approaches are discussed that address specific stressors identified in these analyses.

Presentations:

- Opportunities and challenges to using BCG and stressor-response information in an urbanizing setting, Gerard McMahon, USGS and Susan Davies, ME
- Stream studies in 9 metropolitan areas of the USA: understanding the effects of urbanization across the nation, Larry Brown, USGS
- Using a Bayesian Network Approach to Model the Effects of Urbanization on the Condition of Benthic Macroinvertebrate Assemblages in the Northeast U.S. as Defined by the Biological Condition Gradient, Roxolana Kashuba, Duke University
- The Integration of Monitoring and Modeling to Implement Effective Watershed Management Plans, Neely Law, Center for Watershed Protection
- Open Discussion of Issues and Opportunities

Extended Session 10 – Emerging New Approaches to Water Quality Trend Analysis

Tuesday, April 27 | 1:00 – 5:00 pm | $20 | Room 10

Organized by Bob Hirsch, USGS

Over the past 30 years, a variety of statistical approaches have been developed for the analysis of trends in water quality data. Practitioners are often troubled by the question: which method should I use, given my data set and my goals? This session will focus on how this question might be answered. It will draw on the ideas and experience of several experienced developers and users of these methods. It will also explore some of the common problems with many of the methods and describe some of the new approaches that are being applied to overcome these problems. These new developments that will be discussed include consideration of the following data set characteristics:

1. Data sets with large fractions of the data being censored values ("less thans")
2. Very rich data sets spanning several decades with several hundred observations
3. Regional data sets with large numbers of contemporaneous observations but with very low sampling frequency
4. Methods that consider the role of streamflow history in addition to current streamflow as important determinants of water quality
5. Methods that incorporate large spatial data sets (geographic snapshots) repeated over time to assess trends

Extended Session 11 – Data Flow through the Monitoring Framework, Part 3 – USGS Data from the Lab to the Public

Wednesday, April 28 | 8:00 – 9:30 am | $30 | Room 9

Organized by Dave Mueller, USGS

This seminar is the third part of a tour through the NWQMC "Monitoring Framework", using the flow of USGS data as an example. Part 1 is a field trip to a river sampling site (Sunday afternoon) and part 2 is a tour of the USGS National Water-Quality Laboratory (Monday afternoon). This third session will begin with a review of sampling and lab analysis, and then follow the data through the remaining steps of the monitoring process:

- Compiling and managing data
- Assessing and interpreting data
- Conveying results and findings

Presentations in this seminar will emphasize the quality-assurance measures USGS takes within this process to ensure that the best possible information on water-quality is disseminated to the public.

Extended Session 12 – Science-Based Environmental Report Cards and Indicators from the Watershed to the National Scale

Wednesday, April 28 | 10:00 – 11:30 am | Room 2

Organized by Tracy Hancock, USGS

This facilitated, interactive panel discussion will focus on the use of indicators in water-quality and watershed assessments and management, particularly indicator system development and how indicators developed at smaller scales (e.g., watershed) can be nested to inform larger scale (e.g., state or national) assessments. Panelists will discuss how indicators for disparate environmental and other system components can be aggregated into a single reporting process. These issues will be discussed during state and federal institution presentations, including discussion of the water indicators under development as a component of the National Environmental Status and Trends (NEST) effort, and USEPA's water condition indicators as a component of their National Water Program measures.

Panelists:

- Mary Skopec, Supervisor, Watershed Monitoring and Assessment Section, Iowa Department of Natural Resources (facilitator)
- Denice Shaw, Office of Research and Development, U.S. Environmental Protection Agency
- Leslie McGeorge, Administrator, Water Monitoring and Standards, New Jersey Department of Environmental Protection
- Fraser Shilling, Scientist, Department of Environmental Science and Policy, University of California at Davis
- Bob Hirsch, Research Hydrologist, U.S. Geological Survey
- Carol Murray, Senior Systems Ecologist and Principal, ESSA Technologies Ltd.

Extended Session 13 – Is Your Monitoring Program Producing Measurable Results and How Do You Know?

Wednesday, April 28 | 1:00 – 5:00 pm | $20 | Room 9

Organized by Barb Horn, Rocky Mountain Watershed Network and Colorado Division of Wildlife

The title question is one every monitoring program should be asking itself at some frequency, regardless of whether it is a governmental agency, private or a volunteer monitoring program. Each monitoring program was started for some set of reasons, in some context and evolves over time, usually reacting to the situation and resources of the moment. Whether your monitoring program is 50 years old or brand new, is a state agency implementing the Clean Water Act or a volunteer program monitoring a local stream, our efforts should be relevant. The ability to document relevance keeps funders, constituents and volunteers happy but most importantly tells us if we are really protecting and preserving our waterways. If we are the voices for our waterways, we need to be able to monitor our progress. How do you know your monitoring efforts are relevant, making a difference or producing measurable results? Have you ever evaluated your monitoring program in context with your organization's mission, motivation or needs of volunteers collecting the data or targeted decision maker's information needs?

In this workshop, you will evaluate your monitoring program for its ability to produce measurable results. You will learn how to design a measurable effort if you have not started monitoring. We will identify target decision makers, quantify their information needs and evaluate how that affects:

1) Study design elements (what you do, when, where, how, why and managing raw data),

2) Turning raw data into information, delivery of information or the data-pathway, data management for information

3) How to evaluate monitoring for measurable results in a systematic manner

Colorado's River Watch Program will be provided as a case study to conduct this evaluation. This river watch program is over 20 years old, produces chemical, biological and physical data primarily for Colorado's Clean Water Act processes such as listing of 303(d) impaired stream segments, major basin criteria hearings and to develop criteria such as nutrient standards.

This interactive session will employ the Rocky Mountain Watershed Network's Monitoring and Assessment Design Workbook evaluation tool to evaluate Colorado's program along with your program. Each participant will receive a session workbook and CD of the entire workbook.

Extended Session 14 – The National Lakes Assessment – Just How Good are the Nation's Lakes and Reservoirs – Technical Underpinnings of the NLA and Applications for Statewide Lakes Surveys

Wednesday, April 28 | 1:00 – 5:00 pm | $20 | Room 10

Organized by Neil Kamman, Vermont Agency of Natural Resources

The National Lakes Assessment (NLA) reports on the quality of lakes and reservoirs using consistent multi-media indicators of ecological integrity, recreational suitability, and water quality, at national and ecoregional scales, using a probability-based approach. The NLA is of particular interest to state lakes programs and to statewide and smaller-scale lake associations. The NLA has been conducted in full partnership with states and states' own partners (e.g., lake associations, volunteer groups, allied governmental organizations) in a transparent collaborative fashion. The NLA team has executed the survey in a manner that is highly compliant with NWQMC's mission to "Communicate, Collaborate, and Coordinate" by following all steps in the monitoring cycle. This session is one method by which the NLA team will simultaneously communicate results, coordinate follow-up state survey analyses, and collaborate on the planning of future national lake survey initiatives.

This session is being presented by nine members of NLA analysis team. Presenters will provide details on how the NLA was carried out, while providing training in the use of some of the tools developed by the survey team. The first half will focus on what was done to develop and use the NLA results. Participants will be introduced very briefly to the overall survey results, and then be provided detailed information on the derivation of reference conditions, the development of the biological indicators of the survey, and uses of the data to develop extended regional assessments. The second half of the session will be dedicated to how individuals can use the survey data. Analysis team members will demonstrate how to conduct assessments using advanced "R" statistics, and also a simple Excel-based tool that is packaged and ready-to-go. Participants will also understand how the physical habitat indicators used in the NLA can be calculated using field data from non-NLA lakes, and also how to evaluate and interpret estimates of relative and attributable risk that relate lake stressors to biological impact.

Extended Session 15 – Working with Watershed Tools and Data to Get (and Show) Results

Thursday, April 29 | 8:00 – 11:30 am | $30 | Room 9

Organized by Cynthia Curtis, US EPA

In this hands-on workshop, participants will pull together data and online tools and customize them to their watershed. Participants will leave the workshop with useful materials and contacts to apply to their own watershed work. Tools that are covered include EPA's My Environment, Enviromapper for water, Google Earth, STORET (watershed summary), Data2 Maps (D2M), NPS outreach tool, and Audacity (modify a PSA for a local watershed). Participants should bring their laptops for this hands-on training.

Extended Session 16 – National Aquatic Resource Surveys: Transferring Technical Tools and Approaches

Thursday, April 29 | 8:00 – 11:30 am | $20 | Room 10

Organized by Sarah Lehmann, US EPA

The U.S. Environmental Protection Agency, states, and tribes are conducting a series of national aquatic resource surveys. Often referred to as probability-based surveys, these surveys are designed to assess the status of the nation's waters, identify key stressors, promote collaboration across jurisdictions in providing comparable water quality assessments, and help build state/tribal water monitoring program capacity. An important aspect of these surveys is building and transferring tools associated with the National Aquatic Resource Surveys (NARS) implementation and data assessment. The objective of this workshop is to provide background information on the NARS and then to focus on several key tools available for states, tribes, and others to use in applying NARS data. These technical tools and discussions include screening for reference sites, modifying "R" code to produce population estimates using a probabilistic dataset and examining important aspects of and results from comparability studies. Participants will receive electronic copies of the "R" code presented during the session as well as the Wadeable Streams Assessment and National Lakes Assessment datasets. Participants will have the opportunity to ask questions about these tools, learn how to use them, and provide direct feedback to the NARS team on improving and expanding the available tools.

Concurrent Session Presentations

Monday, April 26

Session A1: Continuous Real-Time Monitoring: Operation and Data Evaluation

Room 14
1:30 – 3:00 pm

Moderator: Robert Ellison, YSI

1:35 pm *U.S. Geological Survey Real-Time Water-Quality Data on the Web in 2010*, **Bradley Garner**, USGS

1:55 pm *Water-quality monitors have improved! Evaluation of real-time water-quality monitoring in the Little Arkansas River Basin near Wichita, Kansas, 1998-2009*, **Trudy Bennett**, USGS

2:15 pm *Value Engineering Study of US Geological Survey Continuous Water-Quality Monitor Data Collection and Processing*, **Kevin Richards**, USGS and **Robert Ellison**, YSI

2:35 pm *Targeting Field Investigations Using Continuous Water Quality Monitoring in the North Bosque and Leon River Watersheds*, **Chuck Dvorsky**, Texas Commission on Environmental Quality

Session A2: Indices of Biotic Integrity for Wetlands

Room 17
1:30 – 3:00 pm

Moderator: Gary Kohlhepp, Michigan Department of Natural Resources and Environment

1:35 pm *The Development of Monitoring Methodologies and Indices of Biotic Integrity for North Carolina Wetlands*, **Virginia Baker**, North Carolina Department of Environment and Natural Resources

1:55 pm *Vegetation Index of Biotic Integrity (VIBI) for Headwater Wetlands in Colorado's Southern Rocky Mountains: Development, Calibration, and Application*, **Joanna Lemly**, Colorado Natural Heritage Program

2:15 pm *Vegetation Index of Biotic Integrity for Ohio Wetlands*, **Mick Micacchion**, Ohio Environmental Protection Agency

2:35 pm *Amphibians as Indicators - Development and Use of the Amphibian Index of Biotic Integrity for Ohio Wetlands*, **Mick Micacchion**, Ohio Environmental Protection Agency

Session A3: Developing Nutrient Criteria 1

Room 15
1:30 – 3:00 pm

Moderator: Charles Rhoades, US Forest Service

1:35 pm *Nutrient Criteria and Standards for Forested Headwater Streams: An Overview of Issues and Solutions*, **George Ice**, National Council for Air and Stream Improvement

1:55 pm *Characterizing Variability of Stream Chemistry at U.S. Forest Service Experimental Forests - Applicability to Development of Numeric Nutrient Criteria for Headwater Forests*, **Charles Rhoades**, US Forest Service

2:15 pm *Comparing Reference Stream Nutrient Concentrations to Harm-to-Beneficial-Use Concentrations Derived from Regional Nutrient Dose-Response Studies: Implications for Setting Nutrient Criteria*, **Michael Suplee**, Montana Department of Environmental Quality

2:35 pm *Developing Numeric Nutrient Criteria in Florida*, **Jeffery Vowell**, Florida Division of Forestry

Session A4: Lessons Learned from National Assessments

Room 11
1:30 – 3:00 pm

Moderator: Jason Jones, Arizona Department of Environmental Quality

1:35 pm *National Rivers and Streams Assessment Project - Ohio's Experience*, **Gregg Sablak**, Ohio Environmental Protection Agency

1:55 pm *Integrating Modeling and Surveys for More Effective Assessments*, **Gretchen Oelsner**, US EPA

2:15 pm *National Aquatic Resource Survey Core Indicators – Appropriate to Determining Arctic and Sub-Arctic Aquatic Ecosystem Status?*, **Douglas Dasher**, Alaska Department of Environmental Conservation

2:35 pm *The 2007 National Lake Assessment - Findings and Lessons from Wisconsin*, **Timothy Asplund** and **Paul Garrison**, Wisconsin Department of Natural Resources

---

Session A5: Strategies for Growing a Volunteer Monitoring Program

Room 12
1:30 – 3:00 pm

Moderator: Jason Pinchback, Texas Stream Team, River Systems Institute

1:35 pm *Monitoring with Community Based AmeriCorps Programs*, **Danielle Donkersloot**, New Jersey Department of Environmental Protection

1:55 pm *EPA's Volunteer Monitoring Equipment Loan Program in New England*, **Tom Faber**, US EPA

2:15 pm *Using Publicity and Community Outreach to Retain Citizen Stream Monitoring Volunteers*, **Kristine Stepenuck**, University of Wisconsin-Extension

2:35 pm *Using eLearning to Support Water Quality Data Management*, **Dave Wilcox**, Gold Systems, Inc.

Session A6: Monitoring and Assessing Groundwater Vulnerability 1

Room 16
1:30 – 3:00 pm

Moderator: Wayne Lapham, USGS

1:35 pm *Groundwater Vulnerability - An Overview of Concepts and Assessment Methodolgies*, **Mike Wireman**, US EPA

1:55 pm *Evaluation of Recharge in Selected Aquifer Systems of the United States Using Tracers of Groundwater Age – What Does it Say About Groundwater Vulnerability?*, **Peter McMahon**, USGS

2:15 pm *Evaluating Aquifer Susceptibility and Vulnerability in Selected Aquifers of the United States: An Improved Modeling Strategy that Incorporates Prediction Uncertainty and Effects of Aquifer Complexity*, **Tristan Wellman**, USGS

2:35 pm *Effects of Development on Groundwater Quality in the Denver Basin, Colorado*, **Suzanne Paschke**, USGS

Session B1: Evaluation and Application of New Technologies for Real-time Monitoring

Room 14
3:30 – 5:00 pm

Moderator: Janice Fulford, USGS

3:35 pm *Continuous Monitoring of Nitrate plus Nitrite and Dissolved Organic Carbon using Ultraviolet-Visible Spectrophotometry in Two New Jersey Rivers*, **Lawrence Feinson**, USGS

3:55 pm *Experiences Using UV Nitrate Sensors for Continuous, In-Situ Measurements*, **Janice Fulford**, USGS

4:15 pm *Comparison of Periodic Sampling and Continuous Monitoring for Determining Effects of Seasonality and Stream Discharge on Nitrate-Nitrogen Concentrations in Agricultural Watersheds*, **Rob Middlemis-Brown**, USGS

4:35 pm *Seeing the light: Applications of in situ optical measurements for understanding dissolved organic matter dynamics in river systems*, **Brian Pellerin**, USGS

Session B2: Developing New Biological Assessment Tools

Room 17
3:30 – 5:00 pm

Moderator: Ellen Tarquinio, US EPA

3:35 pm *A stream algal bioassessment incorporating the Biological Condition Gradient to evaluate tiered aquatic life uses in Maine*, **Tom Danielson**, Maine Department of Environmental Protection

3:55 pm *A Benthic Invertebrate Index for the Nearshore Ocean Waters of New Jersey - Its Development and Application*, **Robert Schuster**, New Jersey Department of Environmental Protection

4:15 pm *Modeling Macroinvertebrate Multi-metric Index Scores in Connecticut's Rivers and Streams Using Landscape Variables -An Approach to Support Restoration Goals and Anti-degradation Policy*, **Chris Bellucci**, Connecticut Department of Environmental Protection

4:35 pm *Water microbioms – indicators of water quality*, **Toomas Neuman**, Biotap LLC

Session B3: Developing Nutrient Criteria 2

Room 15
3:30 – 5:00 pm

Moderator: Leslie McGeorge, New Jersey Department of Environmental Protection

3:35 pm *Assessing Nutrient Impacts in New Jersey Waters*, **Debra Hammond**, New Jersey Department of Environmental Protection

3:55 pm *A linked set of nutrient and biological criteria for the protection of designated uses for Vermont lakes and wadeable streams*, **Neil Kamman**, Vermont Department of Environmental Conservation

4:15 pm *Development of Nutrient Criteria for Lakes and Reservoirs in Northern Plains States*, **Lan Tornes** and **Mark Deutschman**, Houston Engineeering, Inc.

4:35 pm *Numeric Nitrogen Criteria for Streams to Protect Downstream Estuarine Waters in Florida*, **James Hagy**, US EPA

Session B4: Monitoring the Effects of Development on Hydrology and Water Quality

Room 12
3:30 – 5:00 pm

Moderator: Karl Hermann, US EPA

3:35 pm *Online Database, Retrospective Assessment, and Monitoring Program of Water Quality in the Upper Yampa River Basin, Northwestern Colorado, 1975-2009*, **Nancy Bauch**, USGS

3:55 pm *Water-Quality Characteristics of Watersheds in Metropolitan Atlanta, Georgia, 2003-2007*, **Jacob LaFontaine**, USGS

4:15 pm *Trend Analysis for Selected Analytes, South Platte River, Denver, CO*, **Jon Novick**, Denver Department of Environmental Health

4:35 pm *Urban Steam Monitoring Network: Monitoring and Assessment of Chemical, Habitat and Watershed Influences on Aquatic Life in Kansas City Urban Streams*, **Gary Welker**, US EPA

Session B5: Modeling Ecological Conditions

Room 11
3:30 – 5:00 pm

Moderator: Daren Carlisle, USGS

3:35 pm *Predicting Environmental Reference Conditions in Streams from Watershed Geology*, **John Olson**, Utah State University

3:55 pm *NWSA's Physical Habitat Approach - Combining knowledge of habitat requirements with mechanisms of geomorphic and anthropogenic influence on stream channel form*, **Philip Kaufmann**, US EPA

4:15 pm *Establishing Thermal Reference Conditions: Development of Stream Temperature Models in Support of Biological Monitoring and Assessment in the Western USA*, **Ryan Hill**, Utah State University

4:35 pm *Predictive models for streamflow characteristics and assessment of hydrological alteration*, **Daren Carlisle**, USGS

Session B6: Monitoring and Assessing Groundwater Vulnerability 2

Room 16
3:30 – 5:00 pm

Moderator: Michael Rupert, USGS

3:35 pm *Local Government Perspective on Conducting Water Resource Investigations for Optimal Watershed Management*, **Ray Merry**, Eagle County Department of Environmental Health, Colorado

3:55 pm *Predicting the Probability of Groundwater Contamination in the Eagle River Watershed Valley-Fill Aquifer, North-Central Colorado, Using Groundwater Age and Low-Level Volatile Organic Compounds*, **Michael Rupert**, USGS

4:15 pm *Parameter and predictive uncertainty analyses for unsaturated zone nitrogen fate and transport models*, **Bernard Nolan**, USGS

4:35 pm *An Invaluable $25 Investment: Using Isotopes to Better Characterize the Groundwater Quality of the Gila Valley Sub-Basin, Southeastern Arizona*, **Douglas Towne**, Arizona Department of Environmental Quality

Session C1: Monitoring Stressors and Impacts to Lakes and Reservoirs

Room 17
8:00 – 9:30 am

Moderator: Neil Kamman, Vermont Agency of Natural Resources

8:05 am *Assessing Seasonal Inputs of Dissolved Pesticides to the Salton Sea from the Alamo River*, **James Orlando**, USGS

8:25 am *Monitoring the Quality of Water, Sediment, and Aquatic Biota of Lake Powell through the National Park Service and U.S. Geological Survey's Water Quality Assessment and Monitoring Program*, **Robert Hart**, USGS

8:45 am *Shorezone Water-Quality Monitoring Program for Lake Tahoe, California and Nevada*, **Timothy Rowe**, USGS

9:05 am *Measuring the effects of lakeshore development on littoral habitat and macroinvertebrates*, **Kellie Merrell**, Vermont Department of Environmental Conservation

Session C2: Monitoring for Stormwater Management Effectiveness

Room 16
8:00 – 9:30 am

Moderator: Peter Tennant, ORSANCO

8:05 am *Monitoring Stormwater: Do's, Don'ts, Why's and How's*, **Thomas Ballestero**, University of New Hampshire

8:25 am *UDFCD Stormwater BMP Monitoring Program*, **Holly Piza**, Urban Drainage and Flood Control District, Denver, CO

8:45 am *Urban Stormwater BMP Performance and Cost Effectiveness in the Capitol Region Watershed District*, **Melissa Baker**, Capitol Region Watershed District, Saint Paul, MN

9:05 am *Using Stormwater Ponds in East Tampa to Promote Sustainable, Healthy Communities: A Community Partnership Approach*, **Maya Trotz**, University of South Florida

Session C3: Interpreting Water Quality Data

Room 14
8:00 – 9:30 am

Moderator: Richard Mitchell, US EPA

8:05 am *Data Uncertainty Estimation Tool for Hydrology and Water Quality (DUET-H/WQ): Estimating Measurement Uncertainty for Monitoring and Modeling Applications*, **Daren Harmel**, USDA-ARS

8:25 am *Multivariate Methods with Nondetects*, **Dennis Helsel**, Practical Stats

8:45 am *Serial Correlation and Trend Option Basics in the Era of Frequent Data Measurements*, **Roy Irwin**, National Park Service

9:05 am *Increasing Awareness, Understanding, and Availability of Statistical Methods for Water Quality Monitoring and Assessment*, **Douglas McLaughlin**, National Council for Air and Stream Improvement

Session C4: Downstream Impacts from Mined Lands 1

Room 15
8:00 – 9:30 am

Moderator: Katie Walton-Day, USGS

8:05 am *Monitoring spatial and temporal loading patterns to understand contamination from hard-rock mining*, **Briant Kimball**, USGS

8:25 am *Collaborative Efforts to Characterize a Watershed Impacted by Abandoned Mines Using Multiple Sampling Techniques: A Case Study for Lefthand Creek Watershed, CO*, **Alice Conovitz**, Integral Consulting Inc.

8:45 am *Characterization of water quality in a hydrothermally altered and historically mined watershed, Warden Gulch, Colorado*, **Erik Oerter**, Colorado Geological Survey

9:05 am *Impact of historic uranium mining and current mine development operations on water resources in the Grand Canyon Region, Coconino and Mohave Counties, Arizona*, **Donald Bills**, USGS

Session C5: National Monitoring Network: Monitoring Water Quality from Inland to Coastal Ecosystems

Room 12
8:00 – 9:30 am

Moderator: Pixie Hamilton, USGS

8:05 am *The National Water Quality Monitoring Network – Now and into the Future*, **Pixie Hamilton**, USGS

8:25 am *San Francisco Bay Water Quality: Lessons Learned from Four Decades of USGS Observations*, **Tara Schraga**, USGS

8:45 am *Lake Michigan National Monitoring Network Demonstration Pilot - Preliminary Results and Future Plans*, **Charles Peters**, USGS

9:05 am *Progress of the Delaware River Basin Demonstration Project of the National Water Quality Monitoring Network*, **Eric Vowinkel**, USGS

Session C6: PAHs and Coal-Tar-Based Pavement Sealcoat: Stormwater Management, Toxicology, and Public Policy

Room 11
8:00 – 9:30 am

Moderator: Barbara Mahler, USGS

8:05 am *Pavement Sealcoat, PAHs, and the Environment: An Introduction*, **Barbara Mahler**, USGS

8:25 am *PAHs and Parking Lots: A Field Study on PAHs Exported From Sealed and Unsealed Parking Lots at the UNH Stormwater Center*, **Alison Watts**, University of New Hampshire

8:45 am *Contribution of PAHs from Coal-Tar Pavement Sealcoat to 40 U.S. Lakes Evaluated Using Mass-Balance Receptor Modeling*, **Peter Van Metre**, USGS

9:05 am *Low-Hanging Fruit in PAH Reduction: Developing and Implementing a Ban on Coal Tar Pavement Products in the District of Columbia*, **Hamid Karimi** and **Brian Van Wye**, District of Columbia Department of the Environment

---

Session D1: Wetlands Condition Monitoring and Assessment

Room 17
10:00 – 11:30 am

Moderator: Sherry Hazelhurst, US Forest Service

10:05 am *Forging the Link between Wetland Monitoring & Assessment and "Traditional" Water Monitoring Programs*, **David Davis** and **Michelle Henicheck**, Virginia Department of Environmental Quality

10:25 am *Applying Tiered Aquatic Life Uses and the Biological Condition Gradient Model to Maine Wetlands*, **Jeanne DiFranco**, Maine Department of Environmental Protection

10:45 am *Comparison of Three Tiered Wetland Assessment Methods for use on Wetlands in the Prairie Pothole Region*, **Christina Hargiss**, North Dakota State University

11:05 am *Developing a Level 1-2-3 Approach to Wetland Assessment and Monitoring in Montana*, **Karen Newlon**, Montana Natural Heritage Program

---

Session D2: New Tools and Approaches in Data Analysis and Reporting

Room 11
10:00 – 11:30 am

Moderator: Dave Wilcox, Gold Systems, Inc.

10:05 am *H2O Info – A Web-Based Citizen's Tool for Turning Real-Time Water Quality Monitoring Data into Information*, **Christopher Magruder** and **Mike Benedict**, Milwaukee Metropolitan Sewerage District

10:25 am *Water Quality Report Card*, **Warren Kimball**, Massachusetts Department of Environmental Protection

10:45 am *Design and Compilation of a Water Resources Geodatabase for the Rio Grande Basin – San Acacia, New Mexico to Fort Quitman, Texas*, **Thomas Burley**, USGS

11:05 am *Outreach Tools for Obtaining Park Vital Sign Monitoring Data*, **Barry Long**, National Park Service

---

Session D3: Elements of a Long-Term National Ground-Water Monitoring Network and a State-Scale Example

Room 16
10:00 – 11:30 am

Moderator: David Wunsch, New Hampshire Geological Survey

10:05 am *Challenges for Long-Term Implementation of a National Groundwater Monitoring Network*, **Robert Schreiber**, Camp Dresser & McKee

10:25 am *An Example of Using Baseline, Surveillance, Unstressed, and Targeted Monitoring in the Evaluation of Changing Conditions of Ground-Water Quantity and Quality*, **Rick Copeland**, Florida Geological Survey

10:45 am *Lessons Learned: Florida's Status and Trend Surface and Ground Water Monitoring Programs*, **Rick Copeland**, Florida Geological Survey

11:05 am *Status of Pilot Projects for the Proposed National Ground Water Monitoring Network*, **William Cunningham**, USGS

Session D4: Downstream Impacts from Mined Lands 2

Room 15
10:00 – 11:30 am

Moderator: Doug Glysson, USGS

10:05 am *Copper exposure-response relationships derived from monitoring data and their utility to risk management of the Clark Fork River, MT*, **Daniel Cain**, USGS

10:25 am *Influence of Dissolved Organic Matter in Determining Aquatic Copper Toxicity in Iron-Rich Environments*, **Kathleen Smith**, USGS

10:45 am *Assessment of Nonpoint Source Chemical Loading Potential to Watersheds Containing Uranium Waste Dumps Associated with Uranium Exploration and Mining, San Rafael Swell, Utah*, **Mike Freeman**, USGS

11:05 am *Phase I- Jordan River, Utah, Riparian Restoration for the Midvale Slag Superfund Site*, **Erna Waterman**, US EPA and **Terry Kenney**, USGS

Session D5: Effective Communication Leads to Action

Room 12
10:00 – 11:30 am

Moderator: Linda Green, University of Rhode Island

10:05 am *Getting the Message Out: Communicating Water Science*, **Kara Capelli**, USGS

10:25 am *Peer-reviewed Papers to Podcasts and Beyond: Disseminating the Findings from a Long-term Monitoring Study*, **Camille Flinders**, National Council for Air and Stream Improvement

10:45 am *"SWAPS" - Effective Information Exchange at the Watershed Level*, **Barb Horn**, Colorado Division of Wildlife

11:05 am *It makes perfect sense to me, why can't they understand? Conveying technical information to a non-technical audience*, **Shelley Stanley**, City of Northglenn, CO

Session D6: Pharmaceuticals and Other Emerging Contaminants Above and Below the Water's Surface

Room 14
10:00 – 11:30 am

Moderator: Jim Laine, West Virginia Department of Environmental Protection

10:05 am *Combined Sewer Overflows as a Source of Hormones to Surface Water*, **Patrick Phillips**, USGS

10:25 am *Emerging Contaminants in the Columbia River Basin: Examining Sources and Investigating Impacts on the Foodweb*, **Jennifer Morace**, USGS

10:45 am *Occurrence of EDC/PPCPs in Arizona Waters and Impact of Recreational Activities*, **Chao-An Chiu**, Arizona State University

11:05 am *Potential for Biodegradation of Contaminants of Emerging Concern in the Environment*, **Paul Bradley**, USGS

Session E1: Continuous Real-Time Monitoring: Applications in Lakes and Estuaries

Room 14
1:00 – 2:30 pm

Moderator: Reed Green, USGS

1:05 pm *Real-Time Monitoring in the Fraser River Estuary, British Columbia: A Federal-Provincial Water Quality Monitoring and Surveillance Buoy*, **Jennifer MacDonald**, Environment Canada

1:25 pm *Measuring constituent flux in a tidal environment: suspended-sediment flux in San Francisco Bay*, **David Schoellhamer**, USGS

1:45 pm *Monitoring the spatially and temporally variable Great Lakes nearshore using continuously towed instrumentation*, **Glenn Warren**, US EPA

2:05 pm *Real-Time Lake and Reservoir Meteorological and Vertical Water-Quality Monitoring*, **W. Reed Green**, USGS

Session E2: Monitoring BMP Effectiveness

Room 16
1:00 – 2:30 pm

Moderator: Greg Pettit, Oregon Department of Environmental Quality

1:05 pm *The USDA Forest Service's National Best Management Practice Program*, **Pamela Edwards**, US Forest Service

1:25 pm *Demonstrating Success in the Beaty Creek Watershed: Benefits of Continuous Flow-Weighted Data and Paired Watershed Monitoring*, **Stacey Day**, Oklahoma Conservation Commission

1:45 pm *The Good, the Bad and Everything in Between: Evaluating Water Quality Indices and Their Use in Monitoring Agricultural BMPs and Aquatic Ecosystem Health in a Southern Alberta River*, **Janet Scott**, University of Alberta

2:05 pm *High Level Indicators of Oregon's Forested Streams*, **Shannon Hubler**, Oregon Department of Environmental Quality

---

Session E3: Integrating Probabilistic and Targeted Monitoring

Room 11
1:00 – 2:30 pm

Moderator: Dave Chestnut, South Carolina Department of Health and Environmental Control

1:05 pm *Assessment Results from Probabilistic Sampling of Wisconsin's Streams*, **Michael Miller**, Wisconsin Department of Natural Resources

1:25 pm *Notes on a Method for Integrated Biological and Water Quality Stream Surveys*, **Robert Miltner**, Ohio Environmental Protection Agency

1:45 pm *Use of Biological Monitoring Results at Multiple Spatial Scales: Site Specific to Area Wide*, **James Stribling**, Tetra Tech, Inc.

2:05 pm *An Approach for Combining Targeted Diagnostic Monitoring and Probabilistic Ecological Monitoring to Assess the Extent of Impairment in California Streams*, **John Hunt**, University of California, Davis

---

Session E4: Modeling at a Regional Scale

Room 12
1:00 – 2:30 pm

Moderator: Charlie Crawford, USGS

1:05 pm *Upper Gera Watershed (Germany) – Areal Assessment of Water-Quality Monitoring and Associated Model Application*, **Marcel Wetzel**, Friedrich-Schiller-University, Germany

1:25 pm *Sources of Suspended Sediment in the Chesapeake Bay Watershed: A Regional Application of the SPARROW Model*, **John Brakebill**, USGS

1:45 pm *Analyzing SPARROW Data to Quantify Changes in Salt Load from Irrigation*, **Travis James**, USDA-Natural Resources Conservation Service

2:05 pm *SPARROW Decision Support*, **Nathaniel Booth**, USGS

Session E5: Volunteers and State Agencies: Collaborating for Better Decisions

Room 17
1:00 – 2:30 pm

Moderator: Elizabeth Herron, University of Rhode Island

1:05 pm *The Evolution of Virginia Volunteer Water Monitoring Programs: From Public Engagement to Influencing Policy*, **Chris French**, Alliance for the Chesapeake Bay

1:25 pm *Developing Volunteer Monitoring Programs to Support State Agency Restoration Efforts*, **Ginger North**, Delaware Nature Society

1:45 pm *Uses of Missouri Stream Team Data*, **Chris Riggert**, Missouri Department of Conservation

2:05 pm *Citizen Monitoring and TMDL Programs Partner to Identify E. coli Sources, Build Media Relations, Build Trust*, **Jason Pinchback**, Texas Stream Team, River Systems Institute

---

Session E6: Contaminant Effects on Aquatic Ecosystem Health 1

Room 15
1:00 – 2:30 pm

Moderator: Kathy Kuivila, USGS

1:05 pm *Monitoring for Current-Use Pesticides in Amphibians and the Water and Sediment in Their Habitat*, **William Battaglin**, USGS

1:25 pm *Measuring Tissue Concentrations to Link Current-use Pesticide Exposure to Aquatic Ecosystem Health*, **Kelly Smalling**, USGS

1:45 pm *Identifying Sources of Toxicity to Hyalella in the Santa Margarita Watershed*, **Matthew Rich**, MACTEC Engineering and Consulting, Inc.

2:05 pm *Patterns of Fish and Macroinvertebrate Communities Exposed to Pulp and Paper Mill Effluent in Four US Receiving Streams*, **Camille Flinders**, National Council for Air and Stream Improvement

---

Session F1: Continuous Real-Time Monitoring: Applications in Rivers and Streams

Room 14
3:30 – 5:00 pm

Moderator: Ken Hyer, USGS

3:35 pm *Continuous Water Quality Monitoring in the Upper Clear Creek/Standley Lake Watershed – Westminster, Colorado*, **Andrew Cross**, City of Westminster, Colorado

3:55 pm *Real-Time Water-Quality Monitoring and Regression Analysis to Estimate Constituent Concentrations in the Menomonee River Watershed, Milwaukee, Wisconsin*, **David Graczyk**, USGS

4:15 pm *Computing Time-Series Suspended-Sediment Concentrations and Loads from In-Stream Turbidity-Sensor and Streamflow Data*, **Patrick Rasmussen**, USGS

4:35 pm *Trends in Selenium concentration and load in the Gunnison and Colorado Rivers determined using surrogate data from continuous monitors*, **Ken Leib**, USGS

Session F2: Regional Scale Wetlands Monitoring and Assessment

Room 16
3:30 – 5:00 pm

Moderator: Barbara Scott, Kentucky Division of Water

3:35 pm *Probability-Based Sample Designs for Wetland Condition Assessment: Lessons Learned from Real-World Applications in the Rocky Mountains*, **Joanna Lemly**, Colorado Natural Heritage Program

3:55 pm *Gulf of Mexico Coastal Wetlands: A Regional Assessment Perspective*, **Michael Scozzafava**, US EPA

4:15 pm *Toward a Mid-Atlantic Regional Wetlands Condition Assessment*, **Sarah Miller**, Pennsylvania State University

4:35 pm *Establishing a Wetlands Monitoring Program in North Carolina with emphasis on a Piedmont Watershed and a Coastal Plain Watershed*, **Rick Savage**, North Carolina Department of Environment and Natural Resources

---

Session F3: Water Quality Exchanges Improve Data Access and Sharing

Room 11
3:30 – 5:00 pm

Moderator: Danielle Donkersloot, New Jersey Department of Environmental Protection

3:35 pm *Water Quality Data Management and Exchange Among Tribes through a Tribal Consortium*, **Osa Odum**, Northwest Indian Fisheries Commission

3:55 pm *New Jersey's Ambient Water Quality Data Exchange System*, **Paul Morton**, New Jersey Department of Environmental Protection

4:15 pm *The Ocean Data Partnership Exchange Network (ODPX): Building a consensus-based system for discovery, accessibility, and interoperability of diverse water data in the Northeast US and Canada*, **Paul Currier**, New Hampshire Department of Environmental Services

4:35 pm *The USGS-USEPA Water-Quality Data Exchange*, **Nathaniel Booth**, USGS

Session F4: Using Probabilistic Monitoring to Support State and Tribal Programs

Room 12
3:30 – 5:00 pm

Moderator: Sarah Lehmann, US EPA

3:35 pm *Increasing State Biological Monitoring Capabilities Using Probabilistic Monitoring Strategies*, **Jason Hill**, Virginia Department of Environmental Quality

3:55 pm *Probabilistic Monitoring on Arizona Streams*, **Jason Jones**, Arizona Department of Environmental Quality

4:15 pm *Texas' Contributions to the National Probabilistic Surveys and Future Direction of the State's Biological Monitoring Program*, **Anne Rogers**, Texas Commission on Environmental Quality

4:35 pm *Probabilistic Wadeable Streams Survey in Puerto Rico*, **James Kurtenbach**, US EPA

Session F5: Innovation and Longevity in Volunteer Monitoring Programs

Room 17
3:30 – 5:00 pm

Moderator: Barb Horn, Colorado Division of Wildlife

3:35 pm *Volunteer Monitoring: A Sound Investment*, **Julie Vastine**, Dickinson College

3:55 pm *Success Stories: the Northeast's Long-Term Lake Volunteer Monitoring Programs*, **Linda Green**, University of Rhode Island

4:15 pm *River Watch's Evolution Over the Past 20 Years*, **Sarah Tolan**, Colorado River Watch

4:35 pm *Using Volunteers to Collect Ground Water Information: Examples from New Hampshire*, **David Wunsch**, New Hampshire Geological Survey

Session F6: Contaminant Effects on Aquatic Ecosystem Health 2

Room 15
3:30 – 5:00 pm

Moderator: Jerry Diamond, Tetra Tech, Inc.

3:35 pm *Diagnostic Tools to Evaluate Impacts of Trace Organic Compounds on Aquatic Populations and Communities*, **Jerry Diamond**, Tetra Tech, Inc.

3:55 pm *Monitoring Contaminant Exposure of Endangered Species: Lethal, Non-lethal and Surrogate Approaches*, **Adria Elskus**, USGS

4:15 pm *Sediment toxicity testing: (1) Contaminants of emerging concern and (2) Methods for conducting exposures with early life stages of freshwater mussels*, **Chris Ingersoll**, USGS

4:35 pm *A USGS Partnership to Investigate Freshwater Mussel Health Decline: Clinch River Basin in Virginia and Tennessee*, **Jennifer Krstolic**, USGS

Session G1: Continuous Real-Time Monitoring: Regulatory Perspectives

Room 14
8:00 – 9:30 am

Moderator: Chuck Spooner, US EPA

8:05 am *Working Together: Updates on Measurement, Monitoring, and Laboratory Science Issues*, **Lara Autry**, US EPA

8:25 am *Effectively Managing Water Resources by the Use of Near Real-Time Water Quality Monitoring in Partnership with Industry*, **Renée Paterson**, Newfoundland and Labrador Department of Environment and Conservation

8:45 am *Nowcasting to Protect Public Water Supply: Using Real Time Data in a Flow and Transport Model to Evaluate a Spill Emergency*, **Robert Limbeck**, Delaware River Basin Commission

9:05 am *Water Temperature: How to Measure and Interpret the Data*, **Philip Russell**, Littleton/Englewood Wastewater Treatment Plant, Colorado

Session G2: Biological Monitoring with Volunteers

Room 17
8:00 – 9:30 am

Moderator: Kristine Stepenuck, University of Wisconsin-Extension

8:05 am *Invasive Species Monitoring Approaches for Volunteer Programs*, **Elizabeth Herron**, University of Rhode Island

8:25 am *Amphibian Monitoring with the Georgia Adopt-A-Stream Volunteer Program*, **Tara Muenz**, Georgia Environmental Protection Division

8:45 am *Utilizing Volunteers for Big River Biological Monitoring*, **Amy Meier**, Missouri Department of Conservation

9:05 am *Utilization of Large Scale Rapid Screening with Marine Plankton Toxicity Tests by a Citizen Monitoring Group*, **Justin Hohn**, San Diego Coastkeeper

Session G3: Watershed Scale Protection and Restoration Assessments

Room 11
8:00 – 9:30 am

Moderator: Michael Scozzafava, US EPA

8:05 am *A Technical Guide for Identifying and Protecting Healthy Watersheds*, **Laura Gabanski**, US EPA and Corey Godfrey, The Cadmus Group

8:25 am *Recovery Potential Screening for Prioritizing Restoration in Maryland Watersheds*, **Douglas Norton**, US EPA

8:45 am *Assessing Wetland Wildlife Habitat Acquisition and Restoration Opportunities at the Watershed Scale: Milwaukee River Basin, WI*, **Thomas Bernthal**, Wisconsin Department of Natural Resources

9:05 am *Demonstration of an Urban Stream Restoration Project to Reduce Sediment and Nutrient Loadings in the Illinois River Watershed*, **Sandi Formica**, Watershed Conservation Resource Center, AR

Session G4: Examining Nutrient Processing at Multiple Scales

Room 16
8:00 – 9:30 am

Moderator: Jane Caffrey, University of West Florida

8:05 am *Applying SPARROW to Determine the Source and Delivery of Phosphorus to Lakes in the Northeastern and Mid-Atlantic Regions of the United States*, **Richard Moore**, USGS

8:25 am *Principal nutrient sources and transport mechanisms in the Missouri River Basin, where reservoirs and irrigation contribute to a distinctive nutrient cycling signature*, **Juliane Brown**, USGS

8:45 am *Influence of Nutrients and Other Factors on Agricultural Stream Ecosystems: Integrating Bioassessment and Experimental Information*, **Christopher Mebane**, USGS

9:05 am *Seasonal Variations in Stream Metabolism in Four Environmental Settings across the United States*, **Jerad Bales**, USGS

Session G5: Results and Importance of Comparability Studies

Room 12
8:00 – 9:30 am

Moderator: Ellen Tarquinio, US EPA

8:05 am *A comparison of assessment outcomes based on macroinvertebrate condition indices from the New England region using National Wadeable Stream Assessment probability sites*, **David Neils**, New Hampshire Department of Environmental Services

8:25 am *Evaluation of the Lake Macroinvertebrate Integrity Index (LMII) and Alternate Indices for Eastern US Lakes and Reservoirs*, **Sheila North**, Dynamac Corp co/US EPA

8:45 am *Assessing Aquatic Life Use Support on a Great River*, **Peter Tennant**, ORSANCO

9:05 am TBD

Session G6: Evaluating Contaminant Trends in Surface-Water Quality: Streams and Rivers

Room 15
8:00 – 9:30 am

Moderator: Robert Ward, Professor Emeritus, Colorado State University

8:05 am *A Quarter Century of Declining Suspended Sediment Fluxes in the Mississippi River*, **Brian Hughes**, USGS

8:25 am *Water-Quality Data-Assessment of Long-Term Time Trends, Weser River Basin, Germany – A Case Study*, **Timothy D. Steele**, TDS Consulting Inc.

8:45 am *Temporal and spatial trends of pharmaceuticals in the Rhine*, **Peter Stoks**, Association of Rhine River Water Works, Netherlands

9:05 am *Trends in Pesticide Concentrations in Corn-Belt Streams, 1996–2006*, **Aldo Vecchia**, USGS

Session H1: Statewide Bioassessment

Room 16
10:00 – 11:30 am

Moderator: Cathy Tate, USGS

10:05 am *The Maryland Biological Stream Survey: Evolution of a Probability-based Monitoring Program*, **Ronald Klauda**, Maryland Department of Natural Resources

10:25 am *The Surface Water Register: an empirically improved sample frame for monitoring Kansas rivers and streams*, **Elizabeth Smith**, Kansas Department of Health and Environment

10:45 am *Integrating Water Resource Monitoring Data from Diverse Sources: The Willamette Basin (Oregon) Rivers and Streams Assessment*, **Michael Mulvey**, Oregon Department of Environmental Quality

11:05 am *California's Sophisticated State Bioassessment Program and the Challenge of Translating its Tools into a Successful Citizen Monitoring Program*, **James Harrington**, California Department of Fish and Game

---

Session H2: Your Stream Overfloweth: Case Studies in Monitoring Stormwater Quality

Room 14
10:00 – 11:30 am

Moderator: Gregg Good, Illinois Environmental Protection Agency

10:05 am *Local Urban Stormwater Monitoring, Results, and Implications for Future Management*, **Matthew Loyas**, Capitol Region Watershed District, Saint Paul, MN

10:25 am *Sediment Transport from Urban, Urbanizing, and Rural Areas in Johnson County, Kansas, 2006-08*, **Casey Lee**, USGS

10:45 am *Sediment and Phosphorus Evaluation of an Urban Watershed in the Illinois River Watershed*, **Sandi Formica**, Watershed Conservation Resource Center, AR

11:05 am *The impact of stormwater on occurrence of pathogenic and antibiotic-resistant bacteria in urban surface waters*, **Lisa Reynolds Fogarty**, USGS

Session H3: Using Data Sharing as a Pathway to Collaboration

Room 11
10:00 – 11:30 am

Moderator: Barb Horn, Colorado Division of Wildlife

10:05 am *Environmental Visualization Tools*, **Cristina Grosso**, San Francisco Estuary Institute

10:25 am *Use of a Wiki Portal for Watershed Management: An Integrated Approach*, **Soumya Chennapragada**, San Diego Coastkeeper

10:45 am *KCWaters.org – An Interactive Venue to Share Data, Connect Partners, and Help Protect Waterbodies in the Kansas City Metropolitan Area*, **Jeffery Robichaud**, US EPA

11:05 am *USGS-Pakistan Science and Technology Exchange – Creation of a Water Resources Data System for Pakistan*, **Sandy Williamson**, USGS

Session H4: Monitoring Network Design: Implementing Large Scale Solutions

Room 12
10:00 – 11:30 am

Moderator: Gary Kohlhepp, Michigan Department of Natural Resources and Environment

10:05 am *New Zealand's National Rivers Water Quality Network (NRWQN) – 21 years old and still going strong*, **David Smith**, New York City Department of Environmental Protection (retired)

10:25 am *Regional Ambient Fish Tissue Monitoring Program*, **Laura Webb**, US EPA

10:45 am *Longitudinal Spatial Patterns in Riverine Ecological Indicators in the Pacific Northwest; Implications for River Survey Design*, **Alan Herlihy**, Oregon State University

11:05 am *Pennsylvania's Monongahela River Basin Conductivity Monitoring Network*, **Tony Shaw**, Pennsylvania Department of Environmental Protection

---

Session H5: Harmful Algal Blooms and Cyantoxins: How (Blue) Green is my Water?

Room 17
10:00 – 11:30 am

Moderator: Jennifer Graham and Keith Loftin, USGS

10:05 am *Efforts in California to address risk from cyanotoxins and the significance of cyanotoxin ecotoxicology*, **Regina Linville**, California Office of Environmental Health Hazard Assessment

10:25 am *Recreational Exposure to Microcystins during Algal Blooms in Small Lakes*, **Lorraine Backer**, National Center for Environmental Health, CDC

10:45 am *Developing a Harmful Algal Bloom Integrated Observing System for the Gulf of Mexico*, **Ann Jochens**, Texas A&M University

11:05 am *Monitoring to Determine Geosmin Sources and Concentrations in a Northern Colorado Reservoir*, **Jill Oropeza**, City of Fort Collins Utilities, CO

Session H6: Evaluating Contaminant Trends in Lakes and Reservoirs using Sediment Cores

Room 15
10:00 – 11:30 am

Moderator: Peter Van Metre, USGS

10:05 am *Zinc and Copper Isotopes as Tracers of Anthropogenic Contamination in Lake Sediments*, **David Borrok**, University of Texas at El Paso

10:25 am *Application of paleolimnology to a large river to reconstruct metal and organic contaminant inputs*, **Marc Desmet**, ENTPE, France

10:45 am *Sediment Profiles and Accumulation Rates of Mercury and Methylmercury during the Past ~ 100 years, Great Salt Lake, Utah*, **David Naftz**, USGS

11:05 am *Is Sediment Quality Getting Better or Worse? Evaluation of Historical Trends in Lake-Bottom Sediment Using an Overall Measure of Contamination*, **Barbara Mahler**, USGS

Session I1: Biological Assessments – Survey Design and Sampling Considerations

Room 16
1:00 – 2:30 pm

Moderator: Karl Hermann, US EPA

1:05 pm *The condition of stream biological communities and the factors that influence them: A national perspective based on land use*, **Daren Carlisle**, USGS

1:25 pm *Monitoring Water Quality at the Epicenter of Aquatic Biodiversity*, **Fred Leslie**, Alabama Department of Environmental Management

1:45 pm *South Carolina's Integrated Indices Approach for Assessing Water Quality, Sediment Quality and Biotic Condition and Its Uses by Resource Managers*, **Robert VanDolah**, South Carolina Department of Natural Resources

2:05 pm TBD

Session I2: Tracking What Flows Downhill: Microbial Source Tracking

Room 12
1:00 – 2:30 pm

Moderator: Dave Chestnut, South Carolina Department of Health and Environmental Control

1:05 pm *New Jersey's Application of Microbial Source Tracking Techniques in Recreational Waters*, **Robert Schuster**, New Jersey Department of Environmental Protection

1:25 pm *Occurrence and Sources of Escherichia coli in Metropolitan St. Louis Streams, October 2004 through September 2007*, **Jerri Davis**, USGS

1:45 pm *A multifaceted approach to microbial source tracking within the natural environment*, **Megan Monroe**, Tetra Tech, Inc.

2:05 pm *Semi-quantitative evaluation of fecal contamination by human, ruminant, and alternate sources in Upper Fountain Creek, Colorado*, **Don Stoeckel**, Don Stoeckel Environmental

---

Session I3: 21st Century Technical Tools for Water Quality Assessments

Room 14
1:00 – 2:30 pm

Moderator: Sandy Williamson, USGS

1:05 pm *Ecosystem Services Monitoring and Valuation for Better Environmental Decision-making*, **Michael McDonald**, US EPA

1:25 pm *Better Monitoring Program Management through the ATTAINS System*, **Charles Kovatch**, US EPA

1:45 pm *Data Management, Integration and Sharing at the State and Regional Level*, **Dave Wilcox**, Gold Systems, Inc.

2:05 pm *Where's the Data? Improvements in Access to USGS Water Data*, **Yvonne Stoker**, USGS

Session I4: Integrated Land-to-Sea Assessments Based on Multiple Networks

Room 11
1:00 – 2:30 pm

Moderator: Pixie Hamilton, USGS

1:05 pm *Using multiple lines of information to develop eelgrass-based nutrient criteria for New Hampshire's Great Bay Estuary*, **Ru Morrison**, NERACOOS, NH

1:25 pm *Bight Regional Monitoring Program: Coordinating existing programs to provide large scale regional assessments in southern California*, **Stephen Weisburg**, Southern California Coastal Water Research Project

1:45 pm *A Preliminary Evaluation of Trinity River Sediment and Nutrient Loads into Galveston Bay, Texas, During Two Periods of High Flow*, **Michael Lee**, USGS

2:05 pm *Combining monitoring programs observations with models to characterize water quality variability and the role of nitrogen loading: informing management of Narragansett Bay*, **Henry Walker**, US EPA

Session I5: Contaminants in Groundwater

Room 15
1:00 – 2:30 pm

Moderator: Gary Rowe, USGS

1:05 pm *Distribution of Naturally-Occurring Perchlorate in Groundwater in the Southwestern US*, **Miranda Fram**, USGS

1:25 pm *Virus Concentrations in Non-Disinfected Groundwater Used for Drinking: Association with Community Rates of Acute Gastrointestinal Illness*, **Mark Borchardt**, Marshfield Clinic Research Foundation, WI

1:45 pm *Natural Contamination of Domestic Wells in Rural Northern Nevada*, **Ralph Seiler**, USGS

2:05 pm *Predicting the probability of arsenic occurrence in groundwater from bedrock wells in New Hampshire for Environmental Public Health Tracking*, **Joseph Ayotte**, USGS

Session I6: Prioritization of Chemicals for New Methods Development

Room 17
1:00 – 2:30 pm

Moderator: Herb Buxton, USGS

1:05 pm *Disinfection By-Products: Research Plans of the United States Geological Survey*, **Michelle Hladik**, USGS

1:25 pm *Prioritization of High-Production-Volume Chemicals for Assessing Water Resources*, **John Zogorski**, USGS

1:45 pm *Pharmaceuticals in the Environment: A Prioritization for Analytical Methods Development*, **Edward Furlong**, USGS

2:05 pm *Prioritizing Pesticide Compounds for Water Quality Assessment Based on Potential Importance to Human and Ecological Health*, **Julia Norman**, USGS

Session J1: Coastal and Estuarine Assessments

Room 12
3:30 – 5:00 pm

Moderator: Greg Colianni, US EPA

3:35 pm *Water Quality Status of the Nation's Coasts: Incorporating the Nearshore Great Lakes into the National Coastal Condition Assessment*, **Treda Grayson**, US EPA

3:55 pm *Regional Assessment of Sediment Contamination from Marshes to the Continental Shelf: Results of the Western Component of the U.S. EPA National Coastal Assessment*, **Walter Nelson**, US EPA

4:15 pm *Partnering with USEPA to Document Water Quality in our Coastal National Parks*, **Eva DiDonato**, National Park Service

4:35 pm *Linking Monitoring Efforts in the Mississippi River Watershed with Monitoring of Hypoxia in the Gulf of Mexico*, **Nancy Rabalais**, Louisiana Universities Marine Consortium

---

Session J2: Development of Reference Condition for Different Purposes and at Different Scales

Room 16
3:30 – 5:00 pm

Moderator: Tom Sanders, Colorado State University

3:35 pm *Landscape Assessment and Predictive Tools: Methods Guidance for Monitoring, Assessment, and Other Clean Water Act Programs*, **Jim Harrison**, US EPA

3:55 pm *Large River Bioassessment: Challenges and Approaches Used for the Delaware River*, **Robert Limbeck**, Delaware River Basin Commission

4:15 pm *A Framework for Selecting Least Impacted Reference Streams based on Landscape Models for use in Assessing Biotic Integrity of Wadeable Streams in Wisconsin*, **Jana Stewart**, USGS

4:35 pm *Selecting Reference Sites across Ecoregions: The Rocky Mountain ReMAP*, **Linda Vance**, Montana Natural Heritage Program

---

Session J3: Integrating Water Quality Indicators to Support Monitoring and Assessment Decisions

Room 17
3:30 – 5:00 pm

Moderator: Tony Shaw, Pennsylvania Department of Environmental Protection

3:35 pm *Long-term Monitoring: Exploring an Integrated Approach*, **Douglas Yeskis**, USGS

3:55 pm *Integrated sampling on the Monongahela and Allegheny Rivers; Two Components of the Great River Ecosystem in the Central Basin*, **Rick Spear**, Pennsylvania Department of Environmental Protection

4:15 pm *Susquehanna River Basin Commission's Environmental Review of Water Withdrawals: Integrating Water Quality, Biological, and Habitat Information into Water Quantity Decision Making*, **Jennifer Hoffman**, Susquehanna River Basin Commission

4:35 pm *Effective Integrated Physical, Chemical, and Biological Aquatic Monitoring in the Pacific Island National Parks*, **Anne Farahi**, National Park Service

---

Session J4: Overcoming Barriers to Monitoring Collaboration and Partnerships

Room 11
3:30 – 5:00 pm

Moderator: Tracy Hancock, USGS

3:35 pm *Collaborative Interagency Efforts in Sampling, Analyzing, and Developing Models for Arsenic and Methyl Mercury Levels in Florida*, **Rick Copeland**, Florida Geological Survey

3:55 pm *A Cooperative Bi-National Approach to Monitoring the St. Marys River Great Lakes Connecting Channel*, **Gary Kohlhepp**, Michigan Department of Natural Resources and Environment

4:15 pm *Great Lakes Cooperative Science and Monitoring Initiative: Cooperative science to help manage the Great Lakes*, **Paul Horvatin**, US EPA

4:35 pm *Partnership Approach to Optimization of the Chesapeake Bay Program's Bay and Basin Water Quality Monitoring Program 2007-09: Process Review, Lessons Learned*, **Peter Tango**, USGS

Session J5: Evaluating Contaminant Trends in Groundwater Quality

Room 15
3:30 – 5:00 pm

Moderator: Christopher Carlson, US Forest Service

3:35 pm *Trends in Groundwater Quality: Integration of National Network and Regional-Scale Studies*, **Bruce Lindsey**, USGS

3:55 pm *Decadal-Scale Changes of Nitrate in Ground Water of the United States, 1988-2004*, **Michael Rupert**, USGS

4:15 pm *Decadal-Scale Changes in Dissolved-Solids Concentrations in Groundwater Used for Public Supply, Salt Lake Valley, Utah*, **Susan Thiros**, USGS

4:35 pm *Towards understanding how human and aquifer processes interact to produce trends in groundwater quality*, **Jeffrey Starn**, USGS

Session J6: Endocrine Disrupting Compounds – Identification, Sources, and Effects

Room 14
3:30 – 5:00 pm

Moderator: Kathy Lee, USGS

3:35 pm *What is an Endocrine Disrupting Chemical?*, **Larry Barber**, USGS

3:55 pm *Reproductive disruption of fishes by endocrine-active wastewater effluents*, **Alan Vajda**, University of Colorado, Denver

4:15 pm *Distribution of hormones, pharmaceuticals, and other anthropogenic waste indicators in areas of the Potomac River watershed impacted with fish kills and intersex fish*, **James Gray**, USGS

4:35 pm *Endocrine Active Chemicals in Surface Waters: Developing a Consistent Approach to Evaluate Fate and Aquatic Organism Responses*, **Kathy Lee**, USGS

Session K1: Water Quality Monitoring in Coastal and Marine Environments

Room 12
8:00 – 9:30 am

Moderator: Pixie Hamilton, USGS

8:05 am *Benefits of Integrated Physical, Chemical, and Biological Marine Monitoring in Pacific Island National Parks*, **Tahzay Jones**, National Park Service

8:25 am *Connecticut Department of Environmental Protection Long Island Sound Water Quality Monitoring Program: What are we missing, a comparison of monthly survey data and data from a special 72 hour survey*, **Matthew Lyman**, Connecticut Department of Environmental Protection

8:45 am *Combining Routine Monitoring and Research to Understand Estuarine Biogeochemistry*, **Jonathan Sharp**, University of Delaware

9:05 am *Monitoring in the Ahupua'a*, **Michael Tomlinson**, University of Hawaii at Manoa

Session K2: Geospatial Assessments of Water Quality

Room 16
8:00 – 9:30 am

Moderator: Douglas Norton, US EPA

8:05 am *Applying the National Hydrography Dataset Plus (NHDPlus) to Water Quality Assessments*, **Tommy Dewald**, US EPA

8:25 am *Water Clarity Monitoring of Wisconsin Lakes via Remote Sensing*, **Steven Greb**, Wisconsin Department of Natural Resources

8:45 am *Using GIS to Analyze the Environmental Impacts of Mining on Water Resources in the State of West Virginia*, **Edmund Merem**, Jackson State University

9:05 am *National Assessment of Impaired Waters Within or Near US Fish and Wildlife Service Properties*, **Douglas Norton**, US EPA

Session K3: Modeling of Nutrient Transport and Loadings

Room 14
8:00 – 9:30 am

Moderator: Steve Preston, USGS

8:05 am *Application of Regional Regression Models of Nutrient Transport to Water-Quality Assessments in the Southeastern U.S.*, **Anne Hoos**, USGS

8:25 am *Limitations / Needs in Data to Support Regional Water-Quality Modeling*, **Stephen Preston**, USGS

8:45 am *Allocation of Nutrient Inputs to the Laurentian Great Lakes by Source and River Basin Using SPARROW Models*, **Dale Robertson**, USGS

9:05 am *The Regionalization of National-Scale SPARROW Models for Stream Nutrients*, **Gregory Schwarz**, USGS

Session K4: Monitoring Partnerships: Promoting Water Resource Stewardship and Protection

Room 11
8:00 – 9:30 am

Moderator: Barry Long, National Park Service

8:05 am *Interior Agency Water Quality Partnership: New Process, Same Great Results*, **Mark Nilles**, USGS

8:25 am *Strengthening USGS International Partnerships focused on Water Quality, Water Supply, and Sustainability in the Developing World*, **Jo Leslie Eimers**, USGS

8:45 am *15 Years of Monitoring Water Quality Across Southcentral Alaska Through the Citizens' Environmental Monitoring Program Partnership*, **Rachel Lord**, Cook Inletkeeper, Homer, AK

9:05 am *Partnering to Support Monitoring Programs*, **Alyse Greenberg**, Stony Brook-Millstone Watershed Association, NJ

Session K5: Transport and Distribution of Mercury through Aquatic Ecosystems

Room 15
8:00 – 9:30 am

Moderator: Lia Chasar, USGS

8:05 am *Methylmercury in aquatic ecosystems of the United States*, **Mark Brigham**, USGS

8:25 am *Dissolved organic matter, organic matter optical properties and mercury in rivers and streams*, **George Aiken**, USGS

8:45 am *Increased Atmospheric Mercury Deposition near Major Urban Areas*, **Peter Van Metre**, USGS

9:05 am *Effects of Forest Type and Fire on Mercury Deposition in Boreal Ecosystems*, **Randy Kolka**, US Forest Service

---

Session K6: Agrochemical Monitoring

Room 17
8:00 – 9:30 am

Moderator: Mary Skopec, Iowa Department of Natural Resources

8:05 am *Agrochemical surface water monitoring - interpreting results from the Atrazine ecological exposure monitoring study*, **Paul Hendley**, Syngenta Crop Protection Inc

8:25 am *Pyrethroid Insecticides: Collection, Analysis and Occurrence*, **Michelle Hladik**, USGS

8:45 am *Fungicides: Analysis, Occurrence, and Fate of an Understudied Group of Pesticides*, **Kathryn Kuivila**, USGS

9:05 am *Monitoring Colorado's Groundwater for Agricultural Chemicals and Long-Term Contamination Trends*, **Karl Mauch**, Colorado Department of Agriculture

---

Session L1: Monitoring Hydrology: A Critical Consideration for the Interpretation of Water Quality and Biological Assessment Data

Room 12
10:00 – 11:30 am

Moderator: Timothy Rowe, USGS

10:05 am *Confounding Factors and Lessons Learned: Monitoring the Hydrology of Headwater Streams of the Gulf Coastal Plain*, **Kristopher Brown**, Louisiana State University

10:25 am *Monitoring Tidal Water Elevation and Water Quality in Four Embayments of Long Island Sound, New York to Assess Tidal Wetland Loss*, **Richard Cartwright**, USGS

10:45 am *Nutrient sampling, concentrations, and corresponding loads during the historic June 2008 flooding in eastern Iowa*, **Laura Hubbard**, USGS

11:05 am *Century-scale trends in flood peak discharges in the United States*, **Karen Ryberg**, USGS

Session L2: Climate Change: Monitoring Impacts on Water Quality and Quantity

Room 15
10:00 – 11:30 am

Moderator: Barry Long, National Park Service

10:05 am *An Exploratory Evaluation of the Effects of Climate Change on the Water Quality of the South Platte River in Denver, Colorado*, **Jon Novick**, Denver Department of Environmental Health

10:25 am *Red River Valley Tile Drain Water Quality Assessment: A Study of Water Quality on Saline Soils*, **Roxanne Johnson**, North Dakota State University

10:45 am *Monitoring Approaches Adapted by Southwest Usa Tribal and Municipal Water Providers to Address Water Supply Challenges Associated with Drought and Climate Change*, **Steven Sagstad**, Civil & Environmental Consultants and **Deborah Patton**, Rural Community Assistance Corporation

11:05 am *Ecological Monitoring Strategies for Freshwater Systems in Alaska's National Parks*, **Jeff Shearer**, National Park Service

---

Session L3: Linking Sources and Stressors to Water Quality

Room 17
10:00 – 11:30 am

Moderator: Chris Piehler, Louisiana Department of Environmental Quality

10:05 am *Assessing the Condition of Streams in the San Gabriel River Watershed (California): Integration of Multiple Indicators*, **Scott Johnson**, Aquatic Bioassay and Consulting Laboratories

10:25 am *Assessing Ecological Conditions of U.S. Coastal Ocean Waters: Expansion of EMAP from Estuaries to the Offshore Environment*, **Jeff Hyland**, NOAA

10:45 am *Problems and prospects of the application of Soil and Water Assessment Tool (SWAT) Model for the identification of nonpoint source pollution "hotspots" in a flat coastal agricultural watershed in humid tropics*, **Durga Poudel**, University of Louisiana at Lafayette

11:05 am *2010 Release of the U.S. EPA Causal Analysis Diagnosis and Decision Information System (CADDIS)*, **Amina Pollard**, US EPA

Session L4: Unique Collaborative Approaches for Successful Outcomes

Room 11
10:00 – 11:30 am

Moderator: Erick Burres, California State Water Resources Control Board

10:05 am *The Collective Action Continuum: Identifying Critical Elements for Environmental Improvement*, **Jenny Biddle**, George Mason University

10:25 am *Georgia Adopt-A-Stream Database: Beyond the Data*, **Allison Hughes**, Georgia Department of Natural Resources

10:45 am *Development of Comprehensive Volunteer Water Quality Monitoring Education and Support in Response to Agency-directed Targeted Watershed Improvements: Lessons Learned*, **Channah Rock**, University of Arizona

11:05 am *From Citizen Science to Volunteer Monitoring: Seeking hybridization of disparate models for more meaningful public engagement in environmental monitoring*, **Candie Wilderman**, Dickinson College

---

Session L5: Biomagnification of Mercury through Food Webs

Room 16
10:00 – 11:30 am

Moderator: Mark Brigham, USGS

10:05 am *Assessing Impairment of Tomales Bay due to Mercury*, **Kat Ridolfi**, San Francisco Estuary Institute

10:25 am *Contaminants in Sport Fish of California Lakes and Reservoirs*, **Val Connor**, California State Water Resources Control Board

10:45 am *Mercury in National Park Units of the Western Great Lakes Region: Assessing Bioaccumulation in Aquatic Food Webs*, **James Wiener**, University of Wisconsin–La Crosse

11:05 am *Characterizing mercury bioaccumulation and biomagnification in streams across large environmental gradients*, **Lia Chasar**, USGS

Session L6: Contaminant Threats to Drinking Water

Room 14
10:00 – 11:30 am

Moderator: Greg Delzer, USGS

10:05 am *Quality of Water from Public-Supply Wells in the United States*, **Patricia Toccalino**, USGS

10:25 am *Anthropogenic Organic Compounds in Source and Finished Water of Community Water Systems that Withdraw from Streams*, **James Kingsbury**, USGS

10:45 am *EPA's Third Contaminant Candidate List – Evaluating Unregulated Drinking Water Contaminants*, **Thomas Carpenter**, US EPA

11:05 am *The Next Generation of Drinking Water Disinfection By-Products*, **Susan Richardson**, US EPA

Poster Presentations

The following posters will be displayed on Monday, April 26. Join us 5-7 pm at the Exhibit and Poster reception. Poster presenters will be available to answer questions during this time.

Continuous Monitoring, Autosamplers

001 *MiniSipper: a New High-capacity, Long-duration, Automated In-Situ Water Sampler*, **Thomas Chapin** and **Andrew Todd**, USGS

002 *Continuous in situ measurement of dye tracer and physical water quality properties for characterization of overlapping plumes from wastewater treatment facilities discharging to the Missouri River*, **Eric Christensen**, USGS

003 *Continuous Active Low-Flow Extraction Laboratory and Field Evaluations*, **Brent Hepner**, Aqualytical Services Inc.

004 *New and Evolving Technologies For Monitoring and Control*, **Troy Hertog**, Siemens Water Technologies

005 *Evaluation of Regenerated Cellulose Dialysis Membrane Diffusion Samplers for Monitoring Groundwater Quality*, **Thomas Imbrigiotta**, USGS

006 *Implementation Monitoring: Use of Automated Samplers to Effectively Document Water Quality Improvements*, **Jeanette Lamb**, Oklahoma Conservation Commission

007 *Advancements in Continuous Sensor Technologies and Application to Stormwater Monitoring in California*, **Stephen McCord**, Larry Walker Associates

008 *Real Time Monitoring of Urban Water Bodies for Research and Educational Use*, **Ryan Mesmer**, Louisiana State University

009 *Advances in the Automated Monitoring Program in Atlantic Canada*, **Denis Parent**, Environment Canada

010 *Evaluation of time-integrating sediment samplers for assessment of occurrence and concentrations of hydrophobic organic contaminants in small streams*, **Mark Sandstrom**, USGS

011 *Temperature Effects on Conductivity Calibration of Continuous Monitors*, **Evan Tillman**, USGS

012 *Luminescence Sensors: The future of Dissolved Oxygen Monitoring*, **Evan Tillman**, USGS

013 *Assessment of the Cross-Sectional Variability of Water Quality Parameters in the Snake River as a Result of Measurement Location*, **Alexandra Etheridge**, USGS

Nutrients, Algae

014 *Diurnal Fluctuations in Nutrients and Continuously Monitored Parameters in Two Idaho Rivers*, **Andrew Tranmer**, USGS

015 *Cyanobacterial Toxins Found in Upper Klamath Lake, Oregon: Implications for Endangered Fish*, **Kathy Echols**, USGS

016 *A New Fast, Accurate Method for Algae Identification and Enumeration*, **Mary Fabisiak**, City of Westminster, Colorado

017 *Change-Point Analysis for Nutrient Criteria in the Midwest*, **Jeffrey Frey**, USGS

018 *Trends in Water Quality in the Southeastern United States, 1973-2005*, **Douglas Harned**, USGS

019 *Geosmin and Microcystin Occurrence in Two Piedmont Reservoirs, Spartanburg County, South Carolina, 2007 – 2008*, **Celeste Journey**, USGS

020 *A Comparison of Algal, Macroinvertebrate, and Fish Assemblage Indices for Assessing Low-Level Nutrient Enrichment in Wadeable Ozark Streams*, **Billy Justus**, USGS

021 *Assessing the Effects of Nutrients on Algal Responses in Agricultural Streams: The Importance of Seasonal Variations*, **Kathy Lee**, USGS

022 *Influence of Nutrients, Habitat, and Streamflow on Indicators of Eutrophication in Agricultural Streams: Applications for Developing Nutrient Criteria*, **Terry Maret**, USGS

023 *The Dunkard Creek TDS Crisis That Became A Disaster*, **Duane Nichols**, Upper Monongahela River Association

024 *Application of a Quantitative ELISA Screening Procedure Suitable for Shipboard Analysis of Marine Algal Toxins in Shellfish Tissue*, **Jaclyn Pitt**, Abraxis LLC

025 *Post-harvest Nitrogen Leaching and Retention in Riparian Forest Buffers Killed by Mountain Pine Beetle*, **Charles Rhoades**, US Forest Service

026 *Change in Streamwater Nitrogen Export and Soil Nitrogen Dynamics during a Mountain Pine Beetle Infestation of Subalpine Watersheds*, **Charles Rhoades**, US Forest Service

027 *Development of Sensitive Immunoassay Formats for Algal Toxin Detection*, **Fernando Rubio**, Abraxis LLC

028 *Microcystin and Taste and Odor Compound Occurrence, Fate and Transport in Central Indiana Surface Waters*, **Lenore Tedesco**, Indiana University

029 *Cyanobacterial Occurrence and Toxicity in central Indiana Drinking Water Reservoirs with an Assessment of Statewide Occurrence*, **Lenore Tedesco**, Indiana University

030 *Water Quality and Phytoplankton Community Composition in a Source Water Reservoir, Lake Houston near Houston, Texas, April 2006 – September 2008*, **Mike Turco**, USGS

031 *Multiple Lines of Evidence for Spatial Diagnosis of Catchment Water Quality: Sources and Pathways of Nutrients*, **Kirsten Verburg**, CSIRO Land and Water

032 *Monitoring Nutrient Contributions to the Lower Missouri and Upper Mississippi Rivers*, **Gary Welker**, US EPA

033 *Oxygen isotopic composition of phosphate: A new tool for monitoring phosphate sources and cycling*, **Megan Young**, USGS

Mining, Energy

034 *National Water-Quality Assessment (NAWQA) Program Black River Synoptic Study of the Effects of Mining in the Viburnum Trend, Southeastern Missouri, 1993 and 1995*, **Suzanne Femmer**, USGS

035 *Developing water budgets for unconventional oil and gas production: A study in the Williston Basin, Montana and North Dakota*, **Seth Haines**, USGS

036 *Approaches to Volunteer Monitoring in Mining Communities*, **Grady Harper**, North Fork River Improvement Association (AmeriCorps*VISTA)

037 *How Do You Monitor a Pebble?*, **Pete Penoyer** and **Barry Long**, National Park Service

038 *Organic compounds in surface waters near lead-zinc mine and milling operations*, **Colleen Rostad**, USGS

039 *Assessment of Potential Uranium Ore Migration from a Uranium Mill by Monitoring Sediments from Ephemeral Streams, Sagebrush, and Cores from Cottonwood Trees near the Ute Mountain Ute Reservation, Utah*, **Ryan Rowland**, USGS

040 *Impacts of Mining-Derived Metals on Riffle-Dwelling Crayfish and In-Situ Toxicity to Juvenile Crayfish in the Big River of Southeast Missouri, USA*, **Christopher Schmitt**, USGS

041 *Assessing and Monitoring the Effects of Mining-Derived Metals on Crayfish and Sculpin*, **Christopher Schmitt**, USGS

042 *Distribution of Mining-Related Metals in Streambed Sediment of the Viburnum Trend Subdistrict and Sediment core from Clearwater Lake, Southeastern Missouri*, **Christopher Schmitt**, USGS

043 *Cause and Effect Survey of Brine Discharges in South Fork Tenmile Creek, Pennsylvania*, **Rick Spear**, Pennsylvania Department of Environmental Protection

044 *Monitoring Strategies to Assist Remediation of Abandoned Draining Mines*, **Katherine Walton-Day**, USGS

Modeling

045 *Linking landscape characteristics and stream nitrogen in the Oregon Coast Range: empirical modeling of water quality monitoring data*, **Effie Greathouse**, Oregon State University

046 *Evaluation of the Soil and Water Assessment Tool for Predicting Hydrology and Nutrients at Unmonitored Sites in the Cedar River Watershed*, **Kasey Hutchinson**, USGS

047 *Water Quality Measurement Network for Validation and Development of Catchment Models*, **Holm Kipka**, Friedrich-Schiller-University Jena, Germany

048 *Regression Models of Selected Constituents in Two Tributaries to Lake Houston near Houston, Texas, 2005–07*, **Michael Lee**, USGS

049 *Assessing the effect of uncertainties associated with estimated model parameters and small–scale geologic heterogeneity on basin-scale projections of water-quality trends, Salt Lake Valley, Utah*, **Jeffrey Starn**, USGS

050 *Monitoring for Modeling*, **William Elliot**, US Forest Service

Climate Change

051 *Predicting the Effects of Future Climates on Forest Watersheds*, **William Elliot**, US Forest Service

052 *Earth System Observation Network (ESON): a long-term monitoring program in the San Juan Mountains, CO that addresses climate change and its impacts on land, water, air, life & humans*, **Rob Blair**, Mountain Studies Institute, Colorado

Bioassessment

053 *Development of Biological Objectives for Wadeable Streams in California*, **Val Connor**, California State Water Resources Control Board

054 *Applying non-linear (fuzzy) classification rules for grouping streams with similar biological potential in Colorado*, **Ben Jessup**, Tetra Tech, Inc.

055 *Monitoring burrowing mayflies (Hexagenia spp.) in nearshore waters of the Laurentian Great Lakes*, **Don Schloesser**, USGS

Management, Protection, Restoration

056 *Air Quality Management Implications of Forest Service Water Quality Data*, **Ricardo Cisneros** and **Don Schweizer**, US Forest Service

057 *Using long-term ambient water quality data to inform thermal criteria revisions: A case study on the South Platte River, CO*, **Alice Conovitz**, Integral Consulting Inc.

058 *Alternatives for HUC 12 Prioritization during Watershed Management Plan Development: Upper Illinois River Watershed*, **Brian Haggard**, Arkansas Water Resources Center

059 *Linking Changes in Management and Riparian Physical Functionality to Water Quality and Aquatic Habitat*, **Don Kozlowski**, University of Nevada, Reno

060 *North Dakota Discovery Farms: Monitoring Agricultural Runoff in Small Watersheds*, **Kathleen Macek-Rowland**, USGS

061 *Tools and Approaches for Effective Water Quality Monitoring of BMPs for Stream Systems*, **Ginger Paige**, University of Wyoming

062 *Watershed management and decision making in the Region of the Great Bend of the Wabash River*, **Sara Peel**, Wabash River Enhancement Corporation

063 *Use of a Public-Private Partnership to Establish a Regionally Coordinated Water Monitoring Network to Aid in Watershed Decision Making*, **Anthony Seeman**, Iowa Soybean Association

064 *Snake River Watershed (Colorado) – An Assessment of Recent Time-Trends in Monitoring Data*, **Timothy D. Steele**, TDS Consulting Inc.

065 *Challenges and Unintended Consequences: Managing Water Quality in the Lower Yakima River, Washington*, **Daniel Wise**, USGS

066 *Environmental Challenges and Sustainable Solutions for Protecting Water Resources: Integrating Education, Research, and Community Partnerships*, **Eileen Zerba**, Princeton University

067 *Ongoing Efforts of a Public Engineering and Construction Management Agency to Address the Requirements of the NPDES Permit for Construction Stormwater Discharges*, **John Baum**, US Army Corps of Engineers

Lakes, Reservoirs

068 *Addressing Invasive Mussel Concerns at 9 Reservoirs in Northern California*, **John Baum**, US Army Corps of Engineers

069 *Estimating Trophic Status for Michigan Inland Lakes by Relating Field Measurements to Satellite Imagery*, **Lori Fuller**, USGS

070 *Long-term Monitoring with Sediment Cores*, **Paul Garrison**, Wisconsin Department of Natural Resources

071 *Tracking the Impact of Land Use and Sustainable Practices on Lake Water Quality*, **Robert Hackett**, Elon University

072 *Lake Success: Water Quality Monitoring at a Dam Remediation Site*, **Heather Jackson**, US Army Corps of Engineers

073 *Use of Long-Term Monitoring Networks to Evaluate the Effects of Deposition and Climate on Remote Lakes in the Rocky Mountains*, **Alisa Mast**, USGS

074 *Historical Data Evaluation and Supplemental Water Quality Monitoring at Lake Isabella in Preparation for Dam Remediation*, **Alison Plant**, US Army Corps of Engineers

075 *Long-Term Reservoir Monitoring Using Volunteer Field Scientists*, **Anthony Thorpe** and **Daniel Obrecht**, University of Missouri

Coastal, Wetlands

076 *An Overview of Monitoring, Assessment and Regulations of the Wetlands on Navajo Nation*, **Krishna Baskota**, Navajo Nation

077 *Coral Disease, Environmental Drivers, and Coral-Microbial Interactions*, **Laura Hunt**, University of Texas at Arlington

078 *Southeastern Wetlands Workgroup (for U.S. EPA Office of Water and Region 4)*, **Kimberly Matthews**, RTI International

079 *Monitoring Ecological functions in Bung Khong Long Non-Hunting Area, Ramsar Site, Thailand*, **Kamalaporn Kanongdate**, Brandenburg University of Technology, Germany

080 *Monitoring the effectiveness of Ramsar Convention on wetland Ramsar sites: Case study Ramsar Sites Thailand*, **Kamalaporn Kanongdate**, Brandenburg University of Technology, Germany

Groundwater

081 *A Coupled Empirical Model for Understanding Groundwater Contributions to Temporal Trends in Stream Chemistry on the Basis of Routine Monitoring Data*, **Scott Ator** and **Joel Blomquist**, USGS

082 *Problems and Solutions Using Real-Time Geochemical Property Monitoring to Identify Sources of Groundwater under the Influence of Surface Water*, **Christopher Braun**, USGS

083 *Use of Spring Data in a Ground-water Level Monitoring Network: Surveillance and Trend Monitoring in the Evaluation of a Long-term Period of Below Normal Rainfall*, **Rick Copeland**, Florida Geological Survey

084 *Distribution and characteristics of springs and wetlands in headwater basins of the Fraser Experimental Forest, Colorado*, **Kathleen Dwire**, US Forest Service

085 *Innovative Surface and Groundwater Monitoring and Assessment of Energy Development in the Northern Piceance Basin*, **Robert Lange**, Bureau of Land Management

086 *Using specific-conductance profiles and fixed-depth loggers to determine freshwater-lens thickness changes and aquifer properties during recharge events, Northern Guam Lens, Guam*, **Todd Presley**, USGS

087 *Assessment of Potential Uranium Emissions from a Uranium Mill on the Ground- Water, Surface-Water, and Air Quality of the Ute Mountain Ute Reservation, Southeastern Utah, 2007 – 2009*, **Anthony Ranalli**, USGS

088 *Evaluating the potential occurrence of ^{210}Po in US groundwater using uranium concentrations and gross alpha radioactivity*, **Michael Rosen**, USGS

The following posters will be displayed on Tuesday, April 27. Join us 5-7 pm at the Exhibit and Poster reception. Poster presenters will be available to answer questions during this time.

Field Methods

001 *Complications associated with nutrient and dissolved oxygen monitoring in low-gradient headwater streams*, **Den Davis**, Louisiana State University

002 *Assessing Differences in Water Clarity Measurements among Transparency Tube Models and Users*, **Kristine Stepenuck**, University of Wisconsin-Extension

003 *Integrating diel studies into large-scale monitoring programs*, **Megan Young**, USGS

Analytical Methods, Tools

004 *Chemical Constituents in Groundwater from Multiple Zones from the Snake River Plain Aquifer at the Idaho National Laboratory, Idaho*, **Roy Bartholomay**, USGS

005 *Rapid Toxicity Assessments (RTAs) to Optimize Water Quality Testing Budgets*, **Bryan Bjorndal**, Assure Controls, Inc.

006 *Green analytical methods for water quality testing*, **Ellen R. Campbell**, Nitrate Elimination Co., Inc.

007 *Determination of Human-Use Pharmaceuticals by Large-Volume Injection, High-Performance Liquid Chromatography/Tandem Mass Spectrometry*, **Edward Furlong**, USGS

008 *Comparison of Cytotoxicity Bioassay, Protein Phosphatase Inhibition and Liquid Chromatography/ Tandem Mass Spectrometry for the Determination of Microcystins in Alberta Lakes*, **Dorothy Yu Huang**, University of Calgary

009 *Tracing Sources of Nitrate, Organic Matter, and Water in the Willamette River Basin, from the Headwaters to Portland, Using Stable Isotopic Techniques*, **Carol Kendall**, USGS

010 *Tracing Sources and Biogeochemical Cycling of Ammonium and Nitrate in the Sacramento River and Northern San Francisco Bay Using Stable Isotope Techniques*, **Carol Kendall**, USGS

011 *Detecting the neurotoxin BMAA in cyanobacteria and fish by LC-MS/MS*, **David Kinniburgh**, University of Calgary

012 *Determination of Rapid Settling Turbidity Samples*, **Jon Schiller**, Hach Company

013 *Comparison of Soluble Nitrate Reductase and Granular Copperized Cadmium Reducing Agents for Routine, Colorimetric Nitrate Determinations in Water*, **Charles Patton**, USGS

014 *Adapting Automated Discrete Analyzers for Routine Nutrient Determinations at a Large Water Quality Laboratory*, **Eric Schwab** and **Charles Patton**, USGS

015 *Verifying the Use of Specific Conductance as a Surrogate for Chloride in Saltwater Matrices*, **Cristina Windsor**, In-Situ Inc.

016 *Developing a Quick "Portable" Extraction Technique for Urban Water Contaminants*, **Laura Webb**, US EPA

Microbiology, Source Tracking

017 *Comparison of Methods for E. Coli and Total Coliform*, **Laura Webb**, US EPA

018 *Occurrence and Distribution of Pathogen and Source Markers in Water from a Pennsylvania River Monitoring Network, 2008-2009*, **Joseph Duris**, USGS

019 *Multi-Tracer Mapping of Municipal Wastewater Plumes Discharging from Aquifer to Ocean in Hawaii*, **Charles D. Hunt, Jr**, USGS

Data Management, Sharing

020 *EPA Tools for Water Quality Monitoring Data Sharing at the National Level*, **Kevin Christian**, US EPA

021 *Improving Ambient Monitoring Water Quality Data Access, Standardization, Interoperability and Integration in California*, **Val Connor**, California State Water Resources Control Board

022 *A Collaborative Water Quality Knowledge and Information Network – WQIN*, **Fernanda Dalcanale**, Colorado State University

023 *The Colorado Water-Quality Data Repository*, **Jean Dupree**, USGS

024 *A Partnership for Developing Ecosystem Indicators and Tools for the Gulf of Maine*, **Adria Elskus**, USGS

025 *Synthesizing Nutrient Data across the U.S. Forest Service Experimental Forest and Range Network – Methodological Challenges and Opportunities*, **Effie Greathouse**, Oregon State University

026 *An Integrated List of Data Elements: Unifying Concepts in Action*, **Revital Katznelson**, UC Berkeley Extension

027 *Innovative Approaches to Make Water Quality Data Available from EPA STORET*, **Charles Kovatch** and **Deepti Puri**, US EPA

028 *A Geospatial Platform for Accessing Data and Communicating With Security and Water Quality Monitoring Systems*, **Dan Kroll**, Hach Company

029 *A Web-Accessible Aquatic Biological Database System: BioData and BioShare*, **Dorene MacCoy**, USGS

030 *Using Web Portals to Present Meaningful Information*, **Jon Marshack**, California State Water Resources Control Board

031 *Upper Clear Creek Watershed (Colorado) – An Exemplary Water-Quality Monitoring Case Study Revisited*, **Maggie Pierce**, Colorado Department of Public Health and Environment

Interpreting & Communicating Water Quality

032 *Review of Waterbody Assessment Methodologies*, **Lindsay Griffith**, Brown and Caldwell

033 *Volunteers, Data, and the Public – Meaningful Stream Information*, **Jean Lemmon** and **Cheryl Cheadle**, Oklahoma Conservation Commission

034 *Development of Urban Stream Water Quality Indices in the Kansas City Urban Streams Network*, **Gary Welker**, US EPA

035 *Communicating Volunteer Monitoring Data*, **Jinnieth Woodward**, Alliance for Aquatic Resource Monitoring (ALLARM), Dickinson College

Contaminant Threats, Effects

036 *Volatilization of Polycyclic Aromatic Hydrocarbons (PAHs) from Pavement Surfaces and Relation of Fluxes to Pavement Surface Type*, **Christopher Braun**, USGS

037 *Quality of Water from Private Wells in Principal Aquifers of the United States, 1991-2004*, **Leslie DeSimone**, USGS

038 *Exploring the role of photochemical processes on the fates and effects of endocrine disrupting chemicals*, **James Gray**, USGS

039 *Determination of steroid hormones in environmental samples by GC/MS/MS with isotope dilution*, **James Gray**, USGS

040 *Mid-Columbia River Toxics Monitoring Project*, **Lillian Herger**, US EPA

041 *Concentrations Polycyclic Aromatic Hydrocarbons (PAHs) in Settled House Dust and Their Relation to Coal-Tar-Based Pavement Sealcoat*, **Barbara Mahler**, USGS

042 *Occurrence Patterns of Antibiotics in Human and Agricultural Waste and Their Transport in Surface and Groundwater*, **Michael Meyer**, USGS

043 *Advancing endocrine disrupting compound analysis through integrated technology and workflow solutions*, **Cecilia Mazza**, Waters Corporation

044 *Minimizing Sample Turn-around Time When Dealing With Chemicals of Concern in Water Matrices*, **Cecilia Mazza**, Waters Corporation

045 *Temporal and spatial variations in PCB contamination of sediments and source apportionment in a section of the Rhone River, France*, **Gwenaelle Roux**, ENTPE, France

046 *Assessment of Contaminants of Emerging Concern in Surface Water and Fish from U.S. Urban Rivers*, **Leanne Stahl**, US EPA

047 *Reconstructing Trends in Water Quality and Atmospheric Deposition Using Lake and Reservoir Sediment Cores*, **Peter Van Metre**, USGS

048 *WERF Trace Organic Compounds Database Management System for Analyzing Impacts of Trace Organic Compounds on Aquatic Populations and Communities*, **Jeffrey White**, Tetra Tech, Inc.

Agrochemical Monitoring, Effects Of Agriculture On Water Resources

049 *Atrazine ecological exposure monitoring program: study design and conduct*, **Christopher Harbourt**, Waterborne Environmental Inc.

050 *National SSURGO based modeling at the field scale: Comparative exposure potential via PRZM modeling and determining depth to a restrictive or claypan layer*, **Paul Miller**, Waterborne Environmental Inc.

051 *Design and implementation of a study to determine the occurrence and fate of fungicides in aquatic ecosystems*, **Timothy Reilly**, USGS

052 *Foliar Fungicides in Nebraska Streams*, **Mark Sandstrom**, USGS

053 *A new approach in studying the sources of salinization in the Rio Grande*, **Anna Szynkiewicz**, University of Texas at El Paso

Mercury

054 *Assessment of Methylmercury Source Areas in Headwater Catchments in South Carolina and New York*, **Paul Bradley**, USGS

055 *Mercury Trends in Fish from U.S. Rivers and Lakes, 1969 – 2005*, **Mark Brigham**, USGS

056 *Spatial and Temporal Trends in Atmospheric Deposition in the Pensacola Bay Watershed*, **Jane Caffrey**, University of West Florida

057 *The NADP's Mercury Deposition Network: lessons from a continental-scale monitoring network*, **David Gay**, University of Illinois

058 *Evaluating Mercury Issues Resulting from Historical Mining Activities at Two U.S. Army Corps of Engineers Managed Reservoirs in Northern California*, **Daniel Holmberg**, US Army Corps of Engineers

059 *Long-Term, Statewide, Multi-Scale Monitoring of Mercury and Methylmercury in Indiana Watersheds, 2002–2009*, **Martin Risch** and **Amanda Egler**, USGS

060 *Spatial Patterns of Mercury Concentrations in Stream Biota of Forested Catchments in New York and South Carolina*, **Karen Riva-Murray**, USGS

061 *MercNet: A Comprehensive Framework to Monitor Responses to Changing Mercury Loads*, **David Schmeltz**, US EPA

062 *Factors Influencing Mercury Bioavailability and Accumulation in Ozark Stream Ecosystems*, **Christopher Schmitt**, USGS

063 *Mercury in Fish, Bed Sediment, and Water from U.S. Streams, 1998–2005*, **Barbara Scudder**, USGS

National Assessments

064 *Rates, Reasons, and Patterns for Site Attrition in the EPA's National Aquatic Resource Surveys*, **Jennifer Linder**, Tetra Tech, Inc.

065 *Lac du Flambeau Tribal Participation in the National Lake Assessment: Benefits of Local Level (10-digit HUC "Watershed Units") Involvement in National Assessments*, **Gretchen Watkins**, Lac du Flambeau Band of Lake Superior Chippewa Indians

Monitoring Programs, Networks

066 *Application of National Lake Assessment Tools and Approaches in New Jersey Department of Environmental Protection's Ambient Lake Monitoring Network: Successes and Challenges with Integrating the State and National Scale Assessments*, **Debra Hammond**, New Jersey Department of Environmental Protection

067 *The Evolution of the Missouri Ambient Water-Quality Monitoring Network*, **Miya Barr**, USGS

068 *Status Network Water Quality Sampling within the St. Johns River Water Management District: The Second Sampling Cycle (2004 to 2008)*, **Aisa Ceric**, St. Johns River Water Management District

069 *Establishing a Monitoring Network to Characterize Changes in the Groundwater System along the All American Canal, Southeast California*, **Alissa Coes** and **Michael Land**, USGS

070 *Collaborative Monitoring and Quantifying Decreasing Selenium Concentration and Load Trends in the Lower Gunnison Basin*, **David Kanzer**, Gunnison/Grand Valley Selenium Task Forces, CO

071 *Collaborative Development of a North American Spatial Framework for Rivers Assessment and Classification*, **Sheila North**, Dynamac Corporation c/o US EPA

072 *Implementation of EMAP procedures on the Missouri River from the Fort Peck Dam, Montana, to Fort Buford, North Dakota*, **Laurie Shafer**, Fort Peck Assiniboine & Sioux Tribes Office of Environmental Protection, Montana

073 *Expanding the Montana Volunteer Water Quality Monitoring Network and Moving Toward Data Use for TMDL Planning*, **Adam Sigler**, Montana State University

074 *Monitoring Volunteers*, **Tony Williams**, The Coalition for Buzzards Bay, MA

Partnerships

075 *Supporting Volunteer Water Quality Monitoring Efforts Throughout the USA*, **Linda Green**, University of Rhode Island Cooperative Extension

076 *Alaska's Statistical Monitoring Survey's – Implementation through Partnerships*, **Terri Lomax**, Alaska Department of Environmental Conservation

077 *Enhancing Communication with Project Partners*, **Cassandra Pfeifle** and **Mary Giorgino**, USGS

Councils

078 *Water Quality Activities within the Group on Earth Observations (GEO)*, **Steven Greb**, Wisconsin Department of Natural Resources

079 *Lake Michigan Monitoring Coordination Council: A Framework for Collaboration*, **John Hummer**, Great Lakes Commission

080 *The California Water Quality Monitoring Council*, **Karen Larsen**, California State Water Resources Control Board

081 *New Jersey Water Monitoring Council: Promoting Coordination, Communication and Collaboration Across a State Water Monitoring Community*, **Leslie McGeorge**, New Jersey Department of Environmental Protection

082 *Tributary and Near-Shore Monitoring Coordination in the Lake Michigan Watershed*, **Charles Peters**, USGS

083 *Collaborative Trend Monitoring of Ambient Water Quality in the Upper Sacramento River Watershed*, **Alisha Wenzel**, California Regional Water Quality Control Board, Central Valley Region

Abstracts

Session A1: Continuous Real-Time Monitoring: Operation and Data Evaluation

U.S. Geological Survey Real-Time Water-Quality Data on the Web in 2010

Bradley D. Garner[1], Andrew C. Ziegler[2], Steven J. Brady[2], Gerald L. Feese[2], and Xiaodong Jian[2]
[1]U.S. Geological Survey, Arizona Water Science Center, Tucson, AZ, United States; [2]U.S. Geological Survey, Kansas Water Science Center, Lawrence, KS, United States

Abstract
Since 1994, the U.S. Geological Survey (USGS) has embraced the World Wide Web as an effective medium for timely dissemination of water-quality data to the public (http://waterdata.usgs.gov/). The Web has evolved, and the USGS continues to evolve its web presence as well. This presentation will summarize websites and web services that provide USGS real-time water-quality data. One website, National Real Time Water Quality (NRTWQ; http://nrtwq.usgs.gov/), will be explored in detail. NRTWQ presents in-stream direct water-quality measurements, and also combines these direct measurements with discrete water-quality samples using simple and multiple regression analysis to compute estimated concentrations and loads of constituents that are difficult to measure directly in real time. Computed concentrations and loads of water quality are presented in real time with statistically defined uncertainty, compared against water-quality criteria, and summarized using frequency-duration curves. A major goal of NRTWQ is to encourage interactive data exploration. Water-resource managers, regulatory agencies, hydrologists, statisticians, web developers, and information-technology specialists have worked together to overcome the challenges inherent in creating a national-scale, high-performance, and standards-compliant website that interfaces dynamically with existing USGS databases. Many challenges remain as NRTWQ continues to grow, and attendees are encouraged to provide feedback during the session.

Water-quality monitors have improved! Evaluation of real-time water-quality monitoring in the Little Arkansas River Basin near Wichita, Kansas, 1998-2009

Trudy Bennett
U.S. Geological Survey, KS Water Science Center, Wichita, KS

Abstract
In 1998, the U.S. Geological Survey, Kansas Water Science Center began continuous real-time water-quality monitoring. Measurements included water temperature, pH, specific conductance, turbidity, and dissolved oxygen in the Little Arkansas River Basin near Wichita, Kansas. During the last 12 years, advancements in technology have led to improvements in monitors and sensors. The most substantial improvements are optical sensors with wiper technology for turbidity and luminescent dissolved oxygen that led to decreased fouling and increased stability of sensor calibration.

These enhancements have resulted in less site visits, fewer deleted values, and increased data quality. Calibration checks are now done every 2 to 3 months and sensors are cleaned as needed by viewing daily data through the National Water Information System web page. Originally, use of Clark cell dissolved oxygen membranes governed the frequency of site visits because of the need for frequent cleaning and calibration visits. Many organizations avoided monitoring dissolved oxygen because of poor data quality and the need for frequent visits. For example, in 1998, only 78 percent of Clark cell dissolved oxygen data at Little Arkansas River near Sedgwick, Kansas were retained. In 2000, data retention was up to 94 percent.

Because of improved sensor response and stability of calibration for optical dissolved oxygen sensors, specific conductance and turbidity have become the primary sensors to determine fouling. For instance, if real-time values for specific conductance are decreasing or if turbidity values are increasing without a change in discharge or rainfall, then sensor fouling may be occurring and a site visit is necessary.

Advancements in sensor technology have led to better water-quality monitoring programs. Evaluation of real-time water-quality monitoring programs is still essential for assessing changes in monitor and sensor technology, adjusting the frequency of site inspections, reviewing protocols for record review and operation, and providing insight to manufacturers that will create even better monitors and sensors. All these factors lead to a more accurate representation of water quality.

Value Engineering Study of US Geological Survey Continuous Water-Quality Monitor Data Collection and Processing

Kevin Richards[2], Rob Ellison[1]
[1]YSI Inc, Yellow Springs, OH, United States; [2]USGS, Middleton, WI, United States

Abstract
The Geological Survey (USGS) assembled a team of experts in in-situ water quality sensors and applications to conduct a value engineering study on USGS water quality monitoring processes and procedures. Value engineering is a systematic examination of function used to improve the "value" of goods or products and services. Value is defined as the ratio of function to cost, and can therefore be increased by either improving the function or reducing the cost. A primary tenet of value engineering is that basic functions be preserved and not be reduced as a consequence of pursuing value improvements.

The team was comprised of individuals from sensor manufacturers, as well as USGS Water Science Center employees and water quality specialists. The study involved visits to two USGS Water Science Centers to evaluate their current processes: A water science center representing an estuarine environment; and another center representing a large real-time stream network. Each site visit required 3-4 days and involved the observation and review of all activities related to data collection and processing.

The primary goals of the Value Engineering study were to:

- Reduce the cost of data and the number of times data is 'touched' by identifying waste and inefficiencies within the current USGS process for collecting and processing continuous water quality data from field instruments.

- Identify opportunities to adopt new technologies to make the USGS water-quality data collection and processing more efficient; and
- Educate the USGS on principles of a continuous improvement evaluation process to allow the USGS to independently conduct future value engineering activities.

The Value Engineering Team identified four general areas for the USGS to target in order to reduce waste, improve efficiency, and adopt new technologies. The areas include: automation of data entry and record processing, reduction of waste, reduction in the frequency of site visits, and adoption of continuous improvement methods.

Targeting Field Investigations Using Continuous Water Quality Monitoring in the North Bosque and Leon River Watersheds

Chuck Dvorsky
Continuous Water Quality Monitoring Network Coordinator, Texas Commission on Environmental Quality

Abstract
The North Bosque River and Waco Lake, formed by an impoundment of Bosque River, serve as the primary drinking water supplies for more than 200,000 people in the Waco area. Water quality testing found high levels of nutrients in the North Bosque that have contributed to excessive growth of algae and other aquatic plants in the river. A TMDL was developed to address the elevated levels of phosphorus (the limiting nutrient in the watershed). The North Bosque and Leon River watersheds in central Texas have numerous large dairy operations. The dairy operations were determined to be in part responsible for water quality conditions in watersheds. The Implementation Plan for the North Bosque River includes provisions for enforcement of Concentrated Animal Feeding Operations (CAFO) or Animal Feeding Operations (AFO) activities "... Causing or allowing discharges of wastes due to improper management or operation of waste disposal activities or retention structures...." The Texas Commission on Environmental Quality (TCEQ) implemented the Environmental Monitoring and Response System (EMRS) to collect near real time data to target field investigations of CAFO, AFO, and Waste Application Field (WAF) violations. The presentation discusses the development, refinement, and results of the project.

Session A2: Indices of Biotic Integrity for Wetlands

The Development of Monitoring Methodologies and Indices of Biotic Integrity for North Carolina Wetlands

Virginia Baker and Rick Savage
North Carolina Department of Environment and Natural Resources, Division of Water Quality

Abstract
The NC Division of Water Quality is in the process of developing a wetland monitoring program for NC. The objective of this wetland monitoring program is to develop wetland monitoring procedures and analysis methods, including taxa specific Indices of Biotic Integrity, that can be used to determine how wetland quality and function changes along a human disturbance gradient. Monitoring methods and analysis procedures were tested and developed on Piedmont and Coastal Plain headwater forest, riverine swamp forest, bottomland hardwood forest, and basin wetlands of variable quality. Monitoring efforts ranged from "Level I" GIS spatial analyses, "Level II" rapid assessments, and "Level III" intensive physical, chemical, and biological survey. Intensive biological surveys were completed on amphibian, macroinvertebrate, and plant communities. The Level I and Level II results were used to test candidate metrics derived from amphibian and plant community surveys for all wetland types and macroinvertebrate community surveys from the headwater forests. Additionally, intensive survey water quality and soil chemistry results were used to test the amphibian candidate metrics and headwater macroinvertebrate candidate metrics.

Statistical correlations of the candidate amphibian metrics identified five metrics for headwater wetlands, three for riverine swamp forests, six for bottomland hardwood forests, and six for basin wetlands. There were six Coastal Plain and seven Piedmont headwater forest macroinvertebrate metrics identified while candidate metrics for the other wetland types will be analyzed in the future. Statistical correlations of the candidate plant metrics identified five metrics for headwater wetlands, seven for riverine swamp forests, eight for bottomland hardwood forests, and seven for basin wetlands. Stronger correlations were observed between the Level III water quality and soil chemistry results than the Level I GIS and Level II rapid assessment results for the amphibian and macroinvertebrate metrics for the headwater forest and basin wetlands. These results suggest these communities respond more directly to water quality and soil chemistry than disturbances measured by spatial analysis or rapid wetland assessments. The plant metrics correlated more strongly with the Level I and Level II results for all wetland types.

Vegetation Index of Biotic Integrity (VIBI) for Headwater Wetlands in Colorado's Southern Rocky Mountains: Development, Calibration, and Application

Joanna Lemly[1], Joe Rocchio[2]
[1]Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO; [2]Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, WA

Abstract
The primary objective of the Clean Water Act is to "maintain and restore the chemical, physical, and biological integrity of the Nation's waters," which include wetlands. Although Colorado has an ongoing water quality monitoring program for rivers, streams, lakes and reservoirs, data documenting the integrity of Colorado's wetlands are limited. In order to make informed management decisions, credible data on wetland condition are needed. To this end, the Colorado Natural Heritage Program (CNHP) developed a vegetation index of biotic integrity (VIBI) for headwater wetland types within the Southern Rocky Mountains, which includes separate VIBI models for riparian shrublands, wet meadows, and fens. Data collection for initial VIBI development took place over three field season (2004–2006) and included 75 wetlands within central Colorado. Over 100 different vegetation metrics were considered for inclusion within the VIBI models, and those with the highest correlation to human disturbance were selected. Initial VIBI models were then calibrated with additional independent data collected in 2007 from 38 wetlands located in both central and southwest Colorado. Model calibration produced three robust VIBI models with strong correlations to a human disturbance gradient (Spearman's rank correlation coefficients ranging from -0.78 to -0.87). In 2008, CHNP initiated a pilot basin-wide wetland condition assessment project within the Rio Grande Headwaters River Basin, the first large-scale wetland condition assessment in the Rocky Mountains. Between 2008 and 2009, we collected data on vegetation and human disturbance in 150 randomly selected wetlands across the river basin. The calibrated VIBI models were used, along with rapid assessment techniques, to assign a condition class to each wetland and to estimate overall wetland condition in the basin. In this presentation, we will discuss the process of developing and calibrating Colorado's VIBI, and how this valuable tool can be used to evaluate wetland restoration and protection projects, monitor the success of on-going management practices, and assess overall wetland condition within a given landscape.

Vegetation Index of Biotic Integrity for Ohio Wetlands

John J. Mack[1] and Mick Micacchion[2]
[1]Cleveland Metroparks, Natural Resources Division, Fairview Park, OH; [2]Ohio Environmental Protection Agency, Wetland Ecology Group, Groveport, OH

Abstract
An index of biotic integrity (IBI) is a frequently used approach for assessing the ecological integrity of streams with fish and macroinvertebrates the faunal assemblages most commonly used as indicator taxa. The IBI approach has been much less commonly applied to wetlands, despite the legal, policy and scientific need to assess wetland condition and develop ecological performance goals for wetland re-establishment, establishment and rehabilitation. While some IBIs are sophisticated systems with statewide application that have undergone one or more testing iterations, many published IBIs are derived from single data sets of a single class of aquatic resource with limited geographic application.

The State of Ohio initiated development of a wetland IBI using vascular plants in 1996. Sampling methods were investigated and ultimately a plot-based method was adopted. Potential attributes and different human disturbance gradients were evaluated in several studies. IBIs for emergent, forest and shrub dominated wetlands that can be used for all of Ohio's wetland hydrogeomorphic classes were developed. The ten metrics that comprise each IBI were derived from attributes of the plant communities that best reflected the level of human disturbances being experienced by the wetlands. The Vegetation IBI consistently and reliably assessed wetland condition across the whole range of wetland types throughout Ohio's ecological regions. Since its development it has become a vital part of the wetland permitting and monitoring process in Ohio. It is used both to determine the condition of natural wetlands and to set quantifiable performance standards for wetlands constructed or enhanced to provide compensation for wetland loss through the permitting process.

Amphibians as Indicators – Development and Use of the Amphibian Index of Biotic Integrity for Ohio Wetlands

Mick Micacchion
Ohio EPA, Division of Surface Water, Wetland Ecology Group, Groveport, OH USA

Abstract
Ohio EPA has found that amphibians can be used as meaningful indicators of wetland condition. During the past 14 years we have monitored the amphibian communities of approximately 200 natural wetlands and 70 wetland mitigation projects. Data from the natural wetlands has been used to develop the Amphibian Index of Biotic Integrity (AmphIBI) that is employed in Ohio's wetland protection program. The development of three metrics resulted from applying a thorough understanding of the population ecology of each native amphibian species to assign coefficients of conservatism. Additionally, the number of breeding salamander species present and the presence of Spotted Salamanders, Ambystoma maculatum and/or Wood Frogs, Lithobates sylvaticus are also important metrics of the AmphIBI. The AmphIBI correlates strongly with other measures of wetland condition, including the Ohio Rapid Assessment Method for Wetlands, which served as our human disturbance gradient. Results from AmphIBI assessments are used to compare amphibian communities of natural, mitigation and urban wetlands. Utilizing AmphIBI scores as performance standards for mitigation and other restored wetlands is discussed. Finally, the application of the AmphIBI for field checking and validation of a GIS model that identifies sites having a high probability of success for vernal pool restorations is explored.

Session A3: Developing Nutrient Criteria 1

Nutrient Criteria and Standards for Forested Headwater Streams: An Overview of Issues and Solutions

George Ice[1], Douglas McLaughlin[2], Paul Wiegand[3], John Beebe[2], Erik Schilling[4], Effie Greathouse[5], Charles C. Rhoades[6], Sherri L. Johnson[7], Stephen Sebestyen[8], Brian Sugden[9]
[1]National Council for Air and Stream Improvement, Inc (NCASI), Corvallis, Oregon, United States (USA); [2]NCASI, Kalamazoo, Michigan, USA; [3]NCASI, Research Triangle Park, North Carolina, USA; [4]NCASI, Newberry, Florida, USA; [5]Oregon State University, Corvallis, Oregon, USA; [6]United States Department of Agriculture Forest Service (USDA FS), Fort Collins, Colorado, USA; [7]USDA FS, Corvallis, Oregon, USA; [8]USDA FS, Grand Rapids, Minnesota, USA; [9]Plum Creek Timber Company, Columbia Falls, Montana, USA

Abstract
States have developed or are developing numeric nutrient water quality (WQ) standards under guidance and review by the United States Environmental Protection Agency (EPA). Two states especially active in standards development are Florida and Montana. Nonpoint sources are often overlooked in standards development, but WQ standards are the benchmarks against which best management practices (BMPs) and forest practice rules are judged. There are significant challenges to establishing protective but workable standards. EPA-proposed ecoregion nutrient criteria are often not attainable even for least-impaired forested watersheds. Further, in some cases criteria development methods proposed by EPA have been found to not be predictive of biological responses. Here we discuss problems with proposed numeric nutrient criteria and some key principles, including:

- Site-specific factors such as atmospheric deposition, vegetation, and geology influence what criteria are attainable. What is attainable may change over time.
- Nutrient concentrations or loads must be biologically relevant, reflecting a potential to result in impaired designated uses in streams and downstream waterbodies.
- Criteria must recognize key seasons (e.g., the growing season) when nutrient concentrations or loads will be most important.
- Nutrient form affects its biological availability.
- Uncertainty in criteria and especially stressor/response relationships needs to be acknowledged and, if possible, addressed.
- Frequency, duration, and magnitude of exceedence need to be considered in assessing whether a standard has been violated.
- Disturbance events shape systems and can provide long-term benefits. Anti-degradation components of water quality standards have historically not acknowledged cycles in watershed conditions.

Data from USDA Forest Service Experimental Forests and Ranges provide long-term and detailed information on nutrient patterns to inform state efforts on standards development. These data, supportive information from Forest Service monitoring, and information from other forest watershed monitoring and research show that headwater streams can have high variability in nutrient concentrations while still maintaining high quality conditions for aquatic organisms.

Characterizing Variability of Stream Chemistry at U.S. Forest Service Experimental Forests - Applicability to Development of Numeric Nutrient Criteria for Headwater Forests

Chuck Rhoades[1], Effie Greathouse[2], George Ice[3], Sherri Johnson[4], Stephen Sebestyan[5], Devandra Amatya[6], John Campbell[7], Pamela Edwards[8], Jeremy Jones[9], Jennifer Knoepp[10], Gene Likens[11], William McDowell[12], Elaine Sutherland[13], Peter Wohlgemuth[14]

[1]U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO; [2]Oregon State University, Department of Forestry, Corvallis, OR; [3]National Council of Air and Stream Improvement, Inc. Corvallis, OR; [4]U.S. Forest Service, Pacific Northwest Research Station, Corvallis, OR; [5]U.S. Forest Service, Northern Research Station, Grand Rapids, MN; [6]U.S. Forest Service, Southern Research Station, Cordesville, SC; [7]U.S. Forest Service, Northern Research Station, Campton, NH; [8]U.S. Forest Service, Southern Research Station, Parsons, WV; [9]University of Alaska, Fairbanks, AK; [10]U.S. Forest Service, Southern Research Station, Otto, NC; [11]Institute for Ecosystems Studies, Millbrook, NY; [12]University of New Hampshire, Durham, NH; [13]U.S. Forest Service, Rocky Mountain Research Station, Missoula, MT; [14]U.S. Forest Service, Pacific Southwest Research Station, Riverside, CA

Abstract

Development of scientifically defensible numeric criteria to address the consequences of excess nutrient inputs presents a challenge for monitoring the condition of aquatic ecosystems. A multi-faceted approach that combines intensive, site-specific monitoring and process-level studies in conjunction with spatially extensive synoptic sampling is required to adequately characterize both temporal and geographic variability. The USDA Forest Service Experimental Forest and Range (EFR) network was established to evaluate the effects of forest practices and other disturbances on streamflow and water quality of headwater catchments. Most EFR sites rely on paired comparisons of treated and relatively undisturbed reference watersheds. Here we consider the utility of long-term reference watershed stream chemistry data sets maintained by the USFS, as well as state agencies and private groups, to assist in developing streamwater nutrient criteria for small, headwater forest catchments. There are currently eleven USFS hydrologic research sites that maintain seasonal chemistry records for multiple streams that extend at least into the 1980s and as far back as 1963. Most EFRs collect samples weekly, some monthly and few seasonally. This group of EFRs encompasses seven of EPA's Level-III Ecoregions in the continental U.S. within four Aggregate Nutrient Ecoregions.

In EFR reference watersheds, the 25% percentile of streamwater NO_3 concentrations were typically near the minimum reported either for EPA's Level-II Ecoregions or Aggregate Nutrient Ecoregions. Maximum NO_3 concentrations ranged from less than 1 to 81% of EPA maxima. In spite of the relatively undisturbed condition of the EFR reference watersheds, draft EPA numeric nitrogen criteria were exceeded in EFR basins in the Eastern, Central and Western U.S. This cross-site synthesis will provide estimates of seasonal, annual and decade-scale variation in streamwater N and P concentrations for relatively undisturbed and managed forest lands and will examine the magnitude, frequency, and duration of exceedance of nutrient threshold criteria for headwater forests.

Comparing Reference Stream Nutrient Concentrations to Harm-to-Beneficial-Use Concentrations Derived from Regional Nutrient Dose-Response Studies: Implications for Setting Nutrient Criteria

Michael Suplee[1], Vicki Watson[2], Arun Varghese[3], and Josh Cleland[3]

[1]Montana Department of Environmental Quality, Helena, MT, United States; [2]University of Montana, Missoula MT, United States; [3]ICF International, Fairfax, VA, United States

Abstract

Nutrient dose-response studies provide information on the effect nutrients have on stream ecology. Stream reference sites confer an understanding of what nutrient concentrations are like in the absence of substantial human disturbance. For the purpose of setting numeric nutrient criteria over a diverse landscape, each of these pieces of information is, in a sense, incomplete. Structured scientific studies provide understanding as to how eutrophication manifests in streams, but each study has its own statistical uncertainties (they often have fairly low r^2 values), each has limited scope (e.g., specific to a particular stream), there are usually only a few studies available in a region, or they may only be approximations of local stream conditions (e.g., artificial stream studies). In contrast, reference sites — if there are enough of them — provide good landscape coverage for an array of un-impacted regional streams, but do not by themselves tell us about thresholds of harm to beneficial uses. Bringing these two types of information together creates a valuable tool that greatly improves confidence in both pieces of information.

Nutrient concentrations drawn from dose-response studies from four different level-III ecoregions which occur in Montana were compared to the nutrient-concentration frequency distributions of their corresponding ecoregions. Harm-to-beneficial-use nutrient concentration thresholds from the studies were defined as (a) the nutrient concentration that held benthic algae levels to150 mg Chl a/m^2, or (b) the nutrient concentration that maintained dissolved oxygen concentrations at Montana standards. The nutrient concentration at the harm-to-use threshold from each study was matched to its equivalent concentration (and, in turn, percentile) in the corresponding reference-site nutrient distribution (summer/early fall data only). Collectively, harm-to-use nutrient concentrations equaled concentrations at the 91st and 94th percentile of reference (mean, median). This analysis indicates that nutrient concentrations at the 75th percentile of the reference distribution, which are recommended by USEPA as reasonable for numeric nutrient criteria, may be too restrictive in some circumstances. Ramifications for nutrient criteria setting will be discussed, as will appropriate matching of studies, nutrient species, and reference data.

Developing Numeric Nutrient Criteria in Florida

Jeffery Vowell

Florida Department of Agriculture and Consumer Services, Division of Forestry, Tallahassee, FL, United States

Abstract

On January 14, 2009, EPA conveyed an official determination under the Clean Water Act, that new or revised water quality standards for nutrients were necessary to meet the requirements of the Act for the State of Florida. This determination required that numeric nutrient standards for Florida streams and lakes be adopted by January, 2010, and that numeric standards for Florida estuaries be adopted by January, 2011. To meet these deadlines, the Florida Department of Environmental Protection (FDEP) intensified its nutrient criteria development efforts – a process that had been ongoing for several years. FDEP's approach was to establish "response based" criteria based on the relationships between nutrient concentrations and biological measures such as Florida's Stream Condition Index, a developing stream periphyton index, lake chlorophyll *a*, or the Lake Vegetation Index.

While biological response was well correlated to nutrients in lakes, it was determined that cause-effect relationships were insufficiently robust to derive criteria for streams. Therefore, a "nutrient benchmark site distributional" approach was taken for streams, which defined nutrient expectations in five major regions of the state. Benchmark sites for streams were selected through an extensive process including field evaluations. Expectedly, forestry operations were common, if not dominant within the watersheds of the benchmark sites. Consequently, it seemed reasonable to expect that FDEP's criteria would not adversely affect a Florida forest landowner's ability to conduct silviculture operations, including forest fertilization, provided that Best Management Practices were followed.

Despite FDEP's work on numeric nutrient criteria, on January 14, 2010, EPA proposed federal standards for Florida. EPA's numeric nutrient criteria are similar to those prepared by FDEP, but differ significantly in several aspects. In particular, FDEP was proposing a "two tier" approach, where biological assessments would be required to confirm that elevated nutrient concentrations actually resulted in beneficial use impairment. EPA's proposal includes no such "confirmation" process, and poses other uncertainties for all land uses including silviculture.

Session A4: Lessons Learned from National Assessments

National Rivers and Streams Assessment Project – Ohio's Experience

Gregg Sablak, David Altfater, Michael Gray
Ohio Environmental Protection Agency, Columbus, Ohio, United States

Abstract
The National Rivers and Streams Assessment (NRSA) project is a probability based survey designed to assess the condition of the Nation's rivers and streams. Over 1800 sites were sampled across the country during 2008 and 2009. Sampling occurred at boatable and wadeable sites, ranging from 1st through 10th order streams. A number of ecological, water quality, and recreational indicators were measured at each site. Results of these measurements will be used to evaluate good, fair, and poor water resource quality. Within Ohio, the Ohio EPA completed NRSA sampling at 36 sites. Eleven of the sites were sampled using the boatable method, and 25 sites were sampled using the wadeable approach. Highlights of the NRSA project in Ohio will be discussed, including field monitoring activities. Comparisons of NRSA fish and macroinvertebrate monitoring results with standardized Ohio EPA monitoring data will be presented from 12 NRSA sites. Boatable and wadeable sites will be included in an analysis of species richness, abundance, and biological integrity.

Integrating Modeling and Surveys for More Effective Assessments

Gretchen Oelsner, John Stoddard, and Steve Paulsen
U.S. Environmental Protection Agency, Western Ecology Division, 200 SW 35th St, Corvallis, OR 97333

Abstract
A false dichotomy currently exists in monitoring that pits sample surveys based on probability designs against targeted monitoring of hand-picked sites. We maintain that judicious use of both, when designed to be integrated, produces assessments of greater value than either independently implemented. Using experience with monitoring aquatic effects of acidic deposition on streams and lakes in the eastern United States, we demonstrate how surveys can be implemented to estimate the proportion of lakes and stream length experiencing chronic acidification during the summer and monitoring of individual hand-picked sites can be used to evaluate site specific episodic acidification occurring during spring snowmelt. We evaluate several approaches to modeling the relationship between spring and summer acidification status (based on acid neutralizing [ANC]) and then apply those models to estimate the proportion of lakes and stream length experiencing episodic acidification.

This abstract does not necessarily reflect EPA policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

National Aquatic Resource Survey Core Indicators – Appropriate to Determining Arctic and Sub-Arctic Aquatic Ecosystem Status?

Douglas Dasher[1], Arny Blanchard[2], John Kelley[2], Sathy Naidu[2], Stephen Jewett[2], Terri Lomax[3]
[1]Alaska Department of Environmental Conservation, 610 University Avenue, Fairbanks, AK, United States; [2]University of Alaska Institute of Marine Science, Fairbanks, AK, United States; [3]Alaska Department of Environmental Conservations, 555 Cordova Street, Anchorage, AK, United States

Abstract
The Alaska Department of Environmental Conservation Alaska Monitoring and Assessment Program (AKMAP) is adapting the National Aquatic Resource Survey (NARS) methodology to assessing the condition of Alaska's and the Nations Arctic and sub-Arctic aquatic resources. The statistical survey design, with modifications, is proving effective at assessing large regions of our Arctic waters. Important questions, though, remain in regards to NARS "national" core indicators. Do the NARS core indicators provide environmental managers with relevant information to identify current and emerging problems in Arctic and sub-Arctic aquatic resources and to judge the effectiveness of any protection and restoration programs?

Within the contiguous United States multiple pollution sources, both point and non-point, related to urbanization, industrial and agricultural activities are drivers for the resultant NARS core indicators, such as nutrients. In Alaska, many of these pollution sources, while of a concern, are minor or non-existent drivers of aquatic resource condition and change. Alaska stressor sources, indicators, and ecosystems are not the same as the contiguous United States. Many pollutants, such as mercury, are transported to Alaska in atmospheric or oceanic currents. The arctic marine environment is ice covered for long periods, exhibits peak productivity during late season ice cover, and has organisms uniquely adapted to life under these conditions. Climate change appears to be producing the most rapid and dramatic changes to aquatic ecosystems in the Arctic and sub-Arctic.

Core indicators used in the design of the AKMAP 2010 and 2011 Arctic Chukchi Sea statistical survey assessment are compared with those used by the 2010 NARS National Coastal Assessment. While some indicators are the same, there are important differences in core indicators between the two surveys. If NAR surveys are to provide relevant information on current status and help set national priorities for Alaska's and the Nations Arctic and Sub-Arctic aquatic resources the scientific basis for "national" core indicators must be re-assessed.

The 2007 National Lake Assessment: Findings and Lessons from Wisconsin

Timothy Asplund[1] and Paul Garrison[2]
[1]Wisconsin Department of Natural Resources, Bureau of Watershed Management, Madison, WI; [2]Wisconsin Department of Natural Resources, Science Operations Center, Madison, WI

Abstract
The National Lake Assessment (NLA) was conducted in 2007 in the lower 48 states, with the goal of assessing the water quality, ecological integrity, and recreational health of the nation's lakes and reservoirs. Wisconsin was one of a handful of states which conducted monitoring on additional lakes above and beyond those randomly selected, as well as analyzed the biological samples (sediment cores, zooplankton, phytoplankton) in state laboratories. In addition, we supplemented the standard protocol with additional surveys and metrics to better evaluate the ecological integrity component of the NLA. For example, we conducted full point-intercept aquatic macrophyte surveys on each of the target lakes and an additional set of minimally-impacted (reference) lakes, collected additional information on shoreline disturbance and littoral zone complexity, and radio-dated the sediment cores. We also collected independent water quality samples and compared in-lake measurements of disturbance with those obtained from GIS data layers.

As a result of these efforts, Wisconsin has learned useful information for the design and implementation of future national lake assessments, as well as our own statewide lake assessment. For example, we found good correspondence between field-determined shoreline metrics and GIS-derived land-use and housing density information, giving confidence to the NLA shoreline assessment protocol. We also found that the aquatic plant survey information is consistent with the more qualitative metrics in the NLA protocol, but provides a much more robust means of assessing in-lake aquatic habitat. On the cautionary side, we found some discrepancies in water chemistry data between our lab and the contract lab, and that many of the sediment cores were not deep enough to provide a true measure of pre-settlement conditions. In this talk, we will summarize Wisconsin's findings, provide recommendations for future assessments, and discuss how we are integrating the NLA tools into our statewide lake assessment methodology.

Session A5: Strategies for Growing a Volunteer Monitoring Program

Monitoring with Community Based AmeriCorps Programs

Danielle Donkersloot[1], Akili Lynn[2]
[1]New Jersey Department of Environmental Protection, Water Monitoring and Standards, Trenton, NJ, United States; [2]New Jersey Department of Environmental Protection, Division of Watershed Management, Trenton, NJ, United States

Abstract
The NJ Department of Environmental Protection (Department) hosts two public outreach programs in the water resource and watershed management areas; the Volunteer Monitoring Program and NJ Watershed Ambassador Program (AmeriCorps). Both of these programs provide an invaluable resource to the communities of NJ while supplying the Department with water quality information. Participants will get an overview of these two programs and will learn how these programs work hand and hand with each other to serve the agency and the public.

For example, in past years the volunteer monitoring program would run 20+ volunteer trainings per year. Now the AmeriCorps members are conducting over 100 trainings per year and are the primary volunteer recruitment tool for the Volunteer Monitoring Program. The AmeriCorps monitoring program also collects over 1000 habitat and biological assessments per year for the Department. With the proper quality assurance planning, training and oversight this data can be used by the Department for TMDLs, Stressor Identification projects, Integrated Report, and enforcement actions. All of the AmeriCorps and volunteer collected data are submitted to the Department through the NJ Volunteer Data System. This data system helps the agency and the public access these types of data with ease.

EPA's Volunteer Monitoring Equipment Loan Program in New England

Tom Faber and Diane Switzer
U.S. Environmental Protection Agency, Region I, New England Office, Office of Environmental Measurement and Evaluation, North Chelmsford, MA United States

Abstract
In 2006, EPA's New England Regional Office launched a long-term equipment loan program for volunteer organizations monitoring waters within the six New England states. The incentive for the Region to begin the loan program was to help volunteers generate data of sufficient quality so state agencies would be able to use them for assessments and reporting under the Clean Water Act. There have been four rounds of equipment loans, which have supported the work of 43 monitoring organizations. Eligibility requirements and several criteria for accepting the loans include having a state or EPA approved Quality Assurance Project Plan before data is generated for use, agreeing to upload data to EPA's national water quality data system (WQX/STORET) when it is final, and agreement by the state regulatory agency that the organizations data is useful. EPA is finding that the loans are increasing the amount of data that meet state quality requirements for assessments, expanding the number of waters monitored, and, improving partnerships among volunteer organizations, local communities, and environmental agencies. This has been a welcome addition in the face of decreasing state resources and budgets.

Using Publicity and Community Outreach to Retain Citizen Stream Monitoring Volunteers

Kristine Stepenuck[2], Bret Shaw[1], Elizabeth Goers[1]
[1]University of Wisconsin-Madison, Department of Life Sciences Communication, Madison, WI; [2]University of Wisconsin-Extension, Environmental Resources Center, Madison, WI

Abstract
This two-year project focused on volunteer retention in Wisconsin's Citizen-based Stream Monitoring Program – a partnership between the UW-Extension, Wisconsin Department of Natural Resources, and the River Alliance of Wisconsin. A pre-test survey of fifty-one volunteers indicated high satisfaction with the program but there was significant room for improvement related to increasing its visibility and impact.

To address these issues, the following activities were undertaken: Media outreach was significantly increased with seven newspaper articles and one radio story about the program; A letter to the editor campaign was also launched where volunteers were given examples and tips on how to use this outreach strategy through an e-mail and a website link. Research also indicated volunteers wanted to see more youth involvement in monitoring. Working with teachers and state standards, a curriculum was constructed. The pilot program involved a training day for thirteen teachers who are currently using the program in their classrooms. An advanced stream leader workshop was also offered to volunteers. Volunteers were also provided brochures to give to others in their community interested in the program. For volunteers who want to go out into the community and speak with officials of different environmental and service organizations, fundraising materials and a PowerPoint presentation about the program were made available.

Following the approximately 18-month outreach and capacity building campaign, a post-test was conducted in November 2009. Post-test analyses, which included key measures we wanted to evaluate over the course of out outreach work found that our intervention was successful at improving volunteers' perceptions about program efficacy, specifically in the area that the data they collected as a volunteer was being used as effectively as possible to promote conservation issues and that the citizen stream monitoring program was doing a good job getting the word out about the data they collected as a citizen stream monitoring volunteer.

Campaign elements that were viewed as most useful by citizen stream monitors were the new educational curriculum designed to teach youth about stream-related health issues, brochures explaining the citizen stream monitoring program to interested parties, media stories about citizen stream monitoring program published in newspapers throughout state, and the stream leader workshop designed to teach advanced volunteer monitors about how to get more involved with promoting stream health issues in their community.

Using eLearning to Support Water Quality Data Management

Dave Wilcox
Gold Systems, Inc., Salt Lake City, UT, United States

Abstract
For all monitoring programs, effective training in both monitoring techniques and data management is critical to meeting their program goals. For smaller programs, especially those that are spread across great distances, this training can be both costly and time consuming. Likewise, programs organizing volunteer monitoring events often need

to train a large group of volunteers before sending them into the field. Gold Systems has recently released a free online eLearning solution, LearningZen, which can be used to reach these programs effectively and without the cost of a formal training program. Using LearningZen, anyone can create their own eLearning course and make it available to their users. Using the examination and certification capabilities of the system, programs can track all users that have taken and passed their training courses. In this session we will discuss how LearningZen is already being used to support the EPA WQX Web application, the Region VIII Tribal Programs, and the volunteer monitoring community. We will provide a brief demonstration of the LearningZen application and show how you can use this free elearning solution to support your monitoring program.

Session A6: Monitoring and Assessing Groundwater Vulnerability 1

Groundwater Vulnerability - An Overview of Concepts and Assessment Methodologies

Mike Wireman
US EPA Region 8, Denver, CO, United States

Abstract
Groundwater vulnerability describes the concept that some areas are more vulnerable than others to groundwater contamination caused by activities at or near the land surface. The vulnerability of the uppermost groundwater to contamination is related to: (1) the hydrogeologic characteristics of the underlying soils, vadose zone and uppermost aquifer - groundwater sensitivity and; (2) the specific nature of the land overlying use, i.e., nature and magnitude of land disturbance, types and amounts of products that contain contaminants, toxicity and transport and fate properties of contaminants, frequency and intensity of land use. Thus groundwater vulnerability includes both the inherent hydrogeologic properties and anthropogenic factors associated with land use.

During the past 25 years numerous types of groundwater vulnerability assessments have been completed at various scales for different areas (based on different political and hydrologic boundaries) and for a variety of management objectives aimed at targeting areas with a high vulnerability. A variety of assessment methods have been applied. They can be grouped into three categories: (1) overlay / index methods; (2) process-based methods and; (3) statistical methods. The methods range in complexity from subjective evaluation of existing data to the use of complex mathematical transport models. Recent advances in determining apparent ages for ground water and travel times have provided a new emphasis for assessing the vulnerability of ground waters that are withdrawn by public water supply wells.

Uncertainty is significant in all groundwater vulnerability assessments and must be considered in using the results to help manage ground water resources. To help reduce the uncertainty, there have been efforts to standardize some aspects of groundwater vulnerability assessment. Two key research questions related to groundwater vulnerability assessments need to be further addressed: (1) is groundwater/aquifer sensitivity a mappable hydrogeologic property? and; (2) since groundwater vulnerability is not a measurable property -how can the results of vulnerability assessments be validated?

Evaluation of Recharge in Selected Aquifer Systems of the United States Using Tracers of Groundwater Age – What Does it Say About Groundwater Vulnerability?

P.B. McMahon[1], L.N. Plummer[2], J.K. Böhlke[2], S.D. Shapiro[2], S.R. Hinkle[3]
[1]U.S. Geological Survey, Denver, CO; [2]U.S. Geological Survey, Reston, VA; [3]U.S. Geological Survey, Portland, OR

Abstract
Groundwater vulnerability is strongly tied to recharge because of the role of water flux in delivering chemicals to the water table. In this presentation, we synthesize existing datasets of groundwater age into a consistent analysis of the rates and timescales of recharge at a national scale. Apparent age distributions in aquifers determined from 565 chlorofluorocarbon, sulfur hexafluoride, tritium/helium-3, and radiocarbon measurements from 29 nested and 16 water-table well networks were used to calculate recharge rates for groundwater. Timescales of recharge were defined by 1,823 distributed tritium measurements and 228 radiocarbon measurements from 37 well networks. Recharge rates ranged from < 10 to about 1,200 mm/yr in selected unconfined aquifers on the basis of measured vertical groundwater age distributions. Mean groundwater residences times calculated using these recharge rates and data on aquifer thickness ranged from 6 to about 19,000 years. On average, recharge represented 24 percent of mean annual precipitation at non-irrigated sites, whereas it represented 41 percent of precipitation plus applied irrigation water at irrigated sites. Infiltration of excess irrigation water increases the rate of entry of agricultural contaminants into aquifers and reduces the mean age of groundwater, potentially decreasing effects of natural remediation. On a regional basis, recharge exhibited a significant inverse correlation with mean annual air temperature and a significant positive correlation with mean annual precipitation. Empirical characterizations of climate effects on recharge can provide guidance for understanding and modeling how recharge (and groundwater vulnerability) might change in response to future climate scenarios. Radiocarbon-based groundwater velocities and estimates of the depth or distance to the first occurrence of pre-Holocene recharge provided useful perspective on long-term timescales for recharge in selected unconfined and confined aquifers. Estimates of depth or distance to the first occurrence of pre-Holocene recharge provided qualitative measures of the distribution of old water in the aquifers that presumably is not renewable on a meaningful timescale for water resource management but is also less vulnerable to contamination from surface sources. Results from this study show that groundwater age-based recharge estimates can provide useful insights into the spatial and temporal variability in recharge at a national scale and the factors controlling that variability.

Evaluating Aquifer Susceptibility and Vulnerability in Selected Aquifers of the United States: An Improved Modeling Strategy that Incorporates Prediction Uncertainty and Effects of Aquifer Complexity

Tristan Wellman[1], Leon Kauffman[2], and Brian Clark[3]
[1]U.S. Geological Survey, Colorado Water Science Center, Lakewood CO, 80225-0046; [2]U.S. Geological Survey, New Jersey Water Science Center, West Trenton, NJ, 08628; [3]U.S. Geological Survey, Arkansas Water Science Center, Little Rock, AR, 72211

Abstract
Throughout the United States there is a growing awareness of the need for organizations at the Federal, State, and local levels to develop improved methodologies to characterize natural and anthropogenic influences on water quality under current and projected future conditions, and to quantify the uncertainty of these assessments. Natural factors that affect aquifer susceptibility pertain to an aquifer's physical characteristics, such as depth to groundwater, hydraulic properties and structure of the geologic units, and hydrologic conditions. Examples of the latter include climate, net recharge, and linkages between surface-water and groundwater. Natural characteristics affect the time for chemical constituents to reach the water table, the residence time that they remain in the system, potential for contaminant degradation, and the manner in which they are ultimately dispersed. Anthropogenic factors, such as land-use zoning and population density, influence aquifer vulnerability, which is sensitive to the source locations, timing, type, and magnitude of chemical constituents that enter an aquifer. The uncertainty of such

assessments arises from limited hydrologic, geologic, and geochemical field data, assumptions in deriving water-age, and a simplified understanding of the aquifer structure.

The main goals of the investigation are to develop a method to evaluate macroscopic susceptibility in designated large-scale zones within an aquifer, and for source water discharging to streams and wells, and to then apply the technique to 11 field sites selected by the United States Geological Survey National Water Quality Program as having nationwide significance. The effects of aquifer complexity and uncertainty are represented in our evaluation, and are demonstrated to be important considerations when estimating water age. The results are also useful in approximating aquifer vulnerability under a range of conditions. Comparisons of aquifer susceptibility and vulnerability show interesting similarities in aquifer response but also notable differences that relate to unique characteristics of each system. This investigation takes an important first step toward better characterizing aquifer susceptibility and vulnerability in principal aquifer systems throughout the United States.

Effects of Development on Groundwater Quality in the Denver Basin, Colorado

Suzanne S. Paschke and Jennifer A. Beck
U.S. Geological Survey, Colorado Water Science Center, Denver, Colorado

Abstract
The Denver Basin aquifer system is a critical water resource for municipal, industrial, and domestic uses along the semi-arid Front Range urban corridor of Colorado. Groundwater pumping from Denver Basin bedrock aquifers for municipal supply has increased steadily since the 1950s in response to population growth and is concentrated on the western side of the basin where the bedrock sandstones are thickest and demand is greatest. Domestic pumping is less than municipal pumping but is widespread across the basin, and many rural areas depend exclusively on self-supplied groundwater. The Denver Basin aquifer system consists of confined sandstone bedrock aquifers interbedded with shale confining units, which receive little precipitation recharge (less than 1 inch/year) because of the overlying confining units, low precipitation rates, and high evapotranspiration rates. Unconfined sand and gravel alluvial aquifers occur at the land surface along present-day stream channels. Urban and agricultural development in the Denver Basin have increased water use on the landscape and thus recharge to the shallow system, while pumping from the confined bedrock aquifers has lowered bedrock potentiometric surfaces, enhanced downward movement of water through confining layers, and reduced aquifer storage.

Groundwater quality generally evolves along flow paths from young (< 50 years), oxygenated, calcium-carbonate-type water in higher-elevation recharge areas to pre-modern (< 50 years), low-oxygen, calcium-sulfate-type water in downgradient discharge areas and to pre-modern, reduced, sodium-bicarbonate-type water with depth. Urban and agricultural land use has affected groundwater quality in shallow parts of the system as indicated by detections of nitrate, volatile organics, and pesticides in shallow water-table wells. Shallow groundwater also is susceptible to increased salinity and trace-element concentrations in areas where lawn-irrigation and agricultural return flows mobilize evaporative soluble minerals accumulated in the weathered zone. Confined parts of the aquifer system, once considered isolated from the effects of overlying land use, are increasingly vulnerable to contamination because pumping is inducing downward water movement from the land surface. This presentation will describe results of recent water-quality studies in the Denver Basin and relate results to changing groundwater flow conditions caused by development.

Session B1: Evaluation and Application of New Technologies for Real-time Monitoring

Continuous Monitoring of Nitrate plus Nitrite and Dissolved Organic Carbon using Ultraviolet-Visible Spectrophotometry in Two New Jersey Rivers

L.S. Feinson[1], J. Gibs[1], E.L. Silldorff[2], B.J. Gray[1], and P. Schorr[3]
[1]U.S. Geological Survey, West Trenton, NJ, United States; [2]Delaware River Basin Commission, West Trenton, NJ, United States; [3]New Jersey Department of Environmental Protection, Trenton, NJ, United States

Abstract
The continuous measurement of water-quality characteristics such as dissolved oxygen, pH, temperature, and specific conductance has advanced technologically and currently is widely applied in environmental monitoring. Efforts to continuously monitor concentrations of constituents such as nitrate plus nitrite (NO_3+NO_2), suspended solids, and chloride in real time, however, have been unreliable or impractical. Recent advances in optical technology and miniaturization have made possible the quantification of NO_3+NO_2 and dissolved organic carbon (DOC) by ultraviolet-visible spectrophotometry. Because States such as New Jersey have begun to rely more heavily on the convenience of continuous monitors, the availability of this technology could augment the ability to assess the health of streams and rivers and to allow water utilities to rapidly optimize treatment techniques based on the condition of the source water.

In 2008, the U.S. Geological Survey (USGS) deployed a newly available spectrophotometric sensor capable of measuring concentrations of NO_3+NO_2 and DOC in the Delaware River at Trenton, NJ, and in the Passaic River at Two Bridges in Wayne, NJ, two sites with differing water matrices, to evaluate its practicality, precision, and dependability in the transmission of near-real-time data to the USGS National Water Information System Internet (NWISWeb) page (http://waterdata.usgs.gov). The sensor at each location was operated and maintained over approximately a 5-month period, allowing for long-term evaluation. Sensor readings and results of laboratory analyses of concurrently collected Delaware River water samples agreed closely, with long-term correlation coefficients of 0.94 and 0.90 for NO_3+NO_2 and DOC, respectively. Rapid bio- and sediment fouling, especially in Passaic River water, prompted the development of an automated cleaning technique using filtered water sprayed on the sensor's optical windows. Concentrations of NO_3+NO_2 in the Delaware River exhibited unexpected correlations to fluctuations in discharge, pH, dissolved-oxygen concentration, specific conductance, and temperature over daily and weekly time periods. During storm events, however, the times at which peak discharge occurred in the Delaware River did not correlate well to the times of peak NO_3+NO_2 concentrations, making stream flow analysis an unreliable indicator of the occurrence of peak NO_3+NO_2 concentrations in this river.

Experiences Using UV Nitrate Sensors for Continuous, In-Situ Measurements

Janice M. Fulford
U.S. Geological Survey, Office of Surface Water, Hydrologic Instrumentation Facility, Stennis Space Center, MS

Abstract
Nitrate is a common constituent in natural waters that is often found at elevated concentrations as a result of human activity. Because this important nutrient plays a key role in many ecological processes it is often desirable to monitor it continuously in rivers and estuaries. Field deployable, wet chemistry systems can accurately measure nitrate concentrations on a frequent or continuous basis. These systems typically require a high level of expertise to use and also produce a hazardous waste stream that must be managed. These issues have limited the adoption of wet chemistry systems for in-situ continuous monitoring of

nitrate. In the last few years, several manufacturers have developed UV sensors that are easy to use and produce no chemical waste stream. The UV systems can be deployed in-situ to continuously monitor nitrate concentrations.

Several manufacturers offer UV sensors of similar capabilities for in-situ measurement of nitrate. The U.S. Geological Survey, Hydrologic Instrumentation Facility has investigated some of the UV sensors that are commercially available, including the Satlantic SUNA and the TRIOS Props (the use of commercial names is for identification purposes only). The sensors have been deployed at a field site on the Pearl River, at Stennis Space Center, MS. The field site is tidally affected and has nitrate levels that typically range from 0.15 mg/l to 0.60 mg/l. The results of field deployments for the sensors will be presented and compared with field samples collected concurrently and analyzed using a standard laboratory method. Experiences with the deployment and servicing of the sensors will also be presented and discussed. Field data show that these units have the ability to accurately measure nitrate continuously in this test environment.

Comparison of Periodic Sampling and Continuous Monitoring for Determining Effects of Seasonality and Stream Discharge on Nitrate-Nitrogen Concentrations in Agricultural Watersheds

Rob G. Middlemis-Brown[1], Mary P. Skopec[2]
[1]U.S. Geological Survey, Iowa Water Science Center, Iowa City, IA; [2]Iowa Department of Natural Resources, Water Monitoring Section, Iowa City, IA

Abstract
Traditional approach of using nitrate-nitrogen concentrations from discrete measurement during periodic sampling provides a sporadic record of specific concentration values associated with a particular season and stream discharge level. In contrast, continuous monitoring of nitrate-nitrogen concentrations provides a complete record of concentration levels associated with a wide range of seasonal time periods and stream discharges. The study compared periodic sampling with continuous monitoring techniques for understanding effects of seasonality and stream discharge on nitrate-nitrogen concentrations in agricultural watersheds. Periodic water-quality samples were collected over a two-year period from fourteen agricultural watersheds ranging in size from 3,600 to 38,000 square kilometers and analyzed in a laboratory for nitrate nitrogen. Continuous monitoring was during the open-water period (April through November) at four of the fourteen watersheds over the two-year period and was based on 15-minute recordings of nitrate-nitrogen concentration measured by ultraviolet-light probes. Nitrate data from the continuous monitors were compared to periodic discrete samples at the four watersheds for quality assurance. Stream discharge was obtained from USGS continuous streamgages in all fourteen watersheds using the continuously measured stream stage and an established stage-discharge relation.

Nitrate-nitrogen concentrations in the 14 watersheds using the periodic sampling followed a similar seasonal trend over the two-year period. The highest concentrations were found after the application of fertilizer in the spring and during the fall and winter periods and the lowest concentrations were found during July through September when evapotranspiration and biologic uptake is greatest. Continuous monitoring of nitrate-nitrogen concentrations followed a similar seasonal pattern of that observed in the periodic sampling concentrations. However, continuous monitoring provided insight into the brief seasonal effects of snowmelt runoff, diurnal temperature changes, precipitation variations, fertilizer application periods, crop growing patterns, and crop harvesting timing. Spatial and temporal variation in nitrate-nitrogen concentration between the 14 watersheds was likely related to the amount of nitrogen stored in the upper soils during the winter months; input of nitrogen from application of ammonia-nitrogen fertilizer during April and September; and nitrate-nitrogen assimilation by crops during the maximum growing season from June through August.

Seeing the light: Applications of in situ optical measurements for understanding dissolved organic matter dynamics in river systems

Brian A. Pellerin[1], Brian A. Bergamaschi, Bryan D. Downing[1], JohnFranco Saraceno[1], Jacob A. Fleck[1], James B. Shanley[2], George R. Aiken[3], Emmanuel S. Boss[4] and Roger Fujii[1]
[1]US Geological Survey, CA Water Science Center, Sacramento, CA, United States; [2]US Geological Survey, NH-VT Water Science Center, Montpelier, VT, United States; [3]US Geological Survey, National Research Program, Boulder, CO, United States; [4]University of Maine, Orono, ME, United States

Abstract
A critical challenge for understanding the sources, character and cycling of dissolved organic matter (DOM) is making measurements at the time scales in which changes occur in aquatic systems. Traditional approaches for data collection (daily to monthly discrete sampling) are often limited by analytical and field costs, site access, and logistical challenges particularly for long-term sampling at a large number of sites. The ability to make optical measurements of DOM in situ has been known for more than 50 years, but much of the work on in situ DOM absorbance and fluorescence using commercially-available instruments has taken place in only the last few years.

Here we present several recent examples that highlight the application of in situ measurements for understanding DOM dynamics in riverine systems at intervals of minutes to hours. Examples illustrate the utility of in situ optical sensors for studies of DOM over short-duration events of days to weeks (diurnal cycles, tidal cycles, storm events and snowmelt periods) as well as longer-term continuous monitoring for months to years. We also highlight the application of in situ optical DOM measurements as proxies for constituents that are significantly more difficult and expensive to measure at high frequencies (e.g. methylmercury, trihalomethanes). Relatively simple DOM absorbance and fluorescence measurements made in situ could be incorporated into short and long-term ecological research and monitoring programs, resulting in advanced understanding of organic matter sources, character and cycling in riverine systems.

Session B2: Developing New Biological Assessment Tools

A stream algal bioassessment incorporating the Biological Condition Gradient to evaluate tiered aquatic life uses in Maine

Tom Danielson
Maine Department of Environmental Protection, Augusta, ME, United States

Abstract
Maine's Water Classification Law established four classes of streams and rivers: AA, A, B, and C. Maine has Tiered Aquatic Life Uses (TALU) in its water quality standards in the form of tiered biological criteria based on benthic macroinvertebrates. The TALU allow the state to manage streams and rivers at several levels of environmental risk and condition. The Biological Condition Gradient (BCG) provides a conceptual framework to describe the condition and structure of a biological community compared to minimally disturbed reference conditions. Maine relied heavily on the BCG when developing new biological assessment tools for benthic algae. In addition, the BCG provides a cross-walk to compare and aggregate biological assessment results of multiple assemblages and waterbody types. By applying the BCG to multiple assemblages and waterbody types, staff can more effectively assess the condition of watersheds, diagnose stressors, and target resources for conservation, restoration, and other management activities.

A Benthic Invertebrate Index for the Nearshore Ocean Waters of New Jersey – Its Development and Application

Robert Schuster[1], Robert Connell[1], Michael Kennish[2], Charles Strobel[3], Darvene Adams[4]
[1]New Jersey Department of Environmental Protection, Water Monitoring & Standards, Bureau of Marine Water Monitoring, Leeds Point, NJ, United States; [2]Rutgers University, Institute of Marine & Coastal Sciences, New Brunswick, NJ, United States; [3]U.S. Environmental Protection Agency, Office of Research and Development, Atlantic Ecology Division, Narragansett, RI, United States; [4]U.S. Environmental Protection Agency, Region 2, Division of Environmental Science and Assessment, Edison, NJ, United States

Abstract
New Jersey identified the ocean waters as impaired for aquatic life use based on low dissolved oxygen beginning in its 2002 Integrated Water Quality Monitoring and Assessment Report. That report indicated that a benthic indicator was needed to fully evaluate aquatic life use. A benthic invertebrate index is under development in New Jersey for the State's ocean waters. A species tolerance/species sensitivity index is being developed as a cooperative effort between the New Jersey Department of Environmental Protection (NJDEP), Rutgers University, USEPA Region 2 and USEPA Atlantic Ecology Division. The index development is part of NJDEP's efforts to expand ecosystem-based assessment of its coastal waters from the estuarine waters that are being assessed under USEPA's National Coastal Assessment into the State's ocean waters. Sampling for the index development took place in 2007 and was conducted at 100 probability-based locations in New Jersey's ocean waters. Additional samples were collected in 2009 at potentially impaired locations to assure a full range of biological conditions for the index development. The benthic index will provide a better assessment of the general condition of the ocean environment and will be used to demonstrate that aquatic life use is attained and that the periodic low dissolved oxygen reflects a natural condition.

This new benthic indicator will also be used to determine whether the discharges from any of New Jersey's 14 ocean outfalls cause unreasonable degradation based on adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities as required by Section 403 of the Clean Water Act (CWA) known as the Ocean Discharge Criteria. In addition, this information will be used to assess effectiveness of New Jersey's existing mixing zone policy. Sampling in 2009 and 2010 will occur just outside of these mixing zones to evaluate the benthic communities using the index developed.

Modeling Macroinvertebrate Multi-metric Index Scores in Connecticut's Rivers and Streams Using Landscape Variables -An Approach to Support Restoration Goals and Anti-degradation Policy

Christopher Bellucci, Mary Becker, and Mike Beauchene
Connecticut Department of Environmental Protection, Bureau of Water Protection and Land Reuse, Hartford, CT, United States

Abstract
This project expands on prior work relating impervious land cover and drainage basin characteristics by expanding the list of watershed variables to establish the best predictors of current biological condition for freshwater streams in Connecticut. We developed a multiple regression equation to predict macroinvertebrate multi-metric index (MMI) scores using data collected by Connecticut Department of Environmental Protection (CT DEP) from 153 study sites and 43 watershed variables. The three most important watershed variables in explaining variation in MMI were impervious land cover, watershed size, and a measure of diversion quantity and these three variables described 61% of the variance in predicted MMI. This equation can be used to map the expected MMI score for stream segments in the State of Connecticut. Two potential uses of this model will be discussed. In absence of actual field collected benthic data, predicted MMI scores from this model can be used to identify streams that have "better than necessary" aquatic life and can be useful for selecting streams for Tier 2 anti-degradation reviews. In addition, the model can also be used to enhance anti-degradation policy by providing a benchmark to compare monitored streams to identify waters that are not meeting model expectations. This can be useful to prioritize waters for future Stressor Identification work by CT DEP.

Water microbioms – indicators of water quality

Toomas Neuman[1], James Rosa[1,2], Madis Metsis[1]
[1]Biotap LLC, Tallinn, Estonia; [2]BioMap Inc, Golden, CO, USA

Abstract
Biomonitoring as a tool to evaluate the quality of environment and ecosystems in the basis of distribution and abundance of microorganisms has been widely acknowledged by now. Current methodological approaches, based on the morphology and culturing of microorganisms (less than 2% of taxons can be cultured) are time consuming and biased towards taxons that can be cultured. Our approach is based on the assumption that soil, water and air DNA retain molecular imprint of microorganisms which makes the method repeatable across ecosystems regionally and globally.

We used the so-called "ecosystem intactness, human influence" model to detect possible indicator taxa for water ecosystem quality estimation. We have sampled four different water ecosystems, representing different stages of intactness-disturbance gradient. Rivers in mountains and forests represent a template of intact ecosystem, rivers in agricultural and recreational regions under human pressure represent an intermediately disturbed stage, rivers in cities have heavy human pressure and waste waters represent heavily disturbed ecosystems. From each site, 20 water samples were collected. DNA was extracted and subjected to the PCR with ribosomal RNA gene primers (8F & 357R for prokaryote, and EF4 & 518R for eukaryotes amplification) following large scale parallel DNA sequencing. Obtained reads were subjected to the BLAST search in GenBank. In further analysis, reads with GenBank identification were used excluding GenBank nominations with only one hit from our sequences database (procaryota:345 201 sequences in 4671 sequence groups; eukaryota: 298 985 sequences in 1016 sequence group).

Preliminary microbiom composition analysis, on the basis of sequence groups, shows that prokaryote communities are well distinguished between ecosystems and the distinction follows nicely the ecosystem disturbance gradient, while the local variation of community within ecosystem is relatively low. Eucaryote communities are quite homogenous in rivers with no and intermediate human influence, while the local variation of eukaryotes in heavily disturbed ecosystems and wastewater is remarkable. The interpretation of this pattern needs further analysis.

Our data clearly demonstrates that metagenomic analysis approach results in much better qualitative and quantitative analysis of water microorganisms ecosystems than any conventional test methodology.

Session B3: Developing Nutrient Criteria 2

Assessing Nutrient Impacts in New Jersey Waters

Debra Hammond
New Jersey Department of Environmental Protection, Water Monitoring and Standards, 401 East State Street, P.O. Box 409, Trenton, NJ 08625-409

Abstract
Nutrients, in and of themselves, are generally not harmful to the environment; in fact, they are necessary to promote growth among living things. Under healthy conditions, nutrients exist as part of a balanced

natural aquatic system. Excessive nutrients have been associated with ecological impacts that include harmful algal blooms, loss of aquatic habitats, fish kills, natural flora and fauna replacement, hypoxic zones, siltation issues, and loss of spawning habitats. Nationally, the USEPA has identified nutrients as a leading cause of water quality impairments. It is widely recognized that excessive productivity can be influenced by many physical and chemical factors including flow regime, water depth, retention time, land use, channel morphology, stream bank stability, pool/riffle sequence, canopy cover, bottom substrate, water color, organic content, and temperature making the selection of a single numeric criterion applicable to all state waters challenging.

In 1985, New Jersey adopted a narrative criterion for nutrients in freshwaters, as well as numeric criteria for phosphorus for rivers, streams, lakes, ponds and reservoirs. The phosphorus criteria have been used to determined impaired waters and develop TMDLs, as well as to develop water quality based effluent limits for wastewater dischargers. Phosphorus alone did not adequately predict or identify eutrophic waters. The Department developed a technical manual for wastewater facilities to evaluate whether the narrative nutrient criteria were met. This assessment established conservative thresholds for dissolved oxygen and chlorophyll *a* in periphyton and phytoplankton to ensure that phosphorus did not cause aquatic life impairment. The Department built upon this technical manual, and the data generated by these studies, to develop an enhanced nutrient assessment method for freshwater wadable streams. In 2010, the Department will use the enhanced assessment method evaluating the condition of the benthic macroinvertebrate community, dissolved oxygen levels and diurnal fluctuations, and periphyton biomass to identify where phosphorus is a cause of the aquatic life use impairment. Improvements in this assessment method are expected once the Department establishes thresholds for diatoms in 2010. New Jersey's Nutrient Criteria Enhancement plan outlines similar approaches for developing assessment methods for nutrients in estuaries and nearshore ocean waters.

A linked set of nutrient and biological criteria for the protection of designated uses for Vermont lakes and wadeable streams

Smeltzer, E.[1], N. Kamman[1,3], D. Burnham[2], S. Fiske[1]
[1]Vermont Department of Environmental Conservation, 103 S. Main 10N, Waterbury, VT 05671-0408; [2]Emeritus, Biomonitoring and Aquatic Studies Section, VTDEC, Waterbury, VT; [3]Presenting author

Abstract
Vermont's Water Quality Standards establish as policy goals tiered aquatic life and aesthetic uses tied to specific water management types within water classes. These Standards presently contain numeric nutrient criteria for only a subset of Vermont lakes and streams. During the period 2005-2008, the Vermont Department of Environmental Conservation, in partnership with USEPA Region 1, undertook a series of targeted and probability-based surveys to identify levels of nutrients (P and N) that are protective of aquatic life and aesthetic uses, for wadeable streams and lakes. Field surveys were designed to pair site-specific aesthetic condition or biological assessment results from Vermont's Tier III+ Bioassessment and Lake Assessment programs with temporally and hydrologically-relevant nutrient concentrations. Lake response variables were measured water transparency, chlorophyll-*a*, and lake user perception. Stream response variables were in-stream bioattainment using a macroinvertebrate trophic index, and measured in-stream aesthetic rating. Four separate analyses were carried out relating nutrient concentrations to responses: aesthetic uses in lakes, and streams; biological uses in lakes, and streams. A common weight-of-evidence approach was employed for each analysis, combining conditional probability analysis (CPA), independent verification of attainment probabilities implied by CPA changepoints, and professional judgment based on expert understanding of the waterbodies assessed. For lakes, recommended criteria ranged from 12 ppb to 24 ppb total P, 360 to 480 ppb total N, 2.4 m to 3.8 m Secchi transparency, and 9 ppb to 16 ppb chlorophyll-*a*. For wadeable streams, recommended criteria ranged from 10 ppb to 44 ppb total P, and 350 ppb to 750 ppb total N. Policy ramifications of proposed criteria were evaluated in terms of potential impacts to wastewater discharges, and impairment listing implications for waters with existing nutrient concentrations in excess of proposed criteria based on probability surveys of Vermont wadeable streams and lakes.

Development of Nutrient Criteria for Lakes and Reservoirs in Northern Plains States

Lan Tornes[1], Mark Deutschman[1], Michael Ell[2]
[1]Houston Engineeering, Inc, Maple Grove, MN, United States; [2]North Dakota Department of Health, Bismarck, ND, United States

Abstract
Lake and reservoir water-quality conditions are heavily affected by present-day agricultural and other land-use activities. These circumstances make it challenging to identify reference conditions used to establish goals for TMDLs and related water-quality criteria. A model, based on CNET, a spreadsheet version of the BATHTUB model, was developed using data from selected lakes and reservoirs in North Dakota. The output from the model was used to establish reference nutrient ranges based on the reference conditions. A preliminary classification identified four lake and four reservoir classes. Additional data are being compiled for lakes and reservoirs in the plains of Montana, North Dakota, South Dakota, and Wyoming to test the classification model across a broader geographic area and provide a larger data set. Data from the EPA's National Lakes Assessment (NLA) program also will be included in the analysis. Combining monitoring data collected from the four states and the NLA allows us to calibrate the model on a larger and more diverse group of lakes and reservoirs, and provides us with more information on the model's robustness.

Western states have initiated work to evaluate appropriate classification approaches, and to develop nutrient criteria for their lakes and reservoirs. This project will likely expedite the establishment of nutrient-related TMDL targets and progress on nutrient criteria development in multiple states. By refining the previously-developed model, this project potentially will establish a consistent approach and methodology that could be used to set consistent TMDL targets associated with protecting aquatic life, and recreational beneficial uses. In addition, the modeled results can serve as benchmarks for water quality assessments and Section 303(d) listings. Final development of a model with defined nutrient criteria will provide a consistent mechanism for developing TMDLs, which could significantly reduce the amount of time and resources committed to developing individual TMDLs.

Numeric Nitrogen Criteria for Streams to Protect Downstream Estuarine Waters in Florida

James D. Hagy III and Richard M. Greene
US Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL, United States

Abstract
Eutrophication of surface waters resulting from nutrient enrichment is an environmental issue of national and global concern. Environmental management efforts have often failed to improve water quality, suggesting that stronger regulatory action is needed to protect water quality. In the US, the Clean Water Act provides for development of numeric water quality standards which specify pollutant concentrations or levels that ensure waters support their designated uses. The Act also requires standards to protect downstream waters while not being arbitrarily restrictive. An approach was developed for determining total nitrogen (TN) criteria for streams and rivers in Florida that protect 15 Florida estuaries from excessive nutrient enrichment by limiting the aggregate input of TN to estuarine waters. The approach uses results from a regional SPARROW watershed model developed by the USGS to extrapolate hydrologic and water quality data across the stream network and to estimate interception and removal of N within streams. By doing so, TN criteria for downstream use protection can be higher in

streams from which a significant fraction of transported N is removed before eventual discharge to estuaries, generally those most distant from estuaries. Nonetheless, across the watersheds of the target estuaries, 37% of the stream network ultimately delivers >90% of the transported N to estuarine waters while only 10% of the network permanently retains more than 50% of transported N, preventing it's delivery to estuarine waters. For each of the 15 estuaries, we estimated TN loading levels protective of designated use using a weight of evidence approach that also utilized SPARROW model results. TN in streams and rivers discharging directly to Florida's estuaries presently exceeds the targets we derived by 5% to >300% (median=62%), indicating that significant TN reductions will be needed meet the target concentrations.

Session B4: Monitoring the Effects of Development on Hydrology and Water Quality

Online Database, Retrospective Assessment, and Monitoring Program of Water Quality in the Upper Yampa River Basin, Northwestern Colorado, 1975-2009

Nancy J. Bauch[1], Jennifer L. Moore[2], Keelin R. Schaffrath[2], and Jean A. Dupree[1]
[1]U.S.Geological Survey, Colorado Water Science Center, Denver, CO, United States; [2]U.S. Geological Survey, Colorado Water Science Center, Grand Junction, CO, United States

Abstract
The Yampa River in northwestern Colorado is the largest primarily unregulated tributary to the Colorado River in the Upper Colorado River Basin. It is a highly valued resource known for its biological diversity, largely unaltered natural condition, and very good water quality. The upper portion of the Yampa River Basin in Routt County is undergoing increased land and water development to support growing municipal and recreational tourism needs and second-home development. As land and water development proceed, there is the potential for short- and long-term changes in the quality of surface-water and groundwater resources. Assessment and monitoring are needed to periodically redefine baseline conditions and monitor trends in water quality. In response to these concerns, the U.S. Geological Survey, in cooperation with Routt County, compiled historical water-quality data into a web-accessible water-quality database, conducted a retrospective assessment of water quality in the upper Yampa River Basin, and designed a water-quality monitoring program.

Preliminary results of the retrospective assessment for surface water indicate that the water quality generally is very good, although concentrations of some chemical constituents are elevated at some sites. Most stream pH values and dissolved-oxygen concentrations were within State of Colorado water-quality standards for protection of aquatic life. Many nitrate concentrations were less than 1 milligram per liter; most were less than 10 milligrams per liter. Some total phosphorus concentrations were greater than recommendations to control eutrophication in downstream water bodies. Most trace-element concentrations met State of Colorado water-quality standards for aquatic-life protection. For some stream sites, concentrations of sulfate, dissolved-solids and a few trace elements were elevated in the water, mostly likely because of the presence of specific rock types in the drainage basins. Escherichia coli concentrations in a few streams were greater than State of Colorado water-quality standards for recreational use of the water. From discussions with Routt County and other stakeholders and the retrospective assessment of water quality, a water-quality monitoring program was designed to track water quality over time and address specific questions identified by the stakeholders and the retrospective assessment.

Water-Quality Characteristics of Watersheds in Metropolitan Atlanta, Georgia, 2003-2007

Jacob LaFontaine
U.S. Geological Survey, Georgia Water Science Center, Atlanta, GA, United States

ABSTRACT
Atlanta, Georgia is one of the fastest growing metropolitan areas in the United States. With this growth come impacts to the water quality and hydrology of area streams. In 2003, the U.S. Geological Survey, in cooperation with the City of Atlanta, established a 20-site water-quality and water-quantity monitoring network in six City of Atlanta watersheds. Monitoring stations are located on Nancy, Peachtree, Proctor, Sandy, and Utoy Creeks, which drain to the Chattahoochee River, and South River, which drains to the Altamaha River. At each site, data on stream properties (stage, discharge, water temperature, specific conductance, dissolved oxygen, pH, and turbidity) are continually monitored and in water samples are collected periodically for analysis of bacteria, major ions, nutrients, trace elements, and sediment. The data are being used to establish baseline conditions of streams, and to monitor long-term water-quality trends. A primary goal of the study is to evaluate the effectiveness of infrastructure improvements implemented to mitigate impacts of urbanization on stream water quality. This paper provides a spatial and temporal comparison of data across the studied watersheds as well as to other urban areas across the nation.

Trend Analysis for Selected Analytes, South Platte River, Denver, CO

Jon Novick[1] and Philip A. Russell[2]
[1]Denver Department of Environmental Health, Denver, CO; [2]Littleton / Englewood Waste Water Treatment Plant, Englewood, CO

Abstract
In 1998 a group of utilities, communities, and industries in the Denver Metro area formed the South Platte Coalition for Urban River Evaluation (SPCURE) to study the urban South Platte watershed. Since that time, SPCURE members have conducted routine sampling of the South Platte River and it's tributaries in order to develop a more comprehensive understanding of the urban South Platte watershed and to provide data for use in regulatory hearings.

Data from SPCURE monitoring efforts were evaluated using graphical and statistical techniques to determine spatial and temporal trends in levels of several constituents measured in the South Platte River. This paper summarizes the results from the evaluation of nitrate, phosphorous, *E. coli*, and selenium levels and reveals how levels of each constituent have changed through time, how water quality changes as the river passes through the Denver Metro area, and identifies areas where water quality in the South Platte River degrades.

Urban Steam Monitoring Network: Monitoring and Assessment of Chemical, Habitat and Watershed Influences on Aquatic Life in Kansas City Urban Streams

Gary Welker, Jeff Robichaud, Deanna Callier, Shawn Henderson, Ann Jacobs, Venessa Madden, Roberta Vogel–Leutung and Laura Webb
U.S. EPA Region 7, Environmental Services Division, Assessment and Monitoring Branch; 901 North 5th Street; Kansas City, Kansas; 66101

Abstract
The U.S. Environmental Protection Agency in Kansas City has established an urban stream monitoring network in the Kansas City urban area. The monitoring network consists of 36 sites on twelve urban streams. An array of biological, chemical and physical data have been monitored and assessed annually from 2006 to 2009. One objective of the monitoring network is to provide the public and decision maker's data and information as to the condition and trends of urban streams in

the greater Kansas City area. Other objectives include the assessment of aquatic life, chemical and physical effects of urbanization along a gradient of low to highly urbanize watershed conditions; analysis of status and trends and; the adoption of monitoring sites by local universities, municipalities, county and non governmental organizations. Monitoring efforts include sampling phytoplankton, periphyton, macroinvertebrate, fish and bacteria and the assessment of stream habitat and watershed characteristics such as land use and impervious surface. Water column and sediment samples have been analyzed for nutrients, metals, pesticides, herbicides and polycyclic aromatic hydrocarbons (PAHs). Results have indicated a gradient of effects in aquatic life communities associated with combined effects of chemical contaminants found in stream water column and sediment samples and the effects of urban land use and land cover in watersheds up-gradient of monitoring site locations.

Session B5: Modeling Ecological Conditions

Predicting Environmental Reference Conditions in Streams from Watershed Geology

John R. Olson and Charles P. Hawkins
Utah State University, Logan, UT, United States

Abstract
Modeling ecological responses to natural variation in stream environments requires that we measure or characterize stream environments as accurately and precisely as possible. Although ecologists have long recognized the effect of underlying geology on a stream's physical and chemical attributes, the categorical nature of geologic maps has limited their utility in determining stream environmental conditions. Taking advantage of advances in geochemical data management and geologic mapping, we generated a set of maps based on 13 state geologic maps that characterize several chemical and physical properties of the bedrock lithology of the western USA: rock CaO, MgO, P_2O_5, S and N content and rock hydraulic conductivity and strength. We then used these geologic characterizations together with climate and topography data to model stream alkalinity, specific conductivity, nutrient chemistry, substrate size, and ground water stream inputs. Here, we describe models that predict alkalinity (ALK), specific conductivity (COND), Total Phosphorus (TP), and Total Nitrogen (TN). Statewide ALK models had R^2 values ranging from 0.41 to 0.75 and COND models had $R^2 \sim 0.75$. Model assessments based on external validation data resulted in RMSEs ranging from 13 to 30 ppm $CaCO_3$ for stream ALK and RMSEs ranging from 90 to 120 μS/cm for COND. West-wide nutrient models had RMSEs of 12 μg/L for TP (over a range of 0.4-290 μg/L) and 48 μg/L for TN (over a range of 5-900 μg/L). Incorporating the different influences of geology on aquatic ecosystems should improve our understanding of how biotic communities respond to differences in underlying lithology. This increased understanding should also improve predictions of the specific stream biota expected at different reaches and hence the accuracy and precision of bioassessments.

NWSA's Physical Habitat Approach - Combining knowledge of habitat requirements with mechanisms of geomorphic and anthropogenic influence on stream channel form

Philip R. Kaufmann
U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Western Ecology Division, Corvallis, OR, United States

Abstract
Effective environmental policy decisions benefit from stream habitat information that is accurate, precise, and relevant. The recent National Wadeable Streams Assessment (NWSA), carried out by the U.S. EPA and its collaborating partners, required physical habitat information sufficiently comprehensive and precise to facilitate interpreting biotic data, and to address habitat concerns in their own right. The assessment characterized the major habitat features that may operate as controls or limiting factors on biotic assemblage composition under natural or anthropogenically disturbed circumstances. Within sample reaches, the field approach employed a randomized, systematic design; locating habitat observations on reaches with lengths 40 times their low flow wetted width. Two-person crews typically completed NWSA habitat measurements in 1.5 to 3.5 hours of field time. The resultant field measurements quantified 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. We reduce the complexity of the raw field data by calculating metrics to summarize stream reach habitat characteristics. Beyond simple descriptions, the national assessment evaluated habitat indicators that reflect channel responses to basin-riparian disturbances, or elicit biotic responses when altered. In large regions, human land use disturbances typically overlay wide ranges of natural geomorphic factors that control both habitat characteristics and biotic assemblages. We 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 criteria, and the use of process-based or empirical models to estimate reference condition. The survey produced descriptions of habitat adequate for regional assessments of habitat condition, establishing benchmarks for assessing future change, assessing likely causes of habitat alteration, and therefore evaluating relative risk for biotic impairment.

Establishing Thermal Reference Conditions: Development of Stream Temperature Models in Support of Biological Monitoring and Assessment in the Western USA

Ryan A. Hill[1,2], Charles P. Hawkins[1,2,3]
[1]Western Center for Monitoring and Assessment of Freshwater Ecosystems; [2]Department of Watershed Sciences; [3]Ecology Center, Utah State University, Logan, UT 84322-5210

Abstract
The abundance and distribution of most stream organisms are strongly influenced by water temperature. For bioassessments, the effects of 'natural' stream temperatures on the distribution of biota are usually predicted with surrogate variables (e.g., elevation, latitude). However, direct estimates of stream reference condition temperatures that are both accurate and precise across a large diversity of stream types and regions would be preferable. In addition, it is important to understand the potential responses of stream temperatures, and hence stream biota, to anthropogenic effects, such as climate change and riparian cover alteration. To address this goal, we are developing predictive temperature models based on easily measured predictors. We built initial stream temperature models (mean annual, winter and summer temperatures) for the western USA from data collected at 455 reference-quality USGS stream gauges. Multiple linear regression models based on long-term air temperature and precipitation, catchment size and shape, and watershed soils accounted for large percentages of the variation in mean annual, winter and summer stream temperatures (R^2 = 0.87, 0.75 and 0.73; RMSE = 1.0, 1.7 and 2.2 °C, respectively). These thermal estimates were effective for modeling invertebrate and fish distributions in several regions in the West, and were often the most important predictors. We are building on these initial models by screening an additional 1,343 USGS stream gauges in the western USA to identify those in reference quality condition. In addition, we are incorporating reach-level estimates of canopy shading, solar radiation, and discharge to better characterize the physical processes known to influence local variation in stream temperatures. The results of these models will inform our efforts to develop nationwide stream temperature models. These models should allow us to more precisely predict spatial variability in local stream temperatures and the thermal responses to climatic,

landscape, and hydrologic alterations. In doing so, we should be able to better explain current distribution patterns of stream biota and their likely responses to thermal alterations.

Predictive models for streamflow characteristics and assessment of hydrological alteration

Daren Carlisle, Mike Meador, James Falcone
US Geological Survey, Reston, VA, United States

Abstract
Understanding the extent to which natural streamflow characteristics have been altered requires that we quantify the attributes of the flow regime that would be expected in the absence of anthropogenic modifications. The objective of this study was to evaluate whether selected streamflow characteristics could be predicted at regional and national scales using geospatial data. Gaged river basins distributed throughout the contiguous U.S. that had streamflow characteristics representing least disturbed or near pristine conditions were identified. Thirteen metrics of the magnitude, frequency, duration, timing, and rate of change of streamflow were calculated using a 20-50 year period of record for each site. We used random forests, a robust statistical modeling approach, to develop models that predicted the value for each streamflow metric using natural watershed characteristics. We compared the performance (i.e., bias and precision) of national- and regional-scale predictive models to that of models based on landscape classifications, including major river basins, ecoregions, and hydrologic landscape regions. For all hydrologic metrics, landscape stratification models produced estimates that were less biased and more precise than a null model that accounted for no natural variability. Predictive models at the national and regional scale improved predictions of all hydrologic metrics relative to landscape stratification models. Prediction error rates ranged from 15-40%, but were $\leq$25% for most metrics. We illustrate how predictive models could be used to assess hydrologic alteration at specific sites and also demonstrate how the models can be applied to predict expected natural flow characteristics at ungaged sites.

Session B6: Monitoring and Assessing Groundwater Vulnerability 2

Local Government Perspective on Conducting Water Resource Investigations for Optimal Watershed Management

Raymond P. Merry
Department of Environmental Health, Eagle County, Colorado

Abstract
Eagle County, Colorado, is one of the fastest growing counties in the United States. The world class ski areas of Vail and Beaver Creek as well as the excellent fishing and float boating has attracted people throughout the world to relocate or purchase vacation properties, creating additional threats and stressors to the Eagle River Watershed. Maintaining a healthy watershed is germane to maintaining our healthy local economy. It is essential for local organizations to seek out and obtain scientifically-based tools to evaluate potential land development effects on ground- and surface- water resources to enable informed land use and water management decisions. Developing these tools for the Eagle River Watershed is a multi-year strategy with multi-agency partnerships. With the creation of a surface-water quality monitoring network and the ground-water probability maps for the Eagle River alluvial fill aquifer, we now have the basis for discussing the best ways to reduce threats and mitigate stressors to our water resources. Creating a ground-water protection zoning overlay is but one of the land use tools available to local governments who rely on maintaining a healthy watershed.

Predicting the Probability of Groundwater Contamination in the Eagle River Watershed Valley-Fill Aquifer, North-Central Colorado, Using Groundwater Age and Low-Level Volatile Organic Compounds

Michael G. Rupert[1] and L. Niel Plummer[2]
[1]U.S. Geological Survey, Pueblo, CO, United States; [2]U.S. Geological Survey, Reston, VA, United States

Abstract
The Eagle River watershed valley-fill aquifer (ERWVFA) is located within Eagle County near the destination resort town of Vail, Colorado. The area has a fast growing permanent population, and the resort industry is rapidly expanding. As development continues, local organizations need tools to evaluate potential land-development effects on groundwater and surface- water resources so that informed land-use and water management decisions can be made. To support this effort, maps were constructed based upon statistical models that show the probability of groundwater contamination in the ERWVFA. Groundwater age-dating compounds were used to calibrate a groundwater probability model under the assumption that recently recharged groundwater has a greater predisposition to contamination than waters recharged many years earlier. Concentrations of volatile organic compounds (VOCs) determined with low-level laboratory methods were used to calibrate a second groundwater probability model because VOCs are common urban contaminants. The groundwater age-dating data indicated that most groundwater in the ERWVFA was recently recharged water (median recharge date is 1989) and had a high probability of contamination if anthropogenic compounds were released to the environment. VOCs were detected in all water samples at or above the low-level laboratory reporting limit concentrations, but VOC concentrations in all samples were at least one order of magnitude less than their USEPA Maximum Contaminant Level. Some of those VOCs can be naturally occurring at these extremely low concentrations. Low-level VOCs were analyzed from surface-water samples in undisturbed areas to determine naturally-occurring concentrations; total VOC concentrations above 28,000 picograms per liter were attributed to anthropogenic sources. Logistic regression statistical modeling techniques were used to develop two statistical models that predict the probability groundwater contamination. One model predicts the probability of unmixed young water (using chlorofluorocarbon-11 concentrations and tritium activities) and the second model predicts the probability of elevated VOC concentrations. Although the groundwater age dating indicates that most areas of the ERWVFA have a high probability of contamination, the probability maps help to show areas with the greatest probability of contamination if compounds of concern are released to the environment.

Parameter and predictive uncertainty analyses for unsaturated zone nitrogen fate and transport models

Bernard T. Nolan[1] and Christopher T. Green[2]
[1]U.S. Geological Survey, Reston, VA, United States; [2]U.S. Geological Survey, Menlo Park, CA, United States

Abstract
Parameter and predictive uncertainty analyses were performed for unsaturated zone models calibrated by inverse modeling at two sites studied by the U.S. Geological Survey's National Water Quality Assessment Program: an almond orchard near the Merced River, California (CA), and a corn-soybean rotation at Morgan Creek, Maryland (MD). We used the Root Zone Water Quality Model (RZWQM2) to estimate N mass balances for the deeper unsaturated zone where possible (6.5 m at CA). RZWQM2 is a 1D unsaturated zone fate and transport model that also simulates crop growth and agricultural management practices. Unsaturated zone data consisting of soil moisture content and water tension, aqueous nitrate and bromide concentrations, soil nitrate concentration, and organic matter content formed the basis for adjusting soil hydraulic parameters and

an organic matter transformation constant (R45). We used truncated singular value decomposition (SVD) to enhance numerical stability of the inverse models. SVD uses linear combinations of parameters to mitigate potential convergence problems stemming from highly correlated parameters. Parameter uncertainty, sensitivity, and potential nonuniqueness were assessed with parameter confidence intervals, composite scaled sensitivities (CSS), and parameter correlation coefficients (PCC), respectively. Prediction uncertainty was evaluated using a nonlinear calibration-constrained method to develop confidence intervals for predicted annual water flux (groundwater recharge) and average nitrate concentration in deep seepage.

Confidence intervals, CSS, and PCC indicated that most of the parameters could be reliably estimated from the data with the possible exception of R45. The latter had comparatively low CSS and a wide confidence interval. Overall, the calibrated models fitted the observed data reasonably well according to the relative root mean square error (RRMSE) and index of agreement (*d*). The index of agreement varies between 0 and 1, with higher values indicating better fit. RRMSE and *d* were 0.22 and 0.86, respectively, for observed nitrate concentrations and their simulated equivalents at MD (1 m simulation depth), and were 0.40 and 0.60 at CA. The latter result indicated that RZWQM2 showed promise for deeper simulation profiles. Predicted annual water fluxes and average nitrate concentrations were within 90% confidence intervals at both sites, indicating that overall model errors were within acceptable limits.

An Invaluable $25 Investment: Using Isotopes to Better Characterize the Groundwater Quality of the Gila Valley Sub-Basin, Southeastern Arizona

Douglas Towne
Arizona Department of Environmental Quality, Division of Water Quality, Phoenix, AZ, United States

Abstract
The Gila Valley sub-basin of the Safford groundwater basin is located in southeastern Arizona and includes the drainage of the Gila River from the Gila Box National Riparian Conservation Area down gradient to near the tribal lands of the San Carlos Apache Nation. Farming is the major industry in the sub-basin with about 40,000 acres irrigated with a combination of surface water from the Gila River and groundwater from shallow irrigation wells. The Gila Valley sub-basin is part of a large, sediment-filled, trough-like depression typical of the Mexican Highland section of the Basin and Range physiographic province. Basin fill has been divided into two major units, younger alluvial fill and older alluvial fill, that likely function as a single aquifer system.

Groundwater quality studies of the Gila Valley sub-basin were conducted by the Arizona Department of Environmental Quality (ADEQ) in 1995 (79 sites sampled) and 2004-2005 (65 sites sampled). The earlier study used a targeted sampling design while the latter study used a random sampling strategy. For both studies, inorganic samples were collected at each site while radionuclide and pesticide samples were collected at selected sites. The latter study also collected oxygen and hydrogen isotope samples at every site in addition to nine samples collected from surface water sources and precipitation events.

Both ADEQ studies had similar frequencies of sites exceeding water quality standards for constituents of concern in the sub-basin including arsenic, fluoride, nitrate and total dissolved solids. Despite the similar sampling results, each study had different conclusions. The 1995 study termed the occurrence of water quality exceedances as random. In contrast, the 2004-2005 study through the use of isotope data revealed, patterns with constituent concentrations.

The latter study utilized the isotope data to link specific groundwater sample sites to recharge from either the Gila River or local precipitation and, subsequently, to specific alluvial units. Numerous statistically significant water quality differences were found among these alluvial units. Recommendations were consequently made for locating future public water supply wells. Overall, the isotope sampling proved an inexpensive means to more comprehensively assess the hydrology of the Gila Valley sub-basin.

Session C1: Monitoring Stressors and Impacts to Lakes and Reservoirs

Assessing Seasonal Inputs of Dissolved Pesticides to the Salton Sea from the Alamo River

James Orlando, Kelly Smalling, and Kathryn Kuivila
United States Geological Survey, California Water Science Center, Sacramento, California, USA Email: jorlando@usgs.gov

Abstract
The Salton Sea, a large terminal lake located within the Imperial Valley in southeastern California, supports a diverse ecosystem that is impacted by multiple water quality problems, including declining fresh water inflows and the input of pesticides and other contaminants. A wide variety of crops are grown throughout the year in the Imperial Valley resulting in the use of over one million kilograms of pesticides annually. Pesticide applications occur year-round, with peak amounts applied in the spring and fall. Dissolved pesticides are transported in drainage water from agricultural fields to the Alamo River via a complex and highly engineered network of surface and tile drains. The Alamo River, which is made up entirely of these agricultural return flows, is the primary source of fresh water to the Salton Sea. Previous studies have documented high concentrations of multiple pesticides in the Alamo River during the spring and fall. Initial modeling with these data and pesticide application data suggests that pesticides are applied on agricultural fields and then transported relatively rapidly to the Salton Sea. However, this modeling is based on a relatively small dataset, with little data from the summer and winter months. Additional samples are currently being collected every two weeks (December 2008 to present), to better determine the year-round input of pesticides from the Alamo River. Initial analyses of these samples confirm the previously-recognized pattern of pesticide peaks in the spring and fall and show that multiple pesticides are present during the summer and winter. This extended data will be used to model yearly dissolved pesticide concentrations in the Alamo River and loads transported to the Salton Sea. Plans are currently underway to restore the Salton Sea and understanding the seasonal trend in pesticides entering the Sea is crucial to the restoration process.

Monitoring the Quality of Water, Sediment, and Aquatic Biota of Lake Powell through the National Park Service and U.S. Geological Survey's Water Quality Assessment and Monitoring Program

Robert J. Hart
U.S. Geological Survey, Arizona Water Science Center, Flagstaff Programs Office, Flagstaff, AZ, United States

Abstract
The Glen Canyon National Recreation Area is responsible for the overall recreational experience and safety of visitors to Lake Powell. Beginning in 2000, the U.S. Geological Survey in cooperation with the National Park Service, Glen Canyon National Recreation Area, began monitoring for the presence of selected contaminants in Lake Powell. Various studies of the quality of the water and sediment have been completed through the National Park Service and U.S. Geological Survey's Water Quality and Assessment Partnership and have provided information that is being used to manage the lake. Since 2000, water and sediment samples have been collected at high-use areas, marinas, major inflow areas, and at 20 monitoring sites to determine the presence of various contaminants. Concentrations of several contaminants including pharmaceuticals, hormones, household waste products, trace metals, and volatile and semi-volatile organic compounds have been detected throughout the lake. These contaminants are highly associated with recreational activities on the lake, but some contaminants could be present due to

natural processes. Beginning in 2010, monitoring sites will be revisited by the U.S. Geological Survey to sample and instrument for determining the presence of organic compounds and selected trace elements that may bioconcentrate in aquatic biota in Lake Powell. Also beginning in 2010, sediment quality will be assessed in sediment deposits in tributary inflow areas for trace elements, radionuclide's, and other constituents. Continuing to monitor and assess the quality of the lake will significantly add to the information that has been previously gathered and used to best manage the recreation area.

Shorezone Water-Quality Monitoring Program for Lake Tahoe, California and Nevada

Timothy G. Rowe
U.S. Geological Survey, Nevada Water Science Center, Carson City, NV, United States

Abstract
In October 2008, the Tahoe Regional Planning Agency adopted the Lake Tahoe Shorezone Ordinance Amendments allowing possible construction of new buoys and piers, as long as established environmental thresholds are met. Baseline water-quality data are needed to determine if these possible additional shorezone structures result in higher emissions due to increased boat traffic. This effort is part of long term concerns at Lake Tahoe about reductions to lake clarity and cooperative/coordinated program with many agencies and institutions to study causes and effects.

The Shorezone Water-Quality Monitoring Program (SWQMP) is designed to determine the baseline water quality conditions and if Outstanding National Resource Water standards will be exceeded. SWQMP objectives are to; (1) determine a wider baseline of concentrations of gasoline and gasoline-derived compounds (BTEX and PAHs), prior to any shorezone changes, where historical water-quality data are limited, (2) understand temporal and spatial changes in water quality in the lake, and (3) to determine if mitigation measures are effective.

The number of sampling locations increased from 9 sites to 20 to include areas of possible change in shorezone development and boat traffic. BTEX samples were collected by the U.S. Geological Survey in areas of low, moderate, and high boat traffic around Lake Tahoe before, during, and just after the summer boating season. Semi-permeable membrane devices (SPMDs) were used to monitor at 10 of the 20 locations over a 30 to34-day period of high recreation. The SPMDs provide a time-integrated concentration of gasoline-derived compounds (PAHs) during a portion of the boating season and estimate what is bioavailable to aquatic biota.

Preliminary results show the highest BTEX concentrations (0.27 micro grams per liter (μg/L)) were present in samples collected at higher boat-use areas. The lowest concentrations (<0.02 μg/L) were present in samples collected during the pre-season, when boating activity is minimal, and in lower boat-use areas.

Measuring the effects of lakeshore development on littoral habitat and macroinvertebrates

Kellie Merrell[1], Eric Howe[2], Susan Warren[1] and Jeremy Deeds[1]
[1]Vermont Department of Environmental Conservation, Waterbury, VT, United States; [2]Lake Champlain Basin Program, Grand Isle, VT, United States

Abstract
Lakeshore residents convert natural lakeshore vegetation to lawns and impervious surfaces. Results from EPA's first national lakes survey found that this represents the most widespread stressor to lakes across the nation. From 2005-2008 the Vermont Department of Environmental Conservation conducted a study across 40 lakes and 5 lake classes to measure the effects unbuffered lakeshore development has on near shore littoral habitat. Statistically significant changes from the reference condition were found regardless of lake class in the following eight response variables: coarse, medium and fine woody structure, shading, sediment embeddedness, sand, leaf litter, and aufwuchs percent cover. The change in aquatic plant cover varied with lake class. In 2009, staff returned to the 8 large oligotrophic lakes in order to sample buffered developed sites. Seven of the nine habitat response variables no longer differed from the reference condition when lakeshore development was buffered, demonstrating that it is possible to develop lakeshores in a manner that protects aquatic habitat.

The 2009 sampling effort also entailed collecting macroinvertebrate samples from the original unbuffered and reference sandy and rocky littoral sites, the dominant habitat types in these lakes. The purpose was to characterize the macroinvertebrate community at reference sites and determine if it differed from unbuffered developed sites. To date samples have only been processed to the family level, but preliminary analyses suggest that macroinvertebrate communities at sandy littoral sites do not differ, whereas rocky littoral macroinvertebrate densities were higher at unbuffered developed sites.

The Clean Water Act affords the use of aquatic habitat and biotic indicators to determine if designated uses are attainable, to what extent they are supported, and to evaluate the effect of pollutant sources and their controls on water quality. Results from this study suggest that habitat and biotic indicators should be developed and standardized to expand routine lake monitoring into the littoral zones of lakes.

Session C2: Monitoring for Stormwater Management Effectiveness

Monitoring Stormwater: Do's, Don'ts, Why's and How's

Thomas Ballestero, Alison Watts, James Houle, Robert Roseen
University of New Hampshire, Durham, United States

Abstract
The accelerated pace of stormwater management activity has resulted in a burgeoning expectation of monitoring. It is incumbent that any stormwater monitoring strategy first consider the objective, "why is monitoring and monitoring data necessary?". With clearly stated objectives, the monitoring strategy and system can be designed and implemented. There are various ways of meeting the same objective; unfortunately cost, rather than effectiveness, is usually the principle deciding factor. Since 2003 the University of New Hampshire Stormwater Center (UNHSC) has operated a field test facility designed to monitor stormwater runoff and treatment for a variety of stormwater structural technologies, including porous pavements. The UNHSC collects discrete water samples for laboratory analysis (metals, nutrients, organics, particulates), as well as continuous real-time water quality data (flow, temperature, conductivity, DO, pH, and turbidity). In addition, large volume samples have been studied for comparison to laboratory sediment concentration data. Six years of real time and event based data collection will be used to demonstrate effective sample collection, QA, interpretation, and dissemination of data. In addition, various monitoring objectives will be presented and data sets used to demonstrate how the data may or may not meet each objective.

UDFCD Stormwater BMP Monitoring Program

Holly Piza, PE
Urban Drainage and Flood Control District, Denver, CO

Abstract
The Urban Drainage and Flood Control District (UDFCD) includes seven counties and 33 incorporated cities in the Denver Metropolitan area. UDFCD has played an active role in stormwater quality since 1991, marked by the initial release of our Urban Storm Drainage Criteria Manual, Volume 3 – *Best Management Practices*. We have also had an active stormwater quality sampling program for 14 years. A variety of Best Management Practice (BMP) demonstration facilities have been designed and constructed during this period for the purpose of monitoring and assessing the functionality of different BMPs on

stormwater runoff reduction and water quality. Inflow and outflow samples are collected, along with rainfall and runoff data, to determine the event mean concentration of various constituents. BMPs that are currently being monitored include an extended detention basin, porous asphalt pavement, permeable interlocking concrete pavement, pervious concrete pavement, and an open bed sand filter.

This presentation will give an overview of the UDFCD stormwater monitoring program and highlight lessons learned both in BMP construction as well as stormwater monitoring.

Urban Stormwater BMP Performance and Cost Effectiveness in the Capitol Region Watershed District

Melissa Baker
Capitol Region Watershed District, St. Paul, MN, United States

Abstract
From 2005-2007, the Capitol Region Watershed District (CRWD) constructed 18 stormwater BMPs for the Arlington Pascal Stormwater Improvement Project. The project aimed to alleviate flooding and reduce the amount of nutrients and sediment discharging to Como Lake; an impaired water body. The BMPs included an underground stormwater storage and infiltration facility, eight underground infiltration trenches, eight rain gardens, and a regional stormwater pond.

From April to November in 2007 and 2008, CRWD collected continuous flow data and composite water quality samples from the inlet and outlet of the BMPs (except for the rain gardens) to determine the volume reduction and pollutant removal efficiencies. Peak water levels, during storm events, were monitored for each rain garden. These data were used to calibrate a P8 water quality model to determine total annual volume and pollutant load reductions. In addition, CRWD documented all design and construction costs and also operation and maintenance costs for each BMP for 2007 and 2008. The modeled performance data and costs were used to determine the cost-benefit (or life cycle costs) of each BMP. Results of the modeled BMP performance data, comprehensive construction costs as well as maintenance practices and costs, and life cycle costs of the BMPs will be presented.

Using Stormwater Ponds in East Tampa to Promote Sustainable, Healthy Communities: A Community Partnership Approach

Ken D. Thomas[1], Joniqua A. Howard[1], Erlande Omisca[1], Trent Green[2], Maya A. Trotz[1]
[1]University of South Florida, Department of Civil & Environmental Engineering, Tampa, FL, United States; [2]University of South Florida, School of Architecture and Community Design, Tampa, FL, United States

Abstract
Properly maintained stormwater retention ponds play a vital role in flood and pollution control in communities throughout Florida. Community members also play a vital role in reducing pollution inputs to storm water through actions taken in their own yards. Community understanding of and awareness of the water quality in these ponds and the health risks posed by consuming fish caught in them is also needed in places where fishing occurs. This is of particular importance since water quality tests are not routinely carried out by the City of Tampa on these ponds and there are no signs that warn against potential dangers to eating fish from such ponds. It is from this standpoint that the Engineers for A Sustainable World Chapter at the University of South Florida (ESW USF) thought it imperative to use the ongoing community revitalization and pond beautification projects underway to raise awareness of East Tampa community members. This was done through partnerships with the Health, Education and Social Services Committee (HESS) of the East Tampa Community Revitalization Partnership (ETCRP) as well as key local community leaders. To educate students on stormwater pond issues ESW USF created water and storm water teaching modules for Young Middle Magnet School and Lockhart Elementary school of East Tampa so that the students were involved in some of the basic sampling and monitoring in their community's ponds. Samples taken were analyzed for typical water quality parameters and heavy metals, inclusive of mercury, by ESW USF members. At the University level, ESW partnered with an undergraduate Environmental Engineering class to use ponds in East Tampa as the site for its water quality monitoring semester project. This highlighted the importance of stormwater ponds from an engineering perspective and also gave students the opportunity to work on a 'real life' project as they were involved in both sample collection and analysis of samples. All the information collected from this ongoing project is being channeled into the creation of educational kiosks to be placed at the key East Tampa ponds. Kiosks are being designed with collaboration with the City of Tampa's Stormwater Department.

Session C3: Interpreting Water Quality Data

Data Uncertainty Estimation Tool for Hydrology and Water Quality (DUET-H/WQ): Estimating Measurement Uncertainty for Monitoring and Modeling Applications

Daren Harmel
USDA-Agricultural Research Service, Temple, Texas, USA

Abstract
Uncertainty estimates corresponding to measured hydrologic and water quality data can contribute to improved monitoring design, decision-making, model application, and regulatory formulation. With these benefits in mind, the Data Uncertainty Estimation Tool for Hydrology and Water Quality (DUET-H/WQ) was developed from an existing uncertainty estimation framework for small watershed discharge, sediment, and N and P data (Harmel et al., 2006, 2009). Both the software and its framework-basis utilize the root mean square error propagation methodology to provide uncertainty estimates instead of more rigorous approaches requiring detailed statistical information, which is rarely available. DUET-H/WQ lists published uncertainty information for data collection procedures to assist the user in assigning appropriate data-specific uncertainty estimates and then calculates the uncertainty for individual discharge, concentration, and load values. Results of DUET-H/WQ application in several studies indicated that substantial uncertainty can be contributed by each procedural category (discharge measurement, sample collection, sample preservation/storage, laboratory analysis, and data processing and management). For storm loads, the uncertainty was typically least for discharge (±7-23%), higher for sediment (±16-27%) and dissolved N and P (±14-31%) loads, and higher yet for total N and P (±18-36%). When these uncertainty estimates for individual values were aggregated within study periods (i.e. total discharge, average concentration, total load), uncertainties followed the same pattern (Q < TSS < dissolved N and P < total N and P). This rigorous demonstration of uncertainty in discharge and water quality data illustrates the importance of uncertainty analysis and the need for appropriate tools. It is our hope that DUET-H/WQ contributes to making uncertainty estimation a routine data collection and reporting procedure and thus enhances environmental monitoring, modeling, and decision-making. Hydrologic and water quality data are too important for scientists to continue to ignore the inherent uncertainty.

References

Harmel, R.D., R.J. Cooper, R.M. Slade, R.L. Haney, and J.G Arnold. 2006. Cumulative uncertainty in measured streamflow and water quality data for small watersheds. *Trans. ASABE* 49(3): 689-701.

Harmel, R.D., D.R. Smith, K.W. King, and R.M. Slade. 2009. Estimating storm discharge and water quality data uncertainty: A software tool for monitoring and modeling applications. *Environ. Modelling Software* 24(7): 832-842.

Multivariate Methods with Nondetects

Dennis R. Helsel
Practical Stats, Highlands Ranch, CO

Abstract
Multivariate methods such as principal component analysis, cluster analysis and multivariate tests of group differences are useful procedures when a suite of chemicals or biological community variables are analyzed for patterns. For example, a suite of trace elements might be tested to determine whether the pattern of trace elements differs among four land-use groups. Or changes in a suite of chemicals in surface waters might be correlated with changes in the community structure of organisms living in the streams. A complication in the use of these methods is the presence of nondetect values, concentrations below analytical detection limits. A common solution to this issue has in the past been to substitute one-half the detection limit prior to running the procedures. This solution is actually no solution at all, introducing artificial patterns into the data that may obscure the target relationships being evaluated. Instead, rank-based procedures can correctly incorporate nondetects into the mix without stating that actual concentrations for the nondetects are known. Examples using commercial software demonstrate these methods, based on the new second edition of the author's textbook *Nondetects And Data Analysis*, to be published in summer 2010 by Wiley.

Serial Correlation and Trend Option Basics In the Era of Frequent Data Measurements

Roy Irwin
National Park Service, Water Resources Division, Fort Collins, Colorado

Abstract
An introduction to serial correlation issues is presented, concentrating on relatively simple and intermediate-complexity basics and solutions not completely covered in most hydrology, statistics, and time series books. Serial correlation is the time-scale-only subset of autocorrelation and is an estimate of the extent to which successive observations in the same location are correlated. Water quality measurements are increasingly taken with sondes very frequently. Monthly or more frequent surface water quality data is often serially correlated. Groundwater quality or levels, sediment quality, tissue contaminant concentration, or large lake level data may be serially correlated even if collected less often than monthly. Why should we care about serial correlation? Serially correlated data do not meet independence assumptions of many statistical procedures. Most water quality specialists want to answer questions related to status and trends. If serial correlation is present but not properly factored into many statistical analyses, status and trend results may be biased and result in poor environmental management decisions. Relatively simple graphical methods with smoothed trend lines can help provide initial hints about possible trends and may be more important than monotonic trend tests if trend directions are not unidirectional. If hints from simple plots conflict with results of a trend test, determine why. There are logistical and other tradeoffs, but one simple serial correlation solution is to take measurements so frequently that one has a complete census for the site, making complex inferential statistics unnecessary to assess status and trends at that site. There are also some relatively simple but biologically important questions that can be answered with the new and more frequent data, such as: *Are the number of 15 minute periods that exceed a water quality standard increasing over the years?* For less frequent but still serially correlated data, one intermediate-complexity and often acceptable solution is to use a seasonal Kendall test to help answer longer term trend questions after first reducing very frequent data to representative monthly medians or means. Finally, brief mentions are made of more complex time-series strategies used most often by experts or statistical consultants.

Increasing Awareness, Understanding, and Availability of Statistical Methods for Water Quality Monitoring and Assessment

Douglas McLaughlin[1], Daniel Sullivan[2], Leslie McGeorge[3]
[1]National Council for Air and Stream Improvement, Kalamazoo, MI, United States; [2]U.S. Geological Survey, Wisconsin Water Science Center, Madison, WI, United States; [3]New Jersey Department of Environmental Protection, Trenton, NJ, United States

Abstract
It can be a significant challenge for water information practitioners, including decision-makers, water quality scientists and engineers, statisticians, and others to be aware of the range of statistical and water quality assessment methods that may exist in both regulatory and research arenas, how they may be used to address a water information question, and whether or not they yield comparable results. The National Water Quality Monitoring Council's (NWQMC) monitoring framework identifies six steps as part of a systematic process for water quality monitoring to understand, protect, and restore the nation's waters. The framework reflects the NWQMC's interest in supporting collaboration and the use of comparable and scientifically defensible methodologies to improve water quality monitoring. Past efforts of the NWQMC and its subgroups have yielded a number of useful products, including improved data reporting standards to facilitate integration of monitoring programs, and an internet-based search tool, the National Environmental Methods Index (NEMI), that allows users to quickly obtain information about chemical, physical, or biological analysis methods from many different sources.

Two of the monitoring framework steps, "Design monitoring program" and "Assess and interpret data" often involve the use of statistical procedures for project planning and data analysis. Currently, written guidance documents on the selection and use of these procedures, as well as a number of computer programs and calculation tools, are available from many sources. Often, members of the water quality community (e.g. states, federal agencies, academia, and industry) independently develop procedures used to address similar water quality information needs, such as the assessment of water quality impairments or of changes over time. The NWQMC has recently formed a Water Quality Statistics and Assessments (WQSA) workgroup to address the need for better access to available information on statistical procedures relevant to both water quality monitoring program design and data analysis and interpretation. The workgroup is exploring the use of NEMI as well as other tools to increase the accessibility of information on statistical methods used in water quality assessment. This presentation will review the progress of the workgroup to date, and will provide an opportunity for input to the workgroup's activities.

Session C4: Downstream Impacts from Mined Lands 1

Monitoring spatial and temporal loading patterns to understand contamination from hard-rock mining

Briant A. Kimball[1], Robert L. Runkel[2], and Kathrine Walton-Day[2]
[1]US Geological Survey, Salt Lake City, UT 84119, USA; [2]US Geological Survey Denver, CO 80225, USA

Abstract
Effective remediation of the effects of hard-rock mining requires an understanding of the relative contributions of metals from all sources in a catchment, based on a spatially detailed quantification of metal loading. A traditional approach to quantifying metal loading has been to monitor discharge and chemistry at a catchment outlet. This approach can quantify annual loading, temporal changes in load, and compliance to regulations, however, it does not provide the spatial detail to evaluate and compare specific sources of metal contamination, needed to

support remediation decisions. A catchment or mass-loading approach to monitoring provides spatial detail by combining tracer-injection and synoptic-sampling methods to quantify loading. Examples of studies in American Fork, Utah, and its tributary Mary Ellen Gulch illustrate this different approach. The mass-loading study in American Fork treated Mary Ellen Gulch as a single inflow. From that point of view, Mary Ellen Gulch was one of the greatest sources of iron, manganese, zinc, and colloidal lead loads to American Fork. But when Mary Ellen Gulch was evaluated in a separate catchment study, the detailed locations of metal loading were identified, and the extent of metal attenuation upstream from the mouth of Mary Ellen Gulch was quantified. The net, instantaneous load measured at the mouth of Mary Ellen Gulch for remediation planning would greatly underestimate the contributions of principal sources within the catchment. Extending the detailed sampling downstream from Mary Ellen Gulch indicated the possibility of diffuse groundwater inflow from Mary Ellen Gulch to American Fork. Comparing loads for Mary Ellen Gulch in the two studies indicates that metal loads could be substantially underestimated for planning purposes without the detailed catchment approach for the low-flow conditions in these studies. A mass-loading approach provides both the needed quantification of metal loading and the spatial detail to guide remediation decisions that would be the most effective in the catchments. Both temporal and spatial monitoring have important roles in understanding metal loading, as they support different kinds of decisions.

Collaborative Efforts to Characterize a Watershed Impacted by Abandoned Mines Using Multiple Sampling Techniques: A Case Study for Lefthand Creek Watershed, CO

Alice Conovitz[1], Joseph Ryan[2]
[1]Integral Consulting Inc, Broomfield, CO, United States; [2]University of Colorado, Department of Civil, Environmental, and Architectural Engineering, Boulder, CO United States

Abstract
Metal-mining associated wastes in the Lefthand Creek watershed in Boulder County, Colorado have been implicated as a major source of stream water contamination due to acid generation and toxic metal solubility. This watershed hosts hundreds of now inactive mine openings and dozens of sites of former ore milling. No complete analysis of mine sites or their environmental impacts existed at the time of this study. State and EPA officials, as well as a local stakeholder group, the Lefthand Watershed Oversight Group (LWOG), require site-specific contaminant source information in order to develop efficient and effective cleanup and management decisions. To this end, a series of sampling techniques was applied to capture instantaneous, seasonal, and long-term signals of in-stream metal loading along the three major creeks in the watershed: Lefthand Creek, James Creek, and the Little James Creek. Tracer tests, paired with synoptic water sampling, were conducted during high and low stream flow conditions to determine metal loading at individual "snapshots" in time. Tracer tests and synoptic sampling at frequent intervals provided spatially detailed discharge and metal concentration data, which includes stream flow and metal concentration changes resulting from both surface and subsurface flows. Capture, preservation, and acid digestion of benthic macroinvertebrates living in the stream beds was conducted in an effort to evaluate metal loading to the streams on a seasonal scale. Finally, stream bed sediments along two severely impacted stream reaches were also analyzed to determine long-term metal loading. Sediment tests employed a warm 2M HCl-1% H_2O_2 partial digestion to analyze the hydroxide coatings on sediment particles. Downstream changes in metal loads were used to identify surface and ground water metal inputs to streams. These inputs were then traced to potential sources including mine openings, waste rock piles, and unknown inputs. This research, and the funding supporting it, was the result of collaborative efforts between local stakeholders, the University of Colorado, the Colorado Water Quality Control Division, and EPA Region VIII. Integrated monitoring strategies between entities at all levels yielded a comprehensive, cost-effective, and uncontroversial characterization study of water quality in the watershed.

Characterization of water quality in a hydrothermally altered and historically mined watershed, Warden Gulch, Colorado

Erik Oerter
Colorado Geological Survey, Colorado Department of Natural Resources

Abstract
The Colorado Geological Survey performed a watershed-scale characterization of the water quality and hydrologic conditions in Warden Gulch near Keystone, Colorado in order to assess water chemistry and differentiate between the natural background and the impact of historic mining activity on water quality. Discharge from the watershed ranged from approximately 0.46 cfs (206 gpm, 780 lpm) at low flow to 2.4 cfs (1071 gpm, 4054 lpm) at high flow. The pH of surface waters are acidic throughout the Warden Gulch watershed, ranging from a low of 3.36 to a high of 5.12. Eight of 25 samples collected had pH of less than 4. Average dissolved concentrations of selected metals at low flow were 3325.41 μg/L aluminum, 23.27 μg/L cadmium, 63.75 μg/L copper, 8067.01 μg/L iron, 12170.41 μg/L manganese, and 4323.85 μg/L zinc. Streamflow data indicate that anthropogenic sources account for about 0.7% of the total discharge from the watershed at low flow and about 0.5% at high flow. The loading calculations indicate higher anthropogenic contributions – approximately 6-14% during low flow. This low percentage of anthropogenic metal loading indicates that the hydrothermally altered and mineralized rocks underlying Warden Gulch are dominant factors controlling the watershed's water quality.

Impact of historic uranium mining and current mine development operations on water resources in the Grand Canyon Region, Coconino and Mohave Counties, Arizona

Donald Bills[1], Ronald Antweiler[3], Fred Tillman[2], Robert Hart[1]
[1]U.S. Geological Survey, Flagstaff, Arizona, United States; [2]U.S. Geological Survey, Tucson, Arizona, United States; [3]U.S. Geological Survey, Boulder, Colorado, United States; [4]U.S. Geological Survey, Flagstaff, Arizona, United States

Abstract
Rapid increases in the price of uranium beginning in the 2004 has prompted renewed interest in the exploration and mining of uranium ore both north and south of Grand Canyon National Park (GRCA). The increase in filing of mining claims and permits to develop mines in this region has heightened public awareness of the issues and resulted in expressed concerns by Native American Tribes and GRCA for the impacts of exploration and mining to natural resources of the region, especially its water resources. Some of the highest grade uranium ore in the country is located in many potentially mineralized breccia pipes scattered across this region. Concern by the public, tribes, and GRCA has prompted the House Committee on Natural Resources to introduce proposed federal legislation in both 2008 (H.R. 5583) and 2009 (H.R. 644) that would withdraw operation of the public land laws that allow mining from three separate areas both north and south of GRCA. In July, 2009, the Secretary of the Interior temporarily withdrew about one million acres of public lands in the region from mineral entry and directed the U.S. Geological Survey (USGS) to conduct a series of short term assessments to address issues related to uranium mining impacts in the region.

This paper summarizes the results of USGS studies on evaluation of: 1) the extent of natural dissolved uranium and other trace element concentrations in groundwater associated with ore deposits in the region: 2) the relation of dissolved uranium, radium, and other trace element concentrations between mined and unmined drainages, and 3) plans for monitoring of mined and unmined basins to evaluate the impacts of current and potential future mining. In the Grand Canyon Region, dissolved uranium in water range from less than 5 μg/l to about 30 μg/l. The highest concentrations are associated with legacy mining activity on the South Rim of the Grand Canyon. The consequences of continued uranium mining in the Grand Canyon Region are of

national importance. The results of these studies have provided a better understanding of the relationship between a potentially important national energy resource and a World Heritage Site.

Session C5: National Monitoring Network: Monitoring Water Quality from Inland to Coastal Ecosystems

The National Water Quality Monitoring Network - Now and into the Future

Pixie A. Hamilton[1], Tracy L. Hancock[1], and Eric F. Vowinkel[2]
[1]U.S. Geological Survey, Richmond, Virginia; [2]U.S. Geological Survey, Trenton, New Jersey

Abstract
The National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries ("Network") provides information about the health of our oceans and coastal ecosystems and inland influences on coastal waters for improved resource management (http://acwi.gov/monitoring/network/index.html). This Network is, in reality, comprised of a "network of networks" and represents an integrated, multidisciplinary, and multi-organizational approach that leverages diverse sources of data and information and that augments existing monitoring programs and linking observational capabilities. These include the Integrated Ocean Observing System (IOOS), federal agencies, and regional associations representing a broad community of users, including coastal states, tribes, researchers, and non-governmental organizations.

Through Coastal Action Money provided in support of the Ocean Research Priorities plan, design concepts of the Network have been piloted since 2007 in three areas, including Lake Michigan, led by the Great Lakes Commission; Delaware Bay, led by the Delaware River Basin Commission; and San Francisco Bay, led by the San Francisco Estuary Institute. Activities are coordinated with IOOS regional associations, including the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA), Great Lakes Observing System (GLOS), and Central and Northern California Ocean Observing System (CenCOOS).

Monitoring and assessments in the three areas are filling information gaps, including through additional nutrient, carbon, and algal toxin monitoring at selected tributary, head-of-tide, and estuary sites. The projects are improving estimates of oceanic, atmospheric and land-based inputs of sediments, nutrients, and contaminants to U.S. coastal waters and estuaries, and improving assessments on the sources, amounts, timing, and severity of natural and man-made stressors on coastal ecosystems. In addition, the projects continue to show added value from innovative technology and monitoring, such as in real-time monitoring with sensors and autonomous underwater vehicles (AUVs). Lessons learned on monitoring, assessment, management outcomes, and decision tools will be transferred to other regions and used to improve the Network.

San Francisco Bay Water Quality: Lessons Learned from Four Decades of USGS Observations

Tara Schraga, James Cloern, Sarah Foster, Caitrin Phillips
U.S. Geological Survey, Water Resources Discipline, Menlo Park, CA, USA

Abstract
The USGS began measurements of San Francisco Bay water quality in 1968, launching what may be the longest sustained program of research and observation in a US coastal ecosystem. Our regular monitoring now includes, at a minimum, monthly measurements of salinity, temperature, dissolved oxygen, chlorophyll a, suspended particulate matter, and light penetration. Funding from the National Water Quality Monitoring Network Pilot allows us to analyze for two other important constituents, inorganic nutrient concentrations and phytoplankton species composition, as well as extend sampling into salt ponds now being connected to the Bay as part of a large-scale ecosystem restoration program.

We are often asked "when can we stop monitoring?" In reply, we show how four decades of sustained observation have allowed us to detect notable episodic events and longterm trends - such as the disappearance of anoxia/hypoxia after improvements in wastewater treatment in the 1980s and significant trends of chlorophyll increase in South Bay and decrease in North Bay. Dramatic changes in biological communities and water quality occurred after 1999, and these appear to be related to a climate shift detected across the Pacific basin. This result illustrates how water quality of estuaries is influenced not only by processes in connected watersheds, but also climate-driven variability in connected oceans. So our answer is that we can safely stop observations in San Francisco Bay after it stops changing. Sustained time series such as these are rich with surprises and provide unique opportunities to learn how estuaries are influenced by natural processes and human disturbance.

Lake Michigan National Monitoring Network Demonstration Pilot - Preliminary Results and Future Plans

Charles Peters, Kevin Richards
USGS, Wisconsin Water Science Center, Middleton, WI, United States

Abstract
Lake Michigan is the sixth largest lake in the world and the only Great Lake entirely within the U.S. Projections are that by 2025-30 time periods, the built landscape surrounding southern Lake Michigan will grow by nearly 40% and another 2 million people will be added. Various indicators suggest that the southern Lake Michigan area will face significant water-supply and water-quality challenges. These challenges will require a monitoring network to provide information to support management decisions. The monitoring currently being conducted in the Lake Michigan watershed does not fully meet the proposed National Monitoring Network (NMN) design for any of the eight resource components (i.e., rivers, atmospheric deposition, near-shore, etc.).

Lake Michigan demonstration pilot activities during 2008 and 2009 included: 1) augmented sampling at 20 tributaries in order to meet the National Water Quality Monitoring Network Tier I nutrient design criteria (http://acwi.gov/monitoring/network/design/). The 20 tributary sites in Michigan, Wisconsin, and Indiana represent 72% of the total inflow to Lake Michigan; 2) deployment of semi-permeable membrane devices (SPMDs) in the 20 tributaries to assess potential toxicity to fish. SPMD's are passive samplers (designed to mimic biological membranes) for assessing trace levels of hydrophobic organic contaminants.

In 2010 the USGS will deploy an autonomous underwater vehicle (AUV) to map measured parameters in selected embayments and shallow near shore areas of Lake Michigan. This effort will be coordinated with monitoring in tributaries and the deeper near shore areas of Lake Michigan being planned by the Lake Michigan Monitoring Coordination Councils' near shore working group and as a part of the Great Lakes Restoration Initiative (GLRI).

Progress of the Delaware River Basin Demonstration Project of the National Water Quality Monitoring Network

Eric Vowinkel[1] and Robert Tudor[2]
[1]U.S. Geological Survey, New Jersey Water Science Center West Trenton, New Jersey, United States; [2]Delaware River Basin Commission, West Trenton, New Jersey, United States

Abstract
The Delaware River Basin Demonstration Project of the National Water Quality Monitoring Network for Coastal Waters and their Tributaries has resulted in improved cooperation for monitoring and modeling among water scientists and managers from Federal, Interstate, State, and local

agencies, universities, volunteer organizations, and the private sector. The basin is data rich in physical, chemical, and biological monitoring in all compartments of the water cycle including watersheds above the head of tide, estuaries, coastal areas, oceans, wetlands, groundwater, and the atmosphere for a broad spectrum of water-quality characteristics and constituents. In many cases, the data are available to users from web-portals that can be used to estimate the status and trends in water-quality or be used in models to estimate the water quality conditions in areas where data are lacking or to predict future water-quality conditions. Methods of integrating discrete, continuous, probabilistic water-quality data sets are explored. Examples of spatial and temporal trends of physical characteristics (dissolved oxygen) and chemical constituents (nutrients) in water bodies in the basin are presented. As a result of the cooperation among the various organizations, funding for additional monitoring has become available to fill in some of the data gaps needed to answer questions related to the status and trends of the water quality in the basin.

Session C6: PAHs and Coal-Tar-Based Pavement Sealcoat: Stormwater Management, Toxicology, and Public Policy

Pavement Sealcoat, PAHs, and the Environment: An Introduction

Barbara J. Mahler
U.S. Geological Survey, Texas Water Science Center

Abstract
Paved surfaces are ubiquitous in the urban environment. Many of us come into frequent contact with pavement at home, at schools, and at workplaces. Maintenance of some paved surfaces, in particular parking lots and driveways, often includes application of a black, shiny substance referred to as sealcoat. The two primary sealcoat products on the market are asphalt-based emulsion and refined coal-tar-pitch emulsion. The coal-tar-based sealcoat product typically is 20–35 percent refined coal tar, a known carcinogen that is more than 50 percent polycyclic aromatic hydrocarbons (PAHs). PAHs are a large group of compounds composed of various numbers of benzene rings fused in various configurations; several PAHs are suspected mutagens, carcinogens, and (or) teratogens. The PAH content of the coal-tar-based sealcoat product is about 1,000 times that of the asphalt-based product, on average. Since 2003, coal-tar-based sealcoat products have come under increased scrutiny as a source of PAHs to the environment. As a result, new information regarding PAHs in the environment and their relation to coal-tar-based sealcoat is available in several scientific and policy fields, including aquatic biology, air quality, human health, storm-water management, and public policy.

PAHs and Parking Lots: A Field Study on PAHs Exported From Sealed and Unsealed Parking Lots at the UNH Stormwater Center

Alison Watts, Robert Roseen, Tom Ballestero, James Houle, Tim Puls
The Stormwater Center, Department of Civil Engineering, University of New Hampshire, Durham, NH, 03856

Abstract
Recent studies have found that coal tar-based sealcoat may be a significant source of polycyclic aromatic hydrocarbons (PAHs) in the environment. The University of New Hampshire Stormwater Center is conducting a field experiment to quantify the mass of PAHs released from parking lots in cold climates. In October 2007, sealant was applied to two separate areas of a University parking lot. Runoff from the two sealcoated sections and an unsealed control lot is collected and monitored with automated ISCO samplers. Initial unfiltered runoff samples from the sealed lots contained 640μg/l to 5,800μg/l total PAHs. Concentrations from the sealed lots decreased rapidly after the first month, but remain higher than concentrations from the unsealed lot. Flow from the parking lots is monitored, and the total PAH load released during each storm is calculated from the flow volume and concentration. Individual storm PAH loads range from 79.5g total PAHs released from a freshly sealed 0.25 acre lot, to generally less than 0.1g released from an unsealed 9 acre control lot. PAH concentrations in swale sediments downstream of the sealed lot increased from a background concentration of several μg/kg to over 90 μg/kg in the year after sealant was applied. Surface soil samples collected adjacent to the sealed lots contain PAH concentrations of up to 400mg/kg, while samples collected adjacent to the control lot contain less than 5 mg/kg. A second phase of this project is currently monitoring PAH concentrations in air, dust, and surface soil at each of the lots.

Contribution of PAHs from Coal-Tar Pavement Sealcoat to 40 U.S. Lakes Evaluated Using Mass-Balance Receptor Modeling

Peter C. Van Metre and Barbara J. Mahler
U.S. Geological Survey, Texas Water Science Center

Abstract
Contamination of urban lakes and streams by polycyclic aromatic hydrocarbons (PAHs) has been increasing in the United States during the past 40 years. We evaluated sources of PAHs in post-1990 sediments in cores from 40 lakes in urban areas across the United States using a contaminant mass-balance receptor model and including as a potential source coal-tar-based (CT) sealcoat, a recently recognized source of urban PAH. Other PAH sources considered included several coal- and vehicle-related sources, wood combustion, and fuel-oil combustion. The 10 best modeling scenarios all indicate CT sealcoat is the largest PAH source when averaged across all 40 lakes, contributing about one-half of PAH in sediment, followed by vehicle-related sources and coal combustion. PAH concentrations in the lakes were highly correlated with PAH loading from CT sealcoat (Spearman's rho = 0.98) and the mean proportional PAH profile for the 40 lakes was highly correlated with the PAH profile for dust from CT-sealed pavement (r=0.95). PAH concentrations and mass and fractional loading from CT sealcoat were significantly greater in the central and eastern United States than in the western United States, reflecting regional differences in use of different sealcoat product types. The model was used to calculate temporal trends in PAH source contributions during the last 40 to 100 years to eight of the 40 lakes. In seven of the lakes, CT sealcoat has been the largest source of PAHs since the 1960s, and in six of those lakes PAH trends are upward. Traffic is the largest source to the eighth lake, located in southern California where use of CT sealcoat is rare.

Low-Hanging Fruit in PAH Reduction: Developing and Implementing a Ban on Coal Tar Pavement Products in the District of Columbia

Hamid Karimi, Ph.D, and Brian Van Wye
District of Columbia Department of the Environment, Washington, DC

Abstract
Monitoring data have shown that the Anacostia River, which flows through Washington, DC, suffers from heavy contamination, including by polycyclic aromatic hydrocarbons (PAHs). Beginning in 2003, scientists from the City of Austin, USGS, and elsewhere began to identify coal-tar-based pavement sealants as a significant source of PAH contamination and harm to aquatic life. Asphalt-based alternatives to coal-tar-sealants are readily available and contain about 1/1000 the concentration of PAHs. Studies also suggest that total PAH loads washed off parking

lots could be reduced by as much as 90 percent if parking lots were unsealed. Given all of this and the challenge of reducing PAHs from other leading sources (e.g. cars and power plants), the District of Columbia identified a ban on coal-tar based pavement products as low-hanging fruit in the effort to reduce PAHs in our environment. The District's ban took effect on July 1, 2009, making it illegal to sell, use, or permit to be used on one's property coal-tar pavement products in the District, subject to a daily fine of up to $2,500 (D.C. Official Code § 8-151.81). In implementing this ban, the District realized that most members of the public are not familiar with this issue and that the regulated community, especially contractors, may not have heard about the ban. Therefore, in addition to developing an enforcement strategy, the District has put great emphasis on outreach and compliance assistance. Stakeholder groups have mostly responded positively to the ban, though reaction from industry representatives has been mixed. Some policy questions remain, including how best to dispose of coal tar sealant debris; how much of a threat coal tar pavement sealants pose to public health; and how to reduce the harmful impacts of coal tar pavement products nationwide. The District is considering further PAH monitoring to get a better understanding of coal tar pavement sealant as a source of PAHs to the Anacostia River and to track the effect of the ban. The District is only about 1/5 of the Anacostia watershed, and such data could help determine whether a watershed-wide ban would be effective.

Session D1: Wetlands Condition Monitoring and Assessment

Forging the Link between Wetland Monitoring & Assessment and "Traditional" Water Monitoring Programs

David Davis and Michelle Henicheck
Virginia Department of Environmental Quality, Office of Wetland and Water Protection

Abstract
The overall strategy of Virginia's wetland monitoring and assessment program is to develop a long-term implementation plan that protects the physical, chemical, and biological integrity of the Commonwealth's water resources. Virginia is establishing baseline wetland conditions in various broad contexts, such as land use, watershed, and wetland type using a three-tiered assessment approach. This information can then be used in several regulatory and non-regulatory contexts, such as integrating wetland monitoring data into Virginia's comprehensive water quality monitoring program. We will evaluate the six (6) water quality designated uses for applicability to wetland conditions. Additional designated uses of wetlands will be considered. Our objective is to consider narrative wetland quality standards, in addition to existing use standards, if it would lead to further resource protection. Then, assess a suite of core and supplemental indicators to determine whether a particular wetland is meeting the standard. Our overarching goal is for better overall water quality management decisions supported by a comprehensive monitoring and assessment program that integrates all of the Commonwealth's water resources.

Applying Tiered Aquatic Life Uses and the Biological Condition Gradient Model to Maine Wetlands

Jeanne L. DiFranco[1], Beth Connors[1], Thomas J. Danielson[2] and Leonidas Tsomides[2]
[1]Maine Department of Environmental Protection, Biological Monitoring Program, Portland, Maine, United States; [2]Maine Department of Environmental Protection, Biological Monitoring Program, Augusta, Maine, United States

Abstract
The Maine DEP Biological Monitoring Program assesses the condition of rivers, streams and freshwater wetlands by evaluating resident aquatic macroinvertebrate and algal communities. River and stream biological data have been used successfully for many years to determine attainment of State water quality classes and to inform a variety of regulatory and management programs, owing to carefully developed tiered aquatic life criteria. In recent years, requests for wetland data and evaluations of potential water quality impacts from regulated activities have increased. Although Maine has narrative biological criteria for all surface waters, including wetlands, use of wetland monitoring data for regulatory and management decisions has been limited compared with river and stream data. The Biological Monitoring Program also needs the ability to compare monitoring results among different water body types (rivers, streams, wetlands) and biological assemblages (macroinvertebrates, algae) to conduct watershed scale condition assessments. Since different sampling methods are used depending on the habitat of individual monitoring sites (open marsh, riverine fringe, low gradient stream, riffle habitat, lake littoral zone, shaded or unshaded streams, etc.), an integrating assessment framework is essential to this goal. To address these growing assessment needs, the Biological Monitoring Program developed a standardized approach to apply Maine's tiered aquatic life criteria to wetlands. The current focus of this work is on emergent/open water marsh habitat and riverine/lacustrine fringe wetlands. The Program also adapted the Biological Condition Gradient (BCG) model for Maine wetlands. The BCG model provides a common language to integrate monitoring data collected by different methods to produce watershed level biological assessments and allow comparison of assessment results among different water body types and biological assemblages. These initiatives will greatly enhance the Department's ability to evaluate wetland condition and to consistently interpret and communicate wetland monitoring results so that data may be more easily used by other programs.

Comparison of Three Tiered Wetland Assessment Methods for use on Wetlands in the Prairie Pothole Region

Christina L.M. Hargiss[1], Edward S. DeKeyser[1], Donald R. Kirby[1], and Michael J. Ell[2]
[1]North Dakota State University, NDSU Dept 7050, PO Box 6050, Fargo, ND 58108; [2]North Dakota Department of Health, 918 East Divide Avenue, Bismarck, ND 58501

Abstract
We assessed wetland condition based on plant community integrity in a designated area of the Missouri Coteau in central North Dakota using a probabilistic sampling design. Four sampling models were applied to wetlands in the study area: 1) Level 1 - geographic information system-based Landscape Wetland Condition Analysis Model (LWCAM); 2) Level 2 - North Dakota Rapid Assessment Method (NDRAM); 3) Level 3 - vegetative-based Index of Plant Community Integrity (IPCI); and 4) the Hydrogeomorphic (HGM) model. Results from the IPCI were compared to those found using the NDRAM, HGM, and LWCAM Models. The HGM, NDRAM and LWCAM differed in precision for ranking wetlands due to condition and disturbance/stressor intensity when compared to the IPCI. All models tested were valuable for indicating wetland condition and/or disturbance/stress levels, but in different capacities. A combination of all models is best to indicate overall condition and possible stressors at a site. Sample size adequacy was determined for each of the models for use in determining condition in areas of the Prairie Pothole Region that have not yet been tested, as well as for returning to the designated area of the Missouri Coteau to determine change in condition and trends in land use. Results of this study can be used as a model for determining need specific, financial, and time appropriate wetland sampling methods in other areas of the Prairie Pothole Region.

Developing a Level 1-2-3 Approach to Wetland Assessment and Monitoring in Montana

Karen Newlon, Catherine McIntyre, and Linda Vance
Montana Natural Heritage Program, Helena, MT, United States

Abstract
The U.S. Environmental Protection Agency recommends a three-tiered approach to wetland assessment and monitoring. In this approach, the Level 1 assessment relies on GIS-based desktop tools to provide a preliminary assessment of wetlands and their landscape context. Level 2 is a field-based rapid assessment using indicators of ecological integrity and/or function. Level 3 involves intensive assessment using detailed biological indicators. The Montana Natural Heritage Program adopted this approach in 2009 in the Northwestern Glaciated Plains Ecoregion. We selected a suite of field and landscape metrics reflecting key ecological attributes to assess wetland condition for several wetland systems in the project area. Using a spatially balanced survey design, we selected wetlands from existing National Wetland Inventory mapping to conduct Level 1-2-3 assessments. Level 2 and Level 3 indicators were evaluated for their sensitivity and responsiveness to disturbances at multiple spatial scales. In general, our disturbance metrics explained little of the variation in wetland condition across the region. Additionally, Level 3 indicators were not reliable determinants of wetland condition. We discuss our assessment approaches and results, as well implications for assessment approaches in this region.

Session D2: New Tools and Approaches in Data Analysis and Reporting

H2O Info – A Web-Based Citizen's Tool for Turning Real-Time Water Quality Monitoring Data into Information

Christopher Magruder
Milwaukee Metropolitan Sewerage District, Milwaukee, WI, United States

Abstract
The Milwaukee Metropolitan Sewerage District (MMSD) developed a public GIS-based web site called "H2O Info" for interactive reporting and analysis of real-time factors that affect water quality in Southeastern Wisconsin. The web site helps educate the public about regional water quality issues by providing real-time water quality and precipitation data. The data collected provides a way to measure and track the actual health of the region's water resources.

Timely water quality information made available to the public is important for fostering widespread understanding of the impacts of various land uses and stormwater runoff on the region's network of streams, lakes and rivers. H2O Info provides a unique opportunity and a simple means for citizens to see how the water quality of our rivers and lakes are affected by what we do on the land.

The web site provides continuous water quality information using innovative real-time remote sensor technology. In cooperation with the United States Geological Survey (USGS), data is collected and transmitted through MMSD's water quality gauging network and displayed on the District's web site geographically. A mapping interface provides quick navigation to MMSD's /USGS's water quality and precipitation network while simple graphs display both water quality data and precipitation totals over a user-defined period of time.

The data collected and displayed provides a method to review, research, and analyze real-time water quality parameters over a series of time periods. A number of water quality parameters are provided in the site, including: Conductivity, Dissolved Oxygen, Flow, Turbidity, Stage, and Water Temperature. Precipitation is another important water quality factor and rainfall totals can also be displayed in near real-time. Precipitation totals are collected through MMSD's weather station network.

You can visit the website at www.mmsd.com by following the H2OInfo icon.

Water Quality Report Card

Warren Kimball
Massachusetts Department of Environmental Protection, Worcester, MA, United States

Abstract
The water quality report card is a tool developed to report the ecosystem health of watersheds in Massachusetts. It provides an environmental baseline to measure the status of water quality, assess trends and determine whether environmental programs and policies are working. It has practical uses in prioritizing problems, geotargeting problems, identifying remedial actions, coordinating monitoring efforts, guiding decision-making and accounting to the public. It improves upon previous water quality indices by reporting individual indicator groups, accounting for water quality variability, including toxic pollutants and displaying data confidence. Codes and definitions were designed to mesh easily with Federal 305b and 303d reporting requirements. The indicator scheme was adapted from the recommendations of the Intergovernmental Task force on Monitoring. The overall goal was to translate water quality assessments into intuitive and easy to read formats to improve environmental decision-making and build credibility, trust and constructive engagement with the public.

Design and Compilation of a Water Resources Geodatabase for the Rio Grande Basin – San Acacia, New Mexico to Fort Quitman, Texas

Thomas Burley, GISP
U.S. Geological Survey, Texas Water Science Center, Austin, TX

Abstract
Water resources data in the Rio Grande Basin from San Acacia, New Mexico to Fort Quitman, Texas have been collected for a variety of purposes over several decades by numerous agencies, researchers, and organizations (for example, U.S. Geological Survey, Bureau of Reclamation, International Boundary and Water Commission, State agencies, irrigation districts, municipal water utilities, universities, and other entities). However, these data have not been integrated or thoroughly evaluated to enhance usability. Well organized and accessible data are necessary to identify management priorities and project areas, to develop and evaluate management strategies, and to monitor and document water-quality improvement and degradation. The Data and Spatial Investigations Group of the U.S. Geological Survey Texas Water Science Center, in cooperation with the New Mexico Interstate Stream Commission, has built a geospatial water-resources database, or geodatabase, to meet this need for an integrated and comprehensive data compendium. A geodatabase is a spatially enabled database that is capable of handling both spatial and non-spatial data. A geodatabase provides a framework and an interactive tool to aid in the understanding of spatial and temporal trends in water quality and quantity. With a geodatabase, geographically referenced data can be manipulated using a geographic information system to produce maps, make relational database queries, and to provide a foundation for various types of spatial analysis. The end-product of this effort will be a water-resources geodatabase that enables the visualization of primary sampling sites for surface discharges, ground-water elevations, and water-quality and associated respective data for the study area in an environmental context.

Outreach Tools for Obtaining Park Vital Sign Monitoring Data

Barry Long, Gary Rosenlieb, Roy Irwin, and Pete Penoyer
National Park Service, Water Resources Division, 1201 Oakridge Drive, Suite 250, Fort Collins, Colorado 80525

Abstract
Since 2001, the National Park Service (NPS) has been engaged in developing and implementing the Vital Signs Monitoring Program to provide park managers with the information they need to understand and better protect their natural resources. Water resource values are identified as important vital signs in many resource parks, and water quality monitoring has been an integral component of many park and network monitoring plans. These monitoring efforts are being carried out across the country in 32 networks made up of parks from similar geographic areas. These networks are following a similar process to develop their monitoring plans, but they are employing a variety of approaches in their sampling designs, monitoring protocols, and data management. To keep track of this process, an inventory and monitoring web site has been created to provide a front door to the vast amount of scientific information being generated by the program, including background documents, guidance, plans, protocols, and data. The web site at http://science.nature.nps.gov/im/ can be navigated by clicking on the map or the list on the left side of the screen. Each network page displays their vital signs information in the same format, and if you see water quality listed as a vital sign for that network, you can follow the intuitive links to the information you seek. Most national guidance documents and the protocol database can be found by following the "Monitoring" link on the main page.

Newsletters are another approach the NPS is using for communicating on the progress of the network monitoring programs. Our internal, intranet newsletter titled "NPS Naturally Speaking" recently ran an article with an interpreters guide to using inventory and monitoring data from lakes that highlighted the public web site mentioned above. More of these types of tools are needed to insure that interested parties are informed about each others monitoring activities in a convenient way on a regular basis.

Keywords

Vital signs, networks, water quality, monitoring protocols, newsletters, web sites, national parks

Session D3: Elements of a Long-Term National Ground-Water Monitoring Network and a State-Scale Example

Challenges for Long-Term Implementation of a National Groundwater Monitoring Network

Robert Schreiber[1], William Cunningham[2], Christine Reimer[3]
[1]CDM - Camp Dresser & McKee, Cambridge, MA, United States; [2]U.S. Geological Survey, Reston, VA, United States; [3]National Ground Water Association, Westerville, OH, United States

Abstract
The ACWI Subcommittee on Ground Water (SOGW) has been working steadily to develop and encourage implementation of a nationwide, long-term ground-water quantity and quality monitoring network. Recently, the development of the coastal water quality-oriented National Monitoring Network triggered related interest of several groundwater professionals. This led to the development of a steering committee and a strong show of support through volunteer participation from federal, state, private sector, and academic areas.

With approval from ACWI, the SOGW formed from the steering committee. Its primary goal is to develop and implement a national framework to facilitate assessments of the quantity of U.S. groundwater reserves, as constrained by groundwater quality. Significant progress includes the release of a framework document in August 2009, with recommendations for implementation of the network. Now, implementation of its recommendations has entered the piloting phase. This will be followed by full-scale, long-term implementation.

However, several challenges need to be addressed to achieve full-scale implementation of the concepts in the Framework Document. While piloting will help identify and address some of the difficulties, significant challenges are anticipated to remain, including funding and cost-sharing, cross-border consistency, acceptability of field and laboratory data collection techniques, and even some basic network-design related elements. The goal remains full participation of all states, tribes, and regional entities. To this end, the SOGW has mapped out a plan that retains strong participation by member states, tribes, and regional entities, along with day-to-day operations by a "management and operations" group within the U.S. Geological Survey, as well as continued oversight and participation of the multi-party SOGW itself. The SOGW believes that this design will facilitate consensus-building as well as rapid attention to problems if and when they arise, by building on the already-proven success of the SOGW partnership shown by development and publication of the framework document.

Continued collaboration of professionals dedicated to water resource monitoring is a key success factor. Therefore, this conference represents an important opportunity for sharing of experiences and ideas among water resource and environmental science professionals, as well as those from other disciplines. To facilitate this, the SOGW seeks an open discussion with conference participants, for helping the SOGW as it moves toward accomplishing its overall mission. This includes the collection of ideas and recommendations from conference participants, as well as the potential for them to volunteer to join in the further planning and eventual long-term implementation of the Network, following the completion of piloting in 2011.

An Example of Using Baseline, Surveillance, Unstressed, and Targeted Monitoring in the Evaluation of Changing Conditions of Ground-Water Quantity and Quality

Rick Copeland
Florida Geological Survey, Tallahassee, FL, United States

Abstract
The Subcommittee on Ground Water (SOGW) of the Advisory Committee on Water Information is submitting a proposal to the U.S. Congress to establish a long-term national ground-water monitoring network. The national network will be a "network-of-networks" designed to monitor the quantity of the nation's groundwater resources. The network will include two subnetworks (unstressed and targeted) and several monitoring types. The types include baseline, surveillance, trend, and special study monitoring. The operation of the national network will be based on the cooperation of staff currently operating their own federal, state, and tribal networks.

Florida has its own statewide network and has been using many of the concepts being proposed by the SOGW for the national network for many years. As an example, during its lifetime, Florida's network included unstressed and targeted subnetworks. In addition, it used baseline and surveillance monitoring in both of these subnetworks to evaluate the anthropogenic effects of land use on ground-water quantity and quality covering an area of several counties. Florida's experience can potentially be used as an example for how to evaluate changing conditions of ground-water quantity and quality using multiple monitoring strategies and the cooperation of multiple agencies.

Lessons Learned: Florida's Status and Trend Surface and Ground Water Monitoring Programs

Gail M. Sloane
Florida Department of Environmental Protection, 2600 Blair Stone Road, Mail Station 3525, Tallahassee, Florida 32399-2400, gail.sloane@dep.state.fl.us , 850-245-8512

Abstract
Florida has developed and maintained a comprehensive surface and ground water monitoring program for fresh waters from the period 1999 through the present. Several monitoring tiers have been employed, including a probability-based monitoring program, a fixed-station monitoring program, and regionally-focused monitoring for assessment of condition for establishing background condition or determining resident problems. During the course of the program, many lessons have been learned, which may benefit others developing regional or large-scale monitoring programs.

Several outcomes from Florida monitoring programs have included not only the ability to report to EPA on the condition of water resources in the state, but to contribute data to assist in development and validation of Biocriteria, develop sediment quality guidelines, provide information for standards development (i.e., nutrients), provide data for TMDL development, and identify issues that need more intensive surveys for appropriate management actions.

Key lessons include the importance of using EPA's "ten elements" guidance for designing monitoring programs. These elements are essential to ensure the success of any monitoring program, resulting in focused efforts essential to producing meaningful outcomes. Identifying needs of primary stakeholders and agency managers at the onset of the design process is fundamental in the development of the monitoring design, as the analysis and presentation of the data needs to be meaningful to affect measures to protect or restore water resources. It is essential to effectively translate and communicate the significance of the resulting data to decision makers and the public. Examples of reports generated from the surface and ground water monitoring program will be presented.

Key words: Statewide monitoring program, communicating monitoring results

Status of Pilot Projects for the Proposed National Ground Water Monitoring Network

William L. Cunningham[1], Robert P. Schreiber[2], and Christine Reimer[3]
[1]Office of Groundwater, U.S. Geological Survey, 411 National Center, Reston, Virginia 20192; [2]CDM, 50 Hampshire Street, Cambridge, Massachusetts 02139; [3]National Ground Water Association, 601 Dempsey Road, Westerville, OH 43081

Abstract
The federal Advisory Committee on Water Information (ACWI) is directed by the Office of Management and Budget to foster collaboration related to water information collection and sharing. The Subcommittee on Ground Water (SOGW) is a subgroup of ACWI that has developed and is encouraging implementation of a long-term, nationwide ground-water quantity and quality monitoring framework. The overall goal is for the national-scale network to provide the data necessary for the planning, management, and development of ground-water supplies to meet current and future water needs, including ecosystem requirements. ACWI has approved the SOGW report "A National Framework for Ground Water Monitoring in the United States", which proposes a National Ground Water Monitoring Network (NGWMN). ACWI also has approved SOGW's request for moving forward with a piloting phase to test the components of the framework document. NGWMN pilot projects recently have been established. This presentation will provide an update on the activities of the pilot projects.

Pilot projects in Illinois-Indiana, Minnesota, Montana, New Jersey, and Texas in will serve to test the concepts outlined in the NGWMN, and produce information with which to evaluate the network's feasibility. Information gained from the pilot projects will be incorporated into the Implementation Phase of the NGWMN. Pilot projects will evaluate the distribution of wells within principal and major aquifers, well measurement and/or sampling frequency, field practices, data elements stored in their environmental database(s), data management procedures and their documentation, and overall network costs. A key component of the network will be development of a web-based data portal prototype, which will serve data from the participating groups to the analysts requesting network data. Portal implementation involves development of data sharing protocols and web-based software implementation coordinated between the various entities participating in the network. Pilot programs also are evaluating the efficacy of sharing data through the data portal.

Session D4: Downstream Impacts from Mined Lands 2

Copper exposure-response relationships derived from monitoring data and their utility to risk management of the Clark Fork River, MT

Daniel Cain[1], James Carter[1], and Samuel Luoma[1,2]
[1]U.S. Geological Survey, Menlo Park, CA USA; [2]John Muir Institute of the Environment, University of California at Davis, Davis, CA, USA.

Abstract
Cleanup of legacy metal contamination at mining sites is complicated, expensive, and protracted because of the number and type of sites and the scale of contamination at the largest sites. To inform risk managers whether or not remediation is actually stabilizing and reversing ecological injury, indicators that are sensitive and meaningful of ecological response to metal exposure are needed. The Clark Fork of the Columbia River, MT is an expansive Superfund complex that is undergoing remediation. Here, we analyzed the response of the benthic macroinvertebrate assemblage to metals, principally Cu, from monitoring data collected over a 15 year period from 9 sites within the basin. Data for discharge, hardness, conductivity, pH and three measures of Cu exposure (dissolved Cu, sedimentary Cu, and Cu accumulated by a resident invertebrate, *Hydropsyche spp.*) were classified by factor analysis to identify environmental gradients. Regression of factor scores against diversity metrics (total taxa richness, EPT richness, and mayfly richness) identified Cu exposure as the most important explanatory variable for diversity patterns. But in addition to Cu, environmental conditions related to upstream-downstream location influenced spatial patterns in EPT and mayfly diversity. The longitudinal pattern in diversity changed over time due to increases in diversity at sites proximate to remediated areas. These changes were related in part to decreasing Cu exposures and consistent with remediation performance goals. There was no evidence that remediation significantly altered Cu exposures and inter-annual patterns of diversity at more remote, downstream sites. At those sites, total richness appeared to decline in response to high stream flow during 1996—1997, but results also suggested that increased Cu exposures that accompanied those flows imposed additional stress on the assemblage. Strong statistical relationships between richness metrics and Cu exposure emerged when paired data for all sites and years were regressed, suggestive of exposure-response relationships. Further study is needed to establish the accuracy of these relationships and to evaluate their utility to risk management.

Influence of Dissolved Organic Matter in Determining Aquatic Copper Toxicity in Iron-Rich Environments

Kathleen S. Smith[1], James F. Ranville[2], Daniel J. Diedrich[3], Diane M. McKnight[4], and Ruth M. Sofield[5]
[1]U.S. Geological Survey, M.S. 964D, Denver Federal Center, Denver, CO 80225-0046, ksmith@usgs.gov; [2]Colorado School of Mines, Dept. of Chemistry and Geochemistry, Golden, CO 80401, jranvill@mines.edu; [3]Windward Environmental LLC, 200 W Mercer St., Seattle, WA 98119, diedrichdaniel@hotmail.com; [4]INSTAAR, Univ. of Colorado, Boulder, CO 80309-0450, diane.mcknight@colorado.edu; [5]Western Washington Univ., Dept. of Environmental Sciences, Bellingham, WA 98225, ruth.harper@wwu.edu

Abstract
Chemical speciation of dissolved metals influences their potential toxicity to aquatic biota. The biotic ligand model (BLM), a computer model that mathematically estimates the effects of water chemistry on the speciation of metals and their acute toxicity to aquatic biota, is being used to develop site-specific water-quality criteria and to assess aquatic risk for metal exposure. The BLM is incorporated in the 2007 U.S. EPA aquatic life ambient freshwater quality criteria for copper. The presence of dissolved organic matter (DOM) is known to decrease copper toxicity in aquatic systems due to copper binding to DOM. However, in mining areas rich in iron and aluminum, the protective effect of DOM on copper toxicity can be reduced.

We investigated the ability of DOM that was isolated from different sources to decrease acute copper toxicity to *Ceriodaphnia dubia* (water flea). We conducted acute laboratory toxicity tests in water amended with DOM that was isolated from (1) a stream receiving acidic iron- and aluminum-rich drainage, (2) an adjacent stream not impacted by iron- and aluminum-rich drainage, and (3) Suwannee River fulvic acid (a standard reference DOM material with low iron and aluminum content). Our results show that the DOM isolated from a stream receiving acidic iron- and aluminum-rich drainage was 3 times less effective at reducing copper toxicity than DOM isolated from the other two sources. These findings indicate that modifications to the BLM may be necessary for application to iron- and aluminum-rich environments.

Assessment of Nonpoint Source Chemical Loading Potential to Watersheds Containing Uranium Waste Dumps Associated with Uranium Exploration and Mining, San Rafael Swell, Utah

Michael L. Freeman[1], David L. Naftz[1], and Terry Snyder[2]
[1]U.S. Geological Survey, Utah Water Science Center, Salt Lake City, UT; [2]Bureau of Land Management, Utah State Office, Salt Lake City, UT

Abstract
During July and August of 2006, 117 solid-phase samples were collected from abandoned uranium waste dumps, geologic background sites, and adjacent streambeds in the San Rafael Swell, in southeastern Utah. The objective of this sampling program was to assess the nonpoint source chemical loading potential to ephemeral and perennial watersheds from uranium waste dumps on Bureau of Land Management property. Uranium waste dump samples were collected using solid-phase sampling protocols. After collection, solid-phase samples were homogenized and extracted in the laboratory using a field leaching procedure. Filtered (0.45 micron) water samples were obtained from the field leaching procedure and were analyzed for Ag, As, Ba, Be, Cd, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, U, V, and Zn at the Inductively Coupled Plasma-Mass Spectrometry Metals Analysis Laboratory at the University of Utah, Salt Lake City, Utah and for Hg at the U.S. Geological Survey National Water Quality Laboratory, Denver, Colorado.

For the initial ranking of chemical loading potential of suspect uranium waste dumps, leachate analyses were compared with existing aquatic life and drinking-water-quality standards. The ratio of samples that exceeded standards to the total number of samples was determined for each element having a water-quality standard for aquatic life and drinking-water.

Approximately 56 percent (48/85) of the leachate samples extracted from uranium waste dumps had one or more chemical constituents that exceeded aquatic life and drinking-water-quality standards. Most of the uranium waste dump sites with elevated trace-element concentrations were along Reds Canyon Road between Tomsich Butte and Family Butte. Twelve of the uranium waste dump sites with elevated trace-element concentrations in leachates contained three or more constituents that exceeded drinking-water-quality standards. Eighteen of the uranium waste dump sites had three or more constituents that exceeded trace-element concentrations for aquatic life water-quality standards. The proximity of the uranium waste dumps in the Tomsich Butte area near Muddy Creek, coupled with the elevated concentration of trace elements, increases the offsite impact potential to water resources. Uranium waste dump sites with elevated leachate concentrations may need to be further investigated to determine the most appropriate remediation method.

Phase I- Jordan River, Utah, Riparian Restoration for the Midvale Slag Superfund Site

Erna Waterman[1], Terry A. Kenney[2]
[1]U.S. Environmental Protection Agency, Denver, CO, United States; [2]U.S. Geological Survey, Salt Lake City, UT, United States

Abstract
Riparian restoration is required in the final remedy for the Midvale Slag Superfund Site. Phase I of the riparian restoration called for the replacement of a damaged and dangerous sheet pile dam that was built to maintain river bank stability for the portion of the Jordan River running adjacent to the site. The replacement structure reduces bank erosion and helps to prevent the release of buried contaminants into the river and other adjacent properties. The U.S. Environmental Protection Agency (EPA) asked the U.S. Geological Survey (USGS) to construct a two-dimensional model to evaluate the hydraulic characteristics of the river at different streamflows. The model allowed EPA to determine where the highest velocities occurred and indicated areas susceptible to erosion and/or migration of the river from the current channel. The model also provided water-surface elevations throughout the reach for simulated streamflows and aided in planning where to install velocity abatement structures. Information obtained from the model was used to curb the effects of erosion and strengthen the stability of the cap for the Midvale Site.

In addition, EPA tasked USGS to take borehole samples along the river corridor to determine the depth to buried contaminants. Information from the borehole samples helped to avoid pockets of contaminants during planned construction work. EPA replaced the previous sheet pile dam in the fall and early winter of 2008 with a sheet pile grouted boulder structure. In addition, the visual and numeric information that the new model provided was relayed to the Jordan River Stakeholders Group, Salt Lake County, and to other partners along the Jordan River corridor.

Session D5: Effective Communication Leads to Action

Getting the Message Out: Communicating Water Science

Kara Capelli
U.S. Geological Survey

Abstract
Scientists collect and assess a myriad of data, develop responsive and innovative technology, and produce a wide variety of credible and relevant products. However, the full potential of these efforts often falls short of meeting critical audience needs and explaining key water issues related to water management, protection, planning, regulation, policy making, conservation, and monitoring.

Those shortfalls relate to breakdowns in communication. It is important to recognize that a one-size-fits-all approach is generally ineffective in reaching the many audiences who need water information, including state and local policy makers, Congress, Tribal leaders, non-profit organizations, and the public.

The USGS Office of Communication has developed a step-by-step communication strategy to translate and communicate complex water science to a broad range of stakeholders in a meaningful and relevant context, in order to improve water decision-making. The underlying tenet of the strategy is the importance of communicating the benefits of the research, rather than the scientific process by which the research is completed.

The strategy involves determining audience needs, crafting the right message, and delivering the message in a manner that is relevant to specific uses and needs. Specifically, the strategy (1) helps to identify the different values and needs of various audiences and the contexts in which they receive information; (2) presents critical components for developing a strong, clear, and consistent message that can reach and affect these audiences; (3) focuses on anticipating and preparing for questions; and (4) stresses communicating in accurate and straightforward terms that leave no room for misinterpretation.

Peer-reviewed Papers to Podcasts and Beyond: Disseminating the Findings from a Long-term Monitoring Study

Camille Flinders[1], Tim Hall[1], Robert Fisher[2], Seth Moser-Katz[2]
[1]National Council for Air and Stream Improvement, Anacortes, WA, United States; [2]National Council for Air and Stream Improvement, Research Triangle Park, NC, United States

Abstract
The National Council for Air and Stream Improvement (NCASI) is an independent, non-profit research institute that focuses on environmental topics of interest to the forest products industry. In 1998, a long-term receiving water study (LTRWS) was initiated in which the potential effects of pulp and paper mill effluent (PPME) on in-stream biota (fish, macroinvertebrates, periphyton) were examined in four US receiving streams (Codorus Creek [PA], Leaf River [MS], McKenzie and Willamette Rivers [OR]) representing different ecoregions, system types (warm/coldwater), effluent concentration, and mill process types (bleached/unbleached kraft). In-stream biota, water quality, and habitat measures are collected multiple times per year at multiple sites upstream and downstream of PPME discharges to determine the temporal variation of endpoints, and to discriminate naturally-occurring spatial variation from possible effluent-effects. Augmenting the in-stream study are laboratory bioassays to determine acute and chronic toxicity on organism growth, reproduction, and survival.

The scope and duration of the LTRWS is rare for in-stream studies, and unprecedented in examining potential PPME effects on in-stream biota. As such, the LTRWS and its findings are of interest not only to stream researchers, but to industry personnel, stakeholders, regulators, and policy-makers. Because of the varied group to which the study objectives, framework, methods, and results were to be distributed, an unconventional, multifaceted approach to communicating this information was developed with a motivation to reach audiences with an appropriate level of technical language and detail. Typical means of conveying study results include technical reports, the peer-reviewed literature, and presentations at industry-focused and scientific meetings. However, less traditional methods of sharing the scientific results of this study include a short booklet directed toward the lay-person; downloadable podcasts in which researchers discuss various aspects of the study; webcasts in which researchers present information to meeting participants via the internet, and a documentary-style video presenting the study objectives, methods, and results while showing footage of the rivers and sampling activities. The various methods for sharing information on the LTRWS are as unique as the LTRWS itself, useful across audiences, and ensure that the knowledge gained is easily accessible to all interested groups.

"SWAPS" - Effective Information Exchange at the Watershed Level

Barb Horn
Colorado Division of Wildlife, Colorado, United States

Abstract
Effective action requires adequate information in the right place at the right time between the right audiences. The Colorado Water Quality Monitoring Council (CWQMC) exists to strategically facilitate communication that progresses movement along the action continuum of data generation, sharing, translation to information and use. Why? To drive and guide watershed restoration and protection activities, policies and regulations in the most cost effective manner. Why? So water is clean and available in sufficient amounts for all users.

A flagship communication product and service of the CWQMC's Data Sharing Network are called SWAPS. SWAPS work in collaboration with two other CWQMC services, a statewide interactive map and a STORET database. A database and map alone do not maximize data sharing and communication. Build it and some come but not nearly enough.

SWAPS are targeted, place-based, local level, one day events where participants exchange or "swap" their monitoring and assessment activities, priorities, needs and concerns. The information that is exchanged is documented on a fact sheet, posted on the website and distributed to participants, adjacent watersheds, and state and regional decision makers. On the ground monitoring collaborations are negotiated also. SWAPS are a cost effective voice for local efforts to be heard within the watershed, across watersheds, at a state level and for state level information to reach the local level. No entity can do it all, collaboration is essential and effective communication leads to measurable action.

Each SWAP participant is categorized into "data generator", "data user", "both" or entities are lumped by common monitoring and assessment needs and concerns. These categories provide a communication strategy for the Council to ask for financial and in-kind support, conduct "data nag updates" and market our services.

SWAPS have provided a cost effective communication tool to progress cost effective river restoration and protection, activities and policy. This session will cover the role of SWAPS in data sharing, the success or failure of the CWQMC, nuts and bolts of SWAP implementation, lessons learned and tips.

It makes perfect sense to me, why can't they understand? Conveying technical information to a non-technical audience

Shelley Stanley[1], Celeste Olinger[2], John Eisel[2]
[1]City of Northglenn, Public Works Department; [2]City of Northglenn, Administration Department

Abstract
Take one part public perception, two parts varying levels of understanding, add the spending of public money and the venue is ripe for a rift. But, why? You have the facts backed by science; people think logically; so the decision is in the bag, right? Nope! Nothing in 18 years of schooling has prepared me for communicating with either the general public or decision makers. In this presentation, we will show examples of a successful and not-so-successful attempt to convey technical water topics to a non-technical audience, and we will explore what went right and what went wrong. Our footage will be repeated a second time with an on-the-fly description of when this particular discussion turned and what the presenter could have done to turn it back. Dr. Peter Glick wrote, "I am a believer in the power of facts and numbers to help make public policy. I believe that without good science and good numbers, it is difficult to make public policy. And it is impossible to make good public policy with bad numbers." Still, with all the good facts and numbers in the world, public policy decisions can, and often do, go wrong. This presentation will show how effective communication techniques along with the use of "good science" can result in good public policy.

Session D6: Pharmaceuticals and Other Emerging Contaminants Above and Below the Water's Surface

Combined Sewer Overflows as a Source of Hormones to Surface Water

Patrick J Phillips[1], Ann Chalmers[2], James Gray[3], William Foreman[3], Gary Wall[1], Dana Kolpin[4], Kathleen Esposito[5]
[1]US Geological Survey, Troy, NY, United States; [2]US Geological Survey, Montpelier VT United States; [3]US Geological Survey, Denver CO, United States; [4]US Geological Survey Iowa City, IA, United States; [5]AECOM, New York NY, United States

Abstract
Some sources of hormones to surface water, such as wastewater-treatment-plant (WWTP) effluent, have been well documented, but other sources, particularly wet-weather discharges from combined-sewer-overflows (CSOs), are not well characterized. Flow-weighted composite samples of secondarily treated WWTP effluent and untreated sewage discharges from WWTP inflows and CSO discharges were collected during 12 storms and 6 non-storm conditions from November 2007-December 2008 at the main Burlington Vermont WWTP. Concentrations of many androgens and estrogens were highest in samples from untreated sewage, and lower in samples from treated sewage. For example, concentrations of estriol in CSO samples ranged from 5 to over 100 ng/L (nanograms per liter), but were generally less than 1 ng/L in treated sewage. Many androgens were detected in CSO discharge samples in concentrations ranging from 1 to over 1000 ng/L, but were not detected above 1 ng/L in treated samples. For many of the hormones, including androgens and estriol, CSO discharges comprised over half of the total load discharged by the WWTP, even though annual CSO discharge is less than 10% of the treated plant discharge. These results indicate that untreated discharges during CSO events can be a major source of some hormones and other wastewater compounds to the environment.

Emerging Contaminants in the Columbia River Basin: Examining Sources and Investigating Impacts on the Foodweb

Jennifer Morace and Elena Nilsen
USGS Oregon Water Science Center

Abstract
In order to efficiently reduce toxic loading to the Columbia River basin, sources and pathways need to be identified. Little is known about the toxic loadings coming from wastewater-treatment facilities and stormwater runoff in the system. This study provides preliminary data on these sources and pathways throughout the basin. The cities sampled in Oregon and Washington were chosen for their diverse characteristics, including population density. Samples were collected from a wastewater-treatment facility in each of the cities and analyzed for wastewater-indicator compounds, pharmaceuticals, PCBs, PBDEs, organochlorine or legacy compounds, currently used pesticides, mercury, and estrogenicity. Currently, these treatment facilities only sample to meet their permit requirements, which are limited to select nutrients, temperature, and oxygen demand. Nothing is known about the environmental implications of emerging contaminants in these effluents. The second component of the sampling effort was directed at characterizing stormwater runoff for a slightly different set of emerging contaminants—PCBs, PBDEs, organochlorine compounds, PAHs, metals, currently used pesticides, and oil and grease. Studies have shown that stormwater, most often untreated before entering the receiving waters, can deliver significant loadings of these compounds. These two pathways are poorly understood in terms of their toxic contribution to the system, yet they act as integrators of human activities and offer an area where changes could be made to lessen human impact on the environment.

This work directly feeds into a concurrent interdisciplinary project funded by USGS Western Region that is designed to assess contaminants and habitat characterization in the lower Columbia River basin in a subset of the locations included in the study above. We are assessing emerging contaminants in aquatic environmental media and biological organisms, and concurrently assessing the biological effects of these contaminants using fish biomarkers and bird-blood assays. By comparing these results, we will relate contaminant concentrations to biological effects. We will also model the transport of fine-grained sediments and associated contaminants to provide information about contaminant distributions in the system and contribute to understanding how emerging contaminants are affecting the ecosystem and the foodweb in the lower Columbia River.

Occurrence of EDC/PPCPs in Arizona Waters and Impact of Recreational Activities

Chao-An Chiu, Paul Westerhoff, Marisa Masles
Arizona State University, Tempe, Arizona, United States

Abstract
To investigate the occurrence of pharmaceutical, personal care products (PPCPs), endocrine disrupt compounds (EDCs), and other organic contaminants in surface and ground waters throughout Arizona, 26 compounds were analyzed in samples from surface waters, water treatment plant (WTP), wastewater treatment plant (WWTP), ground water, and water recreation area. 116 samples in total were collected and analyzed using liquid chromatograph/tandem mass spectrometry analytical methods during spring, 2008 to summer, 2009. These compounds (PPCP/EDC) were prevalent during this study, being found in 95% of the samples collected. The most frequently detected compounds in serface waters were oxybenzone (up to 0.6 μg/L), caffeine (up to 0.05 μg/L), and sucralose (up to 0.3 μg/L). Three surface waters show different patterns of PPCP/EDC content: oxybenzone was most prevalent in Salt River and Verde River (50 to 80%) while sucralose was most prevalent in CAP canal. The total concentration of PPCP/EDC varied seasonally with highest concentration detected during summer time. The raw water of WTP affected by surface waters significantly and chlorination could exert further oxidation on some compounds (especially oxybenzone). The raw wastewater was detected with high PPCP/EDC concentration and certain compounds (like oxybenzone, ibuprofen, DEET, etc.) shows increasing trend during summer. WWTP processes can remove 11 out of 16 compounds up to 98% efficiency but shows poor removal for erythromycin, carbamazepine, and sulfamethoxazole (< 10%). Sucralose and sulfamethoxazole were dominated compounds (> 60%) in WWTP effluent. The data from water recreation area shows strong effect of human activity on PPCP/EDC in downstream waters, mostly from skin-applied products. These compounds were also present in ground water system of Phoenix water supply area (< 5 ng/L). Only sucralose and sulfamethoxazole were detected to be higher than 0.1 μg/L from one measuring well. Results of this study demonstrate the high potential of PPCP/EDC that might be occurred in Phoenix drinking water system. More different sources of PPCP/EDC, like lakes, WWTP recharging sites, landfill sites, need to be investigated for overall management of drinking water system.

Potential for Biodegradation of Contaminants of Emerging Concern in the Environment

Paul M. Bradley
U.S. Geological Survey, South Carolina Water Science Center, Columbia, SC, United States

Abstract
Over the last decade, the Emerging Contaminants Project of the USGS Toxics Substances Hydrology Program has employed novel analytical methods and national-scale survey investigations to document the widespread environmental occurrence of a number of categories of contaminants that are of "emerging" concern, including: pharmaceuticals and personal care products, endocrine disrupting

compounds, and other domestic, industrial and agricultural wastewater contaminants. Recently, the focus on emerging contaminant research has been extended to include the fate and transport of these newly detectable contaminants in a variety of environmental settings. The potential for in situ biodegradation of candidate waste-water indicator compounds (caffeine and cotinine), endocrine disrupting alkylphenol surfactant compounds (4-nonylphenol), and several natural (17β-estradiol, estrone, and testosterone) and synthetic hormones (17a-ethinylestradiol) have been investigated in hydrologically-distinct, waste-water treatment plant impacted streams in the United States. The potential for in situ biodegradation in the water and sediment matrices has been assessed in microcosm mineralization studies using ^{14}C-radiolabeled model test substrates. Evidence suggests that emerging contaminants can undergo significant biodegradation in effluent-impacted surface waters and, consequently, that in situ biodegradation can be an important component of the management of these contaminants in the environment.

Session E1: Continuous Real-Time Monitoring: Applications in Lakes and Estuaries

Real-Time Monitoring in the Fraser River Estuary, British Columbia: A Federal-Provincial Water Quality Monitoring and Surveillance Buoy

Jennifer MacDonald
Environment Canada, Science and Technology Branch, Water Science and Technology Directorate, Water Quality Monitoring and Surveillance Division, Pacific and Yukon, Vancouver, B.C.

Abstract
Located in the urban setting of Greater Vancouver, where the Fraser River enters the Strait of Georgia, the Fraser River estuary is under increasing pressure from human activities, agricultural intensification, and rapid urban development in the lower Fraser Valley. Monitoring year-round in the Fraser River estuary requires a unique approach as tidal intrusion of marine water into the estuary has made it a challenge to routinely sample for river (fresh) water in this ecologically important reach of the river.

To overcome these challenges Environment Canada, in partnership with the BC Ministry of Environment, has deployed a water quality monitoring and surveillance buoy in the main stem of the Fraser River for unattended, real-time monitoring in the estuary.

This 3-meter moored buoy platform supports instrumentation for measuring water quality (water temperature, conductivity, pH, dissolved oxygen and turbidity), water quantity (water depth and current velocity), and meteorological variables. This data is transmitted via cellular telemetry to a website (http://www.waterquality.ec.gc.ca/) every hour where it is available to the public.

In addition, two sampling devices were designed to collect grab samples for routine monitoring (e.g. major ions, metals, nutrients and bacteriology) and for time-integrated collection of water using solid phase extraction (SPE) for the analysis of dissolved and suspended organic pollutants. Monitoring requirements of these samplers included the ability to schedule continuous and biweekly sampling, as well as the ability to distinguish salt water from fresh water to avoid initiating samplers when brackish water conditions exist.

The sample collection, power systems, and data transmittal are controlled by a data acquisition system located in the buoy's hull. This module provides two-way communication through a digital cellular network and an Inmarsat D+ satellite communication system, enabling the user to remotely manage and configure the system.

The buoy reports out in real-time on water quality, water quantity and meteorological conditions in the Fraser River estuary. Integrated data are used to identify important trends and emerging issues in water quality as well as trends in climate in the most highly sensitive portion of the river. The immediate availability of continuous data and provides a better understanding of the environmental dynamics and the impacts of activities in the Lower Mainland on Fraser River water quality and aquatic life.

Measuring constituent flux in a tidal environment: suspended-sediment flux in San Francisco Bay

David H. Schoellhamer, Gregory G. Shellenbarger, and Scott A. Wright
USGS California Water Science Center, 6000 J Street, Placer Hall, Sacramento, CA 95819 (contact email: dschoell@usgs.gov)

Abstract
Water quality monitoring programs in coastal and estuarine waters typically measure concentrations (constituent mass per unit volume of water) of constituents of concern. Concentration data are useful for comparison to water quality standards and evaluating spatial and temporal variability. Resource management often requires knowledge of the constituent flux (mass per unit time) passing through a cross section. Examples include inputs from tributaries, exchange between estuarine subembayments, and exchange between estuaries and the coastal ocean: values that are essential for Total Maximum Daily Load determinations and constituent budget development. As part of the San Francisco Bay (SFB) Pilot Study of the National Water Quality Monitoring Network for U.S. Coastal Waters and Their Tributaries, we are extending stream-gaging technology and USGS sampling techniques to measure constituent flux in tidal environments.

The purpose of the project is to quantify the suspended-sediment flux past Dumbarton Bridge. Dumbarton Narrows, the location spanned by the Dumbarton Bridge, serves as the seaward entrance to the southernmost embayment of SFB. The project utilizes existing turbidity sensors on the Dumbarton Bridge and couples these data with an acoustic Doppler current profiler (ADCP) to collect index velocity, backscatter data, and stage. Calibration measurements for discharge and suspended-sediment concentration (SSC) are collected with a boat-mounted ADCP and D-96 sampler. Using the "Index-velocity" method for discharge and a combination of turbidity and acoustic backscatter as surrogates for SSC, a continuous record of sediment flux at the measurement cross-section is computed. Preliminary results from November 2008 to September 2009 show that net sediment transport was into southern SFB from the rest of the Bay. A continuous record of the suspended-sediment flux at the Dumbarton Bridge will quantify 1) exchange of sediment and sediment-associated contaminants between far southern SFB and the rest of the Bay, 2) potential sediment supply for restoring former commercial salt ponds on the margins of southern SFB to tidal wetlands, and 3) the role of adjacent mudflats and physical processes on the sediment dynamics of SFB. The data will also serve as a baseline to explore the potential for changing dynamics caused by restoration activities or sea level rise.

Monitoring the spatially and temporally variable Great Lakes nearshore using continuously towed instrumentation

Glenn Warren, Paul Horvatin
U.S. EPA, Great Lakes National Program Office, Chicago, IL, United States

Abstract
The U.S. EPA, Great Lakes National Program Office has maintained a long-term monitoring program in the offshore region of the Great Lakes since 1983. Monitoring the nearshore of the Great Lakes presents problems of logistics, data representativeness and quality, and scale. The coastline of the Great Lakes totals over 10,000 miles, essentially the same as the length of the nearshore to be monitored and assessed. In order to establish a nearshore monitoring program which can provide synoptic information sufficient to evaluate the quality and define regular features of this zone, the Great Lakes National Program Office has

invested in towed sensor technology. Building on research begun at the U.S. EPA Laboratory in Duluth, MN on assessing the nearshore, and with their consultation, this program began in 2008. A towed underwater vehicle contains sensors chosen to span physical, chemical and biological aspects of the nearshore to provide as complete a picture of the zone as possible with present technology. The sensors include: a Laser Optical Plankton Counter to assess sizes and biomass of zooplankton, a Fluoroprobe flourometer to provide information on the main groups of algae in the water, an active flourometer to judge the health of the algae, a nitrate sensor to provide important chemical information on the water, a SeaBird SB 25 CTD to provide temperature, depth, conductivity and dissolved oxygen information, and side scan sonar to evaluate nearshore fish habitat. In 2009 we began use of the towed sensor package on Lake Michigan. Data from the first tow and visualization of the information will be presented.

Real-Time Lake and Reservoir Meteorological and Vertical Water-Quality Monitoring

Reed Green
U.S. Geological Survey, Arkansas Water Science Center, Little Rock, Arkansas

Abstract
Recent advances in sensor technology and data telemetry allow data for a number of surface meteorological and vertical water-column data to be collected simultaneously, in real time, for lakes and reservoirs. With recent advancements in computer technology, three-dimensional lake and reservoir models can be run in much shorter time frames, allowing for real-time simulations of hydrodynamics and water quality. Together, these advances allow for the development of quasi-real-time decision-support systems for water-quality management of individual lakes and reservoir systems. One such water-quality monitoring system has been operating in Beaver Lake in northwestern Arkansas since February, 2008. Meteorological characteristics include air temperature, relative humidity, wind speed and direction, net radiation, shortwave radiation, and photosynthetic active radiation. Water quality characteristics include water temperature and dissolved oxygen. Thermistors (16) and optical dissolved oxygen sensors (8) are distributed at various depths from the surface to about 27 meters deep. All data are recorded every 30 seconds and transmitted hourly to the USGS Arkansas Water Science Center. Data are then loaded into the USGS NWIS database for storage and retrieval.

Session E2: Monitoring BMP Effectiveness

The USDA Forest Service's National Best Management Practice Program

Pamela Edwards[1], Joan Carlson[2], Ken Roby[3], Rick Henderson[4]
[1]U.S. Forest Service, Northern Research Station, Parsons, WV, United States; [2]U.S. Forest Service, Region 2 Regional Office, Golden, CO, United States; [3]U.S. Forest Service (retired), Lassen National Forest, Chester, CA, United States; [4]U.S. Forest Service, Medicine Bow-Routt National Forest, Steamboat Springs, CO, United States

Abstract
Over the past several years, the USDA Forest Service has been developing a national best management practices (BMP) program. The BMP program is designed to meet Department and Agency requirements and policies for BMP implementation and monitoring, to ensure that nonpoint source pollutants are controlled and the objectives of the Clean Water Act are met. While 80 percent of National Forests do some type of BMP monitoring, there is no consistent approach to monitoring across Forests or Regions, and most monitoring is focused only on timber management and road management, which represent only a fraction of the agency's management activities. Additionally, there is no unified database for storing and reporting BMP monitoring data. Consequently, the national BMP effort is focused on remedying those deficiencies, which will also allow the Forest Service to meet both internal and external accountability commitments. The national BMP program contains two parts: a set of Forest Service National Core BMPs for each of 10 major land-management categories that can affect water quality, and a monitoring program to evaluate the implementation and effectiveness of those BMPs. Because of their national scope, the BMPs are non-prescriptive and are aligned with the U.S. EPA's nonpoint source pollution control guidance. By contrast, the monitoring program includes forms with specific implementation and effectiveness questions to evaluate individual BMPs or groups of BMPs within each land-management category. The National Core BMPs and monitoring forms have been developed by teams of resource specialists from across the country and at all levels of the agency. Within the next several years, the monitoring forms will be downloadable to data loggers for electronic capture of information, and data uploading to and storage at the national Forest Service data center also will be available. Once data are stored at a central location, reports summarizing BMP implementation and effectiveness can be generated locally, regionally, or nationally. In turn, National Forest resource specialists can apply the findings to improve adaptive management and better protect water quality.

Demonstrating Success in the Beaty Creek Watershed: Benefits of Continuous Flow-Weighted Data and Paired Watershed Monitoring

Stacey Day
Oklahoma Conservation Commission, Water Quality Division, Oklahoma City, OK

Abstract
Water quality impairments due to excessive nutrient loading have been documented in the Spavinaw Creek watershed, in northeastern Oklahoma, since the early 1990s. In 1998, the Oklahoma Conservation Commission began a watershed project in a 38,000 acre subwatershed, Beaty Creek. The objective of this project was to assess the effect of best management practices (BMPs) on pollutant loads using a paired watershed design. Calibration (pre-implementation) data was obtained from 1999-2001 using automated samplers in the treatment watershed, where BMP implementation occurred, and in the control watershed, where no BMPs were installed. Agricultural BMPs were implemented in the Beaty Creek watershed from 2001 through 2003 to reduce nutrient and sediment runoff, and post-implementation monitoring occurred from 2003 to present. Comparison of the continuous, flow-weighted data between pre- and post-implementation monitoring periods has revealed a 66% decrease in total phosphorus loading so far, along with an 80% decrease in total Kjeldahl nitrogen loading and significant reductions in E. coli and Enterococcus bacteria concentrations in the watershed. Use of the paired watershed monitoring design combined with autosampler data allowed detection of reductions in the expected loading before significant reductions in actual loading were evident; attainment of significant results in a shorter time frame than with trend studies is a major benefit of paired watershed monitoring. Similar results have been observed in another paired watershed project in Oklahoma and are expected in the larger Spavinaw Creek watershed once BMPs, which were installed in targeted areas from 2003-2008, have been in place for several years.

The Good, the Bad and Everything in Between: Evaluating Water Quality Indices and Their Use in Monitoring Agricultural BMPs and Aquatic Ecosystem Health in a Southern Alberta River

Janet Scott[1], David Chanasyk[1], Jim Miller[2]
[1]University of Alberta, Department of Renewable Resources, Edmonton, AB, Canada; [2]Agriculture and Agri-Food Canada, Lethbridge Research Center, Lethbridge, AB, Canada

Abstract
The use of environmental indices, including those for water quality, has been a common means of distilling significant messages out of complex and sometimes cumbersome monitoring data sets. Broad

national or regional water quality indices are available to guide surface water monitors in their interpretation and rating of water condition, yet local watershed characteristics and program objectives often demand tailoring. The selection of index frequency, locally- and ecologically-valid criteria values, and pertinent water quality parameters has the potential to influence how well or how poorly an index may fit the monitoring challenge at hand. For water monitors tasked with looking for quality shifts within one river or micro-watershed, does the index method work to capture ecologically important water quality changes?

Water quality, riparian vegetation, and fish community data was collected in the lower Little Bow River watershed in southern Alberta under Agriculture and Agri-Food Canada's Watershed Evaluation of Beneficial Management Practices (WEBs) program, a national program designed to evaluate the effectiveness of beneficial management practices (BMPs) in agriculture. Water quality was sampled along five study reaches within a 5.5 km (section of the lower Little Bow River, from 2004 to 2007. With this data, we are calculating water quality index values using physical, chemical and microbiological parameters under several index variations designed to consider natural watershed characteristics, sampling frequency and seasonal timing of irrigation water use. Biological indices are also being developed through local fish species and riparian habitat assessments to supplement water quality information and support a broader evaluation of aquatic ecosystem health changes resulting from the application of agricultural BMPs.

High Level Indicators of Oregon's Forested Streams

Shannon Hubler, Sarah Miller, Lesley Merrick, Robin Leferink, Aaron Borisenko
Oregon Department of Environmental Quality, Laboratory and Environmental Assessment Division, Portland, Oregon, United States

Abstract
We assessed the condition of water quality and biological condition on 1,025 forested sites throughout Oregon. The objective was to provide the Oregon Board of Forestry and the public information on Oregon's progress towards sustainable forest management. Conditions of forest lands were assessed at two spatial scales (statewide and 3rd-field hydrological unit codes) and for four ownership classes.

Water quality was assessed using the Oregon Water Quality Index (OWQI). This index combines seven sub-indices into one measure of overall water quality. Biological conditions were assessed using one index as a measure of overall condition of macroinvertebrate assemblages (PREDATOR) and two indices to measure preferences for temperature and fine sediments. PREDATOR provides a measure of taxa loss compared to reference sites. Stream temperature and fine sediments at a site were modeled using macroinvertebrates alone.

At the state scale, over 90% of the sites on forest lands showed water quality in good or excellent condition. The index measuring overall biological condition showed just over half of forested sites in Oregon in least disturbed condition and approximately one-quarter of sites in most disturbed conditions. Approximately one-third of sites had macroinvertebrate assemblages representative of the coldest stream conditions. At 14% of sites, macroinvertebrate communities were more tolerant of the warmest stream conditions. Over two-thirds of forested sites in Oregon had macroinvertebrate assemblages indicating fine sediments at levels that are considered supportive of salmonids.

Federal lands showed the highest percent of sites with water quality in excellent condition. Water quality on privately owned lands showed lower conditions. Despite differences in water quality, overall biological conditions on federal lands were similar to conditions observed on private industrial lands. Private non-industrial lands had the lowest water quality and biological conditions at all scales where this ownership was included.

Session E3: Integrating Probabilistic and Targeted Monitoring

Assessment Results from Probabilistic Sampling of Wisconsin's Streams

Michael A. Miller
Wisconsin Department of Natural Resources, Bureau of Watershed Management, 101 S. Webster St. Madison, WI 53703

Abstract
In 2007, the Wisconsin Department of Natural Resources (WDNR) with support from the U.S. EPA conducted an assessment of the state's 42,000 miles of perennial streams, using a probabilistic sampling design. Physical habitat, water chemistry, macroinvertebrate, and fish assemblage data were collected at both randomly-selected sample sites and targeted "least-disturbed" reference sites. Fifty random sites, equally-distributed among Strahler stream orders 1 – 5, were sampled in each of the state's four major ecoregions. Data gathered during 2003 – 2008 at streams sites (n = 180) thought to be least-disturbed were used to develop reference conditions. Depending upon the measure of interest, between 7 and 31 percent of Wisconsin's streams were estimated to be in "poor" condition. Risk assessment techniques were used to rank the importance of various physical and chemical stressors, and to estimate the miles of Wisconsin streams degraded by these individual stressors.

Notes on a Method for Integrated Biological and Water Quality Stream Surveys

Robert J. Miltner
Ohio Environmental Protection Agency, Ecological Assessment Section, Groveport, OH

Abstract
Watershed surveys used by the Ohio EPA are designed to fulfill various programmatic needs, including 305b/303d integrated reporting, beneficial use designations, NPDES permit support, 319 support, and 401/404 support. Clearly, no one sampling design can serve this multiplicity of needs. Probability surveys have the advantage of providing a population-level assessment using comparatively low effort. However, probability surveys are logistically difficult to design and execute, and yield relatively little information about causes and source of impairment, especially if designed without prior knowledge of the system. Systematic sampling following the geometric progression of a stream network is comparatively easy to design and execute, as the population is defined ad hoc by the stream network within a given catchment, and provides the spatial density to reveal causes and sources of impairment in low order streams. Either design, however, must be supplemented with targeted samples. A case study of how Ohio EPA uses a combination of systematic sampling supplemented by targeted and probability sampling is presented and discussed.

Use of Biological Monitoring Results at Multiple Spatial Scales: Site Specific to Area Wide

James B. Stribling
Tetra Tech, Inc., Center for Ecological Sciences, 400 Red Brook Blvd., Suite 200, Owings Mills, Maryland 21117-5159 USA

Abstract
There is wide misconception that stream biological data gathered at locations selected in a probability-based, area-wide network cannot contribute to site-specific management decisions. First, we must recognize that monitoring programs with probability-based sampling rarely are limited to that, and include some sampling and assessment of targeted sites. The purpose of this paper is to provide insight into use of data from randomly-selected stream sites for site-specific interpretation. Samples collected at individual sites with appropriate and sufficient quality control and performance data provide validity to site-specific assessments, with known confidence. Use of a stratified probability

approach to site selection provides validity to watershed-scale statements of ecological condition, also with known confidence. A stratified random dataset of, for example, 300 sites and assessments, is 300 individual assessments. Take one of those assessments from a stream or small watershed of interest, use it as an indication of conditions at the site from which it was collected, interpret the overall indicator score (narrative assessment), dis-aggregate into the several metrics and taxonomic and autecological composition, and evaluate the potential of different stressors and stressor sources that might have driven sample content. There are limitations to using individual assessments for area-wide statements of condition, as there are for using assessments from randomly selected locations to assess areas from which samples were not taken. The benefit from the latter is that it is usually done with known confidence. Site specific monitoring focused on measuring the stressor that the best management practice, restoration technique, or chemical control was intended to control provides information directly relevant to statements of effectiveness. Routine, consistent biological monitoring is necessary, and critical, at broader scales to demonstrate effectiveness of the overall watershed management strategy, that is, controlling and reducing multiple sources of stressors in the watershed. Physical, chemical, and hydrologic monitoring is necessary at site specific or otherwise targeted small scales to demonstrate effectiveness of specific restoration or control projects.

An Approach for Combining Targeted Diagnostic Monitoring and Probabilistic Ecological Monitoring to Assess the Extent of Impairment in California Streams

John Hunt[1], Karen Worcester[2], Val Connor[3]
[1]Department of Environmental Toxicology, University of California, Davis, CA; [2]Central Coast Regional Water Quality Control Board, San Luis Obispo, CA; [3]California State Water Resources Control Board, Sacramento, CA

Abstract
Three of the primary water quality monitoring objectives identified in the Clean Water Act are: (1) determining standards attainment (Section 305b), (2) identifying impaired waters and their extents (Section 303d), and (3) identifying causes and sources of impairment. Addressing these objectives generally involves a suite of monitoring designs and indicators, which often align on spatial and conceptual gradients. Determining the degree of standards attainment over large areas (e.g., a state) is most efficiently accomplished using probabilistic designs that allow inferences with known uncertainty to be made about entire waterbody populations. Ecological indicators are appropriate for this objective because they more directly measure biological attributes. Causes and sources of impairment are often more efficiently identified using targeted designs and diagnostic indicators, such as toxicity testing and chemical analysis.

The California Surface Water Ambient Monitoring Program (SWAMP) includes two statewide components that address these objectives. The Perennial Streams Assessment uses ecological indicators and a probabilistic design to assess the status of streams in ecoregion populations. The Stream Pollution Trend monitoring program uses diagnostic indicators and a targeted design to establish a network of low watershed sites to link pollutant concentrations and toxicity to land use attributes, which facilitates evaluation of management options. Local SWAMP monitoring has used a variety of indicators and designs to designate impairment and extent, including the number of impaired reaches in a stream.

To address the statewide assessment question of determining the extent of impairment in streams, SWAMP is evaluating the spatial and conceptual intersections between designs. Targeted, diagnostic monitoring is used to characterize impairment, which may then be assumed to extend upstream until either clean sites are available or there is a change in stressor attributes (such as a change to less intensive land use). Probabilistic monitoring with ecological indicators may then be used to test assumptions that upper watershed areas are unimpaired. Because upper watershed areas in California tend to be larger and less intensively characterized, the probabilistic approach is useful for providing a known level of uncertainty with which to evaluate assumptions about the upstream extent of impairment.

Session E4: Modeling at a Regional Scale

Upper Gera Watershed (Germany) – Areal Assessment of Water-Quality Monitoring and Associated Model Application

Marcel Wetzel, Holm Kipka, Daniel Varga, Manfred Fink, Sven Kralisch, Peter Krause, W.-A. Flügel
Department of Geoinformatics, Hydrology and Modeling, Friedrich-Schiller-University Jena, Germany

Abstract
The presentation shows application of a distributed water-quality model to quantify the current status of nutrient release from diffuse sources in meso-scale catchments. Thus, the fully distributed hydrological model J2000 was combined with the nitrogen transport routines of the Soil Water Assessment Tool SWAT model, which are normally applied in a semi-distributive approach. This combination allows extending the quantitative focus of J2000 with qualitative processes and could overcome the semi-distributed limitation of SWAT. For the implementation and combination of the components of the new resultant model J2000-S (J2000-Substance), the Jena Adaptable Modeling System JAMS was used. The application indicated that the new modeling system was able to reproduce the daily hydrological as well as the nitrogen dynamics with a acceptable accuracy.

In many cases, applications of water-quality models have a poor basis of calibration and validation, due to limited or lack of input data. Water-quality monitoring often is limited to a few sites within the stream network at which samples are collected and analyzed at some intermittent frequency (e.g. monthly). In particular, this limited temporal sample coverage causes problems in modeling water-quality variables such as phosphorous that are mainly transported during short-time events. The resultant loads, calculated based upon these data, are often subject to large errors, due to this sparse time resolution.

In order to address this problem, a meso-scale catchment in the German State of Thüringen has been equipped with a measurement/field-instrumentation network for obtaining spatially and temporally high-resolution hydrological and water-quality data. As a pilot-study test case, the upper watershed of the Gera River (approx. 850 km^2) was selected for this study. The catchment features different landscape forms that are typical for middle mountainous regions in middle Europe. The goal of this study is to improve the existing components describing the hydrological, nitrogen loadings, and overall land-use management using the J-2000-S model with the measured data. These data also will aid in development and implementation of an erosion-phosphorus component and a stream water-quality component for this particular model.

The objectives of this presentation are (1) to describe the Jena Adaptive Modeling System (JAMS) (2) present results of J-2000-S water quality model application (3) describe catchment hydrology and water quality conditions, (4) provide estimated nutrient loadings, and (5) discuss preliminary results of further model application.

Sources of Suspended Sediment in the Chesapeake Bay Watershed: A Regional Application of the SPARROW Model

John Brakebill[1], Scott Ator[1], and Gregory Schwarz[2]
[1]U.S. Geological Survey, Maryland-Delaware-D.C. Water Science Center, Baltimore, Maryland; [2]U.S. Geological Survey, National Center, Reston, Virginia

Abstract
To provide information supporting the management of suspended sediment loads from large rivers, a spatially referenced, nonlinear regression model (SPARROW) was developed for the Chesapeake Bay Watershed region. The model empirically relates mean-annual loads of suspended sediment in 129 non-tidal streams to likely sources, overland transport factors, and aquatic retention processes. The model identified the spatial distributions and statistical significance of individual sediment source contributions and landscape factors affecting transport, where 57% of the watershed is forested, 22% agriculture, and 20% urban. In addition, the model provided the capability to quantify suspended-sediment loads in modeled streams.

A range of sediment sources and sinks were identified as significant predictors of stream load. Agricultural lands in the Chesapeake Bay watershed contribute 51% of the delivered suspended-sediment flux eroded annually and transported to the estuary. Thirty-nine percent of the suspended sediment originates from developed areas, 8% from small stream channels, and 2% from forested areas. On average, urban development yields the greatest amount of suspended sediment per unit area (3,928 $Mg/km^2/yr$), although agriculture is much more widespread throughout the region and the greatest overall source of suspended sediment. Environmental factors affecting over land transport of suspended sediment include mean basin slope, physiography, and soil permeability. Net deposition (storage) occurs along larger streams in the Coastal Plain where slopes and velocities are lower, and in reservoirs, where residence times are longer.

Model results indicate that erosion is more likely to be enhanced where physical factors affecting sediment transport have the greatest influence. Sediment controls applied in areas of agriculture and urban development of the northern Piedmont close to the upper Bay may have the greatest impact in mitigating sedimentation in the bay and its tributaries. Stream restoration efforts addressing floodplain and bank stabilization may be more effective in smaller headwater streams outside of the Coastal Plain. However, management actions targeting the preservation of flood plains in the Coastal Plain may be an effective way to maintain the natural landscape conditions beneficial to sediment trapping and storage prior to entering tidal waters of Chesapeake Bay.

Analyzing SPARROW Data to Quantify Changes in Salt Load from Irrigation

Travis James[1], Frank Riggle[2], Jason Peel[2], Kristina Floyd[2], Terry Kenney[3]
[1]USDA-Natural Resources Conservation Service, Salt Lake City, Utah, United States; [2]USDA-Natural Resources Conservation Service, Lakewood, Colorado, U.S.; [3]USDI-U.S. Geological Survey, Utah Water Science Center, Salt Lake City, Utah, U.S.

Abstract
Site specific hydro-salinity studies have been used to assess the salt load for various federally-designated salinity control project areas in the Colorado River Basin. These studies, costly in time and resources, were used to allocate federal appropriations and matching funds from state and local partners to implement salinity control measures on irrigated lands that have local, regional and international benefits. SPARROW data can provide base level salt load estimates from irrigation-induced sources beyond the borders of the current project areas and throughout the Colorado River Basin at a significant savings in time, cost, and effort.

In the areas of the Colorado River Basin outside of the designated salinity project areas, a variety of programs assist landowners with making irrigation system improvements for water quality reasons other than salinity control. The availability of the SPARROW data and identified catchment areas offers the opportunity to assign salt loading values, and to combine with other data sources to predict the potential reduction benefits from making various irrigation improvements, and to quantify a net reduction in salt loading in areas outside of the existing salinity project areas.

This base level analysis can be done at a low cost and thus is a cost-effective viable alternative to expensive studies in the areas with scattered irrigated lands and/or a relatively low salt loading rate. The mix of multiple data provides the opportunity to make a legitimate prediction about the salinity reduction benefits to irrigation improvements on a broader basin-wide scale.

SPARROW Decision Support

Nathaniel Booth, Eric Everman, Greg Schwarz, I-Lin Kuo
USGS, Middleton, WI, United States

Abstract
The USGS National Water Quality Assessment Program (NAWQA) is developing water-quality predictive models for Major River Basins of the conterminous United States. In addition to extrapolating measured water-quality conditions to unmonitored areas to help assess water-quality status, a calibrated Spatially Referenced Regressions On Watershed Attributes (SPARROW) model can be used to produce statistically defensible estimates of load, flow-weighted concentration or yield of any modeled constituent under different land use and management scenarios.

A decision support infrastructure is being developed to offer sophisticated prediction capabilities for research and resource management. The intention is to provide users of the system with these capabilities through a standard web-browser without required proprietary software licenses or significant training.

Three general capabilities are implemented in the tool. (1) View and map all model metrics, query for additional information by river reach, export model prediction data; (2) Run scenarios by treating source terms by reach, or across a class of source/reach types; (3) Understand how constituents are delivered from throughout a river basin by mapping the amount delivered to a river outlet of interest.

Session E5: Volunteers and State Agencies: Collaborating for Better Decisions

The Evolution of Virginia Volunteer Water Monitoring Programs: From Public Engagement to Influencing Policy

Chris French
Alliance for the Chesapeake Bay, Virginia Office

Abstract
Virginia's volunteer water monitoring program turns 25 years old in 2010. The Alliance for the Chesapeake Bay's RiverTrends program – established is 1985 – is the oldest continuous volunteer program in the Commonwealth. Like many volunteer programs, RiverTrends was originally conceived as a way to engage citizens in the Chesapeake Bay restoration effort and to produce water data that can be used by local and regional partners. Today, volunteer water monitoring programs are common throughout Virginia.

Once dismissed by many government agencies, volunteer-collected data is now utilized by the Virginia Department of Environmental Quality (DEQ) in its 305(b)/303(d) water quality assessment program. Water data that has passed Level III QA/QC protocols are considered comparable to state agency and university collected data.

This presentation will discuss how Virginia volunteer monitoring programs and their participants have successfully influenced Virginia state policies and programs. For example, volunteer monitors have mobilized to sustain and/or restore natural resource funding during past and current state budget cuts. In 2007, a 3,000 river mile assessment

goal requiring DEQ to utilize citizen generated water quality data passed the Virginia's General Assembly - an effort initially spearheaded by a volunteer monitoring group.

Current and future directions for Virginia citizen monitoring programs will be discussed, including partnerships and collaborations designed to address local data needs, tracking the success of TMDLs, and stormwater monitoring requirements under MS4 permit programs.

Developing Volunteer Monitoring Programs to Support State Agency Restoration Efforts

Ginger North
Citizen Science Coordinator, Natural Resource Conservation, Delaware Nature Society

Abstract
In today's economic conditions, it is essential to pool and not duplicate our efforts. Having strong partnerships and collaborative projects is a cost effective way to produce needed data through volunteer monitoring that not only saves money but time. The Delaware Nature Society's Volunteer Riparian Habitat Assessment Pilot Project is a great example of this type of collaboration. This project allows the State of Delaware's Department of Natural Resource and Environmental Control to prioritize their restoration projects using volunteer data. The volunteers gain the satisfaction that their data is being used by the state and supporting restoration efforts. The Delaware Nature Society is expanding their citizen science program by adding a new volunteer strategy that is innovative in the way volunteer data can be used. Together with their nationally recognized Technical Monitoring program this new project strengthens partnerships with State and garners interest and support from the public. It informs the public on water quality issues and allows them to see State agency's role in a new light as a partner in improving and protecting the environment.

Uses of Missouri Stream Team Data

Chris Riggert
Missouri Department of Conservation

Abstract
The Missouri Stream Team Volunteer Water Quality Monitoring (ST VWQM) Program offers a tiered level of training allowing for greater flexibility and involvement for citizen volunteers. Data collected by individuals are tagged based on the highest level of training the volunteer has received, and offers different uses by local, state and federal entities. Data collected by individuals attending the Introductory Level and Level 1 training classes is used by sponsoring agencies to alert for potential issues. Data collected by individuals who have successfully completed the Level 2 and 3, as well as CSI QAQC trainings are used as agency collected data by the Missouri Department of Natural Resources, and is considered as part of Missouri's listing methodology for the impaired waters list.

Citizen Monitoring and TMDL Programs Partner to Identify E. coli Sources, Build Media Relations, Build Trust

Jason Pinchback[1], Josh Oyer[1], Robin Berry[2]
[1]Texas Stream Team, River Systems Institute, San Marcos, TX, United States; [2]Colorado River Watch Network, Lower Colorado River Authority, Austin, TX, United States

Abstract
Streams with *E. coli* impairments are inherently difficult to remedy due to complexities of bacteria origins, fate, and transport. Complex problems often call for complex solutions that lead to prolonged stakeholder committee processes involving "partners" with myriad affected interests that can lead to distrust, ineffective decision-making, and solutions that look great on paper but are difficult to apply. Citizen monitoring programs can bring cost-effective solutions that help decision-makers characterize *E. coli* hot spots, build positive relationships, and provide a forum for stakeholders to engage projects outside of meeting rooms and public hearings.

In 2004, Gilleland Creek was identified as not meeting contact recreation standards due to repeated elevated bacteria levels. As a result, the creek was selected for a Total Maximum Daily Load (TMDL) study by the Texas Commission on Environmental Quality (TCEQ).

December 2008 - Texas Stream Team along with the LCRA Colorado River Watch Network coordinated a one day intensive *E. coli* survey at 111 sites on Gilleland Creek and its major tributaries to examine the spatial distribution and concentrations of *E. coli* bacteria in the watershed. This water quality monitoring event utilized the work from volunteers and staff from the TMDL project. Hands-on watershed education to local students, a press event, and media outreach tools were used to expand the impacts from this effort.

This sampling event identified *E. coli* hot spots, built trust among partners, invigorated project staff, provided mass media outreach, and is being used to track *E. coli* to sources. Follow-up sampling by volunteer and professional monitors are adapting monitoring plans to hone in on and halt stream *E. coli* loadings.

In alignment with Texas Stream Team's mission, monitors collect quality-assured data for use by government agencies and other decision-making entities to promote a healthier and safer environment. Information collected by Texas Stream Team volunteers utilizes approved quality assurance project plans to ensure data are correct and accurately reflect environmental conditions being monitored. Sample results are intended to be used for education and research, baseline, local decision making, problem identification, and others uses deemed appropriate by the data user.

Session E6: Contaminant Effects on Aquatic Ecosystem Health 1

Monitoring for Current-Use Pesticides in Amphibians and the Water and Sediment in Their Habitat

William A. Battaglin[1], Kelly Smalling[2], Timothy Reilly[3], and Kathy Kuivila[2]
[1]U.S. Geological Survey Colorado Water Science Center, Lakewood, CO, United States; [2]U.S. Geological Survey California Water Science Center, Sacramento, CA, United States; [3]U.S. Geological Survey New Jersey Water Science Center, West Trenton, NJ, United States

Abstract
Although the occurrence and effects of a few pesticides (atrazine, for example) has been studied extensively in amphibian habitats, little is known about the occurrence of or exposure to most other pesticides that are currently used. Recent studies have shown that amphibians are sensitive to organophosphate insecticides and their metabolites, pyrethroid insecticides, and to some formulations of glyphosate. This study addresses the occurrence of current-use pesticides in amphibians and their habitat, with special focus on fungicides occurrence and accumulation in pond breeding frogs. More than 90 pesticides and pesticide degradates, including 35 fungicides, were measured in water, sediments, and frog tissue using newly developed analytical methods. Sites in California, Colorado, Maine, Georgia, and Oregon were selected as settings where exposure to agricultural and urban chemicals was likely. Preliminary results suggest that pesticide concentrations in water are low in most locations, but other exposure routes (sediment, for example) remain. This pilot-scale interdisciplinary study, supported by the USGS Amphibian Research and Monitoring Initiative (ARMI) and the USGS Toxics Substances Hydrology (Toxics) Program, provides a foundation for a more comprehensive study in the future, one that will evaluate the effects of multiple stressors (such as temperature, toxic chemicals, disease, habitat loss, and invasive species) on amphibians and their habitats in North America.

Measuring Tissue Concentrations to Link Current-use Pesticide Exposure to Aquatic Ecosystem Health

Kelly L. Smalling and Kathryn M. Kuivila
U.S. Geological Survey, California Water Science Center, Sacramento, CA

Abstract
A wide variety of pesticides are applied concurrently in agricultural and urban areas throughout the United States and transported to the environment dissolved in water and bound to suspended sediments. Currently, the effects of these current-use pesticides on aquatic ecosystem health are not well understood. To better assess potential ecosystem effects, the first step will be to characterize pesticide exposure to aquatic organisms of concern by directly measuring specific pesticides in tissue. This new methodology was developed to extract pesticides from either specific organs or whole body using solvent extraction at high temperature and pressure followed by cleanup using size exclusion chromatography and Florisil. As aquatic organisms are typically exposed to complex mixtures of pesticides, the tissue extracts were analyzed for a large suite of pesticides (approximately 100) using gas chromatography/mass spectrometry. The most statistically-significant approach to correlate pesticide exposure and effects is to measure both tissue concentration and biological endpoints (lethal and/or sublethal effects) in individual organisms (rather than composite samples). For this reason, the analytical method was optimized for maximum sensitivity to allow for the analysis of current-use pesticides in single organisms. A variety of tissues including sand crabs, crab embryos, fish and frogs from sites across the United States are being analyzed for current-use pesticides. Preliminary results indicate that organophosphate and pyrethroid insecticides, conazole and strobilurin fungicides, and a variety of herbicides are present at measurable concentrations. Future studies will include collaborative efforts between chemists, toxicologists and ecologists to link observed tissue pesticide concentrations to aquatic ecosystem health.

Identifying Sources of Toxicity to Hyalella *in the Santa Margarita Watershed*

Matt Rich[1], John Rudolph[2], Arlene Chun[3], Armand Ruby[4]
[1]MACTEC Engineering and Consulting, Inc., San Diego, CA, USA; [2]Nautilus Environmental, LLC, San Diego, CA, USA; [3]Riverside County Flood Control and Water Conservation District, Riverside, CA, USA; [4]Armand Ruby Consulting, Inc., Capitola, CA, USA

Abstract
Since the summer of 2007, Riverside County Flood Control and Water Conservation District has been conducting a Toxicity Reduction Evaluation (TRE) for the Santa Margarita River (SMR) Watershed in accordance with the County's NPDES Municipal Separate Storm Sewer (MS4) Permit. The TRE is required to address the causes of toxicity observed in the SMR watershed during wet weather monitoring.

During the 2004-2006, toxicity to *Hyalella azteca* was observed in samples from Temecula Creek and Murrieta Creek during five of eight wet weather events. Toxicity testing during the 2007-2008 reporting period indicated persistent wet weather toxicity. A Toxicity Identification Evaluation (TIE) was conducted, and concentrations of pyrethroids in the samples were analyzed. The TIE indicated that pyrethroids were the primary source of toxicity in both creeks. Dry weather samples also were tested for toxicity and pyrethroids. Neither toxicity nor pyrethroid pesticides were detected in the dry weather samples, indicating that pyrethroid-induced toxicity is primarily a wet-weather issue.

The second step of the TRE was to identify sources of pyrethroid pesticides within the watershed. Relevant scientific literature, pesticide sales and use records, and GIS land use evaluations were reviewed. Uses of pyrethroids were broken down into agricultural, non-agricultural, structural, landscape maintenance, and other categories. Land use data indicated that less than 10 percent of the watershed is urbanized, however, the predominant uses of pyrethroid pesticides appear to occur in urban areas.

The pyrethroid pesticides bifenthrin and permethrin appear to be the primary toxic elements. Based on sales and use records, the major sources of pyrethroid toxicity in the SMR watershed are non-agricultural activities. Structural pest control appears to represent 93% of the total pyrethroids use. Permethrin was used more than any other pyrethroid pesticide in the urban landscape.

This study presents the toxicity and pyrethroid concentration data collected during the current Permit period. TIEs are discussed in detail, as many of the techniques used are highly involved and not yet standardized. Methods for conducting the TRE are described. Results of the source identification efforts are included, as well as a comparison of the data to neighboring counties.

Patterns of Fish and Macroinvertebrate Communities Exposed to Pulp and Paper Mill Effluent in Four US Receiving Streams

Camille Flinders[1], Renee Ragsdale[1], Tim Hall[1], Wayne Minshall[2]
[1]National Council for Air and Stream Improvement, Anacortes, WA, United States; [2]ISU Stream Ecology Center, Idaho State University, Pocatello ID, United States

Abstract
A whole community approach in which periphyton, macroinvertebrates, and fish are monitored concurrently to determine potential point-source effects are rare, and unprecedented in examining the in-stream effects of pulp and paper mill effluents (PPME) on stream biota. Our understanding of PPME effects on aquatic systems is largely derived from short-term, mesocosm, or population-level studies, with little information on long-term, community-level patterns. We examined seasonal and annual patterns in periphyton chlorophyll *a* (chl *a*), and macroinvertebrate and fish communities related to PPME discharge and environmental variables based on the initial 9 years of a long-term study (>10 years) in 4 PPME receiving streams (Codorus Creek [PA], Leaf River [MS], McKenzie and Willamette Rivers [OR]). Receiving waters represent different ecoregions, system types (warm/coldwater), effluent concentration, and mill process types (bleached/unbleached kraft). Measurements are taken multiple times per year at multiple sites upstream and downstream of PPME discharges to determine the temporal variation of endpoints, and to discriminate naturally-occurring spatial variation from possible effluent-effects. Chl *a* concentration, community structure (type and relative abundance of species), and biological metrics measuring ecosystem structure and function (e.g. richness, %dominant taxa, and biomass) were examined. Associated habitat and water quality data were also collected and related to biotic response. Periphyton chl *a* downstream of the PPME discharge in Codorus Creek and the McKenzie River was greater at some, but not all upstream sites. Site differences in macroinvertebrate community structure were seen only in Codorus Creek, but differences were related to stream temperature and not PPME. In remaining streams, seasonal community differences across years were greater than site differences. Fish community structure was variable across sites, seasons, and years, with no site differences related to PPME discharge. Macroinvertebrate (n=6) and fish (n=9) metric changes related to PPME discharge were seen only in the McKenzie River where Hilsenhoff Biotic Index scores increased at sites downstream of PPME relative to upstream sites, with significant differences seen only between one upstream and downstream site. Significant reductions in small-bodied fish, % dominant taxa and % large-bodied piscivores were observed downstream of the PPME discharge relative to upstream sites. Community-environmental relationships were generally weak for all endpoints. The results of this study indicate that PPME exposure has little effect on fish and macroinvertebrate communities in these streams, and that spatial and temporal variability inherent in natural systems requires long-term studies to elucidate patterns.

Session F1: Continuous Real-Time Monitoring: Applications in Rivers and Streams

Continuous Water Quality Monitoring in the Upper Clear Creek/Standley Lake Watershed - Westminster, Colorado

Andrew Cross
City of Westminster, Colorado

Abstract
Standley Lake is a 43,000 acre-foot reservoir located in northeast Jefferson County, Colorado. This reservoir supplies drinking water to the cities of Northglenn, Thornton, and Westminster and their service areas. In addition, the reservoir provides recreational opportunities to the surrounding population and serves as an agricultural water supply. The majority of inflow into Standley Lake is from three canals (Farmers Highline, Church, and Croke Canals) that divert water from Clear Creek in Golden, Colorado. The Clear Creek watershed and tributary basin of Standley Lake cover approximately 445 square miles of varied terrain, ranging from 14,000 foot mountains of the Colorado Rockies to open plains at 5,000 feet. The entire watershed boundary encloses the Upper Clear Creek watershed and land areas draining to the three canals serving Standley Lake. The watershed includes 70% forested areas and protected open space.

A comprehensive water quality monitoring program consisting of grab samples has been in place since 1994. In 2005 the monitoring program was augmented with continuous monitoring stations and autosamplers to help meet the challenges of monitoring a large and diverse watershed. The continuous monitoring data from the watershed assists water resources personnel manage the lake inflows following incidents that could affect water quality. The watershed monitoring stations are programmed to trigger the autosamplers to capture storm events, and the samplers can also be manually triggered from a remote base station.

In 2002, a depth-integrated profiling system was deployed on Standley Lake. The system collects a lake profile every six hours using a multi-parameter sonde. The acquired lake data, coupled with the continuous tributary in-flow data, provide the scientific evidence required to predict possible lake responses and plan appropriate treatment strategies. Daily evaluation of the data and instrument operation requires dedicated staff with the flexibility to respond quickly to a wide variety of environmental and technical challenges.

Real-Time Water-Quality Monitoring and Regression Analysis to Estimate Constituent Concentrations in the Menomonee River Watershed, Milwaukee, Wisconsin

David J. Graczyk
U.S. Geological Survey, 8505 Research Way, Middleton, WI 53562

Abstract
The U.S. Geological Survey (USGS) and the Milwaukee Metropolitan Sewerage District (MMSD) began a water-quality monitoring program for the Menomonee River Watershed in October 2008. Five locations along the Menomonee River; all within the MMSD service area, were selected to represent water-quality conditions within the watershed. Real-time water quality sensors and automatic water samplers were installed at these locations.

Measurements from real-time water-quality sensors are being used as surrogates to estimate real-time concentrations of selected constituents. The sensors measure water temperature, specific conductance, dissolved oxygen and turbidity. Data from the sensors are transmitted to the USGS Wisconsin Water Science Center and to the MMSD Central Office.

Water quality samples are also being collected over selective hydrographs for a full range of stream flows at all five sites. Samples are being analyzed for suspended solids, total phosphorus, chloride, fecal coliform and *E. coli*. Concentration data from water-quality samples (response variables) and the sensor data (explanatory variables) are being used to develop numerical models to estimate real-time water-quality information. Step-wise multiple least-squared regressions are applied to this data to determine which real-time sensor parameters serve best as explanatory variables to develop the numerical models. Preliminary regressions have been developed for the five sites. The squared correlation coefficient (r^2) for the regression equations at the five sites ranged from 0.74 to 0.97 for chloride, from 0.55 to 0.91 for suspended solids, from 0.41 to 0.66 for total phosphorus, from 0.52 to 0.66 for *E. coli* and from 0.42 to 0.71 for fecal coliform respectively. Sensor data and water-quality samples will continue to be collected at the five sites and this data will be used to finalize and verify the regression equations.

Computing Time-Series Suspended-Sediment Concentrations and Loads from In-Stream Turbidity-Sensor and Streamflow Data

Patrick P. Rasmussen[1], John R. Gray[2], G. Doug Glysson[2], and Andrew C. Ziegler[1]
[1]U.S. Geological Survey, Water Science Center, Lawrence, Kansas, United States; [2]U.S. Geological Survey, Office of Surface Water, Reston, Virginia, United States

Abstract
Over the last decade, use of a method for computing suspended-sediment concentration and loads using turbidity sensors—primarily nephelometry, but also optical backscatter—has become more prevalent. Because the *in-situ* turbidity sensor is capable of measuring turbidity instantaneously, a turbidity time series can be recorded and related directly to time-varying suspended-sediment concentrations. Depending on the suspended-sediment characteristics of the measurement site, this method can be more reliable and, in many cases, a more accurate means for computing suspended-sediment concentrations and loads than traditional computation methods using streamflow.

Guidelines and procedures for estimating time series of suspended-sediment concentration and loading as a function of turbidity and streamflow data have been published in a USGS Techniques and Methods report, book 3, chapter C4. The concepts, statistical procedures, and techniques used to maintain a multiyear suspended sediment time series and to prepare sediment data for public dissemination are described. Procedures for comparing computed suspended-sediment concentrations to water-quality criteria and assessing the frequency of exceeding criteria are included. Specific examples of the method used on the Missouri River will be presented.

Trends in Selenium concentration and load in the Gunnison and Colorado Rivers determined using surrogate data from continuous monitors

Kenneth Leib and John Mayo
U.S. Geological Survey, Water Resources Discipline, Colorado Water Science Center, Western Area Office, Grand Junction, CO, United States

Abstract
Selenium levels in the Gunnison and Colorado Rivers are a regulatory concern and also an issue for endangered native Colorado River Basin fish species. Currently there are salinity and selenium control efforts underway in portions of each river basin that are designed to reduce salinity and selenium levels. Salinity control has been documented to also reduce selenium; therefore, areas where salinity control has taken place are also areas where selenium levels in waterways may have been reduced. In order to better understand the results of these efforts, water-quality information from continuously recording water-quality monitors was used to determine the existence of trends in selenium concentration

and load at two agriculturally impacted sites on the Gunnsion and Colorado Rivers for the period 1986-2008. Preliminary results indicate significant downward trends in selenium concentrations and loads for the period at both sites. Decreases in concentration were approximately 1 to 1.2 parts per billion and decreases in load were about 20 percent for the period. Daily-mean specific conductance and streamflow were used as surrogates to predict the changes in selenium levels over time. The approach used a two part regression equation to first estimate changes in specific conductance over time using daily-mean streamflow, centered decimal time, Julian date, and a dummy variable which represented irrigation and nonirrigation season. Output from equation one (specific conductance) was then used in a second regression to estimate trends in selenium concentration. Observed trends in selenium concentration were used to calculate selenium load and estimates of the total decrease in selenium load for the 1986-2008 period. This approach assumes a consistent correlation between selenium and specific conductance exists for the period of study. There was indication that the correlation between selenium concentration and specific conductance was changing over time during the irrigation season as indicated by residual plots from a regression of specific conductance and selenium concentration. This change could result in an underestimation of the total decrease in selenium levels at both sites.

Session F2: Regional Scale Wetlands Monitoring and Assessment

Probability-Based Sample Designs for Wetland Condition Assessment: Lessons Learned from Real-World Applications in the Rocky Mountains

Joanna Lemly[1], Karen Newlon[2] and Linda Vance[2]
[1]Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO; [2]Montana Natural Heritage Program, University of Montana, Helena, MT

Abstract
Probability-based sample designs offer a powerful technique to answer landscape-scale questions regarding the overall condition of aquatic resources. The use of a spatially balanced random sample survey design, such as Generalized Random Tessellation Stratification (GRTS), can increase efficiency in field sampling while lowering the variance associated with small sample sizes. In recent years, probability-based designs have been used to estimate the condition of lakes, large rivers, wadeable streams, and—most recently—wetlands. There are numerous approaches to probability-based sampling and it is important to clarify both study objectives and data limitations before deciding on the optimal survey design. One important consideration is whether to stratify the design by such factors as land management (e.g., public vs. private ownership) or ecological regions (e.g., low elevation regions vs. high elevation regions). Studies may also employ a two- or three-stage design for which the landscape is divided into nested levels and a random sample is drawn from each level, such as selecting target watersheds first and target wetlands second. Additionally, many states and regions lack complete spatial data for wetlands. Though this complicates the use of a random sample design, there are ways to work with such data limitations. Since 2007, we have used probability-based sample designs in four separate wetland condition assessment projects in the Rocky Mountain West to estimate overall wetland condition or to select reference condition wetlands across a large geographic area. Each study has been designed differently to meet different objectives, limitations, and logistical constraints. We have used environmental drivers to classify and stratify the landscape at both the watershed and ecoregional scale; we have employed both one- and two-stage designs; and we have worked in areas with little or no wetland spatial data. In this presentation, we will address the challenges we encountered applying probability-based sample designs to real-world conditions and how we ultimately addressed those challenges. In addition, we will offer suggestions on what has worked best and what pitfalls to avoid.

Gulf of Mexico Coastal Wetlands: A Regional Assessment Perspective

Janet A. Nestlerode (US EPA), Virginia D. Engle (US EPA), John Macauley (US EPA), Pete Bourgeois (USGS), and P. Thomas Heitmuller (USGS)
U.S. Environmental Protection Agency, Gulf Ecology Division
US Geological Survey, National Wetlands Research Center, Gulf Breeze Project Office, 1 Sabine Island Drive, Gulf Breeze, Florida 32561

Abstract
The U.S. Environmental Protection Agency (EPA) and U.S. Geological Survey (USGS) completed a two-year regional pilot survey in 2008 to assess the ecological condition of northern Gulf of Mexico (GOM) coastal wetlands. A probability-based survey design was used to select 100 sites from estuarine and freshwater, herbaceous and forested wetlands within coastal watersheds across the GOM region. A three-tiered, stepwise survey approach to assess ecological condition was implemented at each site. Tier 1 provided landscape-level GIS data on habitat inventory, land use, and environmental stressor information for the watershed from which each wetland site was selected. Tier 2, a rapid assessment based on best professional judgment and on-site evidence, was conducted through a combination of office and field work. Tier 3 involved intensive on-site collection of vegetation, water, and sediment samples to establish an integrated understanding of current wetland condition and to validate methods and results from Tiers 1 and 2. Tier 2 rapid assessment scores for sites visited ranged from 70 to 100. Examples of low- and high-scoring sites will be presented and factors contributing to the scores will be discussed. We also present a comprehensive assessment of the ecological condition of GOM coastal wetlands using available data from each Tier, analysis of links among indicators, and a preliminary assessment of ecosystem services. This regional wetlands survey has provided valuable "lessons learned" for EPA's upcoming National Wetlands Condition Assessment in 2011 by 1) evaluating the feasibility of implementing a probability-based survey design for wetlands on a regional scale, 2) evaluating the applicability of indicators across multiple wetland types, and 3) advancing the science of wetland monitoring and assessment.

Keywords: Coastal wetlands, Gulf of Mexico, Rapid Assessment Methods, Condition Assessment

Toward a Mid-Atlantic Regional Wetlands Condition Assessment

Sarah Miller[1], Robert Brooks[1], Kirk Havens[2], Denice Wardrop[1], Carl Hershner[2], Hannah Ingram[1], Regina Poeske[3]
[1]Pennsylvania State University, University Park, PA, United States; [2]Virginia Institute of Marine Science, Gloucester, VA, United States; [3]U.S. Environmental Protection Agency, Philadelphia, PA, United States

Abstract
A condition assessment of freshwater wetlands representative of the region is being conducted by a team of investigators from two universities, the Mid-Atlantic states, and the regional office of U.S. Environmental Protection Agency. The team is coordinating the project with members of the Mid-Atlantic Wetlands Work Group (MAWWG) and scientists from USEPA's Office of Research and Development (ORD) to complement state specific assessments and to provide input for the National Wetlands Assessment, respectively. We produced a probability-based sample of about 400 wetlands selected from a National Wetlands Inventory frame based on USEPA's Generalized Random Tessellation Stratified (GRTS) design. Two years of field sampling were conducted in 2008 and 2009. Equal numbers of sites were sampled across the five major ecoregions of the area. In 2008, data were collected using three existing rapid field assessment protocols that emphasized the occurrence of stressors. Following the 2008 field season, these three methods were distilled into a single regional protocol, the Mid-Atlantic Rapid Assessment Protocol (RAP) that was used in 2009. We applied a regional hydrogeomorphic (HGM) based classification system to designate wetlands types. An automated landscape approach that

assesses land cover and selected ecosystem services surrounding each wetland was applied to all wetlands within the sampling frame. Our intent is to use this multi-level, regional assessment approach for periodic characterizations of regional wetland conditions at five-year intervals, and to support restoration and protection goals of the region and individual states. Intensive training of field crews was part of a strong quality assurance and quality control program used to enhance data acquisition. Preliminary results from the two field seasons will be reported.

Establishing a Wetlands Monitoring Program in North Carolina with emphasis on a Piedmont Watershed and a Coastal Plain Watershed

Rick Savage and Virginia Baker
NC Department of Environment and Natural Resources, Division of Water Quality

Abstract
The goal of this wetlands monitoring research (the second Wetlands Program Development grant funded by the US EPA) was to continue the development of a wetlands monitoring program in North Carolina. Two watersheds were chosen in which to monitor wetlands; Fishing Creek Watershed in the Piedmont (Granville County) and Lockwood Folly Watershed in the Coastal Plain (Brunswick County).

For the Fishing Creek Watershed, six Basin Wetlands and six Bottomland Hardwood Forests were monitored and for the Lockwood Folly Watershed, six Basin Wetlands, and seven Riverine Swamp Forests were monitored. Level I (remote sensing, spatial analysis), Level II (rapid assessments: North Carolina Wetlands Assessment Method (NCWAM) and Ohio Rapid Assessment Method (ORAM)), and Level III (intensive assessments) data have been completed for the wetland sites. The level I analysis involved a spatial land cover analysis of the watershed and 100m buffer of each site was used to create a land use development index to determine the effects of land use on the wetland monitoring level III data. Level III involved intensive wetland monitoring surveys and samples for amphibians, aquatic macroinvertebrates, vegetation, water quality (physical and chemical measurements), hydrology (30-60 minute intervals), and analysis of soil composition. A preliminary evaluation of NCWAM scores with the wetland monitoring data was also conducted.

The results were used to characterize the physical, chemical, and biological attributes of the three wetland types. Water quality results comparing of upstream samples with downstream samples show Riverine Swamp Forests reduce nutrients and metals and whereas Bottomland Hardwood Forests reduced these potential contaminants, but to a lesser extent. The wetlands in the Lockwood Folly River watershed also had better water and soil quality (lower levels of potential pollutants) than in the Fishing Creek watershed. Additional soil analysis showed that all three wetland types are acting as sink for nutrients and metals for potentially improving water quality. The hydroperiod of the three wetland types was variable and reflected drought conditions. Finally, four Basin Wetlands, two Bottomland Hardwood Forests, and two Riverine Swamp Forests, were combined with our previous six Headwater wetland and added to our long term wetlands monitoring effort.

Session F3: Water Quality Exchanges Improve Data Access and Sharing

Water Quality Data Management and Exchange Among Tribes through a Tribal Consortium

Osa Odum, Bruce Jones
Northwest Indian Fisheries Commission, Olympia, WA, United States

Abstract
Many tribes across the United States have programs designed to monitor the water quality of their watersheds. Data collected as part of this effort need to be properly stored, managed, and analyzed. In addition, and as part of their grant obligations, tribes are required to submit their data to the U.S. Environmental Protection Agency (EPA). Tribes also have a stated need to exchange data with each other as well as with other authorized partners.

Using the National Environmental Information Exchange Network, the Northwest Indian Fisheries Commission (NWIFC), a consortium of 20 federally recognized tribes, implemented a Water Quality Exchange (WQX) solution to help its member tribes meet these challenges. This solution includes a WQX-complaint Tribal Water Quality Database (TWQD), an Exchange Network Node at the NWIFC and custom-built WQX Node Client applications deployed at each tribe. The result is that member tribes are able to exchange water quality data with EPA, the NWIFC and potentially other partners in a timely and efficient manner. The solution provides a cost-effective way for similar organizations to exchange monitoring data.

New Jersey's Ambient Water Quality Data Exchange System

Paul Morton[1], Alena Baldwin-Brown[1], Leslie McGeorge[1], Danielle Donkersloot[1], Angela Witcher[2], Sherry Driber[2]
[1]New Jersey Department of Environmental Protection, Water Monitoring and Standards, Trenton, NJ, United States; [2]New Jersey Department of Environmental Protection, Office of Information Resource Management, Trenton, NJ, United States

Abstract
The primary goal of New Jersey's Ambient Water Quality Data Exchange (WQDE) system is to efficiently integrate and provide access to ambient water quality data from a myriad of organizations monitoring waters in New Jersey (state, county, interstate, and federal agencies, academia, 305(b) data solicitation respondents, Total Maximum Daily Load (TMDL) contractors, National Pollution Discharge Elimination System (NPDES) permittees seeking permit modifications, Section 319(h) grantees and volunteer monitoring organizations). This information will be made available to water resource managers for applications such as the New Jersey Integrated Water Quality Monitoring and Assessment Report as required under Sections 305(b) and 303(d) of the Federal Clean Water Act. Additional goals of this project are to get New Jersey data to the US Environmental Protection Agency's (USEPA) Central Data Exchange (CDX) using Exchange Network (EN) technology and to provide the public with better access to ambient water quality data for New Jersey.

The NJ Department of Environmental Protection and its partners have developed a data management system for ambient water quality data that uses web service based applications and the USEPA Water Quality Exchange (WQX) XML schema to bring data together and make it available to decision makers, planners, researchers and the public. A key component of this system is the ambient water quality monitoring inventory, which was developed in conjunction with the New Jersey Water Monitoring Council and which describes the who, what, where, when and why of ambient water quality monitoring projects.

Perhaps the most exciting product from this project is the enhancement of the Exchange Network shared tool called the EN Browser. Through a single interface, EN Browser users are able to query and bring together ambient water quality data from the US Geological Survey's National Water Information System (NWIS), USEPA's Storage and Retrieval (STORET) system and state systems via Web based services. Users can display ambient water quality monitoring locations on a map, view simple graphs and statistics for the retrieved results and download data to their desktop PC for further analysis.

The goal of this presentation is to share the lessons learned by New Jersey in supporting water resource management and strengthening partnerships with volunteers and other organizations through our water data management experience and strategy, and to discuss the EN Browser enhancements that can be used by any EN partner.

The Ocean Data Partnership Exchange Network (ODPX): Building a consensus-based system for discovery, accessibility, and interoperability of diverse water data in the Northeast US and Canada

Paul Currier[1], Deb Soule[1], Riley Young-Morse[2], Tom Shyka[2]
[1]New Hampshire Department of Environmental Services, Concord, NH, United States; [2]Gulf of Maine Research Institute, Portland, ME, United States

Abstract
The Ocean Data Partnership (officially the Northeast Coastal and Ocean Data Partnership) is an association of diverse data providers and data users in the US Integrated Ocean Observing System (IOOS) northeast region and Atlantic Canada, organized in 2004 to promote and coordinate the sharing, linking, electronic dissemination, and use of data in the region. The partners have determined a coordinated effort is needed to enable users throughout the region and beyond to discover and put to use the vast and growing quantities of environmental data in their respective databases. Our common goal is for our data to be discoverable, accessible, and interoperable.

Funded by EPA Exchange Network grants, and using the National Environmental Exchange Network framework, the participating partners have built a consensus-based schema for diverse data types related to water and aquatic organisms from mountain streams to the ocean depths, from grab samples to buoy data to ocean trawls. The schema is based on the Water Quality Exchange (WQX) and includes data elements from the Global Change Master Directory (GCMD) Directory Interchange Format (DIF), New Jersey Water Monitoring Inventory, Sensor Web Enablement (SWE), and Geography Markup Language (GML). It allows partners to utilize their GCMD records as a basis for developing a catalog record. Partners can contribute beyond that level to providing monitoring location data and then sampling/observation data if time and resources permit. We are now in the process of mapping partners' data to the schema and expect to start exchanging data in the next few months. A subsequent effort, just getting underway, is to develop capability for geospatial data flows compliant with Open Geospatial Consortium standards.

The USGS-USEPA Water-Quality Data Exchange

Nathaniel Booth[1], Jon Scott[2], Kristen Gunthardt[3], Kevin Christian[3], Dorinda Gellenbeck[4]
[1]USGS, Middleton, WI, United States; [2]USGS, Oklahoma City, OK, United States; [3]USEPA, Washington DC, United States; [4]USGS, Denver, CO, United States

Abstract
USGS and USEPA are working together to provide scientists and policy-makers an easier way to integrate access to their large water-quality databases. A common suite of web services allows for the automated sharing of water monitoring data via a common format and terminology. Development of a data portal is underway which will provide a single website from which water-quality for the Nation can be downloaded.

A web service is a computer-to-computer protocol that allows for the direct sharing of information. The services provide the ability to combine data from USGS's NWIS and EPA's STORET systems. Data is formatted according to the Water Quality Exchange (WQX) XML schema, which has been developed by EPA in collaboration with USGS, states, and tribes. Applications such as internet portals can use the web services to access data from both NWIS and the STORET Warehouse without needing an authorized database connection.

Monitoring location information and associated water-quality results will are served through the two individual web services. The Station web service provides information for all monitoring locations within a given geographic area (geographic bounding box) for where specified constituent have been sampled; the Results web service retrieves water-quality results (measurements) by site.

Session F4: Using Probabilistic Monitoring to Support State and Tribal Programs

Increasing State Biological Monitoring Capabilities Using Probabilistic Monitoring Strategies

Jason R. Hill and Lawrence D. Willis
Virginia Department of Environmental Quality, 3019 Peters Creek Road, Roanoke, Virginia 24014

Abstract
Virginia Department of Environmental Quality (VDEQ) is nearing the completion of its second five year freshwater probabilistic monitoring cycle. When the probabilistic program began in 2001, VDEQ's only biological monitoring tool was a family level (100 count) macroinvetabrate tool whose reference sites were not ecoregionally calibrated and only applicable in wadeable streams. VDEQ has used its state-level freshwater probability and the National Stream and River Assessment (NSRA) programs data to pilot multiple biological monitoring tools for wadeable and non-wadeable streams. VDEQ has found the probability monitoring strategy an efficient way to identify reference sites necessary to validate biological indices. Future biomonitoring tools include a periphyton Index of Biotic Integrity (IBI) for wadeable streams, fish IBI for wadeable streams, and a wadeable streams genus level macroinvetabrate index calibrated for each major ecoregion in Virginia. In 2008, VDEQ adopted a modified NSRA protocol for non-wadeable streams in its state- level probability survey. Biological data collections at these large river sites will allow VDEQ to characterize the conditions of these important freshwater resources. This improvement in state monitoring capabilities will improve VDEQ's ability to communicate regional stream and river conditions to the public, help biological TMDL development, and identify the major stressors to several biological communities in the aquatic environment.

Probabilistic Monitoring on Arizona Streams

Jason D. Jones
Arizona Department of Environmental Quality, Phoenix, AZ, United States

Abstract
Arizona is one of about 30 states that instituted a statewide probabilistic monitoring design. Our probabilistic design focused on wadeable perennial streams from July 2007 to July 2010. We worked with the USGS to improve an existing perennial stream map using a predictive hydrologic flow model. Flow regime data from the Arizona Department of Environmental Quality's (AzDEQ) database was also incorporated to increase the accuracy of the stream map. This map served as our target population.

We divided Arizona into three planning units or "monitoring regions" to make logistics easier. Each region contained approximately 1,200 wadeable perennial stream miles. A total of 51 sites (17 sites per region) were sampled quarterly over a three year period. AzDEQ will use the probabilistic data to assess Arizona's wadeable perennial streams for the next 305(b) assessment.

One of the major challenges for states is how to integrate their existing monitoring with a probabilistic design. Some states have chosen to increase the number of samples taken during the national survey to get a statewide picture. Other states, such as Arizona, are conducting random sampling independent of the national surveys. Each of these options has certain benefits and pitfalls that have to be taken into account as states integrate their existing state monitoring objectives with probabilistic monitoring.

Data comparability between state and EPA methods is another major challenge. AzDEQ recently completed a comparability study between our methods and EPA's methods and found that many parameters were comparable for cold water streams. AzDEQ is currently deciding how to use comparable National Survey data in the 305(b) assessment. We are

also deciding if we should collect additional parameters such as fish, enterococci, and legacy trees so that our independent state level survey can be 'scaled up' to the ecoregion and national levels.

Texas' Contributions to the National Probabilistic Surveys and Future Direction of the State's Biological Monitoring Program

Anne Rogers
Texas Commission on Environmental Quality (TCEQ), Austin, TX, United States

Abstract
For the past 25 years, biological monitoring in Texas has been primarily conducted on water bodies of concern using a targeted approach. In 2004, the EPA requested participation by all states in a national probabilistic survey of biological resources called the National Wadeable Streams Assessment (NWSA). This type of statistical monitoring design attempts to answer questions about the general health of the nation's waters which are not inherent in a targeted approach. Because this type of approach to monitoring is of interest to the TCEQ, the agency decided to participate in this project. Six years later, Texas has three national probabilistic surveys under its belt, the NWSA, the National Lakes Survey (NLS) and the National Rivers and Streams Assessment (NRSA). The lessons learned with each round of surveys on such different water body types have continued to improve the agency's ability to carry out such large scale surveys over an immense geographic area.

Due to the enormous size of the state and the diversity within each Level II ecoregion, these projects have relied on participation by entities both within and outside the TCEQ. The TCEQ's Surface Water Quality Monitoring Program coordinated the projects with agency personnel in the central office in Austin and in the TCEQ regional offices. Other cooperators involved in the surveys over the years include the Texas Parks and Wildlife Department, the United States Geological Survey, the Central Plains Center for BioAssessment in Lawrence, Kansas, and Tetra Tech in Santa Fe, New Mexico. The TCEQ has made great strides in capitalizing on what it calls a "virtual" biological monitoring team which works cooperatively with regional offices, river authorities, and contracted entities in conducting strategic biological assessments statewide. The NRSA took this approach to a new level and was very successful in accomplishing such a large project with tight deadlines and numerous factors that can set the best laid plans for sampling awry. These national probabilistic surveys have provided numerous tests for this new "team" and have provided the agency with successful experiences with which to move forward in developing a probabilistic approach to biological monitoring in Texas.

Probabilistic Wadeable Streams Survey In Puerto Rico

James Kurtenbach and ChiSum Chan
U.S. Environmental Protection Agency, Region II, Edison, NJ, United States.

Abstract
Puerto Rico currently lacks a comprehensive stream monitoring program and cannot describe biological conditions using direct measures of aquatic life. This is partly attributed to a lack of development of monitoring tools and limited knowledge of stream ecology in tropical regions. A probabilistic survey design was used to establish baseline environmental conditions of wadeable streams across Puerto Rico. Water chemistry, physical habitat, and macroinvertebrate samples were collected from 50 stream sites. Data were examined to determine what percent of streams in Puerto Rico are in good, fair, and poor condition for key indicators of ecological health; and identify and rank the relative importance of key chemical and physical stressors. Several water chemical and physical habitat parameters showed associations with ecological attributes of the macroinvertebrate assemblage. Results of the survey will help guide future monitoring and stream management decisions in Puerto Rico.

Session F5: Innovation and Longevity in Volunteer Monitoring Programs

Volunteer Monitoring: A Sound Investment

Julie Vastine
Alliance for Aquatic Resource Monitoring, Dickinson College, Carlisle, PA

Abstract
With current economic challenges and the tightening of belts at the local, state, regional, and national levels it is important that the necessary measures are being taken today that do not compromise the integrity of our natural resources in the future. With budget restraints it has become increasingly difficult at the state level to monitor and assess state waterways. All the while those economic and environmental challenges have become more prevalent, we are witnessing a burgeoning interest among communities to assess and understand their environmental context.

States can leverage dwindling dollars by investing in strong volunteer monitoring collaborations. With appropriate study designs, training, quality assurance/quality control measures and data management systems, volunteer monitors can effectively be the eyes, ears, and voices of local waterways enabling states to target their finite resources on the streams that need special attention.

From Pennsylvania to Georgia to Colorado, there is a diversity of models for engaging volunteer monitoring at the state level. So what are the key resources that need to be in place for successful programs and partnership? The focus of this talk is to examine different state volunteer monitoring models and the tools necessary to effectively integrate different monitoring programs to cost effectively support water resource management. Facets to be reviewed include:

- Communication;
- Study design;
- Equipment choices;
- Data use and management;
- Quality assurance/quality control; and
- Capacity building scientific trainings.

Success Stories: the Northeast's Long-Term Lake Volunteer Monitoring Programs

Linda Green
University of Rhode Island Cooperative Extension, Kingston, RI

Abstract
New England arguably hosts many of the longest-lasting lake volunteer monitoring programs in the country. Their home organizations are varied – state environmental agencies, university, and independent community-based organizations. All have passed their twenty year mark; some have even entered their third decade. How do they do it? What are the factors that have contributed to their longevity and success? Over these years, what has stayed the same, and what has changed? What's in the future, especially given these uncertain economic times? The twenty-two year URI Watershed Watch program will be presented as a case study for a bottom-up approach to volunteer monitoring. This program is sponsored by the University of Rhode Island Cooperative Extension, the RI Department of Environmental Management, and 40 local organizations. That approach will be compared with other successful long-term programs in the Northeast - New England and New York. I'll conclude with suggestions from these seasoned programs for helping to ensure the vim, vigor and vitality of any volunteer monitoring program.

The following programs generously contributed information to this presentation: The Maine Volunteer Lake Monitoring Program, the Vermont Lay Monitoring Program, the New Hampshire Lakes Lay

Monitoring Program, the New Hampshire Volunteer Lake Assessment Program, the New York Citizen Statewide Lake Assessment Program and the University of Rhode Island Watershed Watch program.

River Watch's Evolution Over the Past 20 Years

Sarah Tolan
Colorado River Watch

Abstract
River Watch is a statewide volunteer water quality-monitoring program operated by the non-profit 501(c)(3) Colorado Watershed Assembly in cooperation with the Colorado Division of Wildlife (CDOW). River Watch began in 1989 as a response to significant geographic and temporal data gaps for high levels of water quality decision-making. The program began with two primary goals that remain steadfast today. First, is to provide a hands-on experience for individuals to understand the value and function of the river ecosystem. Second, is to collect quality aquatic ecosystem data over space and time to be used for the Clean Water Act and other water quality decision-making processes. This 20 year old monitoring program has successfully generated water quality data for Colorado's Clean Water Act decision making processes such as standard setting and impaired water body listings. Monitoring is a means to protect and restore rivers, not the end point itself. Successes and failures of this 20 year old program will be provided in context to assist others in their efforts to implement a measurable results monitoring program.

Using Volunteers to Collect Ground Water Information: Examples from New Hampshire

David R. Wunsch, Kristen Svendsen, Genevieve Al-Egaily
New Hampshire Geological Survey, New Hampshire Department of Environmental Services, Concord, New Hampshire, United States

Abstract
Volunteers have been used by agencies and organizations that collect monitoring data for surface water, but this practice has been underutilized for collecting ground-water information. The New Hampshire Geological Survey (NHGS) manages the state's ground water monitoring network cooperatively with the USGS. Currently, volunteers collect water-level data from wells in remote areas of the state, saving time and expense while adding to outreach by directly involving members of the public.

From the water quality perspective, private wells are currently not regulated, so the State has promoted the *Private Well Initiative* program to educate and encourage well owners to test their wells. However, the list of parameters recommended for analysis are based on those regulated for public drinking water, which does not include the full suite of major ions or other parameters that are useful for characterizing and understanding the geochemical evolution of ground water. Moreover, often privacy issues limit state agencies from capturing water quality information from well owners who do test their wells. NHGS has conducted two pilot projects using volunteers from towns where detailed bedrock and surficial geological mapping has been completed in order to compare and characterize water quality as a function of geology. Examples will be presented to highlight cooperative projects with two communities that involved the development of sampling schemes, scheduling, community outreach, and funding for water analyses. These programs involved city planners, conservation commissions, concerned citizens, and in one case, the Boy Scouts. NHGS oversaw the selection of representative wells, collection of water samples, and analyzed and interpreted the results.

This symbiotic relationship has allowed NHGS to begin building an aquifer database based on geologic models, while providing the community with locally derived hydrogeologic information to meet community planning and water management needs. In times of economic recession, which often results in anemic funding for basic data collection programs, this paradigm for cooperative data collection is one way science agencies and the public can work cooperatively to meet ground-water management needs, while concomitantly involving and engaging its citizenry, which is important for the success and application of any basic data collection program.

Session F6: Contaminant Effects on Aquatic Ecosystem Health 2

Diagnostic Tools to Evaluate Impacts of Trace Organic Compounds on Aquatic Populations and Communities

Jerry Diamond[1], Henry Latimer[1], Kent Thornton[2], Scott Dyer[3]
[1]Tetra Tech, Inc., Center for Ecological Sciences, Owings Mills, MD, United States; [2]FTN Associates, Inc., Little Rock, AS, United States; [3]Proctor & Gamble, Cincinnati, OH, United States

Abstract
With the advent of improved analytical detection capabilities, a variety of organic chemicals have been found in trace amounts (Trace Organic Chemicals, TOrCs) in surface waters, sediment, and fish tissue. These TOrCs include pharmaceuticals, personal care products, surfactants, and other currently unregulated chemicals. Identifying or predicting ecological effects of TOrCs in typical aquatic systems is challenging, requiring a variety of tools that can diagnose effects at multiple scales of ecological organization. This research developed 3 approaches to prioritize TOrCs: (1) risk-based, (2) chemical persistence, bioaccumulation potential, and toxicity (PBT), and (3) a hybrid based on risk, persistence, and bioaccumulation potential. Using an occurrence database compiled from over 100 monitoring studies, the 3 prioritization approaches were applied to over 450 TOrCs that have been detected in water or effluent samples in the U.S. over the past 10 years. Types of TOrCs identified as high priority differed among approaches: steroids/hormones, pharmaceuticals, and surfactants comprised most of the high priority TOrCs based on risk and pesticides, industrial chemicals, and PAHs comprised most of the high priority TOrCs based on a PBT approach. A screening framework was developed to help identify high versus low risk sites for TOrC impacts based on source characteristics (e.g., type of wastewater treatment) and receiving water characteristics that could affect TOrC fate as well as biota responses. The framework is being tested using several types of analyses of selected sites in Ohio and elsewhere. Using available fate information on high priority TOrCs, and ecological information for other important stressors (e.g., nutrients, sedimentation), we constructed site scenarios with which to evaluate diagnostic tools. Using an ecorisk approach, combined with several eco-epidemiological tools, we are developing a diagnostic framework for certain classes of TOrCs, identifying critical data gaps, and formulating key research questions of interest to stakeholders. A refined framework will be tested using case studies identified during this project, spanning a range of complexity and stressor combinations to help interested parties assess whether impacts on aquatic populations or communities are caused by, or could be caused by TOrCs of concern.

Monitoring Contaminant Exposure of Endangered Species: Lethal, Non-lethal and Surrogate Approaches

Adria A. Elskus
U.S. Geological Survey, S.O. Conte Anadromous Fish Research Laboratory, Maine Toxicology Section, University of Maine, Orono, ME, United States

Abstract
Contaminant monitoring protocols typically require lethal sampling to evaluate the level of exposure and response of the organisms being monitored. This presents particular challenges for endangered and threatened species which cannot be taken lethally. I will present some approaches we have taken to evaluating contaminant exposure and response of Maine Atlantic salmon (*Salmo salar*), a population listed as endangered in the year 2000 and one which comprises the last

wild population of this species in the U.S. The presence of multiple stressors in the spawning habitat of this species, and the impending removal of two dams on the Penobscot, the Maine river with the largest migratory run, represent just two of the challenges facing this Distinct Population Segment. I will discuss two approaches we have taken to evaluate contaminant exposure and response in Atlantic salmon: 1) the use of two aquatic toxicology model fish species, zebrafish (Danio rerio) and fathead minnows (Pimephales promelas) to evaluate habitat conditions, and 2) biomarker expression in gills and scales of Atlantic salmon sampled non-lethally. I will present these in the context of specific laboratory and field studies, including evaluating the toxicity of water following re-suspension of Penobscot River sediments (simulating a dam removal) and the use of the biomarker enzyme CYP1A in fish gills and scales. The limitations and benefits of each approach as it relates to resource management and decision making will be discussed.

Sediment toxicity testing: (1) Contaminants of emerging concern and (2) Methods for conducting exposures with early life stages of freshwater mussels

Chris G. Ingersoll[1], Nile E. Kemble[1], John M. Besser[1], Ning Wang[1], Joseph Mwangi[2], Robert J. Gilliom[3], Kathy M. Kuivila[3], Patrick W. Moran[4], Lisa H Nowell[3]
[1]USGS, Columbia, MO, United States; [2]University of Missouri, Columbia, MO, United States; [3]USGS, Sacramento, CA, United States; [4]USGS, Tacoma WA, United States

Abstract
"Traditional" classes of contaminants of concern in sediment toxicity tests have included metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and pesticides. Recent sediment investigations have considered the contribution of additional classes of contaminants of emerging concern to the toxicity of sediments including pyrethroid insecticides and nanomaterials. For example, the USGS NAWQA program in 2007 evaluated the influence of pyrethroids on the potential toxicity of 98 sediment samples evaluated in an urban gradient study conducted at seven study units across the United States. Results of this study indicated that pyrethroids such as bifenthrin contributed to toxicity in about 25% of the samples evaluated.

Production and application of nanomaterials are increasing; however, little is known about the fate or effects of these materials in the environment. While nanomaterials often exhibit unique chemical or physical properties, many of these materials are relatively insoluble in water and when released into aquatic environments will likely become associated with sediments. We observed toxicity to the amphipod *Hyalella azteca* in 14-day exposures at concentrations of multi-walled carbon nanotubes (MWCNT) as low as 0.01% (dry weight) when spiked in various sediments. Importantly, MWCNTs mixed in sediment tended to stratify, forming higher concentrations of MWCNTs at the sediment-water interface. The toxicity of the MWCNTs may result from a smothering of external respiratory surfaces of the test organisms or by blocking the digestive tract of the test organisms.

Our laboratory has also adapted standard sediment toxicity methods to conduct toxicity tests with early life stages of freshwater mussels. The 28-day sediment exposures start with 2- to 4-month-old juvenile mussels and evaluate potential effects on survival or growth. Survival is typically >90% and increase in shell length is typically >50% for mussels exposed in control sediments for 28 days. Toxicity tests with mussels conducted with metal-contaminated sediments associated with past mining activities in and around Missouri indicate that juvenile mussels are equally or more sensitive compared to many commonly tests species. Moreover, laboratory toxicity tests conducted with mussels were often predictive of metal effects of observed in mussel communities in the field.

A USGS Partnership to Investigate Freshwater Mussel Health Decline: Clinch River Basin in Virginia and Tennessee

Jennifer L. Krstolic[1], Kenneth E. Hyer[1], Gregory C. Johnson[2], Brett J.K. Ostby[3], William H. Orem[4], David A. Kirtland[5]
[1]USGS Virginia Water Science Center, Richmond, VA; [2]USGS Tennessee Water Science Center, Knoxville, TN; [3]USGS Biological Coop Unit at Virginia Tech, Blacksburg, VA; [4]USGS Geologic Discipline, Eastern Energy Resources Science Center, Reston, VA; [5]USGS Eastern Region Geography, Reston, VA

Abstract
The Clinch River flows from Virginia into East Tennessee and supports unique and nationally significant endemic and endangered populations of freshwater mussels and other aquatic fauna. Surveys of mussel and fish community structure over recent decades, and in particular last summer, have shown a pattern of population decline in parts of the upper Clinch in Virginia that have suggested a possible connection to changing land-use practices in this river basin. Localized losses in species richness and declines in population health, however, have not been linked exclusively to any one cause and may in fact be the result of a combination of factors resulting from coal mining, other energy extraction practices, agricultural practices, urban development, and increases in hydrologic extremes.

An interdisciplinary study was initiated in 2008 among USGS disciplines including: the TN and VA Water Science Centers, the Biology Coop Unit at Virginia Tech, Geography, and Geology to monitor water quality, sediment quality, geomorphology, mussel health, and land use change in the Clinch River Basin. The first year of real-time, continuous water-quality monitoring and discrete storm sampling at paired sites in Virginia and Tennessee describe the gradient in water quality from an upstream section of river classified as having 'degraded' mussel health in Virginia to a downstream section of river classified as 'healthy' in Tennessee. Surface water depth-integrated equal-width increment samples are collected using parts-per-billion sampling protocols, and analyzed for 30 metals, nutrients, or major ions.

This study is complimentary to a new collaborative effort of non-profit, state, and federal agencies–the Clinch-Powell Clean Rivers Initiative (CPCRI)–working in Virginia and Tennessee to identify causes for decline and potential management options for preservation of species. Many of the CPCRI participating agencies have responsibilities for administering the Clean Water Act and the corresponding state laws in Tennessee and Virginia. The results from the USGS study will help inform the CPCRI and provide a broad interdisciplinary foundation of reliable and consistent hydrologic, biologic, geologic, and geographic information from which future investigations can be developed.

Session G1: Continuous Real-Time Monitoring: Regulatory Perspectives

Working Together: Updates on Measurement, Monitoring, and Laboratory Science Issues

Lara P. Autry
U.S. Environmental Protection Agency, Office of the Science Advisor

Abstract
The Forum on Environmental Measurement (FEM) is a standing committee of senior US Environmental Protection Agency (i.e., EPA or the Agency) managers established to develop policies to guide the Agency's measurement community in: validating and disseminating methods for sample collection and analysis; for ensuring that monitoring studies are scientifically rigorous, statistically sound, and yield representative measurements; and for employing a quality systems approach that ensures that the data gathered and used by the Agency is of known and documented quality. The FEM was established to promote consistency and consensus within the EPA on measurement issues and provide

an internal and external contact point for addressing measurement methodology, monitoring, and laboratory science issues with multi-program impact.

The FEM is engaged in a number of activities both within the Agency and partnerships outside the Agency to implement its mission. Specific areas of focus include: improving the quality of agency methods; implementation of the performance approach; technical assistance; method detection/quantitation and calibration; general laboratory competency for the Agency; national environmental accreditation; Environmental Measurement Symposium; environmental technology for monitoring (i.e., advancing sensor technology and use); and an Agency monitoring assessment. This talk will address all of these areas of focus and provide general information on how we are working together within and outside the Agency to make a difference in the areas of measurement, monitoring, and laboratory science.

Effectively Managing Water Resources by the Use of Near Real-Time Water Quality Monitoring in Partnership with Industry

Renée Paterson and Ryan Pugh
Water Resources Management Division, Newfoundland and Labrador Department of Environment and Conservation, PO Box 8700, 4th Floor Confederation Building, St. John's NL Canada A1B 4J6

Abstract
The rich natural resources found throughout Newfoundland and Labrador (NL) has lead to expanding industrial operations throughout the province. In particular, mining and hydroelectric developments which are thriving. Monitoring and protecting the abundant natural water resources surrounding industrial operations is a high priority for the Government of Newfoundland and Labrador.

In partnership with industry, the Water Resources Management Division within the NL Department of Environment and Conservation has established a network of approximately 17 stations that utilizes near real-time technology to effectively monitor the ambient water quality in and around industrial operations. Surface water quality monitoring stations are established at specific locations in order to track and identify the impact on water quality resulting from the various industrial processes. In addition, groundwater stations are also established to assess the effectiveness of various containment areas to ensure protection of the surrounding natural environment.

Near real-time water quality monitoring provides continuous water quality information and a clear picture of water quality for a particular water body over time. This technology also allows for the implementation of automated alert systems as well as web-based reporting. It is an effective and pro-active approach to monitoring and managing water resources.

The purpose of this presentation is to provide insight into the state of the art near real-time water quality monitoring technology along with its potential application for effective monitoring at industrial operations. It will present the challenges encountered in establishing and operating these stations and the issues that may arise in applying this technology to monitoring at industrial operations. Case studies will be presented describing the current real-time water quality monitoring networks established in partnership at industrial operations in the province.

Nowcasting to Protect Public Water Supply: Using Real Time Data in a Flow and Transport Model to Evaluate a Spill Emergency

John Yagecic, Namsoo Suk
Delaware River Basin Commission, West Trenton, NJ, United States

Abstract
The Delaware River Basin Commission (DRBC) is coupling real time observations in the Delaware River and Bay with existing flow and water quality models to enhance response to spills in the estuary. DRBC developed a series of computer programs that harvest real time data from the internet, process the data into input files, and run a hydrodynamic model. These programs obtain, via the internet, real time flows from the US Geological Survey's National Water Information System (NWIS), forecasted flows from the National Weather Service's Advanced Hydrologic Prediction Service (AHPS), and current and forecasted tidal elevations from the National Ocean Services gages. DRBC's programs knit the observed and forecasted data sets together into a continuous time series, and develop the model input files. The process is automated and runs overnight 365 days per year with no human labor necessary. When a spill occurs, DRBC modeling staff bring the hydrodynamic output into a water quality model, and use information about the spill volume, location, and duration, to predict where the plume will go, when peak concentrations will occur, and when the plume will dissipate. This presentation will describe the data sets and processing, and show real examples of the utilization of the model.

Water Temperature: How to measure and Interpret the Data

Philip A. Russell
Environmental Analyst, Littleton/Englewood Wastewater Treatment Plant, 2900 S. Platte River Drive, Englewood, CO 80110

Abstract
While temperature is a critical aspect of aquatic life it is seldom discussed in terms of toxicity (or even in general) at national or regional, technical water/wastewater treatment or water monitoring conferences. However, the State of Colorado has recently developed and promulgated limits for streams and lakes. The process was considerably more involved than originally thought necessary. Because of the necessity to measure the impacts of such regulation, it was necessary to collect very detailed in-stream temperature measurements from a number of locations and interpret the data in relation to possible "toxic" impacts. This involved a major effort by the local urban Denver watershed group, the South Platte Coalition for Urban River Evaluation (SPCURE).

Information will be presented on how the Denver urban watershed group (SPCURE) developed and implemented a river temperature study starting in 2004. Information on the selection of sample sites, instrument selection, field deployment, idiosyncrasies of collecting *in situ* temperature data, software selection and data analyses will be discussed in detail. Extensive data sets collected from a location above, at, and below a large wastewater facility will be presented to show the impact of a common river heat source and the potential impact of new stream limits on the wastewater plant. The development process of the new temperature regulations will be discussed. The overall value of collecting fine time increment temperature data over an extended period will be clearly demonstrated.

Keywords: temperature, watershed, stream standards, instrumentation

Session G2: Biological Monitoring with Volunteers

Invasive Species Monitoring Approaches for Volunteer Programs

Elizabeth Herron
URI Watershed Watch, URI Cooperative Extension, Department of Natural Resources Science, University of Rhode Island, Kingston, RI, United States

Abstract
Extensive research conducted on the subject of controlling invasive species suggests that prevention and early detection are the most effective approaches, economically and practically. Training volunteers to monitor for invasive species can significantly enhance both prevention and early detection. Clearly having more eyes in more places watching for potential invasive species will greatly improve the

possibility of identifying a new invasion quickly, conceivably at a point when eradication is more feasible. Perhaps more important is the role volunteer monitoring plays in preventing the spread of invasive species through increased awareness, education, and the development of an informed community and local stewardship.

Monitoring for invasive species can occur as a stand-alone program, or as part of a larger water quality monitoring effort. It can range from simply developing public awareness of various species, to systematic monitoring, or even participating in ecological research. Determining the best approach for your program is dependent upon the species of concern and resources available. This presentation outlines various approaches, and highlights existing programs. Particularly useful websites and program contacts will also be provided to help you develop your strategy for monitoring invasive aquatic species with the help of volunteers.

Amphibian Monitoring with the Georgia Adopt-A-Stream Volunteer Program

Tara Muenz
Georgia Department of Natural Resources, Environmental Protection Division, Atlanta, Georgia

Abstract
Georgia Adopt-A-Stream (GA AAS) is a statewide volunteer monitoring program that was created to increase public awareness of water resources issues. The program engages citizens in river cleanups and restoration projects, and through the monitoring of waterways for macroinvertebrates, bacteria, and chemical and physical parameters. A new component to the program has been the addition of amphibian monitoring, focusing on salamanders and treefrogs. This is a pilot program that strives to foster an appreciation of amphibians, their conservation challenges, and moreover to become a source of information about their location and status.

The Southeastern United States and especially the state of Georgia harbor a rich diversity of amphibians, with over 80 species statewide and 140 regionally living in a variety of freshwater habitats. In Georgia, amphibian monitoring activities by volunteers is in its infancy and there remains to be a national protocol for monitoring other than the identification of anuran (frog and toad) calls. Current protocols for the GA AAS amphibian program are passive captures, and were created for ease of use for volunteers. This includes the use of PVC tree pipe refugia to target treefrogs (Hylidae) and coverboards to attract streamside salamanders. Hands-on field based training workshops are provided for interested volunteers and include an amphibian monitoring manual, information about site selection, how to create equipment, animal identification, and data collection. Discussed will be current and future program goals, including the addition of other capture methods and working with national partners in amphibian conservation.

Utilizing Volunteers for Big River Biological Monitoring

Amy Meier
Stream Team Biologist, Missouri Department of Conservation, Jefferson City

Abstract
The Volunteer Water Quality Monitoring portion of the Missouri Stream Team Program has trained volunteers to conduct biological, chemical, and physical monitoring of wadeable streams for the last 16 years. Recently, growing numbers of volunteers have been seeking more information on larger rivers such as the Missouri and Mississippi Rivers, where a wadeable stream-based protocol for sampling macroinvertebrates is no longer appropriate. With assistance from the US Geological Survey, a macroinvertebrate sampling protocol has been developed involving the use of artificial substrate sampling devices, or "rock baskets", which will enable volunteers to sample benthic invertebrates safely in larger rivers. Our Program is working on providing volunteers with the opportunity to learn more about "big river obligates" by offering a photo library for these macroinvertebrates. While this portion of the Volunteer Water Quality Monitoring Program is still under development, we believe that increasing the information available to volunteers will spark a greater interest in monitoring the biological health of these big rivers and the larger tributaries within their watersheds.

Utilization of Large Scale Rapid Screening with Marine Plankton Toxicity Tests by a Citizen Monitoring Group

Justin Hohn
San Diego Coastkeeper, San Diego, CA, United States

Abstract
San Diego Coastkeeper is the one of the largest and most effective professional organization working to protect San Diego's bays, beaches, watersheds and ocean for the people and wildlife that depends on them. One of Coastkeeper's most successful programs is the Water Quality Monitoring Program. Our data is collected as a coordinated effort between nonprofit and municipal agencies, and is completely fueled by volunteer effort making it an effective platform for citizen involvement in watershed stewardship since 2006. On a monthly basis we have been collecting water samples from the broad San Diego County region and analyzing for chemistry, microbiology, and field screening for multiple ambient constituents and observational data. This program analyzes samples in its volunteer-driven, on-site laboratory, records data in accordance with state-established data protocols, manages data and generates publicly-accessible interpretations after each event. This presentation will illustrate how San Diego Coastkeeper has mobilized volunteers and most recently utilized an innovative and efficient toxicity detection method which provides a cost-effective solution to determining which sites should have further evaluation.

Session G3: Watershed Scale Protection and Restoration Assessments

A Technical Guide for Identifying and Protecting Healthy Watersheds

Laura Gabanski[1], Corey Godfrey[2], Laura Blake[2]
[1]U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans, and Watersheds, Washington, DC; [2]The Cadmus Group, Inc., Watertown, MA

Abstract
The U.S. Environmental Protection Agency's broad mission charges it with protecting the Nation's land, water, and air as parts of a whole ecosystem. The objective of the Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Since enacted in 1972, federal water quality regulations have led to significant reductions in pollutant levels in many impaired waters. Further, significant efforts have been undertaken to restore aquatic ecosystems in our Nation's impaired watersheds. Despite these efforts, our aquatic ecosystems are declining nationwide. The rate at which new waters are being listed for water quality impairments exceeds the pace at which restored waters are removed from the list. Threats such as loss of habitat and its connectivity, hydrologic alteration, invasive species, and climate change as well as pollution continue to increase.

EPA is embarking on the new Healthy Watersheds Initiative to protect our remaining healthy watersheds, prevent them from becoming impaired, and accelerate restoration successes. The concept of protecting healthy watersheds is based on a key, overarching concept: the integrity of aquatic ecosystems is tightly linked to the watersheds of which they are part. There is a direct relationship between land cover and key watershed processes and the condition of aquatic ecosystems. Without protecting this ecological support system, we will not only fail to restore impaired waters, but also waste limited financial resources.

This presentation will give an overview of EPA's forthcoming technical guide for *Identifying and Protecting Healthy Watersheds*. Healthy watersheds will be identified through integrated assessments of landscape condition, habitat, biological integrity, water quality, and watershed processes such as hydroecology, fluvial geomorphology, and natural disturbance regimes. The Guide will provide water quality and aquatic resource managers and their technical staff the basic concepts behind the healthy watersheds approach, detailed examples of assessment approaches for assessing components of healthy watersheds, an integrated assessment framework to identify healthy watersheds, examples of management measures, and key assessment tools and sources of data. With this information, managers will be able to use a strategic, holistic, systems approach to identify and protect healthy watersheds.

Recovery Potential Screening for Prioritizing Restoration in Maryland Watersheds

James D. Wickham[1], Douglas Norton[2], Gregorio Sandi[3], Timothy Wade[1], Lee Currey[3], Paul Emmart[3], and James George[3]
[1]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, NC, United States; [2]U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans and Watersheds, Washington, DC, United States; [3]Maryland Department of Environment, Baltimore, MD, United States

Abstract
States' responsibilities under the Clean Water Act include identifying impaired waters – those not achieving Water Quality Standards – and ultimately restoring them. The high numbers of impaired waters in most states calls for yearly priority-setting decisions on restoration funding. Systematic methods and consistent data can help make the decision process more even-handed and defensible, as well as guide efforts toward waters that are more likely to recover once restoration actions are implemented. The Maryland Department of Environment (MDE) and the US Environmental Protection Agency have developed methods to compare recovery potential of impaired waters and explore priority setting options based on that potential. Recovery potential includes the ecological capacity to regain lost functionality, its exposure to stressors, and the social context affecting efforts to improve condition. Measurements of recovery potential were developed using common GIS datasets and biological data supplied by MDE, and included each of the three main recovery potential themes (ecological capacity, stressor exposure, and social context). MDE assesses impairment by watershed rather than for an individual waterbody. Impairment is determined by pooling scores for benthic and fish indices of biotic integrity (IBI) collected for smaller 'monitoring' watersheds that are nested within the larger 'management' watersheds for which impairment is determined. Recovery potential analyses were conducted at both the 'monitoring' and 'management' watershed scales. Orthogonal measures summarized for each of the three main recovery potential themes were used identify watersheds with relatively high ecological capacity and social context scores and a relatively low stressor score. Since the dataset included both impaired and passing watersheds at both scales, recovery potential could be evaluated based on the 'distances' between impaired and 'healthy' watersheds.

Assessing Wetland Wildlife Habitat Acquisition and Restoration Opportunities at the Watershed Scale: Milwaukee River Basin, WI

Thomas Bernthal1, Gary Casper2, Marsha Burzynski3, Joanne Kline4
[1]Wisconsin Department of Natural Resources, Bureau of Watershed Management, Madison, WI, United States; [2]University of Wisconsin – Milwaukee Field Station, Saukville, WI, United States; [3]Wisconsin Department of Natural Resources, Watershed Management, Southeast Region, Milwaukee, WI, United States; [4]Wisconsin Department of Natural Resources, Environmental Analysis and Review, Southeast Region, Milwaukee, WI

Abstract
With limited time and resources for habitat acquisition and restoration conservation professionals must often choose between opportunities. We describe a GIS Decision Support Tool under development in the Milwaukee River Basin, for assessing the suitability of existing habitats for wetland dependent wildlife, and how to use the Tool to compare potential habitat values of various restoration opportunities. The Tool utilizes expert assigned and research derived habitat suitability rankings for land cover types, minimum viable patch size, and proximity factors to generate habitat suitability maps for various focal species. Focal species represent local species of greatest conservation need, or other species of local interest, and include umbrella species to represent important habitats. Users evaluate the suitability of the existing landscape attributes and habitats for the full range, or a subset of, focal species. Existing conditions can then be compared to future habitat suitability based on alternative restoration and land use scenarios. This is done by assigning likely land cover attributes for development, protection and restoration scenarios in a study area. A GIS layer of Potentially Restorable Wetlands (PRWs) is used to indentify restoration opportunities based on the assumption that drained hydric soils not in urban land use can potentially be restored. This approach allows for incorporating the basic biological constraints for wildlife habitat needs into planning decisions along with other important considerations such as preserving water quality, farming, and transportation options. Currently we are conducting validation studies to compare results to records of species occurrences and ecological niche modeling approaches.

Demonstration of an Urban Stream Restoration Project to Reduce Sediment and Nutrient Loadings in the Illinois River Watershed

Sandi J. Formica and Matthew Van Eps
Watershed Conservation Resource Center, Fayetteville, AR

Abstract
A stream restoration demonstration project using a natural channel design approach was implemented on a section of Niokaska Creek located in Fayetteville, Arkansas. Niokaska Creek flows through a city managed park and is in the Illinois River watershed. The Watershed Conservation Resource Center (WCRC) partnered with the City of Fayetteville, the ANRC, and EPA Region 6 to conduct the project utilizing an EPA 319 grant, administered by the ANRC. The City provided required matching funds.

Increased numbers of roads, parking lots, rooftops, and other impervious surfaces over the past 30 years contributed to changes in watershed hydrology, resulting in channel incision and enlargement along with accelerated streambank erosion. Prior to restoration, the project site, with a contributing drainage area of 1.25 mi^2, had several vertical cut-banks eroding park land that were six to eight feet high. Streambank erosion rates were monitored for one year and streambank soil samples were collected and analyzed to provide data required to calculate sediment and nutrient loads to the receiving stream. The sediment, total phosphorus (TP), and total nitrogen (TN) annual loadings were estimated to be 110,000 lbs/yr, 29 lbs/yr, and 71 lbs/yr, respectively, for an average flow year prior to implementation.

The WCRC designed a natural channel using a local reference reach site that reduced channel instability, reduced sediment and nutrient loads from streambank erosion, and enhanced the aquatic habitat for a 1,200 foot section of the stream. Permits were obtained and the design, which included constructing small floodplains, rock structures that deflect flow away from banks, and defined riffles and pools, was constructed August 2008. Soil mattresses were built to minimize floodplain erosion. 4,500 grass plugs, shrubs, and trees native to the site were planted.

Following implementation, several storm events resulting in peak flow rates ranging from the design flow to over three times the design flow have occurred. The restoration design was effective at preventing streambank erosion during these events. Using post restoration

streambank and channel condition and local streambank erosion prediction curves, the sediment, TP, and TN annual loadings were estimated to be reduced by 96%, 94%, and 95%, respectively.

Session G4: Examining Nutrient Processing at Multiple Scales

Applying SPARROW to Determine the Source and Delivery of Phosphorus to Lakes in the Northeastern and Mid-Atlantic Regions of the United States

Richard Moore[1], Mihaela Enache[2], Richard Smith[3], Bryan Milstead[4], Henry Walker[4]
[1]U.S. Geological Survey, NH/VT Water Science Center, Pembroke, NH, United States; [2]Academy of Natural Sciences, Philadelphia, PA, United States; [3]U.S. Geological Survey, National Center, Reston, VA, United States; [4]U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Narragansett, RI, United States

Abstract
A phosphorus SPARROW model was used to examine the source and delivery of phosphorus to receiving lakes and reservoirs in the Northeastern and mid-Atlantic regions of the United States. The model was developed for the region to represent source conditions for the year 2002, and was calibrated using loads from 483 stream-monitoring sites.

Thirteen large lakes and reservoirs were selected and examined relative to SPARROW predictions for phosphorus sources, delivered loads, and accumulated loads. The results reflect conditions ranging from relatively pristine lakes having watersheds dominated by forested lands to lakes and reservoirs dominated by agricultural land use with higher lake concentrations of phosphorus. The phosphorus SPARROW model was used to identify lakes and lake embayments where phosphorus accumulation is apt to be occurring most rapidly due to upstream sources as well as the rate of phosphorus loss within the lake.

The National Lakes Assessment (2007) lakes survey in-lake phosphorus concentrations and sediment cores were used for the comparison with the SPARROW predictions. Lake concentrations, predicted by the SPARROW phosphorus model, were compared to observed lake concentrations and inferred lake phosphorus concentrations based on sediment diatom assemblages at the top of sediment cores.

Principal nutrient sources and transport mechanisms in the Missouri River Basin, where reservoirs and irrigation contribute to a distinctive nutrient cycling signature

Juliane B. Brown, Lori A. Sprague, Jean A. Dupree
U.S. Geological Survey, Colorado Water Science Center, Denver Federal Center, PO Box 25046, MS 415, Lakewood, CO 80225

Abstract
Nationally, nutrient enrichment has been identified as one of the leading causes of water-quality impairment in rivers, lakes, and estuaries. Nitrogen and phosphorus loads in the Missouri River Basin discharge into the Mississippi River and contribute to hypoxia in the northern Gulf of Mexico. Impairments for nutrient-related criteria occur in multiple Missouri River Basin states. For example, in the Missouri River Basin, nutrients have resulted in the inclusion of more than 500 stream and lake impairments on State 303(d) lists in 2006 and 2008. Understanding the sources and processes influencing nutrient transport in the Missouri River Basin has local, regional, and national implications for nutrient management efforts.

Total nitrogen (TN) and total phosphorus (TP) in rivers and lakes in the Missouri River Basin were modeled using SPAtially Referenced Regression (SPARROW) models to provide spatially-explicit information on local and regional nutrient sources and transport. Model simulations indicate the principal sources of TN and TP are urban runoff, point sources, manure and fertilizer, atmospheric deposition (TN only), and stream channel sediments (TP only). TN and TP transport are affected by precipitation, air temperature, permeability, irrigation, basin slope, loess surficial geology, instream decay, and reservoir attenuation. While fertilizer and manure applications are the largest sources throughout a large part of the Missouri River Basin, irrigation on agricultural land may decrease net delivery of TN to streams by as much as 41 percent in some major tributary basins, likely due to increased denitrification in the soil zone. The eight largest reservoirs retain nearly half of the nutrient loads retained in reservoirs in the Missouri River Basin, though smaller reservoirs (less than 143 km^2) appear to have a large cumulative impact on nutrient attenuation. Unlike other major tributary basins, nearly the entire nutrient load in the Kansas and Platte River Basins reaches the Mississippi River, possibly because of relatively limited reservoir retention and the geographic distribution of large point and nonpoint source inputs. These preliminary results suggest some unique findings as compared to previously published SPARROW models and indicate that some aspects of nutrient cycling in the Missouri River Basin may be atypical of other areas of the United States.

Influence of Nutrients and Other Factors on Agricultural Stream Ecosystems: Integrating Bioassessment and Experimental Information

Christopher A. Mebane[1], Andy M. Ray[2], Amy M. Marcarelli[3], and Flint Raben[4]
[1]U.S. Geological Survey, Boise, Idaho, cmebane@usgs.gov; [2]Idaho State University, Pocatello. Current affiliation, Oregon Institute of Technology, Klamath Falls; [3]Idaho State University, Pocatello. Current affiliation, Michigan Tech University, Houghton; [4]Idaho State University, Pocatello. Current affiliation, U.S. Geological Survey, Idaho Falls, Idaho

Abstract
In 2007 and 2008 the U.S. Geological Survey's National Water Quality Assessment program (NAWQA) collected data in the upper Snake River basin, Idaho and Nevada as part of a study of nutrient enrichment effects (NEET) on stream ecosystems. The study was designed to provide a better understanding of the interrelations among nutrient conditions, stream metabolism, biological community and environmental conditions. More information is available at http://id.water.usgs.gov/projects/usnk_nawqa/neet/index.html.

A unique aspect of the upper Snake River study was a cooperative effort with USEPA to better understand nutrient and plant growth patterns of phytoplankton, periphyton, and a macrophytes through the use of detailed field observations and controlled laboratory and *in situ* experiments. Nutrient limitation bioassays of stream water used the green algae *Pseudokirchneriella subcapitata* (formerly *Selenastrum capricornutum*) and a model macrophyte (duckweed, *Lemna minor*) with attached epiphytes; and *in situ* stream nutrient limitation tests with nutrient diffusing substrates.

The nutrient limitation tests showed that the study streams were seldom nutrient limited by phosphorous (P) alone; rather nitrogen (N) limitation, or co-limitation by both N and P, were more common. With duckweed, a threshold for growth stimulation with total P was indicated when P concentrations reached about 0.05 mg/L, and P saturation occurred when measured concentrations reached about 0.1 mg/L. By about 0.1 mg/L P, periphyton and green algae also appeared P saturated with only slight effects from further increases in the total P concentration. Response patterns with total N were weaker, but suggested a growth stimulation threshold for duckweed when total N concentrations exceeded about 0.3 mg/L. Growth rates of both duckweed and periphyton appeared to plateau indicating the system was approaching saturation at the highest N concentration tested, 1.3 mg/L. Nutrient uptake by epiphytes and macrophytes removed up to 70% and 90% of the N and P respectively.

Integrating information from the controlled experiments and field observations improved understanding of nutrient enrichment effects, and helped explain why correlations between nutrient concentrations and plant growth are elusive in field surveys.

Seasonal Variations in Stream Metabolism in Four Environmental Settings across the United States

Jerad Bales[1], Holly Weyers[2], Kathy Lee[3], Chris Mebane[4], and Jerri Davis[5]
[1]U.S. Geological Survey (USGS), Office of the Chief Scientist for Hydrology, Reston, VA; [2]USGS, North Carolina Water Science Center, Raleigh, NC; [3]USGS Minnesota Water Science Center, Mounds View, MN; [4]USGS Idaho Water Science Center, Boise, ID; [5]USGS Missouri Water Science Center, Rolla, MO

Abstract
Agricultural influences on stream quality have been widely documented, with nutrients detected in concentrations generally higher in agricultural streams than streams in undeveloped basins. Resulting nutrient enrichment in streams and rivers of agricultural areas causes a variety of ecological problems, including increased biomass of aquatic plants and algae. Studies of nutrient enrichment in streams have focused on establishing relations between nutrient concentrations and variability in biomass and community structure and on other factors that may influence the variability. The statistical relations between nutrients and benthic algal biomass often are poor because of the numerous other biological and physical factors that influence biomass.

Stream metabolism is useful for understanding the influence of nutrient enrichment on ecological processes in streams and may be beneficial in the development and refinement of nutrient criteria. Diurnal measures of dissolved oxygen and water temperature can be used to determine gross primary production and 24-hour community respiration, and to calculate the net ecosystem production. A whole-stream approach for measuring GPP accounts for contributions from patchily distributed macroalgae, bryophytes, and vascular plants, and allows for direct comparisons with other reach-scale measurements.

Stream metabolism was measured once in 55 wadeable streams across a gradient of nutrient concentrations in seven agricultural areas of the United States to examine the relative influence of nutrients (nitrogen and phosphorus) and habitat on stream metabolism in agricultural landscapes. Water-quality and algal biomass samples were collected in conjunction with metabolism and stream habitat measurements. Additional metabolism measurements were made at a subset of the stream sites in four of the seven agricultural areas to evaluate the temporal variability in stream metabolism. Measurements were made for two to three consecutive days at each site to determine short-term, light-corrected variability in production and respiration. Seasonal measurements also were made at these sites. Results indicated that light- and temperature-corrected production and respiration can vary by 25 percent from day to day, and that variations in seasonal metabolism rates are a function of environmental setting (irrigated vs. non-irrigated cropland) and habitat (light availability and channel condition).

Session G5: Results and Importance of Comparability Studies

A comparison of assessment outcomes based on macroinvertebrate condition indices from the New England region using National Wadeable Stream Assessment probability sites

David Neils
New Hampshire Department of Environmental Services, Concord, New Hampshire

Abstract
A review of aquatic life use (ALU) assessment outcomes based macroinvertebrates samples collected as part of the National Wadeable Stream Assessment (WSA) in 2004-05 was completed for forty-six sites. ALU assessments were completed using state biocriteria (CT, NH, and VT) and regionally developed thresholds for the WSA. ALU outcomes showed a 70% level of correspondence. Fully supporting assessment outcomes demonstrated a higher level of correspondence among than non-support outcomes. Direct comparisons of multi-metric index (MMI) values and performance were made between CT, NH, and the WSA. MMI scores were significantly correlated on all accounts but could explain only about 50% of the using linear regression. Predicted assessment scores using the respective linear regression equations resulted in the same assessment outcome 78% of the time. However, when MMI score prediction intervals were taken into account, ALU endpoints could only be determined about 20% of the time. When paired MMIs scores were evaluated results indicated that CT and NH MMI scores were similar and greater than WSA MMI scores. Overall, while hypothetical ALU outcomes were similar based on comparisons to the respective state biocriteria or regional WSA thresholds, the translation of MMI scores from one index to another led to a wide range of index scores where an ALU outcome was indeterminate. These results indicate that except for very high or poor quality sites, unaccounted for variation will inhibit the ability to translate MMI scores and in turn ALU outcomes across agency boundaries. The results also indicate that, for the New England region, the WSA MMI consistently underestimated biological condition when compared to the CT and NH MMIs.

Evaluation of the Lake Macroinvertebrate Integrity Index (LMII) and Alternate Indices for Eastern US Lakes and Reservoirs

Sheila North[1], James Kurtenbach[2], Karen Blocksom[3], Frank Borsuk[4]
[1]Dynamac Corp., c/o USEPA, 26 W. MLK Drive, Cincinnati, OH 45268; [2]USEPA, Region II, 2890 Woodbridge Ave., Edison, NJ 08837; [3]USEPA, NHEERL, 200 SW 35th St., Corvallis, OR 97333; [4]USEPA, Region III, 303 Methodist Bldg, 11th & Chapline St., Wheeling, WV 26003

Abstract
We applied the Lake Macroinvertebrate Integrity Index (LMII) to 69 lakes and reservoirs across the Eastern United States. The LMII was originally created by Blocksom et al. (2002) using species-level sub-littoral macroinvertebrates collected in muck and mixed-sediment New Jersey lakes. We used genus-level sub-littoral benthos samples collected in 2007 to calculate LMII scores for lakes across USEPA Regions II and III. We also investigated relationships of LMII scores with physical habitat, water chemistry, and land use variables collected by USEPA's National Lakes Assessment (NLA) team in 2007. The LMII was analyzed by its ability to discriminate between lakes of differing NLA impairment status as well as by its relationships to known physical, chemical, and land use gradients. Using Barbour et al. (1996) box plot scoring guidance, the LMII performed well for mixed sediment lakes but poorly for muck lakes and sand lakes. The LMII performed better for hard lakes (conductivity $>100\ \mu S$) than soft lakes (conductivity $\leq 100\ \mu S$) and for natural lakes than reservoirs. Because LMII performance was found to be generally poor, 30 additional candidate metrics were explored. This resulted in the creation of two Alternate Indices demonstrating strong linkages to taxonomic and environmental distributions across the study area.

Major patterns of environmental variation were detected using principal component analysis and community composition was explored using non-metric multidimensional scaling (NMS). The NMS model converged upon a 3-dimensional solution that captured 75% of species variation. Rank-transformed multi-response permutation procedures (MRPP) validated NMS groupings. Ordination joint plots and Spearman correlations linked biota composition to water chemistry and substrate gradients, revealing stronger linkages to both Alternate Indices than to either the original LMII or NLA impairment status.

Research findings can be used to implement biological criteria in state water quality programs in USEPA Regions II and III, more accurately determine aquatic life use support for 305 (b) reports and 303 (d) listing, and prioritize lakes for protection.

Assessing Aquatic Life Use Support on a Great River

Peter Tennant, Jason Heath, Erich Emery, Eben Hobbins
Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio, United States

Abstract
Every two years, the Ohio River Valley Water Sanitation Commission (ORSANCO) carries out an assessment of water quality conditions in the Ohio River. Data from the Commission's monitoring programs are assessed to determine the degree of support for the river's beneficial uses: source of drinking water supply (after reasonable treatment), aquatic life habitat, contact recreation, and fish consumption. The assessment of aquatic life support has proven the most challenging as several types of data are used, and sometimes provide conflicting results. For example, water quality data from some locations might indicate violations of acute aquatic life criteria, yet fish population data from the same locations show a thriving community.

In order to improve its assessments of aquatic life use support, ORSANCO has conducted studies in recent years to address the following questions:

- Can a routine grab sample from a single site represent conditions within an entire navigation pool? (Ohio River pools vary in length from 6 to 120 miles)
- How many biological monitoring sites are necessary to characterize a navigation pool?
- Can conflicting results from water quality data and biological studies be reconciled?

Results from those studies will be summarized and presented.

Session G6: Evaluating Contaminant Trends in Surface-Water Quality: Streams and Rivers

A Quarter Century of Declining Suspended Sediment Fluxes in the Mississippi River

Arthur J. Horowitz
U.S. Geological Survey, Georgia Water Science Center, Peachtree Business Center, Suite 130, 3039 Amwiler Road, Atlanta, GA 30360

Abstract
Annual fluxes, flow-weighted concentrations, and linear least squares trendline calculations for a number of long-term Mississippi River Basin (MRB) sampling sites covering 1981 through 2007, whilst somewhat 'noisy', display long-term patterns of decline. Annual flow-weighted concentration plots display the same long-term patterns of decline, but are less noisy because they reduce/eliminate variations due to interannual discharge differences. The declines appear greatest in the middle MRB, but also are evident elsewhere. The pattern for the lower Ohio River differs, and may reflect ongoing construction at the Olmsted lock and dam that began in 1993 and currently is ongoing.

The 'Great Flood of 1993' appears to have superimposed a step function (a sharp drop) on the long-term rate of decline in suspended sediment concentrations (SSC), annual fluxes, and flow-weighted concentrations in the middle MRB at St. Louis, Missouri, Thebes, Missouri, and Vicksburg, Mississippi, and in the lower MRB at St. Francisville, Louisiana. Evidence for a step function at other sites is less substantial, but may have occurred. The step function appears to have resulted from losses in available (erodible) sediment, rather than to a reduction in discharge; hence, the MRB appears to be supply- rather than discharge-limited. These evaluations support the need for daily discharge and SSC data collections in the MRB to better address questions regarding long-term trends in sediment-related issues. This is apparent when the results for the Mississippi River at Thebes and St. Louis sites are compared with those from other MRB sites where intensive (daily) data collections are lacking.

Water-Quality Data-Assessment of Long-Term Time Trends, Weser River Basin, Germany – A Case Study

Timothy D. Steele[1], Simon Henneberg[2], and Houshang Behrawan[3]
Department of Geoinformatics, Hydrogeology, and Modelling
[1]President, TDS Consulting Inc., Denver, CO, United States and Alexander von Humboldt-Foundation Guest Research Scholar, Friedrich-Schiller-Universität-Jena, Germany; [2]Executive Secretary, Weser River Basin Commission, Hildesheim, Germany; [3]Ph.D. Graduate Student, Friedrich-Schiller-Universität-Jena, Germany

Abstract
The 1979-2008 period of record for the four Weser River basin monitoring sites was used for demonstrating several data-assessment techniques and evaluation of time trends. Statistical and graphical analyses were conducted, and anomalous or possible erroneous data values were highlighted, modified, and/or deleted as a key part of the quality-assurance/quality- control (QA/QC) process. An overview of results is as follows:

- For major salt-ions as a function of specific conductance (SC), bivariate plots were made. Relative good regression functions resulted for magnesium (Mg), sulphate (SO_4), and especially for chloride (Cl). Such functions can be used to fill in missing data values or gaps in the record.
- Time series plots indicated no time trends in streamflows but rather distinct periods of anthropogenic impacts and post-remediation trends for many of the variables. Seasonality was apparent for water temperature, dissolved-oxygen concentrations, and SC (for this variable, especially in the early part of the period of record (POR)).
- Nitrate-N exhibited a slight downward time trend, especially during the recent period.
- During the data assessment, several anomalous data values and other errors in data entry were apparent. These were changed or otherwise noted in the modified dataset file for further consideration.

The long-term time trends and bivariate relationships provide useful information regarding this monitoring program as well as benefits attained through mining-related remedial actions, especially in the upper part of the basin, changes in agricultural-fertilizer application, and wastewater-treatment plant improvements. Decreased concentrations (hence, loads) of major ions are primarily a result of control of salt point sources and of nitrate as well as a result of controls of application of fertilizers to agricultural lands.

It is recommended that similar data-assessment methods be applied for other monitoring sites having long-term water-quality data. Additional information will be discussed in the presentation, extracted from the river-basin management plan prepared for the Weser River Basin Commission, in accordance with the EU Water Framework Directive (WFD).

Temporal and spatial trends of pharmaceuticals in the Rhine

Thomas ter Laak[1], Monique van der Aa[2] and Peter Stoks[3]
[1]KWR Water Research, Nieuwegein, The Netherlands; [2]RIVM, Bilthoven, The Netherlands; [3]RIWA, Nieuwegein, the Netherlands

Abstract
Over the last decade, several studies have been conducted on the occurrence of pharmaceuticals in surface waters. Generally, these studies use a limited number of samples in time and/or space, which complicates the establishment of temporal and spatial trends of pharmaceuticals in surface waters. The present study uses an exceptionally large dataset; 48 to 127 pharmaceuticals were monitored at 9 sampling locations along the river Rhine in Switzerland, Germany and the Netherlands over a period of 7 years, resulting in over 5000 positive detections of pharmaceuticals.

The obtained information was compared to literature data on the occurrence of pharmaceuticals in the aqueous environment and was interpreted in relation to the consumption of pharmaceuticals in the Rhine catchment area. X-ray contrast media (e.g. iomeprol, iopamidol, iopromide) showed the highest concentrations, exceeding 0.1 μg/L, while concentrations of various other pharmaceuticals (e.g. carbamazepine, bezafibrate, diclofenac) varied between 0.2 and 0.01 μg/L. Concentrations below 0.01 μg/L were, in general, not used because of analytical limitations.

The monitoring data reveal that concentrations of certain frequently detected pharmaceuticals slightly increased over the course of the river Rhine. In contrast, concentrations of carbamazepine, bezafibrate and diclofenac significantly decreased with a factor 2 while two X-ray contrast media (iohexol and iomeprol) significantly increased with a factor 2.5 between 2002 and 2008.

Some pharmaceuticals (e.g. diclofenac, ibuprofen, bezafibrate) showed clear seasonal trends: high loads entered the Netherlands in the winter while up to 10 times lower loads occurred in summer. This may be due to an increased degradation in the wastewater treatment (and river) during summer temperatures and/or seasonal variations in consumption. It was observed that, on average, 25% (1-70%) of the pharmaceuticals consumed by the inhabitants of the Rhine catchment area was recovered in the Rhine. For 15 out of 20 chemicals the actual recovered fractions deviated less than a factor 2 from predicted fractions based on literature data on consumption, on fractions excreted by the users and on removal in the wastewater treatment. This analysis illustrates that such information can be used as an initial estimate of average environmental concentrations, if no monitoring data are available.

Trends in Pesticide Concentrations in Corn-Belt Streams, 1996–2006

Aldo V. Vecchia[1], Daniel J. Sullivan[2], Robert J. Gilliom[3]
[1]U.S. Geological Survey, 821 E. Interstate Ave, Bismarck, ND; [2]U.S. Geological Survey, 8505 Research Way, Middleton, WI; [3]U.S. Geological Survey, Placer Hall, 6000 J St., Sacramento, CA

Abstract
Trends in the concentrations of 11 pesticides were assessed for 31 stream sites in the Corn Belt for two partially overlapping time periods: 1996–2002 and 2000–2006. Pesticides included in the trend analyses were atrazine, acetochlor, metolachlor, alachlor, cyanazine, EPTC, simazine, metribuzin, prometon, chlorpyrifos, and diazinon. A parametric regression model specially designed for pesticide data was used to evaluate seasonality, flow-related variability, and trends in pesticide concentrations. Trend results showed that all of the pesticides assessed, except acetochlor and simazine, were dominated by varying degrees of concentration downtrends in one or both analysis periods. Acetochlor trends were mixed during 1996–2002 and slightly upward during 2000–2006, but most of the trends were not statistically significant. Simazine concentrations trended upward at most sites during both 1996–2002 and 2000–2006.

Trends in the concentrations of four major herbicides – atrazine, alachlor, metolachlor, and acetochlor, were compared with trends in agricultural use of these chemicals for selected large basins for which reliable annual use estimates could be determined. Concentration trends were generally consistent with trends in agricultural use, indicating that agricultural use was the most important factor controlling concentrations of these herbicides in large rivers throughout the region. There were a few isolated cases where concentration downtrends were significantly steeper than use downtrends, indicating the possibility that non-use related changes, such as increases in buffer strips or conservation tillage, may have contributed to the concentration downtrends.

Session H1: Statewide Bioassessment

The Maryland Biological Stream Survey: Evolution of a Probability-based Monitoring Program

Ronald J. Klauda[1], Scott A. Stranko[1], Daniel M. Boward[1], Andrew J. Becker[1], Mark T. Southerland[2]
[1]Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division, Annapolis, MD, United States; [2]Versar, Inc., Columbia, MD, United States

Abstract
The Maryland Biological Stream Survey (MBSS), conducted by the Maryland Department of Natural Resources (MDNR), was implemented in 1994 as a probability-based monitoring program intended to provide unbiased estimates of stream conditions with known precision at spatial scales ranging from medium-sized watersheds (mean = 21,084 ha) to river basins (mean = 161,289 ha) to the entire state. As of 2009, data on water quality, biology, physical habitat, and land use/land cover were compiled by the MBSS from over 3,000 wadeable stream sites. MBSS data were used to develop multi-metric biological indices that support biocriteria. Based on benthic macroinvertebrate and fish community indices, streams are placed on the State's 303d list of impaired waters or designated Tier II (high quality) waters, as part of anti-degradation regulations.

During the first statewide round of the MBSS (1995-1997), all sampled sites were randomly selected. When stream monitoring data needs increased, the second round (2000-2004) sampling design was modified to continue a core component of randomly-selected sites plus targeted sites added for special studies. A network of about 25 minimally-disturbed Sentinel Sites was established in 2000 to track natural variations in stream conditions and responses to climate change. By 2004, 74% of the MBSS sites were randomly selected and 26% were targeted. The MBSS sampling design continued to evolve to meet new monitoring data needs and address more management questions. With completion of the third statewide round in 2009, 29% of the sampled sites were randomly selected.

The MBSS data set provides information on the status of imperiled species, supports Maryland's Wildlife Diversity Conservation Plan, and tracks invasive species distributions. The data are also used to prioritize land acquisition and stream restoration projects, and answer a range of management questions related to water quality and wildlife conservation regulations. Since 2000, MBSS-based assessments of stream conditions in Maryland have been supplemented by benthic macroinvertebrate data collected by volunteers who participate in the Stream Waders Program. Data collected by the MBSS can be found in over 100 peer-reviewed publications. MDNR is also disseminating MBSS data and findings in technical reports, fact sheets, posters, and public-friendly formats via the internet.

The Surface Water Register: an empirically improved sample frame for monitoring Kansas rivers and streams

Elizabeth Smith[1], Anthony Olsen[2]
[1]Kansas Department of Health and Environment, Topeka, KS, United States; [2]USEPA NHEERL Western Ecology Division, Corvallis, OR, United States

Abstract
State-wide monitoring based on probability survey designs requires a spatially explicit representation of all streams and rivers of interest within the state, i.e., a sample frame. The sample frame should be the best available map representation of the resource. Many stream programs use the 1:100K National Hydrography Dataset (NHD) as the basis of their sample frame. In Kansas, the NHD contains about 130,000 miles of rivers and streams. In reality, due to dewatering and other factors, Kansas probably has only about 30,000 miles of perennial and intermittent streams and rivers with sufficient water to support aquatic life. Over the past 15 years, the Kansas Department of Health and Environment has developed and refined the Kansas Surface Water Register, a ground-truthed representation of the state's waters. The KSWR is used as the sample frame for state survey designs, and its mileage is the basis for Integrated Reporting on water quality. However, the NHD is still used for national designs. For this study, we created a survey design based on NHD-Plus, where segments were identified by membership or non-membership in the KSWR. In each of twelve basins, up to 80 sites were evaluated by office reconnaissance (e.g., aerial photos, existing field data) and field reconnaissance to determine if they met the definition of stream of interest. We demonstrate the KSWR is an accurate representation of viable Kansas stream and river resources. To our knowledge, this is the first quantitative attempt to document the accuracy of a state sample frame. This study provides a foundation for future iterations and adjustments of the KSWR. As a corollary project, we present several alternative estimates of the percentage of KSWR stream mileage that can be classified as perennial. We also include a brief discussion of the challenges of monitoring intermittent streams, which are an important component of aquatic resources in the Great Plains and the western United States.

Integrating Water Resource Monitoring Data from Diverse Sources: The Willamette Basin (Oregon) Rivers and Streams Assessment

Michael Mulvey, Aaron Borisenko, Robin Leferink
Oregon Department of Environmental Quality, Laboratory and Environmental Assessment Division, 3150 NW 229th Avenue, Suite 150, Hillsboro OR 97223

Abstract
Oregon's Willamette basin is the hub of the state's population and economy with 70% of the state's population and 75% of the state's employment in only 12% of the state's land area. The basin contains some of the state's most challenging water quality issues.

Over the past 15 years more than a dozen stream and river surveys have monitored approximately 650 randomly selected sites and least-impaired reference sites on streams and rivers in the Willamette basin using common sampling approach and data collection methods. Monitoring was conducted by municipal, state and federal governments; university researchers, and local watershed councils.

The Oregon Department of Environmental Quality has aggregated these various compatible data sets to evaluate stream and river status for the entire basin, for land use types and for 12 subbasins using a range of biological, water quality and physical habitat condition indicators. Randomly selected sites are compared with least-human-impaired reference sites to evaluate the role of natural conditions and human activity to the current stream and river status.

The biological health of 46% of the streams and river miles in the Willamette basin are in most disturbed condition as measured by the stream insect community and other macroinvertebrates.

Agricultural land use is the largest source of most disturbed streams accounting for 62% of the most impaired stream miles while representing only about 30% of the total stream miles.

Nearly 70% of the stream and river extent in the basin violates the temperature criteria for protecting sensitive cold water fish like salmon and trout. Streams with temperature violations were nearly twice as likely to have impaired macroinvertebrate biological condition and 14 times more likely to have impaired fish and amphibian biological condition.

California's Sophisticated State Bioassessment Program and the Challenge of Translating its Tools into a Successful Citizen Monitoring Program

James Harrington
California Department of Fish and Game, Rancho Cordova, CA, USA

Abstract
At the 2004 meeting in Tennessee, I gave a presentation on how the California Department of Fish and Game was developing a bioassessment program for its water quality agency called the State Water Resources Control Board (SWRCB). I explained how we developed sophisticated tools for the SWRCB such as sampling protocols, field and laboratory QA/QC procedures, standard taxonomic levels, regional IBIs, California specific RIVPACS model, State-wide assessment reports (305b) and a reference condition management program. The framework for most of these tools comes from U.S EPA national guidelines, but the field sampling protocol which was developed in 1993 was uniquely Californian. In 2004, we started in earnest to transition our bioassessment sampling protocol to be more in line with the national sampling protocols used by the U.S. EPA for its National Streams and Rivers Assessment (NSRA)(previously Environmental Monitoring as Assessment Program).

This was a seamless move for our State-wide program, but presented a challenge to our many established citizen monitoring programs. Most groups introduced to the NSRA protocols found them too complicated and time consuming. The groups with substantial funding and a larger volunteer base were the most successful in transitioning to the more intense protocol and those with less financial and volunteer support were less successful. To make it a little more manageable, I developed a decision tree that the groups can use to determine how much of the NRSA protocols they will be able to use while gaining the most information on the biotic and physical integrity of their streams and rivers.

Session H2: Your Stream Overfloweth: Case Studies in Monitoring Stormwater Quality

Local Urban Stormwater Monitoring, Results, and Implications for Future Management

Matt Loyas
Capitol Region Watershed District, Saint Paul, Minnesota, United States

Abstract
Capitol Region Watershed District (CRWD), located in Ramsey County, is completely urbanized, with 42% coverage by impervious surfaces and is drained almost solely by storm sewers. CRWD began its water quality monitoring program in 2005 with 8 stormwater water quality monitoring stations and has grown to 20 stations in 2009. At each station, flow is measured continuously and composite water quality samples are collected during storms and baseflow. Water samples are analyzed for nutrients, solids and metals. Results are discussed for 9 subwatershed stations. Pollutant loadings and yields are calculated for TP and TSS. With no water quality standards for stormwater, flow weighted average concentrations are compared to concentrations in the receiving waters (Mississippi River), to surface water quality standards and national averages for stormwater.

Sediment Transport from Urban, Urbanizing, and Rural Areas in Johnson County, Kansas, 2006-08

Casey J. Lee[1] and Andrew C. Ziegler[2]
[1]U.S. Geological Survey, 4821 Quail Crest Place, Lawrence, KS, 66049; PH (785) 832-3515; Email: cjlee@usgs.gov; [2]U.S. Geological Survey, Lawrence, KS, 66049

Abstract
Although construction activities and urban land are frequently cited as causes of increased suspended-sediment transport, sediment loads have rarely been quantified from urbanizing watersheds since the widespread implementation of erosion-control practices at construction sites. In cooperation with the Johnson County Stormwater Management Program, the U.S. Geological Survey studied sediment transport across a continuum of land-use conditions (rural, urbanizing, urban) and watershed scales (3-66 mi^2) within Johnson County, Kansas. Suspended-sediment samples were collected along with continuous monitoring of streamflow and turbidity to characterize suspended-sediment transport at nine stream sites within an urbanizing, 57-mi^2 watershed (Mill Creek) as well as from the four other largest (49-66 mi^2) watersheds (Blue River, Cedar, Indian, and Kill Creeks) in Johnson County. Simple linear regression analysis between turbidity and suspended-sediment concentration was used to compute sediment loads in 5- to 15-minute increments at monitoring sites.

Sediment yields from the smallest watersheds (3-12 mi^2) with increased construction activity within the Mill Creek watershed were approximately two-three times larger than those from established urban or rural watersheds. Sediment concentrations at these sites were larger for prolonged periods, often remaining elevated after stormflows had receded. Within the Mill Creek watershed, watersheds with substantial regulation by reservoirs and those occupied by stable, urban land uses had the smallest sediment yields in Johnson County. However, among larger (49-66 mi^2) watersheds, sediment yield from the only large, mostly established urban watershed (Indian Creek) was more than twice that of the urbanizing Mill Creek watershed, and was as much as 4.6 times that of predominantly rural watersheds. Sediment yield from the 63-mi^2 Indian Creek watershed was similar to yields observed from small (5-11 mi^2), construction-affected sites within Mill Creek. The implication of these findings is that sediment yields can increase relatively rapidly in response to upstream construction in small watersheds (3-12 mi^2), whereas sites downstream from relatively larger (49-66 mi^2) watersheds can take decades longer to adjust to upstream urbanization. Sediments transported by Indian Creek likely result from stream channel erosion, resuspension of sediments deposited from earlier urban construction, and erosion from specific construction sites, such as stream-channel disturbance during bridge renovation.

Sediment and Phosphorus Evaluation of an Urban Watershed in the Illinois River Watershed

Sandi J. Formica and Matthew Van Eps
Watershed Conservation Resource Center, Fayetteville, AR

Abstract
A watershed-based assessment of sediment and total phosphorus was conducted for Blossom Way Branch, a stream that flows through a rapidly urbanizing area of Rogers, Arkansas. Blossom Way Branch is a tributary to Osage Creek, located in the Illinois River watershed. The Watershed Conservation Resource Center conducted this study for the City of Rogers, as part of a larger EPA, Region-6, 319 grant, administered by the ANRC. A detailed land use analysis was conducted and impervious cover was estimated; streambank erosion prediction curves were developed for Osage Creek; and sources of sediment and phosphorus from various land-uses in Blossom Way watershed were identified and load contributions were estimated using GIS data, land-use analysis, published export coefficients, and simple to complex models or relationships.

The total project area was 7.3 mi^2 or 4,660 acres. Using the Anderson Land Use/Land Classification system, Levels I - III, land-use classifications were assigned to hand digitized GIS features using geo-rectified aerial photography. 57.4% of the watershed was developed urban land; 29.0%-agricultural land; 4.9%-forest land; 1.1 %-water; and 7.6 %-barren land. The impervious cover was 20%.

Lateral streambank erosion was observed throughout the study site. Using methods presented by Rosgen (Rosgen, Dave. Watershed Assessment of River Stability and Sediment Supply. Wildland Hydrology, 2006), streambank erosion prediction curves were developed for the upper 30 mi^2 of Osage Creek watershed. An inventory of 407 streambanks was conducted for erosion potential based on a bank erosion hazard index and near-bank shear stress. Erosion rates were measured at 39 sites.

For the purpose of watershed planning and to better direct resources to reduce loadings to Blossom Way watershed, sources of sediment and phosphorus were identified and average annual loads were estimated using information and data collected during this study; existing data; and simple to complex models. An average of 1,658 tons/year of sediment was estimated to enter Blossom Way Branch with construction contributing 49%, developed urban areas-25%, streambank erosion-11%, pasture land-8% and other sources-7%. An average of 2,645 lbs/year of total phosphorus was estimated with developed urban areas contributing 51%, pasture land-17%, construction-11%, septic tanks-7%, streambank erosion-7%, and other sources-7%.

The impact of stormwater on occurrence of pathogenic and antibiotic-resistant bacteria in urban surface waters

Lisa R. Fogarty[1], Joseph W. Duris[1], Jason R. Vogel[2]
[1]U.S. Geological Survey, MI Water Science Center, Lansing, MI; [2]US Geological Survey, NE Water Science Center, Lincoln, NE

Abstract
Pathogens, antibiotic-resistant bacteria, and their impacts on human health have been studied in great detail from a clinical perspective. Recent water- and food-borne outbreaks due to pathogenic bacteria, and increase prevalence in antibiotic-resistant diseases have highlighted the need to better understand the role the environment has on human health. In urban environments, possible sources of pathogens and antibiotic-resistant bacteria in water include runoff from land or impervious surfaces, and discharge of stormwater drains into rivers and streams. Stormwater has been implicated in the transport of sediment, chemicals, and even fecal indicator bacteria to nearby rivers and streams. Recent studies by the U.S. Geological Survey, in cooperation with local agencies, have evaluated the occurrence of specific pathogens and antibiotic-resistant bacteria in surface-water from urban environments and how their occurrence relates to rainfall, streamflow, and the physicochemical characteristics of river water following rain events. The occurrence of Shiga-toxin producing E. coli (STEC) and human-pathogenic Enterococcus in the environment was determined by the detection STEC-related genes and the esp gene respectively. The percentage of E. coli resistant to cephalosporin antibiotics was determined using standard broth dilution protocols. The occurrence of vancomycin resistant enterococci (an antibiotic-resistant pathogen) was determined by the presence of the high-level vancomycin resistance gene vanA. Results of these studies indicate that stormwater may adversely affect microbiological stream water-quality in urban environments. These results have implications for water-quality management in urban settings for the protection of human health.

Session H3: Using Data Sharing as a Pathway to Collaboration

Environmental Visualization Tools

Cristina Grosso, John Oram, Shira Bezalel, Todd Featherston, John Ross, Michael May, Patty Frontiera, Josh Collins, Meredith Williams, Kristen Cayce
San Francisco Estuary Institute, 7770 Pardee Lane, 2nd Floor, Oakland, CA

Abstract
Easy access to reliable data is a primary objective of any environmental information management system. Providing high quality, scientific information allows for the formulation of technically sound policies and the ability to address specific management questions. Tools can assist with the flow of information through the various data management steps of data collection, uploading, and review, and facilitate the retrieval, exchange, and visualization of results. This case study highlights tool development from several projects managed by the San Francisco Estuary Institute.

The South Bay Mercury Project is a collaborative, three-year project that characterizes mercury in the sediment, water, and biota ("sentinel" species) indicative of different landscape management endpoints in the San Francisco Estuary's South Baylands. By leveraging the functionality of Google Earth, mercury concentrations could be displayed at specific sample sites, differentiating concentrations through a range of colors and symbol heights, while also providing a valuable aerial perspective for evaluating the results.

The Regional Monitoring Program for Water Quality (RMP) is the primary source of long-term contaminant monitoring data for the San Francisco Estuary and annually collects water, sediment, and tissue samples. The RMP makes its 15-year dataset available online through a user-defined query tool, from which results can be downloaded into an Excel file in two formats: a cross-tabulated format for reviewing data across stations and time in a table, and a flat-file format for importing data into statistical programs. Dynamic mapping of concentrations allows users to view spatial distributions across the Estuary, and statistical functions, such as cumulative distribution function plots, provide aggregated summaries.

The California Wetlands Portal (Wetlands Portal) is an interactive mapping tool that displays information about wetlands habitat in California, including historical and modern habitats. The Wetlands Portal catalogues planned, active or completed wetland restoration, mitigation, creation, and enhancement projects. The primary purpose of the Wetlands Portal is to give wetland scientists, managers, and the interested public access to authoritative information about where California's wetlands are and how are they doing.

These visualization tools are powerful means for conveying information in meaningful ways to environmental managers and scientists responsible for managing the Estuary's resources.

Use of a Wiki Portal for Watershed Management: An Integrated Approach

Soumya Chennapragada
San Diego Coastkeeper, soumya@sdcoastkeeper.org

Abstract
An interactive wiki site has been developed at San Diego Coastkeeper, a nonprofit environmental organization, to disseminate water quality information collected by its citizen water quality monitoring program along with other watershed information.

Water Quality information which includes water chemistry, pathology, toxicity, ambient measurements and observational information from 10 out of 11 watersheds in the San Diego Hydrologic Region is collected on a monthly basis. This complex water quality data is converted into easy to understand visual maps using Arc GIS and open source GIS applications. These Water quality and watershed maps greatly enhance the comprehension of water-quality monitoring results. Watershed information includes mapping of low impact development projects in the region, beneficial uses of waters, 303(d) listing policy, impaired waters and land-use information.

The online wiki resource is a collaborative and transparent platform integrating multi-media technology and social networking tools. This integration helps the wiki appeal to a wide range of audience and initiates participation and discussions within users using the tool of their choice. During challenging circumstances, where resources are limited and environmental data are more critical than ever, this community-supported approach allows for cost-effective, targeted methods to address environmental concerns.

This presentation will consist of a demonstration of the watershed wiki (www.sdwatersheds.org) along with a tutorial on accessing and editing it. It will also provide a preview into the process of managing the wiki site.

KCWaters.org – An Interactive Venue to Share Data, Connect Partners, and Help Protect Waterbodies in the Kansas City Metropolitan Area

Jeffery Robichaud[1], Shawn Henderson[1], Roberta Vogel[1], Jeremy Yazzie[1], Gary Welker[1], JJ. Li[2], Casey McLaughlin[3]
[1]U.S. Environmental Protection Agency, Region 7, Kansas City , KS; [2]University of Missouri, Kansas City, MO; [3]JMA Information Technology, Overland Park, KS

Abstract
Since 2006, EPA scientists in Kansas City have actively monitored urban water quality, using scientifically-based monitoring and assessment protocols to determine the condition at 36 locations on metropolitan area streams. One goal of this endeavor was to accurately characterize an under-monitored resource (urban waters) and provide the results to those who would be most affected by day-to-day water quality in the metropolitan area. Rather than rely solely on the Agency's STORET Data Warehouse as the only repository for this water quality, biological, and physical data, EPA Region 7 developed a more local approach to sharing data.

KCWaters.org is a Kansas City stream data sharing site hosted by the University of Missouri – Kansas City (UMKC) Geosciences Department. By bringing together all available monitoring data generated by multiple partners in the Kansas City metro area, we hope to create an accessibility and transparency that all partners in the metropolitan area can rely on to understand stream quality both in watersheds, and particular stream segments. This sharing can also further the development of shared monitoring protocols and inform the best use of various stream protection and restoration strategies, such as Best Management Practice placement and green infrastructure development. Most importantly, it can provide local citizens with a single point to access information about waters in their own backyards.

In its infancy, this effort seeks to consolidate and share data in an unprecedented fashion and at the level most accessible to Kansas Citians, for the stream that flows through their neighborhood. As it grows, we hope this will serve as a central location for various entities to share ideas, protocols, resources and above all information regarding the protection and restoration of urban waters in the metropolitan area.

USGS-Pakistan Science and Technology Exchange – Creation of a Water Resources Data System for Pakistan

Alex K. (Sandy) Williamson[1] and Dr. Ingrid M. Verstraeten[2]
[1]U.S. Geological Survey Tacoma, WA 253-376-8273 akwill@usgs.gov; [2]U.S. Geological Survey, Reston, VA, 703-648-5689, imverstr@usgs.gov

Abstract
The U.S. Geological Survey (USGS) and the Pakistan Ministry of Science and Technology and other Pakistani organizations involved in water resources assessment and management have been engaged in this data system project since 2008. The goal is creation of a water-resources data system to support science-based decision making and integrated water resources management. Eight Pakistani scientists from Pakistan Council for Research in Water Resources of the Ministry of Science and Technology, International Water-logging and Salinity Research Institute of the Water and Power Development Authority and Sindh Irrigation and Drainage Authority received training during 4 weeks ending February 2009, at the USGS water science centers (WSC) in Tacoma, WA and Madison, WI. The purpose was training on the use of Pakistan water-resources data transactional system (PSTORET, MS access-based on US National Park Service NPSTORET) and obtain input on database requirements. Training included discussions on data entry and sharing, data standards and quality, and the value of a data warehouse. Also during the training, USGS together with Pakistani colleagues developed a proposed data standards system to create unique names for sampling locations for Pakistani water organizations. A kickoff workshop was held in Pakistan in April 2009 with over 18 organizations and reached consensus to create a water-resources data standards committee and share data. During an August 2009 training workshop in Nepal; USGS scientists provided a preliminary overview of the structure of the water-resources data warehouse and obtained input regarding the needs of Pakistan and potential of sharing data across the 10 organizations that attended. More recently, more IT training was held in the Madison, WI WSC and more water-resources data has been incorporated in the web-implemented Oracle data warehouse (PakWaters). Training by Pakistanis in the PSTORET data system for data entry and management will be held in Pakistan. The PakWaters data warehouse will be installed in Pakistan in August 2010.

Session H4: Monitoring Network Design: Implementing Large Scale Solutions

New Zealand's National Rivers Water Quality Network (NRWQN) – 21 years old and still going strong

David G Smith[1], Robert J Davies-Colley[2]
[1]Retired, New York City Department of Environmental Protection, Valhalla, NY, United States; [2]National Institute of Water and Atmospheric Research, Hamilton, New Zealand

Abstract
After 21 years of operation, New Zealand's NRWQN continues largely unchanged and is the foundation of highly relevant environmental reporting. Several reasons are suggested for its continuing success, particularly its careful initial design (learning from the successes and shortcomings of monitoring networks elsewhere): well defined goals and objectives (with the data end user – ultimately NZ's public – firmly in mind); frequent and relevant information output; relatively parsimonious and cost-effective design; updating as appropriate without compromising objectives; and well-defined QA procedures for both the laboratory and field operations. As well as defining state and trends in water quality in New Zealand, the NRWQN has had diverse applications, including use for estimating national-scale fluxes of carbon and other nutrient elements, and a 'calibration' dataset for national-scale modeling.

Regional Ambient Fish Tissue Monitoring Program

Laura Webb, Deanna Collier
Environmental Protection Agency, Region 7, Environmental Assessment and Monitoring Branch, 901 N 5th St., Kansas City, KS 66101

Abstract
EPA Region VII and the states of Iowa, Nebraska, Kansas and Missouri have participated in the Regional Ambient Fish Tissue Monitoring Program (RAFTMP) since 1977. This program was developed to overcome the shortfall of traditional water and sediment-only monitoring in water bodies. The absence of detectable concentrations of toxic substances in water and sediment samples does not give the full picture of contamination; fish that reside in that water body can bio-accumulate toxins and detection of these contaminants give a more representative picture. The program established a network of station in all four states where whole fish tissue samples were collected and analyzed by the regional laboratory. Contaminants of interest have been chlorinated pesticides and polychlorinated biphenyls (PCBs), metals, and mercury. The program evolved to include edible portions to assist the states in detecting occurrences of exceedances of human health consumption guidelines. Probabilistic sampling was added in later years to add non-trend stations throughout the states. This presentation will discuss the trends found in the 30 years of data, results of the probabilistic sampling, and any unique findings from the region.

Longitudinal Spatial Patterns in Riverine Ecological Indicators in the Pacific Northwest; Implications for River Survey Design

Alan T. Herlihy, Robert M. Hughes, and William J. Gerth
Department of Fisheries & Wildlife, Oregon State University, Corvallis, OR 97331

Abstract
The riverscape concept favors study of an entire river. However a monitoring census of an entire river is a daunting undertaking for most agencies, and it limits the number of rivers that can be sampled with limited resources. On the other hand, one or a handful of water quality samples from bridges is an inadequate representation of the ecological variability expressed by a large river. To address this issue, we sought to determine the number of sites that would yield relatively precise estimates of ecological condition for raftable rivers 100-200 km long and 20-120 m wide. We sampled 20-25 sites on each of seven mainstem rivers in the Pacific Northwest to study longitudinal spatial patterns in riverine water chemistry, physical habitat, and fish, macroinvertebrate, and periphyton assemblages. Within each river, sites were selected using a systematic randomized sampling design so that estimates could be made for the entire raftable river length in two rivers in Washington (Chehalis, Okanogan) and five rivers in Oregon (Willamette, Malheur, Umpqua, Sprague, John Day). The rivers were selected to include those draining cold deserts, dry and wet forests, and agricultural plains. All sites were sampled by a four person crew from two rafts. All data were collected using U.S. EPA EMAP field protocols. Mantel tests were used to assess the relationship among similarity matrices for fish, macroinvertebrates, chemistry, habitat and river distance. Results varied by river but water chemistry similarity tended to be more closely related to biological assemblage similarity than habit or river distance. Ordination analyses showed that among river differences were much greater than within river differences. Pairwise similarity analysis of the fish data showed different spatial patterns in different rivers. The Willamette River showed distinct zones whereas other rivers (e.g. Okanogan, Chehalis) showed no zonation and only slight differences in assemblages from upstream to downstream. Overall, the data suggest a high degree of spatial autocorrelation between sites that are < 10-40 km apart, and we typically observed no marked changes between adjacent sites. This autocorrelation needs to be taken into account in designing regional river monitoring surveys.

Pennsylvania's Monongahela River Basin Conductivity Monitoring Network

Tony Shaw
Pennsylvania Department of Environmental Protection, Water Standards & Facility Regulation, Rachel Carson State Office Building, 400 Market St., Harrisburg, PA 17105

Abstract
The Monongahela River basin is a large river system that joins with the Allegheny River to form the Ohio River at their confluence in Pittsburgh, Pennsylvania. There are many industrial and public water users on the mainstem and major tributaries of the Monongahela River where Specific Conductivity (SC), Total Dissolved Solids (TDS), and Sulfates rose to record levels in the fall of 2008. These elevated constituents caused scaling, additional treatment needs, and taste and odor problems for water users. Instream criteria were exceeded for both TDS and Sulfates. Potential constituent sources of may be abandoned mine drainage, flue gas desulfurization (FGD) of coal-fired power generating stations and regional waste water treatment plants accepting brine waste waters generated by natural gas drilling activities.

In response, Pennsylvania Departmental of Environmental Protection (PA-DEP) launched a water quality survey dedicating significant field and lab personnel hours; resulting in a voluminous set of manually-collected data. Because of the significant drain on basin-wide monitoring resources, state, federal, and local stakeholder representatives met to plan an "early warning network" to detect similar, future water quality problems. The resulting Plan provides for installing 17 new meters in the Monongahela River basin and one each on the Allegheny and Ohio Rivers; year-round operation of 4 existing USGS meters; and 2 new portable meters for short-term "hot-spot" deployment. All meters will provide hourly interval measurements of SC, Temperature, and pH and instantaneously report this data to a centralized web server.

Session H5: Harmful Algal Blooms and Cyantoxins: How (Blue) Green is my Water?

Efforts in California to address risk from cyanotoxins and the significance of cyanotoxin ecotoxicology

Regina Linville[1], Ned Butler[1], Jim Carlisle[1], Kim Ward[2]
[1]Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA, United States; [2]State Water Resources Control Board, California Environmental Protection Agency, Sacramento, CA, United States

Abstract
Regulatory efforts to minimize cyanotoxin exposure in California have been limited by a lack of criteria for these toxins. Voluntary guidance on cyanobacterial exposure is provided for local public health agencies by the California Department of Public Health. In addition, an ad-hoc group of federal, state and local environmental health agencies have provided draft voluntary guidance to assist public resource managers in responding to cyanobacterial blooms. These guidance documents recommend posting public warning signs at water bodies with either a visual presence of a cyanobacterial bloom or a threshold level of cyanobacterial density. Unfortunately the presence or quantity of cyanobacteria does not reliably predict the concentrations of cyanotoxins in the water. Therefore public health decisions should be based on measured concentrations of these cyanotoxins.

To assist government scientists and regulators in the protection of people, pets and livestock, the California Office of Environmental Health Hazard Assessment recently developed draft action levels for microcystin (four congeners), cylindrospermopsin and anatoxin-a in recreational waters. The action levels are health-protective toxin concentration thresholds developed through assessment of toxicity and exposure. Separate action levels were developed for cyanotoxin concentrations in water, sportfish and cyanobacterial crusts that represent minimal to no risk to people, dogs and cattle. Although the action levels are not criteria, they will advance the ability of public and environmental health agencies to manage the risks associated with toxic cyanobacterial blooms. Cyanotoxins also threaten fish and wildlife, although protective criteria or action levels have not been developed for these animals. Exposure to microcystin, cylindrospermopsin and anatoxin-a at concentrations found in the environment can lead to significant adverse health effects in aquatic-dependent animals. However risk assessment is difficult in aquatic ecosystems because the exposure and susceptibility to cyanotoxins can vary significantly between species in the same water body as well as between water bodies. We discuss potential strategies for assessing the risk of cyanotoxins to fish and wildlife.

Recreational Exposure to Microcystins During Algal Blooms in Small Lakes

Lorraine C. Backer[1], Sandra V. McNeel[2], Wayne Carmichael[3], Terry Barber[4], Barbara Kirkpatrick[5], Christopher Williams[6], Mitch Irvin[7], Yue Zhou[7], Kate Nierenberg[5], Mark Aubel[6], Rebecca LePrell[1], Andrew Chapman[6], Amanda Foss[6], Vincent R. Hill[8], Stephanie M. Kieszak[1], and Yung-Sung Cheng[7]
[1]National Center for Environmental Health, Centers for Disease Control and Prevention, 4770 Buford Highway NE, Chamblee, Georgia 30341; [2]Environmental Health Investigations Branch, California Department of Public Health, 850 Marina Bay Parkway, Building P, 3rd Floor, Richmond, California 94804-6403; [3]Carmichael Lab, 42184 Tweedle Lane, Seaside, Oregon 97138; [4]Siskiyou County Department of Public Health and Community Development, 806 South Main Street, Yreka, California 96097; [5]Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, Florida 34236; [6]GreenWater Laboratories, 205 Zeagler Drive, Palatka, Florida 32177; [7]Lovelace Respiratory Research Institute, Inhalation Toxicology Laboratory, P.O. Box 5890, Albuquerque, New Mexico 87285; [8]Center for Infectious Diseases, Centers for Disease Control and Prevention, 4770 Buford Highway NE, Chamblee, Georgia 30341

Abstract
Evidence of adverse human health events from exposure to freshwater cyanobacterial blooms is primarily anecdotal. Our objective was to document recreational exposure by measuring microcystins in blood samples from people at risk for swallowing water or inhaling spray (e.g., water skiers, jet skiers) during a *Microcystis aeruginosa* bloom. We conducted a study of recreational exposure to microcystins among 81 children and adults planning recreational activities on either of three California reservoirs, two with significant, ongoing blooms of toxin-producing cyanobacteria, including *Microcystis aeruginosa* (Bloom Lakes), and one without a toxin-producing algal bloom (Control Lake). We analyzed water samples for algal taxonomy, microcystin concentrations, and potential respiratory viruses (adenoviruses and enteroviruses). We measured microcystins in personal air samples, nasal swabs, and blood samples. We interviewed study participants for demographic and health symptoms information. We found highly variable microcystin concentrations in Bloom Lakes (<10 μg/L–>500 μg/L); microcystin was not detected in the Control Lake. We did not detect adenoviruses or enteroviruses in any of the lakes. Low microcystin concentrations were found in personal air samples (<0.1 ng/m^3 [limit of detection]–2.89 ng/m^3) and nasal swabs (<0.1 ng [limit of detection]–5 ng). Microcystin concentrations in the water-soluble fraction of all plasma samples were below the limit of detection (1.0 μg/L). Our findings indicate that recreational activities in water bodies that experience toxin-producing cyanobacterial blooms can generate aerosolized cyanotoxins, making inhalation a potential route of exposure. Future studies should include collecting nasal swabs to assess upper respiratory tract deposition of toxin-containing aerosols droplets.

Developing a Harmful Algal Bloom Integrated Observing System for the Gulf of Mexico

Ann Jochens[1], Nancy Rabalais[2], Steven Wolfe[3]
[1]Texas A&M University, Department of Oceanography, College Station, TX, United States; [2]Louisiana Universities Marine Consortium, Chauvin, LA, United States; [3]Florida Department of Environmental Protection, Office of Coastal and Aquatic Managed Areas, Tallahassee, FL, United States

Abstract
The Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS-RA) and Gulf of Mexico Alliance (GOMA) are working together to develop a Harmful Algal Bloom Integrated Observing System (HABIOS) for the Gulf of Mexico. While some harmful algal blooms (HABs), e.g., Karenia species "red tide", have been in the Gulf throughout recorded history, the Gulf is clearly in a period of expanding HABs, as elsewhere in the world, with more frequent events involving increasingly different species. GCOOS-RA and GOMA have held two workshops to develop an initial strategic plan for HABIOS and to identify users and their needs. A third is being planned to finalize a HABIOS Implementation Plan.

The goal is to establish a sustained observing system from the mouths of rivers into the coastal ocean as part of the U.S. Integrated Ocean Observing System (IOOS). This system will facilitate and enhance efforts to monitor, model, manage, and reduce detrimental effects of HABs on human health, coastal communities, living marine resources, and ecosystems that support them. HABIOS is being designed to meet needs of many users, including state and federal governmental agencies responsible for water quality and human/animal health and safety, as well as recreational and commercial interests.

Development of an integrated observing system that addresses multiple user goals, a variety of data needs, and multiple impacts must consider the range of HAB occurrences with regard to specific species and toxins, characteristics of bloom formation and transport, routine and event driven observations, and data necessary to populate and verify multiple models. To meet management needs for rapid HAB detection and response, prediction, forecast, prevention, control, and mitigation, the monitoring and modeling capabilities of HABIOS should detect and quantify a broad range of HAB types across the region and implement regional specificity in monitoring and modeling approaches to maximize cost-effectiveness and operational efficiency. Existing observations and models are not adequate to address these system requirements. GOMA and GCOOS-RA are developing a HABIOS Implementation Plan to integrate existing observations, model forecasts, and other products, as well as incorporate a timed, phased and prioritized set of enhancements to the existing systems.

Monitoring to Determine Geosmin Sources and Concentrations in a Northern Colorado Reservoir

Judith A. Billica, Jill Oropeza, G. Keith Elmund
City of Fort Collins Utilities, Fort Collins, Colorado, United States

Abstract
Geosmin is a naturally occurring organic compound produced by some species of cyanobacteria and actinomycetes that imparts an earthy odor to water when present at extremely low concentrations (<5 nanograms/L). In October 2008, a significant geosmin outbreak occurred in Horsetooth Reservoir, a reservoir that supplies water to northern Colorado communities served by three drinking water treatment plants, including the City of Fort Collins Water Treatment Facility (FCWTF). A geosmin outbreak in raw drinking water supplies presents special challenges for traditional water quality monitoring programs because the sources and events leading up to an outbreak are not well understood or easily monitored. The City of Fort Collins initiated geosmin monitoring within Horsetooth Reservoir and upstream components of the Colorado-Big Thompson (CBT) Project in direct response to the 2008 outbreak. This paper outlines the geosmin monitoring program used by the FCWTF and highlights some of the key findings to date and factors that affect the success of the program. The reconnaissance monitoring conducted in 2008 revealed high geosmin concentrations throughout Horsetooth Reservoir, but geosmin production sites could not be determined. The expanded monitoring program in 2009 showed significant spatial and temporal variation in geosmin concentrations in the reservoir and in the upstream components of the CBT Project. The data suggest a very complex system with respect to geosmin, and varying levels of geosmin production, transport, and degradation throughout the system. Many questions remain and it is expected that several years of monitoring will be required to fully understand geosmin sources, transport, and fate, and to identify geosmin occurrence patterns.

Session H6: Evaluating Contaminant Trends in Lakes and Reservoirs using Sediment Cores

Zinc and Copper Isotopes as Tracers of Anthropogenic Contamination in Lake Sediments

David M. Borrok[1], Anita Thapalia[1], Peter C. Van Metre[2], MaryLynn Musgrove[2], Edward R. Landa[3]
[1]Department of Geological Sciences, University of Texas at El Paso, 500 West University Avenue, El Paso, TX 79968; [2]USGS 8027 Exchange Drive, Austin, TX 78754; [3]USGS MS 430, 12201 Sunrise Valley Drive, Reston, VA 20192

Abstract
Metal concentration data from lake sediment core samples can provide a historical record of natural and anthropogenic metal fluxes. However, concentration data alone are often insufficient to identify and resolve metal sources, so new forensic tools must be developed. Here we discuss the novel application of Zn and Cu isotopes for fingerprinting and tracking historical metal sources and demonstrate the technique using a sediment core collected from Lake Ballinger, an urban lake near Seattle, Washington. The lower section of the Lake Ballinger core pre-dates settlement in the region and is characterized by low metal concentrations and a $\delta^{66}Zn = +0.39‰ \pm 0.08‰$ 2σ (n=4) and a $\delta^{65}Cu = +0.77‰$ (n=2). Increasing metal concentrations in the middle sections of the core record the impact of atmospheric emissions from the nearby Tacoma smelter (now the Ruston/North Tacoma superfund site) and isotopic values shift to $\delta^{66}Zn = +0.14‰ \pm 0.06‰$ 2σ (n=6) and $\delta^{65}Cu = +0.94‰ \pm 0.1‰$ 2σ (n=6). Even greater metal input into Lake Ballinger occurred during rapid urbanization of the watershed (~1950 to the 1980s) and Zn concentrations, unlike most other metals, continue to increase to the present. The consistency of the Zn and Cu isotopic signatures from the period of rapid urbanization suggests that metal loads were largely attributable to re-mobilization of soils historically contaminated by the Tacoma smelter. The unique $\delta^{66}Zn$ of the post-smelter Zn ($\delta^{66}Zn = 0.00 \pm 0.6‰$, n=3) likely is from tire wear and/or automobile emissions. This study highlights the utility of these new isotopic tools for reconstructing contaminant trends in sediments.

Application of paleolimnology to a large river to reconstruct metal and organic contaminant inputs

Marc Desmet[1], Gwénaelle Roux[2], Henri Persat[3], Irène Lefevre[4], Philippe Bonté[4], Jean-Paul Bravard[5], Peter Van Metre[6], Barbara Mahler[6], Annie Roy[7] & Marc Babut[7]
[1]Université de Tours - UMR ISTO 6113, 37200 Tours, France; [2]Ecole Nationale des Travaux Publics de l'Etat, Rue Maurice Audin, 69518 Vaulx-en-Velin; [3]UMR 5023 LEHF. Bat. Forel, Université Lyon 1 69221 Villeurbanne cedex; [4]UMR CNRS-CEA-UVSQ. LSCE Bât 121,avenue de la Terrasse, F - 91198 Gif-sur-Yvette; [5]Université Lyon II, Faculté GHHAT - 5 av. Mendes France, 69676 Bron cedex; [6]U.S. Geological Survey - 8027 Exchange Dr., Austin, TX 78754; [7]CEMAGREF -3 bis Quai Chauveau CP 220, 69336 Lyon Cedex 9

Abstract
During the second half of the 19th century, the watershed and the channel of the Rhône, the fourth largest river in Europe, were greatly transformed by human development and channel modifications, altering streamflow and the production and transport of sediment and introducing metals and, later, organic contaminants. Substantial changes in sediment flux have continued in recent decades: for example, in 1950, the Rhône carried 1 Million $m^3 \cdot d^{-1}$ of sand and gravel, but today the load is estimated at 0.2 Million $m^3 \cdot d^{-1}$. To evaluate the quality of historically- and recently-deposited sediment and the potential impact that release of stored sediment might have on the river, cores were collected from four sites on the Rhone upstream and downstream from Lyon.

The sites are in reservoirs or by-pass reaches of the channel where long-term deposition is assumed. Age-dating of the cores was based on fallout radionuclides (^{137}Cs and ^{210}Pb) and on changes in magnetic susceptibility and grain-size related to major floods. Temporal and spatial trends in Pb and PCBs are complex, as they are affected by heterogeneities in bulk sediment properties in this large fluvial system and by spatial and temporal changes in anthropogenic loading. Overall, trends in Pb are downward during the past 20-30 years, as expected, but with considerable inter-sample variation. Variations in PCB congener profiles are being evaluated using receptor modeling to better understand differences in sources temporally and between sites.

Sediment Profiles and Accumulation Rates of Mercury and Methylmercury during the Past ~ 100 years, Great Salt Lake, Utah

David L. Naftz[1], Christopher C. Fuller[2], David P. Krabbenhoft[3], Wade Oliver[4], and Kimberly R. Beisner[5]
[1]U.S. Geological Survey/Utah Water Science Center, Salt Lake City, UT, United States; [2]U.S. Geological Survey/National Research Program, Menlo Park, CA, Untied States; [3]U.S. Geological Survey/Wisconsin Water Science Center, Middleton, WI, Untied States; [4]Texas Water Development Board, Austin, TX, United States; [5]U.S. Geological Survey/Arizona Water Science Center, Tucson, AZ, United States

Abstract
The open water and adjacent wetlands of the Great Salt Lake (GSL) ecosystem support millions of migratory waterfowl and shorebirds from throughout the Western Hemisphere and a multi-million dollar brine shrimp industry. Recent biogeochemical assessments of the GSL ecosystem have found elevated levels of methylmercury (> 30 ng/L) in whole-water samples from the deep brine layer (DBL) and $Hg_{(total)}$ in three duck species that consistently exceed the USEPA screening level for human consumption. Sediment cores were collected from six sites in the south arm of GSL during 2006-07 to reconstruct historical concentration and accumulation profiles for Hg. The highest salt-corrected $Hg_{(total)}$ concentration in sediment samples generally coincide with the most recent high stand in lake elevation that occurred from 1983-89. Recent monitoring data indicate > 80% of the annual $Hg_{(total)}$ loading to GSL is from atmospheric deposition. Unlike most freshwater lakes, small changes in lake elevation results in large changes in the surface area "footprint" of the lake surface that is available to receive Hg inputs via direct atmospheric deposition. Recent (1980 to 2007) sediment accumulation of $Hg_{(total)}$ in the 6 cores ranged from about 30 to 140 $\mu g/m^2/yr$, with median of 50 $\mu g/m^2/yr$ for all 6 cores for the past 30 years. Hg sediment accumulation was corrected for sediment focusing derived from ^{210}Pb-derived focusing factors of up to 2.3. This recent $Hg_{(total)}$ sediment accumulation is much larger than the measured atmospheric + riverine Hg deposition of 11.8 $\mu g/m^2/yr$ for GSL. The large difference may be the result of unmeasured inputs such as dry deposition and/or enhanced removal of Hg from the water column by sulfide precipitation in the anoxic DBL where most of the coring sites are located. Unfortunately, the sediment focusing generally occurs in areas of the lake supporting Hg methylation. The highest proportion of methylmercury-to-$Hg_{(total)}$ in the sediment cores generally occurs in material deposited after 1960. The occurrence of this trend coincides with the establishment of the persistent and anoxic DBL in GSL that is sustained by the construction of a railroad causeway in the late 1950s. Previous studies have found that the distribution of methylmercury in sediment cores can be complicated by active methylation and demethylation after sedimentation.

Is Sediment Quality Getting Better or Worse? Evaluation of Historical Trends in Lake-Bottom Sediment Using an Overall Measure of Contamination

Barbara J. Mahler and Peter C. Van Metre
U.S. Geological Survey, Texas Water Science Center

Abstract
Evaluation of the quality or toxicity of lake-bottom sediment is complicated by the number of associated chemical compounds, which can include trace elements and a wide array of organic compounds. We examined historical trends in the quality of lake-bottom sediment from 50 lakes and reservoirs across the United States using a measure of sediment quality that takes into account concentrations of multiple contaminants: the mean sediment-quality guideline quotient (mean SQG-Q). The mean SQG-Q is computed by normalizing the concentration of each contaminant in three groups (metals, polycyclic aromatic hydrocarbons, and chlorinated hydrocarbons) to its probable effect concentration (PEC, the concentration at which adverse effects to benthic biota are expected), computing the mean PEC-normalized concentration for each group, and computing the mean of the group means. Historical trends (50–100-year time frame) in overall sediment quality for the 50 lakes were evaluated by computing the mean SQG-Q for multiple samples from a sediment core from each lake. Historical shifts in the primary causes of toxicity were evaluated by comparing trends in the group-mean PEC-normalized concentrations for the three contaminant groups and shifts in their relative contributions to the mean SQG-Q. In many lakes, particularly those in urban watersheds, there is a downward trend in the relative contribution of the chlorinated hydrocarbons to the mean SQG-Q. Results for the 1970s and recent years (2000–08) are compared to urban land use in each watershed during those periods to investigate the effects of changes in land use on sediment quality, and, by extension, on water quality. In general, urbanization leads to decreased sediment quality. However, some regulatory changes, for example the phasing out of the use of leaded gasoline and organochlorine pesticides, have resulted in improved sediment quality.

Session I1: Biological Assessments – Survey Design and Sampling Considerations

The condition of stream biological communities and the factors that influence them: A national perspective based on land use

Daren Carlisle
US Geological Survey, Reston, VA, United States

Abstract
The U.S. Geological Survey assessed the condition of fish, macroinvertebrate, and algae communities in more than 1500 streams across the United States in relation to important environmental factors including physical and chemical measures such as the degree of hydrologic alteration and concentrations of nutrients and other dissolved and particulate contaminants. The greatest changes to biological condition (relative to regional reference conditions) occurred in urban settings, where at least one community was altered in 90% of assessed streams. Factors associated with agricultural and urban development affected biological communities in different ways. The percentage of altered streams in agricultural land-use settings more than doubled when the assessment was based on all three communities, indicating that assessments based on a single community may underestimate

the severity of biological alteration, especially in agricultural settings. Reduced biological condition was associated with several contaminants occurring in the water column and in bed sediment particularly pesticides in water and bed sediment in agricultural settings and polycyclic aromatic hydrocarbons in urban settings. Reduced biological condition was also associated with nutrient enrichment in both urban and agricultural settings. Streamflow magnitudes were altered in nearly 90% of assessed streams and were related to differing water-management strategies in wet and dry climates. Losses of native fish and invertebrate species were associated with increasing severity of hydrological alteration at national and regional scales.

Monitoring Water Quality at the Epicenter of Aquatic Biodiversity

Fred Leslie[1], Lisa Huff[1], Johnathan Hall[1], Paul Johnson[2], Steve Rider[2], Pat O'Neil[3], Jeff Powell[4]
[1]Alabama Department of Environmental Management, Montgomery, AL, United States; [2]Alabama Department of Natural Resources, Montgomery, AL, United States; [3]Geological Survey of Alabama, Tuscaloosa, AL, United States; [4]US Fish and Wildlife Service, Daphne, AL, United States

Abstract
With a variety of physiographic regions and aquatic habitats, Alabama has one of the most diverse populations of aquatic life in North America. Historically, Alabama waters were home to over 170 species of freshwater snails, more than 170 species of freshwater mussels and over 300 species of freshwater fishes. Currently, the number of mussels, snails, crayfish, and aquatic turtles in Alabama exceed those of all other states, and Alabama is second only to Tennessee in the number of freshwater fish species. Approximately 300 species of mussels are recognized in the U.S. and Canada, with 178 species found in Alabama. Alabama has one of the largest fish faunas of any comparable area in the temperate world, with 54% of the extant freshwater fishes of the southeastern United States represented, and 38% of the extant freshwater fishes of the entire United States and Canada combined. Alabama also has 84 of the more than 300 species of crayfish known to North America.

To monitor water quality in the midst of this amazing diversity, wadeable river and stream monitoring is conducted through the ADEM Rivers and Streams Monitoring Program (RSMP), monitoring of larger, nonwadeable rivers and reservoirs through the Rivers and Reservoirs Monitoring Program (RRMP), and monitoring of contaminants in fish through the Fish Tissue Monitoring Program (FTMP).

During this presentation the aquatic biodiversity of Alabama will be discussed, along with water quality monitoring programs within the state. In addition, information on the Alabama Aquatic Biodiversity Center (AABC) will be presented. The AABC is the largest state non-game recovery program of its kind in the United States and is operated by the Alabama Department of Conservation and Natural Resources.

South Carolina's Integrated Indices Approach for Assessing Water Quality, Sediment Quality and Biotic Condition and Its Uses by Resource Managers

Bob Van Dolah[1], Derk Bergquist[1], David Chestnut[2]
[1]South Carolina Department of Natural Resources, Marine Resources Research Institute, Charleston, SC; [2]South Carolina Department of Health and Environmental Control, Bureau of Water, Columbia, SC

Abstract
The South Carolina Estuarine and Coastal Assessment Program (SCECAP) has been evaluating the condition of South Carolina's estuaries since 1999 using a probability-based sampling design and sampling 30-60 stations per year. Integrated indices of condition have been developed and refined for water and sediment quality, and combined with a benthic index of biotic integrity to form an overall index of habitat quality that is equally weighted for all three components. The Integrated Water Quality Score incorporates six measures: dissolved oxygen, pH, fecal coliform bacteria concentrations, total nitrogen (TN), total phosphorus (TP), and chlorophyll-*a* concentration. Scores for each parameter are based either on state water quality standards, or exceedances of the 75th and 90th percentiles of an 8-year database compiled from SCECAP sampling throughout the state. Scores of the latter three measures (TN, TP, Chl-*a*) are averaged into one score for potential eutrophication risk. This score is then averaged with the scores of the other three measures (DO, pH, fecals) to compute the final IWQS for a site. The Integrated Sediment Quality Score includes three measures: a combined measure of sediment contaminant concentrations related to benthic responses (ERM-Q, sediment toxicity based on 2-3 assays, and TOC. The rationale and benefits/limitations of different scoring procedures will be presented along with results obtained from the first 8 years of the program. This includes relationships of benthic condition to the other indices and parameters. Because the SCECAP scoring process is easy to understand and simplifies results representing many parameters, the data are requested and utilized by a wide-variety of users, including coastal municipalities, resource managers and scientists at state and federal levels, and NGOs.

Session I2: Tracking What Flows Downhill: Microbial Source Tracking

New Jersey's Application of Microbial Source Tracking Techniques in Recreational Waters

Eric Feerst, Virginia Loftin, Robert Schuster
New Jersey Department of Environmental Protection, Water Monitoring & Standards, Bureau of Marine Water Monitoring, Leeds Point, NJ, United States

Abstract
Microbial Source Tracking (MST) Methods have recently been applied to help identify sources responsible for the microbial contamination of fresh and marine waters in New Jersey. This presentation will describe the application of MST methods to ocean waters impaired for recreational bathing at Spring Lake and Sea Girt, New Jersey. In the study area most closures are due to a "precautionary policy", where the beaches are closed after rain events greater than 0.1 inches.

New Jersey uses a tiered approach to microbial source tracking. This approach includes performing, the evaluation of long-term bacteria monitoring data to identify impacted areas, sanitary surveys, GIS land use coverage, hydrographic studies, inventories of actual and potential pollution sources, stormwater monitoring, laboratory analysis of conventional microbial indicators, and the use of the following specialized tests, F+RNA coliphage, Antibiotic Resistance Assay (ARA), and Optical Brighteners.

Data resulting from the above process are compiled for both spatial and temporal analysis. Patterns of traditional indicators in the water in relation to physical factors such as tide or rainfall provide information on pollution sources. The specialized tests provide information about the sources, human versus animal. This results is an assessment of the principal sources of microbial pollution relating to water quality impairment and the ability to prioritize the sources based on their degree of public health concern. Results of this study suggest the primary source of microbial contamination is from failing sanitary infrastructure at several locations.

Occurrence and Sources of Escherichia coli *in Metropolitan St. Louis Streams, October 2004 through September 2007*

Jerri V. Davis[1], Donald H. Wilkison[2]
[1]U.S. Geological Survey, Rolla, MO, United States; [2]U.S. Geological Survey, Lee's Summit, MO, United States

Abstract
The Metropolitan St. Louis Sewer District (MSD) is a customer-owned utility providing sanitary sewage and stormwater service to properties within the 535 square miles of St. Louis City and County. MSD, in cooperation with the U.S. Geological Survey (USGS), has been developing a baseline of stream stage, discharge, and water-quality data for several sub-basins within its jurisdictional area. These data will be used by engineers to develop stormwater management strategies that address concerns resulting from the U.S. Environmental Protection Agency's Phase II stormwater regulations. One concern is the presence of large densities of fecal indicator bacteria, including *Eschericia coli* (*E. coli*), in streams. Identification of the possible sources of *E. coli* would provide MSD with data to help determine the effects of Sanitary Sewer Overflow (SSO) and Combined Sewer Overflow (CSO) on the fecal indicator bacteria densities in streams that receive overflow during storm events.

The USGS utilized microbial source tracking techniques, including repetitive polymerase chain reaction (rep-PCR) and *thetaiotaomicron* (*B. tim*), to help identify the primary sources of *E. coli* in select streams from October 2004 through September 2007. Samples were collected for rep-PCR, *B. tim*, and fecal indicator bacteria analysis at 3 sites on the Missouri River, 5 sites on the Mississippi River, and 6 sites on small streams affected by SSO or CSO and urban runoff. In general, 5 to 6 base-flow and 2 to 3 storm-event samples were collected each year. A St. Louis area source library was developed from locally collected landscape samples, including dog and goose feces and sewage samples. The rep-PCR, *B. tim*, and fecal indicator bacteria data were analyzed to identify potential sources of *E. coli* in these streams. Data indicated that *E. coli* at most sites in the study area came from multiple sources, including some portion that could be attributed to human sources. Samples from small streams typically had higher *E. coli* densities than did samples from the Missouri or Mississippi Rivers, which was especially evident in storm-event samples.

A multifaceted approach to microbial source tracking within the natural environment

Monroe, M.[1], J. Munakata-Marr[2], G. Brown[3], L. Barber[3], D. Scott[4]
[1]Tetra Tech, Golden, Colorado 80401, USA; [2]Colorado School of Mines, Environmental Science and Engineering, Golden, Colorado 80401, USA; [3]United States Geological Survey, Boulder, Colorado 80302, USA; [4]City of Boulder, Boulder, Colorado, 80301 USA

Abstract
To address the concern of elevated *Escherichia coli* (*E. coli*) from possible wastewater contamination, a multifaceted "toolbox" approach was employed to investigate the correlation of alternative wastewater constituents with sites with known elevated concentrations of *E. coli*. The primary objective was to implement state-of-science source-tracking tools to identify analyses that allowed for detection of wastewater contamination in the environment, specifically contamination within an urban drainage area. A rudimentary evaluation of *E. coli* persistence within sediments enhanced source-tracking data at select locations.

Boulder Creek in Boulder, Colorado was listed as impaired by *E. coli* in 2006. Samples were collected in 2007-2008 from storm drain outfalls within the urban corridor of Boulder, Colorado.

Utilizing fluorescence, quantitative polymerase chain reaction, enzyme linked-immunosorbent assays and gas-chromatography-mass spectrometry, areas of concern associated with constituents such as *E. coli*, *Bacteroides*, total organic carbon, caffeine, bisphenol-A, estradiol and triclosan were successfully identified. Despite detection, no correlation could be found between *E. coli* and/or alternative wastewater indicators.

Semi-quantitative evaluation of fecal contamination by human, ruminant, and alternate sources in Upper Fountain Creek, Colorado

Donald M Stoeckel[1] and David P Mau[2]
[1]don stoeckel environmental, Columbus, Ohio 43202; don@dsh2o.com; [2]USGS Colorado Water Science Center, Southeast Colorado Office, Pueblo, Colorado 81003; dpmau@usgs.gov

Abstract
Management of sanitary quality for inland recreational waters of the United States—such as Upper Fountain Creek, Colorado—is hindered by lack of data to inform management decisions for impaired waters. Emerging protocols for microbial source tracking of fecal contamination have successfully identified when a human or nonhuman source of contamination is present but, thus far, have been unable to distinguish samples with trace levels of human-source (or other source) fecal contamination from those with higher levels, relevant to water-quality standards. A mathematical approach to estimation of *E. coli* contribution from various sources, based on the concentration and distribution of microbial source tracking markers, was developed. The approach was validated using dilute fecal suspensions, and then applied to an impaired headwater stream in the Rocky Mountains. The overall data pattern indicated that, contrary to expectations, birds rather than humans or ruminants were a major cause of fecal contamination to Upper Fountain Creek in summer months. Although human- and ruminant-associated markers often were detected, concentrations in water samples were not high enough to meet expectations based on marker concentrations and *E. coli* densities in reference feces. The pattern of high summer *E. coli* densities (relative to cool-weather months and local standards) combined with low concentrations of general and host-associated microbial source tracking markers, low concentrations of nutrients, and infrequent detection of wastewater-associated chemicals was consistent with bird sources. Contamination by any of the other animals tested (human, ruminant, pet, horse) would have resulted in a different pattern. Without the semi-quantitative approach described, the frequency of simple detects of the human-associated marker would have supported the expectation that human contamination was a major source of fecal contamination and may have led to costly, likely ineffective management action aimed at control of human contamination sources.

Session I3: 21st Century Technical Tools for Water Quality Assessments

Ecosystem Services Monitoring and Valuation for Better Environmental Decision-making

Jawed Hameedi[1] and Michael McDonald[2]
[1]National Oceanic and Atmospheric Administration, Center for Coastal Monitoring and Assessment., Silver Spring, Maryland; [2]U.S. Environmental Protection Agency, Office of Research and Development, RTP, NC

Abstract
Ecosystems provide a broad range of goods and services to people, including aesthetic value. NOAA and EPA, as well as other agencies and organizations, have ongoing research and assessment programs to document such services, highlighting the economic value of a clean environment and, conversely, the cost of pollution. Ecosystem service valuations are made for tangible assets (e.g., economic value of commercial fish landings or a recreational fishery), ecosystem functions (e.g., nutrient removal), and less tangible services (e.g., a sunset over a salt marsh), not all of which are equally appreciated by society. Thus, it is not certain if, or how, valuation of the world's ecosystems (estimated at twice that of the annual global gross domestic product, currently $60 trillion), or even the value of an individual species (individual horseshoe crab's value may be up to $2,500 in Delaware Bay) has been incorporated into the cost-benefit analyses or environmental decision-making at levels from local to national to global. There are also human health costs associated with the loss of ecosystem services that have

not been readily appreciated. Forests remove particulate matter from the air reducing asthma and lost economic productivity, and extending the life of the general population. Coastal wetlands protect against storm surge and flooding and its concomitant loss of life and property. There are real costs associated with the loss of ecosystem services and real value associated with their restoration. Until we can monitor these ecosystem services and include their value in a true cost accounting, our environmental decisions will be limited and the full range of ecosystem services needed for our health and well-being will be lost.

Better Monitoring Program Management through the ATTAINS System

Charles Kovatch
U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans and Watersheds, 1200 Pennsylvania Ave NW MC-4503T,Washington, DC 20460

Abstract
State monitoring programs can benefit from an integrated water monitoring and assessment program. Every two years under the Clean Water Act, states submit to EPA an Integrated Report that describes the condition of a state's assessed waters (305b) and lists those waters that are deemed impaired or not meeting water quality standards (303d). Historically, these reports occurred separately through the 305b and 303d processes, and the reports often did not align. As a result, the reports would contain discrepancies and inaccurately represent the status of a state's waters. In an effort to improve state reporting, EPA is taking steps to integrate the 305b and 303d programs through policy and technical support. The Assessment Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS) provides information reported by the states to EPA about the conditions in their surface waters and joins the 305b, 303d, and TMDL reports into one data set. The data is displayed charts and maps. All data within ATTANS are linked to National Hydrography Dataset, which enables geographical analysis with other water program data. Through data integration with ATTAINS, program managers have another tool to better support decision making on water program policies, resource decisions, and program measures.

Data Management, Integration and Sharing at the State and Regional Level

Dave Wilcox
Gold Systems, Inc., Salt Lake City, UT, United States

Abstract
This presentation will discuss the use of the web-based Ambient Water Quality Monitoring System (AWQMS) to facilitate the sharing of data on both the state and regional level. Two separate implementations of this software will be explored with the advantages to each of the communities highlighted. The first implementation is with the Colorado Data Sharing Network where AWQMS is used to support volunteer programs as well as state and local government agencies throughout the state of Colorado. The second use of the software is on a regional basis with the EPA Region VIII Tribes.

In each implementation, AWQMS provides the programs with the ability to securely manage their data independently, share their data regionally, or submit their data via the Water Quality eXchange (WQX) where it is made available nationally.

Where's the Data? Improvements in Access to USGS Water Data

Gary T. Fisher[1], Yvonne E. Stoker[2]
[1]U.S. Geological Survey, Office of Water Information, Baltimore, MD, United States; [2]U.S. Geological Survey, Office of Water Quality, Tampa, FL, United States

Abstract
The USGS National Water Information System (NWIS) includes publically accessible data for more than 1.5 million sites, including 377,000 sites with water-quality data, 4.8 million water-quality samples, and 89 million discrete analyses. These data have been provided online since 2001 at http://waterdata.usgs.gov/nwis. Recent enhancements enable searches for sites or samples by discrete parameters, revised groups of parameters, and searches for sites using an interactive map. Discrete water-quality data are now searchable by USGS Parameter Code, American Chemical Society Registry Number, and USEPA Substance Registry System Names. Parameter grouping has been revised to a common schema for data from USGS and USEPA. The NWIS Mapper adds map-based searching by location for specific site types and for active, inactive, and real-time sites. In addition to on-screen access to data from a clickable map, the NWIS Mapper provides a clickable list of search results and a KML file that can be used in other mapping applications. These enhancements complement additions made in the last year that provide daily updates of water-quality data, and links to USGS real-time water-quality data from across the Nation. Also, improved system performance has enabled an increase in the allowable size of a single download from 20,000 to 35,000 site records.

USGS is also working with USEPA to provide consistent web services to access water-quality data from NWIS and STORET. The use of web services to obtain data is growing rapidly, particularly by users who require regular or automated access to data. These services are described at http://qwwebservices.usgs.gov/.

Session I4: Integrated Land-to-Sea Assessments Based on Multiple Networks

Using multiple lines of information to develop eelgrass-based nutrient criteria for New Hampshire's Great Bay Estuary

J. Ruairidh Morrison[1], Philip Trowbridge[2,3], Paul Currier[3], Shachak Pe'eri[4], Frederick T. Short[5]
[1]Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS), Rye, NH; [2]Piscataqua Region Estuaries Partnership (PREP), University of New Hampshire, Durham, NH; [3]New Hampshire Department of Environmental Services (NHDES), Concord, NH; [4]Center for Coastal Mapping (CCOM), University of New Hampshire, Durham, NH; [5]Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH

Abstract
Increasing nitrogen concentrations and declining eelgrass beds in the Great Bay Estuary, NH are clear indicators of impending problems for the state's estuaries. A workgroup established in 2005 by the NH Department of Environmental Services and the Piscataqua Region Estuaries Project (PREP) adopted eelgrass survival as the water quality target for nutrient criteria development for NH's estuaries. The establishment of nutrient criteria will result in substantial effort and cost to individuals, municipalities, and industries in the watershed for nutrient reductions from point and nonpoint sources, so criteria must be fully supported by data. Multiple lines of information were used in developing the nutrient criteria including multiple years of grab samples, in situ autonomous observations including stream gauges, aerial eelgrass mapping, and hyperspectral aerial remote sensing. Observing assets from local volunteers, the University of New Hampshire, the state environmental agency, the US Geological Survey, the Great Bay National Estuarine Research Reserve, and the Northeastern Regional Association of Coastal Ocean Observing Systems were integrated to provide a robust dataset for successful analysis and publication of estuary nutrient criteria. Continued monitoring of water quality and eelgrass will be essential to measure performance once the criteria are ratified. Development of these water quality criteria depended on advanced buoy and remote sensing technologies as well as novel analytical techniques.

Bight Regional Monitoring Program: Coordinating existing programs to provide large scale regional assessments in southern California

Meredith D.A. Howard, Martha Sutula, Stephen Weisberg
Southern California Coastal Water Research Project (SCCWRP), Costa Mesa, CA, United States

Abstract
Many organizations conduct high-quality environmental monitoring to assess the potential effects of human activities on southern California's coastal ocean. Formerly, most of this monitoring was focused on assessing site-specific conditions rather than regional management questions of significance. In addition, monitoring program methodologies differed among agencies, which hampered data integration. To address this issue, the Southern California Coastal Water Research Project (SCCWRP) initiated a series of regional monitoring efforts beginning in 1994 and continuing at five year intervals. The Southern California Bight Regional Monitoring Program involves over sixty organizations that contribute scientific expertise and resources to conduct broad scale surveys targeted at answering management questions in an integrated fashion. This effort also incorporates intercalibration exercises to standardize and improve the quality of data collection across the participating organizations.

In 2008, the Bight Regional Monitoring Program expanded from its primary focus on toxic contaminants and their biological effects into one of several new study components on quantifying regional nutrient loading and subsequent biological response, particularly with respect to harmful algal bloom species. The study design leverages resources from existing NPDES monitoring programs that measure nutrient loading (e.g., at wastewater discharge and stormwater agencies), and additionally includes measurements of atmospheric loading and natural nutrient additions through upwelling. Investigation of the linkages to biological response is being accomplished through coordination with academic research programs that employ new molecular techniques to measure the density of algal species and their toxin byproducts. The program also partners with the Southern California Ocean Observing System (SCCOOS). SCCOOS uses high frequency radar and autonomous underwater vehicles to produce continuous oceanographic condition data, which feed directly into models for hindcasting and forecasting how nutrient conditions contribute to algal blooms. Collectively, this study approach provides an excellent model for integrating routine monitoring, academic research, and advanced oceanographic sensors into a cohesive regional program that addresses questions of management interest.

A Preliminary Evaluation of Trinity River Sediment and Nutrient Loads into Galveston Bay, Texas, During Two Periods of High Flow

Michael Lee
U.S. Geological Survey, Texas Water Science Center, Gulf Coast Program Office, 19241 David Memorial Drive, Suite 180, Conroe, TX 77385, ph. (936) 271-5313

Abstract
Galveston Bay is a shallow estuary in southeastern Texas; the Trinity River watershed is largest contributing area to the bay. The Trinity River watershed extends from Galveston Bay northwestward to the Dallas/Fort Worth area, and the river is regulated by several reservoirs; Lake Livingston in southeast Texas is the largest. The Trinity River contributes more than 50% of the average total inflow to Galveston Bay and historical sediment concentrations in the Trinity River can vary appreciably upstream from the entrance into the estuary.

In 2009, the U.S. Geological Survey (USGS), in cooperation with the Texas Water Development Board, began evaluating the variability of sediment and nutrient loads in the lower reaches of the Trinity River during a variety of hydrologic conditions. Suspended-sediment and water-quality data measured during two periods of high flow, one during April 20–23, 2009, and a second during September 22–November 3, 2009 are evaluated. On the basis of streamflow and continuous and discrete water-quality measurements, the two periods of high flow had different flood and nutrient loading characteristics. Some differences in the nature of these two periods of high flow were evident. Preliminary results indicate that it might be possible to better understand the extent of sediment and nutrient loading in Galveston Bay using selected measurements of discrete and continuous water-quality data. The r^2 values associated with linear regressions were used to assess correlations between discrete measurements of selected water-quality constituents and continuous measurements of selected physical water-quality properties. An apparent correlation was observed between the concentrations of selected nutrients and suspended sediment. An apparent correlation was also observed between suspended sediment and total nutrient concentration with *in-situ* turbidity measurements during periods of high flow in Trinity River at the USGS streamflow gaging station 08067252 Trinity River at Wallisville, Tex, about 3.5 miles upstream from where the Trinity River enters Galveston Bay. Additional data are needed to confirm these preliminary results.

Combining monitoring programs observations with models to characterize water quality variability and the role of nitrogen loading: informing management of Narragansett Bay

Henry Walker[1], Richard Moore[2], Edward Dettmann[1], Candace Oviatt[3], Daniel Codiga[3]
[1]U.S. Environmental Protection Agency, ORD NHEERL Atlantic Ecology Division, 27 Tarzwell Dr. Narragansett, RI 02882; [2]United States Geological Survey, New Hampshire/Vermont Water Science Center, 361 Commerce Way, Pembroke, NH 03275; [3]University of RI, Graduate School of Oceanography, Narragansett, RI 02882

Abstract
The proposed National Monitoring Network is a framework for linking water quality monitoring in coastal bays, estuaries and the Great Lakes with observations in upland areas and offshore waters, and includes freshwater flows and contaminant inputs from inland and coastal rivers, groundwater, and atmospheric deposition. We use: (1) nutrient fluxes measured in rivers by multiple state and federal agencies and modeled as part of the USGS National Water Quality Assessment (NAWQA) program; (2) probability-based surveys from EPA's National Coastal Assessment (NCA); and (3) estuarine and coastal monitoring components supported by NOAA. Flux based monitoring data are used in USGS SPARROW models to estimate spatial variations in nutrient fluxes in stream networks. NCA surveys provide physical, chemical and biological information for unbiased comparisons among coastal regions of the U.S., but lack spatial and temporal detail within individual estuaries. Estuary-specific surveys, targeted monitoring, and moored instrumentation can provide additional spatial and temporal detail on within-estuary gradients and dynamics.

We focus on Narragansett Bay to illustrate the combined use of monitoring and modeled results using (a) the New England SPARROW model calibrated to the early 1990s, (b) the Northeast and Mid-Atlantic SPARROW model results calibrated to 2002 nutrient source conditions (USGS), (c) estuary nitrogen mass balance calculations (EPA), and (d) observations from moored instrumentation on a variety of factors affecting stratification and episodic hypoxia events (NOAA). Recent analysis from moored instruments documents variations in stratification which appears closely linked to hypoxic events over a broad range of time scales. However, a multiple linear regression using a range of physical and biological parameters (including stratification), available from monitoring programs and meteorological analyses, did not capture variability in hypoxic event severity well. This motivates application of more sophisticated analysis methods. Relative importance of nutrient loads, meteorologic/hydrologic cycles, and climate variations remain to be determined.

Combined monitoring and modeled data help inform management related to: (1) control of nitrogen loading to Narragansett Bay from sewage treatment plants in the Narragansett Bay watershed; and (2) the effectiveness of management actions in the context of other factors affecting the bay and diverse human uses of this estuary.

Session I5: Contaminants in Groundwater

Distribution of Naturally-Occurring Perchlorate in Groundwater in the Southwestern US

Miranda S. Fram[1] and Kenneth Belitz[2]
[1]U.S. Geological Survey, California Water Science Center, Sacramento, California; [2]U.S. Geological Survey, California Water Science Center, San Diego, California

Abstract
Perchlorate from natural and anthropogenic sources occurs in groundwater in the Southwestern US. In this study, we distinguish between perchlorate from natural and anthropogenic sources on a groundwater-basin scale, and use logistic regression to predict the probability of detection of perchlorate from natural sources across a wide aridity gradient. Groundwater samples were collected from over 1600 wells in California, and were analyzed for perchlorate, VOCs, pesticides, nutrients, and other water-quality constituents as part of the California Groundwater Ambient Monitoring and Assessment (GAMA) Program Priority Basins Project. The wells were sampled in 30 study units representing a range of climatic, hydrologic, and land-use conditions. Within each study unit, the strengths of potential industrial (primarily aerospace) and agricultural (Chilean nitrate fertilizer) sources were assessed by testing the significance of correlations between perchlorate and VOCs (solvents and fuel components), density of or distance to the nearest sites of known perchlorate contamination, and percentage of urban land use for industrial sources, and perchlorate and pesticides (including fumigants), nitrate, and percentage of agricultural land use for agricultural sources. Logistic regression for the entire dataset used two variables: aridity index (average annual precipitation divided by average annual evapotranspiration) and an anthropogenic influence index (integer 0 to 5, counting the number of anthropogenic indicators present: solvents or fuel components, pesticides or fumigants, nitrate > 10 mg/L, trihalomethanes > 0.1 μg/L, and proximity to known sites). Regressions were made for data screened at perchlorate reporting limits of 0.1, 0.5, 1, and 4 μg/L. Perchlorate detection probabilities predicted by the aridity index term alone agreed well with observed detection frequencies in study units in which there were no significant correlations between perchlorate and markers of industrial or agricultural sources, indicating that the aridity index term adequately described the distribution of naturally-occurring perchlorate in relatively deep groundwater in California. Probabilities were then predicted for the entire Southwestern US. Results suggest that concentrations of naturally-occurring perchlorate are low, mostly < 0.5 μg/L and rarely > 1 μg/L, and that the probability of detection is non-negligible across a wider range of climate conditions than previously considered.

Virus Concentrations in Non-Disinfected Groundwater Used for Drinking: Association with Community Rates of Acute Gastrointestinal Illness

Mark Borchardt[1], Susan Spencer[1], Burney Kieke, Jr[1], Elisabetta Lambertini[2], Frank Loge[2]
[1]Marshfield Clinic Research Foundation, Marshfield, WI; [2]University of California - Davis, Davis, CA

Abstract
Human enteric viruses are present in the source waters (surface water and groundwater) of many municipal drinking water systems in the United States. Although viruses can be detected by molecular methods, the relationship of these measurements to human health risk is unknown. In the present study virus levels quantified in the tap water of 14 Wisconsin communities that use non-disinfected groundwater as their drinking water source were related to community rates of acute gastrointestinal illness (AGI). Virus samples were collected monthly from eight households per community by passing tap water through a novel glass wool filter. Six virus groups were quantified by real-time qPCR: enterovirus, adenovirus, hepatitis A virus, rotavirus, and norovirus genogroups I and II. AGI incidence rates were estimated from health diaries completed weekly by participating households within each study community (n = 673 households, 1786 people). AGI surveillance and virus sampling were conducted for four three-month periods in 2006 and 2007. AGI incidence was related to virus concentrations using Poisson regression with random effects. Among 1,204 tap water samples from 14 communities, 287 (24%) were positive for at least one virus type and 41 (3%) were positive for two or more types. The most frequently detected types were adenoviruses, enteroviruses, and GI noroviruses. Concentrations of enteroviruses and G1 noroviruses were on the order of ones to hundreds genomic copies/liter, whereas adenovirus concentrations were one or two orders of magnitude lower. AGI incidence, unadjusted for age, ranged from 1.4 to 5.0 episodes person year^{-1} between communities and surveillance periods. The arithmetic mean and maximum concentration of total viruses in the communities' tap water was positively associated with AGI (P-values = 0.012 and 0.006, respectively). Virus exposure resulting in significantly elevated AGI risk occurred whenever the mean concentration of enteric viruses was greater than two genomic copies per liter. Similar significant associations were observed between genogroup I norovirus and AGI. Enterovirus levels were weakly related to adult AGI and no relationship was found between AGI and adenoviruses. Research is ongoing in these communities to determine the proportion of AGI attributable to drinking water exposures.

Natural Contamination of Domestic Wells in Rural Northern Nevada

Ralph Seiler
U.S. Geological Survey, Carson City, NV, United States

Abstract
Owners of domestic wells in Lahontan Valley, near Fallon, in northern Nevada are exposed to several natural contaminants in their drinking water, including arsenic, tungsten, uranium, and polonium-210 (^{210}Po). The U.S. Geological Survey (USGS) studied groundwater quality in the valley in 1989 as part of the NAWQA, and in 2001 USGS undertook a detailed reconnaissance of groundwater quality in the valley as part of a Centers for Disease Control and Prevention (CDC) investigation of a childhood cancer cluster. Since 2001, USGS has also investigated the occurrence of radionuclides in groundwater and the potential for shock chlorinating wells to inadvertently expose well owners to lead. The goals of those investigations have been to (1) understand processes responsible for natural contamination and (2) provide the data used to answer questions about levels of exposure to contaminants and temporal changes in contaminant concentrations, and to evaluate the effectiveness of water-treatment options. Drinking-water standards for arsenic and uranium are commonly exceeded in domestic wells in the valley, and concentrations for both sometimes exceed 1,000 μg/L. Monitoring for arsenic and uranium in numerous domestic wells indicates their concentrations have not changed since 1989. In 2002 CDC discovered residents of the valley have levels of urinary tungsten that are much higher than the national population, which prompted an investigation by USGS on the occurrence of tungsten in aquifers used as drinking water sources. The maximum tungsten concentration was 742 μg/L and approximately 20 percent of the domestic wells had concentrations >100 μg/L. Stable isotope data showed water in most contaminated wells was more than 100 years old, indicating a natural tungsten source. Findings in 1989 and 2001 that gross alpha radioactivity greatly exceeded the uranium activity in some wells led to the discovery in 2007 of ^{210}Po at some of the highest reported levels in the United States. Repeated measurements over periods longer than its half life indicate steady-state production of ^{210}Po in the aquifer, and that under some circumstances gross-alpha radioactivity and uranium activity can be used to predict ^{210}Po activity.

Predicting the probability of arsenic occurrence in groundwater from bedrock wells in New Hampshire for Environmental Public Health Tracking

Joseph Ayotte[1], Matthew Cahillane[2]
[1]U.S. Geological Survey, Pembroke, NH, United States; [2]New Hampshire Department of Health and Human Services, Concord, NH, United States

Abstract
Inorganic arsenic in groundwater used for drinking water has been a worldwide concern due to adverse impacts on human health such as carcinogenic and other health outcomes related to ingestion. Arsenic is prevalent in groundwater from bedrock aquifers in New England and concentrations in bedrock well water are generally low to moderate (< 10 to 50 μg/L). One study estimated that over 100,000 people in eastern New England have wells with groundwater arsenic concentrations exceeding the U.S. EPA standard of 10 μg/L. Parts of the region, particularly in New Hampshire and Maine, have well water arsenic concentrations exceeding 1,000 μg/L, although such occurrences are rare. A previous regional model predicting groundwater arsenic concentrations exceeding 5 μg/L indicated that geologic information was among the most significant predictors. Other predictors included hydrologic and geochemical determinants. Health outcomes related to well water arsenic are currently being investigated in the northeast U.S. and in Atlantic Canada.

In this study, regression analysis is used to model arsenic in bedrock groundwater across New Hampshire and the results (probabilities of exceeding various threshold concentrations) will be stored in the New Hampshire Environmental Public Health Tracking (EPHT) database (www.nh.gov/epht/), a CDC-funded initiative for linking environmental hazards to potential public health impacts. New dependent and independent variable data, as well as support from the New Hampshire Environmental Public Health Tracking program, was the impetuous for developing a state-specific arsenic model. Sixty-six percent of 1,576 observations had groundwater arsenic concentrations $\geq$ 1 μg/L and 21% were $\geq$ 10 μg/L. Models predicting the probability of arsenic in groundwater at thresholds of 1, 5, and 10 μg/L were evaluated. Preliminary explanatory variables include regional and local-scale geologic information, rainfall, recharge, elevation, glacial marine inundation, stream alkalinity, stream-sediment geochemistry (Al, Na, As, V, Ba), land use, population density, and waste-site information. Results from the model may have application in raising awareness among residents of areas with predicted high arsenic levels, or in implementing public health risk reduction activities.

Session I6: Prioritization of Chemicals for New Methods Development

Disinfection By-Products: Research Plans of the United States Geological Survey

Michelle L. Hladik[1], Michael J. Focazio[2], Colleen E. Rostad[3], and Gregory C. Delzer[4]
[1]U.S. Geological Survey, California Water Science Center, Sacramento, CA, United States; [2]U.S. Geological Survey, Office of Water Quality, Reston, VA, United States; [3]U.S. Geological National Research Program, Denver, CO, United States; [4]U.S. Geological Survey, NAWQA National Synthesis, Rapid City, SD, United States

Abstract
The U.S. Geological Survey conducts research on new and understudied water-quality issues. Recently, the USGS has explored, and written a conceptual research plan to study, the chemical by-products of water disinfection as potential ecological- and human-health issues. Disinfection of drinking waters is one of the most important advances in public health that has occurred over the last century. But since the 1970s researchers and health officials have recognized the potential implications related to human exposures to disinfection by products (DBPs). The U.S. Environmental Protection Agency has set drinking water standards for 9 DBPs including 4 trihalomethanes and 5 haloacetic acids. However, several hundred DBPs have been identified either through direct monitoring or modeling of disinfected waters. Carcinogenicity and genotoxicity studies of many DBPs have been documented and suggest that the currently regulated DBPs may not be among the most toxic to humans or ecological systems. In addition, reproductive endocrine system impacts to vertebrates exposed to disinfected water has been alleged.

The USGS is planning a multi-phase, long-term study of DBPs from source-to-receptor. The research will include efforts to prioritize DBPs based on potential health impacts, sources of precursor material, type of disinfection, and ability to detect the targeted molecules at relevant levels. Method development activities will then take place using state-of-the-art mass spectrometric techniques for the prioritized DBPs and precursors. After a requisite set of field reconnaissance efforts of disinfected sources of wastewater, re-use water, and drinking water the research will further prioritize research needs for studies on the behavior of DBPs in the environment including relations between precursor compounds and DBP formation potential, natural attenuation of DBPs, and aquatic-life and human exposure. The plan also calls for laboratory and controlled field studies for concurrent investigations of targeted aquatic-life-health impacts potentially associated with DBP exposures.

Prioritization of High-Production-Volume Chemicals for Assessing Water Resources

John Zogorski[1], James Pankow[2]
[1]U.S. Geological Survey, National Water-Quality Assessment Program, Rapid City, SD, United States; [2]Portland State University, Civil-Environmental Engineering and Chemistry Department, Portland, OR, United States

Abstract
The chemical industry produces many thousands of different organic compounds that are in widespread use across the United States. Some of these compounds are classified as high-production-volume (HPV) chemicals based on an estimated production volume exceeding one million pounds per year. As part of this study, about 1,700 HPV chemicals were systematically evaluated for priority of monitoring in the National Water-Quality Assessment Program of the U.S. Geological Survey (USGS). Emphasis was placed on HPV chemicals that are expected to occur in the water phase of source waters derived from surface water.

Four variables were used and given a score to rank each HPV chemical including: (1) the low-end of the estimated production volume, (2) chemical end use, (3) persistence, and (4) Kow value. A Chemical Prioritization Ranking System (CPS) Calculator was developed and facilitated the evaluation of these four variables. The CPS Calculator is a computational tool for inputting relevant data, manipulating that data by user-designed algorithms, and ranking the results.

Output from the CPS Calculator identified about 150 HPV chemicals that are expected to occur frequently in surface water. These chemicals are being further evaluated to characterize the current state of knowledge concerning adverse human- and aquatic-life effects. In parallel, the feasibility of adding these HPV chemicals to existing USGS approved methods or new methods is in progress.

This study of HPV chemicals is one of several activities by the USGS to identify organic chemicals for inclusion in future monitoring programs. Collectively, these activities will result in an enhanced focus for ambient water-resource assessments.

Pharmaceuticals in the Environment: A Prioritization for Analytical Methods Development

Edward T. Furlong[1], Michael T. Meyer[2], Dana W. Kolpin[3], Herbert T. Buxton[4]
[1]U.S. Geological Survey, National Water Quality Laboratory, Denver, CO, United States; [2]U.S. Geological Survey, Kansas Water Science Center, Lawrence, KS, United States; [3]U.S. Geological Survey, Toxic Substances Hydrology Program, Iowa City, IA, United States; [4]U.S. Geological Survey, Toxic Substances Hydrology Program, Trenton, NJ, United States

Abstract
Human and veterinary pharmaceuticals are now recognized as environmental contaminants that are a potential concern on a global scale. Thousands of pharmaceuticals and their metabolites and degradates can enter the environment through a variety of sources and mechanisms. Thus, studies are needed to quantify the relative contributions of complex sources (e.g. wastewater treatment plants, septic systems, and animal agriculture, etc.), characterize the persistence of pharmaceuticals in the environment, and understand potential effects from ecological exposure and uptake. To successfully accomplish such research, the ability to measure pharmaceutical compounds in a wide range of complex environmental matrices, including human and animal wastewaters and waste solids, water, sediments, soils, and tissue is required. In response, substantial progress has been made developing and/or improving analytical methods using sensitive tools such as tandem mass spectrometry (MS/MS) to determine concentrations down to nanograms per liter or nanograms per kilogram (part-per-trillion) levels. While the U.S. Geological Survey can currently measure over 100 such pharmaceutical compounds, this represents only a small number of possible pharmaceutical contaminants to the environment. Thus, a prioritization scheme is required to efficiently determine where future analytical methods development efforts should be focused. Criteria for prioritization must include consideration of chemical toxicity, quantities manufactured, use and disposal patterns, environmental persistence, and other factors. Efforts to implement such a prioritization scheme are underway within the U.S. Geological Survey to enhance the current analytical method capabilities for pharmaceuticals and to be prepared to meet the highest priority research needs.

Prioritizing Pesticide Compounds for Water Quality Assessment Based on Potential Importance to Human and Ecological Health

Julia Norman, Kathryn Kuivila
U.S. Geological Survey, 6000 J Street, Sacramento, CA 95819

Abstract
The U.S. Geological Survey (USGS) has been assessing the occurrence and fate of pesticides in the environment for over two decades. But there is a continual need to re-evaluate which pesticides and degradates are being studied in response to the introduction of new chemicals, changing pesticide use patterns, and increasing knowledge about potential human and ecological effects. Although all appropriate environmental compartments will eventually be considered, the re-evaluation began with a focus on surface water. A strategy was developed to prioritize pesticides and degradates based on predicted pesticide concentrations in streams relative to aquatic life and human health concerns. The previously-developed Watershed Regressions for Pesticides (WARP) methodology was applied using recent (2007) agricultural pesticide-use intensity in watersheds and factors accounting for the physical-chemical properties of each compound. For pesticide degradates, the use-intensity of the parent pesticide was substituted in the calculation. Estimated 95th percentile and annual mean concentrations were determined for individual stream reaches. For each pesticide compound, the maximum 95th percentile and annual mean concentration were determined for comparison to aquatic life and human health water-quality benchmarks, respectively. Ratios of these concentration statistics to water-quality benchmarks were calculated and used to prioritize pesticide compounds for potential effects on aquatic life and human health. A subsequent evaluation will be conducted to identify which pesticides and degradates should be measured in other environmental matrices, such as sediment and tissue. Appropriate analytical methods will be developed to measure the compounds of interest in the appropriate matrices at the levels of environmental concern. The USGS will use the results of this comprehensive prioritization process to help guide the design of future water quality assessments with an emphasis on potential importance to human and ecological health.

Session J1: Coastal and Estuarine Assessments

Water Quality Status of the Nation's Coasts: Incorporating the Nearshore Great Lakes into the National Coastal Condition Assessment

Treda S. Grayson and Gregory Colianni
U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans, and Watersheds, Washington, D.C.

Abstract
Working with our partners in the states, tribes, and other federal agencies, the U.S. Environmental Protection Agency (EPA) is conducting statistical surveys of the nation's waters designed to provide nationally-consistent assessments of water quality we can use to gauge the impact of our national investment in protecting and restoring the nation's waters. In collaboration with the National Oceanic and Atmospheric Administration and the U.S. Geological Survey (USGS), EPA has produced three national reports since 2001. These reports present a clear message about the challenges facing our ocean and coastal resources.

Sampling will begin in summer 2010 for the 2010 National Coastal Condition Assessment, which expands upon the previously conducted surveys and includes a Great Lakes component. The survey is designed to answer three key questions: 1) what percent of the nation's coastal waters are in good, fair and poor condition; 2) how widespread are the most significant problems; and 3) what are the trends in marine coastlines and the baseline conditions of the Great Lakes nearshore area from which future trends can me measured?

Although previous reports included information on the Great Lakes, this is the first survey that specifically includes the Great Lakes in the survey design and field implementation. The Great Lakes portion of the National Coastal Condition Assessment will help fill a critical gap in our understanding of Great Lakes by focusing on nearshore areas and providing statistically valid assessments of this critical resource. This talk will provide a brief overview of the national surveys and specifically the NCCA, the assessment goals, the integration of the Great Lakes shoreline into the NCCA, the design of the survey, the indicators that will be collected and plans for implementation.

Regional Assessment of Sediment Contamination from Marshes to the Continental Shelf: Results of the Western Component of the U.S. EPA National Coastal Assessment

Walter Nelson, Henry Lee II, Faith Cole, Janet Lamberson, Patrick Clinton
U.S. Environmental Protection Agency, Western Ecology Division, 2111 SE Marine Science Dr, Newport OR 97365, USA

Abstract
The U.S. EPA National Coastal Assessment (NCA) program on the U.S. West Coast was designed as a pilot project to explore assessment of new components of coastal resources not previously incorporated in the NCA. The Western Regional program began with a two year assessment (1999-2000) of estuarine condition for the states of Washington, Oregon and California. The estuarine intertidal areas, including low emergent marsh habitats, of these states were sampled in 2002. In 2003, an

assessment of condition of the continental shelf of these three states was conducted. This was followed in 2004 with a reassessment of estuarine condition largely equivalent to the 1999-2000 survey. The final NCA assessment of the estuaries of these three states was conducted in 2005-2006, with sampling effort divided approximately equally between the two years. The Western Regional NCA has therefore generated the first comprehensive, probability based data set which may be used to describe the condition of soft sediment benthic resources across the bathymetric gradient from low marsh to 120 m on the continental shelf. Integrated results for sediment contamination parameters (metals, PAHs, PCBs, pesticides) across this bathymetric gradient and across the 8-year span of the study will be presented. Sediment contamination was detected in all portions of the bathymetric gradient examined. However, sediment contamination at levels which exceed the Effects Range Median (ERM) concentration is very limited in spatial extent. In tidal wetlands, only an estimated 0.3 % of total area had any measured contaminant in excess of the ERM. On the continental shelf in depths from 0-120 m, a similar (<1%) extent of sediment contamination was found. A greater spatial extent (3%) of sediment contamination at levels above the ERM was found within the deeper portions of estuarine systems, which typically includes port and harbor facilities. Thus, sediment contamination at levels that affect the benthic community tends to be small in areal extent in the western coastal region. However, sediment contaminants are still present at levels that may be bioaccumulated, generating concern for fish or invertebrate consumption over much larger areas.

Partnering with USEPA to Document Water Quality in our Coastal National Parks

Eva DiDonato
National Park Service, Natural Resource Program Center, Water Resource Division, Fort Collins, CO, United States

Abstract
With the development of the 2006 Ocean Park Stewardship Action Plan and the formation of the Ocean and Coastal Resources Branch in the Natural Resource Program Center, the National Park Service is focusing more effort on issues beyond park shorelines. Currently, water quality is assessed within National Park boundaries but the assessments are not consistent nationwide. The probabilistic survey design used by the USEPA National Coastal Assessment Program provides a mechanism to assess the quality of park waters and to identify water quality issues that may impact park resources, but originate beyond park boundaries. NPS benefits in several ways by using the probabilistic survey design to assess and monitor coastal water quality. At the individual park level, park managers get a snapshot of resource conditions. At the regional level, park managers can compare water and sediment quality inside and outside park boundaries. Examples are presented at the park level by a water quality survey conducted in the National Park of American Samoa, and at the regional level from water quality surveys in five National Parks along the Southeast US coast. A partnership is developing between the NPS Natural Resource Program Center and the EPA National Coastal Condition Assessment to survey water quality at Great Lakes National Parks to complement the planned EPA Great Lakes survey in 2010.

Linking Monitoring Efforts in the Mississippi River Watershed with Monitoring of Hypoxia in the Gulf of Mexico

Nancy N. Rabalais[1], R. Eugene Turner[2]
[1]Louisiana Universities Marine Consortium, Cocodrie, Louisiana USA; [2]Department of Oceanography and Coastal Sciences, Louisiana State University, Baton Rouge, Louisiana USA

Abstract
Hypoxic water masses in bottom waters of the northern Gulf of Mexico occur when the oxygen concentration falls below 2 mg/L. This hypoxic water is distributed across the Louisiana shelf west of the Mississippi River and onto the upper Texas coast, from near shore to as much as 125 km offshore, and in water depths up to 60 m. Hypoxia has become more common east of the Mississippi River delta in recent years. Systematic mapping and monitoring of the area of hypoxia began in 1985. There are multiple models of the size of the hypoxic zone that are useful in evaluating the influence of nitrogen load on its size in summer. One model is based primarily on the nitrate+nitrite load delivered to the Gulf of Mexico by the Mississippi River in May. The residence time of the surface waters along this coast is about 2 to 3 months in the summer, hence the 2-3 month lag between the loading rate calculated in May and the size of the hypoxic zone in July. The statistical model used here is the most accurate model based on past performance. The prediction in 2006 and 2007, for example, was 99% and 107%, respectively, of the measured size. The estimate of nitrate-nitrate loading from the Mississippi River into the Gulf of Mexico is made by the United States Geological Survey (USGS), which publishes estimates of the flow-adjusted nutrient loads to the Gulf of Mexico. The USGS includes an estimate of the 95% confidence range for the nitrogen load, which averages 41% of the predicted value. Exploratory trial runs were made to determine if other nutrients, e.g., discharge, phosphate, ammonium were useful predictors, but the relationships were not as strong in predicting the summer area of hypoxia or were not significant.

Session J2: Development of Reference Condition for Different Purposes and at Different Scales

Landscape Assessment and Predictive Tools: Methods Guidance for Monitoring, Assessment, and Other Clean Water Act Programs

Jim Harrison[1], Susan Cormier[2]
[1]U.S. Environmental Protection Agency, Region 4, Atlanta, GA, United States; [2]U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, OH, United States

Abstract
A new landscape and predictive tools methods manual, developed collaboratively by EPA's Office of Water, Office of Research and Development, Regional Offices and others, describes the purpose, rationale and basic steps for using landscape data and empirical predictive tools for Clean Water Act monitoring, assessment and management purposes. Landscape and predictive tools are needed to guide efficient filling of monitoring gaps and to target and prioritize our protection and rehabilitation actions. This should yield better protection for high quality waters and quicker, more cost-effective restoration of impaired waters.

The document has four sections: (1) Introduction to Landscape and Predictive Tools; (2) Examples and Case Studies; (3) Geographic Frameworks, Spatial Data, and Analysis Tools; and (4) Gaps and Needs for Research and Applications. In addition, the extensive Toolbox provides links to and short descriptions of a wide range of easily accessed datasets and analytical tools. This guidance stresses simultaneous use of matched (or paired) landscape and in-situ data for empirical modeling to enhance our predictive capabilities and encourage science-based targeting and priority setting. The examples and case studies cover a series of real world applications of landscape and predictive tools. They include:

- Impervious area estimates and projections to guide problem identification in EPA Region 4,
- Assessments of the water temperature regime for TMDL development in the Umatilla River Basin in Oregon,
- Integrated Pollutant Source Identification (IPSI) process for analysis of aerial photography to identify a wide range of non-point sources in the Oostanaula Creek watershed of Tennessee and develop/implement a watershed action plan,

- Classification and Regression Tree (CART) analysis to classify natural phosphorus and nitrogen regions of the upper mid-West to aid development of nutrient criteria, and
- Tiered watershed and reach scale reference site screening process in the State of Oregon to identify candidate reference areas based on least disturbed condition.

Landscape and predictive tools have a wide range of current and potential applications including: criteria and standards development, problem identification and prevention, prioritization and targeting of rehabilitation, and advancing science to improve society's ability to effectively manage watershed aquatic and terrestrial resources.

Large River Bioassessment: Challenges and Approaches Used for the Delaware River

Robert Limbeck and Erik Silldorff
Delaware River Basin Commission, 25 State Police Drive, PO Box 7360, West Trenton, NJ, United States

Abstract
The Delaware River Basin Commission (DRBC) has historically assessed the "aquatic life" designated use for the main-stem Delaware River through physical and chemical water quality standards alone. Annual macroinvertebrate monitoring of the Delaware River above the head-of-tide since 2001 provides an opportunity to directly assess the "aquatic life" designated use through direct measurements of the living resources in the Delaware River. With assistance from U.S. EPA, we developed both traditional multi-metric assessment tools as well as multivariate RIVPACS models to translate the biological data into a classification scale. Yet both approaches require "reference" designations to set expectations for healthy or unimpaired biological conditions. In this talk, we describe the development of the biological monitoring program and discuss the decision to use, and the implications of, same-system data for defining reference conditions in this large anti-degradation river on the eastern seaboard.

A Framework for Selecting Least Impacted Reference Streams based on Landscape Models for use in Assessing Biotic Integrity of Wadeable Streams in Wisconsin

Jana Stewart[1], John Lyons[2], Lizhu Wang[3], Matthew Mitro[2], Mike Miller[4]
[1]U.S. Geological Survey, 8505 Research Way, Middleton, WI, United States; [2]WI Department of Natural Resources, 2801 Progress Road, Madison, WI, United States; [3]MI Institute of Fisheries Research, MI Department of Natural Resources, 212 Museums Annex, 1109 N. University Avenue, Ann Arbor, MI, United States; [4]WI Department of Natural Resources, 101 S. Webster, Madison, WI, United States

Abstract
A framework was developed to designate and sample a group of representative wadeable streams with relatively low levels of human impacts in Wisconsin using models that characterize anthropogenic disturbance and classify streams based on thermal and flow regimes. These "least-impacted" reference streams were identified by developing a model to characterize human disturbance for streams based on data representing land cover, population density, transportation, nutrient enrichment, agricultural pollutants, and point sources. Streams were classified into eight natural communities that represent stream temperature-flow combinations for cold, cool-cold transitional, cool-warm transitional, and warm water systems in both wadable headwater and mainstem river systems. Streams were further subdivided into Wisconsin's four major ecoregions, for a total of 32 possible natural community-ecoregion combinations, in which up to 10 discrete least-impacted stream reaches were sampled. Field samples were collected for fish, invertebrates, and habitat, along with a single grab-sample of water for nutrients and suspended sediment during the summers of 2007 – 2009. Data from these "least-impacted" reference reaches will serve as benchmarks for use by watershed managers to provide a realistic estimate of the best-attainable biotic integrity and environmental quality for streams in Wisconsin based on regions and stream types. In addition, these data will be used for model verification and to improve existing bioassessment procedures and develop effective biocriteria.

Selecting Reference Sites Across Ecoregions: The Rocky Mountain ReMAP

Linda Vance[1], Karen Newlon[1], Joanna Lemly[2]
[1]Montana Natural Heritage Program, University of Montana, Helena, MT, United States; [2]Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO, United States

Abstract
Wetland assessment is premised on the idea that key ecological attributes of wetlands vary in a predictable and consistent way in response to human disturbance, and that there are identifiable indicators of changes in those attributes. The challenge inherent in selecting indicators for assessment is finding those that respond only to human disturbance, or at the very least, calibrating metrics to different wetland types so that natural variability within or between wetland types is not misconstrued as a disturbance response. The first step in meeting this challenge involves establishing a baseline reference standard condition. By identifying and describing the natural variability associated with reference condition wetlands, it becomes easier to separate the signal (response to human disturbance) from noise (natural variability) when sampling different types of wetlands across a human disturbance gradient. In the Rocky Mountains, we are fortunate enough to have a wealth of minimally disturbed wetlands. In our current Regional Monitoring and Assessment Project (ReMAP), we are working to define reference standard for six wetland types found across the Rocky Mountains, and to identify natural variation within and between those types. In this presentation, we will discuss issues of classification, and why we chose ecological systems classification over Cowardin or Hydrogeomorphic (HGM) groupings; we will describe our experience selecting appropriate landscape units within which to apply our sampling scheme; and we will demonstrate the screening tool we used to identify areas where minimally disturbed wetlands were most likely to be found. We will also briefly describe the Generalized Random Tessellation Sampling (GRTS) design we used to select sampling locations, and give an overview of field data collection protocols.

Session J3: Integrating Water Quality Indicators to Support Monitoring and Assessment Decisions

Long-term Monitoring: Exploring an Integrated Approach

Douglas J. Yeskis[1], Patrick C. Mills[1], and Arthur R. Schmidt[2]
[1]U.S. Geological Survey, Illinois Water Science Center, 1201 W. University Ave., Suite 100, Urbana, IL 61801, djyeskis@usgs.gov; pcmills@usgs.gov, 217-344-0037; [2]University of Illinois of Illinois at Urbana-Champaign, Department of Civil and Environmental Engineering, 205 N. Matthews Ave., Urbana, IL 61801, aschmidt@illinois.edu, 217-333-4934

Abstract
Long-term monitoring programs commonly have been media specific or integrated over discontinuous spatial or temporal intervals. Environmental monitoring programs currently use frequencies and locations that are linked to resource-management needs, which may not be consistent with the spatial and temporal scales of the underlying environmental processes. Monitoring networks traditionally have been media specific, driven by regulation and division of monitoring responsibilities within and among government agencies. Media specific examples include surface-water, groundwater, or weather networks for the monitoring of trends, hazards, or other user-defined

goals. Discontinuous spatial networks may involve collection of many environmental data from similar, but distributed locations and use of extrapolation to determine environmental changes. As a result, few monitoring sites can be considered fully integrated with respect to the collection, display, and automation of the needed wide range of environmental data. Constraints on the design of existing monitoring networks may include network objectives, cost, funding partners, and other factors.

New cost-effective, real-time presentation of environmental data and an expanding array of automated data sensors offer the opportunity to enhance monitoring programs by integrating the collection and display of diverse inter-related data (surface-water, groundwater, weather, and water-quality, among others). Integrated data would allow a more comprehensive understanding of our environment and the causal factors. However, challenges remain in the implementation of integrated monitoring networks.

The U.S. Geological Survey (USGS), in cooperation with the University of Illinois, is developing a research site where integrated, multi-media, monitoring systems can be developed and evaluated. A component of the monitoring-system design will be its direct association with the national network of USGS real-time streamflow gaging stations. Various design questions to be addressed include: what constitutes effective groundwater, water quality, or biological monitoring that is indicative of near-stream and watershed conditions and is appropriately integrated with other environmental indicators and conditions. Research efforts are intended to demonstrate effective integrated monitoring systems and to increase awareness of the benefits of wider deployment of such systems; particularly to better understand the heterogeneous processes that interact at different scales to produce the variability found in the environment.

Integrated sampling on the Monongahela and Allegheny Rivers; Two Components of the Great River Ecosystem in the Central Basin

Rick Spear[1], Daniel Counahan[1], Gary Kenderes[1], Mark Pearson[2], Tony Shaw[3]
[1]Pennsylvania Department of Environmental Protection, SWRO 400 Waterfront Drive Pittsburgh, PA 15222; [2]U.S. Environmental Protection Agency, Watershed Diagnostics Research Branch, Mid-Continent Ecology Division 6201 Congdon Blvd Duluth, MN 55804; [3]Pennsylvania Department of Environmental Protection, RCSOB 400 Market Street Harrisburg, PA 17105

Abstract
A large river integrated assessment using water quality, physical habitat, and biological measures is being conducted on portions of the Monongahela and Allegheny Rivers; two Great River Ecosystems in the upper Ohio River basin. The biological components include fish, benthic macroinvertebrate, and mollusk sampling. While this assessment employs a probabilistic sample design, additional sites are being targeted to characterize reference conditions and evaluate indicators across condition gradients in these large rivers. The project is building Pennsylvania's capacity to assess conditions of large rivers by providing a beginning foundation for the development of large river assessment protocols for non-wadeable streams. These large river protocols will provide the capability to conduct bioassessments and monitor environmental conditions with a scientifically defensible method applicable to Pennsylvania's non-wadeable rivers. This presentation will focus on first year sampling results, sampling design, large river protocols, and integration of all the different parameters.

Susquehanna River Basin Commission's Environmental Review of Water Withdrawals: Integrating Water Quality, Biological, and Habitat Information into Water Quantity Decision Making

Jennifer L. R. Hoffman
Susquehanna River Basin Commission, Harrisburg, PA, United States

Abstract
The Susquehanna River Basin Commission (Commission) regulates surface and groundwater withdrawals and consumptive uses in the Susquehanna River Basin (Basin) in New York, Pennsylvania, and Maryland. As part of its project review activities, the Commission integrates water quality, biological, and habitat data into its decision-making process for determining appropriate water withdrawal timing and amounts from the Basin's streams and rivers. Increased pressure has been applied to the streams and rivers of the Basin in response to natural gas industry activity in the Marcellus Shale formation, particularly on the smaller coldwater, headwater systems. Water is integral to the sustainable development of the natural gas reserves in the Marcellus Shale formation, both for water supply for hydrofracing gas wells and for disposal of flowback fluids and brines. The Commission has improved and expanded its environmental screening and aquatic resource survey programs for project review activities associated with water withdrawals. Additionally, the Commission will be starting a low-flow monitoring plan to collect ecological information regarding the effects of low flows on in-stream parameters, and has begun developing a network to collect water quality data in real-time on a selected subset of streams in the Basin.

Effective Integrated Physical, Chemical, and Biological Aquatic Monitoring in the Pacific Island National Parks

Tahzay Jones and Anne Farahi
National Park Service, PACN Inventory & Monitoring Program, Hawaii National Park, HI

Abstract
The National Park Service Pacific Islands Inventory and Monitoring Network monitors the status and trends of aquatic resources across the tropical Pacific National Parks in Hawaii, Guam, Saipan, and American Samoa. High costs and complicated logistics required for working in these National Parks has necessitated the development of an integrated approach to ecosystem monitoring which has increased the National Parks Service's capabilities of ecological interpretation of the monitoring information. By co-locating and co-visiting water quality and freshwater animal communities monitoring efforts, direct correlation of biological data to physical and chemical environmental data has increased the interpretability results to management. Additionally, this approach has decreased per sample costs associated with monitoring efforts, allowing increased monitoring results with reduced costs.

Session J4: Overcoming Barriers to Monitoring Collaboration and Partnerships

Collaborative Interagency Efforts in Sampling, Analyzing, and Developing Models for Arsenic and Methyl Mercury Levels in Florida

Kate Muldoon
Florida Department of Environmental Protection, Watershed Monitoring Section, Tallahassee, FL

Abstract
State agencies, federal agencies, and regional entities have recently collaborated on studies to address critical surface and ground water quality issues in Florida. Some of these issues include continued growth

and subsequent increase in infrastructure needs, expansion of urban and agricultural land use, and increasing water supply demands. Recent state directives to develop a statewide mercury TMDL, and the discovery of widespread high arsenic levels in groundwater have initiated significant large-scale studies and coordination among affected monitoring entities.

Florida agencies are collaboratively sampling a variety of matrices in Florida lakes statewide to develop models on methyl mercury fate and transport to develop TMDLs. The issue concerns contamination of sediments and surface waters, with subsequent exposure, uptake, and bioaccumulation in fish. Some surface waters are also designated as potable water supplies, and there is a need to meet drinking water standards for protection of consumers.

Results from several on-going monitoring programs have revealed arsenic levels above drinking water standards in ground water aquifers that provide a significant portion of Florida's drinking water supply. Several Florida agencies have collaborated in a focused monitoring initiative to develop a predictive model that determines whether arsenic is naturally-occurring, anthropogenic, or is anthropogenically-released in ground water.

Both projects illustrate how state agencies can focus on meshing their complementary strengths and experience to result in greater coordination, cooperative interaction, and project success.

A Cooperative Bi-National Approach to Monitoring the St. Marys River Great Lakes Connecting Channel

Gary Kohlhepp
Michigan Department of Natural Resources and Environment, Lansing, MI, United States

Abstract
The St. Marys River, which separates Canada and the United States, starts as the outlet of Lake Superior and flows southeasterly to Lake Huron. During summer 2006, residents along the north shore of Sugar Island within the St. Marys River reported numerous episodes of floating material in the water and washing up on shoreline property and beaches. These incidents were accompanied by high levels of *Escherichia coli* (*E. coli*) in the surrounding water. There was disagreement among various entities on the nature and source of the floating material. In response to these events, the Sugar Island Monitoring Workgroup (SIMWG) was established in 2007. The bi-national workgroup, consisting of federal, state/provincial, tribal, and local agencies, was tasked with developing and implementing a monitoring plan to determine the source and nature of the floating materials and the cause(s) of high *E. coli* levels.

The monitoring plan, implemented in 2007 and 2008, consisted of weekly water monitoring of approximately 30 stations from June through September by multiple agencies; analysis of floating material reported on the river; sediment sampling; DNA source identification; a sanitary survey to identify potential sources; site inspections of the wastewater treatment facilities on both sides of the river; and adherence to an Incident Response Protocol. A Quality Assurance Project Plan was developed to ensure data quality and consistency among the agencies.

Of the eight samples of floating material collected during 2007 and 2008, all were natural phenomena such as algae, detritus, and pollen. Of the more than 1000 weekly samples collected in 2007 and 2008, fewer than 10% exceeded the Michigan *E. coli* Water Quality Standard (300cfus/100mL); most of these exceedances occurred below storm water outfalls. DNA analysis of *E. coli* in selected samples indicated that few had traces of human origin. Although there are still disagreements on the nature and source of the floating solids in 2006, the 2007-2008 monitoring program was extremely successful. Specific steps taken by the SIMWG to work cooperatively and effectively will be discussed.

Great Lakes Cooperative Science and Monitoring Initiative: Cooperative science to help manage the Great Lakes

Paul Horvatin, Glenn Warren
U.S. EPA, Great Lakes National Program Office, Chicago, IL, United States

Abstract
Annual monitoring programs that assess Great Lakes water quality are operated by U.S. EPA and Environment Canada. These programs provide fundamental long-term data to help determine the status of the lakes. As environmental problems have emerged- for example, invasive species and new chemicals of interest - these programs have not been able to provide the data needed to understand and manage them. A new approach was required to provide this information. The Cooperative Science and Monitoring Initiative was developed for that purpose. This initiative brings together managers and scientists from federal and state agencies to develop coordinated programs that focus resources on one of the five lakes per year. The five-year rotation is in its second iteration. By bringing together agency and university scientists to investigate significant environmental issues in this framework, we have made tremendous progress in providing management-relevant information. As examples, a focus of the 2007 Lake Huron effort was an assessment of lower-to-upper food web components, and the effects of dreissenid mussels on the food web, the 2008 Lake Ontario focus was nearshore-to-offshore nutrient and particle movement, and the 2009 Lake Erie focus was phosphorus input and movement in the lake. The process, details of completed efforts, and challenges encountered in this Initiative will be presented.

Partnership Approach to Optimization of the Chesapeake Bay Program's Bay and Basin Water Quality Monitoring Program 2007-09: Process Review, Lessons Learned

Peter Tango[1], Carlton Haywood[2], Denice Wardrop[3], William Dennison[4], Kirk Havens[5], Scott Phillips[6], Jeni Keisman[7], Katie Foreman[7], Jackie Johnson[8], Richard Batiuk[9]
[1]USGS@CBPO, 410 Severn Ave Suite 109, Annapolis, MD; [2]ICPRB, 51 Monroe St, Suite PE 08, Rockville, MD; [3]Penn State Cooperative Wetlands Center, 216 Walker Building, University Park, PA; [4]UMCES, PO Box 775, 2020 Horns Point Rd. Cambridge, MD; [5]VIMS, Rt. 1208 Greate Road, P.O. Box 1346, Gloucester Point, VA; [6]USGS, 5522 Research Park Drive, Baltimore, MD 21228; [7]UMCES@CBPO, 410 Severn Ave Suite 109, Annapolis, MD; [8]ICPRB@CBPO, 410 Severn Ave Suite 109, Annapolis, MD; [9]USEPA, CBPO, 410 Severn Ave Suite 109, Annapolis, MD

Abstract
A comprehensive review of the U.S. Environmental Protection Agency's Chesapeake Bay Program (CBP) Partnership's Bay and Basin water quality monitoring programs was conducted from 2007 through 2009. The process for year 1 involved the CBP Scientific and Technical Advisory Committee coordinating a workshop series with Senior and Program Managers representing the jurisdictions and agencies across the watershed. Management recognized a need for a wide-range of information but requested programmatic optimization focusing the limited Federal and Match funding resources on a narrow set of objectives:

- To support monitoring needed for tracking 303d listing and delisting analyses in the Bay and tidal tributaries
- Simultaneously, to support the assessment of effectiveness of management actions in the watershed.

The CBP Management Board used a stakeholder developed, community ranked disinvestment-reinvestment-consequences matrix of trade-offs supporting decision options of the CBP Bay and Basin Monitoring Program realignment. Programming adjustments were supported at a level below the initial target funding goal; trade-offs at the target goal

were deemed to jeopardize the integrity of the Chesapeake Bay Tidal long-term water quality monitoring program. Reprogramming, in the context of other financial forces simultaneously affecting funding pools, supported first tier priority directions for Chesapeake Basin Monitoring program growth in analysis, synthesis and monitoring for management effectiveness. The Chesapeake Bay Tidal Long-term Water Quality Monitoring Program needs of the partnership were sustained with acknowledged gaps for Bay and Basin programs. The final funding decisions were recognized by the CBP Management Board as much for the progress on addressing monitoring programming priorities as for the identifying and illustrating priorities remaining unfunded to support the stated monitoring, analysis, synthesis and communication needs of the decision-makers.

Session J5: Evaluating Contaminant Trends in Groundwater Quality

Trends in Groundwater Quality: Integration of National Network and Regional-Scale Studies

Bruce D. Lindsey
U.S. Geological Survey, 215 Limekiln Road, New Cumberland, PA 17070

Abstract
The U.S Geological Survey (USGS), National Water-Quality Assessment (NAWQA) Program has ongoing studies that evaluate groundwater-quality trends at both the national and regional scales. At the national scale, hundreds of wells sampled in the 1990s are being resampled on a near-decadal time scale. This resampling effort provides a large data set, collected using nationally-consistent methods, for analysis of trends in groundwater quality. At the regional scale, the focus is on two types of studies: (1) simulation and forecasting of trends for specific areas, and (2) factors affecting groundwater trends.

The approaches to analyzing trends in groundwater quality vary depending on the goals of the analysis. Determining whether or not a constituent has increased or decreased in concentration on a near-decadal basis is the simplest question that can be answered; however, this is typically not the only relevant question. What caused the apparent trend or non-trend in concentration? Will the same trend continue into the future? What management practices could affect future trends? Some of these questions may require additional supporting data or studies at several scales to obtain meaningful answers.

In some cases, ancillary data sets are utilized to enhance the understanding of groundwater-quality trends. Ancillary data include groundwater age, geochemistry, changes in groundwater levels, changes in climate, or changes in chemical use. The combination of groundwater quality, groundwater age, and ancillary data can provide insight into the causative factors for trends in groundwater quality.

Decadal-Scale Changes of Nitrate in Ground Water of the United States, 1988–2004

Michael G. Rupert
U.S. Geological Survey, Pueblo, CO, United States

Abstract
This study evaluated decadal-scale changes of nitrate concentrations in ground water samples collected by the USGS National Water-Quality Assessment Program from 495 wells in 24 well networks across the USA in predominantly agricultural areas. Each well network was sampled once during 1988–1995 and resampled once during 2000–2004. Statistical tests of decadal-scale changes of nitrate concentrations in water from all 495 wells combined indicate there is a significant increase in nitrate concentrations in the data set as a whole. Eight out of the 24 well networks, or about 33%, had significant changes of nitrate concentrations. Of the eight well networks with significant decadal-scale changes of nitrate, all except one, the Willamette Valley of Oregon, had increasing nitrate concentrations. Median nitrate concentrations of three of those eight well networks increased above the USEPA maximum contaminant level of 10 mg L^{-1}. Nitrate in water from wells with reduced conditions had significantly smaller decadal-scale changes in nitrate concentrations than oxidized and mixed waters. A subset of wells had data on ground water recharge date; nitrate concentrations increased in response to the increase of N fertilizer use since about 1950. Determining ground water recharge dates is an important component of a ground water trends investigation because recharge dates provide a link between changes in ground water quality and changes in land-use practices.

Decadal-Scale Changes in Dissolved-Solids Concentrations in Groundwater Used for Public Supply, Salt Lake Valley, Utah

Susan Thiros and Lawrence Spangler
U.S. Geological Survey, Utah Water Science Center

Abstract
Groundwater in the basin-fill deposits of Salt Lake Valley naturally has a large range in dissolved-solids concentration that is controlled primarily by recharge sources to and water/rock interactions within the aquifer. Human activity at the land surface and withdrawals from wells also affect the distribution of dissolved solids in groundwater. Similar to other basins in the southwestern United States, groundwater is a source of public supply for the urbanized valley and its use is managed to sustain the quality of the resource.

Areas of increasing dissolved-solids concentrations in Salt Lake Valley are evident from data collected since about the 1950s by the U.S. Geological Survey, public suppliers, and others. The extent of the aquifer with concentrations less than 500 mg/L has decreased and concentrations in water from wells in some areas near the Jordan River and on the east side of the valley have increased by more than 20 percent. Dissolved-solids concentrations in water from selected wells in some of these areas have increased from less than 500 mg/L to more than 1,000 mg/L, while other nearby wells show little or no change. Possible causes of increasing dissolved solids in groundwater are short circuiting of water through confining layers due to well completion, recharge originating as urban runoff and irrigation seepage, and changes in flow gradients resulting from pumping. The cumulative effect of withdrawals from multiple wells in areas of the valley could allow vertical and (or) lateral movement of poorer quality water to parts of the aquifer. Evidence for the movement of shallow groundwater to wells used for public supply includes anthropogenic compounds in well water, warmer recharge temperatures, younger apparent groundwater ages, and downward hydraulic gradients.

Concentrations of dissolved solids in groundwater above the U.S. Environmental Protection Agency's secondary (non-enforceable) standard of 500 mg/L can limit its use for drinking-water purposes. Groundwater with concentrations above the standard is typically blended with other sources of water containing lower concentrations. Additional cost will be incurred if the construction of treatment systems (desalting facilities), new wells, and (or) transmission systems are needed in the future to provide water for public supply.

Towards understanding how human and aquifer processes interact to produce trends in groundwater quality

J. J. Starn[1]; C. T. Green[2]; S. R. Hinkle[3]; F. H. Chapelle[4]; B. Lindsey[5]; S. Thiros[6]
[1]USGS, East Hartford, CT, United States, jjstarn@usgs.gov; [2]USGS, Menlo Park, CA, United States; [3]USGS, Portland, OR, United States; [4]USGS, Columbia, SC, United States; [5]USGS, New Cumberland, PA, United States; [6]USGS, Salt Lake City, UT, United States

Abstract
Trends in groundwater quality are the result of many complicated and interacting factors. Statistical relations among some of these factors have been established for selected constituents, but to understand why a specific trend occurs, a model is needed that can simulate the relevant processes and their rates. Models can't include all the complexity of the real world; they must be simplified. Choices made in the simplification process affect the accuracy and precision of projections made with the model. These choices include what data to use, how to use it, how many parameters should be included in the model, how parameters should be represented, and what processes to simulate. By investigating different combinations of input data and model calibration techniques, this study contributes to the understanding of how simplification of geologic heterogeneity and data/model uncertainty affect the quality of predictions made using aquifer-scale groundwater models.

This study is in the early stages of development. Although the study encompasses work at multiple sites, this presentation will focus on efforts in Salt Lake Valley, Utah and the San Joaquin Valley, California. Both aquifers are composed of alluvial fan sediments, and water quality trends in both aquifers result from the interaction of human activities and aquifer processes, such as denitrification, rock/water interaction, changes in land cover, changes in water use, and changes in agricultural practices. To help understand these trends, existing groundwater flow models were calibrated using atmospheric tracer data and then used to predict the possible influence of these factors. Future work will include testing a variety of approaches to account for some of the mixing, dilution, and transformation that occurs; assessing the predictive ability of the model by comparison of simulated historical trends with historical data for selected constituents; assessing the possible effect on future groundwater quality from processes, rates, and feedback loops arising from climate change and increased development; assessing prediction uncertainty using Monte Carlo simulations; and evaluating the affect that input data uncertainty, model simplification, and model uncertainty has on the predictive outcome.

Session J6: Endocrine Disrupting Compounds – Identification, Sources, and Effects

What is an Endocrine Disrupting Chemical?

Larry Barber[1], Steffanie Keefe[1], Herb Buxton[2], Kymm Barnes[3], Dana Kolpin[3], James Gray[4]
[1]U.S. Geological Survey, 3215 Marine Street, Boulder, CO 80303; [2]U.S. Geological Survey, 810 Bear Tavern Road, West Trenton, NJ 08628; [3]U.S. Geological Survey, 400 South Clinton Street, Iowa City, IA 52240; [4]U.S. Geological Survey, Denver Federal Center, MS 407, Denver, CO 80225

Abstract
Chemically induced endocrine disruption to vertebrate organisms is a water resource issue of global concern. Because of the complexity of aquatic ecosystems there are many challenges in working at the interface of hydrology, chemistry and biology. Thus, an interdisciplinary approach is essential to unraveling the underlying causes of environmental endocrine disruption that has been observed worldwide. An important component for such research is knowledge of the environmental and biological conditions in the physical world, obtained through development of comprehensive and contemporaneous sets of hydrological, chemical and biological data. This begs the question, however, of what chemical constituents to measure. An extensive search and review of literature published from 1930 to 2010 (over 500 original research articles) was conducted, and a list of specific chemical compounds documented to induce endocrine disruption was compiled. The chemical and biological data are complex and include results from fish, mammal, amphibian, reptile, and avian species. While multiple modes of action for endocrine disruption were considered, the majority of the literature has focused on reproductive and thyroid function. This review covered a diverse range of organic, inorganic, and organo-metallic chemicals reported to have endocrine disrupting properties, and the compilation of endocrine disrupting chemicals was cross referenced against analytical capabilities of the U.S. Geological Survey (e.g. National Water Quality Laboratory, Kansas Water Science Center Organic Geochemical Research Laboratory, etc.) for water, sediment, and biota. Individual chemicals were categorized as having analytical methods currently available, methods not available but currently under development, methods not available but a top priority for development, or methods not available and a secondary priority for development.

Reproductive disruption of fishes by endocrine-active wastewater effluents

Alan Vajda[1], Ashley Bolden[2], Larry Barber[3], David Norris[2]
[1]Department of Integrative Biology, University of Colorado, Denver; [2]U.S. Geological Survey, Boulder, CO; [3]Departmentof Integrative Physiology, University of Colorado, Boulder

Abstract
We investigated the impact of a wastewater treatment plant (WWTP) effluent on fish reproduction. This effluent is known to contain endocrine-active compounds including alkylphenols, reproductive steroids, and pharmaceutical contraceptives. Previously, we identified female biased sex ratios, gonadal intersex, asynchronous ovarian development, and other forms of reproductive disruption in feral white suckers (*Catostomus commersoni*) collected downstream of WWTP effluent but not at reference sites.

To investigate the putative link between reproductive disruption observed in feral fish and wastewater effluent, we conducted on-site exposure experiments in 2005 and 2006 using a mobile flow-through laboratory. In these experiments, adult male fathead minnows (*Pimephales promelas*) were exposed to either WWTP effluent, reference water from Boulder Creek upstream of the wastewater plant, or mixtures of reference water and WWTP effluent. Exposure to diluted wastewater treatment plant effluent significantly elevated vitellogenin and suppressed primary and secondary sex characters.

In 2008, we conducted similar on-site experiments to determine effects of an engineering upgrade (change from trickling filter to activated sludge) on the estrogenicity of the effluent. We report a physiological assessment of changes that have occurred in the endocrine activity (estrogenicity) of the WWTP effluent.

Distribution of hormones, pharmaceuticals, and other anthropogenic waste indicators in areas of the Potomac River watershed impacted with fish kills and intersex fish

James Gray[1], Luke Iwanowicz[2], Vicki Blazer[2], William Foreman[1], Dana Kolpin[3], David Alvarez[4], Gary Speiran[5]
[1]US Geological Survey, Denver, CO, United States; [2]US Geological Survey, Leetown, WV, United States; [3]US Geological Survey, Iowa City, IA, United States; [4]US Geological Survey, Columbia, MO, United States; [5]US Geological Survey, Richmond, VA, United States

Abstract
Recent studies conducted by some of the co-authors of this abstract have documented a high incidence of fish kills as well as intersex in adult smallmouth bass (SMB) in the Potomac River watershed. It has been hypothesized that this could be the result of the presence of trace organic contaminants in the watershed. It is well documented that steroid hormones and other anthropogenic contaminants can induce endocrine disruption in fish at low (i.e., ng/L) concentrations. To investigate this distribution of trace organic contaminants, we deployed passive samplers and collected grab samples of both water and sediment at sites throughout the watershed near SMB nesting sites. These sites were subject to varied human impacts including runoff from poultry and dairy agriculture and the discharge of treated wastewater. These samples were analyzed for hormones (estrogens, androgens, and progestins), human-health pharmaceuticals, and a suite of anthropogenic waste

indicators (AWIs) including alkylphenol and its ethoxylates which have known estrogenic activity. Both sites where fish kills were observed were potentially subject to runoff from poultry farms, and estrogens were present at relatively high levels. Pharmaceuticals and AWIs were elevated at the four sites impacted by wastewater discharge, while estrogens were elevated at three of these sites as well as one site with a poultry source but low wastewater impact, indicating that pharmaceuticals and AWIs are likely to be primarily derived from wastewater discharge while agriculture may provide an additional source for the biogenic hormones. Furthermore, intersex SMB, defined by the presence of testicular oocytes in adult males, were observed at all 4 sites with high levels of estrogens and were not observed at either site where estrogens were absent or present at low levels. Since intersex SMB appear to be correlated with the presence of estrogens in the water and fish kills appear to be correlated with the presence of poultry agriculture it is likely that different suites of chemicals are responsible for these two effects.

Endocrine Active Chemicals in Surface Waters: Developing a Consistent Approach to Evaluate Fate and Aquatic Organism Responses

Kathy E. Lee[1], Heiko L. Schoenfuss[2], Richard Kiesling[1], Jeff Writer[3], and Larry B. Barber[3]
[1]USGS Minnesota Water Science Center, Mounds View, MN; [2]St. Cloud State University, St. Cloud, MN; [3]USGS National Research Program Laboratory, Boulder, CO

Abstract
Numerous research and monitoring efforts have consistently shown the presence of endocrine active chemicals (EACs) and endocrine disruption in native fish in streams throughout the United States. However, aggregation of results across the country is difficult as individual studies often do not have consistent analytical methods for chemical analyses and use different biological response variables. A consistent approach to monitoring needs to be developed. Potential approaches include the creation of a fixed-site network which would provide information on spatial and temporal variability in chemical concentrations and occurrences for streams, lakes and groundwater. Such a monitoring system would be used to: 1) determine the occurrence and distribution of EACs and endocrine disruption; 2) determine factors contributing to EAC occurrence and fate in surface waters; 3) define factors related to endocrine disruption; 4) determine source pathways of EACs to streams; and 5) determine population-level effects on fish and other organisms. The development and use of consistent and streamlined chemical and biological measures is necessary to understand spatial and temporal trends in occurrence of EACs and endocrine disruption.

Session K1: Water Quality Monitoring in Coastal and Marine Environments

Benefits of Integrated Physical, Chemical, and Biological Marine Monitoring in Pacific Island National Parks

Tahzay Jones and Anne Farahi
National Park Service, Pacific West Region, Pacific Islands Inventory and Monitoring Program, Hawaii Volcanoes National Park, Hawaii National Park, Hawaii

Abstract
The Pacific Islands Inventory and Monitoring Network of the National Park Service monitors physical, chemical, and biological marine resources across the tropical Pacific in Hawaii, Guam, Saipan, and American Samoa. Remote locations and the nature of marine work yield high costs and complicated logistics that have necessitated developing an integrated approach to ecosystem monitoring. The integrated approach taken increases the National Parks Service's capabilities of ecological interpretation and managerial relevance for the natural resources monitored while decreasing the total cost per sample associated with combined monitoring efforts. Co-location and co-visitation of multiple marine monitoring programs (water quality, benthic marine communities, and marine fish communities) yields biological data that is directly correlated because the data is collected simultaneously. Additionally, by visiting simultaneously, the number of site visits is reduced decreasing per sample costs associated with monitoring efforts, ultimately allowing for increased monitoring efforts in other natural resource areas of concern.

Connecticut Department of Environmental Protection Long Island Sound Water Quality Monitoring Program: What are we missing, a comparison of monthly survey data and data from a special 72 hour survey

Christine Olsen, Matthew Lyman and Katie O'Brien-Clayton
Connecticut Department of Environmental Protection, Bureau of Water Protection and Land Reuse, Long Island Sound Monitoring Program, Hartford, CT

Abstract
Since 1991, the Connecticut Department of Environmental Protection (CTDEP) has been monitoring the water quality of Long Island Sound (LIS). Year-round monthly sampling includes monitoring for nutrients, chlorophyll a, biological oxygen demand, and water column profiles of temperature, salinity, irradiance and dissolved oxygen. Additional biweekly summer sampling provides data on the recurrent low dissolved oxygen condition known as hypoxia.

From August 10-14, 2009 DEP staff joined the crew of the EPA's OSV Bold for an intensive 72 hour survey. The survey sampled a series of 9 sites located in western Long Island Sound with sampling repeated on a rotating basis over the course of the 72 hours. A total of 12 cycles were completed during the survey with a total of 106 site visits, water column profiles were conducted at each site and 130 samples for nutrient analysis were collected from 62 site visits including 3 blanks and 3 surface duplicates.

Data from this survey will assist with the assessment of short-term variability in water quality measurements (specifically dissolved oxygen and nutrients). Quantifying this short-term variability will be helpful in the interpretation of monthly and bi-weekly data collected as part of the Long Island Sound Water Quality Monitoring program, and in the consideration of alternate sampling schemes that might improve the utility of the ongoing monitoring program into the future.

The CTDEP encourages the research community to make use of the monitoring program and the resultant database as an aid to complementary research and assessment efforts in Long Island Sound and elsewhere.

Combining Routine Monitoring and Research to Understand Estuarine Biogeochemistry

Jonathan H. Sharp
School of Marine Science and Policy, University of Delaware, Lewes, DE 19958, jsharp@udel.edu; (302) 645-4259

Abstract
Since direct extension of lake or stream nutrient criteria and assessment tools are not appropriate, and criteria for estuarine waters are still in the development stage, it is timely to take a broader temporal and spatial view to understand estuaries. The Delaware Estuary, extending from the head of tide near Trenton, NJ to the Atlantic Ocean includes the fourth largest metropolitan region in the country, the greater Philadelphia area. My laboratory group has been conducting microbial biogeochemical research on the Delaware Estuary for over 25 years. Most of the sampling stations and many of the analytical parameters from this research effort are the same as those used by the Delaware River Basin Commission (DRBC) in routine monitoring. The DRBC sampling and laboratory analyses have been performed consistently

for over 40 years by the State of Delaware; I have worked with the state agency and the DRBC for years to facilitate analytical compatibility. Combining the DRBC long term monitoring data with frequent sampling and my less frequent, but more in-depth research results provides an understanding of ecosystem response to measured water quality parameters. Using these two databases plus information from less consistent monitoring and anecdotal information, an extension is made for water quality trends and ecosystem response of the estuary over the past 50 to 120 years. The period of this trend analysis is one in which the urban region of the Delaware Estuary deteriorated to become one of the most "polluted" rivers in the US and then underwent one of the most successful water quality improvements in the world. The present day Delaware Estuary has extremely high nutrient loadings but does not suffer from typical eutrophication symptoms. I served for several years on the NOAA national estuarine eutrophication update and US EPA national estuarine nutrient criteria workgroups; both have recommended that estuaries be viewed with differing typology and that ecosystem response guide management rather than simply using uniform loadings or concentrations of nutrients. Our local research community has made and continues to make recommendations to improve the monitoring of the Delaware Estuary for more effective management.

Monitoring in the Ahupua'a

Michael Tomlinson, Eric De Carlo, Margaret McManus, Geno Pawlak, Grieg Steward, Francis Sansone, Olivia Nigro, Chris Ostrander, Patrick Drupp, Ross Timmerman, Jennifer Patterson, Sergio Jaramillo Uribé
School of Ocean and Earth Science and Technology,
University of Hawai'i at Mānoa, Honolulu, HI, United States

Abstract
The ancient Hawaiian concept of the ahupua'a extended natural resource stewardship from the mountain summit to the outer edge of the offshore reef system. With the inception of the Hawai'i Ocean Observing System (HiOOS), part of the nationwide Integrated Ocean Observing System, we have been provided with the unprecedented opportunity to extend continuous environmental monitoring, recently restricted primarily to land-based installations, into the nearshore ocean: in other words – the entire ahupua'a. This network of land- and ocean-based environmental monitoring stations provides us with a unique opportunity to study the effects of storms, other natural phenomena, and accidental pollutant releases on the nearshore waters of O'ahu, Hawai'i. The existing land-based network consists of National Weather Service rain gages, US Geological Survey stream gages, and National Ocean Service tide gages additionally equipped with meteorological sensors. These data have been augmented with data collected by the ocean-based HiOOS network consisting of water quality, wave, and ocean current sensors mounted near the shore, on buoys, and on the seafloor, and supplemented with manual sampling. We will show in this presentation that even storm runoff from a relatively small, partially urbanized watershed can profoundly affect the coastal ocean for periods ranging from only a few days to more than a month. We also will show that antecedent conditions are important, and that an understanding of lag times between rainfall and changes in nearshore water quality can contribute to an effective early warning system to protect the people using Hawai'i's popular recreational beaches. Finally, we will discuss some of the challenges presented when integrating large quantities of data from diverse sources collected at disparate time intervals (from 4 to 30 minutes), some problems encountered and possible solutions, and suggestions for future monitoring efforts.

Session K2: Geospatial Assessments of Water Quality

Applying the National Hydrography Dataset Plus (NHDPlus) to Water Quality Assessments

Tommy Dewald[1], Cindy McKay[2]
[1]U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans and Watersheds, Washington, DC, United States; [2]Horizon Systems Corporation, Herndon, VA, United States

Abstract
The National Hydrography Dataset Plus (NHDPlus) is a suite of geospatial products that build upon and extend the capabilities of the National Hydrography Dataset (NHD) by integrating the NHD with the National Elevation Dataset (30 Meter) and the Watershed Boundary Dataset. NHDPlus includes improved NHD stream names and networking, value-added attributes (such as stream order) that enable advanced query, analysis and display, elevation-derived catchments that integrate the land surface with the network, catchment attributes (such as temperature, precipitation, land cover), stream flow volume and velocity estimates for pollutant dilution modeling, and associated flow direction and accumulation grids. This presentation will provide an overview of different ways that NHDPlus is being used to support the EPA National Aquatic Resource Surveys including sample frame development, drainage area delineation, and stream slope computation.

Water Clarity Monitoring of Wisconsin Lakes via Remote Sensing

Steven R. Greb
Wisconsin Department of Natural Resources, Madison, Wisconsin, USA

Abstract
The State of Wisconsin has over 15,000 lakes. They are important in supporting the state's recreation economy as well as a diverse aquatic ecological community. Increased costs for lake monitoring along with staff shortages have forced the state to seek alternative methods to monitor these numerous water bodies. The state has successfully developed a "Lakes from Space" program, using Landsat 5 and 7 images to generate water clarity measurements for approximately 8000 lakes. The multi-year continuity of this program is now providing the ability to examine inter-annual variability and trends in trophic status and their relationship to geophysical differences. This program relies on citizen-based monitoring for *in-situ* calibration. This broad-based participation provides an important linkage for public engagement in water resources protection.

Using GIS To Analyze The Environmental Impacts of Mining On Water Resources In The State of West Virginia

Edmund Merem, Bennetta Robinson, Sudha Bapu
Jackson State University, Jackson, Mississippi, United States

Abstract
The state of West Virginia and the people have for decades relied on the mining sector as an integral part of its economy. In that setting, sizeable environmental externalities resulting from mining continue to degrade stream water quality and the stability of the surrounding ecosystem. With much of the mining activities occurring within the vicinity of sensitive watersheds and habitats for rare species, very little has been done to spatially identify the frequency and scales of the problems with the latest advances in spatial technology such as Geographic Information Systems (GIS). Notwithstanding this void in the literature, there remains widespread growth in the number of mining operations in various areas of the state at the expense of environmental welfare. The problems of mining hazards and the threats to watersheds do not operate in a vacuum; they emanate from policy defects and socio-economic elements. Some of the impacts associated with mining activities in the

state range from non-point sources of pollution, impairment of stream and watersheds, loss of vegetation and numerous environmental health threats that impede water quality. To address the research problems herein identified in the context of water quality monitoring, the integration of ecosystem principles and geospatial information systems of GIS for the monitoring of vulnerable watershed ecosystems remains vital in the study area of West Virginia. Accordingly, this paper stresses a mix-scale approach involving the use of descriptive statistics and geospatial technology of GIS in the analysis of environmental impacts of mining on watersheds and the quality of water. Emphasis is on the issues, environmental analysis of the trends, factors fueling the problems as well as current efforts to remedy the problems along with future lines of action. The initial results point to spatial concentration of mining activities in ecologically sensitive areas and the presence of impaired watersheds and stressed ecosystem.

National Assessment of Impaired Waters Within or Near US Fish and Wildlife Service Properties

Douglas J. Norton[1], Seth Mann[2], Jamie Fowler[1], Jo Ellen Hinck[3], Linda Lyon[4], Susan Finger[3], and Doug Vandegraft[4]
[1]U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans and Watersheds, Washington, DC; [2]Computer Sciences Corp., Washington, DC; [3]U.S. Geological Survey, Biological Resources Division, Columbia, MO; [4]U.S. Fish and Wildlife Service, National Wildlife Refuge System, Arlington, VA

Abstract
The US Fish and Wildlife Service (FWS), US Environmental Protection Agency (EPA), and US Geological Survey (USGS) conducted a joint national assessment of the impaired waters and public lands managed by the FWS in order to assist FWS planning, restoration, monitoring and management. This assessment utilized Geographic Information Systems (GIS) to analyze spatial data layers to show where FWS properties including National Wildlife Refuges (NWRs), Waterfowl Production Areas (WPAs), and National Fish Hatcheries (NFHs) co-occur with impaired waters reported by states under Clean Water Act Section 303(d). The analysis summarized counts, linear and area statistics both within and near each of the FWS property types. Impaired waters near FWS properties were separately summarized by using a catchment-based "near" zone around each property. The assessment also aggregated the co-occurrence information by HUC12 watershed. Detailed attributes such as impairment type, year reported, waterbody name, property name, and other fields were provided in tabular and mapped project outputs. Overall, 804 impaired waters were found to occur within or near 303 FWS properties. These waters totaled 10,755 km and 2,510 sq km. and constituted approximately 6 percent by length of the total waters within FWS properties. Also, 270 of the 804 impaired waters have at least 1 finalized TMDL available. The rank of leading impairment causes varied by whether based on frequency of occurrence, length impaired, or area impaired. Nutrients, oxygen depletion and mercury were 3 of the top 4-ranked impairments in all three ranking methods. Assessment products for FWS users included the national GIS database; a read-only ArcReader version; spreadsheets matching individual waters, properties, and HUC12 watersheds; interpretive maps; a demonstration method for prioritizing water quality issues affecting resources of concern; guidance for data updates; a project Web site; and a project report.

Session K3: Modeling of Nutrient Transport and Loadings

Application of Regional Regression Models of Nutrient Transport to Water-Quality Assessments in the Southeastern U.S.

Anne B. Hoos[1] and Ana Maria Garcia[2]
[1]U.S. Geological Survey, 640 Grassmere Park, Suite 100, Nashville, Tennessee 37211; [2]U.S. Geological Survey, 3916 Sunset Ridge Road, Raleigh, North Carolina, 27607, 919.571.4058 agarcia@usgs.gov

Abstract
The National Water-Quality Assessment Program of the U.S. Geological Survey has developed regional water-quality models in the southeastern U.S. to investigate the transport and fate of nitrogen and phosphorus from watershed landscapes to streams and through stream networks. The models integrate water-quality monitoring data with geospatial information describing nutrient sources to estimate mean annual rates of combined overland and subsurface nutrient transport from watershed sources to receiving stream channels. Landscape delivery rates are characterized as functions of landscape variables such as soil permeability and depth. The models produce estimates of mean annual load and concentration of total nitrogen and total phosphorus for each stream reach in the model area, providing a tool for addressing questions about stream loading to nutrient sensitive water bodies. Results are presented for selected water bodies to illustrate application of the model estimates; for example, the mass of nitrogen delivered annually to Mobile Bay, Alabama, from tributaries is estimated to be 49 million kilograms or 4.2 kilograms per hectare (kg/ha) with a standard error of about 30 percent. The predominant source (estimated to account for 56 percent) of nitrogen delivered to the Bay is atmospheric deposition. Other sources of nitrogen to the Bay – application of commercial fertilizer to agricultural land, livestock production, urban runoff, and point-source wastewater discharge – account for 14, 12, 11, and 8 percent, respectively. This information can be used to estimate how changes in any one of these sources could affect annual nitrogen loads delivered to the Bay, which in turn can help formulate management scenarios that reduce the delivery of nutrients to coastal areas.

Limitations / Needs in Data to Support Regional Water-Quality Modeling

Stephen D. Preston
U.S. Geological Survey, 1289 McD Drive, Dover, Delaware 19901

Abstract
To effectively manage nutrient loads in large watersheds over regional scales, significant amounts of information are required for defining the spatial distribution of sources, landscape characteristics and other environmental factors. To address this need the U.S. Geological Survey (USGS) conducted studies to compile information and build models based on the **SPA**tially **R**eferenced **R**egressions **O**n **W**atershed Attributes (SPARROW) modeling framework. SPARROW is designed to provide information across large spatial extents while preserving the spatial detail inherent in geospatial data sets. To accomplish the development of SPARROW models four major categories of data must be compiled and integrated. These include: 1) digital stream network data; 2) measured stream load at sites throughout the region; 3) geospatial information describing sources of nutrients; and 4) geospatial information describing landscape characteristics that affect delivery of nutrients to streams. In most cases, national geospatial data sets were used to support the development of regional models. However, many of the national data sets were found to have significant limitations. A notable example is a data set that describes point source contributions of nutrients to streams that was developed from the Environmental Protection Agency (EPA) Permit Compliance System (PCS) data base. The level of reporting in the PCS system varies widely by state. This necessitated the gathering of additional information, extrapolating information where it was unavailable and omitting information for many smaller dischargers. A second notable example is data describing agricultural practices including fertilizer use, manure handling and management practices. Fertilizer and manure data are only available by county which can be a coarse resolution for regional analysis. Additionally complete and consistent data describing nutrient management practices are generally unavailable or nonexistent at the national or even regional scales. Lastly model calibration is dependent upon the number of sites from which appropriate monitoring data are available. While large amounts of data have been collected nationally and regionally, each monitoring program is designed with separate objectives thus complicating the integration of the data. In all these cases, improvements in the available data bases are needed to support future modeling of nutrient fate and transport at national and regional scales.

Allocation of Nutrient Inputs to the Laurentian Great Lakes by Source and River Basin Using SPARROW models

Dale M. Robertson and David A. Saad
U.S. Geological Survey, Wisconsin Water Science Center, 8505 Research Way, Middleton, WI 53562, United States

Abstract
The Laurentian Great Lakes receive water and nutrients from many tributaries that drain areas ranging from pristine forests, to intensively farmed land, to large urban centers. This nutrient loading has resulted in eutrophication problems in many areas, ranging in size from entire waterbodies like Lake Erie to smaller areas like Green Bay on Lake Michigan. In an attempt to reduce eutrophication problems, specific target loads were established for phosphorus (P) for each Great Lake as part of a Great Lakes Water Quality Agreement between the U.S. and Canada. In addition, detailed TMDLs are being developed for many tributaries. Detailed water-quality and streamflow data are needed to determine the status of nutrient loading to each lake and from their individual tributaries. Most tributaries are not monitored, however, and in recent years, the number of monitored tributaries has decreased. Without detailed monitoring data, it is difficult to determine if target loads are being met, what are the main nutrient sources to each lake, and where the largest nutrient sources originate. In an attempt to address these issues in the absence of more complete monitoring data, SPARROW (SPAtially Referenced Regression On Watershed attributes) models were developed for P and nitrogen (N) for a 2002 base year for the Great Lakes, Upper Mississippi, Ohio, and Red River Basins. Results from the SPARROW models are used to: 1) estimate P and N loads to each Great Lake and from each of their tributaries (from the U.S. contributing area); 2) rank individual tributaries to each lake based on their total loadings and relative yields; 3) determine the relative importance of different P and N sources (atmospheric, point sources, fertilizers, manure, fixation, and forested and urban lands); and 4) compare relative P and N yields and importance of nutrient sources among Great Lakes watersheds and with those from the Upper Mississippi, Ohio, and Red River watersheds.

The Regionalization of National-Scale SPARROW Models for Stream Nutrients

Gregory E. Schwarz[1], Richard B. Alexander[1], Richard A. Smith[1], and Stephen D. Preston[2]
[1]U.S. Geological Survey, 12202 Sunrise Valley Dr., Reston, VA 20192; [2]U.S. Geological Survey, 1289 McD Dr., Dover, DE 19901

Abstract
Existing national-scale SPAtially Referenced Regression On Watershed attributes (SPARROW) nutrient models are estimated with the assumption that the coefficients of the model that describe the marginal effects of water-quality processes on stream nutrient loads (e.g., the loading response from an incremental change in soil permeability; the change in the fraction of nutrient removed in streams from a unit change in water travel time) are the same for all locations. This assumption insures that the widest ranges of conditions are used to estimate the effects of individual model processes, and imparts a parsimonious form that facilitates the interpretation of the estimated coefficients; however, the assumption may be overly simplistic and could lead to model misspecification causing biased results. This analysis evaluates the empirical validity of the assumption that the marginal effects of water-quality processes on stream nutrient loads are the same for all locations using recently published total nitrogen and total phosphorus national-scale SPARROW models. The analysis modifies the parsimonious specification of these models to allow individual water-quality processes (i.e., model coefficients) to vary according to eight major river basins of the conterminous United States. Regional SPARROW nutrient models are currently under development for these river basins as part of evaluations by the U.S. Geological Survey's National Water-Quality Assessment Program. The analysis here finds that regionalization of all water-quality coefficients results in a statistically significant improvement in model fit, reducing the uncertainties in the prediction of total nitrogen and total phosphorus loads for any given stream reach by about 10 percent and 14 percent, respectively. The analysis further investigates whether coefficients describing the effects of processes on the delivery of contaminants to streams (modeled at the 1:500,000 scale in the Reach File 1 network) vary regionally more than those that describe the effects of aquatic processes. The finding that regionalization improves model fit implies that the current national-scale SPARROW models are incomplete and that additional improvements are feasible in both the process specifications of the models and their prediction accuracy.

Session K4: Monitoring Partnerships: Promoting Water Resource Stewardship and Protection

Interior Agency Water Quality Partnership: New Process, Same Great Results

Barry Long[1], Mark Nilles[2]
[1]National Park Service, Water Resources Division, Fort Collins, CO, United States; [2]U.S. Geological Survey, Office of Water Quality, Denver, CO, United States

Abstract
For more than a decade the National Park Service (NPS) and U.S. Geological Survey (USGS) have been coordinating to jointly administer and operate a water quality partnership program. The partnership was initiated under the Clean Water Action Plan in 1998 and is funded by the USGS Water Resources Discipline, Office of Water Quality. Since its beginning, more than $22 million has been allocated for partnership water quality projects in national parks. Through 2009, 150 partnership projects have been initiated in 107 national park units; and 129 of these projects have been completed. Ten new projects were funded in FY2010 for a total of $736,100. Projects range from one-year technical assistance activities that provide consultation of USGS scientists with park personnel to three-year intensive projects involving hypothesis-driven data collection, data assessment and production of one or more peer-reviewed publications. The current program bibliography documents over 100 publications from these partnership studies.

An ongoing process of assessment and improvement is a necessary step to ensure the long-term health and vitality of interagency science partnerships. Beginning in FY2010, for projects with initial funding in FY2011, the partnership program implemented significant changes to strengthen the program, improve communication between the two agencies, and provide more consistency in the project selection process. The new program model employs a joint agency regional competition and selection process administratively based on USGS regional boundaries (Eastern, Central, and Western) that replaced the former NPS region-based selection process. The national panel will continue to be represented by USGS and NPS discipline specialists on an equal basis and will continue to include national, regional, park, and Water Science Center personnel. One immediate result of this change is a common national deadline for all proposals and the provision to preliminary screen shorter proposals prior to national review and selection for funding.

Strengthening USGS International Partnerships focused on Water Quality, Water Supply, and Sustainability in the Developing World

Ingrid M. Verstraeten[1], Verne Schneider[2], Jo Leslie Eimers[2]
[1]U.S. Geological Survey, International Programs Office, Reston VA, United States; [2]U.S. Geological Survey, International Water Resources Branch, Reston VA, United States

Abstract
Access to adequate and safe supplies of water for all people is a major problem in developing countries, affecting health, food supply, and economic development. A growing world population has increased the

demand for water, while water resources remain limited. At present, millions of people in developing countries lack a potable water supply, as well as the scientific information needed to assess and manage their water resources. To improve these conditions, monitoring infrastructure, analytical tools, and management strategies are needed to assess, understand, and manage water resources. Successful implementation of these measures requires and emphasis on education and institutional capacity-building.

U.S. Geological Survey (USGS) science has been crucial to the quest for sustainable and safe drinking water supplies and the development of sound environmental and water-resources management policies in the United States. As part of its international mission, the USGS engages in numerous partnership efforts to improve hydrologic understanding to support wise management of water resources throughout the world. Recently, the USGS has cooperated with local, regional, and national agencies and non-governmental organizations using a variety of approaches, depending on country and agency or organization needs and mission. Examples include implementation of building a water-quality data warehouse and microbiological sampling in Pakistan, implementation of a flood warning system in India, development of hydrologic databases in the Middle East and Cyprus, and other hydrologic science projects with Afghanistan, Jordan, United Arab Emirates, Sudan, Ethiopia, Madagascar, Cape Verde, Mozambique, and Ecuador.

15 Years of Monitoring Water Quality Across Southcentral Alaska Through the Citizens' Environmental Monitoring Program Partnership

Rachel Lord
Cook Inletkeeper, Outreach & Monitoring, Homer, AK, United States

Abstract
Alaska volunteer water quality monitoring began in 1996 with the formation of Cook Inletkeeper's Citizens' Environmental Monitoring Program (CEMP). Beginning in 1997, organizations in Southcentral Alaska forged a regional partnership to train citizens in effective water quality monitoring methods to ensure resource protection. These partnerships formally became the Citizens' Environmental Monitoring Program Partnership (CEMP Partnership). The CEMP Partnership objectives include: to inventory baseline water quality; detect and report on trends and changes in water quality; and to raise public awareness and promote stewardship through hands-on involvement in watershed protection. Since 1997, over 1000 Alaskans have been trained through organizations in the CEMP Partnership. These volunteer water monitors have collected nearly 5,000 observations at over 250 stream, wetland, lake, and estuarine sites around Southcentral Alaska.

The CEMP Partnership recognizes the need for regional performance uniformity among the numerous volunteer water quality monitoring projects. Only through collaborate management and uniform training can scientifically defensible data be collected for valid comparisons and interpretations. Regional collaboration through the CEMP Partnership allows the member organizations to benefit from standardized protocols that have been State and Federally approved, yearly recertification for volunteer monitor coordinators through a partnership with the University of Alaska's Environment and Natural Resources Institute (ENRI), and a support network of monitoring organizations around Alaska's most populated region. In the past two years, the CEMP Partnership has provided technical support to new monitoring groups in the region, applied jointly for grant funding, and begun working towards a tiered system for selecting and prioritizing monitoring sites. Through regional collaboration, we look forward to further leveraging of existing funding and resources for water quality monitoring in the State of Alaska.

Partnering to Support Monitoring Programs

Alyse Greenberg
Stony Brook-Millstone Watershed Association, Pennington, NJ

Abstract
This session will address ways nonprofits and government entities can work together to support monitoring activities, how each type of entity benefits from such partnerships, and the outcome of one specific partnership.

Beginning in 2006, the nonprofit Stony Brook-Millstone Watershed Association and the New Jersey Department of Environmental Protection partnered to provide funding for water quality monitoring projects throughout the state. The Watershed Association has been providing small grants to nonprofits since 2003 through its Watershed Institute program. These grants have traditionally been awarded for capacity building projects, such as outreach and membership campaigns, and watershed management activities, such as stream cleanups and storm drain stenciling. The program has now been enhanced with funds from the Department to include volunteer water monitoring efforts. This collaboration has enabled the Watershed Association to expand the grant program, the Department to help build monitoring efforts, and monitoring groups statewide to receive much needed funding and guidance.

Furthermore, both the Watershed Association and the Department have partnered with World Water Monitoring Day. They promote WWMD through outreach to monitoring groups statewide, and provide assistance to those interested in participating.

Session K5: Transport and Distribution of Mercury through Aquatic Ecosystems

Methylmercury in aquatic ecosystems of the United States

Mark E. Brigham
U.S. Geological Survey, Mounds View, MN

Abstract
There are widespread fish-consumption advisories and water-quality impairments due to methylmercury contamination of freshwater fish. This presentation summarizes several findings from recent studies. Human activities have increased the amount of mercury entering aquatic ecosystems, both through direct industrial and mining discharges, and through atmospheric emissions. In the continental U.S., modern atmospheric mercury deposition rates are typically about 3-4 times background, pre-industrial rates, although much higher rates are observed in highly urbanized settings. Once deposited, some inorganic mercury is converted to methylmercury, a toxic form of mercury that is retained by aquatic organisms. The U.S. Geological Survey measured methylmercury as part of a national survey of 291 streams, and in detailed temporal studies of 10 streams covering a range of seasons and hydrologic conditions. Both studies spanned important gradients relative to the Hg cycle, including wet Hg deposition rate and wetland density. Both within regions of similar Hg atmospheric deposition, and among all streams nationally, wetland density was an important influence on methylmercury in stream water and in fish. Multiple lines of evidence indicate that the source of methylmercury to streams is Hg methylation that occurs predominantly within wetlands and subsequent transport to the stream. Within streams, methylmercury in stream water typically increases as streamflow and dissolved organic carbon increase. Methylmercury production within the stream channel, in streambed sediment, is measurable, but appears to be a minor contributor to methylmercury in stream water. Implications of this work are that changes in Hg atmospheric deposition would likely produce the greatest changes in methylmercury levels in fish in streams that drain watersheds with a high density of wetlands. Other ecosystem disturbances, such as sulfate loading and wet and dry cycles, that affect Hg methylation will also likely have a greater impact in ecosystems with a higher density of wetlands in the watershed than in low-wetland-density ecosystems.

Dissolved organic matter, organic matter optical properties and mercury in rivers and streams

Aiken, G.R[1], Brigham, M.E.[2], Shanley, J. B.[3], and, Krabbenhoft, D.P.[4]
[1]U.S. Geological Survey, National Research Program, Boulder, CO, United States; [2]U.S. Geological Survey, Minnesota Water Science Center, Mounds View, MN, United States; [3]U.S. Geological Survey, New Hampshire Water Science Center, Montpelier, VT, United States; [4]U.S. Geological Survey, Wisconsin Water Science Center, Middleton, WI, United States

Abstract
Interactions of mercury (Hg) with dissolved organic matter (DOM) play important roles in controlling concentrations, reactivity, bioavailability and transport of Hg in aquatic systems. In this paper we present the results of watershed based studies associated with US Geological Survey NAWQA and WEBB Programs designed to better define the factors controlling the export of Hg in stream systems. We investigated the seasonal and spatial variability of dissolved organic matter quantity and quality, and the concentrations of dissolved Hg and methylmercury (MeHg) in 12 rivers and streams representing a range of watershed types. DOM concentrations and composition, based on DOM fractionation and ultraviolet/visible absorption spectroscopic analyses, varied greatly both between sites. Strong relationships were found between DOM and total dissolved Hg concentrations in almost all of the systems. Relationships between total dissolved Hg concentration and hydrophobic organic acid (HPOA) content (aquatic humic substances) were stronger than those observed between Hg and DOM, supporting the hypothesis that interactions between Hg and the HPOA fraction are important drivers for the transport of dissolved Hg in aquatic systems. Relationships between MeHg and DOM and HPOA content were not as strong as those observed with Hg. In all systems, UV absorbance (λ=254 nm) correlated strongly with DOM, HPOA content and Hg concentrations. The relationships between DOM concentration and absorbance for the range of systems were quite variable because not all of the dissolved organic carbon in a given sample absorbs UV light to the same degree. These results demonstrate that optical properties, such as UV absorbance, are excellent proxies for DOM and HPOA concentrations within a given system. By extension, because of the strong relationships between Hg and DOM, these properties can also be used to derive relationships between DOM optical properties and Hg concentrations. Optical measurements are relatively inexpensive to obtain, can be designed into *in situ* monitoring devices and, when combined with discharge data, can be used to tighten estimates of both DOM and Hg flux in streams and rivers, especially at high flows when fluxes are greatest and manual sampling is difficult.

Increased Atmospheric Mercury Deposition near Major Urban Areas

Peter C. Van Metre
U.S. Geological Survey, Texas Water Science Center

Abstract
Modeling of atmospheric deposition of mercury (Hg) is generally in agreement with monitored wet deposition at the regional scale in North America, but, unlike monitoring, indicates large increases in deposition near major urban areas. Lake-sediment core reconstructions of Hg deposition for remote and near-urban reference lakes confirm these large increases in atmospheric Hg deposition as one approaches major urban areas. Sediment cores from six remote lakes (>150 km from the closest major urban area) from Oregon to Maine indicate modern anthropogenic Hg deposition rates of 16±9 micrograms per square meter per year (μg/m^2 yr), roughly double monitored wet-deposition rates (2001-2008) in the same regions as the lakes (6.9±1.3 μg/m^2 yr). Modern anthropogenic Hg deposition rates to reference lakes near (<50 km) New Haven, Conn., Boston, Mass., in contrast, are 56 and 77 μg/m^2 yr, respectively. Deposition to lakes near Chicago, Ill., and Atlanta, Ga., at 60 and 66 μg/m^2 yr, respectively, also is elevated compared to regional background. Monitored wet-deposition rates within ~100 km of these cities, in contrast, averaged 9.3±2.4 μg/m^2 yr. Modeling and comparison of core deposition rates to monitored wet deposition suggests greater dry deposition of Hg might be responsible for much of the near-urban fallout signal. Emissions of Hg(II) and particulate Hg and the formation of Hg(II) from oxidation of Hg(0) in the urban atmosphere could be important factors in the increased deposition.

Effects of Forest Type and Fire on Mercury Deposition in Boreal Ecosystems

Randy Kolka[1], Emma Witt[2], Trent Wickman[3], and Ed Nater[4]
[1]USDA Forest Service Northern Research Station, Grand Rapids, MN, United States; [2]University of Kentucky, Lexington, KY, United States; [3]USDA Forest Service Superior National Forest, Duluth, MN, United States; [4]University of Minnesota, St. Paul, MN, United States

Abstract
As a result of a large blowdown event that occurred in 1999 in the Boundary Waters Canoe Wilderness Area of the Superior National Forest, concern arose over the use of fire for fuels management and the effect that fire has on mercury availability in aquatic systems. As part of a larger study aimed at understanding the effects of fire on the watershed cycling of mercury, we assessed the influence of fire on the deposition of mercury. We measured mercury deposition in both non-fire conditions and following three significant fires. In non-fire conditions we found that forest canopy type and density were the primary influences on total mercury (THg) and methyl mercury (MeHg) deposition. THg and MeHg concentrations in throughfall where higher under conifers than under deciduous canopies or open conditions. Fluxes of THg were also higher under conifers than deciduous or open, however, fluxes of MeHg where similar among canopy types. Higher canopy densities increased concentrations of both THg and MeHg under conifers but only for THg under deciduous canopies, however, canopy density did not influence the total deposition either THg or MeHg. To understand the effect of fire on mercury deposition, we placed collectors in the path of three fires that occurred in 2005-2006. THg concentrations increased significantly postfire in conifer throughfall (>4× increase), open precipitation (2.5×), and when all canopy types were considered (2.9×). MeHg concentrations also increased after fire regardless of the cover type (conifer throughfall: 10×increase; open precipitation: 3.5× increase; deciduous throughfall: 1.7× increase; all canopy types analyzed together: 8× increase). THg deposition increased significantly under conifer cover (3.8×). MeHg deposition increased significantly after fire when all canopy types were analyzed together (4.6×) and under conifers (5.9×). It is apparent that from the compilation of our data that conifer canopies are very important contributors of mercury inputs to our watersheds and that fires mobilize considerable stored mercury that is deposited locally. From a mercury deposition perspective we should be concerned about using fire as tool to lessen fuel loads. The larger question is if this increased local deposition finds it's way into the food chain.

Session K6: Agrochemical Monitoring

Agrochemical surface water monitoring - interpreting results from the Atrazine ecological exposure monitoring study

Paul Hendley[1], Christopher Harbourt[2], Paul Miller[2] and Jessica Prenger[2]
[1]Syngenta Crop Protection Inc, Greensboro, NC, United States; [2]Waterborne Environmental Inc., Champaign, IL, United States

Abstract
In 2003, EPA requested a study to monitor small watershed streams to understand the magnitude and duration of potential Atrazine exposures. This extensive multi-site study has now successfully generated over 95 site years of high frequency Atrazine monitoring data in over 40 subwatersheds constituting an unique dataset for small Midwest

agricultural streams. Three subwatersheds in south eastern Nebraska experienced higher residues matched with periods of dryness precluding full analysis. Two subwatersheds located in north eastern Missouri characterized by continuous very shallow restrictive layers on sloping cropped land experienced higher residues. Detailed spatial analyses have shown that these watershed characteristics co-occur infrequently across the Midwest. The study results and other available atrazine surface water data have been compared with output from high spatial resolution PRZM modeling in order to extrapolate study findings to over 35,000 watersheds similar in size to those monitored in the study.

Pyrethroid Insecticides: Collection, Analysis and Occurrence

Michelle L. Hladik, Kelly L. Smalling, Kathryn M. Kuivila
U.S. Geological Survey, California Water Science Center, Sacramento, CA, United States

Abstract
Pyrethroid insecticides are of increasing environmental concern because of their widespread use and high aquatic toxicity. Pyrethroids are frequently detected in California in both agricultural and urban areas and more recently pyrethroids have become a concern in other parts of the United States. Pyrethroid insecticides are highly hydrophobic compounds (log K_{oc} >5) that easily partition out of the dissolved phase. Because of their hydrophobicity pyrethroids can be lost during to containers during sample collection which can confound the interpretation of analytical and toxicity test results.

Methods have been developed for the collection and analysis of 14 pyrethroids in water and sediment (both bed and suspended). Sampling method, container material and water composition have a significant influence on the association of pyrethroids to container walls, which can be as high as 50 percent. Accurate collection of a representative sample requires the proper container material and sample transferring techniques. Samples were processed using solid-phase extraction (SPE) for water and microwave-assisted solvent extraction (MASE) for sediment samples. Sediment extracts were separated from co-extracted matrix interferences using carbon and alumina columns. Extracts were analyzed using ion-trap gas chromatography/mass spectrometry (GC/MS) and tandem mass spectrometry (GC/MS/MS). Detection limits as low as 0.5 to 1 ng/L for water and 0.2 to 0.5 ng/g for sediment were achieved; these low detection limits are necessary to measure pyrethroids below aquatic toxicity levels.

Data from agricultural and urban areas are summarized including nationwide studies conducted by the USGS in 2007 and 2009. Agricultural areas tend to have a greater variety of pyrethroids detected while urban areas tend to have higher concentrations. Pyrethroids are usually found associated with sediments although in some urban areas with low suspended sediment concentrations the pyrethroids partition between both phases.

Fungicides: Analysis, Occurrence, and Fate of an Understudied Group of Pesticides

Kathryn Kuivila, Kelly Smalling, Michelle Hladik
U.S Geological Survey, California Water Science Center, Sacramento, CA, United States

Abstract
Fungicides are pesticides designed to control fungal diseases and tend to be understudied or even ignored during routine monitoring of contaminants in aquatic environments. Used on a wide variety of crops, fungicides are typically applied repetitively throughout the growing season (up to 12 times). Other types of use include landscape maintenance, turf, and residential use. Chlorothalonil, a broad spectrum fungicide, has been applied for over 50 years, but recently the use of other new fungicides has been increasing. In particular, the registration and use of fungicides have changed dramatically over the last 5 years in response to the potential threat of soybean rust and late blight. Fungicides are moderately hydrophobic (log K_{ow} 3-4) and are considered to be relatively persistent in water and sediments. To better understand the environmental occurrence of fungicides, a method was developed to analyze 34 currently-used fungicides in water and sediments using gas chromatography/mass spectrometry. Method detection limits for all compounds were in the low ng/L for water and μg/kg for sediments. In a series of studies across the United States, water and sediment samples were collected from a variety of agricultural and urban use settings. To-date, at least 12 fungicides were detected in water and sediments. The final results of this study will be used to evaluate the importance of adding fungicide analyses in both water and sediments to national monitoring programs. Currently, there is limited environmental data available for many of these compounds and the aquatic toxicity of the newer fungicides, especially in sediment, is still unknown. Future method development will include the analysis of fungicides in aquatic organisms.

Monitoring Colorado's Groundwater for Agricultural Chemicals and Long-Term Contamination Trends

Karl Mauch[1], Troy Bauder[2], Greg Naugle[3], Reagan Waskom[2], Robert Wawrzynski[1]
[1]Colorado Department of Agriculture, Conservation Services Division, Agricultural Chemicals & Groundwater Protection Program, Lakewood, CO, United States; [2]Colorado State University, Soil and Crop Sciences Department, Fort Collins, CO, United States; [3]Colorado Department of Public Health and Environment, Water Quality Control Division, Restoration and Protection Unit, Denver, CO, United States

Abstract
The quality of groundwater throughout Colorado continues to be impacted by the use of pesticides and fertilizers prompting for continued monitoring efforts for acquisition and analysis of long-term data. The Agricultural Chemicals & Groundwater Protection Program, in the Colorado Department of Agriculture, has successfully been monitoring areas with vulnerable conditions for the presence of agricultural chemicals since 1990. Networks of various well types have been sampled in all major, shallow alluvial aquifer systems of Colorado and the deeper unconfined aquifer of the Ogallala formation. A current Program focus is to establish long-term, monitoring well networks in the various basins that may have previously been studied using domestic, irrigation, or municipal wells. This is an essential component in reducing unknown and dynamic variables between sampling events and increasing the accuracy of interpretation when working with long-term projects. Limiting variables tied to sampling methodology increases the likelihood of accurately interpreting relationships of contaminant temporal variability to land-use practices, management of soil fertility, agricultural chemical application, personal and municipal sewage treatment, irrigation, and animal waste. In 2008, a network of 20 monitoring wells was established in the Ogallala formation of the High Plains of eastern Colorado. This network will eventually provide ample data for trend analysis of agricultural chemical contamination. Such is the case for the Program's Weld County Long-Term monitoring and irrigation well networks – long-term networks monitoring groundwater quality annually in the South Platte Basin alluvial aquifer since 1995.

Trend analysis of temporal variability in nitrate-nitrogen concentration, during the period 1995 to 2008, suggests that when viewing each network in whole, neither the 19 monitoring wells or the 36 irrigation wells show a significant trend at $\alpha = 0.05$. Response for trend on individual wells of each network during the same period shows 3 of 19 monitoring and 8 of 36 irrigation wells with significant upward trends, and significant downward trends in 6 of 19 monitoring and 13 of 36 irrigation wells. Trend responses are a result of interpretive statistical analyses with Mann-Kendall, Sen's Slope, Kendall's Tau, and linear regression using MINITAB® statistical software.

Session L1: Monitoring Hydrology: A Critical Consideration for the Interpretation of Water Quality and Biological Assessment Data

Confounding Factors and Lessons Learned: Monitoring the Hydrology of Headwater Streams of the Gulf Coastal Plain

Kristopher Brown, Y. Jun Xu, Den Davis
School of Renewable Natural Resources, Louisiana State University AgCenter, Baton Rouge, LA, United States

Abstract
The development of accurate stage-discharge rating curves is essential for the calculation of nutrient and sediment loads, which are utilized in nonpoint source pollution control efforts. Forested headwater streams of the Gulf Coastal Plain are characterized by highly variable seasonal hydrology and an abundance of beaver/debris dams, both of which complicate the development of rating curves. In this study, 15 monitoring locations were positioned throughout a 365 km^2 low-gradient, third-order watershed of north-central Louisiana. Streamflow and stage measurements were made at monthly intervals and during storm events to develop rating curves. Water level data was recorded by pressure transducers at 15-minute intervals from December 2005 to December 2009. This study found that baseflow discharge was typically zero from May through September due to high evapotranspiration rates, low stream gradients and beaver impoundments. This indicates that dry season sampling may be unnecessary for large, low-gradient watersheds. Conversely, streams commonly exceeded bankfull height during the wet season. Underestimation of these high flow events is inevitable due to rating curve limitations. This paper will address complications in headwater monitoring associated with hydrologic discontinuity, overbank flows, and beaver impoundments. Troubleshooting strategies for hydrologic monitoring in this region, such as site placement and timing of sampling will be discussed.

Monitoring Tidal Water Elevation and Water Quality in Four Embayments of Long Island Sound, New York to Assess Tidal Wetland Loss

Richard Cartwright[1], Christopher Schubert[1], Tristen Tagliaferri[1], Fred Mushacke[2*], Heather Young[2], Kirk Cochran[3]
[1]U.S. Geological Survey, New York Water Science Center, Coram, NY, United States; [2]N.Y.S. Department of Environmental Conservation, Bureau of Marine Resources, East Setauket, NY, United States (*retired); [3]State University of New York, School of Marine and Atmospheric Sciences, Stony Brook, NY, United States

Abstract
Recent trend analysis of tidal wetlands by the New York State Department of Environmental Conservation (NYSDEC) indicates that low marsh vegetation is disappearing. To investigate the cause(s), the U.S. Geological Survey (USGS) is monitoring four wetland embayments of Long Island Sound (LIS) in collaboration with NYSDEC and Stony Brook University (SBU). The embayments—East Creek, West Pond, Frost Creek, and Flax Pond—are of similar size, but differ greatly in the degree to which vegetative cover was lost between 1974 and 2005-06. East Creek showed very little vegetative loss over this period and was selected as a control marsh.

The USGS is continuously monitoring water-surface elevation at each embayment. Water temperature, specific conductance, and salinity are recorded at three embayments, one of which is also monitored for dissolved oxygen, pH, and turbidity. The NYSDEC is installing sediment elevation tables at these and other tidal wetland sites to provide long-term marsh accretion rates and elevation data. Scientists from SBU are collecting pore-water samples from marsh soils for analysis of sulfide, nitrate, nitrite, ammonia, dissolved phosphorus, pH, and Eh. They are also determining accretion rates for the past century from detailed ^{210}Pb chronologies.

Provisional results indicate that mean lower low water (MLLW) elevation and, to a lesser degree, water chemistry differ among embayments and LIS. During January-September 2008, MLLW elevations at Flax Pond and Frost Creek averaged 0.16 and -0.28 feet above NGVD 1929 (National Geodetic Vertical Datum of 1929), respectively, whereas MLLW elevation at the East Creek control site averaged 3.52 feet above NGVD 1929. Differences between MLLW elevations at the sites are due to varying degrees of shoaling in inlets that connect the embayments to LIS. Despite the MLLW differences, mean temperatures and salinities were similar between embayments during this period; minor variations in these parameters are attributed to differences in tidal hydrology, and magnitude and mechanism of freshwater inflow.

Marsh habitats are the result of long-term adaptations to local differences in tidal hydrology and water quality, such as those among the three embayments. Understanding these adaptations may provide clues to ongoing and potential future rates of tidal wetland loss.

Nutrient sampling, concentrations, and corresponding loads during the historic June 2008 flooding in eastern Iowa

L. Hubbard[1], Kolpin, D.W.[1], Kalkhoff, S. J.[1], Robertson, D. M.[2]
[1]U.S. Geological Survey, 400 S. Clinton St., Room 269, Iowa City, Iowa, 52240, USA; [2]U.S. Geological Survey, 8505 Research Way, Middleton, WI, 53562, USA

Abstract
A combination of above normal precipitation during the winter and spring of 2007-2008 and extensive rainfall during June 2008 led to severe flooding in many parts of the Midwest. This resulted in a massive transport of nutrients and sediment from Iowa basins into the Mississippi River. Water samples were collected from 29 sites on six large Iowa tributaries of the Mississippi River to characterize water quality and quantify nutrient and sediment loads during this extreme discharge event. Each sample was analyzed for total phosphorus, total nitrogen, nitrate, ammonia, orthophosphate, and suspended sediment. While the statistical difference between the peak June 2008 and mean June 1979-2007 varied ($p<0.5$; $p>0.05$) depending on constituent, the peak June 2008 instantaneous loads were statistically higher ($p<0.05$) than the median June 1979-2007 instantaneous loads for the same sites with the exception of ammonia. Transport loads for a 16-day period were calculated for four major tributaries and totaled 54,600 tons (49,500,000 kilograms) of nitrogen and 3,210 tons (2,910,000 kilograms) of phosphorus leaving Iowa. Yields calculated from the 16-day flood loads accounted for 22-46% of the total annual nutrient yield, depending on constituent. This analysis shows the impact of large events to the annual nutrient load budget. It also characterizes nutrient output during extreme discharges from various Iowa basins.

Century-scale trends in flood peak discharges in the United States

Robert Hirsch[1], Karen Ryberg[2], Gregg Wiche[2]
[1]U.S. Geological Survey, Reston, VA, United States; [2]U.S. Geological Survey, Bismarck, ND, United States

Abstract
Climate change literature indicates that enhanced greenhouse forcing of the atmosphere is causing an intensification of the hydrologic cycle, which may cause an increase in flood magnitudes. We analyze annual peak streamflow records to add to the understanding of the issue of flooding and greenhouse forcing. We attempt to discriminate between changes due to long-term persistence and those that might reflect a response to changes in atmospheric composition and circulation by using the longest peak streamflow records available (85-126 years). Our focus is on broad regional patterns, not on the statistical significance

of any site-specific trend, and we did not identify a strong general tendency toward increasing peak streamflow. Some parts of the US show modest and consistent increases and others show modest and consistent decreases, the one exception being the Red River of the North and surrounding rivers, which show a comparatively large and consistent increase. However, the ability to causally link the increase of the last 70 years to enhanced greenhouse forcing is questionable, given longer-term Canadian (downstream) data that show that the large floods of the last few decades are not unprecedented. We show that estimated trends can change significantly with the addition of only a few decades of older data. We also consider the correlation between peak magnitudes and variables that relate to the state of the atmosphere and oceans. These analyses suggest that ocean-atmosphere climate variables are related to peak magnitude, although there remains a substantial amount of variation in peaks that is not explained by these variables.

Session L2: Climate Change: Monitoring Impacts on Water Quality and Quantity

An Exploratory Evaluation of the Effects of Climate Change on the Water Quality of the South Platte River in Denver, Colorado

Jon Novick
Denver Department of Environmental Health, Denver, CO, United States

Abstract
Current models suggest the effects of climate change on the Front Range of Colorado will include increased frequency of drought during summer months and earlier runoff from snowmelt in the Rocky Mountains. It is anticipated that these effects will impact instream flows and water quality in Cherry Creek and the South Platte River as they pass through Denver.

Data from Cherry Creek and the South Platte River near downtown Denver were analyzed to determine potential effects of climate change on water quality. The analysis included comparison of instream water quality data collected during periods of drought with data from non-drought periods. Analytical results were classified by flow conditions and compared graphically using box and whisker plots. Observations from the comparison were further examined using statistical techniques.

Results of the analysis of South Platte River data indicated that instream levels of TDS, chloride, sulfate, total ammonia, nitrite, nitrate, TKN, total phosphorous, DOC, calcium, dissolved copper, magnesium, and dissolved manganese were higher during drought conditions than at other times while TSS levels were lower. TOC, *E. coli*, and fecal coliform levels were not related to drought conditions. Data from Cherry Creek reveal that TDS, sulfate, nitrite, nitrate, total phosphorous, calcium, dissolved copper, and magnesium were higher at low instream flows while TSS levels were lower. Chloride, total ammonia, TKN, DOC, TOC, *E. coli*, and fecal coliform, and dissolved manganese levels were not related to drought conditions. Instream selenium levels in both the South Platte River and Cherry Creek were related to drought conditions, however; the highest selenium levels were observed during periods of normal instream flows suggesting ground water recharge is more important as a control on instream selenium levels then flow.

This study indicates that instream levels of certain analytes decreased as a result of decreases in instream flows during drought conditions. Observed changes may be a result of a loss of dilution capacity within the South Platte River and Cherry Creek. The study results imply that some weather extremes resulting from climate change, such as drought, will have a negative impact on water quality in the South Platte River Basin.

Red River Valley Tile Drain Water Quality Assessment: A Study of Water Quality on Saline Soils

Roxanne Johnson, Thomas Scherer
North Dakota State University, Fargo, North Dakota, United States

Abstract
Following years of increased precipitation in eastern North Dakota, the practice of subsurface drainage of agricultural land has rapidly increased. Farmers install tile drains to allow earlier access to fields, to remove wet areas that interrupt field traffic patterns, and to decrease salinization, thus increasing crop yield and profit. While many states have used subsurface drainage, eastern North Dakota is unlike others because of high saline soils and subsequent increased soluble salts in the tile effluent. Concerns include possible impacts of this water flowing into the Red River of the North and Lake Winnipeg in Manitoba, Canada.

A two-phase monitoring project was developed to gather base-line water quality data, including but not exclusive of soluble salts and nitrates in effluent from tile drains. In Phase I, eighteen tile drains in one county were sampled each week for thirty-two weeks in 2008. Cooperators provided information on cropping and fertilizer history, tile maps and soil samples.

Findings showed high levels of sulfates at thirteen of eighteen sites, two sites with high chloride or boron and all sites showed nitrate levels over the standard of quality for waters of the state standard (1mg/L). Trace metals selenium and aluminum were found to be over the aquatic threshold. Electrical conductivity at the lift stations were quadruple the levels found at gravity flowed outlets, which may indicate tile placed lower in the soil profile result in higher mineral loading because an increased area is being drained. Other suggestions include the proximity of the tile to the water table with groundwater being drawn into the tile along with the water moving through the profile.

Phase II, a five-year project, expands sampling into eight counties and includes samples from the drain, downstream, a surface sample from the tiled field and a comparable un-tiled field surface sample. Precipitation and flow will be monitored to determine loading effects. Results from the first year have not been released at this time.

Monitoring Approaches Adapted by Southwest USA Tribal and Municipal Water Providers to Address Water Supply Challenges Associated with Drought and Climate Change

Steven Sagstad[1], Deborah Patton[2]
[1]Civil & Environmental Consultants, Inc., Phoenix AZ; [2]Rural Community Assistance Corporation, Phoenix, AZ

Abstract
The challenges associated with persistent drought conditions, that may be attributed to climate change, are now being incorporated into long-term water resource management monitoring and planning by tribes, towns, and cities to better manage groundwater supplies in the semi-arid Southwestern U.S. Recent climactic changes have resulted in decreasing precipitation and surface runoff causing a significant drop to groundwater recharge throughout the area. Local groundwater resources have historically been the principal source of potable water supplies of many small towns. Pressures of population growth put additional demands on the groundwater supply resulting in the need to implement adaptive measures. In many cases, very little groundwater quantity or quality data is available to make long-term water management decisions. After 10 years of a persistent drought, and the accompanying reduction in recharge to groundwater, water levels in the aquifers have declined significantly. The drop in groundwater levels and significant reduction in well production capacity and water quality in some wells has caused towns to monitor and investigate the development of very different approaches to groundwater management.

Without having perennial surface water resources available for supply, groundwater sustainability evaluations have to be performed to obtain an estimate of sustainable extraction based upon long-term drought (climate) conditions. Consequently, adaptive measures to meet long-term water demands have been identified and implemented, which includes developing alternative water sources. The unique nature of the local hydrogeologic conditions throughout the Southwest make these case studies a prime example of the challenges of climatic change that many water providers may face in the coming decades. Adaptation to drought and climate change will determine the impacts to humans from water supply changes. Seasons of increased precipitation creates changes in behavior that last until the next dry season comes along, therefore understanding available resources and planning for future needs is critical. With three generations of people who have not subsisted on the land, adaptation to the stresses of drought conditions becomes more difficult. Tribes, culturally, feel responsible for the earth as "Mother" and see the need for behavior changes in order to sustain life on this planet.

Ecological Monitoring Strategies for Freshwater Systems in Alaska's National Parks

Jeff Shearer[1], Trey Simmons[2], Amy Larsen[2]
[1]National Park Service, Southwest Alaska Inventory and Monitoring Network, Anchorage, AK, United States, [2]National Park Service, Central Alaska Inventory and Monitoring Network, Fairbanks, AK, United States

Abstract
The National Park Service Inventory and Monitoring Program is a nationwide effort initiated to monitor status and trends in park resources. Within Alaska, the Central, Arctic, Southeast and Southwest Alaska Networks cover 217,300 km^2 of mostly roadless wilderness spanning 16 national park units. Freshwater resources within these parks are as vast as the landscape, ranging from the 588-km^2 Naknek Lake to Wild and Scenic Rivers to countless small ponds and streams. The geologic and hydrologic characteristics of these waters, many of which have glacial or thermokarst origins, make them ideal for assessing the potential impacts of climate change on otherwise relatively undisturbed systems at high latitude, where those impacts are expected to occur earlier and be more intense. Developing robust monitoring programs to assess chemical, physical, and biological characteristics within this diverse array of aquatic ecosystems is a daunting task given logistical and programmatic challenges. Herein, we will discuss a multi-faceted approach of combining remote sensing data with intensive and synoptic field data to assess both systemic and local-scale changes on high latitude aquatic systems.

Session L3: Linking Sources and Stressors to Water Quality

Assessing the Condition of Streams in the San Gabriel River Watershed (California): Integration of Multiple Indicators

Scott C. Johnson[1], Edward Belden[2], Kristy Morris[2]
[1]Aquatic Bioassay & Consulting Laboratories, Inc., Ventura, CA; [2]The Los Angeles and San Gabriel Rivers Watershed Council, Los Angeles, CA

Abstract
The San Gabriel (California) River Regional Monitoring Program (SGRRMP) was the first watershed-wide monitoring effort initiated in California based on a multilevel, probabilistic (ambient) monitoring design. The development of the monitoring design brought together watershed stakeholders that included regulators, NPDES permittees and citizen groups who are vested in water quality and ecosystem health. Next, the workgroup recommended monitoring designs to effectively and efficiently answer these questions. A key goal of the program has been to describe, for the first time, the overall watershed condition using a triad of indicators that includes water quality, toxicity, macroinvertebrate and algae bioassessment, and physical habitat conditions. Sampling for this program has included five annual summer surveys that began in 2005. During that time field crews have collected samples at 69 randomly selected locations throughout the watershed.

Assessment of these data has included the use of traditional biological metrics as well as a multimetric index unique to southern California, comparison of water quality measurements against State standards, and finally parametric and multivariate statistical techniques in an attempt to describe the condition of streams in the watershed and to define key stressors. Results to date illustrate clear patterns that distinguish the upper (un-developed) portions and lower developed) portions of the watershed in terms of water quality and habitat condition. Furthermore, results of the ambient assessment provide context for evaluating water quality and stream conditions below permitted discharge locations. Finally, the results are helping to identify areas where expanded monitoring or special studies should be focused.

These data have begun to elucidate the ambient condition of streams in the watershed and to provide managers with information regarding how and where resources might be spent to improve degraded conditions and to protect more pristine areas. In addition, after five years of monitoring the San Gabriel River Watershed Stakeholder group has begun to assess how the program can be improved through improved cost efficiencies that better target key water quality issues.

Keywords: Multiple lines of evidence, stressors, ambient condition, cost efficiencies, multivariate, biological indicators, probabilistic

Assessing Ecological Conditions of U.S. Coastal Ocean Waters: Expansion of EMAP from Estuaries to the Offshore Environment

Jeff Hyland[1], Walt Nelson[2], John Macauley[3]
[1]National Oceanic and Atmospheric Administration (NOAA), 219 Fort Johnson Road, Charleston, South Carolina, 29412-9110, USA; [2]U.S. Environmental Protection Agency (U.S. EPA), 2111 SE Marine Science Drive, Newport, Oregon, 97365, USA; [3]U.S. Environmental Protection Agency (U.S. EPA), 1 Sabine Island Drive, Gulf Breeze, Florida, 32561, USA

Abstract
Since 2003 NOAA, U.S. EPA, and various coastal states have conducted studies to assess the status of ecological condition and potential stressor impacts throughout coastal-ocean waters of the U.S. Protocols are similar to those used in EPA's Environmental Monitoring and Assessment Program (EMAP) and National Coastal Assessment (NCA), which have focused on estuarine and inland waters. The recent offshore series extends these prior efforts onto the continental shelf, from near-shore depths seaward to the shelf break (typically 100 m). Where applicable, sampling has been included in NOAA's National Marine Sanctuaries to provide a basis for comparing conditions in such protected areas to surrounding non-sanctuary waters. To date surveys have been conducted throughout the western U.S. continental shelf, from the Straits of Juan de Fuca, WA to the U.S./Mexican border; South Atlantic Bight; mid-Atlantic Bight; and continental shelf off southern Florida, from West Palm Beach to Tampa. There are plans to conduct surveys throughout the remainder of the Gulf of Mexico and U.S. North Atlantic coast by 2012. Multiple indicators of water quality, sediment quality, and biological condition (benthos and fish) are sampled throughout these waters using random probabilistic sampling designs. Synoptic sampling of the various indicators provides a "weight-of-evidence" approach to assessing condition and a basis for evaluating linkages between the status of condition and source drivers and pressures. In addition, the probabilistic sampling design provides a basis for making unbiased statistical estimates of the spatial extent of a region's health relative to the various measured indicators and corresponding management thresholds and using this information as a baseline for determining how conditions may be changing with time. Because the protocols and indicators are consistent with those used in previous EMAP/NCA estuarine surveys, comparisons also can be made between conditions in offshore waters and those observed in neighboring estuaries, thus providing a more holistic account of ecological conditions and processes throughout the

inshore to offshore resources of a region. Such information should provide valuable input for future National Coastal Condition Reports, as well as other evolving management priorities including marine spatial planning and ecosystem approaches to management.

Problems and prospects of the application of Soil and Water Assessment Tool (SWAT) Model for the identification of nonpoint source pollution "hotspots" in a flat coastal agricultural watershed in humid tropics

D.D. Poudel[1], R. Srinivasan[2], K.C. Abbaspour[3], and C.Y. Jeong[4]
[1]Department of Renewable Resources, University of Louisiana at Lafayette, Louisiana, USA; [2]Texas A&M University, College Station, Texas, USA; [3]Eawag:Swiss Federal Institute of Aquatic Science and Technology, Ueberlandstr 133, P.O. Box 611, 8600, Duebendorf, Switzerland; [4]School of Plant, Environmental, and Soil Sciences, AgCenter, Louisiana State University, Baton Rouge, Louisiana

Abstract
The Bayou Plaquemine Brule in southwestern Louisiana, USA, has been included in Louisiana's 303(d) list of impaired water bodies for several years. In order to examine the spatial and temporal variations of nonpoint source pollution in Bayou Plaquemine Brule watershed, we monitored surface water quality at seven monitoring sites in the watershed from March 2002 to February 2008. Water quality parameters monitored included dissolved oxygen, turbidity, conductivity, pH, temperature, total suspended solids, 5-day biological oxygen demand, total nitrogen, nitrate/nitrite-nitrogen, total phosphorus, and soluble reactive phosphate. Using the Soil and Water Assessment Tool (SWAT) Model we identified "hotspots" for sediment, nitrate, and mineral-P in the watershed. In modeling water quality, several problems related to discharge and flow calibration, hydrology, land use representation, and the development of management files were encountered. As a result, the parameter optimization statistics were not very appreciative. Nevertheless, the SWAT simulation results were in line with our monitoring results and effectively helped us in identifying the sediment, nitrate, and mineral-P "hotspots" in the watershed. Water quality monitoring as well as the SWAT modeling results for Bayou Plaquemine Brule watershed will be presented. Problems and the prospects of SWAT application in a flat agricultural landscape in coastal Louisiana will be discussed.

2010 Release of the U.S. EPA Causal Analysis Diagnosis and Decision Information System (CADDIS)

Amina Pollard
National Center for Environmental Assessment, USEPA, Washington DC 20460, United States

Abstract
According to the January 2009 305(b) Report to Congress, the fourth most common cause for listing waters as impaired is: cause unknown - impaired biota. To remediate these waters, the causes must first be identified. The U.S. EPA Causal Analysis Diagnosis and Decision Information System (CADDIS) describes the process and provides information for developing and weighing evidence to determine a probable cause. The 2010 release is available as a review draft. Some highlights include new case studies and examples, new analytical tools, a new module on streamlining the process. and information on additional candidate causes: ammonia, pH, insecticides, and in-stream habitat alteration. This methodology has proven to be a dependable asset for evaluating and using causal relationships in eco-epidemiological studies.

Session L4: Unique Collaborative Approaches for Successful Outcomes

The Collective Action Continuum: Identifying Critical Elements for Environmental Improvement

Jenny Biddle and Nicole Darnall
George Mason University, Department of Environmental Science and Policy

Abstract
Assessing the relationship between different types of collective actions and their corresponding environmental improvements has proven difficult in large part because of inconsistencies in how researchers have operationalized a collective action. Such inconsistencies also impede the rigor of collective action scholarship because they decrease the generalizability of the research and can lead to inaccurate assessments of relationship among variables of interest. This paper addresses these concerns by developing a novel conceptual framework for disentangling the "black box" of collective action. It describes a continuum of collective action that is composed of three levels (organized cooperation, systematic coordination, and synergistic collaboration) and that is conceptually related to variations in environmental improvements.

Keywords: Collective action, continuum, organized cooperation, systematic coordination, and synergistic collaboration, environmental improvement

Georgia Adopt-A-Stream Database: Beyond the Data

Allison M. Hughes
State Coordinator, Georgia Adopt-A-Stream, Georgia Department of Natural Resources, 4220 International Parkway, Suite 101, Atlanta, GA 30354, gaadoptastream@gmail.com

Abstract
Georgia Adopt-A-Stream (GA-AAS), a statewide volunteer water quality monitoring program, has recently launched its new on-line database. The database was designed with programmatic goals in mind with data as a secondary focus. We chose to focus on programmatic goals to help us better meet our administrative needs and those of our local trainers and coordinators.

The GA AAS program has two full time State Coordinators who coordinate 55 local Adopt-A-Stream trainers. To better meet the needs of our most vital partner, our trainers, we designed the database with their needs in mind. Their needs included the ability to enter data on-line, methods to track volunteer numbers and hours spent monitoring, easy access to data, and ways to interpret data, all while being presented in a user-friendly manner.

The GA-AAS database was transformed from a static, state coordinator access only database to an on-line, dynamic database that can be accessed by all GA-AAS staff, our local trainers and certified volunteers. This gave our local coordinators and volunteers the choice to enter their own data, which before was done by the State Office.

In these tough economic times, we have to justify how our time is spent and often have to prove validity of our programs. To combat this, we have added a tracking function that produces the number of volunteers and hours spend monitoring based on a chosen target area (i.e. watershed, county, city) during a specified time period. These data are being used in annual reports and grant proposals and include the monetary of volunteer time based on the national standard for volunteer hourly rate. Our hope is that this will help our coordinators show the importance of volunteer monitoring as well as secure funding to support their programs.

The creation of our database has energized our trainers and volunteers resulting in an increase in number of volunteers, monitoring groups and sites registered. Come join us and learn about how our database was designed, learn about it's functionally and how it has helped our program grow.

Development of Comprehensive Volunteer Water Quality Monitoring Education and Support in Response to Agency-directed Targeted Watershed Improvements: Lessons Learned

Channah Rock[1], Candice Rupprecht[2], and Kristine Uhlman[2]
[1]Department of Soil, Water, and Environmental Science, University of Arizona, Maricopa Agricultural Center, Maricopa, AZ, United States; [2]University of Arizona Water Resources Research Center, Tucson, AZ, United States

Abstract
In partnership with Arizona Department of Environmental Quality (ADEQ), Arizona Cooperative Extension (ACE) developed the Arizona Master Watershed Steward (MWS) Program to educate and train citizens across Arizona to serve as volunteers in protection, restoration, monitoring, and conservation of their water and watersheds. With program support from EPA 319 Clean Water Act funds, Arizona MWS has grown to over 400 volunteers in 15 cities with unparalleled educational value and community impact.

In an effort to better address impairment issues of Arizona waterways, ADEQ identified targeted watersheds with specific nonpoint source pollution issues that need to be mitigated. Specifically, this is reflected in the Arizona Integrated 305(b) and 303(d) Listing Report, and is expected to show approximately thirteen reaches impaired for *E. coli* contamination in the 2010 assessment. In 2009 ADEQ solicited proposals for Targeted Watershed Improvement Grants focusing on three priority Arizona Watersheds classified as "impaired" for the fecal indicator bacteria *E.coli*. These watersheds included the San Francisco, Granite Creek and Oak Creek.

To facilitate on the ground improvements, local identified watershed groups received targeted grant funds from ADEQ to develop Watershed Improvement Plans (WIP's) and direct improvement project and monitoring needs in their watershed. Arizona Non-point Source Education for Municipal Officials (NEMO) and MWS Programs were leveraged to support these watershed groups to implement on the ground water quality assessments led by volunteers within each watershed. Currently, there is a critical need for the development of guidance documents that will empower water resource managers and the community with the tools necessary to accurately identify and mitigate non-point source pollution. Working together, these groups were employed to evaluate select reaches that are currently impaired for *E.coli* for targeted sampling, analysis, and watershed health evaluation. Throughout this process it became apparent that a comprehensive approach to watershed education should be utilized when working with watershed groups on projects of this nature. In order to successfully execute project plans, project partners implemented strategic educational workshops, intensive training sessions, and planning meetings. This comprehensive approach was critical to the success of these projects and the execution of the participatory process.

From Citizen Science to Volunteer Monitoring: Seeking hybridization of disparate models for more meaningful public engagement in environmental monitoring

Candie Wilderman[1] and Jennifer Shirk[2]
[1]Dickinson College, Carlisle, PA; [2]Cornell Lab of Ornithology, Ithaca, NY

Abstract
Community science, often defined as a research partnership between volunteers and professional scientists, is practiced in the U.S. using a variety of models with the common goals of scientific research, education, and/or environmental action. The NSF-funded Center for the Advancement of Informal Science Education recently opened an inquiry into community science as an educational strategy. A major agenda of this inquiry was to document the particular strengths of different project models for fostering environmental learning and/or action skills. The Inquiry Group distinguished models of community science based primarily on the varying degrees to which the public were involved in the steps of the scientific process and the control that the participants had over the different steps. The results led to three major categories: contributory projects which are generally designed by scientists and for which members of the public primarily contribute data (often called citizen science); collaborative projects which are also designed by researchers but where the public may help refine the project design, analyze data, or disseminate findings; and co-created projects, which are designed by the public with the technical support of scientists and for which public participants are actively involved in all steps of the scientific process. Many water quality volunteer monitoring programs fall into this third category.

Through consideration of a variety of examples from throughout the spectrum of community science, a rubric developed by the inquiry group for evaluation of outcomes will be presented and the implications of the engagement strategies as they pertain to science education, scientific research, and environmental action will be discussed. Although there has been little communication between the communities of practice of the different models, we suggest that collaboration across project types could be of great benefit. A strengths analysis will be presented, as well as suggestions as to how each model can incorporate the strategies of other models to make targeted choices that meet specific project goals. This hybridization could lead to stronger volunteer monitoring programs, more meaningful outcomes for the public in contributing data to research programs, and valuable interaction between the communities of practice.

Session L5: Biomagnification of Mercury through Food Webs

Assessing Impairment of Tomales Bay due to Mercury

Kat Ridolfi, Jay Davis, Letitia Grenier, Aroon Melwani, Lester McKee, Don Yee
San Francisco Estuary Institute, 7770 Pardee Lane, 2nd Floor, Oakland, CA 94621

Abstract
Mining of natural mercury deposits in the 1960s on a major tributary of Tomales Bay produced about 300,000 m^3 of mine tailings with average mercury concentrations of 320 mg/kg. Since then, storm events have transported the mercury-laden sediment into Tomales Bay, and contaminated sport fish commonly consumed by humans. This study investigated the possible impairment of the beneficial uses of Tomales Bay by mercury, in order to help the San Francisco Bay Regional Water Quality Control Board with the development of a Total Maximum Daily Load. Numeric targets for the protection of wildlife were developed, and small prey fish were collected to determine if mercury concentrations in fish exceed these targets, putting wildlife at risk of mercury contamination. Additionally, sediment and water samples were collected to answer key questions regarding the spatial distribution of total and methylmercury and if there are additional sources of mercury in the Bay. Prey fish 5-15cm in length had a mean Hg concentration of 0.05 μg/g ww, meeting the numeric target for protection of wildlife. Sediment mercury concentrations were elevated around the Walker Creek delta (where mining-contaminated sediments discharge), though there was evidence that methylmercury in sediment was higher in marshes, as compared to intertidal mudflats, and it was not correlated

with total mercury in sediment. The results of the study will be used by state regulators to define the most appropriate implementation measures to reduce the risk to wildlife and other beneficial uses in the Bay.

Contaminants in Sport Fish of California Lakes and Reservoirs

Jay Davis[1], Valerie Connor[2], Aroon Melwani[1], Shira Bezalel[1], John Hunt[3], Gary Ichikawa[4], Autumn Bonnema[5], Wesley Heim[5], Stacey Swenson[5], Mark Stephenson[4]
[1]San Francisco Estuary Institute, Oakland, CA, United States; [2]California Environmental Protection Agency, Water Resources Control Board, Office of Information Management & Analysis, Sacramento, CA, United States; [3]Department of Environmental Toxicology, University of California at Davis, Monterey, CA, United States; [4]California Department of Fish & Game, Moss Landing Marine Laboratories, Marine Pollution Studies Laboratory, Moss Landing, CA, United States; [5]San Jose State University, Moss Landing Marine Laboratories, Marine Pollution Studies Laboratory, Moss Landing, CA, United States

Abstract
The California State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP) has established a new statewide bioaccumulation monitoring program. The program has begun with a two-year screening survey of bioaccumulation in California's 9,000 lakes and reservoirs in 2007 and 2008. The lakes survey included two major components: 1) a probabilistic sampling of 50 lakes to provide a statewide assessment of condition and 2) sampling of the state's 200 most popular fishing lakes to determine the need for inclusion on the 303(d) list of impaired waters. Species targeted at each lake include a top predator as a mercury indicator and a high-lipid benthic species as an indicator for organic contaminants. Largemouth bass, carp, and catfish were the species most commonly sampled. Mercury analyses in predator species were performed on individual fish. A compositing strategy was used for other contaminants to maximize use of limited resources. Edible muscle was analyzed. Samples were collected from a single location in small lakes (< 500 ha) and multiple locations in larger lakes. Sport fish tissue concentrations were evaluated using thresholds developed by the California Office of Environmental Health Hazards Assessment (OEHHA). Lakes were considered "clean" if all average pollutant concentrations in all species were below all OEHHA thresholds. Only 15% of the lakes sampled in 2007 were in the "clean" category. Methylmercury was the pollutant primarily responsible for the remaining 85% of lakes having at least one species with an average concentration above thresholds. Approximately 26% of the 152 lakes surveyed had a species with an average concentration greater than 0.44 ppm. PCBs were second to methylmercury in reaching concentrations posing potential health risks to consumers of fish caught from California lakes. Approximately 37% of the lakes had a fish species with an average PCB concentration above the lowest OEHHA threshold (3.6 ppb). In contrast to methylmercury, only 1% of the lakes sampled had a species with an average concentration high enough that OEHHA would consider recommending no consumption of the contaminated species (120 ppb). Concentrations of dieldrin, DDT, chlordane, and selenium were generally low, and infrequently exceeded OEHHA thresholds.

Mercury in National Park Units of the Western Great Lakes Region: Assessing Bioaccumulation in Aquatic Food Webs

James Wiener[1], Bill Route[2], Sean Bailey[1], Roger Haro[1], Kristofer Rolfhus[1], Mark Sandheinrich[1], Nicole Forseth[1]
[1]University of Wisconsin-La Crosse, River Studies Center, La Crosse, WI, United States; [2]National Park Service, Great Lakes Inventory and Monitoring Network, Ashland, WI, United States

Abstract
We are assessing the bioaccumulation of methylmercury in national parks of the western Great Lakes region. The nine parks, which are managed by the National Park Service, range from human-impacted landscapes (Indiana Dunes) to relatively pristine wilderness (Isle Royale). Analyses of dated sediment cores and regional forest soils have shown that atmospheric deposition is the dominant source of mercury—most from anthropogenic sources. The parks contain abundant aquatic resources (perennial streams, inland lakes, wetlands, and near-shore areas in lakes Michigan and Superior) that support diverse assemblages of warm, cool, and coldwater fishes. Many fishes—including walleye, northern pike, smallmouth bass, and lake trout—are harvested recreationally in the parks. Aquatic biota (larval dragonflies, prey fish, and predatory fish) are being monitored in six parks and nestling bald eagles in three parks to (1) assess spatiotemporal patterns in contamination, (2) identify parks and surface waters where methylmercury poses the greatest ecological risk, and (3) identify factors influencing bioaccumulation of methylmercury in food webs. We are also evaluating the utility of gomphid, corduliid, and libellulid dragonflies (Insecta: Odonata), the most abundant and diverse odonate taxa in the region, as biosentinels that could provide an indicator of methylmercury contamination in fishless aquatic and wetland environments or in situations where sampling of fish is not logistically feasible. Mercury levels in axial muscle of piscivorous fish from several lakes substantially exceeded 0.3 μg/g ww, the USEPA tissue residue criterion for methylmercury (established to protect the health of persons who eat noncommercial fish), and many exceeded 0.5 μg/g ww, an estimated threshold concentration associated with altered biochemical processes, damage to cells and tissues, and reduced reproduction in fish. In some lakes, concentrations of mercury in whole prey fish may be high enough to adversely affect production of nesting common loons. In nestling bald eagles, the concentrations of mercury in feathers were highest in birds from reaches of the St. Croix Scenic Riverway that contain abundant wetlands, which are sites of active methylmercury production. Some of these parks contain mercury sensitive landscapes in which organisms atop aquatic food webs bioaccumulate toxicologically significant concentrations of methylmercury.

Characterizing mercury bioaccumulation and biomagnification in streams across large environmental gradients

Lia Chasar[1], Barbara Scudder[2], Karen Riva-Murray[3], A. Robin Stewart[4], Mark Brigham[5]
[1]U.S. Geological Survey, Florida Water Science Center, Tallahassee, FL; [2]U.S. Geological Survey, Wisconsin Water Science Center, Middleton, WI; [3]U.S. Geological Survey, New York Water Science Center, Albany, NY; [4]U.S. Geological Survey, National Research Program, Menlo Park, CA; [5]U.S. Geological Survey, Minnesota Water Science Center, Mounds View, MN

Abstract
Recently the US Environmental Protection Agency (EPA) released guidelines for implementing the 2001 fish-tissue-based methylmercury water quality criterion (0.3 mg methylmercury per kg fish tissue, wet weight), suggesting that water quality standards be based on methylmercury concentrations in fish typically consumed by the general population. Biologically derived water quality criteria may be established by calculating a mercury bioaccumulation factor (BAF; the ratio of the methylmercury concentration in fish muscle tissue to the concentration of methylmercury in water) for a species of interest. BAFs are influenced by many practical, environmental, and biological factors including: sample timing and number of samples; environmental setting (e.g., mercury source strength, extent and proximity of contributing wetlands, stream biogeochemistry, and hydrodynamics); and foodweb structure, as well as physiology and life-history of target organisms. The US Geological Survey National Water-Quality Assessment and Toxics Substances Hydrology Programs recently completed two studies that help inform the application of BAFs to develop water quality criteria for methylmercury: (1) a nationwide survey of methylmercury in stream water and fish from 1998 to 2005; and (2) intensive studies of stream water chemistry and aquatic biota from 2002-2009 in 10 distinct geographic areas in Oregon, Wisconsin, New York, South Carolina, and Florida. Study areas spanned large gradients in watershed size, environmental setting, and stream biogeochemistry. Biomagnification rates were similar among

most study areas. Log10BAFs for predator fish across all sites averaged 6.33 (range, 4.36-7.59) for the nationwide survey, and 6.19 (range, 6.01-6.42) for the intensive studies. The results of these studies will be described in relation to stream basin characteristics, sample frequency, target species, and other factors that contribute to computation of BAFs.

Session L6: Contaminant Threats to Drinking Water

Quality of Water from Public-Supply Wells in the United States

Patricia L. Toccalino[1] and Jessica A. Hopple[2]
[1]U.S. Geological Survey, Sacramento, CA; [2]U.S. Geological Survey, West Trenton, NJ

Abstract
About one-third of the Nation's population obtains drinking water from public-supply wells. The U.S. Geological Survey assessed water-quality conditions in source (untreated) water from 932 public wells, and in source and finished (treated) water from a subset of 94 wells. The wells are located within selected areas of 30 principal aquifers in 41 states. A greater number of chemical contaminants (as many as 337), naturally occurring and man-made, were assessed in this study than in any previous national study of public wells. Study objectives were to evaluate (1) contaminant occurrence in source water and its potential significance to human health, (2) whether contaminants that occur in source water also occur in finished water, and (3) the occurrence of contaminant mixtures.

More than one in five (22 percent) source-water samples from public wells (and none of the finished-water samples) contained one or more contaminants at concentrations greater than human-health benchmarks (Maximum Contaminant Levels or Health-Based Screening Levels). Contaminants from natural sources accounted for about three-quarters of concentrations greater than benchmarks in source water, including trace elements, such as arsenic, and radionuclides, such as radon. Contaminants that originate primarily from man-made sources accounted for about one-quarter of concentrations greater than benchmarks, including nitrate, pesticide compounds, such as dieldrin, and volatile organic compounds (VOCs), such as perchlorethene. Collectively, pesticide compounds or VOCs were detected in 64 percent of source-water samples, and concentrations of one or more of these contaminants were greater than benchmarks in 4.5 percent of samples. Many organic contaminants detected in source water also were detected in finished water at similar concentrations. Benchmarks were not available for 144 contaminants analyzed in this study. Contaminants usually co-occurred with other contaminants in source and finished water, and mixtures of two or more individual contaminants at concentrations greater than one-tenth of benchmarks were dominated by inorganic contaminants. The most complex mixtures in source water—those with the greatest number of contaminants—were most often detected in samples from unconfined aquifers. These findings indicate the ubiquitous nature of contaminant sources, and the vulnerability of the Nation's aquifers to contaminants from natural and man-made sources.

Anthropogenic Organic Compounds in Source and Finished Water of Community Water Systems that Withdraw from Streams

James A. Kingsbury
U.S. Geological Survey, 640 Grassmere Park Road, Suite 100, Nashville, TN 37211

Abstract
Twenty 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. An associated finished-water sample was collected to characterize the extent to which compounds detected in source water were present in treated water prior to entering the distribution system. The studies are intended to complement existing drinking-water monitoring required by Federal, State, and local programs, which focus primarily on post-treatment compliance monitoring. Most samples were analyzed for 258 anthropogenic organic compounds including pesticides, pesticide degradates, volatile organic compounds, and personal care and domestic use products.

About fifty compounds were detected commonly (in 10 percent or more of the samples), and chloroform, atrazine, simazine, metolachlor, deethylatrazine and the fragrance HHCB were among the most frequently detected compounds. About two thirds of the compounds detected commonly in source-water samples had similar detection frequencies in finished water. Although the water treatment steps differ somewhat among the water systems, the amount of change in concentration of the compounds from source- to finished-water samples generally did not differ systematically among the water systems for compounds with similar detection frequencies in source and finished water. Changes in concentration over time in source water of some compounds, for example seasonal changes in atrazine concentrations, usually were reflected in the associated finished water. Annual mean concentrations of all compounds in both source and finished water were less than human-health benchmarks. Samples typically contained mixtures of two or more compounds. The total number of compounds and their total concentration in samples generally increased with the amount of urban and agricultural land use in a watershed.

EPA's Third Contaminant Candidate List – Evaluating Unregulated Drinking Water Contaminants

Thomas R. Carpenter
Office of Ground Water and Drinking Water, US Environmental Protection Agency

Abstract
EPA developed the CCL process to identify contaminants that may require drinking water regulation and may occur in public water system. The CCL is a list of contaminants that may require drinking water regulation that EPA evaluates to ascertain if they have substantial likelihood to occur in public water systems and a drinking water regulation presents a meaningful opportunity to protect public health. The Agency published the final CCL3 in September 2009 and identified the information and research needs for the 104 chemicals and 12 microbes included on the list.

The CCL classification process involves three major stages. The first stage identifies contaminants known or anticipated to be occur in public water systems and may have adverse health effects. EPA evaluated approximately 6,000 chemicals and 1,400 microbes during this step. Initial compilations of potential drinking water contaminants gathered data that indicated a potential to occur in a public water system and adverse health effects. Approximately 90 percent of the 6,000 unregulated chemical contaminants evaluated did not have occurrence studies or detected occurrence for this analysis. The second stage narrows the pool of candidates by applying screening criteria, taking into account both the occurrence and adverse health effects data, to a Preliminary CCL (PCCL) of 562 chemicals. Approximately 60 percent of the contaminants on the PCCL have ambient water or public water systems occurrence data. The third stage of the process involves analyzing contaminants on the PCCL to develop the CCL. EPA's evaluation of contaminants on the PCCL included rule-based methods, prototype classification algorithms, and expert judgment to identify the 116 contaminants on the list.

One of the challenges the Agency faced in selecting an approach is the diversity of available data for the PCCL contaminants. Indicators of potential occurrence in public water systems include measured values in finished, ambient, source waters, release/use data (lbs, number of States), production data (lbs), persistence (half-life, biodegradation rates). The Agency identified contaminants used in commerce, produced

in high volume, or persistent even though not produced in high volumes that do not have nationally representative occurrence data. This presentation discusses the types of contaminants, data sources, and other considerations researchers, agencies, and other organization may consider as they develop analytical methods, monitoring strategies, programs to protect sources of drinking water or advance public health protection.

The Next Generation of Drinking Water Disinfection By-Products

Susan D. Richardson
U.S. Environmental Protection Agency, National Exposure Research Laboratory, Athens, GA

Abstract
The disinfection of drinking water has been rightly hailed as a public health triumph of the 20th century. Millions of people worldwide receive quality drinking water every day from their public water systems. However, chemical disinfection has also produced an unintended health hazard: the potential for cancer and reproductive/developmental effects that are associated with chemical disinfection by-products (DBPs). Chemical disinfectants are effective for killing harmful pathogens in drinking water, but they are also powerful oxidants, oxidizing the organic matter, anthropogenic contaminants, and bromide/iodide naturally present in most source waters (rivers, lakes, and many groundwaters). Chlorine, ozone, chlorine dioxide, and chloramines are the most common disinfectants in use today, and each produces its own suite of DBPs in drinking water.

Of more than known 600 DBPs, only 11 are currently regulated in the United States. And, those that are regulated do not cause the primary type of cancer (bladder cancer) that is observed in the human epidemiologic studies. Recent research has identified 'emerging', unregulated DBPs that are more cytotoxic and genotoxic than those that are currently regulated, and the use of newer alternative disinfectants (chloramines, ozone, chlorine dioxide) can increase their formation. This is important because many drinking water utilities in the U.S. are changing from chlorine to alternative disinfectants to meet stricter regulations. Emerging DBPs include iodo-acids, iodo-trihalomethanes (Iodo-THMs), bromonitromethanes, haloamides, and nitrosamines (including nitrosodimethylamine, NDMA). New research on emerging DBPs will be presented, along with results from an occurrence study of iodo-acids and iodo-THMs and new research on the formation of iodo-DBPs from pharmaceuticals used for medical imaging (X-ray contrast media). Finally, results from an interdisciplinary EPA study (the Four Lab Study), which involves the chemical and toxicological evaluation of complex drinking water mixtures treated with chlorine and alternative disinfectants, will be briefly discussed, along with other important new health effects information.

Monday Poster Session

MiniSipper: a New High-capacity, Long-duration, Automated In-Situ Water Sampler

Thomas Chapin and Andrew Todd
U.S. Geological Survey, Denver, CO, USA

Abstract
Currently available automated water samplers are typically large, heavy, cannot operate in freezing conditions, and collect twenty-four 1000 mL samples. High-sensitivity analytical instruments such as inductively coupled plasma mass spectrometry (ICP-MS) only require a few mL of sample per analysis so large sample volumes are often unnecessary. The USGS has developed a small, light, low-cost, high-capacity, in-situ water sampler (MiniSipper) to overcome the limitations of currently available automated samplers. MiniSipper components are: 1) waterproof housing for microcontroller, micro-pumps, and rechargeable battery; 2) 150 m Teflon tubing sample coil; and 3) collapsible bags for an inert gas (N2) and a stabilizing reagent (HNO_3). The MiniSipper injects 1 to 20 mL water samples into the Teflon coil and adjacent samples are separated by a gas bubble. Over 250 five mL water samples can be loaded into the sample coil and carryover is typically <2%. The MiniSipper collects discrete or integrated samples at programmed intervals. After recovery, samples are pumped out of the sample coil and analyzed by high sensitivity multi-element methods.

The *in-situ* design of the MiniSipper allows for easy concealment under streambed rocks and the MiniSipper can operate under surface ice for >8 months for over-winter sampling. The large number of water samples collected and long deployment duration of the MiniSipper greatly reduces fieldwork costs, making it ideal for remote-site monitoring. The MiniSipper also is ideal for sampling at various time scales to resolve diel, episodic, or long-duration events. We have deployed the MiniSipper in support of an Environmental Protection Agency (EPA) project evaluating metal inputs from acid mine drainage areas to the Snake River watershed near Keystone, CO, USA. Our initial results reveal very high correlations (R^2>0.9) between potentially toxic metals (Al, Cu, Ni, Zn) and conductivity. The large number of samples collected by the MiniSipper over the entire water year provides the requisite data to examine the robustness of conductivity-metal relationships. MiniSipper results will help guide EPA sampling strategy and help evaluate the use of real-time conductivity as a proxy for real-time trace metal concentrations. A smaller Borehole MiniSipper is being developed to collect multiple samples from monitoring wells.

Continuous in situ *measurement of dye tracer and physical water quality properties for characterization of overlapping plumes from wastewater treatment facilities discharging to the Missouri River*

Eric Christensen[1], Shelley Niesen[1], Richard Norman[1], and Jeffrey Weitzel[2]
[1]U.S. Geological Survey, Missouri Water Science Center – Kansas City, Lee's Summit, MO; [2]National Geospatial-Intelligence Agency, St. Louis, MO

Abstract
Continuous in situ measurement of rhodamine WT dye, ammonium concentrations, and physical water-quality variables (temperature, specific conductance, pH, and turbidity) were made with boat-deployed continuous water-quality monitors and used to characterize the spatial extent of effluent plumes from three wastewater treatment facilities in the Missouri River near Kansas City. The data were collected in February 2008 as part of a cooperative effort between the U.S. Geological Survey and the U.S. Environmental Protection Agency. The continuous water-quality monitors were time-synchronized and communicated with a sub-meter accuracy global positioning system. Data collection methods used in this study quickly and efficiently delineated the wastewater plumes because differences in measured dye concentration, other water-quality variables, and three dimensional spatial extent values were available in real time. This approach, which coupled continuously collected (5-second) water quality measurements with sub-meter GPS accuracy, allowed for increased data density and enhanced mapping resolution. Data density was only limited by the number and response time of the water-quality sensors employed. The methods used in this study may have application to other environmental water-quality studies and prove economical compared to traditional dye-tracing methods. Strong correlations with rhodamine WT concentration data indicated that temperature, ammonium, and specific conductance, have the potential to be used independently of dye tracers to characterize wastewater plumes.

Continuous Active Low-Flow Extraction Laboratory and Field Evaluations

Brent Hepner, Don Mabe, Jamie Aderhold
Aqualytical Services Inc., Center for Environmental Research, 23010 SE. 222nd St., Maple Valley, WA 98038

Abstract
Standard grab sampling only provides a few seconds snapshot in time of a changing dynamic system, and a liter sample to take to the laboratory for extraction and analysis. Automatic samplers are expensive, cumbersome and yield only standard reporting limits. The passive samplers provide long term integrative sampling, but provide only qualitative data at best.

The ideal continuous sampler should be small, stealth, and able to continuously field sample for extended periods of time in a quantitative manner. It should also be immune to the effects of temperature, flow and bio-fouling, and provide ultra-low quantitative detection capabilities if necessary.

A new device has been developed that addresses these needs. This novel device is a small submersible extraction sampler. It uses SPE (Solid Phase Extraction) media to sequester; pesticides, herbicides, PAH's, TPH, other CEC's, and metals from water. The device actively draws water in a submersed state through a SPE disk that has special lofted pre-filtration filters, and draws water slowly through the filter disk at 10 ml/min. This reduces media clogging allowing for a pre-extracted quantitative continuous sampling event representing days to weeks, and up to a hundred liters of water, providing ultra low detection of target analytes. The small dry extraction disk is all that is sent to the laboratory for solvent elution and analysis. These SPE disks are EPA approved for the analysis of trace organics, and are a standard extraction device used in laboratories worldwide to extract any aqueous sample. The sampling is active and is powered using newly developed micro-pumps and small chips for control. The pump can run continuously for over two weeks with 4 AA batteries. The device draws water through the SPE disks first so contamination due to tubing and pump is avoided. Volumes of water passing through the unit can be collected from the outlet end and measured or determined by starting and ending flow rates and calculated from total time deployed allowing for quantitative calculations. The continuous low flow extraction is not affected by temperature or flow rates, only the amount of water passing through the filter disk. The small foot print will allow stealth enclosures and is fully submersible up to 100 feet. Laboratory evaluations and ongoing field trials will be displayed to illustrate its efficacy as a valuable and cost saving tool to obtain a large volume extraction event representing days to weeks instead of a few seconds.

New and Evolving Technologies For Monitoring and Control

Troy A. Hertog
Siemens Water Technologies, Control Systems, Vadnais Heights, MN, United States

Abstract
Until recently, economical remote monitoring over a wide geographic area has been difficult and expensive. The evolution of wireless cellular technologies, increased geographical coverage, and digital transmission, in conjunction with internet and website development have significantly reduced cost while increased functionality and reliability has made these technologies feasible for a diversity of monitoring and control applications.

The presentation will focus on how these technologies are used in an integrated fashion to produce exceptional results. Through cellular/web based technology, you can reduce your system liability, lower monitoring costs, achieve real time data, increase your access to remote stations and utilize technology to monitor station performance providing instant notification of poor performance, equipment failure or remote override control of stations. The data resolution is meaningful and is stored within the web-based system or can be easily exported in a widely supported format for use by other applications or reporting systems.

Examples will show how these advanced technologies can be tightly integrated and provide dedicated application specific functions of water/wastewater pump stations and or other facility control and monitoring applications. Total system visibility and remote access is achieved while performing vital control functions in a distributed stand alone fashion. The technology can provide immediate benefit as it is easily integrated into new systems or retrofitted in to existing systems. Wireless cellular communication systems provides an active communications media that is an essential part of insuring reliability and prompt notification of critical system status and will reduce liability associated with less reliable passive communication systems.

A web based historical data bank provides easy access to the site and historical data relating to performance and station status. Historical data can reside on a third party hosted site or can reside within the users own computer storage media.

Evaluation of Regenerated Cellulose Dialysis Membrane Diffusion Samplers for Monitoring Groundwater Quality

Thomas E. Imbrigiotta[1], Joseph S. Trotsky[2]
[1]U.S. Geological Survey, West Trenton, NJ, United States; [2]U.S. Navy, Naval Facilities Engineering Service Center, Port Hueneme, CA, United States

Abstract
Diffusion samplers constructed of polyethylene membrane can be used to collect valid samples for analysis for volatile organic compounds (VOCs) in groundwater, but do not allow the passage of inorganic ions or other types of organic compounds. Diffusion samplers constructed of regenerated cellulose dialysis membrane (RCDM) that is permeable to both inorganic and organic constituents were developed to address this limitation. In this study, RCDM samplers were evaluated in the laboratory to determine the minimum equilibration times needed for a range of inorganic and organic constituents and in the field by comparing the measured constituent concentrations in groundwater samples collected with these samplers to those collected using low-flow purging.

Equilibration times were tested in the laboratory in a series of stirred batch experiments using groundwater spiked with known concentrations of 104 inorganic ions and organic compounds at both 10 °C and 21 °C. The minimum equilibration time was defined by the time the concentrations diffusing into the RCDM sampler became greater than 95 percent of the concentrations present in the test solution outside the sampler. RCDM samplers equilibrated within 1 to 3 days for all anions (including perchlorate), silica, methane, dissolved organic carbon, and all VOCs (including MTBE) and within 3 to 7 days for most cations, trace metals, and explosives-related compounds. Lower temperatures were found to lengthen equilibration times for several inorganic constituents from 3 days to 7 days and for several organic constituents from 1 day to 3 days. Groundwater temperatures across the continental United States vary within the range of the temperatures tested, so these findings are expected to have transfer value to most sampling locations.

Field-comparison testing was conducted in 8 to 10 wells at each of five sites. In each well, the RCDM sampler was suspended at a chosen depth in the open interval, and after the appropriate equilibration time, the sampler was retrieved, and a sample was collected from it. A low-flow purge sample was then collected from the same depth. Graphical comparison of the concentrations of 61 inorganic and organic parameters measured in the field samples showed that concentrations obtained using the two sampling techniques agreed fairly closely for most constituents. Statistical testing showed that median concentrations recovered by the RCDM samplers were not significantly different from those recovered by low-flow purging for 53 of the 61 organic and

inorganic constituents. Comparability was best when the RCDM sampler was positioned at the depth of the highest mass flux of a contaminant into the open interval of a well.

Implementation Monitoring: Use of Automated Samplers to Effectively Document Water Quality Improvements

Jeanette Lamb
Oklahoma Conservation Commission, Water Quality Division, Oklahoma City, OK

Abstract
Implementation monitoring is a vital component of the Conservation Commission's NPS Monitoring Program, and is performed to determine the effects of best management practices (BMPs) on water quality in priority watersheds. Implementation monitoring involves sampling streams during defined periods before and after BMPs are installed in a watershed.

The Conservation Commission has developed reliable methods for deploying and maintaining autosamplers which are critical in documenting the effects of the implementation projects. The autosamplers are programmed to collect continuous, flow-weighted composite water samples and discharge data. This type of monitoring allows for continuous assessment of both a true average concentration of constituents in the stream water and continuous discharge data, both crucial to calculating loading estimates.

The implementation monitoring results from two Paired Watershed Projects (Peacheater Creek and Beaty Creek) have shown that BMPs are successful in significantly reducing the amount of nonpoint source pollution.

Advancements in Continuous Sensor Technologies and Application to Stormwater Monitoring in California

Stephen McCord, Jeffrey Walker
Larry Walker Associates, Davis, CA, United States

Abstract
Water quality conditions in urban runoff can vary over the course of the day, during storm events, seasonally, and inter-annually. Instantaneous field measurements and "grab" samples cannot characterize such variability and may misrepresent water quality for longer averaging periods. Recent advances in remote sensing technology enable real-time continuous (typically fifteen-minute intervals) measurement and reporting of water quality conditions surrounding stormwater sampling events. These high temporal-resolution data can used to schedule and interpret grab samples, improve watershed assessments and permit compliance monitoring, calibrate water-quality models and estimate pollutant loadings.

Continuous sensor units deployed in multiple tributaries in the Sacramento, California metropolitan area for weeks to months in years 2007-2009 exemplify recent innovations. Multiple sensors (temperature, pH, water depth, dissolved oxygen, turbidity and specific conductivity) in each unit confirmed that conditions were changing. Concurrent sensor units in three adjacent tributaries (draining predominately older urban development, newer urban development and agricultural lands) allowed for comparisons of the effects of land uses. Real-time telemetry data assisted with timing of storm sampling events and tracking of both water quality and equipment status.

Continuous data enabled interpretation of grab data with respect to rainfall runoff, physical conditions, and sediment transport throughout storm events (only some of which were also targeted for grab sampling events). Timing of sampling events was then characterized as early, peak, or late with respect to the likely pollutant loads.

Results illustrate how only early season storms produced conductivity peaks at the leading edge of the hydrograph. Early season storms also led to anoxia, while creeks remained at 50-100% of oxygen saturation following later season storms. Strong algal-related diurnal patterns in pH and dissolved oxygen were diluted by larger storms, taking 5-10 days to recover to pre-storm levels. Rainfall runoff events exhibited better water quality, while some of the more significant changes in conditions were not associated with rainfall runoff events. These surrogate measures also provided context for grab samples analyzed for nutrients, trace metals, pesticides, and other trace organic compounds.

This low-cost (10% of project cost) application of new technology encourages stormwater managers to incorporate real-time, continuous sensors in water-quality monitoring programs.

Real Time Monitoring of Urban Water Bodies for Research and Educational Use

Y. Jun Xu[1], Ryan Mesmer[1], Kevin Labbe[2], Kyle Waits[2]
[1]School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA; [2]Sontek/YSI Gulfcoast, 12231 Industriplex Blvd., Suite A, Baton Rouge, LA

Abstract
The application of real-time water quality monitoring has become increasingly critical in assessing changes in chemical and biological conditions. This information is extremely valuable in urban water management, research, and public education. In early 2008 we deployed an environmental monitoring buoy with sensors recording water quality parameters onto University Lake located in an urban environment within the Louisiana State University's campus. These water quality parameters included dissolved oxygen, temperature, pH, conductivity, chlorophyll, and blue-green algae. Readings were transmitted at 15 minute intervals and were made available online. At an adjacent stream a similar multi-probe as well as acoustic doppler sensors were installed to record stream water quality and flow at the same time interval. Data collected from both locations has proven extremely beneficial for research on stormwater due to the rapid changes in nutrient composition and dissolved oxygen resulting from stormwater runoff. The data has been utilized in the classroom allowing students compare standard practices with advanced techniques in water quality monitoring. This presentation discusses the benefits of real-time monitoring as well as the activity associated with data utilization.

Advances in the Automated Monitoring Program in Atlantic Canada

Denis Parent[1], Joe Pomeroy[1], Daniel Bastarache[1], Renee Paterson[2], Richard Harvey[3]
[1]Water Quality Monitoring and Surveillance – Atlantic, Environment Canada, Dartmouth, NS, Canada; [2]Water Resources Management Division, Newfoundland and Labrador - Department of Environment and Conservation, St. John's, NL, Canada; [3]Memorial University of Newfoundland, St. John's, NL, Canada

Abstract
The federal and provincial governments in Atlantic Canada currently have over 30 automated water quality monitoring stations within networks spread across four provinces. These networks are also part of the larger National Automated Water Quality Monitoring Network (NAWQMN). Partnerships have been key to the development of this automated network. Delivering water quality data in real-time and also at a high frequency requires specialized tools and resources that are not always readily available and compatible when dealing with multiple partners. Several components of the current NAWQMN were developed and tested in Atlantic Canada by Environment Canada and by their provincial counterparts. Key examples of this include: developing a database to store raw and corrected data as well as hardware information, conducting work to identify relationships between variables in order to predict chemical concentrations, and designing and testing of a mobile automated monitoring trailer.

All of these advances support implementation of a network that is relevant (addressing areas of concerns, especially trans-boundary and inter-provincial waters) and gives timely information for complementing traditional sampling methods, and ultimately for assessing aquatic ecosystem health.

Evaluation of time-integrating sediment samplers for assessment of occurrence and concentrations of hydrophobic organic contaminants in small streams

Mark W. Sandstrom and Max E. Stroppel
U.S. Geological Survey, National Water Quality Laboratory, Denver, CO

Abstract
Hydrophobic organic contaminants are primarily associated with sediments in streams. Transport of suspended sediments is episodic and related to storm runoff, so obtaining representative suspended sediment samples for organic contaminant analysis can be problematic. It is difficult to schedule sampling to coincide with episodic storms and the mass of sediment in typical 1-liter samples is too small for determination of environmental concentrations of contaminants. Bed sediments are commonly used in sampling programs, but they might include older sediment unrelated to recent storm runoff. We have evaluated time-integrating suspended-sediment samplers previously developed for use in geochemical source studies for their application to studies of hydrophobic and ionic organic contaminants sorbed to suspended sediments. The samplers were installed in small, wadeable streams during June through September 2007 at nine locations in predominantly urban areas in Seattle, Washington to study pyrethroid pesticides, and at four locations in agricultural areas in Iowa and Mississippi to study glyphosate. The samplers were installed in the streams for time periods ranging from 27 to 70 days. Sufficient sediment mass (median 1.8 g sediment; range 0.5 to 40.1 g) was collected for determination of organic contaminants and other parameters. At sites where the samplers were installed for more than one time period, more sediment was collected during storm runoff. At the agricultural sites, glyphosate concentrations increased in suspended sediment during storm runoff, and the amount of glyphosate increased relative to aminophosphomethylamine (a glyphosate degradate), suggesting shorter residence times in the soil before transport to the streams. In general, the mean particle size and sorting of sediment collected by the samplers was generally similar to that in discrete samples obtained concurrently at the different sites using equal-width increment methods. The evaluation of physical parameters of the sediments suggests that these time-integrating samplers can provide a simple technique for obtaining a representative suspended sediment sample for determination of organic contaminants. Future work planned includes flume studies to evaluate hydraulic and trapping efficiency of the sampler, analysis of blanks to evaluate contamination, and determination of other contaminants (polycyclic aromatic hydrocarbons) in the sediment collected by the samplers.

Temperature Effects on Conductivity Calibration of Continuous Monitors

Evan F. Tillman
United States Geological Survey, Office of Surface Water, Hydrologic Instrumentation Facility, Stennis Space Center, MS, United States

Abstract
Conductivity is a measure of an aqueous solution's ability to carry an electrical current. Specific conductivity is the conductivity of a solution at 25 °C. At temperatures other than 25 °C, the specific conductivity is a value calculated using the measured temperature and conductivity of the solution. The equation found in Standard Methods is typically used by most, if not all, US manufacturers in their conductivity sensors to give specific conductivity at 25 °C.

Because it is a calculated value, measuring conductivity at 25 °C is the only way to accurately measure specific conductivity. As this is not always practical, we have accepted a close approximation for the value that works well.

Ten to fifteen years ago, calibrating conductivity at field temperature for in-situ continuous monitoring was prudent, as the electronics in field instruments were more sensitive to temperature effects than they are today. When calibrating conductivity, we typically enter the specific conductivity of the calibrating solution and the sonde calculates what the conductivity of the solution should be at the current temperature using the Standard Methods formula. Within a 15 degree range, this introduces less than a 1% error, but at temperatures below 10 °C the error goes up to 4% at 1 °C. Laboratory testing showed that using specific conductivity to calibrate at low and high temperatures did not appreciatively improve the readings and the data indicates that field calibration at temperature using specific conductivity may not produce the best field data possible.

Luminescence Sensors: The future of Dissolved Oxygen Monitoring

Evan F. Tillman
United States Geological Survey, Office of Surface Water, Hydrologic Instrumentation Facility, Stennis Space Center, MS, United States

Abstract
Luminescence oxygen sensors are an optical sensor technology that is becoming more popular within the USGS for in-situ continuous monitoring of dissolved oxygen (DO). Most DO sensors that use optical methods rely on luminescence quenching to measure dissolved oxygen concentration in water. Luminescence DO sensors differ from Clark cell sensors in several ways. They do not require calibration as often as a Clark cell sensor, their maintenance requirements are simpler, and they do not consume oxygen during the measurement process. Luminescence DO sensors do not need a stirrer for low flow conditions. Luminescence DO sensors can be calibrated with water saturated air or in air saturated water, can be cleaned with a soft brush and the membrane usually only has to be replaced once every year of use.

Field deployment is similar to a Clark cell sensor, with overexposure to sunlight, fouling, and abrasion of the membrane being of concern

Assessment of the Cross-Sectional Variability of Water Quality Parameters in the Snake River as a Result of Measurement Location

Alexandra B. Etheridge and Molly S. Wood
US Geological Survey, Idaho Water Science Center, 230 Collins Road, Boise, ID 83702, Email: aetherid@usgs.gov, mswood@usgs.gov

Abstract
The U.S. Geological Survey (USGS), in cooperation with the City of Boise, is conducting water-quality monitoring in the Snake and lower Boise Rivers upstream of the Snake River – Hells Canyon complex in support of a Total Maximum Daily Load program. Three continuous water-quality monitors (CWQMs) were installed as part of the monitoring program to assess seasonal and short-term trends in chlorophyll-*a* concentrations and other water-quality parameters. One CWQM was installed on the Boise River above its confluence with the Snake, and two CWQMs were installed above and below the Snake River's confluence with the Boise River. The CWQMs record temperature, dissolved oxygen, pH, specific conductance, turbidity, and chlorophyll-*a* fluorescence at 15-minute intervals. USGS scientists evaluated deployment locations for the CWQMs and determined that the downstream side of a bridge pier was the best location at each of the Snake River sites to minimize equipment damage due to debris and high velocities. A bank-mounted installation at the Boise River site had been successfully used in previous studies and remained in use for this study.

Data were collected to evaluate whether turbulence induced by a bridge pier would have a deleterious effect on recorded water-quality parameters. Horizontal and vertical profiles completed at both Snake River sites showed that water-quality parameters observed downstream of the bridge pier were representative of conditions throughout the channel. Grab samples collected at the bridge pier and mid-channel at one of the Snake River sites showed that chlorophyll-*a* concentrations are not significantly different at the two locations.

Diurnal Fluctuations in Nutrients and Continuously Monitored Parameters in Two Idaho Rivers

Andrew W. Tranmer and Molly S. Wood
US Geological Survey, 230 Collins Rd., Boise ID, 83702

Abstract
The U.S. Geological Survey has initiated a three-year continuous water quality monitoring effort to evaluate nutrient inputs from the Boise River watershed to the lower Snake River ecosystem and hydropower reservoirs. The Snake River rises from its headwaters in Wyoming, flows through arid southern Idaho, enters the reservoirs near the Idaho-Oregon border, and empties into the Columbia River in southeastern Washington. The lands that it drains incorporate nutrient-rich agricultural runoff, open rangeland, confined animal feeding operations (CAFOs), and municipal outflows, which may elevate levels of phytoplankton production in downstream reservoirs.

The Boise River, a Snake River tributary, is influenced both by recent urbanization in the Boise metropolitan area and by long-standing agricultural use in the lower watershed. One component of the USGS study was a 24-hour sampling effort conducted at three sites in August 2009 to gain a better understanding of diurnal variability in nutrient concentrations and continuously-monitored parameters. Diurnal fluctuations in stream conditions and nutrients can be significant in this desert environment because of rapid vegetation growth and associated nutrient uptake, as well as irregular agricultural pulses. Bias may be introduced to the study if sampling efforts are concentrated during a particular time of day. Water-quality samples were collected hourly at three sites, the Boise River near the confluence with the Snake River, the Snake River 7 mi upstream of the confluence, and the Snake River 9 mi downstream of the confluence. Permanently-installed continuous monitors measured temperature, dissolved oxygen, pH, chlorophyll-*a* fluorescence, turbidity, and conductance at 15 minute intervals throughout the diurnal study. These 15-minute measurements were compared with the hourly samples and analyzed for chlorophyll-a, dissolved orthophosphate, total phosphorus, dissolved ammonia, dissolved nitrite and nitrate, and total nitrogen.

Cyanobacterial Toxins Found in Upper Klamath Lake, Oregon: Implications for Endangered Fish

Kathy Echols[1], Tamara Wood[2], Chris Ottinger[3], Barry Rosen[5], Summer Burdick[4], Scott Vanderkooi[4]
[1]US Geological Survey, BRD, Columbia Environmental Research Center, Columbia MO, USA; [2]US Geological Survey, WRD, WRD District Office, Portland OR, USA; [3]US Geological Survey, BRD, Leetown Science Center, National Fish Health Research Laboratory, Kearneysville WV, USA; [4]US Geological Survey, Klamath Falls Field Station, Klamath Falls, OR, USA; [5]US Geological Survey, Florida Integrated Science Center, Orlando, Florida, USA

Abstract
Upper Klamath Lake is a large hyper-eutrophic lake, found on the east side of the Cascade Mountains in Southern Oregon. Conditions in the lake include high levels of nitrogen and phosphorus nutrients that facilitate large, continuous cycles of cyanobacterial blooms from late spring through the fall. These cyanobacterial blooms include species of algae that are known to produce toxins that adversely affect other aquatic organisms. This study was designed to evaluate the presence of these toxins over three summer seasons (2007 - 2009) and to determine if there is any risk to the two endangered fish in the system: the Lost River sucker (*Deltistes luxatus*) and the shortnose sucker (*Chasmistes brevirostris*). Juvenile fish of these species are rare and appear to have poor survival in this ecosystem. Water and algae samples were collected monthly in 2007; bi-weekly in 2008 and weekly in 2009 from late June through September. Collected water/algal samples were filtered, extracted and analyzed using an enzyme-linked immunoassay (ELISA) method for quantitation of microcystin toxins, in water and algae. In 2007, high levels of microcystin toxins (up to 17.4 μg/L) were found in algae late in the summer and evidence from fish pathology showed exposure and adverse effects from these toxins. In 2008, lower levels of total microcystin were found in water/algal samples; from a low of 0.17 μg/L to a high concentration of 6.1 μg/L. The high water concentration for total microcystin in 2009 was 83 μg/L. Published LD50s for fish are around 1,700 μg/kg for one microcystin toxin variant; so assuming that juvenile fish are consuming 1% of their body mass in toxic algae, the average exposure to fish from microcystin was assessed to be approximately 1.5-fold greater than the published effects levels of microcystins to fish in 2007 and 0.7-fold greater in 2008 and 1.4-fold greater in 2009. Thus, cyanobacterial toxins may be limiting survival of juvenile endangered Lost River sucker and shortnose sucker in Upper Klamath Lake.

A New Fast, Accurate Method for Algae Identification and Enumeration

Mary Fabisiak[1], Kelly Cline[1], Harry Nelson[2]
[1]City of Westminster, Colorado, United States; [2]Fluid Imaging Technologies, Inc., Yarmouth, Maine, United States

Abstract
Monitoring the health of lakes and reservoirs, and tracking environmental change requires a knowledge and understanding of the system's algal communities. A major drawback of algal monitoring and analysis using traditional microscopy for identification and enumeration from samples is the amount of time required for preparation and analysis. Fluid Imaging Technologies, Inc. has developed an instrument for algal detection and analysis called a FlowCAM®.

The FlowCAM is a continuous imaging flow cytometer now being used for monitoring of microorganisms and particles in both marine and freshwater systems. A laser interacts with a high resolution digital camera to capture images and data of a passing particle or cell. It offers cell counts, size data, pattern recognition, volume calculation, organism classification, image management, and library development. A key benefit of the technology is the collection of digital images – either black and white or color - for further analysis and post-processing. FlowCAM applications include algal monitoring in surface water supplies, lake monitoring, aquatic research, and invasive species monitoring. An overview of the technology will be presented along with a demonstration of the application at the City of Westminster.

Change-Point Analysis for Nutrient Criteria in the Midwest

Jeffrey Frey[1] and Dave Lorenz[2]
[1]US Geological Survey; 5957 Lakeside Blvd. Indianapolis, IN 46278; jwfrey@usgs.gov; (317) 290-3333 ext. 151; [2]US Geological Survey; 2280 Woodale Dr. Mounds View, MN 55112; lorenz@usgs.gov; (763) 783-3271

Abstract
Change-point analysis is a statistical method that can be used to identify transition areas (thresholds) in the relation between two variables. It has recently been applied to the development of nutrient criteria by identifying thresholds of biological responses in relation to nutrient stressors, such as nutrient or chlorophyll *a* concentrations.

In the process of applying change-point analysis to streams in Midwestern United Sates, statistical characteristics of the change-point analysis that affect the interpretation of the results were identified—the influence of individual observations, bootstrapping techniques for

confidence interval estimation and determination of the significance of the change point. Those statistical characteristics, their implication, and the results of the change-point analysis are presented for streams in the Ohio, Mississippi, and Great Lakes River Basins.

Trends in Water Quality in the Southeastern United States, 1973-2005

Douglas Harned[1], Erik Staub[1], Kelly Peak[1], Kirsten Tighe[2], Silvia Terziotti[1]
[1]U.S. Geological Survey, Raleigh, North Carolina, United States; [2]U.S.Forest Service, Lakeview, Oregon, United States

Abstract
As part of the U.S. Geological Survey (USGS) National Water-quality Assessment (NAWQA) program water-quality data for 334 streams in 8 states of the Southeastern United States were assessed for trends from 1973 to 2005. Forty-four USGS sites were examined for trends within the period of 1973-2005 in pH, specific conductance, and dissolved oxygen, and in concentrations of dissolved solids, suspended sediment, chloride, sodium, sulfate, silica, potassium, dissolved organic carbon, total nitrogen, total ammonia, total ammonia plus organic nitrogen, dissolved nitrite plus nitrate, and total phosphorus. An additional 290 sites from the U.S. Environmental Protection Agency Storage and Retrieval (STORET) database were tested for trends in total nitrogen and phosphorus concentrations for the 1975-2004 and 1993-2004 periods. The seasonal Kendall test or Tobit regression was used to detect trends. Concentrations of dissolved constituents have increased in the Southeast during the last 30 years. Specific conductance increased at 62 percent and decreased at 3 percent of the sites, and pH increased at 31 percent and decreased at 11 percent of the sites. Decreasing trends in total nitrogen were detected at 49 percent of the sites and increasing trends were detected in 10 percent of the sites. Ammonia concentrations decreased at 27 percent of the sites and increased at 6 percent of the sites. Nitrite plus nitrate concentrations increased at 29 percent of the sites and decreased at 10 percent of the sites. These results indicate that the changes in stream nitrogen concentrations generally coincided with improved municipal wastewater treatment methods. Long-term decreasing trends in total phosphorus were detected at 56 percent of the sites and increasing trends were detected at 8 percent of the sites. Concentrations of phosphorus have decreased over the last 35 years which coincided with phosphate-detergent bans and improvements in wastewater treatment that were implemented beginning in 1972. Multiple regression analysis indicated a relation between changes in atmospheric inputs and agricultural practices, and changes in water quality. A long-term water-quality and landscape trends-assessment network for the Southeast is needed to assess changes in water quality over time in response to variations in population, agricultural, wastewater, and landscape variables.

Geosmin and Microcystin Occurrence in Two Piedmont Reservoirs, Spartanburg County, South Carolina, 2007 - 2008

Celeste A. Journey
U.S. Geological Survey, South Carolina Water Science Center, Columbia, SC, United States

Abstract
The U.S. Geological Survey, in cooperation with the Spartanburg Water, monitored two Piedmont reservoirs that serve as public drinking water supplies in South Carolina. This presentation will provide preliminary findings from this monitoring effort. Reservoir monitoring consisted of lake profiles, bathymetric survey, and depth-specific chemical and biological sampling from May 2007 to August 2008. Nutrient loading from the watershed and internal nutrient cycling also are being quantified in conjunction with lake monitoring to evaluate the sources of nutrients to the lake. The focus of the monitoring was (1) to identify spatial and temporal occurrence of geosmin, a taste-and-odor compound, and microcystin, an algal-derived toxin, and (2) to assess the associated limnological conditions before, during, and after these occurrences. Seasonal changes in algal community structure, especially the abundance of potential geosmin-producing genera of Cyanophyta, and Actinomycetes concentrations were compared to geosmin concentrations in the reservoirs to identify the predominant source of geosmin. Temporal and spatial occurrence of geosmin and microcystin were highly variable from 2007 and 2008, but highest geosmin and microcystin concentrations tended to occur in the spring and late summer, respectively. In general, elevated geosmin and microcystin concentrations appeared to be complexly interrelated with nutrient dynamics, type and density of cyanobacterial species, water temperature, residence time, and degree of stratification.

A Comparison of Algal, Macroinvertebrate, and Fish Assemblage Indices for Assessing Low-Level Nutrient Enrichment in Wadeable Ozark Streams

B.G. Justus[1], James C. Petersen[1], Suzanne R. Femmer[2], Jerri V. Davis[2], J.E. Wallace[1]
[1]U.S. Geological Survey, Arkansas Water Science Center, 401 Hardin Road, Little Rock, AR 72211, United States; [2]U.S. Geological Survey Missouri Water Science Center, 1400 Independence Road MS 100, Rolla, MO 65401, United States

Abstract
Biological indices for algae, invertebrate, and fish communities can be effective for monitoring streams with high nutrient concentrations, but little is known regarding the efficacy of each community for monitoring low-level nutrient concentrations. The U.S. Geological Survey (USGS) National Water-Quality Assessment Program collected nutrient (nitrogen and phosphorus) and biological samples from 30 Ozark streams in 2006 and compared biological metric and index response to a nutrient index calculated from log-transformed and normalized total nitrogen and total phosphorus concentrations. Biological metrics that were the best candidates for the three indices were identified with a process that included a combination of nonparametric multivariate-, univariate-, and visual-selection procedures. After consideration of 78 algal metrics and 58 metrics each for invertebrates and fish, 4 metrics were selected for each of the three biological indices. The algal index had higher correlations to the nutrient index and to agriculture land uses (poultry and cattle production) than did the invertebrate and fish indices. Data indicate that the algal assemblage may be most appropriate for monitoring exposure to low-level nutrient concentrations, perhaps, because nutrient uptake is more direct for primary producers than for consumers.

Assessing the Effects of Nutrients on Algal Responses in Agricultural Streams: The Importance of Seasonal Variations

Kathy E Lee[1], Jeffrey W. Frey[2], Mark D. Munn[3], and Jill D. Frankforter[4]
[1]USGS Minnesota Water Science Center, Mounds View, MN; [2]USGS Indiana Water Science Center, Indianapolis, IN; [3]USGS Washington Water Science Center, Tacoma, WA; [4]USGS Nebraska Water Science Center, Lincoln, NE

Abstract
Elevated stream nitrogen and phosphorus concentrations are a leading cause of water quality impairments. Since 2003, the U.S. Geological Survey's National Water-Quality Assessment Program has studied nutrient-biota interactions in eight agricultural areas across the United States. In 2006 and 2007, from 6-8 sites within each of three study areas (Minnesota, Arkansas, and Idaho) were sampled monthly to determine seasonal patterns in nutrient concentrations and algal responses (benthic and sestonic chlorophyll a). These sites were selected to span probable gradients in nutrient concentrations. Data on nitrogen and phosphorus, benthic and sestonic algal chlorophyll a, and habitat were collected monthly at each site. Nutrient concentrations and instantaneous loads varied among streams and were generally

greatest in spring and early summer. Algal responses such as seston chlorophyll *a* concentrations also varied seasonally at individual streams and were generally greatest in summer. Complex interactions among physical, chemical and biological variables in stream ecosystems results in non-linear relations among nutrient concentrations and algal response variables and highlights the importance of characterizing seasonal variability to arrive at science-based management decisions.

Influence of Nutrients, Habitat, and Streamflow on Indicators of Eutrophication in Agricultural Streams: Applications for Developing Nutrient Criteria

Terry R. Maret[1], Christopher P. Konrad[2], Andrew W. Tranmer[1]
[1]U.S. Geological Survey, Idaho Water Science Center, 230 Collins Road, Boise, ID 83702 United States; [2]U.S. Geological Survey and The Nature Conservancy, 1917 1st Avenue, Seattle, WA 98101, United States

Abstract
The effects of varying nutrient concentrations on stream eutrophication were examined in three diverse agricultural regions of the United States. Sites within each study area were selected along a nutrient concentration gradient while minimizing natural variation. Seventy wadeable sites were selected with 18 to 30 sites per study area with nutrients, habitat, algal biomass, and macrophyte/macroalgae cover sampled during a single summer period in 2006 or 2007. Continuous stream stage and water temperature were collected at each site for 30 days prior to sampling to evaluate antecedent conditions. Wide ranges of concentrations were found for total nitrogen (TN, 0.07-9.61 mg/L) and total phosphorus (TP, 0.002-0.361 mg/L) across all sites. Biotic measures of stream eutrophication including periphytic (RCHL) and sestonic (SCHL) chlorophyll-*a*, and aquatic macrophyte (AQM) growth were not strongly related to concentrations of TN or TP; R^2 values ranged from 0.02 to 0.32. Model performance generally did not improve when applied to individual study units. An index combining RCHL, SCHL, and AQM is offered as an alternative to evaluate eutrophic status. A significant multiple regression model ($R^2 = 0.50$, $P < 0.001$) identified TN, percent canopy, median riffle depth, and daily change in stage as important variables in predicting index scores.

The Dunkard Creek TDS Crisis That Became A Disaster

Duane G. Nichols[1], Barry G. Pally[2], and Betty L. Wiley[3]
[1]Chemical Engineer, Upper Monongahela River Association, 330 Dream Catcher Circle, Morgantown, WV 26508; [2]Vice President, Upper Monongahela River Association, 124 Diamond Court, Morgantown, WV 26505; [3]President, Dunkard Creek Watershed Association, 373 Dunkard Avenue, Morgantown, WV 26501.

Abstract
The extensive fish and mussel populations of Dunkard Creek of the Monongahela River, which extends some 40 miles along the Mason-Dixon Line of northern WV and southwestern PA, were killed during September 2009 by a bloom of golden algae that invaded from the Deep South. This algae bloom was possible because coal mining operations, coal-bed methane operations and other activities rendered the stream high in total dissolved solids, high in pH, and low in flow rate. Low rainfall was also a factor.

Thousands of dead fish and mussels were observed and photographed; and, many have been studied by the WV Division of Natural Resources and US EPA. Analyses of the macroinvertebrates in the stream segments were conducted by the WV Department of Environmental Protection. Extensive chemical analysis data have been examined including our data from volunteer network studies and recent findings of the various governmental agencies. While calcium and sulfate ions have been predominant, the chloride ions appear to have facilitated the algae bloom and its generation of toxins.

We examine whether the death of Dunkard Creek could have been prevented, whether it will happen again, and can this happen to other steams in the middle Atlantic region? It appears that more than 18 other streams of our region may be susceptible to blooms of the golden algae.

Limited cooperative efforts have taken place among state and federal agencies. The available information points to the need for three major steps. First, water quality standards are needed for all the streams in West Virginia and southwestern Pennsylvania to maintain drinking water quality, to permit economic development and to prevent golden algae blooms. Second, limits and/or management of water withdraw activities are needed given the incredible number of coal mine operations, coal-bed methane operations as well as oil and natural gas drilling operations in the Monongahela River watershed. Additionally, a watershed management plan for the entire region can utilize the data sources now being developed by the various agencies and organizations involved to balance the demands upon the streams while protecting them.

Application of a Quantitative ELISA Screening Procedure Suitable for Shipboard Analysis of Marine Algal Toxins in Shellfish Tissue

Fernando M. Rubio, David C. Deardorff, Jaclyn A. Pitt
Abraxis LLC, 54 Steamwhistle Drive, Warminster, PA 18974

Abstract
The need for quantitative, real time, shipboard detection methods for risk management of shellfish poisons is imminent. Harvesting resources are more effective when they have the ability to accurately determine the level of toxins that may be present in shellfish. Current semi-quantitative, lateral flow, shipboard procedures for Paralytic Shellfish Poisoning (PSP) have been shown to have a false positive rate in excess of 30%. Harvesting costs have increased as a result, where samples were determined to be positive by the shipboard procedure, were therefore passed by and later determined by dockside mouse bioassay (MBA) to be safe to harvest. A quantitative, microtiter plate format, Saxitoxins (STX) ELISA procedure has been adapted and customized for shipboard testing of PSP. The PSP assay ranges from 20 μg to 120 μg (STX equivalent)/100 g composite sample of shellfish, with regulatory interests at 40 μg and 80 μg/100 g. The application employs a handheld, durable photometric analyzer with LCD readout. Absorbances are entered into a tailored program in a mini-laptop computer and concentrations of shellfish toxin are calculated. Crews have achieved timely, reproducible results while at sea with both ease and precision. With samples obtained off the coast of Northeastern United States, a false positive rate, based on MBA results, is less than 1%. The shipboard protocol can be applied to other marine toxins in shellfish such as ASP, DSP and NSP. The Abraxis shipboard applications allows shellfish harvesting operations to make specific, measurable, actionable, realistic and timely decisions enabling improved cost efficiency while managing the public health risks associated with shellfish poisons.

Post-harvest Nitrogen Leaching and Retention in Riparian Forest Buffers Killed by Mountain Pine Beetle

Chuck Rhoades[1], Banning Starr[2], Kelly Elder[1], Derek Pierson[1]
[1]U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO; [2]U.S. Forest Service, Fraser Experimental Forest, Fraser, CO

Abstract
Bark beetles currently threaten 10s of millions of hectares of pine forest in the United States. In Colorado, where mountain pine beetle outbreaks have killed most of the overstory lodgepole pine in many forests there is an immediate need to assess how well riparian buffers consisting of beetle-killed trees protect watershed resources in salvage-logged areas. In this study, we evaluate the effectiveness of riparian buffer filtering by comparing soil nutrient pools and nutrient leaching across upland to riparian gradients for 1) unharvested beetle-killed hillslopes, 2)

harvested hillslopes with 30 m wide riparian buffers and 3) harvested hillslopes with harvested riparian forests. Harvesting increased resin exchangeable nitrate in surface soils by almost 7-fold and doubled nitrate and dissolved organic nitrogen leaching compared to uncut beetle-killed forests. Nitrogen leaching was also higher in riparian zones below salvage-logged areas compared to uncut beetle-killed forests. Similarly, soil nitrate and ammonium concentrations were 2 to 5-fold higher in riparian zones below logged areas, both during summer and winter/snowmelt periods. Removal of the dead riparian forest buffer increased herbaceous biomass and soil nitrate but had no effect on nitrate leaching compared to riparian zones where the dead overstory was retained. Leachate nitrate concentration declined by about 30% downslope of harvested areas and the concentration of nitrate in riparian zone leachate was no greater than that of wetfall deposition. Riparian zone plant composition and nutrient dynamics will change in uncut and salvage-logged forests as dead overstory trees topple, but at present riparian buffer zones are effective at preventing excess nitrate from entering streams after forest harvesting in areas affected by severe pine beetle outbreak.

Change in Streamwater Nitrogen Export and Soil Nitrogen Dynamics during a Mountain Pine Beetle Infestation of Subalpine Watersheds

Chuck Rhoades, Rob Hubbard, Kelly Elder
U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO

Abstract
Forested watersheds of western North America are experiencing rapid and extensive canopy mortality caused by a variety of insect species. The mountain pine bark beetle (*Dendroctonus ponderosae*) began to attack lodgepole pine (*Pinus contorta*) at the U.S. Forest Service, Fraser Experimental Forest in 2002. By 2007, bark beetles had killed 50 to > 80% of the overstory pine in Fraser research watersheds. The hydrologic, climatic, biogeochemical and vegetation records available at the Fraser Experimental Forest provide a unique opportunity to quantify the impacts of this widespread, but poorly- understood disturbance in basins relative to a multi-decade, pre-disturbance period. Here we compare streamwater chemistry and nutrient export in the seven years since the bark beetle outbreak began with the twenty years pre-attack record for Fraser's four main research watersheds. During the years following the onset of bark beetle activity, spring and late fall streamwater nitrate was higher than pre-outbreak concentrations in basins dominated by old-growth forest. In these basins, bark beetles had killed more than 75% of the pine and 40% of the total overstory basal area. Soil nitrate has also increased in response to the pine mortality. In spite of these responses Fraser streamwater nitrate remains extremely low, and the change in N export is equivalent to about 2% of annual nitrogen deposition (~2 kg N ha^{-1} yr^{-1}). Since physical forest structure has changed little at this point, higher streamwater nitrate concentration and export and higher soil nitrate pools are the likely result of decreased nutrient demand following mortality of overstory pine. The influence of the outbreak is an aggregate of short (i.e. halted overstory water and nutrient use) and longer-term (i.e. altered canopy interception, windthrow, and understory growth) processes, and the consequence of current beetle active will not be fully realized for decades.

Development of Sensitive Immunoassay Formats for Algal Toxin Detection

Fernando Rubio, Lisa Kamp, Jennifer Church, David Deardorff
Abraxis LLC, Warminster, PA, United States

Abstract
Cyanobacteria are known to produce various toxins. Cyanobacteria live in terrestrial, fresh, brackish, or marine water. Some of the toxins they produce can be toxic, others can cause severe taste and odor problems in drinking water supplies. Cyanobacterial toxins can make drinking water and recreational use of water unsafe. Animals die yearly as a result of cyanotoxins, and though human death is not commom, many people experience symptoms indicative of cyanotoxin exposure. Very little is known about the long-term side effects of ingestion of cyanotoxins, although there is a guideline set by WHO for safe concentrations, minimal concentrations could cause an effect over time. Concerns about contamination of lakes and reservoirs with algal toxins have led to the need for more rapid, and sensitive methods of analysis.

Immunoassays (ELISAs) have proven to be rapid, sensitive, accurate, and cost-effective. Microtiter plate ELISAs have previously been described and widely applied to the detection of many environmental contaminants. Other immunoassay formats utilizing immuno-chromatography are often single step devices where a test sample is analyzed for the presence of an analyte. The sample is contacted with one end of a test strip. The test strip contains colored particles coated with a binder dried on the strip. As the sample is wicked up the strip, the analyte in the sample reacts with the binder coated on the particles. The test strip also contains antigens in discrete zones. As the reaction mixture flows up the strip, any reaction between the antigens and the analyte, if present, may be observed by the appearance or non-appearance of color in the zones.

This paper describes the development and assay performance of microtiter plate ELISAs for microcystins, cylindropsermopsin, methyl isoborneol (MIB), and saxitoxin in water samples, and an immunochromatography device for the quick analysis of microcystins in drinking and recreational water samples. The results showed that the ELISAs exhibits excellent sensitivities: 0.1, 0.04, 0.01, and 0.02 ppb respectively in water samples. Average recoveries in water were between 85-115% and within and between assay precision of < 12%. Data obtained with water samples as well as sample comparison will also be presented.

Microcystin and Taste and Odor Compound Occurrence, Fate and Transport in Central Indiana Surface Waters

Lenore P. Tedesco[1], Nicolas Clercin[1], Angie Cowan[1], Michael Stouder[1], and Mark Gray[2]
[1]Indiana University – Purdue University Indianapolis, 723 West Michigan Street Room SL118, Indianapolis, IN 46202; [2]Veolia Water Indianapolis 1220 Waterway Blvd, Indianapolis, IN

Abstract
Cyanobacterial blooms are known to produce cyanotoxins as well as taste and odor causing metabolites. Efforts to find correlations between algal community structure and density and cyanotoxins and common taste and odor metabolites, MIB (methyl isoborneal) and geosmin are frequently unsuccessful. Difficulties correlating these variables in central Indiana drinking water reservoirs led researchers to seek watershed sources of these compounds.

High resolution sampling through a May, 2008 storm discharge event in two area streams upstream of drinking water reservoirs documented storm flow transport of both MIB and geosmin to area reservoirs. Levels as high as 70 ng/l geosmin were documented moving from watershed areas into drinking water supply reservoirs. Gesosmin concentrations in stream water were shown to peak with the peak in discharge while MIB concentrations peaked prior to peak discharge suggesting either a different flow pathway or source area for the metabolites.

In 2009, we monitored the occurrence, fate and transport of microcystin, MIB and geosmin in small residential reservoirs and wet stormwater detention basins and documented very high cell counts of potentially toxic cyanobacteria, elevated microcystin levels, and high MIB and geosmin levels. Further, both toxins and taste and odor metabolites were measured in adjacent water bodies downstream of these source areas. In most cases, microcystin and taste and odor metabolites persisted downstream for long distances with measurable decreases in concentration only associated with dilution by uncontaminated tributaries.

These findings may help explain at least some of the poor correlations between lake and reservoir algal community structure and cyanotoxin and/or taste and odor metabolite occurrence. It also raises concerns about the suitability of stormwater wet detention as an effective means of managing stormwater when outflow are to either recreational or drinking water supply resources.

Cyanobacterial Occurrence and Toxicity in central Indiana Drinking Water Reservoirs with an Assessment of Statewide Occurrence

Lenore P. Tedesco[1], Nicolas Clercin[1], Angie Cowan[1], Mark Gray[2]
[1]Indiana University – Purdue University Indianapolis, 723 West Michigan Street Room, SL118 Indianapolis, IN 46202; [2]Veolia Water Indianapolis 1220 Waterway Blvd, Indianapolis, IN

Abstract
Blue-green algae and algal toxins are a concern for both recreational and drinking water resources. Research regarding the distribution and toxicity of blue-green algal blooms in Indiana and the Midwest, with particular emphasis on Indiana and central Indiana drinking water reservoirs will be discussed. During the summers of 2007, 2008, and 2009, blue-green algal concentrations in multi-use reservoirs in the Indianapolis area, and the detection of the algal toxin Microcystin has resulted in recreational usage advisories. An extensive research program has been undertaken in three drinking water reservoirs that are part of the water supply for more than 1 million residents of Indianapolis and central Indiana. The three reservoirs are shallow, well mixed, highly productive reservoirs that experience frequent taste and odor causing algal blooms. Monitoring has been ongoing on a biweekly basis for nutrients, MIB and geosmin, algal community structure, and microcystin for three years. Cylindrospermopsin and anatoxin-a were monitored in 2008.

In addition to central Indiana reservoirs, we have analyzed samples for microcystin and algal community structure at a series of sites throughout the state of Indiana in an effort to document the potential risk of microcystin in Indiana water resources. Monitoring has documented the widespread occurrence of microcystin in both natural lakes and reservoirs, as well as area streams. Concentrations are typically low, but several instances of elevated microcystin levels have been documented.

In this paper, we will discuss cyanobacterial algal patterns in the central Indiana reservoirs, the likely producers of toxins, explore relationships between reservoir physical and chemical structure, algal community structure, and toxin and taste and odor production. Finally, we will compare central Indiana information with information on algae and toxin occurrence statewide.

Water Quality and Phytoplankton Community Composition in a Source Water Reservoir, Lake Houston near Houston, Texas, April 2006—September 2008

Amy Beussink[1], Jennifer Graham[2], Timothy Oden[1]
[1]U.S. Geological Survey, The Woodlands, Texas, United States; [2]U.S. Geological Survey, Lawrence, Kansas, United States

Abstract
Lake Houston, a shallow, turbid reservoir, is currently (2009) a primary source of drinking water for the city of Houston, Texas. The U.S. Geological Survey (USGS), in cooperation with the City of Houston, established a water-quality monitoring network to track daily changes in water quality. Continuous and discrete water-quality data were collected during April 2006-September 2008 at multiple sites to characterize the in-lake processes that affect water quality. Physiochemical water-quality properties (water temperature, pH, specific conductance, dissolved oxygen concentration, and turbidity) were monitored hourly from mobile, multi-depth monitoring stations developed and constructed by the USGS at five sites on the lake. Discrete samples were collected routinely at the continuous monitoring stations and analyzed for various water-quality properties and constituents-nutrients, acid-neutralizing capacity, fecal indicator bacteria, suspended sediment (and loss on ignition), phytoplankton (abundance, biovolume, and community composition), taste-and-odor compounds (geosmin, 2-methylisoborneol), cyanobacterial toxins (microcystin), and actinomycetes bacteria; and physiochemical properties were measured in the field. In addition to the routinely sampled compounds, synoptic samples were collected and analyzed for major ions and trace metals, wastewater indicators, pesticides, and volatile organic compounds. During the study period, cyanobacteria never dominated the phytoplankton community, taste-and-odor episodes did not occur, and detection of cyanotoxins was rare.

Multiple Lines of Evidence for Spatial Diagnosis of Catchment Water Quality: Sources and Pathways of Nutrients

Kirsten Verburg[1], Hamish Cresswell[1], Ulrike Bende-Michl[1], Carol Kendall[2]
[1]CSIRO Land and Water, GPO Box 1666, Canberra ACT 2601, Australia; [2]U.S. Geological Survey, 345 Middlefield Rd, MS 434, Menlo Park, CA 94025; Corresponding author: kirsten.verburg@csiro.au

Abstract
Targeting actions to address water quality issues within catchments requires an understanding of how the catchment 'works'. It is important to know which nutrients, and in what form, contribute to the problem, the origin of the nutrients, and the location of critical source areas within the catchment. Knowledge of the nutrient pathways and when they reach the stream is also critical - not only for the choice of management action, but also for the design of monitoring to evaluate its effectiveness. In other words, for management actions to be efficient and useful they need to be underpinned by a spatial 'diagnosis' of catchment water quality.

A range of different types of information can contribute to such a diagnosis and often complement each other. Using examples from case studies that explore the sources and pathways of nutrients in catchments we illustrate the role of the different types of information, including effective combinations, and place these in a 'multiple lines of evidence' framework.

This multiple lines of evidence framework is the basis on which "Guidelines for spatial diagnosis of catchment water quality" have been developed in Tasmania, Australia to support catchment management organisations in making sound evidence-based investment decisions and demonstrating the environmental outcomes from management interventions.

Keywords: Watershed management, high frequency monitoring, dual isotope analysis, spatial conceptual model, critical source area, weight-of-evidence

Monitoring Nutrient Contributions to the Lower Missouri and Upper Mississippi Rivers

Gary Welker, Jeff Robichaud, Larry Shepard, Ann Jacobs, Laura Webb, Deanna Callier, Shawn Henderson and Holly Mehl
U.S. EPA Region 7, Environmental Services Division, Assessment and Monitoring Branch; 901 North 5th Street; Kansas City, Kansas; 66101

Abstract
Nutrients originating in the upper Mississippi and lower Missouri watersheds have been recognized as sources contributing to hypoxia in the Gulf of Mexico. To help identify relative contributions of nutrients, samples have been collected on over 30 major tributaries discharging into the lower Missouri and upper Mississippi Rivers. Monitoring site locations are located near USGS gauging stations and on tributaries that represent more than three quarters of the flow that enters each of the two rivers from watersheds in the region. Three rounds of sampling have been conducted (spring, summer and fall of 2009). Samples have been analyzed of total nitrogen, total phosphorus and chlorophyll *a*

along with basic *in situ* parameters. Preliminary results show the relative contributions of nutrients (total nitrogen and total phosphorus) from tributaries to the main stems of the Missouri and Mississippi Rivers, and will assist the Agency and its partners as they move forward to address gulf hypoxia.

Oxygen isotopic composition of phosphate: A new tool for monitoring phosphate sources and cycling

Megan Young[1], Carol Kendall[1], Steve Silva[1], Karen McLaughlin[2], Adina Paytan[3]
[1]U.S. Geological Survey, Isotope Tracers Project, Menlo Park, CA, United States; [2]Southern California Coastal Water Research Project, Costa Mesa, CA, United States; [3]University of California, Institute of Marine Sciences, Santa Cruz, CA, United States

Abstract
Selecting appropriate and practical sampling strategies is a critical component of designing and maintaining monitoring programs. Understanding short-term fluctuations in monitored constituents can have significant implications for selecting sampling sites and time frames, interpreting long-term monitoring data, and integrating data from other types of studies (for example, laboratory, mesocosm and toxicity studies) with the data provided by monitoring programs. When sampling over large areas and/or over long time periods (typical of monitoring program designs) it is usually not possible to sample each site at the same point in the diel or tidal cycle. Therefore, it is necessary to understand short term fluctuations in order to correctly interpret larger spatial and temporal trends. It is also important to understand both seasonal and spatial differences in the magnitudes of short-term fluctuations in order to identify times and places when more intense sampling is required. For example, exact time and location of sample collection in a eutrophic river during the summer could result in widely different load calculations, while much less short term variability might be seen during other seasons or in other locations within the same aquatic system.

Here we present the stable isotope and nutrient concentration results from three separate diel studies that were conducted as part of a three year monitoring study of nutrient and dissolved oxygen dynamics on the San Joaquin River (SJR) and tributaries in the Central Valley, California, and discuss how these results impacted the interpretation of the larger data set. Nutrient concentrations, dissolved oxygen and other environmental parameters, and a suite of stable isotopes (water, nitrate, particulate organic matter (POM), dissolved oxygen, dissolved organic and inorganic carbon) were collected every two hours over either twenty-four or forty-eight hour periods. The total variability (2005 through 2007 monitoring study samples) in the mainstem SJR sites was much greater than diel variability at the upstream site for all measured isotopes, making seasonal variability fairly easy to separate from short-term variability. The downstream spatial variability during July and August (peak of algal growth in the river) in nitrate isotopes, water isotopes, and δ^{13}C-POM was much greater than the observed diel variability, indicating that the observed spatial variability was not significantly affected by sampling time. However, the diel variability in δ^{15}N-POM, C:N-POM, and δ^{13}C-DOC was greater than the observed downstream variability, suggesting that apparent spatial variability in these measurements could be an artifact of sample collection times. The results from this study highlight the importance of incorporating various sampling strategies into long term studies, and constraining the short term variability early within the study.

National Water-Quality Assessment (NAWQA) Program Black River Synoptic Study of the Effects of Mining in the Viburnum Trend, Southeastern Missouri, 1993 and 1995

Suzanne R. Femmer
U.S. Geological Survey, Missouri Water Science Center, Rolla, Missouri, United States

Abstract
Water-chemistry, streambed-sediment, fish-tissue, and invertebrate samples were used to evaluate the effects of lead and zinc mining and related activities on streams in the Viburnum Trend Subdistrict (Viburnum Trend). Mining-related metals in the Viburnum Trend are arsenic, cadmium, cobalt, copper, lead, nickel, and zinc. The sampled sites were grouped according to their proximity to mining activity: non-mining – sites upstream from mining activity or mine tailings, or sites where no mining activity is present in the basin; near-mining sites – mining activity or mine tailings ponds within 7.5 miles upstream from the site; and distal-mining sites – mining activity greater than 7.5 miles upstream from the site.

Compared to non-mining sites, most near-mining and distal-mining sites had elevated dissolved concentrations of several major and trace elements. Concentrations of sodium, chloride, sulfate, cobalt, copper, nickel, lead, zinc, lithium, and strontium peaked at near-mining sites, and then decreased downstream at distal-mining sites. However, concentrations of sodium, chloride, sulfate, and cobalt at distal-mining sites did not decrease to the lower concentrations detected at non-mining sites. Sodium, chloride, sulfate, and potassium concentrations significantly increased after 1967 (pre-mining period is considered 1964-67) in Strother Creek Basin, and remained elevated throughout the most recent sampling period (1995 through 2005).

In streambed-sediment and fish-tissue samples, the largest concentrations of mining-related metals, except arsenic and copper, were detected at near-mining sites, followed by the distal-mining sites. The smallest mean concentrations were in samples from non-mining sites. Arsenic and cobalt concentrations gradually increased and cadmium, lead, and zinc decreased as the distance downstream from mining activity increased.

Invertebrate community structure data indicated disturbances in invertebrate community structure near mining activities. Results of multiple metrics applied to the invertebrate community data consistently indicated effects to the community near mining activities. There was apparent recovery in community structure metrics as the distance downstream from mining activities increased.

Developing water budgets for unconventional oil and gas production: A study in the Williston Basin, Montana and North Dakota

Seth S. Haines[1], Joanna N. Thamke[2], Larry O. Anna[1], Bruce D. Smith[3], Mark A. Engle[4]
[1]U.S. Geological Survey, Central Energy Resources Science Center, Denver, CO; [2]U.S. Geological Survey, Montana Water Science Center, Helena, MT; [3]U.S. Geological Survey, Crustal Geophysics and Geochemistry Science Center, Denver, CO; [4]U.S. Geological Survey, Eastern Energy Resources Science Center, Reston, VA

Abstract
New drilling and completion technologies have expanded domestic oil and gas production to include low-permeability sandstone and shale targets once considered inaccessible and/or uneconomic. Hydrocarbon production from these formations commonly requires considerable quantities of fresh water to increase conductivity through the process of hydraulic fracturing (fracing). This water must be removed prior to resource extraction (flowback water) and generally contains salts and minerals from the formation as well as the additives used to increase fracing efficiency. The large volumes of water involved in these practices have already led to supply and disposal problems in some areas.
In order to address such issues and to help stakeholders prepare appropriately for future production scenarios, U.S. Geological Survey (USGS) scientists are developing water budget methods for oil and gas production on a regional scale. USGS oil and gas assessments provide estimates of technically recoverable resources and facilitate the determination of future hydrocarbon production scenarios. We extend these results to include volume estimates for the water involved.

The Williston Basin in Montana and North Dakota is the area of our initial focus due to (1) the large quantity of oil present in the Bakken Formation, and (2) the Prairie Pothole wetlands that host large numbers of migrating waterfowl. Current, rapidly escalating production of Bakken Formation oil requires a million or more gallons of fresh water per well for fracing. Historic and ongoing oil production from other Williston Basin formations has resulted in large volumes of highly saline co-produced waters; in the past some of these waters escaped into shallow aquifers and have impacted wetlands. We estimate the quantities of water (frac, flow-back, and co-produced) that could be involved in a range of future hydrocarbon production scenarios and compare these quantities with estimated total water budgets for the region. This will allow for an evaluation of water-related impacts of oil and gas production for a range of possible future production scenarios.

Approaches to Volunteer Monitoring in Mining Communities

T. Allan Comp[1], Jenna Fehr[2], Joe Campbell[2], Heather Lucas[3]
[1]US Office of Surface Mining, Washington, DC; [2]Appalachain Coal Country Watershed Team, Beckley, WV; [3]Stanford University, Stanford, CA

Abstract
The OSM/VISTA Watershed Team places college-educated AmeriCorps VISTA/Office of Surface Mining Volunteers with community-based watershed organizations (CWOs) for three-year capacity building projects. Developing and enhancing citizen-based water monitoring efforts are core activities for OSM/VISTAs. The team is conducting an EPA-funded research project exploring volunteerism for rural watershed organizations.

Volunteers are essential to water monitoring in rural mining communities. The team works in the Western hardrock mining region and in Appalachian coal country to fight decades of environmental degradation. Although isolated from major population centers, the streams that originate in these mountain ranges serve as major headwaters to our nation's water resources. In these regions, CWOs often struggle to find financial, technical, and human resources for water monitoring.

Issues presented by point and non-point source water pollution in rural mining areas often require broad efforts to develop a range of government and local community support. Community leaders and government officials seek to develop strategies to encourage citizen support. Described as stakeholders, engaged citizens, or simply watershed volunteers, concerned and active local people are helping solve problems in these regions. Although engaging volunteers in service to CWOs is essential to solving water quality issues in the United States, little empirical research has investigated the role that volunteers play in these areas. Approaches to improving volunteer management have been examined in urban areas and trends have been uncovered nationally, but little investigation has occurred in rural and under-resourced mining communities. This study looks at motivations, concerns, demographics, beliefs, and behaviors of rural watershed volunteers through survey data. Over 270 surveys have been received from volunteers in Appalachia and western Colorado. Twenty-five different volunteer management approaches currently being practiced by CWOs are also being evaluated. Preliminary findings suggest rural watershed volunteers often have higher rates of educational attainment and income in comparison to the general population within the local community; are highly active in other community and civic organizations; have strong beliefs in the effectiveness of their CWOs to improve the environment; and have fairly high levels of distrust in government and local citizens to take action to improve the environment.

How Do You Monitor A Pebble?

Barry Long and Pete Penoyer
National Park Service, Water Resources Division, 1201 Oakridge Drive, Suite 250, Fort Collins, Colorado 80525

Abstract
Lake Clark National Park and Preserve is located at the crossroads of a national energy debate. It is a remote, isolated park of 4 million acres with no roads, major ports or urban infrastructure, and 2.4 million acres are designated wilderness. The park and preserve is home to a rich variety of landscapes, plants and animals, and its watersheds provide critical spawning and rearing habitat for one of the world's largest sockeye salmon fisheries. The area is also in close proximity to lands containing valuable mineral deposits with mining claims awaiting potential development. One such deposit is located less than 14 miles from the preserve's western boundary on Alaska state land, and it is estimated to contain 80.6 billion pounds of copper, 107.4 million ounces of gold, and 5.6 billion pounds of molybdenum valued at over $400 billion dollars. The proposed Pebble Mine is a joint venture of Anglo American PLC and Northern Dynasty Minerals Ltd. If the project is permitted, it would include the largest open-pit mine in North America, an underground mine, a 700 foot high tailings dam(s), a tailing pond, a 104 mile transportation corridor with a road and slurry pipeline, a port facility on Cook Inlet, and extensive support facilities and power lines. The Chulitna River Basin is located adjacent to the project area and drains into Lake Clark. Water from this basin influences Lake Clark ecosystems and provides habitat and food for salmon in the Bristol Bay fishery.

So, how can the National Park Service protect the public's resources from a potential threat of this size and magnitude? Is it possible to design a monitoring plan with limited resources that can target and identify potential impacts, and measure real changes over time at this scale? Our first step has been to form an interdisciplinary team of specialists to identify resource data that are needed and select areas to focus on. Those areas will include surface water quality on the Chulitna River, sediment coring in upper watershed lakes, shallow groundwater monitoring near the divide adjacent to Pebble, air monitoring stations downwind of the mine, and fish sampling.

Keywords: Mining, mineral deposits, water quality, sediment coring, sockeye salmon, national park service

Organic compounds in surface waters near lead-zinc mine and milling operations

Colleen E. Rostad[1], Christopher J. Schmitt[2], John G. Schumacher[3]
[1]US Geological Survey, Water Resources Discipline, Branch of Regional Research, Denver, CO, United States; [2]US Geological Survey, Biological Resources Discipline, Columbia, MO, United States; [3]US Geological Survey, Water Resources Discipline, Missouri Water Science Center, Rolla, MO, United States

Abstract
Surface-water samples were collected from a lead mine-mill complex in Missouri to determine if polar (water soluble) organic compounds from the milling process were present that could be a contributing factor to documented negative effects on biota in receiving streams. Water samples collected previously contained relatively high dissolved organic carbon (greater than 20 mg/L) for surface waters, but were colorless, which precluded naturally occurring aquatic humic or fulvic acids. Previous analysis by gas chromatography/mass spectrometry indicated that samples were devoid of pesticides and acid/base/neutral extractable semi-volatile organic compounds, such as polycyclic aromatic hydrocarbons. Because large amounts of xanthate complexation reagents are used in the milling process, techniques were developed to extract and analyze for sodium isopropyl xanthate and sodium ethyl xanthate. Although these xanthate compounds were not found, trace amounts of the degradates, isopropyl xanthyl thiosulfonate and isopropyl xanthyl sulfonate, were found in most locations sampled, including the tailings pond downstream. Dioctyl sulfosuccinate, a process filtering aid that is slightly toxic to fish, was found at concentrations estimated at 350 micrograms per liter. Release of these organic compounds downstream from lead-zinc mine and milling areas has not previously been reported. A majority of the dissolved organic carbon remains unidentified.

Assessment of Potential Uranium Ore Migration from a Uranium Mill by Monitoring Sediments from Ephemeral Streams, Sagebrush, and Cores from Cottonwood Trees near the Ute Mountain Ute Reservation, Utah

Ryan Rowland[1], Dave Naftz[1], Anthony J. Ranalli[2], Sam Vance[3], Robert Duraski[3], Colin Larrick[4], and Scott Clow[4]
[1]U.S. Geological Survey, 2329 Orton Circle, Salt Lake City, UT 84119-2047; [2]U.S. Geological Survey, Denver Federal Center, PO Box 25046, MS 415, Lakewood, CO 80225; [3]U.S. Environmental Protection Agency Region 8, 1595 Wynkoop Street, Denver, CO 80202-1129; [4]Ute Mountain Ute Tribe, PO Box 448, Towaoc, CO, 81334

Abstract
The White Mesa uranium (U) mill, located 6 km north of the Ute Mountain Ute Indian Reservation in southeastern Utah, began operating in 1980 to extract yellowcake (U_3O_8) and vanadium from U ores mined in the region. Potential exposure pathways to U and other metals associated with the mill and its operation include (1) airborne dust from ore storage pads, from trucks delivering ore to the mill, and from the mill's drying ovens, (2) dissolution of airborne dust deposited on the soil and accumulated in ephemeral stream channels and native plants, and (3) leakage from tailings ponds to the unconfined aquifer. To supplement water-quality monitoring data from springs, shallow wells, and stock ponds near the mill, 31 ephemeral stream sediment samples, 70 sagebrush samples, and 12 cottonwood tree cores were collected from near the mill. Sediment samples were collected from the surface to 0.5-cm depth along 3-m transects. Samples of new growth sagebrush were composited from up to six plants within a 15-m radius. Both fine sediment (passing a -200 mesh sieve) and sagebrush samples were analyzed for 43 elements, including U and elements associated with U ore. Uranium concentrations in ephemeral stream sediments ranged from 1.5 to 16.2 mg/kg. The concentration of U in seven ephemeral stream sediment samples exceeded the background concentration of 3.6 mg/kg (the background concentration was the maximum concentration of U measured at three control sites over 6 km north of the mill) and were from ephemeral drainages east and south of the mill. Uranium concentrations in sagebrush samples ranged from 1.3 to 171 μg/g, with a median of 15.3 μg/g. Sagebrush samples from sites northeast of the mill, near an uncovered U ore storage pad, had uranium concentrations that exceeded the 90th percentile (54.8 μg/g). Pattern recognition modeling of the multi-element sediment and sagebrush data matrices identified several sites near the mill with potential U ore fingerprints. Cores collected from living cottonwood trees near springs around the perimeter of the mill site indicated U concentrations in recent growth rings were below the analytical detection limit (0.1 μg/g). Dendrochronolgy showed that the trees predate mill operations.

Impacts of Mining-Derived Metals on Riffle-Dwelling Crayfish and In-Situ *Toxicity to Juvenile Crayfish in the Big River of Southeast Missouri, USA*

Ann L. Allert[1], Robert J. DiStefano[2], James F. Fairchild[1], Christopher J. Schmitt[1], William G. Brumbaugh[1]
[1]U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO; [2]Missouri Department of Conservation, Resource Science Center, Columbia, MO

Abstract
The Old Lead Belt mining sub-district in southeast Missouri, USA was one of the largest producers of lead-zinc ore in the world. Previous stream surveys found evidence of metal exposure to fish and crayfish. We studied crayfish populations in riffle habitats at eight sites to assess the ecological effects of mining-derived metals in the Big River, which drains much of the Old Lead Belt. We also conducted an *in-situ* 56-d test to assess toxicity and bioavailability of mining-derived metals to juvenile woodland crayfish (*Orconectes hylas*) and golden crayfish (*Orconectes luteus*). Riffle crayfish density, survival and growth of caged crayfish, physical habitat, and water quality were examined at sites with no known upstream mining activities and at sites downstream of mining areas. Metals (Co, Ni, Cu, Zn, Cd, Pb) were analyzed in surface water, pore water, sediment, detritus, fish, crayfish and other macro-invertebrates. Mean crayfish densities in riffle habitats were significantly higher ($P < 0.05$) at reference sites compared to mining and downstream sites. Densities were negatively correlated with metal concentrations in surface water, sediment, and crayfish, which were significantly higher at mining sites than at reference sites or downstream sites. Survival of caged crayfish was significantly lower at mining sites than at reference sites. Metal concentrations in surface water, pore water, sediment, detritus, fish, crayfish, and other macro-invertebrates were significantly higher at mining sites than at reference sites. These findings indicate that metals associated with previous mining activities in the Old Lead Belt negatively affect on crayfish populations in the Big River and that in-situ toxicity testing was a valuable tool for documenting the effects of lead-zinc mining on crayfish.

Assessing and Monitoring the Effects of Mining-Derived Metals on Crayfish and Sculpin

Ann L. Allert, James F. Fairchild, Christopher J. Schmitt, John M. Besser, William G. Brumbaugh
U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO

Abstract
Lead-zinc mining in the New Lead Belt (NLB) of southeast Missouri, USA has resulted in extensive contamination of water, sediment, detritus, and biota. We studied the ecological effects mining-derived metals (Pb, Zn, Cd, Ni, and Co) on free-ranging crayfish (*Orconectes spp.*) and sculpin (*Cottus spp.*) populations at 16 sites in and near the NLB. Crayfish and sculpin densities were reduced at sites directly downstream of mines. In a 56-d laboratory study, survival and growth of *Orconectes hylas* was reduced at the highest concentration of a mixture of metals (190 μg Pb/L:190 μg Zn/L:2 μg Cd/L:380 μg Ni/L:380 μg Co/L) that simulated metal exposure in mining-affected habitats. A 56-d *in-situ* cage study revealed an inverse relationship between survival of crayfish (*O. hylas*) and metal concentrations in water, sediment, and detritus. *In-situ* leaf processing by crayfish was also negatively affected by metals. In both field and lab studies, weight loss of leaves was greater with than without crayfish, and weight loss of all leaves was reduced with increasing metal concentrations. Weight loss of leaves from only microbial decomposition was greatest for cottonwood (*Populus deltoids*) > willow (*Salix nigra*) > sycamore (*Platanus occidentalis*) in both field and laboratory studies. The absence or reduced abundance of crayfish may have negative effects on leaf processing and therefore, on ecosystem processes such as nutrient and energy cycling in Ozark streams. These results indicate that crayfish and sculpin are affected by metals in the Black River watershed. Crayfish and sculpin may be useful indicators or sentinels for assessing and monitoring the effects of mining in aquatic ecosystems.

Distribution of Mining-Related Metals in Streambed Sediment of the Viburnum Trend Subdistrict and Sediment core from Clearwater Lake, Southeastern Missouri

Michael Kleeschulte[1], Lopaka Lee[2], John Schumacher[1], Gary Krizanich[3]
[1]U.S. Geological Survey, Missouri Water Science Center, Rolla, Missouri, United States; [2]U.S. Geological Survey, Hawaiian Volcano Observatory, Hawaii National Park, Hawaii, United States; [3]University of Central Missouri, Department of Biology and Earth Science, Warrensburg, Missouri, United States

Abstract
Lead and zinc mining operations along the Viburnum Trend Subdistrict in the Black River Basin of southeastern Missouri began during 1966. Streambed-sediment samples from sites in non-mining basins, sites upstream, and sites at varying distances downstream from mining activities in the Viburnum Trend indicate that streambed sediments are

significantly enriched in mining-related metals. The degree of enrichment depends on the metal and the distance downstream from mining activities.

Streambed sediments from near-mining sites (mining activity within 7.5 miles upstream from sampling site) were significantly enriched (up to ten times) in cobalt, lead, nickel, and zinc compared to non-mining sites. Nickel and zinc concentrations in non-mining and distal-mining sites (sampling sites greater than 7.5 miles downstream from mining activity) were similar. Cobalt and lead concentrations remained slightly elevated at distal-mining sites.

Every lead and nickel concentration, and all but one zinc concentration from nine near-mining sites exceeded their respective probable effects concentration (PEC) thresholds, whereas these metals only exceeded their respective PEC thresholds occasionally in samples from 22 non-mining sites. None of the 13 distal-mining sites exceeded PEC thresholds for copper or zinc, but three sites exceeded the lead PEC threshold, and two sites exceeded the nickel PEC threshold.

Sediment cores were collected from six sites in Clearwater Lake (completed in 1948) downstream from the Viburnum Trend. Lead concentrations in core from the Webb Creek arm of the lake (basin where no mining occurs) exhibited no trend for lead concentration with depth. However, lead concentrations were positively correlated with depth ($r_s = 0.91$) in core near the dam. Using lead-210 isotopic dating methods, lakebed sediment core collected near the dam indicated the most abrupt increase in lead concentration occurred between 1965 and 1967 (from 43.9 to 77.9 milligrams per kilogram). The mean lead concentration of the 1967 and later samples (78.9 milligrams per kilogram) was twice the mean lead concentration of the 1965 and earlier samples (37.4 milligrams per kilogram). All lead and zinc concentrations were below the PEC thresholds at all core sampling sites. The only PEC exceedance occurred for nickel in 7 percent of samples from two core sites.

Cause and Effect Survey of Brine Discharges in South Fork Tenmile Creek, Pennsylvania

Rick Spear[1], Daniel Counahan[1], Gary Kenderes[1], Julia Eichman[2], Tony Shaw[3]
[1]Pennsylvania Department of Environmental Protection, SWRO 400 Waterfront Drive, Pittsburgh, PA 15222; [2]EcoAnalysts, Inc., 7304 Haskill Lane Joplin, MO 64804; [3]Pennsylvania Department of Environmental Protection, RCSOB 400 Market Street, Harrisburg, PA 17105

Abstract
The energy market economics that commanded recent high fossil fuel costs spurred significant natural gas industry interest in developing the deep gas-bearing Marcellus shale beds underlying large portions of Pennsylvania, West Virginia, Ohio, and New York. Gas drilling operations in western and northern Pennsylvania is creating the need to treat and dispose of high volumes of resulting brine wastewater. During these early phases of Marcellus shale field development, the industry's primary solution is to contract with large regional waste water treatment plants to accept the brines.

Two sewage treatment plants (STPs) on the South Fork Tenmile Creek in Pennsylvania have been accepting and treating Marcellus brine water at flows varying from 10-15% of the sewage plants' effluent volume for much of 2008. Given the volume of waste water treated and the low flow conditions of the stream throughout the year, concerns were raised as to the possible impact this water may have to the aquatic community. A cause and effect survey was conducted to investigate any impacts from the STP discharges. Water and macroinvertebrates were collected at stations upstream and downstream of the STPs. In addition, plankton tows were conducted at the same locations. The collected data showed a gradient of increasing degradation moving from upstream to downstream. Similarly, plankton sampling revealed that phyto- and zooplankton community dominance shifted from freshwater taxa to brackish or halophilic ("salt-loving") taxa downstream of the STPs.

Monitoring Strategies to Assist Remediation of Abandoned Draining Mines

Katherine Walton-Day
U.S. Geological Survey, Denver, CO, United States

Abstract
The poor quality of water draining from abandoned mines is a long-term obstacle to water-quality improvement in many locations nationwide. Although treatment plants could remediate these sites, their installation and operation may be cost prohibitive due to long-term operation and maintenance costs and/or remote locations. Increasingly, lower-cost hydraulic controls are being used to help limit water flow and water-quality degradation from draining mines. Understanding the hydrology of these mines is essential for design of successful hydraulic remediation strategies. Some of the monitoring techniques that may increase understanding of the hydrology of draining mines, and potentially increase success of remediation include: interpretation of continuous hydrographs of draining mines; isotopic, geochemical and geologic characterization of draining mines, surrounding watersheds, and underground workings; borehole geophysical techniques; and groundwater modeling. In addition, pre- and post-remediation characterization of watershed and mine-water quality and hydrology can be used to examine the effects of hydraulic remediation. Some of these techniques have seen limited application; however, increased use of the techniques may help improve understanding of pre-remediation hydrology, improve remediation design, and increase the potential for hydraulic remediation to offer sustained water-quality improvement.

Linking landscape characteristics and stream nitrogen in the Oregon Coast Range: empirical modeling of water quality monitoring data

Jana Compton[1], Effie Greathouse[2], John Van Sickle[1]
[1]US Environmental Protection Agency, Western Ecology Division, Corvallis, OR; [2]Presenter, Oregon State University, Corvallis, OR

Abstract
Background sources of nitrogen (N) provide a challenge for setting stream nutrient criteria in the Pacific Northwestern US. Red alder (*Alnus rubra*), an early successional nitrogen fixing tree, and sea salt inputs can strongly influence stream N concentrations observed in individual studies in western Oregon and Washington. We used data from various monitoring and GIS efforts (e.g., US EPA, Oregon DEQ, LEMMA GNN vegetation maps) to compile a database of stream N and landscape characteristics in the Oregon Coast Range. Dissolved nitrate was the most commonly measured N parameter. Nitrate was measured at 386 non-tidal stream sites that we considered independent (sites were > 5 km apart, if nested) and with watersheds entirely contained within the Coast Range; 336 sites had measurements or estimates of total nitrogen (TN). We focused on nitrate and TN because ammonium concentrations were generally below a high detection limit (20 μg N/L), and total dissolved N was not well represented in the database. Basal area of alder as a percent of watershed area accounted for 37% and 38% of the variation in summer nitrate and TN, respectively. Stream nitrate and TN concentrations from watersheds with high cover of alder were above nutrient criteria proposed by US EPA. Distance to the coast and latitude, which are likely surrogates for sea salt inputs, were also related to nitrate values. Nitrate levels were lowest in the summer, highest in winter and at an intermediate level in fall and spring, but there was no interaction between alder and season in our models of log(x+1)-transformed nitrate. Although outliers in our model of nitrate against season and alder consistently had high values of urban land cover, few sites had substantial human land use in the watershed (324 sites had natural land cover >90%), and thus, best fit multiple regression models did not include land use (e.g., urban land cover, agricultural land cover, number of confined animal feeding operations). Our results provide evidence, at a regional scale, that background sources (alder) and processes (sea salt interactions) cause many Coast Range streams to exceed proposed nutrient criteria.

Evaluation of the Soil and Water Assessment Tool for Predicting Hydrology and Nutrients at Unmonitored Sites in the Cedar River Watershed

Kasey J. Hutchinson, Daniel E. Christiansen
U.S. Geological Survey, Iowa Water Science Center, Iowa City, IA, United States

Abstract
The Soil and Water Assessment Tool (SWAT), a physically-based continuous hydrologic model, was used to estimate streamflow and nutrient loadings at sites within the Cedar River watershed, located in central Iowa. The Cedar River watershed drains approximately 7,785 square miles and is dominated by agriculture consisting mostly of corn and soybeans. This watershed has been listed as a major contributor of nutrient loadings to the Gulf of Mexico in past studies and is included on the state's Clean Water Act, section 303(d) list. Streamflow and nutrient data are available for multiple sites located on the Cedar River dating back to 2000. Two SWAT model scenarios were created. The first SWAT model calibrated the streamflow and nutrient loadings to measured streamflow and nutrient data from U.S. Geological Survey and Iowa Department of Natural Resources measurement sites located within the watershed. The second model calibration incorporated only a subset of the measurement sites used in the first model. The measurement sites not incorporated into the second model were used as surrogates for unmonitored sites, to examine how well the SWAT model predicted both observed streamflow measurements and nutrient concentrations at unmonitored sites. Simulation results between the two models also were compared to examine the effects on predictive capabilities when using a greater number of observed data sources. Results show that increasing the number of observation sites increases model prediction accuracy and that the SWAT model can be used to estimate water-quality conditions at unmonitored locations.

Water Quality Measurement Network for Validation and Development of Catchment Models

Holm Kipka, Marcel Wetzel, Daniel Varga, Manfred Fink, Sven Kralisch, Peter Krause, W.-A. Flügel
Department of Geoinformatics, Hydrology and Modeling, Friedrich-Schiller-University Jena, Germany

Abstract
A relatively small (approx. 850 km^2) watershed in the German State of Thüringen has been equipped with a measurement/field-instrumentation network for obtaining spatially and temporally high-resolution hydrological and water-quality data. As a pilot-study test case, the upper catchment of the Gera River was selected for this study. The catchment features different land uses that are typical for middle mountainous regions in middle Europe. The measurement network consists of six online water-quality stations and 24 additional monthly water-quality sampling sites distributed throughout the watershed. At each monitoring site, the following variables are measured in the field or analyzed in the laboratory: streamflow, temperature, pH, electrical conductivity, turbidity, total solids (TS), dissolved oxygen, nitrate, ammonium, total phosphorous and other variables. Water-quality data to date cover a 2 years period beginning in January 2008, although some sites and variables were initiated later. A complete year's data are available for evaluating seasonal patterns for each monitoring site. The water-quality data reflect impacts of both point and/or nonpoint sources (such as domestic wastewater discharges and agricultural-land runoff to streams, respectively). In addition, eight climatological stations and 23 soil-moisture sites have been installed on agricultural lands located throughout the catchment.

The objectives of this poster presentation are (1) to describe the measurement network and the catchment hydrology and water quality properties, and (2) to present preliminary results of Jena Adaptive Modeling System (JAMS) application of the J2K model. The monitoring program provides a high-resolution, detailed dataset for improved model calibration and validation. Thus, a better fit in modeling water-quality variables, such as phosphorous that are mainly transported during short-time events, can be achieved. These collected data also will aid in development and implementation of an erosion-phosphorus model component and a stream water-quality model component.

Regression Models of Selected Constituents in Two Tributaries to Lake Houston near Houston, Texas, 2005–07

Michael Lee[1], Timothy Oden[1], William Asquith[2]
[1]U.S. Geological Survey, Texas Water Science Center, Gulf Coast Program Office, 19241 David Memorial Drive, Suite 180, Conroe, TX 77385, ph. (936) 271-5300; [2]U.S. Geological Survey, Texas Water Science Center, North Texas Program Office, Geoscience Department, 2500 Broadway, Texas Tech University, Lubbock, TX 79409-1053, ph. (806) 742-3129

Abstract
The U.S. Geological Survey, in cooperation with the City of Houston, Texas, has an ongoing study to estimate water-quality constituent concentrations in Spring Creek and East Fork San Jacinto River, two tributaries to Lake Houston near Houston. As a result of groundwater regulations limiting withdrawals, increased dependence on Lake Houston as a source-water supply requires a comprehensive understanding of the factors that affect lake water quality. Regression analyses were done on the streamflow, discrete water-quality samples, and continuous water-quality data collected during December 2005 through December 2007 to provide real-time concentration estimates for suspended sediment, nutrients, total organic carbon, atrazine, and *Escherichia coli* bacteria. The explanatory variables considered for regression analysis at each site were continuously monitored streamflow, pH, water temperature, turbidity, specific conductance, and dissolved oxygen concentration. Streamflow was a significant explanatory variable for all constituents at both sites, except for total phosphorous and total organic carbon at Spring Creek. Turbidity was a significant explanatory variable for all constituents at both sites, except nitrate plus nitrite at East Fork San Jacinto River. For total organic carbon at Spring Creek and suspended sediment and total phosphorous at East Fork San Jacinto River, sine and cosine functions of time were used to explain seasonal patterns in concentrations. For each equation, adjusted R-squared, (R_a^2) was evaluated as an indicator of the regression equation to explain the variability in the constituent concentrations. The regression equations also were evaluated by computing relative percent difference between the measured concentrations and estimated concentrations from the regression equations. At Spring Creek, R_a^2 ranged from a low of 0.756 for total organic carbon to 0.925 for nitrate plus nitrite. Relative percent difference at Spring Creek ranged from 2.6 for total organic carbon to 9.8 for *Escherichia coli*. At East Fork San Jacinto River, R_a^2 ranged from 0.607 for *Escherichia coli* to 0.878 for total organic carbon. Relative percent difference at East Fork San Jacinto River ranged from 4.8 for total organic carbon to 10 for nitrate plus nitrite.

Assessing the effect of uncertainties associated with estimated model parameters and small–scale geologic heterogeneity on basin-scale projections of water-quality trends, Salt Lake Valley, Utah

J. J. Starn[1]; C. T. Green[2]; S. R. Hinkle[3]; F. H. Chapelle[4]; B. Lindsey[5]; S. Thiros[6]
[1]USGS, East Hartford, CT, United States, jjstarn@usgs.gov; [2]USGS, Menlo Park, CA, United States; [3]USGS, Portland, OR, United States; [4]USGS, Columbia, SC, United States; [5]USGS, New Cumberland, PA, United States; [6]USGS, Salt Lake City, UT, United States

Abstract
Increasing total dissolved solids concentrations (TDS) have been observed in groundwater in parts of the Salt Lake Valley, Utah. Possible explanations for the observed trends include changes in source-water areas in the basin and (or) the input of relatively high TDS water from human activities. Combinations of these two causal mechanisms, as well as other factors such as climate change, could contribute to the

observed trends. A groundwater flow model, calibrated using head and tritium data, was used to assess the effect of parameter uncertainty and geologic heterogeneity on projected water-quality trends in the valley. The use of a flow model to evaluate the effects of these causal mechanisms requires an understanding of the relative confidence in model projections. The effect of parameter uncertainty is considered by using calibration-constrained Monte Carlo simulations to evaluate the confidence in simulated source-water areas. To incorporate uncertainty in geologic heterogeneity at the model-cell scale, Monte Carlo runs included a one-dimensional random walk that was applied to particles that simulate groundwater flow from source-water areas to well screens. This technique simulates the longitudinal dispersion of groundwater but does not simulate the transverse or vertical spreading of mass.

The Monte Carlo-based approach shows that incorporation of atmospheric tracer observations leads to more precise simulations of source-water areas to pumped wells and that atmospheric tracer observations are an effective means to reduce standard deviation of parameter estimates. Constraining the Monte Carlo parameter sets to those that met acceptance criteria, which included a standard error criterion, did not appear to bias model results. Uncertainty in the source area, derived from parameter and geologic uncertainty, leads to uncertainty in estimates of land cover within the source area associated with a well, which in turn propagates into uncertainty in projections of groundwater quality trends. Simulations that include parameter and geologic uncertainty can be used to assess possible causes of groundwater trends, and the results can be expressed in ways that might be useful to water-resource managers.

Monitoring for Modeling

William J. Elliot, Peter R. Robichaud, Randy B. Foltz
USDA Forest Service, Rocky Mountain Research Station, Moscow, ID

Abstract
Prior to the development of digital computers, predictive empirical models for watershed processes were built from large sets of observed data, and most research studies were developed to add to those data sets. Predictive tools from that era included the Universal Soil Loss Equation and the SCS (Now NRCS) Curve Number runoff technology. These models continue to perform well for sites with conditions similar to where the data were collected. With the advent of computer modeling since the 1970s, new physically-based models were developed that described the processes for infiltration and runoff, and sediment detachment, transport, deposition and delivery. The large databases that were developed for the empirical models are of limited use for providing inputs to this new generation of predictive models. With the initiation of the interagency WEPP project in the 1980s, scientists with the Agriculture Research Service and the Forest Service developed new monitoring methods to estimate soil erodibility properties to support WEPP hydrologic and sedimentation predictions. These methods included high intensity rainfall simulation to estimate hydraulic conductivity and Interrill erodibility, and runoff simulation to estimate rill erodibility. Similar simulation methods were applied to agriculture fields, rangelands, forests, and forest roads. The results of these studies showed large differences in hydraulic conductivity and soil erodibility values between the four conditions, with the agricultural sites being the most erodible, and undisturbed forests the least erodible. Another finding of these studies was that the plant community in forests and rangelands was more important than the soil texture in determining erodibility, with rangeland soils beneath coppice canopies less erodible than soils between coppice canopies, and forests disturbed by fire much more erodible (up to 1000 times) than undisturbed forests. Now that the input parameter values for these models are better known, runoff and sediment delivery from larger areas from natural rainfall events can be used to validate the models.

Predicting the Effects of Future Climates on Forest Watersheds

William J. Elliot
USDA Forest Service, Rocky Mountain Research Station, Moscow, ID

Abstract
It is widely accepted that climates will change in the coming century. For most places in the western U.S., this change is generally expected to result in warmer temperatures, with increases or decreases in monthly precipitation amounts. Much of the water in the western U.S. is from winter snowfall, and much of the western hydrology is driven by snow accumulation and melt processes. Changes in the temperature and distribution of precipitation will lead to differences in the timing and intensity of runoff, in evapotranspiration, and in the amount of water leaving forest watersheds. It is not easy to estimate what those changes mean for a given location. Managers are challenged to decide what impacts there will be to forested watersheds associated with different climates. Methods are under development to use the Water Erosion Prediction Project (WEPP) model to predict the watershed responses to future climates. Two new technologies have been developed to aid in such a prediction. The first is the development of an online tool that provides future monthly temperature and precipitation distributions as a function of prediction method, location, and elevation. Monthly data for the years 2030, 2060, and 2090 generated by 8 different widely accepted methods can be obtained and used to parameterize the climate input file for the WEPP model. In addition to erosion and sediment delivery, the WEPP model will predict runoff generated by rainfall, snowmelt, or rain on snow, as well as snow accumulation and soil freezing. From the WEPP outputs, the three components of upland stream flow can be estimated: surface runoff, shallow subsurface lateral flow, and "base flow" from groundwater. The WEPP model can be calibrated and validated for historical conditions on gauged watersheds, and then run for future climate scenarios. The output files from the model can be used to determine changes in peak flow rates, water yield, upland erosion and sediment delivery. Channel base flow can be estimated as a function of predicted deep seepage and included with the water yield estimate. An example watershed analysis will be included in the presentation. Areas requiring further work will be identified.

Earth System Observation Network (ESON): a long-term monitoring program in the San Juan Mountains, CO that addresses climate change and its impacts on land, water, air, life & humans

Rob Blair, Koren Nydick, Bruce Kowalski
Mountain Studies Institute, San Juan Mountains, CO

Abstract
The San Juan Mountains are in a state of environmental flux. This is evident from earlier peak discharges from rivers, reduced snow pack in alpine terrain, higher frequency of dust events and stress on native habitats. Based on how rapidly some of these changes appear to be occurring, it is apparent that a coordinated effort to assemble and make available a more complete and timely regional database would enhance and accelerate decisions made at the local level. The Earth System Observation Network (ESON) addresses this problem.

ESON is a long-term mountain region monitoring program being initiated in the San Juan Mountains, Colorado by the Mountain Studies Institute (MSI). It focuses on documenting and tracking climate change, and human impact using a systems model (geosphere, hydrosphere, atmosphere, biosphere & anthrosphere). The goals are to take existing & new scientific data to create meaningful information that leads to a knowledge base upon which action(s) by stakeholders becomes feasible. Specifically it will provide regional stakeholders via website, conferences and news bulletins applicable up-to-date information (i.e. environmental trends) upon which to make informed decisions related to land use, public policy, natural hazards, fiscal issues and adaptation.

The program is multi-disciplinary and involves communities, local agencies, and volunteers. It adheres to scientific research protocols and uses multivariate analysis. This program identifies existing observation data from more than 50 agencies and organizations. The intent is to monitor over decades environmental changes related to climate, water resources, geologic hazards, ecological assemblages and human impact. It will increase the data value of existing monitoring stations by introducing temporal protocols and add long-term repeat photography amenable to GIS analysis. This part of the program can be carried out by citizens, students and volunteer organizations. Volunteers are trained in the research protocols necessary to maintain data integrity.

The volunteer program accomplishes three goals: inviting public participation in tracking climate change, educating citizens and youth on how science works, and reducing costs of environmental monitoring. The ESON program addresses the collaboration between diverse agencies and organizations that has been specifically promoted by DOI Secretary Ken Salazar in the fall of 2009.

Development of Biological Objectives for Wadeable Streams in California

Karen Larsen[1], Thomas Suk[1], Peter Ode[2], Ken Schiff[3], Valerie Connor[1]
[1]California Environmental Protection Agency, Water Resources Control Board, Sacramento, CA; [2]California Department of Fish & Game, Office of Spill Prevention & Response, Rancho Cordova, CA; [3]Southern California Coastal Water Research Project, Costa Mesa, CA

Abstract
The development of biological objectives for streams in California presents many unique challenges. California includes the highest point (Mt. Whitney, 14,494 ft.) and the lowest point (Death Valley, 282 ft. below sea level) in the contiguous United States, with many ecosystem types in between these extremes. Much of the state is urbanized and intensively farmed, with few undisturbed streams available in many areas to establish reference conditions. During the past ten years, the state has developed multimetric indices of biotic integrity (IBIs) for several ecoregions, as well as statewide multivariate (i.e., "RIVPACS"-type) models to establish biological expectations for streams and rivers.

In recent years, a state-sponsored external scientific review and a USEPA-sponsored review both determined that California's bioassessment program is sound and ready to proceed to criteria, the State Water Board began the process of establishing regulatory biological objectives for wadeable streams and rivers. The biological objectives will rely on benthic macroinvertebrates as the primary indicator organism for stream bioassessments in California. The process includes three review and oversight committees to advise the Water Board: 1) a public Stakeholder Advisory Group, 2) a Scientific Advisory Group, and 3) a Regulatory Advisory Group. Methods and products are vetted through the committees prior to consideration by the Water Board.

The final products will include standardized taxonomic designations, assessment tools, user-friendly data management systems, a state-of-the-art quality assurance program, and—most importantly—objective biological criteria for California streams and rivers.

Applying non-linear (fuzzy) classification rules for grouping streams with similar biological potential in Colorado

Ben Jessup
Tetra Tech, Inc., Center for Ecological Sciences, 73 Main Street, Suite 38, Montpelier, VT 05602, Benjamin.Jessup@TetraTech.com, (802) 229-1059

Abstract
The Colorado Department of Public Health and Environment (CDPHE) monitors streams throughout the state for assessment of water resource quality. The benthic macroinvertebrate assemblage can be associated with known gradients of natural conditions and of human disturbance. Association of biological communities with natural gradients allows classification by expected community characteristics, which should be recognized before trying to find relationships between biology and the disturbance gradient. Site classes were conceptualized by first grouping reference sites with similar taxonomic composition and then identifying distinctive environmental characteristics of the groups. The classification approach differs from the approach commonly used in multimetric index development in that site membership was not distinctly assigned using precise environmental thresholds. Rather, partial membership in each class was determined by combining non-linear, fuzzy classification rules for three variables.

Cluster analysis and ordination of benthic samples suggested five site classes that were biologically and environmentally distinctive. The environmental variables that best predicted site classes were determined using Discriminant Function Analysis, NMS ordination, and examination of distributions of the most meaningful variables in the site clusters. The variables included elevation, average precipitation, and stream slope. The degree of membership of a site for each variable was determined by comparison to the intraquartile and extreme ranges of the environmental variables. If a site's characteristics resembled those of the intraquartile range of the reference cluster for all three variables, the site membership in that class would be 1. Diminishing degrees of membership for each site class were determined based on departure of site characteristics from the intraquartile range.

While this classification approach recognizes partial and hybrid site membership, the multimetric index development process required assignment of sites into distinct classes. Sites were assigned to the class for which the predicted membership was the highest. Index development resulted in two index formulations, because biological metrics were not equally responsive to stress in high elevation and low elevation streams. While the indices performed well in all site classes, the proper technique for applying and interpreting the indices in hybrid sites is still under consideration at the state.

Keywords: Site classification

*Monitoring burrowing mayflies (*Hexagenia *spp.) in nearshore waters of the Laurentian Great Lakes*

Don W. Schloesser
USGS, Great Lakes Science Center, Ann Arbor, Michigan, dschloesser@USGS.gov

Abstract
Mayfly nymphs disappeared from nearshore waters of the Great Lakes in the 1950s because of low oxygen caused by nutrient enrichment, subsequent growth of fertilized plants, and decomposition of plant tissues. Then in 1992, swarms of adult mayflies were observed along shores and in open waters of western Lake Erie. In 1993, the Great Lakes Science Center repeated a benthic survey that had been performed in the 1930s, 1960s, and 1980s and verified the beginning of the recovery of mayflies in Lake Erie. Sporadic surveys between 1995 and 1999 revealed nymphs occurred at high densities found in the 1930s (ca.400/m^2). In the late 1990s, adult mayflies were so abundant on shore they disrupted electrical power generation, created slippery roads and automobile hazards, impacted tourism, and discouraged recreational use of the lake. In 2000, the U S Geological Survey initiated systematic annual monitoring specifically designed to monitor mayfly nymphs in Lake Erie. Surveys reveal a cycle of mayfly abundances that resembles a 'boom-and-bust' pattern of an organism that reproduces until it is limited by some environmental factor which causes a sudden 'crash' in abundance. To date, monitoring has revealed three, four-year cycles of high abundance followed by a sudden decrease in abundance. This has led to a working hypothesis that mayfly populations in western Lake Erie are 'self-regulating' through mayfly respiration of oxygen that contributes to low oxygen concentrations which in turn causes mortality of benthic populations. Recent environmental modeling and laboratory studies have shown that low oxygen impacts young-of-the-year production of mayflies and the presence of mayflies may increase oxygen demand by a factor

of 2.5 and account for up to 70% of the total oxygen demand. These results are important links to confirm the relationship between oxygen use by mayflies and the potential for a density-dependent mechanism limiting mayflies in western Lake Erie. Further testing of the density-dependent hypothesis is needed through laboratory-to-field verification of oxygen models. If the density-dependent hypothesis is proven correct, inclusion of respiration by benthic fauna into widely used eutrophication models could improve understanding of lake restoration efforts in Lake Erie, the Great Lakes, and other water bodies throughout the world.

Air Quality Management Implications of Forest Service Water Quality Data

Don Schweizer, Ricardo Cisneros, Trent Procter
USDA Forest Service Air Quality Program, Porterville, CA, United States

Abstract
The USDA Forest Service Air Program collects and analyzes surface water primarily to inventory aquatic systems sensitive to atmospheric deposition, provide early detection of pollutant deposition, evaluate the effects of deposition, and to understand future risk in wilderness areas. Wilderness areas are important national resources providing relatively unaltered natural landscapes. Although watershed activities in Wilderness are highly constrained, damage to some of the fragile systems is possible through short and long range transport of air pollutants.

The principle objective of this monitoring has been to address the management goal of maintaining or improving aquatic, physical, and biological air quality related values (AQRVs) of Class I Wilderness Areas. This direction is mandated by amendments to the Clean Air Act and interpreted by the US Senate as an "affirmative responsibility" of federal land managers. The monitoring data currently has its highest management value in addressing the Forest Service Class I Clean Air Act responsibility to make permit recommendations on major stationary sources of pollutants. Exactly how and what data is used to accomplish this has been evolving in recent years. In addition further work is needed to leverage the data, analyses, and convey the importance of these fragile ecosystems in State Implementation Plans (SIPs), where a much larger component of state emissions are addressed.

Using long-term ambient water quality data to inform thermal criteria revisions: A case study on the South Platte River, CO

Alice Conovitz[1], Mary Gardner[2], Deborah Rudnick[3], Randi Wexler[4], Les Williams[3]
[1]Integral Consulting Inc., Broomfield, CO, United States; [2]Littleton/Englewood Wastewater Treatment Plant, Englewood, CO, United States; [3]Integral Consulting Inc., Seattle, WA, United States; [4]Integral Consulting Inc., Portland, OR, United States

Abstract
Long-term ambient water quality monitoring data can provide an important framework for setting appropriate and achievable water quality standards. Integral Consulting and the Littleton/Englewood Wastewater Treatment Plant (WWTP) recently received a successful outcome in a rulemaking hearing before the Colorado Water Quality Control Commission to revise the states' proposal for a temperature standard on Segment 14 of the South Platte River. Littleton/Englewood and Integral Consulting requested a site specific temperature standard that accounted for ambient in-stream temperature patterns in this river segment. The Littleton/Englewood WWTP is permitted to discharge up to 50 MGD of secondarily treated wastewater from the cities of Littleton and Englewood to the South Platte River approximately 10 km downstream of the Chatfield Reservoir in the urban Denver corridor. In 2008, South Platte River thermal criteria were targeted for revision as part of the state-wide criteria revision process. We conducted a reasonable potential analysis to evaluate whether in-stream temperatures up- and downstream of the WWTP were likely to exceed proposed criteria. We analyzed multiple long-term (5 to 20 year) high-frequency (5 to 30 minute sample interval) temperature data sets, which required substantial review to ensure consistency and quality of the data. We evaluated empirical data and also conducted statistical analyses to identify predicted exceedances of ambient in-stream temperatures based on the variability inherent in the data set. Our analyses identified the potential for upstream temperature conditions unaffected by the WWTP to exceed proposed criteria. These technical analyses formed the foundation for a successful site-specific temporary modification to State thermal criteria and assisted the WWTP in obtaining criteria that improved opportunity for compliance by accounting for ambient in-stream conditions.

Alternatives for HUC 12 Prioritization during Watershed Management Plan Development: Upper Illinois River Watershed

B.E. Haggard[1], A.N. Sharpley[2], L.B. Massey[1], N. Hardiman[1], K. Teague[3]
[1]Arkansas Water Resources Center, University of Arkansas Division of Agriculture, Fayetteville, AR, United States; [2]Crop, Soil and Environmental Sciences Department, University of Arkansas Division of Agriculture, Fayetteville, AR, United States; [3]Washington County Extension Service, University of Arkansas Division of Agriculture, Fayetteville, AR, United States

Abstract
A critical component of any watershed management plan is the spatial scale at which the watershed will be managed, and this must be based on the ability to detect subtle improvements in watershed quality during often shot-time periods. The ability to detect subtle improvements in water quality over short periods of time that result from the implementation of management strategies at the HUC 8 scale might be limited because of the effects of changing weather, episodic rainfall and upstream sources of pollution that may mask water quality improvement at large scales. The larger watersheds can be subdivided into smaller HUC 12s, and it is at this spatial scale where the ability to monitor water quality change might be greatest. The most common approach to prioritizing smaller watersheds would be the use of a watershed assessment model, e.g. the Soil and Water Assessment Tool (SWAT). However, data at the scale where the larger watershed will be prioritized is often limiting, if available at all. A HUC 12 water sampling program may be designed to provide measured water quality data from each HUC 12 within the larger watershed. Then, the decision must be made how to use the monitoring and modeling output to define the priority ranking for the smaller HUC 12 watersheds.

Surface water samples were collected during base flow conditions at 29 sites within the Illinois River Watershed in northwest Arkansas. These 29 sites represented the HUC 12s within the majority of land area within Arkansas, and this data was combined with data from a volunteer monitoring program. An alternative prioritization scheme that considers the influence of land use on stream water chemistry was selected by the stakeholder group, where HUC 12s were separated into low, medium and high priorities for select water quality constituents. Results from this monitoring program educated stakeholders on land use and water quality, and clearly showed stream sites that have high nutrient concentrations relative to the average conditions at a given land use.

Linking Changes in Management and Riparian Physical Functionality to Water Quality and Aquatic Habitat

Don Kozlowski[1], Sherman Swanson[1], Robert K. Hall[2], Daniel Heggem[3]
[1]Natural Resources and Environmental Science, University of Nevada, Reno, MS186, 1000 Valley Rd., Reno, Nevada 89512; [2]USEPA Region IX, 75 Hawthorne St., San Francisco, CA 94105; [3]USEPA ORD NERL ESD, 944 E. Harmon Ave., Las Vegas, NV 89119

Abstract
Wildlife and aquatic habitat and water quality depend on riparian area management, based upon ecological and economic relationships considered at the proper spatial and temporal scales. These relationships

are functions of riparian and watershed ecosystems: a.) Hydrologic and geomorphic conditions and processes; b.) Growth and reproduction of woody and herbaceous plant communities; c.) Erosion and deposition effects on soils, sediment, water quality, water storage, and recovery rates; d.), the dependency of aquatic and terrestrial wildlife on riparian areas, and e.) Multiple interactions with land uses. Anthropogenically altered riparian conditions often lead to hydrologic alterations such as increased/decreased volume and velocity of runoff, frequency of flood severity, changes in chemical concentrations, increases/decreases in natural runoff storage capacity in vegetation, wetlands and soil, and altered groundwater discharge. These riparian changes dominate water quality management in many watersheds. Riparian proper functioning condition (PFC) assessment is used to interpret changes from a management action/inaction, which result in changes in water quality and aquatic habitat in Maggie Creek, a major tributary to the Humboldt River in north-central Nevada. With a history of agriculture, grazing and mining, previous alterations in riparian function led to opportunities for recovery. Trends in functionality were evaluated via on-the-ground assessments augmented with historic aerial photographic interpretations. Aspects of water quality and biological communities have been monitored over time. Interpretation of PFC for water quality adds layers of understanding that empowers adaptive management for watershed functions and water quality remediation.

North Dakota Discovery Farms: Monitoring Agricultural Runoff in Small Watersheds

Kathleen M. Macek-Rowland[1], William C. Damschen[2]
[1]U.S. Geological Survey (USGS), North Dakota Water Science Center, Bismarck, North Dakota; [2]U.S. Geological Survey (USGS), North Dakota Water Science Center, Bismarck, North Dakota

Abstract
North Dakota Discovery Farms is a cooperative, multi-year, producer-integrated, environmental research project that will determine the economic and environmental impacts of best management agricultural practices when applied to actual farm and ranch settings in small watersheds. North Dakota Discovery Farms is the second project of its kind in the United States and is a cooperative effort between the USGS North Dakota Water Science Center, North Dakota State University Extension Service, North Dakota Agricultural Experiment Station, North Dakota Department of Health, Environmental Protection Agency and participating farms and ranches. The USGS began assisting Discovery Farms in 2008 by collecting, processing, and analyzing water-quantity, water-quality, and meteorological data from edge-of-field and drain-tile sites located on three North Dakota farms. As the project develops, additional farms and ranches representing the diverse North Dakota landscape will be integrated into the project.

In the past, many agricultural regulations and policies across the country have been developed and implemented based on limited information and practical data from real-life farm and ranch settings. Farmers and ranchers often struggle to integrate farm legislation and environmental concerns with practical day-to-day farm operations while maintaining profitable agriculture. The USGS North Dakota Water Science Center will quantify annual and event-by-event runoff volumes and losses of nutrients, sediment, and other selected constituents using meteorological data, soil composition, topography, and geology to help establish the connection between agricultural practices and water quantity and quality in farm and ranch settings in small watersheds. North Dakota Discovery Farms will use the data collected to develop a better understanding of the relations of actual farm practices with the environment in small watersheds, suggest new best management practices (BMPs) if needed, and continue to monitor the effects of the new BMP's on water quality and quantity.

Tools and Approaches for Effective Water Quality Monitoring of BMPs for Stream Systems

Ginger Paige[1], Nancy Mesner[2], Liberty Blain[3]
[1]Department of Renewable Resources, University of Wyoming, Laramie, WY, United States; [2]College of Natural Resources, Utah State University, Logan, UT, United States; [3]Laramie County Conservation District, Cheyenne, WY, United States.

Abstract
Effective water quality monitoring programs require that careful thought and consideration be given to collecting quality data that will meet the specific monitoring objectives. This is especially true if the objectives change from monitoring for "compliance" to monitoring for assessing the effectiveness of a BMP that has been implemented. We will present a guidance document and associated tools and approaches that have been developed to assist water quality monitors in developing "effective" monitoring programs for stream systems. This talk will present an overview of 1)principles developed within the guide based on lessons learned from assessments of monitoring programs and 2) tools and approaches currently being used to develop and or modifying monitoring programs. The guide and approaches are currently being evaluated by USEPA Region 8, Utah, Idaho, and Wyoming Departments of Environmental Quality, NRCS and USGS personnel, and other professionals currently struggling with the implications of poorly designed and implemented monitoring programs. The target audience is federal and state agencies that conduct or use water quality monitoring data as well as anyone actively involved with water quality monitoring programs.

Watershed management and decision making in the Region of the Great Bend of the Wabash River

Sara Peel[1], Ronald Turco[2,3], Linda Prokopky[2], Laura Bowling[2], Indrajeet Chaubey[2], Reuben Goforth[2], Megan Heller[2,3]
[1]Wabash River Enhancement Corporation (WREC), Lafayette IN, United States; [2]Purdue University's Living Laboratory on the Wabash (LLOW), West Lafayette IN, United States; [3]Indiana Water Resources Research Center (IWRRC), West Lafayette IN, United States

Abstract
The Wabash River extends for 764 km, includes five 8-digit Hydrologic units (HUCs), crosses 19 counties and stretches across the state of Indiana on its way to the Mississippi River. However, the Wabash River is underutilized as an economic driver in sustainable development. This is surprising because it includes the longest free-flowing main stem river (661 km) in the eastern U.S., making it potentially a significant natural attraction. Much of the reluctance to use the river results from an ongoing negative perception about the river's water quality. The Wabash River Enhancement Corporation (WREC) and Purdue University's Living Laboratory on the Wabash (LLOW) are working to change this negative perspective.

WREC and LLOW are focused on both the main stem and the tributaries feeding the river. Our current watershed project focuses on the tributaries draining to the Wabash River from immediately downstream of Wildcat Creek to immediately upstream of Big Pine Creek. This 478 square mile region, known as the Region of the Great Bend of the Wabash River, is the subject of a watershed management planning effort. We are in the data collection phase of the project which includes gathering and reviewing of historic information and data; collecting public input and opinions; and implementing a water quality monitoring program on the river itself and on Elliot Ditch, Little Wea Creek and Little Pine Creek with sampling occurring on a weekly basis. Most recently, this region was the target of a major public participation-sampling event known as the Wabash Sampling Blitz. Through the sampling blitz, more than 200 stream sites were sampled by 180 volunteers. Samples were analyzed in both the field and laboratory. Fall 2009 and Spring 2010 sample data will be presented. A preliminary review of data collected via both the targeted weekly professional monitoring program and the regional volunteer monitoring program will assist in targeting implementation

efforts. Additionally, the data collected to date provides some answers to why the Wabash River may soon become the key economic feature of the region.

Use of a Public-Private Partnership to Establish a Regionally Coordinated Water Monitoring Network to Aid in Watershed Decision Making

Roger Wolf[1], Anthony Seeman[1], Todd Sutphin[1], Gordon Brand[2], Chris Jones[2]
[1]Iowa Soybean Association, Ankeny, IA, USA; [2]Des Moines Water Works, Des Moines, IA, USA

Abstract
The Raccoon River (RR) and Des Moines River (DMR) watersheds in central Iowa drain 6.3 million acres dominated by farmland and are also a source of drinking water to almost 500,000 people. Increasing nitrate concentrations since the 1970s forced the Des Moines Water Works (DMWW) to invest in expensive treatment technologies to comply with the USEPA 10 mg/L MCL. In 1999, a synoptic study funded by USEPA and led by DMWW was initiated using trained volunteers to assist in monitoring smaller tributaries in the RR watershed for contaminant contributions. Results showed that: 1. the majority of nitrate was contributed from the North Raccoon main stem, 2. the majority of fecal indicator bacteria were contributed from the South Raccoon, and 3. trained volunteers could be relied on to collect representative samples. DMWW also initiated a meeting with the fertilizer retailers that operate in the watershed to discuss the role of fertilizer management to river water quality. In 2000 those retailers formed Agriculture's Clean Water Alliance (ACWA); a 501(c)(3) with the mission of reducing nutrient loss from farm fields in the RR watershed. ACWA coordinated and funded the continuation of the volunteer water monitoring during each crop growing season using technical and administrative support provided by the Iowa Soybean Association (ISA) Environmental Programs. ACWA also developed a mutually agreed upon code of practice, which provides members practicable guidelines for fall nitrogen sales and application. Members annually reaffirm their commitment to the code of practice, even during uncertain weather and market conditions. In 2008 ACWA expanded to the DMR and also began funding the installation and evaluation of several tile line bioreactors, a practice intended to remove nitrate from tile drainage water. ACWA data has been used by ISA to target subwatersheds for planning and implementation of environmental programs and by Iowa DNR in developing TMDLs for the RR and DMR. ACWA resources have been leveraged with state, local, and private organizations to investigate *E. coli* dynamics, assess emerging contaminates and other acute contaminant episodes in the rivers, and to assist in applying for and to support implementing watershed improvement projects.

Snake River Watershed (Colorado) – An Assessment of Recent Time-Trends in Monitoring Data

Timothy D. Steele[1], Thomas R. Wildeman[2], John D. Stednick[3], Lane Wyatt[4], and William C. Schroeder[5]
[1]President, TDS Consulting Inc., Denver, CO; [2]Professor Emeritus, Department of Chemistry, Colorado School of Mines, Golden, CO; [3]Professor, College of Natural Resources, Colorado State University, Ft. Collins, CO; [4]Director (Water Quality/Quantity Committee), Northwest Colorado Council of Governments, Silverthorne, CO; [5]Aquatic Biologist, U.S. Environmental Protection Agency, Reg. 8 Laboratory, Golden, CO

Abstract
Hydrologic and water-quality monitoring in this 78-mi^2 mountain watershed in central Colorado has consisted of hydrological data from two stream-gages and water-quality sampling surveys, and research conducted by diverse entities. Resultant water-quality data have been collected somewhat intermittently since the 1970s. The watershed has a history of mining activity, exposed tailings piles, near stream iron bogs, and hydrologic modification from up-stream ski area operations. From 2006 through 2009, the U.S. Environmental Protection Agency (USEPA) and Colorado Department of Public Health & Environment (CDPHE) conducted a series of intensive watershed-wide water-quality sampling surveys to help fill data and information gaps inherent in the historical data set. Key areas of interest within these recent surveys were (1) to better characterize the relatively rapid changes in water quality during the springtime snowmelt period and (2) to monitor metals concentrations during baseflows within a multiyear period that has included in recent years below-normal precipitation. Funded by several USEPA and state-administered non-point source grants, a water-quality data assessment, a draft use-attainability analysis (UAA), and a watershed plan all have been completed.

This preliminary data evaluation suggests that increases during wintertime months (November through April) in streamflows (average of +17.7 percent) and dissolved-zinc concentrations (average of +35.0 percent) have occurred at the USGS gaging-station near the downstream terminus of the watershed for the 1994-2009 period of record. These responses may result from more water percolating into the subsurface, possibly in part through mineralized zones and mine-waste materials and picking up trace metals, and then flowing into stream waters. Various statistical and graphic presentations of site-specific data facilitated the data evaluation and associated time-trend analyses. This updated assessment should provide a useful technical basis for further investigation of the potential causes of the observed trends – whether principally controlled by hydrologic conditions (seasonally and year-to-year), adverse effects of the watershed's mineralized zones, anthropogenic (predominately, historical mining) factors, recent beetle-killed forest areas, or some combination thereof. In this manner, future regulatory decisions and remediation work currently envisioned within this watershed can be executed in a more informed, objective, and quantitative manner.

Challenges and Unintended Consequences: Managing Water Quality in the Lower Yakima River, Washington

Daniel Wise
U.S. Geological Survey, Portland, OR, United States

Abstract
The Yakima River in south-central Washington State provides important passage for migrating Pacific salmon and is home to other endangered, threatened, or otherwise sensitive fish species. The lower part of the river flows through an arid landscape containing large areas of irrigated agriculture. In response to high concentrations of DDT and its degradation products measured in Yakima River fish, a TMDL was implemented during the late 1990s that successfully reduced the runoff of sediment-bound DDT from agricultural fields and lowered the concentrations of sediment and DDT in the river. Turbidity in the river decreased as a result of the TMDL, but nutrient concentrations remained high. After an exceptionally low spring snowmelt in 2001, abundant rooted aquatic plant growth was observed in the river. This abundant growth was also observed during subsequent years, even after periods of average spring runoff.

Assessments were conducted between 2005 and 2007 to determine how the plant growth and adverse secondary impacts (low dissolved oxygen concentrations and high pH levels, both of which stress fish) were related to seasonal and annual variations in hydrologic conditions. Much higher streamflow and turbidity were measured during the spring snowmelt periods of 2006 and 2007 compared to 2005 and, as a result, the biomass of rooted aquatic plants was much less at the end of the growing seasons in those years compared to 2005. Although dissolved oxygen and pH conditions improved in 2006 and 2007 in response to lower plant productivity and dilution from higher streamflow, the Washington State standards for these parameters were exceeded consistently throughout the summer in all three years. Reducing the adverse impacts from rooted aquatic plants will be a challenge because the plants are now firmly established in the river bed, which is very stable and would probably not be disturbed except by extremely large streamflow events. In addition, reducing nutrient loads to the river will

not reduce plant growth substantially because the plants can obtain nutrients from the nutrient-enriched bed sediment as well as from the river water.

Environmental Challenges and Sustainable Solutions for Protecting Water Resources: Integrating Education, Research, and Community Partnerships

Eileen Zerba
Princeton University, Princeton Environmental Institute, Washington Road, Princeton, NJ 08544

Abstract
Success of integrating sustainable practices into curricula requires communication, collaboration, and coordination of education, research, university staff, and community partnerships. A top priority of Princeton University is to reduce its "carbon footprint" with strategies that will reduce carbon dioxide emissions to 1990 levels by 2020 as part of a comprehensive Sustainability Master Plan. Goals in areas of greenhouse gas emissions reduction and resource conservation include increased sensitivity to the surrounding community and natural environment. Emphasis is being placed on sustainable building design, expanded landscaping and reforestation, increased conservation and recycling and better water management. This presentation highlights using the campus as a "Living Laboratory" to address the effectiveness of sustainable practices and commitment of the University to reduce its impact on the environment. The program emphasizes environmental challenges and sustainable solutions for protecting water resources with the goal of improving water quality and ecological balance across the University and within the local watershed. Notably, the campus is situated on a hillside with a lake valley on its southern edge, which acts as a natural drainage basin. Forest, ravines, wetlands and streams surrounding the lake have been fragmented by development, fields, parking, roadways and utilities. Chemical and physical characteristics of the surface water collected by the watershed and ground water, which flows into the lake, is influenced by land use change, stream flow dynamics and flow through buffer zones. Environmental studies courses and an undergraduate research program are tracking the impact of land use and sustainable practices of the Campus Sustainability Master Plan on water quality and capacity of the regional watershed. Two central questions provide the framework for this program: First, how will land use changes, driven by the Campus Sustainability Master plans, impact the health of lake and the regional watershed? Second, how might this information influence the University's implementation of sustainable practices and environmental policies? Examples are presented for long-term monitoring programs and baseline data that track the impact of two major sustainable practices: 1) a stream restoration, including channel modification and enhancement of forest and wetlands, and 2) storm water run-off and energy balance of green roofs.

Ongoing Efforts of a Public Engineering and Construction Management Agency to Address the Requirements of the NPDES Permit for Construction Stormwater Discharges

John J. Baum, John R. Esparza
U.S. Army Corps of Engineers Sacramento District, Environmental Chemistry Section

Abstract
On December 2009 the U.S. Environmental Protection Agency (USEPA) published changes to the regulatory requirements administered under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). Effective February 1, 2010 the regulation incorporates new effluent limitation guidelines (ELGs) and source performance standards (NSPS). Similarly the State of California is scheduled to implement a new CGP in July 2010 that has more stringent management and monitoring requirements than that proposed by the USEPA. The U.S. Army Corps of Engineers (USACE) Sacramento District is responsible for designing, constructing, and managing projects that touch nine western states. Being the world's largest public engineering, design, and construction management agency, the USACE will take the lead in compliance with and implementation of regulatory requirements on projects.

Adequately addressing the CGP requirements on our projects has been a continuous struggle. The Sacramento District manages several construction activities along the American and Sacramento River watersheds. Two of our project sites (The Folsom Dam Raise/Modification Projects and The Mayhew Levee Construction Project) have received Notice of Violations (NOVs) due to site stabilization issues and the poor quality of storm water discharges. Addressing problems has required a new level of communication and coordination between construction managers, contractors, land owners, and regulatory agencies. Additionally the USACE Sacramento District continues to manage construction activities along water bodies listed as impaired for sedimentation, turbidity, and/or siltation under section 303d of the Clean Water Act. Work performed in support of the Napa Flood Protection project must incorporate additional management requirements due to the impaired status of the Napa River.

The proposed CGP changes will significantly impact how USACE projects are designed, constructed, and managed. Our agency is developing new procedures to allow for a smooth transition to the new CGP requirements. We will be using the relationships that have been cultured and knowledge we have gained to assist in the new CGP implementation. Based on the draft versions of the CGP's that have been provided for review, USACE projects will require a new level of stormwater detail and an increase in oversight by staff trained in applicable treatment and management technologies.

Addressing Invasive Mussel Concerns at 9 Reservoirs in Northern California

John J. Baum
U.S. Army Corps of Engineers Sacramento District, Environmental Chemistry Section

Abstract
In response to the recent discovery of invasive quagga mussels (*Dreissena rostriformis bugensis*) and zebra mussels (*Dreissena polymorpha*) at regional facilities, the U.S. Army Corps of Engineers (USACE) Sacramento District has initiated management plans for 9 reservoirs in Northern California. Development of the management plans has been a cooperative process between our field offices located the reservoirs, District technical staff, and external State and Federal technical resources. The management plans will include: monitoring for both adult and juvenile phase mussels, the baseline evaluation of current bivalve populations (and other potentially impacted biota), habitat quality determination, boat inspection requirements, and response plans in the event of infestation discovery.

A risk assessment was performed last year for each reservoir using pre-existing data. The assessment included evaluating the historical water quality data, number of reservoir visitors, and proximity to known areas of infestation. Results of the assessment were incorporated into an initial guidance document that laid the groundwork for the management plans.

Biological, water quality, and infrastructure baseline studies are in development to confirm the absence of invasive mussels and understand pre-infestation conditions. These studies include testing for juvenile invasive mussels by polymerase chain reaction (PCR) analysis and the detailed classification of current bivalve, zooplankton, and phytoplankton populations in the reservoirs. Continuous water quality data will be collected using solar powered water quality sensors as part of a habitat study at each of the reservoirs. A long-term boat inspection program in development requires minimal staffing due to limited resources. Boat inspections will include mandatory surveys for all boaters, a self inspection procedure, and spot check inspections by park staff and volunteers. Representatives at the State of California Department of

Fish and Game have volunteered to visit the reservoirs to train staff and concerned citizens. Additionally informational signs and radio transmitters have been purchased for each facility.

The management plans currently under development will provide a direction for future activities at each facility. They will provide guidance for staff protecting our reservoirs, detail a long term monitoring program, and provide direction in the event of an infestation.

Estimating Trophic Status for Michigan Inland Lakes by Relating Field Measurements to Satellite Imagery

Lori Fuller[1], Russ Minnerick[2], Rick Jodoin[1]
[1]U.S. Geological Survey, Michigan Water Science Center, 6520 Mercantile Way Suite 5, Lansing, MI 48911; [2]U.S. Geological Survey, Michigan Water Science Center, 1955 Harwick Pines Rd, P.O. Box 485, Grayling, MI 49738

Abstract
Inland lakes are an important economic and environmental resource for Michigan. The U.S. Geological Survey and the Michigan Department of Natural Resources and Environment cooperatively monitor the quality of selected lakes in Michigan through the Lake Water Quality Assessment program. Through this effort, approximately 730 inland lakes will be sampled to categorize water quality. The Cooperative Lakes Monitoring Program supported by the Michigan Department of Natural Resources and Environment and the Michigan Lake and Stream Associations Inc., Michigan's volunteer water-quality monitoring network, also monitors approximately 250 lakes each year. However, these selected lakes represent a small portion of over 11,000 inland lakes in Michigan. We developed a method to estimate water clarity for unsampled inland lakes using remotely sensed imagery. The method, using a regression, estimates lake trophic status based upon the relation between field measurements and satellite imagery. Results are available through an interactive mapping site at: http://mi.water.usgs.gov/splan1/sp00301/remotesensing.php

Long-term Monitoring with Sediment Cores

Paul Garrison
Wisconsin Department of Natural Resources, Bureau of Science Services, Madison, WI

Abstract
It is often true that long-term data is not available to monitor changes in a lake's water quality. When data is available, it has often only been for a few years at best. Lakes have been subjected to numerous perturbations, especially for the last 50-100 years. Managers are often presented with the problem of determining how a lake has changed under various disturbances and other watershed activities. An excellent means of filling this knowledge gap is through the science of paleolimnology. This science uses information deposited in the sediments of a waterbody, e.g. lake. After a core is extracted, much information can be learned. Since the period of interest is often the last century, a time line is frequently determined using the naturally occurring radionuclide lead-210. The impact of watershed activities can be determined through geochemical analysis of the sediments. In the last few decades, great strides have been made using biological fossils to quantitatively reconstruct water quality changes. The algal group, diatoms, is frequently used for this purpose.

This talk will use the results from a sediment core taken from Lake Ripley, WI to demonstrate the usefulness of paleolimnology for long-term monitoring. The core shows that early agricultural activities resulted in increased soil erosion and thus increased sediment deposition in the lake. Intensified agriculture in the watershed resulted in increased phosphorus levels in the lake with peak concentrations occurring during the period 1940-90. Starting in the 1990s, the lake and its watershed were part of a State program to reduce nutrients and sediment input to the lake. The sediment core showed that this program was very successful with both sediment deposition and inlake phosphorus levels being reduced. Phosphorus levels were reduced by nearly 10 $\mu g\ L^{-1}$ to 17-18 $\mu g\ L^{-1}$.

Tracking the Impact of Land Use and Sustainable Practices on Lake Water Quality

Raymond Brusca[1], Robert Hackett[2], and Meagan Prier[1]
[1]Princeton University, Washington Road, Princeton, NJ 08544; [2]Elon University, Elon, NC 27244

Abstract
Princeton University approved Campus and Sustainability Master plans in 2007 to promote conservation, research, education, and service with the final goal of decreasing the University's carbon emissions and other waste. Lake Carnegie acts as a natural drainage basin for the campus and is an important indicator for the environmental influences of large scale campus changes. Environmental studies courses and an undergraduate research program are tracking the impact of land use and sustainable practices of the Princeton Campus Sustainability Master Plan on water quality and capacity of the regional watershed. The principle strategy of the environmental monitoring program is to gather baseline data prior to the initiation of major innovations for sustainable practices for protecting water resources. This presentation will highlight the initiation of a long-term monitoring program for the lake and its stream input sites, including baseline data prior to initiation of a major stream restoration project. Physical, chemical and biological parameters of the lake and stream are being characterized to assess the trophic dynamics and current ecological health. Drainage sites into the lake from campus and surrounding areas indicate possible nutrient and coliform pollution which significantly impact lake health. Initial data indicate a meso-eutrophic classification. We predict that locations in which buffer zones and green roofs will be put in place will result in water quality improvements and reductions in the quantity and rate of runoff into Lake Carnegie and thus positively impact the lake and regional watershed.

Lake Success: Water Quality Monitoring at a Dam Remediation Site

Heather Jackson, Suzette Ramirez, John J. Baum
U.S. Army Corps of Engineers Sacramento District, Environmental Engineering Branch

Abstract
Lake Success, located in Porterville, California, is owned and operated by the U.S. Army Corps of Engineers (USACE). California has a warm Mediterranean climate with wet winters and dry summers, so water is a valuable resource. Success Dam is used primarily for flood control, but also captures and stores water in winter to use in summer for irrigation and recreation purposes.

Seismic deficiencies were discovered in the dam and remediation is planned to occur. Remediation activities at the reservoir and a lowered pool elevation are expected to impact water quality (WQ), so USACE implemented monitoring to minimize negative effects. Monitoring is ongoing before construction to determine baseline conditions for comparison during construction. The monitoring program includes use of electronic probes, field instruments, and collection of wet samples for contracted laboratory analysis. Continuous WQ data is collected using a sonde placed near the surface by the dam which captures readings every hour. The data (water temperature, turbidity, dissolved oxygen, nitrate, pH) is then downloaded and sonde recalibrated every 2-3 weeks.

Data is then stored in a database and analyzed for trends. Data has been collected since 2008 allowing for evaluation through all seasons. Each WQ parameter was examined individually to determine how it was affected by time of day and season. Then parameters were analyzed together to observe interactions. Also, data was compared to Tulare Basin Plan WQ requirements to check that parameters meet local objectives. Significant observations have included clear daily cycles and

seasonal changes of all WQ parameters, a difference in WQ at a low pool elevation, and pre-existing conditions that appear to be in violation of Basin Plan goals. Data analysis is also used to investigate historical problems such as fish kills, hazardous algal blooms, and low dissolved oxygen.

The monitoring program has been successful thus far by determining baseline conditions at the lake. Due to reduced funding, continuous monitoring before remediation will terminate until further notice, but should resume during any construction. Continuous monitoring at Lake Success will be important to help meet regulations, protect aquatic species, and ensure construction activities do not exacerbate historical problems.

Use of Long-Term Monitoring Networks to Evaluate the Effects of Deposition and Climate on Remote Lakes in the Rocky Mountains

M. Alisa Mast[1] and Jeff Sorkin[2]
[1]U.S. Geological Survey, Colorado Water Sciene Center, Denver, Colorado; [2]United States Forest Service, Region 2 Regional Air Program, Denver, Colorado

Abstract
High mountain environments are sensitive indicators of change in atmospheric pollution and climate yet have received less monitoring efforts than other ecosystems in the U.S. Here we bring together over 2 decades of data from several monitoring networks in the Rocky Mountain region including a Forest Service lake monitoring program, a USGS snowpack monitoring network, the National Atmospheric Deposition Program, and the National Resources Conservation Service SNOTEL network. Trends in precipitation chemistry and hydrologic and climatic data were examined as drivers of changing lake chemistry in several Class I wilderness areas. During 1987-2008, sulfate and acidity in precipitation decreased by nearly 40% reflecting regional reductions in SO_2 emissions perhaps related to the Clean Air Act Ammendments of 1990. In some of the wilderness areas, lake-water sulfate concentrations also declined over the same period of record. Sulfur isotopic data indicate lake-water sulfate primarily is derived from atmospheric inputs, supporting the hypothesis that decreases in atmospheric deposition are driving the chemical response in these lakes.

In contrast to reductions in deposition, some study lakes showed sharp increases in sulfate concentrations. Analysis of long-term climate records indicates that annual air temperatures have increased between 0.43 to 0.93 °C per decade over mountainous areas of the region suggesting climate may be a factor. Isotopic data reveal that sulfate in these lakes is largely derived from pyrite, which may indicate warming is preferentially affecting the rate of pyrite weathering. Because pyrite is often associated with other base-metal sulfides and its breakdown generates acidity, climate warming could result in increased acidity and trace metal concentrations in surface water to levels where impacts on aquatic life may become evident.

Historical Data Evaluation and Supplemental Water Quality Monitoring at Lake Isabella in Preparation for Dam Remediation

Alison Plant, John J. Baum, Suzette Ramirez
US Army Corps of Engineers, Environmental Engineering Branch, Sacramento, CA.

Abstract
Lake Isabella is a reservoir made of up two earthen dams on the Kern River about 45 miles northeast of Bakersfield, California. The dams are operated and maintained by the US Army Corps of Engineers (USACE). The dams were constructed to prevent downstream flooding and provide water storage, but were recently found to have major seepage and seismic instability issues. The dams have been classified as a Dam Safety Action Class Level I: urgent and compelling. A plan to modify the dams has been initiated and water quality data is being collected to establish the water quality baseline prior to remediation activities.

Lakes similar in depth and location to Lake Isabella have noticeable layers, such as the epilimnion, thermocline and hypolimnion. However, Lake Isabella's historical data indicates a well-mixed water column and that does not display these typical layers. Historical blue-green algal blooms maybe related to the lake's lack of stratification. Possible reasons for this condition are to be analyzed with the help of continued data collection and evaluation.

A field team from USACE Sacramento District visits the reservoir every 3 weeks to monitor a wide range of parameters with a multi-sensor sonde. Water data is collected at the Kern River's north and south fork inlets, and at both outlets, just downstream of the dams. Profiles are also taken upstream of both dams at 1-meter intervals to examine the reservoir's strata. The collected data includes water temperature, pH, specific conductivity, dissolved oxygen, nitrate, and turbidity.

An extensive monitoring program is being implemented at the lake. USACE will be installing buoys upstream of both dams which will house multi-sensor sondes to collect readings at regular intervals (about every 1-hour). The buoys will be solar powered and have telemetry capabilities to allow real-time data accessibility. Monitoring locations have been selected to enhance the existing monitoring program.

Future goals of this project include implementation of the expanded monitoring program to further define baseline conditions and assist in the development of mitigation plans for construction activities. The data collected will further clarify the existing water quality issues and seasonal water changes in the lake.

Long-Term Reservoir Monitoring Using Volunteer Field Scientists

Anthony P. Thorpe, Daniel V. Obrecht, John R. Jones
302 A.B. Natural Resources Bldg, University of Missouri Columbia, MO USA

Abstract
The Lakes of Missouri Volunteer Program (LMVP) uses volunteers to collect and process water samples that are later analyzed at the University of Missouri's limnology laboratory. Among the parameters monitored is Inorganic Suspended Solids (ISS) which serves as an estimate of the concentration of sediments suspended within the water column. Given budget constraints, utilizing volunteers as field scientists is not only cost effective, but it allows more samples to be collected and more sites to be monitored than if only paid employees were used. Since 1992, LMVP volunteers have collected and processed nearly 4000 ISS samples on 186 sites at 93 lakes. The LMVP's high-quality database is commonly used by agencies for its nutrient, chlorophyll and water clarity data, but the ISS data remains largely untapped. Of particular value is the potential for higher resolution spatial and temporal examinations than is typical of broad-scale research data.

An Overview of Monitoring, Assessment and Regulations of the Wetlands on Navajo Nation

Krishna Baskota
Navajo Nation, Window Rock, AZ, United States

Abstract
The Navajo Nation, the largest Indian reservation in the United States covers 27,000 square miles of land and population of over 172,000 in Arizona, New Mexico, and Utah. Despite being mostly desert, the presence of two major rivers, the San Juan and Little Colorado, as well as numerous arroyos, washes, and mountain streams have created unique wetlands. Some of the wetlands are in the proximity of famous historic sites, tourism places such as Canyon De Chelly National Monument, Hubbell Trading Post National Historic Site, Monument Valley Navajo Tribal Park and Wupatki National and Crater National

Monuments. These wetlands are habitat for large diversity of wildlife including several Threatened and Endangered species. Wetlands are the most productive ecosystems in the world comparable to rain forests and coral reefs. Wetlands functions provide economic and environmental benefits to the society. Wetlands on Navajo Nation are also culturally and spiritually important as they supply unique herbs and medicinal plants for the local people. Many wetlands in Navajo Nation are isolated, widely scattered and gradually disappearing. It is therefore an urgent necessity to protect the wetlands on the Navajo Nation.

Monitoring, Assessment and Classification of major wetlands on Navajo Nation has been done using Navajo Nation Rapid Assessment Method in the line of Ohio Rapid assessment. Wetland protection regulation is being drafted and is on the way of completion. EPA approved Navajo Nation water quality standards are being amended to incorporate wetland specific water quality standard. Wetland mapping is now completed and has been digitized as per National Wetland Inventory (NWI) Maps. Unregulated grazing was impacting the health of the wetlands and the habitats but with the development of the land user's manual this problem has reduced. The ultimate goals of all these activities will be conserving, enhancing, and restoring the quantity, quality and biological diversity of all wetlands on Navajo Nation with net-gain/no net loss policy and a sustainable wetland protection program.

Coral Disease, Environmental Drivers, and Coral-Microbial Interactions

Hunt L.R., Downum, K, and Mydlarz, L.M.
Department of Biology, University of Texas at Arlington

Abstract
Various Caribbean corals have declined due to a number of factors related to poor water quality, including coastal degradation, climate change, pollution, and emerging diseases. Potential sources of coral disease include invasive microbes that thrive under conditions of increased coral stress. In this study we investigated whether Caribbean corals have mechanisms, such as quorum sensing and antimicrobial activity, for controlling microbe populations. We surveyed dominant Caribbean gorgonians for the presence of quorum sensing (QS) activity and antimicrobial activity against a suite of bacteria strains, including ecologically relevant marine pathogens. Ethanol extracts of gorgonians collected from Puerto Rico and the Florida Keys (*Briareum sp*, *Eunicea laciniata*, *Eunicea tourneforti*, *Eunicea mammosa*, *Gorgonia ventalina*, *Plexaura flexuosa*, *Plexaura homomalla*, *Plexaurella sp*, *Muriceopsis flavida*, *Pseudoplexaura porosa*, *Pseudopterogorgia americana*, and *Pseudopterogorgia acerosa*) showed a range of activities. Quorum sensing activity was detected using two different QS reporters; a short chain AHL biosensor, *Chromobacterium violaceium*, and a specific *Pseudomonas aeruginosa* QS reporter, sensitive to long chain AHLs. For QS activity, the gorgonians, *P. americana*, *P. acerosa*, and *P. flexuosa* had the highest inhibitory effect on long-chain AHL production, with a 34, 25, and 22% reduction in signal, respectively. The corals *P. americana*, *P. acerosa*, and *P. porosa* inhibited short-chain AHL production as measured by a 50% inhibition of violacein pigment production in *C. violaceium*. *P. porosa* extracts stimulated QS activity in *P. aeruginosa* with a striking 17-fold increase in fluorescent signal over background. None of the corals induced violacein production in *C. violaceium*. For antimicrobial activity, Caribbean gorgonians lack broad spectrum activity and are significantly less active against marine bacteria when compared to non-marine strains. Interestingly, very little inhibitory activity was observed against the coral pathogen *S. marcescens* PDL100 (activity score = 7.02), which may indicate that antimicrobial activity is not a crucial factor in the evolution of secondary metabolites in Caribbean gorgonians. Overall, this study provides tangible evidence for antibacterial and quorum sensing activity in Caribbean gorgonians, which may open new directions for coral microbiology. Future studies will reveal a better understanding of microbial regulation and provide valuable insight into coral-pathogen interactions.

Southeastern Wetlands Workgroup (for U.S. EPA Office of Water and Region 4)

Kimberly Matthews and Robert Truesdale
RTI International, 3040 Cornwallis Road, Research Triangle Park, NC 27709, www.rti.org

Abstract
Under a cooperative agreement with the U.S. Environmental Protection Agency (EPA), RTI International (RTI) has partnered with EPA Region 4 states (i.e., Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee) to create the Southeastern Wetlands Workgroup (SEWWG). SEWWG provides technical assistance that reinforces and enhances each state's capacity to build and improve its wetland monitoring and assessment programs, with a particular emphasis on preparing for the 2011 National Wetland Condition Assessment. The primary objectives are to (1) provide participating states with technical training on wetland monitoring and assessment, (2) facilitate communication among state wetland regulators and scientists, and (3) encourage sharing of data, techniques, and methodologies that enhance monitoring and assessment programs across Region 4. SEWWG provides a forum for participating states to collaborate on regional wetland monitoring and assessment goals. The initial technical focus is on rapid wetland assessment methods; methods for collecting wetland assessment data for parameters such as vegetation, soils, hydrology, and water chemistry; wetlands program funding options; and statistically-based monitoring and data analysis. Technical assistance is provided through web-based training (webinars), field training visits to participating states, and telephone assistance. The cornerstone of this group is a website (http://sewwg.rti.org/) where features such as discussion forums, training opportunities, calendar, links to other resources, and data sharing enable information to be easily disseminated. In this pilot project, SEWWG is cultivating regional expertise in wetlands assessment by sharing project participants' expertise across the region. As the 2011 date approaches, SEWWG plans to support the national assessment in Region 4 and expand to address regulatory, restoration, and mitigation interests.

Monitoring Ecological functions in Bung Khong Long Non-Hunting Area, Ramsar Site, Thailand

Kamalaporn Kanongdate and Gerhard Wiegleb
Brandenburg University of Technology, Germany, Chair of General Ecology, Faculty of Environmental and Resources Management

Abstract
Bung Khong Long Non-Hunting Area is the second Ramsar site in Thailand. It is a freshwater ecosystem which backs up the drainage of several streams, especially Songkram River, before discharging into Mekong River. In 1982, it became a wildlife non-hunting area by the proclamation of the Royal Forest Department; thereafter it was designated as an Important International Wetland of the Ramsar Convention, 2001. At least 67 species of birds, six species of amphibians, ten species of reptiles, and 90 species of fish were found in this area. Only three groups of vegetation types (shallow water, open water, and overlaying dense and floating communities) were reported. Conservation monitoring in Ramsar Sites always focuses on water quality and quantity. Thus, influences, which may affect ecosystem functions, especially, the food web is often overlooked. Besides other factors, the population of the migratory bird, e.g. Purple Heron (*Ardea purpurea*) recently downgraded from endangered to vulnerable in the lake area might be influenced by changes in food availability.

The study of biodiversity of fishes in Bung Khong Long Lake forms part of ecological function monitoring in wetland ecosystem. It focuses on pelagic fish which serves as one of the food sources of water birds (Purple Herons). Fishes species sampling were at six stations (To avoid pseudo replication) in April and October 2009, which is the latest and earliest of bird migratory season, respectively. Fish net bags were drawn along 100-200 m at 30-50 cm depth. Fishes were found 20 species together in April and October (14 species in April, 15 species in

October). *Trichopsis vittata* was the dominant species in both periods, but the number in October was higher than in April. Two Purple Heron were found in April and six were found in October. The decrease in number of *Trichopsis vittata* and other fish species suggests that fish population might influences Purple Heron population and other water birds. However, other factors beside species and number of fish which might influence the population of Purple Heron such as fishery, fish introduced, and reed beds management need to be addressed in further study.

Keywords: Ecological function, Biodiversity, Wetland monitoring, Ramsar, Thailand

Monitoring the effectiveness of Ramsar Convention on wetland Ramsar sites: Case study Ramsar Sites Thailand

Kamalaporn Kanongdate and Gerhard Wiegleb
Brandenburg University of Technology, Germany, Chair of General Ecology, Faculty of Environmental and Resources Management

Abstract
The effort to conserve wetland ecosystem were tired by the Ramsar Convention, which was developed for the conservation of wetlands of international importance in particular, waterfowl habitat. It was adopted on February 2, 1971. Thailand became the Convention's 110th Contracting Party in 1998. At the present there are 158 members. Although Ramsar Convention is a tool to encourage wetland conservation, the primary intention is often distorted by researchers soliciting funds for study. After a wetland has been proclaimed a Ramsar site, monitoring and implementation on sustainable conservation usually tend to decrease over time, making the effectiveness of Ramsar Convention difficult to measure. Thus, to ensure that Ramsar sites are conserved sustainably, quantitative and qualitative indexes of conservation effectiveness should be developed. The number of Ramsar sites is a quantitative aspect whereas the monitoring and implementation after a wetland have been designated a Ramsar site are a qualitative aspect. Scores ranging from 1 to 3 will be assigned in each Ramsar site (1 = Fulfills Ramsar criteria, 2=Deteriorated, 3=Out of Ramsar criteria). 0-50% of wetland in criteria 3 implies ineffectiveness of Ramsar Convention, 51-80% in criteria 2 implies Ramsar Convention is effective which comprehensive management, and 81-100% in criteria 1 suggests Ramsar Convention is fully effective.

Within 12 years (1998-2010) there are 11 Ramsar sites, representing 18% of total wetlands of international importance in Thailand (61 sites) and 0.21% of total wetland areas. The information and data base on each Ramsar site could be made for the effective management and addressing the problem confronting Ramsar sites especially rapid urbanization. Therefore, the outcome of this study would assist in assessing the extent to which the Ramsar Convention is effective in conserving wetlands in Thailand. Even though most of Ramsar sites are deteriorating, attempt to reverse the trend is ongoing.

Keywords: Ramsar Convention, Monitoring, Effectiveness, Thailand

A Coupled Empirical Model for Understanding Groundwater Contributions to Temporal Trends in Stream Chemistry on the Basis of Routine Monitoring Data

Scott W. Ator and Joel D. Blomquist
U.S. Geological Survey, Baltimore, Maryland, United States

Abstract
Numerous statistical methods have been developed for detecting and quantifying temporal trends in stream chemistry on the basis of long-term monitoring data. Relating observed trends to changing land-use, chemical applications, watershed management, or other potential causal factors, however, is often complicated by the multitude of sources of water and chemical contaminants to many streams and widely variable associated travel times. Effective adaptive management of watersheds requires an understanding of the multiple vectors contributing contaminants to surface waters. A coupled binary-mixing and multiple-regression model was developed to estimate temporal trends in nitrate concentrations in major sources of water to the Choptank River, Maryland over recent decades (1964 through 2008) on the basis of routine nitrate observations and continuous stream-flow data. Like most other streams in the Chesapeake Bay Watershed, the Choptank River receives a majority of its flow from groundwater discharge. Increasing nitrate concentrations in the river since 1964 are attributable to increasing nitrate in both groundwater-discharge and overland-runoff sources of water, but the estimated rate of increase of nitrate in groundwater discharge was several times greater than that of overland runoff. These results demonstrate the importance of addressing groundwater transport and associated multi-decadal travel times to nitrate management in the Choptank Watershed. The coupled modeling approach should be useful for similarly understanding temporal trends in other watersheds for which routine monitoring and continuous stream-flow data are available.

Problems and Solutions Using Real-Time Geochemical Property Monitoring to Identify Sources of Groundwater under the Influence of Surface Water

Christopher L. Braun[1] and Gregg S. Tatum[2]
[1]United States Geological Survey, Water Resources Division, Austin, TX, United States; [2]Texas Commission on Environmental Quality, Austin, TX, United States

Abstract
Sources of groundwater that are under the influence of surface water are particularly susceptible to contamination. The influence of surface water inflow on groundwater might be brief in duration and is most likely to occur in aquifers with high permeabilities or shallow depths to water. Indicators of surface-water influence on groundwater include specific conductance, temperature, turbidity, or presence of microscopic particulates characteristic of surface water. Random sampling of wells for indicators of surface water is unlikely to result in the identification of groundwater affected by surface water, especially at locations where surface water influence is sporadic. This study demonstrates that real-time monitoring of properties can be used in conjunction with analyses for microscopic particulates characteristic of surface water to evaluate connection to surface water. Temperature, pH, specific conductance, and turbidity were continuously monitored at nine public water-supply wells in 2009 using multi-parameter water-quality sondes to measure geochemical variation in response to surface-water inflow. Data were used to determine the timing of sample collection for microscopic particulate analysis (MPA) and when sample collection was unnecessary. In some cases, geochemical property monitoring data provided sufficient evidence to declare a site under the influence without supporting evidence that might be provided by MPA results. Numerous challenges are associated with the use of geochemical property monitoring and the collection of samples for MPA. Considering the brevity of some episodes of surface-water influence, it is likely that some events will not be apparent in the record of geochemical conditions. To date (July 2009), a solution has not been devised to circumvent this issue, but fortunately, solutions to other problems associated with sources of groundwater potentially under the influence of surface water have recently been developed. For example, the majority of sites monitored do not have backflow-prevention mechanisms; to alleviate this problem, adjustable-pressure check-valves were installed to prohibit flow at low pressures associated with backflow. Another issue for MPA sample collection is the difficulty in satisfying the 500-gallon minimum filtrate volume requirement established by the Environmental Protection Agency. This can be addressed by use of a 500-gallon holding tank when the well is active.

Use of Spring Data in a Ground-water Level Monitoring Network: Surveillance and Trend Monitoring in the Evaluation of a Long-term Period of Below Normal Rainfall

Rick Copeland
Florida Geological Survey, Tallahassee, FL, United States

Abstract
The Subcommittee on Ground Water (SOGW) of the Advisory Committee on Water Information is submitting a framework proposal to the U.S. Congress to establish a long-term ground-water monitoring network. The purpose of the network will be to provide data and information necessary to assist in sustaining the nation's ground-water resources.

Independent of the development of the conceptual framework for the national network, Florida has been operating a statewide ground-water monitoring network for approximately two decades. Florida has addressed several analogous concepts presented by the SOGW. For example, during its lifetime, the operation of the Florida network has been carried out by multiple groups and agencies working together in a cooperative manner. In addition, the network has addressed local, regional and statewide issues, each with its own set of unique hydrogeological environments.

Recently, Florida used its network to evaluate the impacts of a below normal rainfall period almost a decade. In Florida, with its karst terrain, the evaluation of spring data proved to be more effective in evaluating the effects of the dry period than did the monitoring of wells. Florida's experience can be used as an example as to how to incorporate multi-agency spring and well data in surveillance and trend monitoring at a variety of scales.

Distribution and characteristics of springs and wetlands in headwater basins of the Fraser Experimental Forest, Colorado

Kathleen A. Dwire[1], Charles C. Rhoades[1], Roberto Bazan[1], Monique LaPerriere[2], Ryan Sincavage[3,4], Emily Reinsel[3], Kelly Elder[1]
[1]USDA Forest Service, Rocky Mountain Research Station and Fraser Experimental Forest, Fort Collins, CO, United States; [2]USDA Forest Service Ecosystem Management Coordination, Fort Collins, CO, United States; [3]GeoCorps America Program, Geological Society of America, Boulder, CO, United States; [4]University of Colorado, Denver, CO, United States

Abstract
Groundwater discharge from seeps and springs provide a major source of water for many Rocky Mountain streams and wetlands. At the Fraser Experimental Forest (FEF), north central Colorado, we initiated a comprehensive inventory of springs and wetlands to (1) examine their distribution in relation to slope, aspect, elevation, duration of snowpack, and geology; and (2) characterize spring water solute chemistry and hydrologic connectivity within high-elevation catchments. Preliminary results (2740 – 3535 m asl) indicate that the number of springs is highest in basins with late-season snow cornices on east and northeast-facing slopes. Multiple springs were commonly found along fault zones, near bases of over-steepened valley walls and lateral moraines, and near stream channels. Approximately 30% of the springs support slope wetlands, most of which are small peatlands and located either in alpine or subalpine riparian settings; all wetlands provide direct linkages from springs to streams. Spring water pH and conductivity average 7.3 and 73 μS cm-1, respectively. Calcium is the dominant cation and bicarbonate-derived ANC and sulfate are the dominant anions. Average calcium and magnesium concentrations vary 3 and 6-fold among individual first-order watersheds with the highest levels found in the largest basin with the greatest extent of exposed rock. In general, the extent of alpine cover within a basin relates closely to spring nitrate concentration; for six study watersheds, alpine cover explained 84% of the variability in spring water nitrate concentration.

This survey compliments previous research at FEF that demonstrates the dominant influence of physical watershed characteristics and complex lithology and faulting on the chemical composition of high-elevation surface water. Future sampling will include basins in adjacent wilderness areas to expand the range of physical and geologic conditions surveyed. Collectively, results will increase understanding of the role of springs and wetlands in the maintenance of water quality and quantity and provide a baseline for assessing the effects of climate change.

Innovative Surface and Groundwater Monitoring and Assessment of Energy Development in the Northern Piceance Basin

Bob Lange[1], Edward Rumbold[2], Pete McMahon[3], Ronald Johnson[4], Judith Thomas[5], Joseph Sullivan[5], and Harry H. Posey[6]
[1]Bureau of Land Management (BLM) – White River Field Office, Meeker, CO; [2]BLM – Colorado State Office, Lakewood, CO; [3]United States Geological Survey (USGS) Colorado Water Science Center, Lakewood, CO; [4]USGS Energy Resource Program, Lakewood, CO; [5]USGS Colorado Water Science Center, Grand Junction, CO; [6]Shell Exploration & Production Company, Houston, TX

Abstract
Energy development is occurring in the northern Piceance Basin of Colorado, requiring targeted partnerships for developing shared data, collaborative efforts, expertise and infrastructure to understand regional surface and groundwater hydrology. Over 17,000 natural gas wells are expected to be drilled in the Bureau of Land Management (BLM) White River Field Office (WRFO) in the next 20 years. The WRFO also administers research and development leases to evaluate technologies for oil shale extraction and could have commercial oil-shale development leases in the future on BLM administered lands. Understanding regional hydrology is essential to assessing and avoiding impacts from natural gas drilling and oil shale retort and extraction. Direct impacts from energy development on water resources could include contamination of aquifers during drilling and completion activities, fresh water use, erosion from surface disturbance, injection of produced water and used drilling fluids, and indirect impacts such as aquifer cross-contamination and spills. The BLM, along with the U.S. Geological Survey (USGS) are establishing five dedicated groundwater monitoring wells in critical aquifers, developing regional groundwater information, gathering surface water quality and streamflow data, inventorying almost 40 existing USGS monitoring wells; inventorying springs on BLM lands, establishing new streamflow measurement sites, supporting five conductivity probes, collecting additional surface water quality data, geophysical logging; and geological expertise. The USGS in cooperation with the BLM and other government agencies and with energy companies have created a public, web-accessible common data repository to assemble data collected from industry, local, State, Federal, and other sources. This collaborative process is innovative by allowing entities to contribute funds, data, authority, materials, and expertise to understanding regional groundwater and surface hydrology. Surface water quality data, streamflow and groundwater information will be added to the repository including water data collected at BLM sponsored USGS streamflow sites, streamflow and water quality data from the BLM along with water chemistry for major streams, groundwater wells, and aquatic studies collected by energy companies. BLM will benefit from this partnership and repository by developing indicators to evaluate direct and indirect impacts from northern Piceance Basin energy development.

Using specific-conductance profiles and fixed-depth loggers to determine freshwater-lens thickness changes and aquifer properties during recharge events, Northern Guam Lens, Guam

Todd Presley
U.S. Geological Survey, Pacific Islands Water Science Center, Honolulu, Hawaii

Abstract
The people of Guam utilize both surface water and groundwater for municipal and military use. The primary groundwater resource is the Northern Guam Lens, a freshwater lens within a high-permeability karstic limestone aquifer.

Proper management of the resource requires an understanding of how lens thickness and groundwater salinity respond to periods of intense rainfall and recharge, and how tides and ocean-level fluctuation affect the water in wells drilled to measure freshwater-lens thickness. This poster explores water-level data, and specific-conductance profiles and time-series data collected from deep monitor wells during 2004 to 2010.

Collection of specific-conductance profiles began in 2000. A more intense data-collection program, during May 17, 2004 to February 24, 2005, collected rainfall, water-level, specific-conductance profiles, and fixed-depth specific-conductance data from four wells in the Northern Guam Lens. Since 2005, profiles have been collected four times a year at seven wells.

During the intense data collection program, two storms contributed heavy rainfall. Hydrographs of water level and specific conductance from the fixed-depth loggers show response to the storms within hours. The specific-conductance profiles also show a deepening of the transition zone by about 3 ft after the storms. From the data, if we assume that all precipitation infiltrates as recharge with little runoff (a limiting case), we can estimate the porosity of the aquifer necessary to reproduce the rise in water level and the increase in lens thickness.

To determine the effect of tides on measured salinity, specific-conductance profiles were collected during high and low tides. The data indicate that borehole flow affects the salinity distribution in the well more than would be expected by a vertical translation of the profile by an amount equal to the water-level change. Profiles measured at high and low tides indicate differences that are similar in magnitude to seasonal differences. This artifact suggests the importance of consistent timing of the data collection with respect to tides, and the care required when analyzing long-term trends of lens thickness.

Keywords: Freshwater lens, Deep wells, Borehole flow

Assessment of Potential Uranium Emissions from a Uranium Mill on the Ground- Water, Surface-Water, and Air Quality of the Ute Mountain Ute Reservation, Southeastern Utah, 2007 - 2009

Anthony J. Ranalli[1], David L. Naftz[2], Sam Vance[3], and Robert Duraski[3]
[1]U.S. Geological Survey, Denver Federal Center, PO Box 25046, MS 415, Lakewood, CO 80225; [2]U.S. Geological Survey, 2329 W. Orton Circle, Salt Lake City, UT 84119-2047; [3]U.S. Environmental Protection Agency Region 8, 1595 Wynkoop Street, Denver, CO 80202-1129

Abstract
A uranium mill, located on the White Mesa in San Juan County, Utah, began operating in 1980 to extract yellowcake (U_3O_8) and vanadium from uranium ores. Potential air and ground-water exposure pathways of uranium and other metals to tribal members include (1) airborne dust from ore storage pads, from trucks delivering ore to the mill, and from the mill's drying ovens, (2) dissolution of airborne dust deposited on the soil, and (3) leakage from the tailings ponds to the groundwater aquifer, which flows from the mill toward the reservation.

An evaluation of the concentration of major ions and metals in the groundwater up- and down-gradient of the mill reveals complex spatial variations in (1) the concentration of uranium and other metals in bedrock, soils, and groundwater, (2) the geochemical conditions favorable for either uranium solubility or precipitation in ground water, and (3) geologic conditions that can influence groundwater residence times in White Mesa. This spatial variability makes it extremely difficult to assess the environmental impact of the mill by using concentration data alone. In this study we supplement the ground-water concentration data by (1) age dating groundwater to determine the time required for groundwater to flow from the mill to the reservation, (2) analyzing ground-water samples for uranium, oxygen, and sulfur (S and O in sulfate) isotopes to determine if the source of uranium in groundwater is natural or is a result of extraction processes, (3) using geochemical modeling to determine the mobility of uranium and other metals in the groundwater in White Mesa, and (4) trace-element analysis of <-200 mesh stream sediments from ephemeral drainages surrounding the mill. This presentation will focus primarily on how the results from this supplemental monitoring are helping to determine the effects of the mill on ground-water and surface-water chemistry in White Mesa.

Evaluating the potential occurrence of ^{210}Po in US groundwater using uranium concentrations and gross alpha radioactivity

Michael R. Rosen
Nevada Water Science Center, US Geological Survey, Carson City, NV

Abstract
The radioactive isotope ^{210}Po causes health effects at low activity concentrations (<5 pCi/L), but is rarely analyzed directly in drinking-water supplies or during routine monitoring. Evaluation of groundwater data contained in the U.S. Geological Survey National Water Information System (NWIS) from 1985 to 2009 contained only 103 records of filtered ^{210}Po measurements from 5 states (Florida, Nevada, New Jersey, Oklahoma, and Washington) out of over 29,000 records containing data on various radionuclides. Polonium was detected in 28 percent of these wells at relatively low concentrations (usually <2 pCi/L) but with some wells ranging up to 52 pCi/L. Higher concentrations of unfiltered ^{210}Po samples have been reported in Nevada (up to 170 pCi/L) but unfiltered data are not available elsewhere. Extensive data from most states exist for uranium concentrations (>20,000 records) and gross alpha activity (>4500 records), although only 1,536 paired records occur. If uranium isotopes are the main alpha emitters in a water sample, then uranium concentrations converted to activity should correlate with gross alpha activity in the sample. If gross alpha activity is significantly greater than uranium activity (here termed excess gross alpha activity), other alpha-emitting isotopes (such as radium or polonium) may be present. Gross alpha activity, more than 5 times greater than the uranium activity, was measured in 16 different states, mostly in the north and southeast, southwest, and south. ^{226}Ra and ^{234}U do not always appear to account for the excess gross alpha in many samples, indicating that other alpha emitters are responsible for the high excess gross alpha activity. For example, the observation of high excess gross alpha led to the discovery of natural ^{210}Po contamination in Maryland and Nevada. In old gross alpha samples that were held up to a year, ingrowth of ^{226}Ra and ^{224}Ra may have affected gross alpha measurements, and gross alpha measurements errors may be as high as 30 percent. This method should be used with caution to evaluate large databases; however, its careful use may provide a first-order screening tool to determine if further evaluation of radionuclides is warranted.

Tuesday Poster Session

Complications associated with nutrient and dissolved oxygen monitoring in low-gradient headwater streams

Den Davis and Y. Jun Xu
School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA, United States

Abstract
Water quality monitoring has become an integral component in the management of watersheds. Nutrient concentration and loading are both factors regulated within individual watersheds by local, state, and federal governments. Headwater streams in Louisiana are generally characterized by very gentle slopes, intermittent flow, and large drainage areas. Our study site was the Flat Creek watershed located in north-

central Louisiana with a drainage area of 365 km^2. Streamflow, nutrient (nitrogen and phosphorus) and dissolved oxygen concentrations were monitored at 15 locations monthly and during storm events from January 2006 to September 2009. Two of the major complications encountered during our study were lack of stream connectivity during summer months and storm events exceeding bankfull capacity. Storm events accounted for a significant portion of the total yearly loadings. With no accurate loading method currently available for above bankfull capacity, storm event loading is greatly underestimated. How these complications were handled during our study and how they can be effectively used in other watershed monitoring programs with similar topography will be presented.

Assessing Differences in Water Clarity Measurements among Transparency Tube Models and Users

Kristine Stepenuck
University of Wisconsin-Extension, Environmental Resources Center, Madison, WI

Abstract
Many citizen monitoring groups across the nation use transparency tubes to assess water clarity in streams. Transparency tubes are commercially produced using clear PVC, or can be made using such materials as lake coring tubing or fluorescent light protection covers. In Wisconsin, transparency tubes have been used in the statewide volunteer stream monitoring program to assess water clarity in streams since 1997. Early on, these tubes were constructed by program staff. Nowadays, commercially-produced tubes are provided to program participants.

These tubes provide an economical means of obtaining water clarity information, but additional information is needed to be able to use the information to its fullest extent. Two aspects of concern related to transparency tube measurements include differences in materials used to construct the tubes causing differences in measurement results, and variability among individuals' results due to differences in eyesight. To address these issues, we assessed if there were differences in volunteer measurements based on materials used to construct the tubes. We also assessed the variance in readings among citizen monitors so that we could better interpret the data produced in the program. This poster will provide results from these studies.

Integrating diel studies into large-scale monitoring programs

Megan Young[1], Carol Kendall[1], Steve Silva[1], Randy Dahlgren[2], Peggy Lehman[3], William Stringfellow[4]
[1]U.S. Geological Survey, Isotope Tracers Project, Menlo Park, CA, United States; [2]Dept. of Land, Air, and Water Resources, University of California, Davis, CA, United States; [3]Department of Water Resources, Division of Environmental Services, West Sacramento, CA, United States; [4]Environmental Engineering Research Program, University of the Pacific, Stockton, CA, United States

Abstract
Selecting appropriate and practical sampling strategies is a critical component of designing and maintaining monitoring programs. Understanding short-term fluctuations in monitored constituents can have significant implications for selecting sampling sites and time frames, interpreting long-term monitoring data, and integrating data from other types of studies (for example, laboratory, mesocosm and toxicity studies) with the data provided by monitoring programs. When sampling over large areas and/or over long time periods (typical of monitoring program designs) it is usually not possible to sample each site at the same point in the diel or tidal cycle. Therefore, it is necessary to understand short term fluctuations in order to correctly interpret larger spatial and temporal trends. It is also important to understand both seasonal and spatial differences in the magnitudes of short-term fluctuations in order to identify times and places when more intense sampling is required. For example, exact time and location of sample collection in a eutrophic river during the summer could result in widely different load calculations, while much less short term variability might be seen during other seasons or in other locations within the same aquatic system.

Here we present the stable isotope and nutrient concentration results from three separate diel studies that were conducted as part of a three year monitoring study of nutrient and dissolved oxygen dynamics on the San Joaquin River (SJR) and tributaries in the Central Valley, California, and discuss how these results impacted the interpretation of the larger data set. Nutrient concentrations, dissolved oxygen and other environmental parameters, and a suite of stable isotopes (water, nitrate, particulate organic matter (POM), dissolved oxygen, dissolved organic and inorganic carbon) were collected every two hours over either twenty-four or forty-eight hour periods. The total variability (2005 through 2007 monitoring study samples) in the mainstem SJR sites was much greater than diel variability at the upstream site for all measured isotopes, making seasonal variability fairly easy to separate from short-term variability. The downstream spatial variability during July and August (peak of algal growth in the river) in nitrate isotopes, water isotopes, and δ^{13}C-POM was much greater than the observed diel variability, indicating that the observed spatial variability was not significantly affected by sampling time. However, the diel variability in δ^{15}N-POM, C:N-POM, and δ^{13}C-DOC was greater than the observed downstream variability, suggesting that apparent spatial variability in these measurements could be an artifact of sample collection times. The results from this study highlight the importance of incorporating various sampling strategies into long term studies, and constraining the short term variability early within the study.

Chemical Constituents in Groundwater from Multiple Zones from the Snake River Plain Aquifer at the Idaho National Laboratory, Idaho

Roy C. Bartholomay and Brian V. Twining
U.S. Geological Survey, Idaho National Laboratory Project Office, Idaho Falls, ID, United States

Abstract
From 2006 to 2009, the U.S. Geological Survey (USGS) Idaho National Laboratory (INL) Project office in cooperation with the U.S. Department of Energy (DOE) collected water quality samples from multiple water-bearing zones in the Snake River Plain aquifer. Water samples were collected from eight monitoring wells completed in 400 to 600 feet of the upper part of the Snake River Plain aquifer and analyzed for major ions, selected trace elements, nutrients, selected radiochemical constituents, and selected stable isotopes. Multi-level sampling systems were installed in each well with 4 to 7 sample ports per well isolated by permanent packer systems. The sample ports were installed in zones of the aquifer that had large transmissivity of groundwater and represented the water chemistry of the top 4 to 5 model layers of the USGS INL groundwater model for steady-state and transient groundwater flow.

Water chemistry and particle tracking simulations are being used to better define movement of wastewater constituents in the aquifer. The water chemistry results indicate that one zone in each of four different wells were markedly different from other zones of water in the same well. Six of the wells had water from one to five zones that contained radiochemical constituents that originated from wastewater disposal at selected INL facilities. The new sampling systems are defining the vertical distribution of wastewater constituents in the Snake River Plain aquifer and changing the long held belief that the wastewater constituents are only moving in the upper 150 feet of the aquifer at the INL.

Rapid Toxicity Assessments (RTAs) to Optimize Water Quality Testing Budgets

Bryan Bjorndal, Alexandra Osorio, Mickele Bragg
Assure Controls, Inc., Vista, California, United States

Abstract
This presentation will illustrate how an innovative and efficient toxicity detection method can provide a cost-effective solution to determining which sites should have further evaluation. The test uses cultured and packaged bioluminescent dinoflagellates to indicate if water samples contain biologically harmful levels of inorganics, organics or heavy metals (and all combinations of these). The light output of the organism can be optically measured with a benchtop instrument after they have been exposed to water samples. Bioluminescence is reduced in a direct and inverse relationship (as toxicity increases, light decreases) and all tested samples are compared to a control group.

This technology enables faster and more frequent water quality testing, providing the capability to focus scarce resources and improve response to environmental water quality management decisions. The rapid toxicity assessment performs a "live species test," which is part of the Clean Water Act in several key areas of environmental protection, but has utility in source water testing, watershed protection and characterization; and in remediation projects. Water toxicity can be determined in 24 hours compared to 4 days with conventional methods and tests can be done for 70% less cost. This means that from 5 to 8 times more toxicity tests can be completed for the same budget compared to conventional methods, thus saving both the government and private industry millions of dollars a year in water toxicity testing. For example, over 30 sites have been tested in a two days and results have been made available in less than a week. The test method is also one of the few rapid toxicity assessment methods that is a first level universal indicator of toxic effects to both animals and to plants. The availability of this test has made toxicity detection an affordable and achievable capability for environmental projects and larger scale requirements; providing the capability to confirm or update existing information and perform critical contaminant screening of water bodies.

Green analytical methods for water quality testing

Ellen R. Campbell, Wilbur H. Campbell
Nitrate Elimination Co., Inc., Lake Linden MI, United States

Abstract
The Nitrate Elimination Co., Inc. (NECi) has developed an analytical method for determining the nitrate content of water, which is based on the enzyme nitrate reductase. In this method, nitrate is reduced to nitrite with nitrate reductase as catalyst using the natural reductant NADH to drive the reaction, which requires about 10 min to achieve complete reduction. The nitrite is quantified by reaction with the Griess Reagents yielding a magenta color. The color is measured with a spectrophotometer at 540 nm or estimated by eye using a color comparison chart. Although the NECi Nitrate Analysis Method is available for many platforms from test tube or manual methods to automated discrete analyzers, the NECi Field Nitrate Test Kit is best for citizen monitoring of local streams, lakes and other bodies of natural water. The Field Kit is very easy to use and requires only one drop of water (0.05 mL). When using the color comparison chart, all the equipment needed for the Nitrate Test is provided in the Kit. The reagents are non-toxic and the disposal of waste is not a problem, especially since the test volume is very small (about 1 mL). Thus, the NECi Field Nitrate Test Kit, which provides accurate analysis in the range of 0.5 to 10 ppm Nitrate-N, is ideal for "on-the-spot" use and is safe for the person doing the testing as well as for the environment

Determination of Human-Use Pharmaceuticals by Large-Volume Injection, High-Performance Liquid Chromatography/Tandem Mass Spectrometry

Edward T. Furlong[1], Mary Noriega[1], Mark R. Burkhardt[2], Laura Coffey[1], Stephen L. Werner[1]
[1]U.S. Geological Survey, Denver, Colorado; [2]U.S. Environmental Protection Agency, Denver, Colorado

Abstract
Accurate assessment of the presence and distribution of human-use pharmaceuticals and personal-care product chemicals (PPCPs) in aquatic systems is predicated on accurate, unbiased determination of these chemicals in environmental samples at ambient concentrations. In this paper, we present results of a study in which we developed a large-volume injection, high performance liquid chromatography (HPLC)/ tandem mass spectrometry (MS/MS) method for the determination of 98 human-use PPCPs in filtered-water samples. The method is applicable to groundwater, surface water, and drinking water.

The HPLC separation is accomplished using a 1.8-micron particle size, C-18 reversed-phase column and an aqueous formic acid/ methanol gradient. Identification and quantitation of the PPCPs is by chromatographic retention time and multiple reaction monitoring (MRM) of two unique product ions produced by fragmentation of the pseudomolecular precursor ion. The method combines the specificity and sensitivity of MRM and injection of volumes of up to 1,500 microliters directly onto the analytical column to permit direct analysis of filtered water samples, particularly groundwater and drinking water, without sample preconcentration. The lowest calibration standard for most compounds ranges between 4 and 40 picograms on-column. At an injection volume of 1,000 microliters this results in routine detection levels of between 4 and 40 nanograms per liter, sufficient for determination of PPCPs at expected ambient environmental concentrations. An added benefit of this approach is that eliminating sample preconcentration prior to analysis minimizes suppression or enhancement effects by interfering matrix components during analysis. The method has been applied to finished drinking water, groundwater, and surface water samples and results from those comparisons will be presented.

Keywords: Pharmaceuticals, Environmental Analysis, Personal-Care Products, Water Quality, Liquid Chromatography/Mass Spectrometry

Comparison of Cytotoxicity Bioassay, Protein Phosphatase Inhibition and Liquid Chromatography/Tandem Mass Spectrometry for the Determination of Microcystins in Alberta Lakes

Dorothy Yu Huang[1], Xu Zhang[1], Ron Zurawell[2] and David W. Kinniburgh[1]
[1]Alberta Centre for Toxicology, University of Calgary, Calgary, Alberta, Canada; [2]Alberta Environment, Edmonton, Alberta, Canada

Abstract
Microcystins are natural hepatotoxic substances produced by cyanobacteria (blue-green algae). High dose exposure is responsible for human and domestic-animal acute intoxication and death; low dose exposure is related to the promotion of liver tumors. Since microcystin-producing species of cyanobacteria inhabit Alberta's lakes and reservoirs, it is important to monitor toxin levels in recreational and drinking waters to protect human and animal health.

Our laboratory has developed three detection methods for microcystins: cytotoxicity (CT) bioassay, colorimetric protein phosphatase inhibition (PPI) assay, and liquid chromatography / tandem mass spectrometry (LC/MS/MS). The CT bioscreen was developed to replace the traditional mouse bioassay. It uses an artificial cell line expressing the OATP1B3 transporter, which is responsible for microcystin uptake, in conjunction with a novel real-time cell electronic sensing system to detect toxicity at the cellular level. The PPI assay provides a semi-quantitative measurement of the total microcystin inhibition of protein phosphatase 1. The LC/MS/MS method employs direct injection and rapidly identifies and quantifies specific microcystin congeners.

Water samples were collected throughout the summer and fall from over 10 Alberta lakes. The samples were pretreated to release cell-bound toxins then analyzed for total microcystins by the cytotoxicity bioassay, PPI, and by LC/MS/MS. The data were generally in agreement. Microcystin-LR was found in majority of the positive samples, at concentrations as high as hundreds of micrograms per litre. Other

microcystin congeners (-YR, -RR, -LF and -LW) were identified in a few samples, but at relatively low concentrations. Co-occurrence of the microcystin congeners was usually observed in samples with high levels of microcystin-LR.

Tracing Sources of Nitrate, Organic Matter, and Water in the Willamette River Basin, from the Headwaters to Portland, Using Stable Isotopic Techniques

Carol Kendall[1], Hank Johnson[2], Chauncey Anderson[2], Kate Lajtha[3]
[1]U.S. Geological Survey, Menlo Park, CA, United States; [2]U.S. Geological Survey, Portland, OR, United States; [3]Oregon State University, Corvallis, OR, United States

Abstract
The Willamette River Basin contains more than 70 percent of Oregon's population and is under increasing pressure from continued urbanization. To better understand the sources of nutrients, organic matter, and water to the Willamette River and how these sources are linked to land uses, our team, which included volunteers from several local agencies, conducted two synoptic samplings of the Willamette River and its major tributaries under summer baseflow conditions in late August 2006 and under winter baseflow conditions in January 2007. We collected (1) mid-river grab-samples from the entire length of the Willamette River (> 275 km), at sites selected to provide both uniform geographic coverage plus samples of different sources of nitrate, including feedlot operations, urban sewer and septic drainage, industrial effluent, and agriculture; (2) near-shore grab-samples from all major tributaries near their confluence with the Willamette River, from the mouths of minor tributaries to the Willamette River that had largely urban or agricultural land use, and from major sub-tributaries, reservoirs, or other sites of local hydrologic interest; and (3) samples from upstream sites to assess diel variability. About 300 samples were analyzed for nitrate, ammonium, and DOC concentrations, conductivity, water-$\delta^{18}O$ and $\delta^{2}H$, and nitrate $\delta^{15}N$ and $\delta^{18}O$. This dataset provides a fundamental assessment of the potential usefulness of isotopic techniques for identifying spatial and temporal changes in nitrate and water sources in the Willamette Basin during contrasting hydrological conditions.

Tracing Sources and Biogeochemical Cycling of Ammonium and Nitrate in the Sacramento River and Northern San Francisco Bay Using Stable Isotope Techniques

Carol Kendall[1], Megan Young[1], Steve Silva[1], Tamara Kraus[2], Marianne Guerin[3], Alex Parker[4]
[1]U.S. Geological Survey, Menlo Park, CA, United States; [2]U.S. Geological Survey, Sacramento, CA, United States; [3]Resource Management Associates (RMA), Fairfield, CA, United States; [4]San Francisco State University, Tiburon, CA, United States

Abstract
One potential cause of declines in several threatened and endangered fish species in the northern San Francisco Bay Estuary is NH_4-inhibition of algal productivity, which causes pelagic organism declines via foodweb interactions. Hence, there is considerable interest in determining the relative contributions of NH_4 from waste water treatment plants (WWTPs) and various agricultural, wetlands, and urban land uses to the ecosystem, and evaluating their effects on algal growth. N cycling within the ecosystem, including mineralization of organic N, nitrification, assimilation of NH_4 and NO_3, and other processes might mask the effects of specific sources and control the concentrations and speciation of N. To address these issues, we have employed a multi-isotope approach to investigate N source, fate, and transport in the Sacramento River, the major river tributary to the estuary. A previous study had investigated N source, fate, and transport in the San Joaquin River, the other main tributary. Approximately 25 samples were collected during each of 3 transects along a 100 mile section of the river and mesohaline segment of the estuary in 2008-2009, and analyzed for nutrients, chlorophyll, various physical parameters, NH_4-$\delta^{15}N$, NO_3-$\delta^{15}N$ and $\delta^{18}O$, DIC-$\delta^{13}C$, DOC-$\delta^{13}C$, water-$\delta^{18}O$ and $\delta^{2}H$, and seston-$\delta^{15}N$, $\delta^{13}C$, $\delta^{34}S$, and C:N. These data showed many distinctive downstream changes that are indicative of specific sources and processes. NH_4 concentrations increased sharply downstream of the Sacramento WWTP, remained high for over 20 miles before starting a steady decline at ~20 miles upstream of the confluence with the San Joaquin River. The decline in NH_4 was mirrored by an increase in NO_3 concentration, and the changes in isotopic composition of NH_4 and NO_3 confirmed that the dominant N cycling process in this reach of the river was nitrification. NH_4 derived from the Sacramento WWTP achieves a very distinctive high $\delta^{15}N$ value due to progressive nitrification. This N source is readily distinguishable from other sources of estuarine NO_3. Hence, the isotopic signatures resulting from nitrification, plus the wealth of other chemical and isotopic data, permit estimation of relative uptake rates of NO_3 and NH_4 by algae and bacteria along the transects, and well as nitrification rates.

Detecting the neurotoxin BMAA in cyanobacteria and fish by LC-MS/MS

Xu Zhang[1], Dorothy Yu Huang[1], Ron Zurawell[2], David W. Kinniburgh[1]
[1]Alberta Centre for Toxicology, University of Calgary, Calgary, Alberta, Canada; [2]Alberta Environment, Edmonton, Alberta, Canada

Abstract
The non-protein amino acid, β-N-methylamino-L-alanine (BMAA), is a naturally occurring, non-lipophilic, non-essential amino acid that has neurotoxic properties. It has been proposed as contributing factor in the amyotrophic lateral sclerosis/ parkinsonism-dementia complex (ALS/ PDC). BMAA was first isolated and characterized from *Cycas circinalis* seeds and a recent publication suggested that over 95% of cyanobacteria strains tested produce BMAA (Cox et al, 2005). Since cyanobacteria are found in water world wide the presence of BMAA poses a great potential risk to human health.

Hydrolyzed cyanobacteria and fish samples were derivatized using AccQ-Fluor reagent; α-aminobutyric acid served as the internal standard. Derivatized BMAA was separated and detected using an Agilent 1100 Liquid Chromatograph and a Sciex API 4000 Triple Quadrupole Mass Spectrometer. Gradient chromatography in Multiple Reaction Monitoring (MRM) mode was performed on a Hypersil BDS C18 column, maintained at 40 °C; MRM transitions were as follows: 459/171 and 459 /289 for BMAA, 274/171 for α-aminobutyric acid. The identification and quantitation was performed based on the two MRM transitions combined with the retention time.

Cyanobacteria and fish were spiked with BMAA (5 - 1000 μg/g) to validate the method (accuracy 85% - 115%, relative standard deviation 6% - 10%). The detection limit for total BMAA was 2 μg/g dry weight (2 pg on column). BMAA was successfully identified and quantified in cycad leaf, which served as a positive biological reference material. All samples were also tested by a published LC method using HILIC column without derivatization viz Kubo et al. (2008). Data from both methods were in agreement.

In conclusion, our laboratory has developed a novel and highly specific procedure based on LC-MS/MS to quantify total BMAA in various matrices such as water, algae and fish samples. The method is being used to determine if BMAA occurs in phytoplankton samples from Alberta lakes and reservoirs.

Determination of Rapid Settling Turbidity Samples

Jon Schiller and Mike Sadar
Hach Company, 5600 Lindbergh Drive, Loveland, CO 80528

Abstract
Turbidity is key indicator of water quality. It is also recognized that accurately measuring turbid samples that settle rapidly can be very difficult. This is even more evident with multiple operators, using different mix rates, and using different delay times before recording the reading.

A new algorithm for measuring turbidity of all types of samples, including those with rapidly settling solids has been developed. The algorithm analyzes and characterizes the initial turbidity and its rate of change over time and statistically determines the actual turbidity level. Influences such as particulate settling and bubbles are determined and removed by the calculation algorithm. This algorithm has been applied using a more strenuous mixing technique resulting in better precision and repeatability for samples with rapidly settling particles. This analysis technique applies statistical methods to the readings to calculate the most probable turbidity value, and a confidence interval is associated with the result for a true statistical assessment of the measured sample.

Experimental results verifying the precision, and repeatability of different operators running the same samples in a normal measurement mode, a signal averaged measurement mode, and the new analysis technique will be presented. During initial investigations the linearity and precision obtained across dilutions of concentrated samples have shown marked improvement over the pre-established techniques. These were QC samples that had differing levels of both sands and fines.

Using these new techniques the inter-operator variability of field sample turbidities should be reduced.

Keywords: Turbidity, Innovative Measurement

Comparison of Soluble Nitrate Reductase and Granular Copperized Cadmium Reducing Agents for Routine, Colorimetric Nitrate Determinations in Water

Charles J. Patton
U.S. Geological Survey, National Water Quality Laboratory, Denver, CO, United States

Abstract
Most colorimetric analytical methods for determining nitrate in water samples involve reducing nitrate to nitrite with a suitable reagent followed by determination of resulting nitrite by the Griess Reaction using sulfanilamide and N-(1-Naphthyl) ethylenediamine reagents. Although zinc, hydrazine, vanadium (III), and ultraviolet radiation have been used for this purpose, copperized cadmium—reactor types include packed bed, wire-in-tube, and open tubular—generally is the preferred reagent because it provides near-quantitative reduction of nitrate to nitrite (see equation below) with negligible reduction of nitrite to lower oxidation species.

$$NO_3^- + Cd^0 + 2H^+ \xrightarrow[\text{imidazole buffer}]{pH=7.5} NO_2^- + Cd^{2+} + H_2O$$

Widespread acceptance and application of cadmium reduction methods for nitrate determination not withstanding, reactor geometry, activation procedures, and reagent formulations remain topics of perennial discussion among environmental analytical chemists. Ease-of-use, toxicity, and waste-disposal issues associated with cadmium reduction devices, however, led the USGS National Water Quality Laboratory (NWQL) to explore commercially available, nontoxic nitrate reductase (NaR) as a replacement for granular copperized cadmium in routine nitrate assays. Nitrate reductase quantitatively reduces nitrate to nitrite and does not reduce nitrite to lower oxidation states (see equation below)

$$NO_3^- + NADH + H^+ \xrightarrow[(pH=7-8)]{NaR} NO_2^- + NAD^+ + H_2O$$

Nitrate reductases manufactured by recombinant expression techniques in *Pichia pastoris* systems—bispecific NAD(P)H:NaR from *Pichia angusta* (Enzyme Commission # 1.7.1.2) and specific NADH:NaR from *Arabidopsis thaliana* (EC 1.7.1.1, formerly EC 1.6.6.1)—offer soluble, nontoxic replacements for granular copperized cadmium. This poster summarizes the USGS NWQL's considerable analytical experience using these enzymes as replacements for cadmium in automated and manual colorimetric nitrate assays and provides details of reagent systems, instrumentation, and data demonstrating statistical equivalence of nitrate concentrations in surface water and groundwater that were determined with granular copperized cadmium and soluble nitrate reductase reducing reagents.

Adapting Automated Discrete Analyzers for Routine Nutrient Determinations at a Large Water Quality Laboratory

Eric A. Schwab[1] and Charles J. Patton[2]
[1]U.S. Geological Survey, Water Resources Division, National Water Quality Laboratory, Nutrients Unit, Denver, CO; [2]U.S. Geological Survey, Water Resources Division, National Water Quality Laboratory, Methods Research and Development Program, Denver, CO

Abstract
Air-segmented continuous flow analysis and flow injection analysis, which were described some 53 and 35 years ago, respectively, have been the workhorses of environmental water-testing laboratories for nearly half a century. These venerable technologies now face a serious challenge in this arena from automated discrete analyzer (DA) technology. Replacement of CF analyzers by automated discrete analyzers in clinical diagnostic testing laboratories was nearly complete by the late 1980s. This was because DAs performed the same routine, colorimetric assays that CF analyzers did with less sample and reagents, less waste, less operator intervention, and less maintenance. Furthermore, they typically achieved comparable analysis speeds and detection limits and provided levels of automation not available in CF analyzers at that time. For several years, a number of instrument vendors have begun to market discrete analyzers to water-testing laboratories as replacements for CF analyzers. In this presentation, we share the experience of the National Water Quality Laboratory in using discrete analyzers for routine colorimetric nutrient analyses and our continuing efforts to achieve levels of automation similar to those typical in clinical diagnostic testing laboratories.

Verifying the Use of Specific Conductance as a Surrogate for Chloride in Saltwater Matrices

Cristina Windsor
In-Situ Inc., Research and Development, Fort Collins, CO, United States

Abstract
Coastal groundwater supplies, when overused, are vulnerable to chloride contamination due to their close proximity to saltwater. Elevated chloride concentration in groundwater is the most commonly used indicator of saltwater intrusion. Additionally, road salt runoff can elevate chloride levels in surface water and groundwater.

Rather well-defined relationships of specific conductance (SC) to chloride exist. Chloride, a chemically conservative constituent, was used to characterize salinity in water samples. To validate the relationship between SC and chloride, SC measurements by electrochemical conductivity cells and chloride concentration measurements by ion-selective electrode (ISE) were determined for 35 PSU OSIL Atlantic Seawater Standard and 10 dilutions at six different temperatures (66 unique samples). Statistical analysis on the ratio of SC values and chloride concentration showed a strong linearity (r^2 = 0.9845) for samples having chloride concentrations up to 35,000 mg/L and a strong linearity (r^2 = 0.9887) for samples having chloride concentrations up to 2,000 mg/L.

The stability of the conductivity sensor and the strong linear correlation of SC and chloride indicate an advantage for using a conductivity sensor in estimating chloride over currently available methods. This is especially true for field deployments or long-term monitoring projects, in which sensor stability is essential for accurate results. ISEs are accurate when

recently calibrated, but are sensitive to drift, fouling, and are not ideal for long-term deployments. Ion chromatography (IC) provides accurate results, but cannot produce real-time data. IC is useful when establishing correlation data and when verifying chloride values.

To generate real-time field data that avoids using costly methods or methods sensitive to drift and fouling, chloride-conductivity relationships can be developed. This study verifies the strong linear relationship between SC and chloride for seawater and demonstrates that SC is much less susceptible to drift and requires less maintenance than available ISEs. SC can provide more robust data sets for long-term projects such as saltwater intrusion studies and total maximum daily load (TMDL) studies. This paper will also discuss a TMDL study in the Shingle Creek Watershed (Wisconsin). By developing chloride-conductivity relationships, researchers were able to increase the accuracy of load estimations and decrease manual data collection.

Developing a Quick "Portable" Extraction Technique for Urban Water Contaminants

Laura Webb[1], Lorraine Iverson[2], Margie St. Germain[2]
[1]US EPA Region 7, Environmental Services Division, Assessment and Monitoring Branch, 901 N. 5th St., Kansas City, KS 66101; [2]US EPA Region 7, Environmental Services Division, Chemical Analysis and Response Branch, 300 Minnesota Ave., Kansas City, KS 66101

Abstract
The extraction and analysis of urban water contaminants requires large volumes of sample water, large volumes of hazardous extraction solvent, typically dichloromethane, and multiple extraction techniques, each of which requires several hours to perform. The water monitoring team, in conjunction with the regional laboratory, has developed a quick extraction method which uses 100 mL or less of water sample, no organic solvents, and can be accomplished in a little over an hour. The method is portable and has been developed in the mobile laboratory.

The technique uses stir bar sorbtive extraction (SBSE) which consists of a small 10 mm stir bar encased in glass which is then coated with polydimethylsiloxane. The stir bars (or Twisters©) are placed in a volume of sample and stirred for a period of time. In this study, several different volumes and times were investigated. Once sorption is complete, the Twister© is placed in Gerstel's thermal desorption unit (TDU) which is attached to a Gerstel cooled injection system (CIS) installed on an Agilent 6890/5973 GCMS system. The organic analytes that were held on the Twister© are thermally desorbed into the chromatography column and analyzed by mass spectrometry.

The analytes of interest in this study were compounds of concern in the urban environment: polynuclear aromatic hydrocarbons (PAH), triclosan, polybrominated diphenyl ethers (flame retardants), bisphenol A, hormones, and phthalates. Several urban pesticides were also investigated, including atrazine and DEET. Acceptable results were obtained on both spiked blanks and spiked samples, and there was good agreement between samples prepared in the field mobile laboratory and in the fixed regional laboratory.

Comparison of Methods for E. Coli *and Total Coliform*

Laura Webb
US EPA Region 7, Environmental Services Division, Assessment and Monitoring Branch, 901 N. 5th St., Kansas City, KS 66101

Abstract
In an effort to assess the condition of Urban Streams, the EPA Region 7 Assessment and Monitoring Branch has conducted extensive chemical, biological, and physical sampling and assessment of twelve urban streams in the Kansas City area since 2006. The use of urban streams for recreation, especially by children, prompted the monitoring team to add *E. Coli* to the list of analytes of interest in 2007. The team has used membrane filtration with the m-coliblue24 media from HACH for these urban samples. This technique has proved easy and affordable. However, in response to several customer inquiries for bacteria sampling, the team has investigated the use of another test – Colilert – for bacteria monitoring. During the summer of 2009, most urban stream samples were simultaneously analyzed by both methods and the results compared, along with the cost and ease of use. Quality control samples were also run side-by-side to compare the results for both *E. Coli* and Total Coliforms.

Occurrence and Distribution of Pathogen and Source Markers in Water from a Pennsylvania River Monitoring Network, 2008-2009

Joseph W. Duris[1], Donna A. Krouse[2], Natasha Isaacs-Cosgrove[1], Andrew G. Reif[3]
[1]U.S. Geological Survey, Michigan Water Science Center, Lansing, MI, United States; [2]Pennsylvania Department of Environmental Protection, Bureau of Laboratories, Harrisburg, PA, United States; [3]U.S. Geological Survey, Pennsylvania Water Science Center, Exton, PA, United States

Abstract
The U.S. Geological Survey (USGS) Michigan and Pennsylvania Water Science Centers, in cooperation with the Pennsylvania Department of Environmental Protection, are conducting research into the occurrence of pathogens and fecal source markers in Pennsylvania Rivers. River water samples were collected quarterly for two years, from a 27-station water quality monitoring network using standard USGS sampling protocols. The water samples were analyzed for *E. coli* and enterococci fecal indicator bacteria concentrations, gene markers of bacterial pathogen Shiga-toxin producing *E. coli* (STEC), gene markers of bovine, human, and porcine fecal sources, and the protozoan pathogens *Cryptosporidium* and *Giardia*. The distribution of pathogen and source gene markers was evaluated based on land use, season, hydrological conditions, and biological and chemical water quality parameters. Study results will improve understanding of the environmental distribution of pathogens and different fecal sources in rivers and streams in Pennsylvania, and will improve understanding of the relation of specific pathogens to common fecal indicator bacteria and other environmental and anthropogenic factors.

Multi-Tracer Mapping of Municipal Wastewater Plumes Discharging from Aquifer to Ocean in Hawaii

Charles D. Hunt, Jr.[1], Sarah N. Rosa[1], Watson T. Okubo[2]
[1]U.S. Geological Survey, Honolulu, HI, United States; [2]Hawaii Department of Health, Honolulu, HI, United States

Abstract
We conducted wading and kayak surveys to map wastewater plumes at Kihei and Lahaina, Maui. Several million gallons per day of tertiary-treated, disinfected sewage effluent are disposed by deep-well injection at each locale, and there is long-standing uncertainty about where and how the effluent emerges offshore. Our surveys culminate three years of source-tracking method development to support beach water-quality monitoring by the Hawaii Department of Health under the U.S. Environmental Protection Agency BEACH Act. The tiered approach progressed from reconnaissance mapping of submarine groundwater discharge with a multi-parameter water-quality sensor to targeted sampling of water and benthic algae. Samples were analyzed for a suite of "inherent tracers" (chemicals typically present in wastewater) rather than an introduced tracer such as fluorescent dye.

We detected the pharmaceuticals carbamazepine, sulfamethoxazole, caffeine, and diphenhydramine; household chemicals including musk fragrances, fire retardants, and plasticizers; and the disinfection byproduct bromoform. Nitrogen isotopes provided a high-contrast signal that best mapped plume extent. Source compositions of $\delta^{15}N$ in effluent nitrate were +15 and +23 per mil at Kihei and Lahaina, shifting to heavier values of +23 and +40 through denitrification in the sub-oxic groundwater plumes. These values contrasted distinctly against

a background of +5 to +6 outside the plumes and +1 in groundwater containing probable fertilizer nitrate. Plumes also were marked by high nitrogen and phosphorus concentrations and elevated UV fluorescence at the emission wavelength of laundry fabric brighteners. University of Hawaii researchers had previously detected heavy $\delta^{15}N$ in macroalgae at both locales, and our wastewater confirmation across several additional tracers (pharmaceuticals, household chemicals, fluorescence) is likely to be even more recognizable and convincing to a broad spectrum of stakeholders.

Each wastewater plume spans about a mile (1.6 km) of shoreline, agreeing well with prior modeling. We did not attempt to map the full offshore extent of plume discharge, which would be better assessed by scuba sampling of benthic algae and porewaters (using drive points and seepage chambers). Results of our surveys may help guide further research into possible effects of wastewater effluent on the marine ecosystem and natural attenuation of nutrients within the aquifer.

EPA Tools for Water Quality Monitoring Data Sharing at the National Level

Kevin Christian and Deepti Puri
US EPA Office of Water, christian.kevin@epa.gov, puri.deepti@epa.gov, 1200 Pennsylvania Ave, NW Mail Code 4503T, Washington, DC 20460

Abstract
In compliment to data sharing efforts at the local, state, and regional scales, water quality monitoring data is compiled at a national level in the STORET Data Warehouse. The STORET Warehouse has been a source for water quality information for many years, and continues to provide data from all scales of organizations across jurisdictions.

This poster presents the EPA framework and tools being used to manage, integrate and share water quality monitoring data at a national level. The framework and tools include the National Environmental Information Exchange Network (including the Central Data Exchange), the Water Quality Exchange (or WQX), and the WQX Web tool. The poster also highlights the data standard that WQX provides so that at a national level, data integration and sharing from local level data management systems is possible.

This poster serves as part one of a two part series. The second part titled "Innovative Approaches to Make Water Quality Data Available from EPA STORET" highlights improved ways of retrieving water quality data from the STORET Warehouse.

Improving Ambient Monitoring Water Quality Data Access, standardization, Interoperability and Integration in California

Karl Jacobs
Project Manager, California Environmental Data Exchange Network (CEDEN), Office of Information Management and Analysis, State Water Resources Control Board, 1001 I Street Sacramento, CA 95814, Voice (916) 341-5545, FAX- (916) 341-5550, E-Mail kjacobs@waterboards.ca.gov

Abstract
The goal of the California Environmental Data Exchange Network (CEDEN) is to promote collaboration and interaction among data providers and provide integration, standardization and access to the State's ambient monitoring data. CEDEN provides data management and sharing infrastructure using combinations of three major components:

- Data architecture,
- Standards and
- Applications.

Data architecture includes a distributed network of data sets. These data sets reside with the groups that collect them and/or at regional data centers located throughout the State. Technologies include data replication/synchronization and web services provided by the EPA's Data Exchange Network.

Data standards include naming conventions for monitored attributes and database objects in addition to standardization of QA/QC procedures and monitoring protocols. Standards were initially developed, by the Surface Water Ambient Monitoring Program (SWAMP) and will be augmented by the CEDEN Data Management and Information Team (DMIT).

Applications that convert CEDEN data into information can be developed by the many groups who need to analyze ambient monitoring data, within the State, comprehensively. Data query tools have been developed and additional query tools are being developed.

Many Groups within California, including multiple agencies, academic, private, and stakeholder entities, collect large amounts of environmental data. These data currently exist in diverse formats and in different databases with inconsistent formats, and can be difficult to access. CEDEN will help fix this problem and provide integration, standardization and comprehensive access to and help meet the State's need for comprehensive data sharing and management. In addition, CEDEN data will be made accessible to the EPA's Exchange Network using the WQX XML schema.

A Collaborative Water Quality Knowledge and Information Network - WQIN

Fernanda Dalcanale[1], Darrell G. Fontane[2]
[1]Ph.D. candidate, Colorado State University, Fort Collins, CO (fernanda@dalcanale.net); [2]Professor, Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO (fontane@engr.colostate.edu)

Abstract
Managing water quality information is becoming increasingly complex, as uncertainties, conflicts and participatory processes add to the need for data collection, knowledge and information exchange, and cooperation.

WQIN is the pilot project for a collaborative Water Quality Knowledge and Information Network. Instead of relying on a handful of editors to gather and publish information, WQIN's framework proposes a broader collaboration within the water quality community. Using the most recent developments in technology for online communities, the goal of the network is to bring together different players in water quality management and build a self sustained knowledge base that will advance water quality education and knowledge sharing; encourage distribution and access to data and information; provide networking opportunities; allow public perceptions and concerns to be collected; promote exchange of ideas and; give general, open, and free access to information. The network can be accessed at http://www.wqin.org.

The Colorado Water-Quality Data Repository

Jean Dupree[1], Catherine Costello[2], Tamara Ivahnenko[3], M. Alisa Mast[1], Jodi Riegle[2], Keelin Schaffrath[4], and Judith Thomas[4]
[1]U.S. Geological Survey, Colorado Water Science Center, Denver, CO; [2]U.S. Geological Survey, Rocky Mountain Geographic Science Center, Denver CO; [3]U.S. Geological Survey, Colorado Water Science Center, Pueblo, CO; [4]U.S. Geological Survey, Colorado Water Science Center, Grand Junction, CO

Abstract
The U.S. Geological Survey (USGS) in cooperation with other government agencies, stakeholder groups, and private entities has developed a web-based data management system for ambient water-quality data for selected study areas in Colorado including the Piceance Basin, the Arkansas, Blue, Eagle, Gunnison, Roaring Fork, and Yampa Rivers, and

the Southwestern portion of the state. This data repository combines water-quality data from the USGS National Water Information System (NWIS) and the U.S. Environmental Protection Agency STORET databases with smaller datasets from a wide variety of sources. The data repository is accessible to the public through a USGS web site at http://rmgsc.cr.usgs.gov/cwqdr/index.shtml. The web site includes an interactive map that allows users to zoom in to an area of interest and select sites for retrieval of water-quality data. Query pages allow the user to identify the data of interest based on the period of record, data source, and parameter category. Query results can then be exported to either a tab-delimited text file or Excel spreadsheet. The repository is being used to evaluate available water-quality data to develop baseline assessments of the region's water resources. Assessment results will facilitate the design of regional monitoring strategies to fill identified data gaps and minimize redundancies in current and future water-resource monitoring.

A Partnership for Developing Ecosystem Indicators and Tools for the Gulf of Maine

Christine M. Tilburg[1], Adria Elskus[2], Jawed Hameedi[3], Susan Russell-Robinson[4], and Kathryn Parlee[5]
[1]Gulf of Maine Council on the Marine Environment, Buxton, Maine, ctilburg@securespeed.us; [2]University of Maine and USGS, School of Biology and Ecology, 5751 Murray Hall, Orono, Maine, aelskus@usgs.gov; [3]National Oceanic and Atmospheric Administration, Silver Spring, Maryland, Jawed.Hameedi@noaa.gov; [4]U.S. Geological Survey, Reston, Virginia, srussell@usgs.gov; [5]Environment Canada, Halifax, Nova Scotia, Kathryn.Parlee@EC.GC.CA

Abstract
The Gulf of Maine Council on the Marine Environment (GOMC) is a U.S.-Canadian partnership of government and non-government organizations focused on the health, environmental quality and productivity of the Gulf of Maine. In 2006, the Ecosystem Indicator Partnership (ESIP) commenced activities in six priority theme areas: coastal development, climate change, contaminants, eutrophication, aquatic habitats, fisheries, and aquaculture. Subcommittees were established for each theme area. Currently more than 100 contributors from local, state and federal governments, along with academics and partners from non-government organizations participate in one or more of these subcommittees. Based on a consensus-based process, a total of twenty-two priority indicators were selected and are available on the ESIP webpage (www.gulfofmaine.org/esip).

Following the indicator selection process, ESIP developed an Indicator Reporting Tool to provide an easily accessible site for data on the priority indicators (www.gulfofmaine.org/esip/reporting). The Tool allows users to visually assess data and use a graphing function to view status and trends at specific sites or for specific time periods. Data are automatically updated on a regular basis, providing the user with access to the most current data available. Presently, indicator data are available for some aquatic habitats, contaminants, and climate change indicators with more datasets expected to be added in the coming months. By providing this compilation of information in an easily accessible format, along with developing more detailed indicator fact sheets, ESIP is accomplishing one of the priority goals of the partnership: assisting users in locating and utilizing information on priority indicators in the transboundary Gulf of Maine Region.

Synthesizing Nutrient Data across the U.S. Forest Service Experimental Forest and Range Network – Methodological Challenges and Opportunities

Effie Greathouse[1], George Ice[2], Chuck Rhoades[3], Sherri Johnson[3], Stephen Sebestyen[3], David Wright[3], Devendra Amatya[3], John Campbell[3], Jennifer Knoepp[3], William McDowell[4], Mary Beth Adams[3], Peter Wohlgemuth[3], Jeremy Jones[5]
[1]Oregon State University, Corvallis, OR; [2]National Council for Air and Stream Improvement, Inc., Corvallis, OR; [3]US Forest Service Research and Development; [4]University of New Hampshire, Durham, NH; [5]University of Alaska, Fairbanks, AK

Abstract
Monitoring and experimental research conducted across the U.S. Forest Service Experimental Forest and Range (EFR) Network represents a key national resource of long-term data in least-impaired watersheds as well as managed and disturbed watersheds. The EFR Network consists of 80 sites across the continental U.S., Puerto Rico and Alaska, established progressively since 1908. Multi-site syntheses and online data collations have been done for EFR climate and hydrology monitoring stations, but the potential wealth of stream nutrient data in experimental forests has remained disparate and unsynthesized. For example, some EFR sites have web-accessible stream chemistry data and metadata on an individual site basis, while other sites' data are only available if requested directly from site personnel. We are collating and organizing stream nitrogen and phosphorus data in order to: (1) synthesize effects of forest disturbances on EFR stream nutrients, (2) compare proposed nutrient criteria to the range and variability of nutrients in least-impaired/reference watersheds, and (3) create a web-based database for use by academic researchers, the public, and water quality managers who are responsible for developing nutrient criteria. In our initial work on 11 EFR sites, we have documented metadata, organized data into common formats and designed a relational database to handle diverse nutrient data across sites. Challenges we have faced in collating this data and designing our database include differing analytical and sampling methods, differences in the forms of nutrients reported, divergent terminology and units, differences in time steps of sampling, differences in detection limits and the manner in which they are reported, and lack of documentation of methods and detection limits for historic data. Methodological opportunities from this synthesis work include greater communication amongst EFR sites about stream chemistry monitoring protocols, development of common frameworks for data collation, and documentation of metadata and methods for long-term public use.

An Integrated List of Data Elements: Unifying Concepts in Action

Revital Katznelson
University of California Extension, Berkeley (Instructor), revitalk@sbcglobal.net, Berkeley, CA

Abstract
Data Elements are placeholders for bits of information that describe environmental monitoring results. In many ways, data elements are equivalent to the "data fields", or column headers, in a database table. The people who generate, verify, validate, and manage monitoring data (at the Project level) need a comprehensive array of data elements (i.e., a "long list") to organize and document their datasets. This paper presents a newly revised list of data elements which addresses that need. The author's original comprehensive list has been molded into the NWQMC's Water Quality Data Elements (NWQMC Tech. Report no. 3) to create this new list and to address the following challenges:

(a) Integration of data elements from different areas of inquiry: The content and types of information needed for environmental monitoring projects vary widely, and many data elements are specific to a certain area of inquiry. However, monitoring activities in all major areas of inquiry share several groups of common elements, or "unifying concepts". These unifying concepts are the foundation of the revised

list, and will facilitate integration of monitoring and assessment data from various areas of inquiry, including chemical analyses, discrete and continuous field measurements, bacterial counts, toxicity testing, biological assessments such as fish, benthic macroinvertebrate, or periphyton assemblages, and physical habitat assessments.

(b) Independence of database structure and data models: the list is built by subject matter, i.e., by "who, what, why, when, where, and how". In other words, data elements are categorized, grouped, and placed in the list based on what each of them describes.

(c) Comprehensiveness with flexibility: this improved list provides an extremely detailed foundation that can be easily tailored to any Project by culling irrelevant elements or by adding elements into the right place in the list if additional detail is needed.

(d) Standardization of contents: for consistency and comparability among projects, the revised list of data elements is already associated with an array of pick-lists (a.k.a. Lookup tables), that are also expandable to maintain inclusiveness and flexibility.

(e) Data sharing and comparability: Only a sub-set of the data elements in this list are necessary for data sharing beyond the Project, and these can be easily extracted to form a "short list" of core data elements that accompany the monitoring results as they are uploaded into central data management systems.

Keywords: Data elements, areas of inquiry, data management, unifying concepts

Innovative Approaches to Make Water Quality Data Available from EPA STORET

Charles Kovatch and Deepti Puri
U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans and Watersheds, 1200 Pennsylvania Ave NW MC-4503T,Washington, DC 20460

Abstract
States, Tribes, and volunteer monitoring organizations can now better share and view data stored in EPA's STORET data warehouse. Numerous States, Tribes, and volunteer monitoring organizations use EPA to store their water quality data in the STORET data warehouse, EPA's national repository for water quality, biological, and physical data. Until now, data could only be viewed by downloading files generated from queries through a web interface. Now, EPA has built web services technology for STORET. Through web services, water quality data in STORET is more available for use by agencies and volunteer organizations to perform water quality analysis by allowing interested parties to establish automated data calls which can deliver data directly to their personal computer or populate a web page. The web services make data better available to help water program managers, researchers, and interest groups to gather data when assessing the water quality of a water body or supporting water policy and resource decisions.

This poster serves as part two of a two part series. The first part titled "EPA Tools for Water Quality Monitoring Data Sharing at the National Level" highlights improved ways of entering water quality data into the STORET Warehouse.

A Geospatial Platform for Accessing Data and Communicating With Security and Water Quality Monitoring Systems

Dan Kroll
Hach Company, Homeland Security Technologies, Hach World Headquarters, Loveland, Colorado, USA

Abstract
On-line monitoring systems used to survey our water supply networks are becoming more ubiquitous. There are drawbacks to these monitoring platforms. The main deficiency derives from their widespread geographical deployment. Monitoring site access can become daunting when it is understood that a system may be comprised of tens or even hundred of individual monitoring nodes. This, combined with the expediency of being able to view the network as a whole, makes the need for a hierarchical centralized system of command and control an absolute must. The solution to this problem described here consists of communication and data handling software that will give utilities a bi-directional monitoring and control system that integrates the data flow from water quality monitoring points strategically located throughout a community's water supply network. This gives utility personnel the ability to simultaneously view and minimize response time to critical water quality data anomalies from any location.

The capabilities of the system provide utilities with a virtual command center for water distribution monitoring and control from a location(s) of their choice. Previously, utilities could either physically download data from an individual instrument monitor or use a remote service such as Virtual Network Computing to view one distribution-monitoring site at a time. With the new system, multiple utility personnel can simultaneously view all the data, giving the utility a comprehensive, immediate and real-time picture. On a single screen, utility personnel can view the status of all monitoring points in the network; download data and clear alarms. Users can "drill down" into data from an individual monitoring point in the same manner as if they were physically standing at the site. The utility personnel's ability to collectively access real-time and historic data can provide utilities with a deeper understanding of their network's performance. This can allow them to streamline operations, reduce costs, and boost efficiency - all while enhancing public health protection. The Beta version of this software package has been deployed at a number of sites. Impressions and experiences with the beta version of the system and will be discussed along with recommendations for further improvements.

A Web-Accessible Aquatic Biological Database System: BioData and BioShare

Dorene E. MacCoy[1], Jill Frankforter[2], Scott Grotheer[3]
[1]U.S. Geological Survey Idaho Water Science Center, Boise, ID; [2]U.S. Geological Survey Montana Water Science Center, Helena, MT; [3]U.S. Geological Survey National Water Quality Laboratory, Lakewood, CO

Abstract
Science centers of the U.S. Geological Survey (USGS) Water Resources Discipline (WRD) collect surface-water, ground-water, and water-quality data at sites throughout the United States to monitor the condition of our Nation's waters. Many of these centers also collect biological community data to assess the long-term effect of water quantity and quality on aquatic ecosystems. Until now, no concerted effort has been made to aggregate and disseminate biological data currently stored in project files, in spreadsheets, and independent databases. In March 2007, the USGS formed a working group to determine the need for a national biological database. A survey of water science centers indicated that at least 140 project activities in 47 centers included the collection of aquatic biological community data. In response to this finding, the USGS Executive Leadership Team allocated funding in fiscal year 2008 for the development of a biological database (BioData) in which to compile and maintain the WRD's aquatic community data. Concurrent, is the development of an on-line query tool, (BioShare), to make the data available to USGS scientists and the public. The BioData/BioShare development team consists of a steering committee made up of USGS managers and National Water Quality Assessment program leaders; a biological users group (BUG) that includes biologists from different regions of the country; and a software development contractor, Comprehensive Computer Consulting, in Sun Prairie, Wisconsin, that has partnered with database developers from the USGS Center for Integrated Data Analytics, in Middleton, Wisconsin. The BUG assembled requirements and references necessary for software development and in February 2009, development began on the BioData database and BioShare on-line query tool. Beta testing of selected components of the database system by science center is scheduled for fiscal year 2011.

Using Web Portals to Present Meaningful Information

Jon Marshack, Karen Larsen, Valerie Connor, Jeff Kapellas
California Environmental Protection Agency, Water Resources Control Board, Office of Information Management & Analysis, Sacramento, CA, United States

Abstract
The California Water Quality Monitoring Council is making monitoring data more meaningful by improving access to assessment products that answer questions important to both managers and the public. The Council is addressing problems—stemming from inconsistent monitoring and assessment methods, fragmented data management systems, and the absence of global or unified points of access—through a system of issue-specific web portals linked from a single point of access, the *My Water Quality* website (www.waterboards.ca.gov/mywaterquality). Each portal focuses on a specific high-level question (e.g., Is it safe to swim in our waters? Is it safe to eat fish and shellfish from our waters?) that provides access to assessment products that address more detailed questions (e.g., What are the long-term trends at my beach, lake, or stream?). Users can also follow links from these questions to monitoring data at different spatial scales (site, region, statewide), more detailed assessment reports, and legal and regulatory background.

We present operational versions of three web portals, addressing the Safe to Swim, Safe to Eat Fish and Shellfish, and Wetland Ecosystem Health questions. Each portal integrates data, information, and assessment products that reside in a variety of locations that include both state databases and those maintained by other public and private partners. In addition to improving access to meaningful information, these portals have highlighted data gaps and inconsistencies in monitoring and assessment methods. This creates a structure for identifying and prioritizing efforts to address these shortcomings as well motivating the state and its partners to maintain a process of continual improvement. The transparency and efficiency of this approach has improved the Council's credibility and prompted requests for participation from additional partners. The Council has targeted a number of additional issues for future development.

Upper Clear Creek Watershed (Colorado) – An Exemplary Water-Quality Monitoring Case Study Revisited

Maggie Pierce[1], Timothy D. Steele[2], Ronald J. Abel[3], Mike Holmes[4]
[1]Colorado Department of Public Health & Environment, Water Quality Control Division, Denver, CO; [2]TDS Consulting Inc., Denver, CO, United States; [3]Formerly affiliated with the Colorado Department of Public Health & Environment, Hazardous Materials & Waste Management Division, Denver, CO, United States; [4]U.S. Environmental Protection Agency, Region VIII, Denver, CO, United States

Abstract
The Upper Clear Creek Watershed is a 400-mi^2 mountain watershed located in central Colorado that has benefited from long-term systematic hydrologic monitoring (water-quality and stream-gaging since 1994). In a coordinated and collaborative effort between the Colorado Department of Public Health & Environment, the Environmental Protection Agency, the Colorado Division of Wildlife, and the Upper Clear Creek Watershed Association, a comprehensive common database for hardness, trace metals, and stream flow was developed for use by various parties involved in evaluating watershed goals, including water-quality stream standards setting. A recent application of the database was during the June 2009 steam standards hearing convened by Colorado's Water Quality Control Commission. By combining results from several data sources, the database enhanced the various parties' ability to understand steam conditions. The database facilitated comparison of stream quality to proposed water-quality criteria and assisted with assessing the reasonableness of attaining criteria. The database was used to assess proposed alternative stream segmentation. More critically, this effort helped provide a common database overcoming potential disagreement over water quality conditions avoiding selective or inconsistent application of various data sets by parties at the standards hearing.

A variety of statistical and graphic presentations of site-specific or segment-related data drawn from the database facilitated the 2009 regulatory deliberations. It is envisioned that the database, with periodic updates, should provide a sound technical basis for future watershed planning and stream-standards deliberations. This presentation updates a previous NWQMC conference presentation.

Review of Waterbody Assessment Methodologies

Lindsay Martin Griffith
Brown and Caldwell, Golden, Colorado, United States

Abstract
Despite improvements over the last decade in both monitoring and assessment, the states continue to struggle with the uncertainty involved with determining attainment of designated uses. For many states, the biannual assessment and listing cycle continue to evolve as they try to determine which monitoring and assessment methodologies — based on chemical or biological water quality indicators or both — should be the focus of their limited funding and resources. To learn about the various approaches used by the states, the project team gathered and organized information on current assessment methodologies and identified methodologies that optimize available data and minimize the statistical uncertainty associated with characterization of waterbody conditions. The focus of the research was on the most common methodologies and unique methodologies with particular strengths for determining support of designated uses with consistency and confidence.

The project team developed recommendations to assist the states with developing or refining their waterbody assessment and listing methodologies. In the report, the specific recommendations are organized into six overarching areas:

1. Development and publication of minimum data requirements;
2. Integration of monitoring programs into waterbody assessment needs;
3. Development of standardized assessment units that allow for water quality extrapolation;
4. Development of numeric water quality criteria by which to more reliably determine support or impairment of designated uses;
5. Use of statistically based data evaluation techniques to more confidently determine attainment of water quality standards; and
6. Inclusion of public input in the methodology development process.

By applying the recommendations based on this WERF-sponsored research, the states should have a basis for more effectively integrating monitoring data and scientifically defensible assessment methodologies into the waterbody assessment and listing process.

Volunteers, Data, and the Public – Meaningful Stream Information

Cheryl Cheadle, Jean Lemmon
Oklahoma Blue Thumb, Oklahoma Conservation Commission

Abstract
Oklahoma's Blue Thumb water pollution education program has supported citizen stream monitoring for seventeen years. Data collected includes monthly water chemistry, benthic macroinvertebrate and fish collections, habitat assessment and bacteria information.

The role of the Blue Thumb volunteer is growing. The first volunteers primarily accomplished stream monitoring; data rolled in year after year. Now we expect volunteers to be involved in public education. The whole purpose of the data collection is to let citizens know how their streams

are doing. In some cases, wonderful streams should be protected. In other cases, unhealthy streams should be improved. Knowledge of the local streams is step one.

Public understanding of the data collected by Blue Thumb volunteers skyrocketed when the Water Quality Division made available data from "high quality" streams in the various ecoregions of Oklahoma. Blue Thumb staff members "average" the streams identified as high quality so Blue Thumb streams within the ecoregion can be compared to these.

Being able to compare the streams with this ecoregion high quality average simplifies the understanding of stream health for the average citizen (who is not a scientist.) The high quality streams average offers a benchmark of what is a good, functioning stream within a particular ecoregion. Dependable metrics allow staff to work with volunteers to come up with comparisons that result in an understandable ranking for the volunteer monitored streams.

Once volunteers sit down and experience a data interpretation with a Blue Thumb staff member, the volunteers create a draft data report. The reports are very representative of their authors - some are going to be scientific, and some a little less so.

Every report is reviewed by Blue Thumb staff, often with edits being made. Each report contains invaluable information that is presented in a way that most citizens can understand it. There is always help available for a citizen with questions.

In summary, this presentation will cover:

- Blue Thumb stream monitoring effort
- The value of pulling data together within a concise report
- Volunteers adding the "personality" and the motivation to care
- A Tale of Two Streams, One Ecoregion

Development of Urban Stream Water Quality Indices in the Kansas City Urban Streams Network

Gary Welker
U.S. EPA Region 7, Environmental Services Division, Assessment and Monitoring Branch; 901 North 5th Street; Kansas City, Kansas; 66101

Abstract
Water column and sediment samples from the 36 urban network monitoring sites in the Kansas City metropolitan area revealed the presence of chemical contaminants. Some contaminants were above published thresholds and criteria but most were either below criteria levels or, as with the case of most sediment contaminants, have no published criteria. In recognition of the fact that co-occurrence of toxicants occurs in aquatic ecosystems and can lead to joint toxicity as a result of exposures to combinations of contaminants, an indicator concept was developed to express the potential exposure to multiple toxicants. An index related to the occurrence of anthropogenic related compounds (ARC) was proposed. This richness index is based on the summed occurrence of toxicants that are anthropogenic in origin. Chemical species such as metals and salts, which could be present at normal (i.e. background) levels, were not included in the ARC indices. ARC indices were developed for water, sediment and water & sediment contaminants. ARC scores regressed with land use and land cover data were statistically significant when regressed with land cover data and biotic indices.

To assess the combined physical, biological and chemical effects on overall stream health an urban stream index has been proposed. The Urban Stream Index (USI) is an index that scores streams from zero (highly degraded) to 100 (pristine conditions). The USI is composed of ten factors: urban land use, habitat (QHEI score), invertebrate richness, fish richness, ARC water & sediment, algae biomass (chlorophyll a), nutrients (total nitrogen), bacteria (total coliforms) and sediment (total dissolved solids). USI results revealed a gradient of stream health conditions from highly degraded stream conditions on streams in the urban core to moderately degraded conditions on streams on the urban fringe.

Communicating Volunteer Monitoring Data

Jinnieth Woodward
Alliance for Aquatic Resource Monitoring (ALLARM), Dickinson College, PO Box 1773, Carlisle, PA 17013-2896, woodwarj@dickinson.edu, 717.245.1021

Abstract
Nationwide, volunteer monitors spend countless hours collecting, processing, and analyzing water samples in order to learn more about of the quality of their local streams and watersheds. In conjunction with conservation organizations, the resultant data is often transmitted to the public to inform local policy decisions and educate citizens.

Volunteer water quality monitoring programs are often assisted by service providers, who provide technical assistance in the form of physical trainings, volunteer-friendly protocols, quality assurance/quality control plans, databases, and other ad-hoc support. However, once the data have been stored, it is usually up the volunteer monitors to translate and communicate the learned information to their designated audience. This step can be challenging and intimidating, especially without additional support or guidelines. In addition, most volunteer monitoring programs stem from organizations that do not have the financial capability to hire an external consultant to process their information and create communication materials.

The Alliance for Aquatic Resource Monitoring (ALLARM), a Pennsylvania and Dickinson College-based service provider, has identified the need to assist volunteer monitors in communicating their data to their intended audience. To address this issue, ALLARM has developed templates in the forms of PowerPoint presentations and State of the Watershed reports that allow groups to disseminate their information easily and efficiently. The talk will explain the need for this assistance as well how groups can utilize these tools to their benefit.

Keywords: Volunteer monitoring, data communication, service provider, ALLARM

Volatilization of Polycyclic Aromatic Hydrocarbons (PAHs) from Pavement Surfaces and Relation of Fluxes to Pavement Surface Type

Barbara J. Mahler and Christopher L. Braun
U.S. Geological Survey, Water Resources Division, Austin, TX, United States

Abstract
Volatilization from pavement surfaces sealed with refined-coal-tar-based sealcoat has been proposed as a mechanism for PAH loss from the surface but has not been documented or quantified. In an ongoing investigation, the U.S. Geological Survey is measuring volatilization of PAHs from pavement surfaces to the atmosphere. The approach is to concurrently measure PAH concentrations in surface particulates, in air at the pavement surface, and in ambient air above the pavement surface. Concentrations in air are measured using high-volume air samples and polyurethane foam plugs (PUFs). A novel "hat sampler" is used to sample air at the pavement surface and a conventional sampler for ambient air above. As a first phase, 10 in-use parking lots, some with coal-tar-based sealcoat and some without, were sampled synoptically during summer 2009. Air was pumped continuously through the PUFs for 2 hours; samples were collected during the hottest and coolest times of the day. As a second phase, a 15- by 15-meter area of a parking lot was sealed with coal-tar-based sealcoat, and samples were collected in a time-series beginning just after the sealcoat was applied; sampling will continue for 1 year following sealcoat application. These data will provide information on flux of PAHs from sealcoated pavement to ambient air and the potential implications for air quality.

Quality of Water from Private Wells in Principal Aquifers of the United States, 1991-2004

Leslie A. DeSimone[1], Pixie A. Hamilton[2], and Robert J. Gilliom[3]
[1]U.S. Geological Survey, Water Resources Discipline Northborough, MA; [2]U.S. Geological Survey, Water Resources Discipline, Richmond, VA; [3]U.S. Geological Survey, Water Resources Discipline, Sacramento, CA

Abstract
More than 40 million people, or 15% of the U.S. population, rely on privately owned, household wells for drinking water. These wells are not regulated under the Safe Drinking Water Act and water-quality monitoring is the responsibility the homeowner. Consequently, data about the quality of water from private wells typically are limited. About 2,100 private wells from 30 regionally extensive aquifers in the U.S. were sampled from 1991 to 2004 as part of the National Water-Quality Assessment Program of the U.S. Geological Survey (USGS). As many as 219 water properties and contaminants were measured, in samples collected prior to any treatment, and concentrations were compared to human-health benchmarks (USEPA Maximum Contaminant Levels (MCLs) or USGS Health-Based Screening Levels). Overall, 23% of the sampled wells had 1 or more contaminant at a concentration greater than a human-health benchmark. The contaminants most often greater than benchmarks (1% to 7% of wells) were primarily naturally occurring, and included radon, arsenic, uranium, and nitrate. Anthropogenic contaminants (pesticides and VOCs) were detected in more than half the sampled wells, but were above benchmarks in <1% of wells. Microbial contaminants were detected as many as 1/3 of 400 sampled wells. Regional patterns were apparent. Radon was highest in crystalline-rock aquifers that were present, for example, in the northeastern U.S. Arsenic concentrations were most frequently greater than the MCL in several aquifers in the Northeast, upper Midwest, and western U.S. Concentrations of nitrate greater than the MCL were more frequent in areas of agricultural land use than in other areas. Mixtures of contaminants individually above benchmarks were uncommon (4% of wells), but mixtures of contaminants at concentrations below but approaching benchmarks were found in most wells (73%). Mixtures are of concern because of the potential for synergistic effects and the lack of health benchmarks for mixtures. These findings suggest that, while most private wells do not have contaminants at concentrations greater than existing health benchmarks, they are vulnerable to contamination and routine monitoring is essential for managing this important source of drinking water.

Exploring the role of photochemical processes on the fates and effects of endocrine disrupting chemicals

Doug Latch[2], Kelly Daumit[2], Christopher Whidbey[2], James Gray[1], George Aiken[3]
[1]US Geological Survey, Denver, CO, United States; [2]Seattle University, Seattle, WA, United States; [3]US Geological Survey, Boulder, CO, United States

Abstract
We have developed an analytical method to determine photochemical degradation kinetics for a suite of 17 endocrine-disrupting compounds (EDCs). After solid-phase extraction, EDCs-diethylstilbestrol and 16 steroid hormones-are determined by GC/MS/MS analysis. This approach allows simultaneous monitoring of degradation rates of our entire suite of EDCs , rather than independently monitoring each EDC. This procedure is advantageous in that additional experiments can focus on altering water-quality parameters rather than analytes. We have found that many of our studied EDCs are susceptible to direct photolysis. In addition, indirect photolysis processes contribute to the degradation of the subset of EDCs that contain phenolic moieties. We will discuss experimental approaches taken to elucidate the primary pathways of degradation and the relative importance of various photochemically produced reactive intermediates. We will also discuss experiments conducted to determine the chemical structures and estrogenic potency of degradation products. The findings of this research could be used to estimate environmental half-lives for our suite of EDCs for various water-quality conditions and to provide important information regarding their fates.

Determination of steroid hormones in environmental samples by GC/MS/MS with isotope dilution

James Gray[1], William Foreman[1], Rhiannon ReVello[1], Christopher Lindley[1], Larry Barber[1]
[1]U.S. Geological Survey, Denver, CO; [2]US Geological Survey, Boulder, CO

Abstract
It has been well documented that exposure to estrogenic hormones can affect the sexual development of fish and other vertebrates, and it is likely that androgens and progestins could work by similar mechanisms. Furthermore, many of these hormones are present in wastewater effluents and biosolids. Therefore, a robust means of quantifying trace hormone concentrations in solid and liquid samples is desirable.

An isotope dilution method for 17 steroids plus cholesterol and coprostanol in water and solid samples was developed that uses 12 deuterium-labeled analogs added prior to sample extraction. Estimated detection levels range from 0.4–2 ng/L, with higher levels for cholesterol and coprostanol because of blank limitations.

Mean ($n \geq 7$) isotope dilution standard (IDS)-corrected compound recoveries from spiked water matrices (all from or affected by waste-water treatment plant effluent) range from 52–154 percent, with relative standard deviations (RSDs) from 3–83 percent with the greatest variation for cholesterol and coprostanol due to high ambient-to-spike concentrations. Ninety-three percent of compound mean recoveries are between 68–122 percent with RSDs <25 percent. Individual spiked samples with low (<50 percent) absolute IDS recoveries typically have IDS-corrected compound recoveries of greater than 80 percent.

A recent survey showed 11 of the 19 steroids studied were present in a wastewater treatment plant's influent, and hormone concentration ranged from 14 to 2970 ng/L. Six compounds were detected in a secondary effluent, whereas seven compounds were found in a tertiary effluent. Hormone concentrations in effluents ranged from 0.24- 4.7 ng/L and were substantially lower than in the influents. Samples collected in an effluent-dominated stream downstream of wastewater discharge contained only four compounds with hormone concentrations of 0.9 ng/L (androstenedione) and 3.1 ng/L (estrone), although cholesterol and coprostanol were approximately 1000-fold higher . Androstenedione, cis-androsterone, 17a-estradiol, and 11-ketotestosterone were not observed in one effluent but were detected in the waste-activated sludge (solid stream) from the same site at concentrations from 49-440 ng/g (dry weight). This finding indicates that hormone removal from the aqueous phase likely takes place via physical processes. Therefore, it is important to have methodologies for solid and liquid media to fully understand hormone behavior during wastewater treatment.

Mid-Columbia River Toxics Monitoring Project

Lillian Herger, Gretchen Hayslip, Lorraine Edmond
U.S. Environmental Protection Agency, Region 10, Office of Environmental Assessment, Seattle, Washington, United States

Abstract
The Columbia River Basin is a priority for states, tribes, federal agencies, and nonprofits and has been elevated in status to a 'great water body' in the Environmental Protection Agency's (EPA's) 2006-2011 Strategic Plan. Past EPA studies and state monitoring programs have found significant levels of toxins in fish and the waters they inhabit within the basin. There are limited data from the mid-Columbia River (between Bonneville Dam to Grand Coulee Dam) for levels of toxins in fish tissue, so a comprehensive sampling effort to evaluate problems in this section of the river was needed.

A study to help fill the data gaps on toxic contaminants in water and fish tissue matrices was initiated cooperatively by the EPA Region 10 and Oregon Department of Environmental Quality. This project was tailored to meet the goals of Oregon's water quality toxics monitoring Program, which emphasizes the need to monitor and control toxics pollutants in Oregon's waters to protect human health and other beneficial uses, and EPA's goals to prevent water pollution and improve and protect water quality and ecosystem to reduce risks to human health and the environment.

Forty sites were selected using a spatially distributed random sample design along the mid- Columbia River mainstem to represent this entire section of the river. Additionally, several tributary and mainstem sites were targeted to test locations that may be associated with elevated inputs of pollutants. During the summers of 2008 and 2009, field crews sampled for water quality, fish tissue, invasive species and habitat at each selected site. In water, we measured temperature, dissolved oxygen, nutrients, chlorophyll *a*, turbidity and other constituents. Selected fish species were analyzed for a variety of toxic contaminants for both human health and ecological endpoints. This poster presents preliminary results of the assessment of the mid-Columbia River focusing on the ecological endpoint fish species.

Concentrations Polycyclic Aromatic Hydrocarbons (PAHs) in Settled House Dust and Their Relation to Coal-Tar-Based Pavement Sealcoat

Barbara J. Mahler and Peter Van Metre
U.S. Geological Survey, Texas Water Science Center

Abstract
Dust from parking lots and driveways with coal-tar-based sealcoat has concentrations of PAHs in the thousands of milligrams per kilogram. To investigate the relation between these high concentrations and PAH concentrations in settled house dust, the USGS analyzed dust collected from the interiors of 23 ground-floor apartments in Austin, Tex., and from their associated parking lots. The median concentration of PAHs in dust from parking lots with coal-tar-based sealcoat (4,760 mg/kg; n=11) was 530 times greater than that in dust from parking lots with other surface types (9.0 mg/kg; n=12; asphalt-based sealcoat, unsealed asphalt, and concrete), and the median concentration in house dust from apartments with parking lots with coal-tar-based sealcoat (129 mg/kg) was 25 times higher than that in dust from apartments with parking lots with other surface types (5.1 mg/kg). An ANOVA of possible explanatory variables indicated that the presence or absence of coal-tar-based sealcoat on parking lots explained 86% of the variation in log-transformed PAH concentrations in dust from parking lots and 48% of the variation in that in house dust. The results of this study indicate that use of coal-tar sealcoat on parking lots and driveways is more strongly related to elevated concentrations of PAHs in house dust than are other potential explanatory variables such as tobacco smoking and urban location.

Occurrence Patterns of Antibiotics in Human and Agricultural Waste and Their Transport in Surface and Groundwater

Michael T. Meyer[1], Keith Loftin[1], Dana Kolpin[2], Michael Focazio[3]
[1]U.S. Geological Survey, 4821 Quail Crest Place, Lawrence, KS 66049;
[2]U.S. Geological Survey, 400 S. Clinton Street, Iowa City, Iowa 52244;
[3]U.S. Geological Survey, 412 National Center, Reston, Virginia 20192

Abstract
As much as 90% of the parent antibiotics used for human and veterinary purposes can be excreted unmetabolized. Several antibiotics have been previously detected in surface and ground water. Eighteen antibiotics were analyzed in stored liquid manure in 49 swine animal feeding operations in six states between 1998-2006. Twenty-eight antibiotics and degradates were analyzed in 21 solid-waste samples collected from 10 municipal and septic waste systems and 11 cattle, swine, and poultry operations and also in 11 municipal wastewater effluents from six states. Antibiotics were detected in 90% of the liquid swine waste samples at concentrations ranging from less than 1 μg/L to 6000 mg/L. Three or more antibiotics were detected in 63% of the samples. Chlortetracycline (total = sum of parent and isomers), sulfamethazine, lincomycin, tetracycline, and oxytetracycline were the most frequently detected antibiotics, respectively. Lincomycin (100%), tetracycline (100%) and erythromycin or erythromycin-$H_2$0 (degradate, 95%) were detected in nearly all of the solid-waste samples. Sulfamethazine (62%) and sulfathiazole (57%) were detected approximately equally between the 21 agricultural and human solid-waste samples. Chlortetracycline (47%) and oxytetracycline (29%) were primarily associated with agricultural waste and ciprofloxacin (57%), azithromycin (52%), ofloxacin (47%), and clindamycin (43%) were primarily associated with human waste. Antibiotic concentrations ranged from less than 10 μg/kg to more than 1,000 μg/kg. Multiple antibiotics were detected in all the municipal wastewater effluents. Erythromycin- $H_2$0 (100%), erythromycin (100%), sulfamethoxazole (91%), trimethoprim (91%), ofloxacin (91%), and ciprofloxacin (82%), were the most frequently detected antibiotics, respectively. The maximum concentration of the summed antibiotics in the municipal wastewater effluents was less than 3.5 μg/L. These data show that antibiotics occur in both agricultural and human sources with total concentrations reaching part-per-million levels in some wastes. Data from studies examining the environmental fate of antibiotics in surface water will also be presented.

Advancing endocrine disrupting compound analysis through integrated technology and workflow solutions

Paul Silcock[1], Peter Hancock[1], Cecilia Mazza[2] and Joe Romano[2]
[1]Waters Corporation, Atlas Park, Simonsway, Manchester M22 5PP, UK;
[2]Waters Corporation, Milford, Massachusetts, USA

Abstract
Endocrine disrupting compounds (EDCs) have become important emerging contaminants, due to their presence in environmental waters (following incomplete removal in wastewater treatment or point-source contaminations), threat to drinking water sources, and concern about possible estrogenic and other effects, both to wildlife and humans[1].

Compounds identified as EDCs include steroid hormones and are of special concern due to their potency. These contaminants do not need to be persistent in the environment to cause negative effects since their high transformation and removal rates can be compensated by their continuous introduction into environment. The prerequisite for risk assessment and monitoring is the ability to quantify these contaminants at sub-ppt levels. Flexibility, sensitivity and selectivity, especially for very complex environmental matrices are of paramount importance.

The list is continuously changing due to detection of new compounds and reclassification of emerging contaminants to, for example, POPs. Although emerging contaminants are not directly legislated, they are often candidates for regulation or, increasingly frequently, are self-regulated by the industry.

Innovations in tandem quadrupole mass spectrometry have allowed a rapid analysis of EDCs in environmental waters at ng/L levels to be set-up in an automated fashion. New software tools automate the set-up and creation of methods whilst providing real-time QC decision making on the data as acquisition occurs. During acquisition the unique Dual Scan MRM enables simultaneous matrix monitoring, helping reduce method development timescales and providing essential QC/QA during an analytical run. High performance quantification is complemented by the capability to perform long term studies of trends within results with the generation of electronic control (Shewhart) charts.

References
[1]Richardson, S., Anal. Chem., 79 (2007) 4295.

Minimizing Sample Turn-around Time When Dealing With Chemicals of Concern in Water Matrices

Claude Mallet, Dimple Shah, Joe Romano and Cecilia Mazza
Waters Corporation, 34 Maple Street, Milford, MA 01568

Abstract
The general population expects utilities to supply clean, safe water and also look ahead to quality water for recreation including swimming and boating. However, recent reports point to the fact that beyond the commonly regulated compounds many more chemicals such as pharmaceuticals, personal care products and endocrine disruptors are present in all sources of water causing alarm at the local and global levels. A significant number of these chemicals have already been classified as chemicals of concern because of their potential effects on wildlife including fish metabolism and plant growth.

The issue with these chemicals of concern is that they are mostly present at the parts per trillion level and these traces require pre-concentration to detect them with present day equipment. The limiting steps in the analysis of these compounds are the sample preparation for the elimination of sludge, debris and algae as well as pre-concentration filled with labor intensive steps including extraction, evaporation and reconstitution procedures.

The alternative for a fast, cost effective sample turn-around is implemented using on-line sample preparation to meet the high selectivity, resolution, high-speed analysis time that LC/MS/MS can provide.

The work presented here addresses the laboratory benefits of using online SPE/LC/MS/MS in water matrices for the quick, sensitive and cost effective analysis of a number of chemicals of concern. Several examples will be discussed including drinking and surface waters.

Temporal and spatial variations in PCB contamination of sediments and source apportionment in a section of the Rhone River, France

Gwenaelle Roux[1], Cécile Miege[2], Annie Roy[3], Barbara Mahler[4], Irène Lefevre[5], Philippe Bonte[5], Marc Desmet[1], Henri Persat[6], Peter Van Metre[4] and Marc Babut[3]
[1]ENTPE, Laboratoire des Sciences de l'Environnement 69518 Vaulx en Velin, France; [2]CEMAGREF, UR QELY, 69336 Lyon, France; [3]CEMAGREF, UR BELY, 69336 Lyon, France; [4]U.S. Geological Survey, Texas Water Science Center, Austin, TX, pcvanmet@usgs.gov; [5]LSCE, CNRS-CEA, 91191 Gif sur Yvette, France; [6]LEHF, CNRS UMR 5023 – Université Lyon1, 69221 Villeurbanne, France

Abstract
In fall 2005, fish contamination by dioxin-like PCBs above the threshold for fish consumption was observed in the Rhône River, in the vicinity of Lyon (France). This observation triggered a series of investigations on sediment contamination initially along the mainstem of the Rhone and more recently expanded to tributaries. In addition to collection of bed sediment in presumed depositional areas, by-pass reaches and reservoirs were explored along a ~200 km reach. Short cores were collected from locations protected from erosion and analyzed for PCBs (18 congeners) and age-dating radionuclides. These data will be used to help regional authorities identify the principal PCB sources among the host of potential ones, provided that distinct congener patterns can be identified in relation to these sources. PCB congener pattern analysis in sediments is challenging because weathering processes can modify the original patterns in several ways and, in a large river basin like the Rhône, mixing of various upstream sources result in mixed patterns at mid- and downstream sites. We used two factor analysis techniques to identify typical source profiles (factors) and their relative contribution to total PCB content in each sediment sample. These results will be discussed in relation to the hydrology, geography, and water management of the area.

Assessment of Contaminants of Emerging Concern in Surface Water and Fish from U.S. Urban Rivers

Leanne Stahl[1], John Wathen[1], Angela Batt[2], James Lazorchak[2], Blaine Snyder[3], Harry McCarty[4]
[1]U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC, United States; [2]United States Environmental Protection Agency, National Exposure Research Laboratory, Ecological Exposure Research Division, Cincinnati, OH, United States; [3]Tetra Tech, Inc., Center for Ecological Sciences, Owings Mills, MD, United States; [4]CSC, Alexandria, VA, United States

Abstract
The U.S. Environmental Protection Agency (EPA) is conducting a study of contaminants of emerging concern (CECs) in surface water and fish under the Agency's National Rivers and Streams Assessment (NRSA). The Office of Science and Technology (OST) within the Office of Water (OW) and the Office of Research and Development (ORD) National Exposure Research Laboratories (in Cincinnati, OH; Las Vegas, NV; and Research Triangle Park, NC) are collaborating to conduct this study of CECs. The study involved collection of fish composite and surface water samples during 2008 and 2009 at about 150 randomly-selected urban river sites (fifth order and larger) throughout the lower 48 states. These 150 sites are a subset of approximately 900 river sites being sampled for the NRSA.

Surface water grab samples are being analyzed for 54 pharmaceutical compounds and 13 perfluorinated compounds (PFCs, including PFOA and PFOS). The fish samples consist of composites of fillets from five similarly-sized adult fish of a single species that target fish commonly consumed by humans. Fillets from each fish composite sample are being analyzed for up to 30 pharmaceutical compounds, 13 PFCs, and a few musks. This is EPA's first broad assessment of CECs on a national scale using a statistically-based sampling design. Results from these nationally representative urban river fish and water samples should be available by the end of 2011.

Reconstructing Trends in Water Quality and Atmospheric Deposition Using Lake and Reservoir Sediment Cores

Peter C. Van Metre
U.S. Geological Survey, Texas Water Science Center

Abstract
Understanding environmental trends is a high priority because it can provide a warning of degradation, indicate success or failure of management strategies, and improve our understanding of cause and effect. Historical water-quality and atmospheric deposition data for trace contaminants, however, generally are inadequate for trend analysis or are nonexistent. An alternate approach, paleolimnology—specifically, analysis of age-dated sediment cores from lakes in undeveloped and developed watersheds—is being used by the U.S. Geological Survey to evaluate trends as a part of the National Water Quality Assessment (NAWQA) Program. Sediment cores from natural lakes in undeveloped watersheds are used to estimate long-term (50–150 years) rates of atmospheric deposition of mercury and polycyclic aromatic hydrocarbons. Sediment cores from urban lakes and reservoirs are used to determine trends in contaminants in urban streams and lakes in response to urbanization and environmental regulation. Reference lakes tend to have low sedimentation rates, and contaminant inputs are dominated by atmospheric deposition. Urban lakes tend to have high sedimentation rates, and contaminant inputs are dominated by fluvial transport from streams. The differences in setting between reference and urban lakes necessitate different sampling and interpretation approaches. Data from some of the more than 100 lakes and reservoirs sampled by NAWQA since the 1990s illustrate these approaches.

WERF Trace Organic Compounds Database Management System for Analyzing Impacts of Trace Organic Compounds on Aquatic Populations and Communities

Jeffrey White[1], Vladi Royzman[2], Jerry Diamond[1], Henry Latimer[1]
[1]Tetra Tech, Inc., Center for Ecological Sciences, Owings Mills, Maryland; [2]Tetra Tech, Inc., Fairfax, Virginia

Abstract
With the recent advent of improved analytical and biomarker detection capabilities, a variety of organic chemicals (pharmaceuticals, personal care products, surfactants, pesticides, flame retardants, and other largely unregulated organic chemicals) have been found in trace amounts in surface waters and fish tissue. Identifying or predicting ecological effects of these chemicals is challenging, requiring the use of sophisticated epidemiological tools and a database that allows one to query, display, and assess monitoring data at local, regional, and national scales. One of the objectives being addressed in this research is the development of a relational database of high priority trace organic compound exposure and effects data. The database will be used to help develop a screening framework that can be used to assess whether impacts on aquatic populations or communities are caused by or could be caused by these compounds of concern.

We started with Tetra Tech's Environmental Data Analysis System2 (EDAS2), a relational database for water monitoring data that includes a graphical user interface (GUI) and is web-enabled. The new WERF Trace Organic Compounds (TOrCs) database (http://werf2.tetratech-ffx.com/Home/Index) includes easy import and export of data, QC tools, data filtering, data query, and screening tools as part of the user interface. WERF TOrCs database includes standardized biological, chemical, and toxicological data elements for reporting water quality results as recommended and defined by the National Water Quality Monitoring Council (NWQMC) and Environmental Data Standards Council (EDSC). The data elements and metadata in WERF TOrCs provide the who, what, when, where, why, and how required for complete and known quality data. Included are EPA's WQX data elements to enable users to export to WQX. The geospatial components of the database include a GIS based interface that allows users to view, query, and select sites on a map interface. The GIS map integrates with the EPA Office of Water data and analytical services to provide additional map layers of geographic information that can be turned on and off by the user. Summary data of selected compounds and locations may be viewed on the map and detailed data are easily exported to a spreadsheet. Data quality and searching are improved through dynamic data completeness and validation. The environmental data management and analysis tools included in the WERF TOrCs database are based on 17 years of experience working with tribal, state, and federal agencies engaged in managing and analyzing water quality data.

Atrazine ecological exposure monitoring program: study design and conduct

Christopher Harbourt[2], Les Carver[3], Paul Miller[2], Nathan Snyder[3], Jennifer Trask[3], Elizabeth Johnston[3], SunMao Chen[1], Paul Hendley[1]
[1]Syngenta Crop Protection Inc., Greensboro, NC; [2]Waterborne Environmental Inc., Champaign, IL; [3]Waterborne Environmental Inc., Leesburg, VA

Abstract
An Atrazine Ecological Exposure Monitoring Program (AEMP) was initiated in 2003 and continues in 2009. Monitoring in 45 corn and sorghum agricultural watersheds in nine Midwestern states produced over 95 "site years" of land use, residue, total suspended solids, meteorological, and stream flow data. Sampling locations were identified on streams at the outlets of watersheds based on defined criteria for potential atrazine use and watershed scale. Watershed sampling locations were equipped with an integrated system of weather stations, automatic samplers, and stream stage measurement stations. Monitoring in each watershed was designed to collect four-day grab samples during the five month growing season. Runoff event based and daily automatic sample collection programs were used during the study. Land use was characterized by customized satellite image classification or USDA NASS Cropland Data Layer data. Results show that the AEMP study design adequately captured atrazine runoff events following chemical applications for each growing season.

National SSURGO based modeling at the field scale: Comparative exposure potential via PRZM modeling and determining depth to a restrictive or claypan layer

Paul Miller[2], Mark Cheplick[3], Jessica Prenger[2], Luke Zwilling[2], Dahzi Mao[2], Christopher Harbourt[2], and Paul Hendley[1]
[1]Syngenta Crop Protection Inc., Greensboro, NC, United States; [2]Waterborne Environmental Inc., Champaign, IL, United States; [3]Waterborne Environmental Inc., Leesburg, VA, United States

Abstract
A probabilistic modeling framework was developed based on PRZM (Pesticide Root Zone Model). Simulations were parameterized to represent atrazine environmental fate scenarios for soils based on the available SSURGO (Soil SURvey GeOgraphic) soils database at the CONUS (COntinental National United States) level. The simulation runs were configured using the SAMSON meteorology dataset, SSURGO county databases, atrazine chemical characteristics, and cropping parameters representing conventional corn/sorghum cropping across the CONUS region. Simulation results were then adjusted using estimates of corn/sorghum derived from remotely sensed data and proprietarily available atrazine usage. Results are presented in a probabilistic framework and were used to rank potential watershed sensitivity for runoff potential across the US.

The Atrazine Ecological Monitoring Project (AEMP) identified a small cluster of watersheds having extended-duration concentrations of atrazine in Northeastern Missouri. A few field-scale publications indicated that the presence of a shallow claypan layer can cause rapid shallow interflow like processes and a hypothesis was developed that the landscape-dominant presence of soils with shallow/restrictive claypan layers that are cropped and treated is critical in identifying and ranking watersheds. Evaluation of this hypothesis, processing of results on a national scale, and ranking of watershed sensitivities will be presented.

Design and implementation of a study to determine the occurrence and fate of fungicides in aquatic ecosystems

Timothy J. Reilly[1], Kelly L. Smalling[2], James L. Orlando[2], Kathryn M. Kuivila[2], William A. Battaglin[3], Michael T. Meyer[4], and Mark W. Sandstrom[5]
[1]U.S. Geological Survey, New Jersey Water Science Center, W. Trenton, NJ; [2]U.S. Geological Survey, California Water Science Center, Sacramento, CA; [3]U.S. Geological Survey, Colorado Water Science Center, Lakewood, CO; [4]U.S. Geological Survey, Kansas Water Science Center, Lawrence, KS; [5]U.S. Geological Survey, National Water Quality Laboratory, Lakewood, CO

Abstract
Fungicides include organic compounds that span many chemical classes and vary with respect to their hydrophobicity, persistence, and toxicity. Data that document the fate and effects of fungicides in the aquatic environment are limited despite decades of agricultural and urban use. The presence of new plant diseases (Asian Soybean Rust), persistence of older diseases (Late blight), and increased fungal resistance has led to the development of new fungicides and expansion of their use. To investigate the occurrence and fate of some of the highest-use fungicides, studies are being conducted by the US Geological Survey Toxic Substances Hydrology Program. In the United States, potatoes receive

3,270 metric tons of fungicides per year. Because potatoes are typically grown in well-drained soils, fungicides used in these agricultural settings may be easily transported to groundwater systems. The fungicides most widely used on potatoes include chlorothalonil and organometallic compounds, but use of newer compounds such as conazoles and strobilurins is increasing as a result of their greater effectiveness and lower application rates. The study has been designed to evaluate areas of intense fungicide use near sensitive aquatic environments. Results will assist stakeholders planning to design or augment water quality monitoring programs and will be used in assessing the impact of fungicides on aquatic ecosystem health.

Study sites are located in Idaho, Maine, and Wisconsin with intense potato cultivation in sandy soils. They are located in first-order stream drainage basins that represent a range of climatic and hydrologic settings. Samples collected from streams, groundwater, suspended and bed sediments, soils, and unsaturated and saturated zone sediments are being analyzed for a suite of 33 fungicides using gas chromatography/mass spectrometry. Initial results indicate that chlorothalonil, fludioxinil, boscalid, pyraclostrobin, and azoxystrobin are frequently detected in the surface waters draining the study sites. A better understanding of the occurrence and fate of these fungicides will be developed once groundwater, core sample, and stream sediment analyses are completed.

Foliar Fungicides in Nebraska Streams

Jason Vogel[1], Mark Sandstrom[2]
[1]US Geological Survey, Lincoln, NE; [2]US Geological Survey, Denver, CO

Abstract
Foliar fungicides are applied to foliage in urban and agricultural landscapes to kill or inhibit the growth of fungi on plants. The U.S. Geological Survey completed a study from May through September 2008 to determine the occurrence of fungicides in surface-water samples from six streams in eastern Nebraska. The samples collected during this study were analyzed for the fungicides azoxystrobin, boscalid, chlorothalonil, cyproconazole, metconazole, myclobutanil, cis-propiconazole, trans-propiconazole, pyraclostrobin, tebuconazole, tetraconazole, and trifloxystrobin. This presentation will compare fungicide occurrence in a stream draining a mixed urban/agricultural watershed to occurrence in streams draining agricultural watersheds within the study area. Results indicate that more types of fungicides were detected in the mixed urban/agricultural stream than in the agricultural stream, and that timing of fungicide occurrence in the stream was also different in the urban watershed compared to the agricultural watersheds.

A new approach in studying the sources of salinization in the Rio Grande

Anna Szynkiewicz[1,2], David Borrok[2], James Witcher[3], Lisa M. Pratt[1]
[1]Department of Geological Sciences, Indiana University, Bloomington, IN; [2]Department of Geological Sciences, University of Texas at El Paso; [3]Witcher and Associates, Las Cruces, NM

Abstract
The Rio Grande River is located in an arid climate zone and it is used mainly as a municipal water supply and for agriculture. High evaporation rates and groundwater recharge associated with salt-rich sedimentary rocks increase the solute content of the river. Irrigation likely contributes additional constituents into the Rio Grande; however, no information has been acquired on the potential role of fertilizers in salinization. To assess the effect of agricultural on water resources, in 2007 and 2008 we determined the chemistry and sulfur isotope composition ($\delta^{34}S$ of sulfate) for the Rio Grande and for several commonly used fertilizers to evaluate potential impact on the Rio Grande from Espanola to El Paso. The $\delta^{34}S$ of sulfate ranged from -4.2 to +2.0 ‰ over this ~500 km distance and was significantly lighter compared to natural sulfate inputs of geologic origin (ranging from +6.1 to +12.9 ‰). The $\delta^{34}S$ of commonly used liquid and solid fertilizers varied over similar range to the river, -2.1 to +4.8 ‰, suggesting that fertilizers contribute to the Rio Grande sulfate ions. Other potential sources of lower $\delta^{34}S$ of sulfate may include municipal waste streams into the river and biogenic processes in soils and shallow groundwater.

Our preliminary results suggest that $\delta^{34}S$ value of sulfate may be a valuable tracer for studying the effect of agricultural and urban development on water resources in semi/arid environments.

Assessment of Methylmercury Source Areas in Headwater Catchments in South Carolina and New York

Paul M. Bradley[1], Celeste A Journey[1], Karen R Murray[2], Douglas A Burns[2]
[1]U.S. Geological Survey, South Carolina Water Science Center, Columbia, SC, United States; [2]U.S. Geological Survey, New York Water Science Center, Albany, NY, United States

Abstract
The USGS National Water Quality Assessment Program (NAWQA) is investigating the ecological interactions affecting methylmercury (MeHg) accumulation in the water-columns and indigenous biota of surface water systems across the USA. Previous NAWQA research examined environmental factors associated with biotic mercury (Hg) burdens in intermediate reaches of eight nationally distributed stream basins. Results indicated that main-channel, water-column MeHg concentrations were an integrated reflection of the cumulative supply of MeHg from up-gradient (upstream and out-of-channel) sources. The current focus is on the sources, transport, and bioavailability of MeHg in two headwater catchments (Fishing Brook in the Adirondacks region of New York; McTier Creek in the Atlantic Coastal Plain of South Carolina) in which clear hydrologic and geochemical connections have been demonstrated between the main stream channels (the presumptive primary habitat for higher trophic-level fish species) and the out-of-channel wetland environments (the presumptive primary locations of Hg methylation and MeHg supply). Spatial variability within each study catchment was assessed based on concentrations and area-weighted fluxes of dissolved MeHG from selected catchment sub-compartments. Relatively little spatial variability was observed in the McTier Creek system, suggesting a similar supply of MeHg and water to the stream channel throughout the study area. In contrast, substantial spatial variability was observed in the Fishing Brook system, with distinct areas of MeHg supply and removal being identified. In both study catchments, maximum dissolved MeHg concentrations were observed in out-of-channel wetland areas.

Mercury Trends in Fish from U.S. Rivers and Lakes, 1969 - 2005

Ann T. Chalmers[1], Denise M. Argue[2], David A. Gay[3], Mark E. Brigham[4], Christopher J. Schmitt[5], and Dave L. Lorenz[4]
[1]U.S. Geological Survey, Montpelier, VT, telephone: 802-828-4511, email: chalmers@usgs.gov; [2]U.S. Geological Survey, Pembroke, NH; [3]Illinois State Water Survey, Champaign, IL; [4]U.S. Geological Survey, Mounds View, MN; 5U.S. Geological Survey, Columbia, MO

Abstract
A national compilation of fish-mercury concentration data from state and federal monitoring programs was used to analyze trends in mercury (Hg) concentrations in fish from rivers and lakes across the U.S. Trends were analyzed by site and by state using samples of the same fish species, and tissue type, and using fish of similar lengths. Trends were evaluated during two time periods, 1969 – 1987, and 1988-2005. In addition, trends for the most recent fish data (1995 – 2005) were compared to trends in wet Hg deposition data from the Mercury Deposition Network (MDN) for the same period. Downward Hg trends in fish from data collected during 1969-1987 exceeded upward trends by a six to one ratio. Downward Hg trends in fish during the 1970s and 1980s are consistent with decreases in atmospheric Hg deposition inferred from many records of sediment, ice, and peat cores. The southeastern U.S. had more upward trends in fish than other regions of the country.

Upward Hg trends in fish from the southeastern U.S. were supported by increases in wet deposition in the region and may be attributed to a greater influence of global atmospheric emissions to the southeastern U.S. No significant trends were found in 62 percent of the fish data aggregated by state from 1996 to 2005. A lack of Hg trends in fish in the more recent data was consistent with the lack of trends in Hg wet deposition at MDN sites and relatively constant global emissions over the same time period. Although few significant trends were observed in the more recent Hg data in fish, it is anticipated that Hg concentrations in fish may decrease with decreases in atmospheric Hg deposition, however, the magnitude and timing of the response is uncertain.

Spatial and Temporal Trends in Atmospheric Deposition in the Pensacola Bay Watershed

J.M. Caffrey[1], W.M. Landing[2], S.D. Nolek[3], K. Gosnell[2], S.S. Bagui[4], S.C. Bagui[5]
[1]Center for Environmental Diagnostics and Bioremediation, University of West Florida, 11000 University Parkway Pensacola, FL 32514; [2]Department of Oceanography, Florida State University, 1015 West Call Street, Tallahassee, FL 32306-4320; [3]PetroAlgae, 1901 S. Harbor City Blvd., Suite 300, Melbourne, FL 32901; [4]Department of Computer Science, University of West Florida, 11000 University Parkway, Pensacola, FL 32514; [5]Department of Mathematics and Statistics, University of West Florida, 11000 University Parkway, Pensacola, FL 32514

Abstract
Event based atmospheric deposition of mercury, trace metals and major ions has been monitored in the Pensacola Bay (Florida) watershed over the last 3 years at 3 locations to evaluate the temporal and spatial patterns in atmospheric wet deposition. A goal of this project was to evaluate the contribution of local sources (coal fired power plant and paper mill) to atmospheric deposition. There were no significant differences in the rainfall mercury flux between the three sites or between the Pensacola Bay sites and nearby Mercury Deposition Network monitoring sites along the Gulf Coast. Mercury deposition during the summer months is higher than other months due to higher concentrations in rainfall throughout the region. Correlation of mercury with other elements and major ions suggest that coal combustion is a significant source of mercury to the region, and may account for between 25 and 54% of the mercury deposited. Deposition of constituents like H+, sulfate, nitrate, ammonium, chloride and sodium, are much higher in Pensacola Bay that at NADP sites. Chloride and sodium fluxes are higher because Pensacola Bay sites are closer to the Gulf of Mexico which is a source of sea salt aerosols. Acid rain constituents, H+, sulfate, nitrate and ammonium are most likely higher at Pensacola Bay sites than NADP sites because Pensacola Bay sites are much closer to emission sources of these constituents than NADP sites, particularly the two Florida NADP sites FL14 and FL23 which are located in rural counties far from major industrial activities.

The NADP's Mercury Deposition Network: lessons from a continental-scale monitoring network

David A. Gay
National Atmospheric Deposition Program, Institute of Natural Resource Sustainability, University of Illinois, 2204 Griffith Drive, Champaign, IL 61820, 217.244.0462, dgay@illinios.edu

Abstract
Since 1978, the National Atmospheric Deposition Program (NADP) has tracked the status and changes in the many different chemical compounds within precipitation across the continent. The NADP monitors the removal of pollutants from the atmosphere; but as importantly, it monitors the addition of chemical compounds into the Biosphere of North America. In 1996, the Mercury Deposition Network began monitoring total and methyl mercury wet deposition in the U.S. and Canada (currently at 113 sites). Our primary charge has been to provide data for the determination of both spatial and temporal trends in mercury wet-deposition. And during these 14 years and with the 40,000 or so measurements of mercury wet deposition (and also the 350,000 basic chemical measurements from the NTN network), NADP has shown the value of consistent monitoring techniques, high quality assurance standards, and rigorous attention to procedures and data validation. This has allowed MDN data to be use to reliably quantify the flow of mercury into the environment, map this distribution over the U.S. and southern Canada, and identify and estimate trends.

This presentation will be used to discuss a) the general description of the network design; b) how we have successfully sustained financing over the years; c) how we maintain our data quality; d) new directions of the NAPD (dry Hg deposition); and e) a few lessons we have learned over the years. This information should be of interest for people contemplating starting their own cooperative-style networks for water-quality or ecosystem based observations.

Evaluating Mercury Issues Resulting from Historical Mining Activities at Two U.S. Army Corps of Engineers Managed Reservoirs in Northern California

Daniel Holmberg, John J. Baum and Tommy Waldrup
U.S. Army Corps of Engineers Sacramento District, 1325 J Street, Sacramento, California 95814

Abstract
Several water bodies within California are listed as impaired due to mercury contamination. Two United States Army Corps of Engineers (USACE) managed reservoirs with mercury concerns are Lake Englebright and Lake Sonoma. When examined together, the reservoirs encompass two main sources for mercury deposition in California water bodies due to the gold mining industry. The first, Lake Sonoma located north of San Francisco, is in close proximity to mercury mines that were abundant in the Coastal Range of California. Skaggs Springs quicksilver mine, active in the 1940s, was actually submerged in Lake Sonoma upon completion of the dam. Lake Englebright, located in the Sierra Nevada mountain range, was built in the 1940s with the intent of catching sediment from hydraulic gold mining run-off. Hydraulic mining methods in the Sierra Nevadas include the use of mercury extracted from the Coastal Range resulting in widespread mercury contamination of Northern California.

Interest in mercury issues within reservoirs has grown and fish consumption advisories are in place at both facilities. Currently the California State Water Resources Control Board is coordinating a study that anticipates developing Total Maximum Daily Load (TMDL) values for Lake Sonoma. Several steps have been taken to evaluate the scope of the mercury problem.

The monitoring program implemented at USACE Sacramento District involves bi-annual measurement of chemical characteristics, physical qualities, and phytoplankton species counts. Vertical profiles and grab samples are taken in areas of concern and the USACE analyzes the data for possible problematic trends and baseline values. At Lake Sonoma and Lake Engelbright an annual coordination is performed with local park staff and anglers to provide fish for laboratory analysis. Ongoing coordination with outside agencies takes place as issues develop. The fish tissue levels of methyl-mercury are much more elevated when compared to total mercury samples taken from the reservoir indicating the affects of bioamplification.

The current goals of the USACE reservoir monitoring program are to improve sharing of data between agencies, continue to evaluating the usability of historical data, identify specific hot spots or areas of concern, and inform the public of any issues.

Long-Term, Statewide, Multi-Scale Monitoring of Mercury and Methylmercury in Indiana Watersheds, 2002–2009

Martin R. Risch and Amanda L. Egler
U.S. Geological Survey, Indiana Water Science Center, Indianapolis, Indiana, United States

Abstract
The U.S. Geological Survey (USGS), in cooperation with the Indiana Department of Environ-mental Management monitored concentrations of total mercury and methylmercury in water samples from Indiana streams from 2002–2009. Quarterly monitoring was done statewide at or near 25 USGS stream-gaging stations. The network included watersheds with different types of land cover and upstream drainage areas ranging from 152 km^2 to 74,293 km^2. The data included 8 years of monitoring from 14 stations and 2 to 4 years from 23 stations. In total, 636 stream-water samples from 37 stations were analyzed, along with 207 quality-control field blank and duplicate samples. Samples were collected and processed with ultra-clean protocols and analyzed with low-level methods. Quality-control results indicated the data were unbiased and representative. Data from these samples represent major watersheds draining most of Indiana, multiple seasons, and a range of streamflow conditions.

Median whole-water total mercury concentrations were 2.32 nanograms per liter (ng/L) in 2002–2006 and 2.45 ng/L in 2007–2009. The maximum whole-water total mercury concentration was 38.3 ng/L. When these concentrations were compared to Indiana water-quality criteria for mercury, 6 percent exceeded the 12 ng/L chronic-aquatic criterion, 61 percent exceeded the 1.8 ng/L Great Lakes human-health criterion, and 74 percent exceeded the 1.3 ng/L Great Lakes wildlife criterion. Mercury concentrations were related to streamflow; the highest mercury concentrations were associated with the highest streamflows. On average, whole-water total mercury was 67 percent particulate in samples from 2002-2006 and 75 percent particulate in samples from 2007-2009. Particulate total mercury concentrations were significantly lower downstream from dams.

The median whole-water methylmercury concentration was 0.1 ng/L in 2002-2009. In streams with flow that was not impeded by dams, the median percentage of methylmercury was 3.7 percent in 2002–2006 and 3 percent in 2007–2009. The percentages of methylmercury in water were significantly higher in samples collected downstream from reservoirs.

Atmospheric mercury wet deposition was a predominant source but not the single source of mercury loading to Indiana watersheds. Mercury in wastewater discharges and atmospheric mercury dry deposition contributed a substantial portion of the mercury yield from some watersheds.

Spatial Patterns of Mercury Concentrations in Stream Biota of Forested Catchments in New York and South Carolina

Karen Riva-Murray[1], Lia S. Chasar[2], Douglas A. Burns[1], and Paul M. Bradley[3]
[1]U.S. Geological Survey, New York Water Science Center, Troy, NY, United States; [2]U.S. Geological Survey, Florida Water Science Center, Tallahassee, FL, United States; [3]U.S. Geological Survey, South Carolina Water Science Center, Columbia, SC, United States

Abstract
Recent studies of streams across the nation have revealed a widespread occurrence of fish mercury concentrations that are elevated in relation to human-health and wildlife-health guidelines. Many of these occur in forested landscapes to which the principal source of mercury is atmospheric deposition, and which have environmental characteristics that favor the transformation of atmospherically-deposited elemental mercury into methylmercury, which is the toxic and bioavailable form. Methylmercury is biomagnified in aquatic food webs such that long-lived and predaceous organisms can have mercury concentrations many orders of magnitude higher than surface water concentrations. The purpose of our study was to investigate the linkages between mercury bioaccumulation in streams and factors associated with the production and transport of methylmercury to those streams. We evaluated spatial variation of methylmercury in biota and water across a relatively heterogeneous 26 square mile headwater catchment of New York's Central Adirondacks, and a 30 square mile, more homogeneous headwater catchment of South Carolina's Inner Coastal Plain.

Several functional feeding groups of macroinvertebrates (scraper, shredder, and predator), and fishes (omnivorous, invertivorous, and piscivorous) were collected from eight sites in the Fishing Brook catchment (Hamilton and Essex Counties, NY), and three sites in the McTier Creek catchment (Aiken County, SC). Samples were collected seasonally during 2007-2009, in conjunction with the collection of water samples. Invertebrates were analyzed for methylmercury, and fish were analyzed for total mercury. Mercury concentrations increased with trophic (feeding) level in both NY and SC study areas. Concentrations within most functional feeding groups were not significantly different between NY and SC, and were not different among SC sites (ANOVA $p > 0.05$), but were highly variable among the NY sites. Mercury concentrations in aquatic biota within functional feeding groups were strongly related to measured concentrations of aqueous methylmercury and DOC. In the heterogeneous landscape of the Fishing Brook catchment, the spatial patterns of methymercury concentrations in biota were strongly related to hydrogeomorphic factors such as catchment slope that indicate favorable conditions for methylmercury production.

MercNet: A Comprehensive Framework to Monitor Responses to Changing Mercury Loads

David Schmeltz[1], Richard Artz[2], Charles T. Driscoll[3], David Evers[4], David Gay[5], Richard Haeuber[1], David P. Krabbenhoft[6], Rob Mason[7], Greg Masson[8], Kristi Morris[9], James G. Wiener[10]
[1]U.S. EPA, Office of Atmospheric Programs, Washington D.C.; schmeltz.david@epa.gov; [2]NOAA, Silver Spring, MD; [3]Syracuse University, Syracuse, NY; [4]BioDiversity Research Institute, Gorham, ME; [5]National Atmospheric Deposition Program, University of Illinois, Champaign, IL; [6]U.S. Geological Survey, Middleton, WI; [7]University of Connecticut, Groton, CT; [8]U.S. Fish and Wildlife Service, Arlington, VA; [9]National Park Service, Denver, CO; [10]University of Wisconsin-La Crosse, La Crosse, WI

Abstract
EPA in partnership with other federal, state, and tribal agencies, academic scientists and scientists from research and monitoring organizations are collaborating to establish a national, policy-relevant network that measures mercury in the atmosphere, land, water, and biota in terrestrial, freshwater, and coastal ecosystems. Scientists, policy-makers, and resource managers need a comprehensive, long-term monitoring program to help answer critical questions related to changes in mercury emissions and deposition and ecosystem effects and responses, and to provide comprehensive mercury data for developing and refining predictive models. Considerable progress has been made in the design of a national mercury monitoring program. In 2003, ~ 40 scientists from across the U.S. and several other countries assembled to discuss the major elements of a network whose purpose was to detect environmental responses to anticipated changes in mercury deposition. Detailed recommendations from this workshop were published in the scientific literature (Mason et al. 2005, Harris et al. in 2007). At a follow-up workshop in May 2008, ~ 50 U.S. and Canadian scientists met to discuss the major design elements of a functioning mercury monitoring network - MercNet. At the workshop, scientists agreed on the overall goal and objectives of a network and considered a conceptual network of monitoring sites distributed across the U.S. Since 2008, significant progress has been achieved by improving the capacity and coordination of several key programs: the National Atmospheric Deposition Program's (NADP) newly established atmospheric mercury/dry deposition network (AMNet), and collaborative efforts to develop common mercury multi-

media databases for the Great Lakes region. Lastly, MercNet is the scientific underpinning of Congressional legislation introduced in late 2009 - *S.2913* The Comprehensive National Mercury Monitoring Act.

Factors Influencing Mercury Bioavailability and Accumulation in Ozark Stream Ecosystems

Christopher J. Schmitt[1], Craig A. Stricker[2], William G. Brumbaugh[1]
[1]U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO; [2]U.S. Geological Survey, Denver Federal Center, Denver, CO

Abstract
Mercury (Hg) is a ubiquitous pollutant released to the environment from natural and anthropogenic sources. Although much of the Hg in aquatic ecosystems originates as inorganic Hg, biogeochemical processes can convert inorganic Hg to the highly toxic methyl mercury (MeHg), which bioaccumulates and biomagnifies in aquatic ecosystems. Concentrations of Hg (as MeHg) in predatory fishes tend to increase with fish age and body size. The Missouri Department of Health and Senior Services recommends that sensitive populations (pregnant women, women of childbearing age, nursing mothers, and children <13 y old) consume not more than one meal per month of black basses (*Micropterus spp.*) of $\geq$12 inches (305 mm) total length (TL), including smallmouth bass (*M. dolomieu*) from Ozark streams. Our objective was to document pathways and mechanisms of Hg bioaccumulation in stream ecosystems. Samples of crayfish (*Orconectes spp.*), Asian clam (*Corbicula fluminea*), northern hog sucker (*Hypentelium nigricans*), and smallmouth bass were collected from sites in the Current River, Eleven Point River, and Big River systems of southeastern Missouri and analyzed for total Hg and for stable isotopes of carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and sulfur ($\delta^{34}S$). Total Hg concentrations were lower and $\delta^{15}N$ was higher in all biota from the Big River than the other streams investigated, which were similar to each other. On average, total Hg was lowest in crayfish and highest in smallmouth bass. Concentrations in smallmouth bass and hog suckers were strongly correlated with concentrations in crayfish, but not in *Corbicula*. Total Hg and trophic position (computed from $\delta^{15}N$) in hog suckers increased with TL at several sites whereas neither variable changed with TL in smallmouth bass. Regression models incorporating TL and trophic position, $\delta^{15}N$, or both accurately and precisely predicted total Hg concentrations in smallmouth bass and hog suckers regardless of collection location, whether the species were considered separately or together. Large hog suckers, which may be eaten by sport fishers, tended to occupy the same trophic position and contain as much Hg as similar-sized smallmouth bass, and could therefore warrant restricted human consumption.

Mercury in Fish, Bed Sediment, and Water from U.S. Streams, 1998–2005

Barbara C. Scudder[1], Lia C. Chasar[2], Dennis A. Wentz[3], Nancy J. Bauch[4], Mark E. Brigham[5], Patrick W. Moran[6], and David P. Krabbenhoft[1]
[1]U.S. Geological Survey, Middleton, WI; [2]USGS, Tallahassee, FL; [3]USGS, Portland, OR; [4]USGS, Lakewood, CO; [5]USGS, Mounds View, MN; [6]USGS, Tacoma, WA

Abstract
The main source of mercury to natural waters of the U.S. is inorganic mercury that is emitted to the atmosphere and deposited with precipitation or dry particles. However, atmospheric deposition alone does not explain high mercury levels in fish from our nation's streams. Specific ecological conditions can enhance the conversion of inorganic mercury to the more toxic organic form, methylmercury, which is readily taken up and retained by aquatic organisms. Over 95% of the mercury in fish is methylmercury. From 1998 to 2005, mercury was examined in top-predator fish, bed sediment, and water from 291 streams in targeted land use/land cover settings across the nation. Sampled settings included stream basins that were agricultural, urbanized, undeveloped (forested, grassland, shrubland, and wetland land cover), and mined (for gold and mercury). The highest fish mercury levels were from southeastern and eastern Coastal Plain streams draining largely undeveloped forested and wetland basins, as well as from western streams draining gold- or mercury-mined basins. Fish from more than a quarter of sampled sites were found to contain mercury at levels exceeding the 0.3 ppm U.S. EPA criterion for the protection of people who consume average amounts of fish. Fish from more than two-thirds of sampled sites exceeded 0.1 ppm, the level of concern for fish-eating mammals. Mercury in largemouth bass was related to methylmercury in stream water which, in turn, is related to the amount of mercury input to a stream basin, the amount of organic carbon in the water, and the susceptibility of the stream basin to transform mercury to methylmercury. Findings from this study will be helpful to natural resource managers who need to anticipate where they may expect higher mercury levels in water and fish.

Rates, Reasons, and Patterns for Site Attrition in the EPA's National Aquatic Resource Surveys

Jennifer Linder[1], Tara Kolodiej[1], Michael Barbour[1], Ellen Tarquinio[2], Anthony Olsen[3]
[1]Tetra Tech, Inc., Center for Ecological Sciences, Owings Mills, MD; [2]U.S. Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans, and Watersheds, Washington, DC; [3]U.S. Environmental Protection Agency, Western Ecology Division, ORD/National Health and Environmental Effects Laboratory, Corvallis, OR

Abstract
A Generalized Random Tessellation Stratified (GRTS) survey design was used to select the target population of streams, rivers, and lakes for the EPA's National Aquatic Resource Surveys. The target populations included randomly selected waterbodies on both public and private property. All selected waterbodies were assumed to meet the study definition of a stream, river, or lake before the site evaluation process began. After the site evaluation process, many waterbodies were rejected because they were either non-target (did not meet the study definition) or they physically could not be sampled. In addition to the various physical reasons, landowner denial to access a waterbody on private property was another major reason that prevented field teams from sampling a selected site. When a site was rejected, a site from an "oversample" list was evaluated to replace it. We have looked at the site attrition data for the Wadeable Streams Assessment (WSA), the National Lakes Assessment (NLA), and the National Rivers and Streams Assessment (NRSA) to determine the rates, reasons, and possible geographic patterns for site attrition.

Lac du Flambeau Tribal Participation in the National Lake Assessment: Benefits of Local Level (10-digit HUC "Watershed Units") Involvement in National Assessments

Gretchen Watkins
Water Resource Specialist/Hydrologist, Lac du Flambeau Band of Lake Superior Chippewa Indians, Lac du Flambeau, WI

Abstract
The Lac du Flambeau Band of Lake Superior Chippewa Indians (Tribe) is using the National Lakes Assessment (NLA) study to enhance the Tribal Water Resource program. The ability to develop protective site-specific water quality criteria and assess lake health is limited when available data covers only a small geographic area such as 87 thousand acres of the Lac du Flambeau Reservation. Tribal participation in the NLA enabled the Tribe to compare reservation lake data to national and regional lake health. The Tribe used the NLA protocols for physical habitat, water chemistry, and vertical water profiles on an additional 11 lakes within the reservation. These data are being entered into EPA's Water Quality Exchange (WQX) using an excel template to ensure data uniformity for comparison. The Tribe will develop lake report cards that assess the health of reservation lakes as compared to national and regional lake health. The report cards will then be distributed to the general public,

managers, and decision makers. Comparison of data collected on the reservation following the national lake assessment protocol will also enable to the Tribe to develop site specific nutrient criteria using a statistically valid NLA datasets. Nutrient criteria developed for specific Tribal water uses are vitally important to protect native traditions and the way of life for the next seven generations of the Lac du Flambeau Tribe.

Application of National Lake Assessment Tools and Approaches in New Jersey Department of Environmental Protection's Ambient Lake Monitoring Network: Successes and Challenges with Integrating the State and National Scale Assessments

Victor Poretti
New Jersey Department of Environmental Protection, Water Monitoring and Standards, Bureau of Freshwater and Biological Monitoring

Abstract
New Jersey's Ambient Lake Monitoring Network (ALMN) staff participated in the 2007 sampling of NJ lakes for the National Lake Assessment (NLA) study, with only eight lakes chosen in NJ. Several components of the national study are being considered for incorporation into New Jersey's program for a more robust assessment of the State's lakes. Specifically, the NLA assessment tools derived for Total Nitrogen, as NJ does not have established criteria for this parameter, and a Physical and Shoreline Habitat assessment similar to that used in the NLA given that the draft results of the NLA have shown habitat to be a key indicator. The lakes in NJ's network were probabilistically chosen using a GRTS based approach similar to the NLA study, with one significant design difference. The entire NJ-ALMN consists of 200 lakes, with 40 lakes sampled / year, seasonally, on a five year rotation. However, in the NJ network the selection of candidate lakes excluded potable water reservoirs actively being managed as drinking water sources, since the management of these reservoirs precludes them from behaving like natural lentic ecosystems. This distinction was not made in the NLA survey so it is believed that the data generated by the state cannot be integrated with the NLA data.

The NLA provides a broad geographic scale assessment of the nation's lentic resource condition. In order for the water quality data generated from the NLA to be of greater value to the States in performing CWA Section 106 mandated assessments, the future national study design may benefit from being more finely tuned to local and regional lentic resource characteristics. Greater equity among the states in the designation of monitoring stations would be desirable, so that each state is assigned a minimum number of stations necessary for a valid probabilistic assessment of its own lake water resources within an acceptable level of confidence. This would enable states to either initiate their own ambient lake monitoring program using the NLA sites within their state as the network foundation, or to use the NLA sites to supplement / enhance an existing ambient lentic network.

The Evolution of the Missouri Ambient Water-Quality Monitoring Network

Miya N. Barr
U.S. Geological Survey, Missouri Water Science Center

Abstract
The U.S. Geological Survey (USGS) in cooperation with the Missouri Department of Natural Resources (MDNR), collects data pertaining to the surface-water resources of Missouri as part of the Ambient Water-Quality Monitoring Network (AWQMN), considered one of the premier networks of its kind in the Nation. These data constitute a valuable source of reliable, impartial, and timely information for developing an improved understanding of water resources in the State. The AWQMN was established in 1964 with 18 surface-water quality stations, grew to 41 stations by 1986, then decreased to only 5 stations during the 1991 water year. By 1994 MDNR funding allowed the AWQMN to increase to 39 stations. The size of the AWQMN has remained stable over the past 5 years with samples collected at 60 to 65 stations.

Stations within the AWQMN are sampled 6 to 12 times per year for physical properties, major ions, total suspended solids, select nutrients, fecal indicator bacteria, select trace metals, and pesticides. The data are published annually in the USGS Annual Water Data Report and also are available on the USGS National Water Information System website. In addition, an annual statistical summary of the data collected at all stations within the AWQMN has been published since 2007.

The USGS is currently (2010) analyzing and evaluating data collected from 1993 to 2008 at six stations that were chosen by the MDNR. Current water-quality conditions are being assessed to develop relationships between stations and comparisons to the State water-quality standards. Long-term trends are being analyzed using flow and non-flow adjusted models.

Future objectives include: evaluating baseline water-quality conditions, comparing selected constituents across the entire AWQMN, analyzing long-term trends in select constituents, determining loads contributed by major river basins to the Missouri and Mississippi Rivers, and to evaluate the AWQMN to determine if the objectives of the network itself are being met, such as proper quality control and quality assurance, sampling frequency, consitiuents analyzed, and location of sampling stations.

Status Network Water Quality Sampling within the St. Johns River Water Management District: The Second Sampling Cycle (2004 to 2008)

Aisa Ceric[1], Steve Winkler[1], Gail Sloane[2], and Thomas Seal[2]
[1]St. Johns River Water Management District, Division of Environmental Sciences, Palatka, Florida; [2]Department of Environmental Protection, Watershed Monitoring Section, Tallahassee, Florida

Abstract
Since 1996, the Florida Department of Environmental Protection (FDEP) and the Environmental Protection Agency (EPA) have been working together to implement a new kind of water quality monitoring network, known as the Integrated Water Resources Monitoring (IWRM) - Status Monitoring Network. This is a probabilistic network whereby 30 randomly selected sites of each of six inland water body types are sampled only once in a specific area of the state called a Reporting Unit. The main advantages of the Status Network are two-fold 1) elimination of sampling bias in the data collection and 2) establishment of a database that can be used for determination of statewide or region-wide conditions. FDEP contracted the St. Johns River Water Management District (SJRWMD) to sample surface water quality sites in its area. During the period from 2000 to 2008, two sampling cycles were completed. This poster presents results from the second five-year sampling cycle that started in 2004 and ended in 2008. During the last cycle, one or two of seven basins in the SJRWMD were sampled each year and 30 samples were collected for each of four surface water body resource types (major rivers, streams, large lakes, and small lakes) in each basin. The resource types were sampled during a so-called "index period", which was established as a time of the year with high biological activity. Thus, the Status Network would potentially indicate the "worst-case scenario" for the selected indicator of each resource type. In general, the Status Network is useful for: 1) characterizing regional and basin water resource conditions using a rotating, multi-year probabilistic sampling approach, 2) determining percentages of each resource type that met/exceed state standards within each reporting unit with known confidence limits using core indicators (e.g., DO < 5.0 mg/L), 3) comparing resource conditions within reporting unit, region and state (e.g., Ocklawaha River Basin to St. Marys-Nassau Basins), and 4) comparing resource types with each other (e.g., large lakes to small lakes).

Establishing a Monitoring Network to Characterize Changes in the Groundwater System along the All American Canal, Southeast California

Alissa Coes[1] and Michael Land[2]
[1]U.S. Geological Survey, Water Resources Discipline, Tucson, AZ; [2]U.S. Geological Survey, Water Resources Discipline, San Diego, CA

Abstract
The All American Canal (AAC) delivers water from the Colorado River to the Imperial Valley of California. Since its completion in 1940, seepage from the unlined AAC has recharged the groundwater system, resulting in a groundwater mound. In 2007, construction began on lining 23 miles of the AAC; the lining will be completed in 2010.

The Lower Colorado Water Supply Project (LCWSP) is a well field adjacent to the AAC from which groundwater is pumped and delivered into the AAC in exchange for withdrawals upstream from the Colorado River. The Total Dissolved Solids (TDS) concentration of the groundwater pumped by the LCWSP wells must, by agreement between stakeholders, be less than 879 ± 30 mg/L on an average annual flow-weighted basis to be delivered into the AAC; this water-quality criterion has been temporarily waived until January 1, 2027.

Previous studies of the groundwater system and chemistry near the LCWSP suggest there is a potential for increases in TDS as the mounded groundwater under the AAC declines and native (higher TDS) groundwater replaces the recharged AAC water. The objective of this study is to improve the understanding of native groundwater conditions in the vicinity of the LCWSP wells, and to estimate the long-term (up to 2070) impact of the lining of the AAC on those conditions. This current study is the first of three phases in which a monitoring network will be established and an initial characterization of the groundwater system will be completed.

The monitoring network is currently being established near the newly lined AAC with an emphasis on the LCWSP. To date, approximately 70 sites have been inventoried. Groundwater levels are being measured in approximately 45 wells; continuously in 10 of these wells. Samples have been collected from 18 wells and analyzed for major ions, stable isotopes, and tritium. Twelve stations have been established for measurement of gravity. Additional data collected at the LCWSP include depth-dependant wellbore flow and water-quality sampling, and an aquifer test.

Collaborative Monitoring and Quantifying Decreasing Selenium Concentration and Load Trends in the Lower Gunnison Basin

David Kanzer[1] and Kenneth Leib[2]
[1]Colorado River District, Glenwood Springs, CO and Gunnison Basin Selenium Task Force member; [2]U.S. Geological Survey, Water Resources Discipline, Colorado Water Science Center, Western Area Office, Grand Junction, CO and Gunnison Basin Selenium Task Force member

Abstract
The Gunnison Basin Selenium Task Force (GBSTF) monitoring program brings together a diverse set of local volunteer, state and federal water quality monitoring efforts to target and optimize the acquisition of selenium and related water-quality monitoring data in the lower Gunnison Basin. This comprehensive monitoring program has helped create an accurate and extensive water quality database of dissolved selenium, major ions and specific conductivity that has helped quantify concentrations, loads and trends to support a host of crucial Endangered Species Act (ESA) and Clean Water Act (CWA) issues in the Lower Gunnison River Basin. The GBSTF has strengthened partnerships with local stakeholders, leveraged existing water-quality monitoring efforts and has ensured that common sampling and analytical techniques are utilized and that the results are publicly-accessible in common data repositories via the Colorado Data Sharing Network and USGS NWIS. Monitoring events are coordinated to ensure that water quality samples (selenium, total dissolved solids, field parameters, etc.) are collected at strategic times and locations that leverage separate but contemporaneous monitoring efforts (e.g., USGS, Colorado Water Quality Control Division, Colorado Division of Wildlife's RiverWatch Program, etc.). The GBSTF has also teamed up with diverse funding partners to install four additional real-time specific conductivity monitors at existing USGS real-time flow monitoring stations to help develop correlations and to quantify interrelationships between chemical and physical parameters. These collaborative efforts have led to several important conclusions.

Preliminary results indicate significant downward trends in selenium concentrations and loads in the Gunnison River near Grand Junction. Decreases in concentration were approximately 1 to 1.2 parts per billion and the decrease in selenium load was about 20 percent for the period of record (1986-2008). Daily-mean specific conductance and streamflow were used as surrogates to predict the changes in selenium levels over time (USGS, 2010, in press). Collaborative monitoring is crucial to leveraging and refining these important scientific conclusions and the cost-effective and robust datasets that are being crafted in the Lower Gunnison will be the basis for better analysis, modeling and decision-making today and into the future.

Collaborative Development of a North American Spatial Framework for Rivers Assessment and Classification

Joseph E. Flotemersch[1], Paul W. Seelbach[2], Iris A. Goodman[3], James H. Thorp[4], Jonathan V. Higgins[5], Scott P. Sowa[6], and Sheila H. North[7]
[1,3]U.S. Environmental Protection Agency; [2]Institute for Fisheries Research, Michigan Department of Natural Resources, and University of Michigan; [4]Kansas Biological Survey, University of Kansas; [5,6]The Nature Conservancy; [7]Dynamac Corporation c/o U.S. EPA

Abstract
Recognition that rivers function and are threatened at large regional scales demands coordinated science and management planning approaches across traditional geo-political boundaries. In response, powerful river GIS frameworks have been created recently in Ontario and the USA states surrounding the Great Lakes and Missouri River, and new initiatives are developing in the northeastern and southeastern USA and around Chesapeake Bay. Each is a consistent, ecologically meaningful, spatially structured data system that ultimately frames conceptual understanding and communication, data collection and storage, analytical questions and approaches, and reporting. The regional efforts share generally similar conceptual underpinnings and components, and collegial ties exist among their science leaders. However, significant differences in content and utility are developing because of occasional geographic overlap and a lack of coordination in technical development processes. Many opportunities for effective science, education, and management are wasted from this lack of geographic consistencies. This developing data incompatibility among what otherwise will be sophisticated and elegant information systems, will erect significant obstacles to technology transfer among North American river scientists and managers. To address this issue, a multidimensional workgroup is developing a collective vision for a North American spatial framework for rivers assessment and classification. The goal of these efforts is to create a vehicle for coordination among existing regional and national efforts towards common, trans-boundary conceptual, spatial, analytical, and reporting frameworks for river science and assessment. We will discuss here the status of the workgroups and provide a forum for consideration and incorporation of a wider perspective.

Implementation of EMAP procedures on the Missouri River from the Fort Peck Dam, Montana, to Fort Buford, North Dakota

Laurie Shafer and Sandra White Eagle
Fort Peck Assiniboine & Sioux Tribes Office of Environmental Protection, Poplar, MT

Abstract
The Environmental Monitoring and Assessment Program (EMAP) was established in the late 1990s by the U.S. Environmental Protection Agency (EPA) and other entities, as a pilot program to provide unbiased, statistically sound, and policy-relevant assessments of the ecological condition of the nation's Great Rivers. EMAP has developed indicators to monitor and assess the condition of ecological resources at both regional and state scales through the use of physical and chemical measures. This data is then used to estimate the biological integrity of the sites. Since the river sites are randomly selected, the data collected can be used to make regional and statewide estimates of stream condition. EMAP's goal was to further the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into assessments of ecological condition and forecasts of the future risks to the sustainability of our natural resources.

In 2001 EMAP collaborated with the Fort Peck Assiniboine and Sioux Tribes Office of Environmental Protection (FPT-OEP) in an effort to monitor the Upper Missouri River (UMR). For the next four years the FPT-OEP Division of Water Quality monitored the UMR between Fort Buford, North Dakota, and the Fort Peck Dam in Eastern Montana using EMAP protocols. In this approximately 189 mile stretch, 108 randomly generated sites were sampled in three different population areas: (1) River Openwaters (41sites), (2) River Shorelines (51 sites), and (3) River Backwaters (50 sites).

Each site was sampled for chemical, physical, and biological parameters. Chemical samples quantified concentrations of pollutants and conditions that influence aquatic life; physical parameters included measurements of temperature, turbidity, and suspended solids; and, biological data was collected to measure the health of aquatic communities. The pilot project identified sample populations in the river, examined sources of sampling variation in indicators, evaluated sampling protocols and made changes that were needed to these protocols to complete the project.

Expanding the Montana Volunteer Water Quality Monitoring Network and Moving Toward Data Use for TMDL Planning

Suzanna Carrithers and Adam Sigler
Montana State University – Department of Land Resources and Environmental Sciences, Leon Johnson Hall, RM 334, Montana State University, Bozeman, MT 59717-3120

Abstract
Volunteer water quality monitoring is an opportunity to connect with your community, contribute to the understanding and management of your local water resources, and experience hands on learning opportunities with water monitoring. In 2008-2009, the Montana State University Water Quality Program partnered with the Montana Watercourse to develop a volunteer monitoring certification program that expanded on the existing Montana Volunteer Monitoring network. The certification program was designed for groups and individuals who want to advance their monitoring skills and be certified to collect data of sufficient quality for use in water resource decision making.

The overarching goals of the Volunteer Monitoring Certification program were to 1) facilitate well trained, committed, conscientious water monitoring volunteers who play an important role in protecting and restoring water quality in Montana; 2) provide rigorous training through a certification program designed to give dedicated volunteer monitors the technical skills and support needed to collect data that could be used to influence TMDL planning within their watershed, as well as serve community needs; 3) develop a standardized certification module and monitoring methods which could be transferred to other areas with minor modifications; and 4) utilize the existing volunteer water monitoring network in cooperation with water quality professionals to produce quality data and a program structure that will support on-going monitoring.

The learning objectives of this poster are to inform viewers of the mechanisms used to develop an effective volunteer monitoring certification program which will assist in collection of credible data for use in water resource management decisions.

Monitoring Volunteers

Tony Williams
Director of Monitoring Programs, The Coalition for Buzzards Bay, 620 Belleville Avenue, New Bedford, MA 02745, Phone: 508-999-6363, Email: williams@savebuzzardsbay.org

Abstract
The condition of water resources can be monitored by the efforts of people who are passionate about it; they live near it, swim in it, boat on it and often help work to protect it. Monitoring may be rooted in one or many objectives; however volunteer monitoring may become more than promoting public awareness and understanding. The science findings of your monitoring program may be what many towns, organizations and institutes are looking for. The Coalition for Buzzards Bay's monitoring program has the main task on collecting data on excessive nutrient inputs from land use and then reporting on these impacts as changes in habitat health and water quality along the coastline. The program is recognized locally for providing water quality data to both the Local and State Environmental Managers. And although the monitoring results are showing the effects of nutrient pollution (eutrophication), management is often challenging and difficult because of its widespread distribution from an array of sources- runoff, septic, sewage, agriculture. This program's success has relied in getting citizens involved with monitoring and as a cost effective alternative where other resources are absent. Keeping volunteers, getting results even if your volunteers don't have a science background, this success depends on have a good monitoring objective and getting your toes in the sand.

The Buzzards Bay Citizens Water Quality Monitoring Program or Baywatchers began in 1992 in S.E. Massachusetts and is one of the largest coastal monitoring programs in Massachusetts. For 18 years a trained group of 130+ volunteers has been monitoring @ 200 sites in the harbors and coves of Buzzards Bay. The focus is to better understand the Bay ecosystem and its response to human– related impacts, specifically nutrient pollution.

Supporting Volunteer Water Quality Monitoring Efforts Throughout the USA

Linda Green[1], Elizabeth Herron[1], Kristine Stepenuck[2], Frank Finley[3], Ken Genskow[4], Arthur Gold[1]
[1]University of Rhode Island Cooperative Extension, Kingston, RI; [2]Wisconsin-Extension, Madison, WI; [3]Salish Kootenai College, Pablo, MT; [4]University of Wisconsin, Madison WI

Abstract
The USDA NIFA Cooperative Extension-based Volunteer Water Quality Monitoring National Facilitation Project began in 2000. The goal - to build a comprehensive support system for volunteer water quality monitoring efforts across the country, to expand and strengthen the capacity of existing programs and support development of new ones. We developed the "*Guide for Growing Volunteer Water Quality Monitoring Programs*" as the centerpiece for our efforts, which can be found on-line at http://www.usawaterquality.org/volunteer. This Guide provides succinct, comprehensive and timely information distilled from successful programs across the country, packaged as a suite of factsheet learning modules, which can be accompanied by workshops. Modules exist to help program coordinators design a monitoring strategy, effectively train volunteers and support them over time, ensure data credibility, and plan a data management system. Designed for "one-stop-shopping,"

the modules highlight techniques of successful programs and link to a multitude of available resources. This poster will provide an overview of the Project, the Guide for Growing Programs and additional resources on our virtual hub.

Alaska's Statistical Monitoring Survey's – Implementation through Partnerships

Terri Lomax
State of Alaska, Alaska Monitoring & Assessment Program

Abstract
Alaska is rich in aquatic resources containing approximately 40% of the total surface waters of the United States. Our near shore marine resources account for over 50% of the total U.S. coastline and contain almost three times the estuarine area of the contiguous 48 states.

Freshwater resources include over 15,000 salmon streams – an important resource to Alaskans and the world. Direct human impact to these resources, such as wastewater discharges, only occur over small percentage of the aquatic resources, but transboundary transport of contaminants and climate change have the potential to effect large segments of Alaska's aquatic resources. Due to Alaska's immense size and great number of water bodies assessing the status of our aquatic resources presents the Alaska Department of Environmental Conservation (DEC) with logistical and budgetary challenges.

DEC's Alaska Monitoring and Assessment Program (AKMAP) is responsible, for implementing Alaska's statistical surveys to assess water quality on a regional and statewide basis. AKMAP accomplished its surveys by forming partnerships with other federal, state, and local agencies and organizations. Capacity building is a crucial aspect of AKMAP's implementation strategy.

This presentation will describe the collaborative effort to implement a statistically valid survey of the Yukon River, from Ft Yukon to Kaltag. This effort is part of the Environmental Protection Agency (EPA) National Rivers survey and provides ADEC with an estimate of the Yukon River water quality status. On July 18, 2009, the AKMAP survey team completed a landmark water quality (49 sites) and physical habitat survey (550 sites) of the Yukon River from Fort Yukon to Kaltag, Alaska. This collaborative effort involved the US EPA, USGS, NPS, USF&W, Council of Athabascan Tribal Governments and the Yukon River Intertribal Watershed Council. Three teams made up of ADEC, UAA ENRI, USF&W and Yukon River Inter-tribal Watershed Council personnel worked on this survey, spending almost two weeks on the river. Without this collaborative effort, the survey would not have been possible.

Enhancing Communication with Project Partners

Cassandra M. Pfeifle and Mary J. Giorgino
U.S. Geological Survey, North Carolina Water Science Center, Raleigh, NC, USA

Abstract
The U.S. Geological Survey (USGS) has a long history of cooperating with local, state, and other federal agencies on water-resources investigations. The importance of informing these agencies about the progress of the project work cannot be overstated. The Triangle Area Water Supply Monitoring Project (TAWSMP) began in October 1988 as a collaborative effort between 11 local government partners and the USGS North Carolina Water Science Center to document the water quality of water-supply sources in a 5-county area of central North Carolina. Previous communications with the TAWSMP partners occurred at a yearly meeting, in emails responding to information requests, when proposals were submitted and reviewed, and through published reports of study results.

The traditional approach limits the flow of information to the project partners. Sample-collection progress and conditions observed in the field can prove critical for tailoring water-supply withdrawals, adjusting treatment processes, and supporting water-resource management decisions. Recent advances in information technology have increased the number of communication options and raised expectations, making it imperative for the USGS to exchange information in a more efficient manner.

In June 2009, a proactive approach was implemented to improve the dissemination of water-quality monitoring information to those involved in the TAWSMP. This information exchange must be accurate, relevant to partner interests, compiled quickly, delivered in a manner that is unobtrusive to the recipient, and facilitate feedback with the USGS. Based on these guiding principles, a rapid reporting process was developed using two widely distributed software programs to deliver field observations, basic sample-collection information, and links to online data within 1 week of sampling by email. The process evolved as various obstacles were overcome and in response to partner feedback. This effort represents one piece of a multifaceted approach to enhance communication with our partners, which includes the North Carolina Hydrologic Alert System (NC-HAS), a TAWSMP Web page, and annual project summaries for TAWSMP.

Water Quality Activities within the Group on Earth Observations (GEO)

Steven Greb
Wisconsin Department of Natural Resources, Madison, WI, United States

Abstract
The Group on Earth Observations (GEO) is a voluntary partnership including 80 Governments, the European Commission and 56 intergovernmental, international, and regional organizations. The GEO mandate is to coordinate efforts to build a Global Earth Observation System of Systems (GEOSS), integrating multiple sources of data such as disparate in-situ measurements collected globally to remote sensing products. International collaboration is essential for utilizing the growing potential of Earth observations to support decision making in an increasingly complex and environmentally stressed world. One of the many societal benefit areas GEO is addressing is water quality. This paper discusses the activities currently underway within this important GEO activity.

Lake Michigan Monitoring Coordination Council: A Framework for Collaboration

John Hummer[1], Judy Beck[3], Charlie Peters[2], Gary Kohlhepp[4]
[1]Great Lakes Commission, Ann Arbor, Michigan, Great Lakes, United States, [2]U.S. Geological Survey, Madison, Wisconsin, Great Lakes, United States, [3]U.S. EPA Great Lakes National Program Office, Chicago, Illinois, Great Lakes, United States, [4]Michigan Department of Environmental Quality, Lansing, Michigan, Great Lakes, United States

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, methods, data analysis, and data management make it difficult to share monitoring information and results. Yet, it is important that monitoring organizations collaborate to accomplish similar goals 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.

Council membership is comprised of federal, state and local organizations, nonprofit groups and environmental groups, educational entities, and the regulated community. The Council generally meets in-person twice each year and holds numerous conference calls to achieve the group's objectives. The Council meetings, national and regional conferences, and feedback from constituents shape the Council's workplan and activities. The organization also provides recommendations and serves as the monitoring "expert arm" for the Lake Michigan Lakewide Management Plan (LaMP). One of the main purposes of the Council is to determine whether the current monitoring

coverage is sufficient to support indicators developed for the Lake Michigan LaMP and to assess monitoring gaps and needs that must be addressed.

This poster will illustrate how active collaboration among Lake Michigan basin monitoring entities and other affected stakeholder groups enhances the planning and implementation of existing and future basinwide monitoring around several common elements: monitoring objectives; resource components, media and parameters sampled; sampling frequency; station locations; sampling platform; metadata; methods comparability; quality assurance and quality control; and data management, including data sharing and data analysis approaches.

The poster will also spotlight a current effort of the Council's Nearshore Monitoring Workgroup (NEMO) which is a network of government, university and Sea Grant scientists and managers engaged in the monitoring of the Lake Michigan nearshore. Its goal is to coordinate and plan monitoring efforts for the 2010 Lake Michigan Intensive Year Monitoring effort that coincides with the 2010 Coastal Condition Report field activities.

The California Water Quality Monitoring Council

Jon Marshack, Karen Larsen, Valerie Connor
California Environmental Protection Agency, Water Resources Control Board, Office of Information Management & Analysis, Sacramento, CA, United States

Abstract
Local, regional, state, and federal agencies, along with volunteer groups, conduct a large variety of water quality and aquatic resources monitoring in California. While these efforts help address site-specific issues and fulfill regulatory compliance mandates, shortcomings in the state's system for managing water quality information limit the usefulness of these data. Inconsistent monitoring objectives and methods for collecting and assessing data can create spurious findings. In addition, it is often not possible to integrate data from different studies, nor is there a single user-friendly place to access data and assessment results. The California Water Quality Monitoring Council is intended to help take advantage of this tremendous opportunity for improvement and was established, pursuant to state legislation, by a memorandum of understanding between the California Environmental Protection Agency and the California Natural Resources Agency.

Members of the Council represent a number of public agencies, private parties (e.g., agriculture), and citizen monitoring interests. The Council's initial recommendations, reported in December 2008, emphasize providing a platform for intuitive, streamlined access to water quality information that directly addresses users' questions. This is being accomplished through a series of linked web portals that provide question-driven access to map-based assessment results, as well as to more detailed monitoring data, download tools, ad hoc queries and analyses, and more comprehensive reports. A fundamental aspect of the Council's philosophy is that the path to solving the problems inherent in the current information management system starts with providing ready access to assessment products that focus on clearly defined questions. Prototype web portals developed during 2009 demonstrate that this furnishes both the structure and the motivation for more efficiently addressing technical issues such as data formats and methods standardization. This approach has fostered the organization of several issue-based collaborative workgroups based on partnership among multiple entities with a common interest in a particular issue. Using this experience as proof of concept, the Monitoring Council has developed a comprehensive water quality monitoring program strategy for California.

New Jersey Water Monitoring Council: Promoting Coordination, Communication and Collaboration Across a State Water Monitoring Community

Alena M. Baldwin-Brown[1], Leslie J. McGeorge[1], Richard H. Kropp[2] and Eric F. Vowinkel[2]
[1]NJ Department of Environmental Protection, Water Monitoring and Standards, Trenton, NJ, United States; [2]USGS NJ Water Science Center, West Trenton, NJ, United States

Abstract
With a common interest in integrating and strengthening the water monitoring community in the state, the New Jersey Water Monitoring Council (NJ Council) was formed on World Water Monitoring Day in 2003. The NJ Council's vision is to provide a water information foundation for the management and protection of the State's aquatic resources. The mission of this consensus-driven organization, modeled after the National Water Quality Monitoring Council, is to promote the coordination, collaboration and communication of scientifically sound water data. The NJ Council addresses biological, chemical, physical and ecosystem aspects of water monitoring, including surface and ground waters, freshwater, estuarine and marine environments. Goals include: facilitating monitoring technology transfer; enhancing data exchange and compatibility; promoting the integration and efficient use of monitoring resources; developing support for monitoring and assessment; identifying water research needs; and interacting with other national/state councils. The NJ Council is comprised of representatives of federal (USGS, EPA, NOAA), state (NJDEP), regional and local government entities (e.g., Pinelands Commission), interstate organizations (e.g., Delaware River Basin Commission), academia, and the volunteer monitoring community. NJDEP and USGS chair the NJ Council. Members are responsible for ambient monitoring programs and/or aquatic research in the State's waters. Council products include: the NJ Water Monitoring Inventory as a component of the new NJ Water Quality Data Exchange System; development of partnerships for the Delaware Basin Pilot for the National Monitoring Network, the NJ Pilot for the National Groundwater Monitoring Network, and the nation's first extension of the National Coastal Assessment (NCA) estuarine survey to near-shore ocean waters; development of a NJ Continuous Monitoring matrix; two New Jersey Water Monitoring Workshops; increased data submittals for the NJ Integrated Water Monitoring and Assessment Reports; and input to the *NJ Water Monitoring and Assessment Strategy (2005-2014)*. Information exchange is conducted on topics such as emerging contaminants, fish and shellfish tissue monitoring, microbial source track down, water quantity measurements, biological monitoring, nutrient sampling, and county/volunteer monitoring. Additional information is available at: www.state.nj.us/dep/wms/wmcchome.

Tributary and Near-Shore Monitoring Coordination in the Lake Michigan Watershed

Charles Peters[1], Glenn Warren[2]
[1]USGS, Wisconsin Water Science Center, Middleton, WI, United States; [2]USEPA, Great Lakes National Program Office, Chicago, IL, United States

Abstract
Since 1997 the Lake Michigan Monitoring Council (LMMCC) has worked to develop collaborative approaches to monitoring. In 2008 the LMMCC established a near-shore monitoring workgroup (NeMo) to support collaborative monitoring efforts in the tributaries, embayments, near-shore (0 - 30 m), and mid near-shore (30 - 80 m) of Lake Michigan. The NeMo workgroup is a network of Federal, State, and Local government, Academia, and non-governmental organizations. The workgroup is developing plans for coordinated monitoring during 2010.

The collaborative monitoring effort will be built on current or developing programs in the Great Lakes, including: the cooperative science and monitoring initiative (CSMI); the national monitoring network (NMN)

demonstration pilot: the national coastal assessment (NCA); the Great Lakes restoration initiative (GLRI); and other Federal, State, and University activities.

The effort is planned to result in: an inventory of current nearshore monitoring objectives and activities; a coordinated nearshore monitoring network with a five-year implementation cycle goal; an evaluation of nearshore monitoring methods and data comparability; the development of a coordinated nearshore monitoring database; an integrated data analyses and reporting approach.

Collaborative Trend Monitoring of Ambient Water Quality in the Upper Sacramento River Watershed

Alisha Wenzel[1], Fraser Sime[2], Dennis Heiman[3], Scott McReynolds[2], Perry Lebouf[2], and Jeanne Chilcott[1]
[1]California Regional Water Quality Control Board, Central Valley Region, Rancho Cordova, CA, United States; [2]California Department of Water Resources, Northern District, Red Bluff, CA, United States; [3]California Regional Water Quality Control Board, Central Valley Region, Redding, CA, United States

Abstract
In 2009 the California Regional Water Quality Control Board, Central Valley Region and the Department of Water Resources (DWR) Northern District began a collaborative monitoring program in the Upper Sacramento River Watershed of Northern California. The Central Valley Water Board is leveraging Surface Water Ambient Monitoring Program (SWAMP) funding to maintain and expand long-term DWR trend monitoring that had been threatened with severe budget cuts.

The collaborative effort allows seasonal monitoring at 41 sites and the addition of key constituents of interest. The monitoring sites include seven stations along the Sacramento River main-stem, four stations on the Pit River, and 30 stations near the mouth of key tributaries. Monitoring constituents include physical parameters, metals, and nutrients. SWAMP funding has made possible the addition of E. coli, organic carbon, Kjeldahl nitrogen, and, at select sites, water column toxicity and benthic macroinvertebrates.

Efforts have been made to coordinate with other monitoring programs in order to maximize monitoring resources. Eleven of the sites are coordinated with SWAMP Stream Pollution Trends (SPoT), a statewide study monitoring contaminant trends in sediment. Overall water quality assessments will benefit from the added value of both monitoring programs for these sites. In addition, monitoring runs are scheduled to coincide with another Central Valley Water Board SWAMP study monitoring 19 sites in the Lower Sacramento River Watershed, San Joaquin Watershed, and Tulare Lake Basin. The combination of these datasets will provide information on the entire Central Valley.

SWAMP has developed guidelines and tools for projects funded by SWAMP to ensure data quality and comparability. This program follows SWAMP quality assurance guidelines and has a SWAMP-approved monitoring plan and quality assurance program plan. Benthic macroinvertebrate sample collection also follows SWAMP standard operating procedures. SWAMP comparability will help ensure data quality and simplify the process of combining and comparing different datasets.

Attendees

Pre-registered attendees as of April 9, 2010

Dan Abercrombie
Mescalero Apache Tribe
Po Box 250
#268 Pine Drive
Mescalero, NM 88340
575-464-4711
dan@mescalerodrmp.net

Thomas Abrahamsen
USGS
720 Gracern Rd
Ste. 129
Columbia, SC 29210
803-750-6197
tabraham@usgs.gov

Peter Abrams
City of Portland
6543 N Burlington Ave
Portland, OR 97203
503-823-5533
peter.abrams@portlandoregon.gov

BiJay Adams
Liberty Lake Sewer and Water District
22510 E. Mission Ave
Liberty Lake, WA 99019
509-922-5443
bijay@libertylake.org

Darvene Adams
USEPA-Region 2
2890 Woodbridge Ave.
Edison, NJ 08837
732-321-6700
adams.darvene@epa.gov

Mary Adams
Water Quality Control Board
895 Aerovista Pl. Suite 101
San Luis Obispo, CA 93401
805-542-4768
madams@waterboards.ca.gov

Jamie Aderhold
Aqualytical
11760 Commonwealth Drive
Louisville, KY 40299
562-619-8708
jamie@ciagent.com

Andrew Albright
City of Longmont
WQ Lab
501 East 1st Ave
Longmont, CO 80501
303-774-4654
drew.albright@ci.longmont.co.us

Jeff Albright
National Park Service
1201 Oakridge Drive
Fort Collins, CO 80525
970-225-3528
jeff_albright@nps.gov

Sharon Alcalde
USGS
417 National Center
12201 Sunrise Valley Drive
Reston, VA 20192
703-648-5838
salcalde@usgs.gov

Dan Alexander
EarthSoft
P.O. Box 1376
Concord, MA 01742
440-212-4062
dan.alexander@earthsoft.com

Scott Anderholm
USGS
Suite 400
5338 Montgomery Blvd NE
Albuquerque, NM 87109
505-830-7955
anderhol@usgs.gov

Leah Anderson
Yukon River Inter-Tribal Watershed Council
815 2nd Ave. Suite 201
Fairbanks, AK 99701
907-451-2530
landerson@yritwc.org

Dave Anning
USGS AZ Water Science Center
2255 N. Gemini Drive
Flagstaff, AZ 86001
928-556-7139
dwanning@usgs.gov

Stephen Anthony
U.S. Geological Survey
677 Ala Moana Blvd.
Suite 415
Honolulu, HI 96813
808-587-2406
santhony@usgs.gov

Nancy Arazan
EPA Office of Water
1200 Pennsylvania Ave NW
Washington, DC 20460
202-566-0815
arazan.nancy@epa.gov

Carmen Armitage
Timbisha Shoshone Tribe
P.O. Box 206
Death Valley, CA 92328
760-786-2374
crmn_rmtg@yahoo.com

Trent Armstrong
Idaho National Laboratory
P.O. Box 1625
Idaho Falls, ID 83415-3695
208-526-0495
Trent.Armstrong@inl.gov

Jody Arthur
IN Dept. of Environmental Mgt.
100 N. Senate Ave.
PO Box 6015
Indianapolils, IN 46206-6015
317-234-1424
jarthur@idem.in.gov

Tim Asplund
Wisconsin Dept of Natural Resources
101 S. Webster, P.O. Box 7921
Madison, WI 53707
608-267-7602
tim.asplund@wisconsin.gov

Scott Ator
US Geological Survey
5522 Research Park Drive
Baltimore, MD 21228
443-498-5564
swator@usgs.gov

Viswatej Attili
Kickapoo Environmental Office
1107 Goldfinch Road
Horton, KS 66439
785-486-2601
Viswatej.Attili@ktik-nsn.gov

Joseph Ayotte
U.S. Geological Survey
331 Commerce Way
Pembroke, NH 03275
603-226-7810
jayotte@usgs.gov

Lorraine Backer
CDC
4770 Buford Highway NE
MS F-57
Chamblee, GA 30341
770-488-3426
lfb9@cdc.gov

Matt Baerwalde
Snoqualmie Tribe
PO Box 969
Snoqualmie, WA 98065
425-292-0249 ext. 2
mattb@snoqualmienation.com

Bryant Baker
Pressure Systems, Inc
34 Research Dr
Hampton, VA 23666
757-865-1243
bryant.baker@pressuresystems.com

Melissa Baker
Capitol Region Watershed District
1410 Energy Park Drive
Suite 4
St. Paul, MN 55108
651-644-8888
melissa@capitolregionwd.org

Milt Baker
Blue Water Satellite
440 E. Poe Rd
Suite 203
Bowling Green, OH 43402
419-728-0060
mbaker@bluewatersatellite.com

Nancy T. Baker
U.S. Geological Survey
5957 Lakeside Blvd.
Indianapolis, IN 46278
317-290-3333 x185
ntbaker@usgs.gov

Tyler Baker
Tennessee Valley Authority
1101 Marker Street
(PSC 1X-C)
Chattanooga, TN 37402
423-876-6733
tfbaker@tva.gov

Virginia Baker
NC Division of Water Quality
2321 Crabtree Blvd.
Suite 250
Raleigh, NC 27604
919-715-3475
virginia.baker@ncdenr.gov

Jerad Bales
U.S. Geological Survey
12201 Sunrise Valley Drive
MS 436
Reston, VA 20192
703-648-5044
jdbales@usgs.gov

Thomas Ballestero
University of New Hampshire
35 Colovos Rd.
Durham, NH 03824
603-862-1405
tom.ballestero@unh.edu

Larry Barber
U.S. Geological Survey
3215 Marine Street
Boulder, CO 80303
303-541-3039
lbbarber@usgs.gov

Carise Barbour
U.S. Geological Survey
413 National Center
Reston, VA 20192
703-648-5716
cbarbour@usgs.gov

John W. Barr
Alpine Watershed Group
5 Clipper Hill
Oakland, CA 94618
925-698-6249
jwbarr@earthlink.net

Miya Barr
USGS
1400 Independence Road
Mail Stop 100
Rolla, MO 65401
573-578-7877
mnbarr@usgs.gov

Roy Bartholomay
U.S. Geological Survey
1955 N. Fremont
Idaho Falls, ID 83415
208-526-2157
rcbarth@usgs.gov

Bill Battaglin
U.S. Geological Survey
Box 25046, MS 415
DFC
Lakewood, CO 80225
303-236-4882-256
wbattagl@usgs.gov

Nancy Bauch
U.S. Geological Survey, CWSC
Denver Federal Center
PO Box 25046, MS 415
Denver, CO 80225
303-236-2101 x231
njbauch@usgs.gov

Troy Bauder
Colorado State University
Campus Delivery 1170
Fort Collins, CO 80523
970-491-4923
troy.bauder@colostate.edu

John Baum
US Army Corps of Eng
1325 J Street
CESPK-ED-EC
Sacramento, CA 95814
916-557-6656
john.j.baum@usace.army.mil

Dale Beardsley
Pressure Systems, Inc., KPSI Transducers
34 Research Dr
Hampton, VA 23666
757-865-4618
dale.beardsley@pressuresystems.com

Delicia Beaty
Branch Quality of Systems
DFC B95 MS401
Lakewood, CO 80225
303-236-1817
dbeaty@usgs.gov

John Beaver
BSA Environmental Services
23400 Mercantile Rd.
Suite 8
Beachwood, OH 44122
216-765-0582
j.beaver@bsaenv.com

Mark Becker
USGS
Building 7
202 NW 66th
Oklahoma City, OK 73116
405-810-4412
mfbecker@usgs.gov

Rick Bell
USGS
5338 Montgomery NE
Suite 400
Albuquerque, NM 87109
505-830-7942
rwbell@usgs.gov

Chris Bellucci
CT Department of Environmental Protection
79 Elm Street
Hartford, CT 06106
860-424-3744
christopher.bellucci@ct.gov

Randy Belston
City of Portland, OR
6543 N. Burlington Ave
Portland, OR 97203
503-823-5536
randybe@bes.ci.portland.or.us

David Bender
U.S. Geological Survey
1608 Mt View Rd
Rapid City, SD 57702
605-394-3248
dabender@usgs.gov

Michael Benedict
Milwaukee Metropolitan Sewerage District
260 W. Seeboth Street
Milwaukee, WI 53204
414-225-2259
mbenedict@mmsd.com

Trudy Bennett
U.S. Geological Survey
7920 W. Kellog, Suite 4
Wichita, KS 67209
316-773-3225
trudyben@usgs.gov

Thomas Bernthal
Wisconsin Dept of Natural Resources
101 S. Webster St - WT/4
Po Box 7921
Madison, WI 53707
608-266-3033
thomas.bernthal@wisconsin.gov

Petronella H. Best
US EPA-ORD
26 W M.L. King Drive
Cincinnati, OH 45268
513-569-7517
best.elly@epa.gov

Jenny Biddle
US EPA
1200 Pennsylvania Ave. NW
Mailcode 4503T
Washington, DC 20460
202-566-1281
biddle.jenny@epa.gov

Justin Bieri
Central Colorado Water Conservancy District
3209 West 28th St
Greeley, CO 80634
970-330-4540
jbieri@ccwcd.org

Donald Bills
U.S. Geological Survey
2255 N. Gemini Dr. bldg. 3
Flagstaff, AZ 86001
928-556-7142
djbills@Usgs.gov

Bryan Bjorndal
Assure Controls, Inc.
2440 Grand Avenue, Suite B
Vista, CA 92081
760-505-3000
bryan@assurecontrols.com

Rob Blair
Mountain Studies Institute
2409 Delwood Ave
Durango, CO 81301
970-247-2703
blair_r@fortlewis.edu

Kevin Boden
City of Longmont
1100 S. Sherman St.
Longmont, CO 80501
303-774-4516
kevin.boden@ci.longmont.co.us

Carol Boland
City of San Jose
Environmental Services
170 West San Carlos Street
San Jose, CA 95113
408-277-2697
carol.boland@sanjoseca.gov

Mark Borchardt
Marshfield Clinic Research Foundation
1000 North Oak Avenue
Marshfield, WI 54449
715-389-3758
borchardt.mark@mcrf.mfldclin.edu

David Borrok
University of Texas at El Paso
T500 W. University Avenue
El Paso, TX 79968
915-747-5850
dborrok@utep.edu

Sharon Bosse
Prairie Band Potawatomi Nation
15434 K Road
Mayetta, KS 66509
785-966-2946
sbosse@pbpnation.org

Daniel Boward
Maryland Department of Natural Resources
580 Taylor Avenue
C-2
Annapolis, MD 21401
410-260-8605
dboward@dnr.state.md.us

Jean Marie Boyer
AMEC Earth & Environmental
1002 Walnut St
Suite 200
Boulder, CO 80302
303-443-7839
jean-marie.boyer@amec.com

Windy Brace
U.S. Geological Survey
12703 Research Parkway
Orlando, FL 32826
407-803-5570
wbrace@usgs.gov

Paul Bradley
USGS
720 Gracern Rd, Suite 129
Columbia, SC 29210
803-750-6125
pbradley@usgs.gov

Mickele Bragg
Assure Controls, Inc.
2440 Grand Avenue, Suite B
Vista, CA 92081
760-505-3000
mickele@assurecontrols.com

John Brakebill
USGS
5522 Research Park Drive
Baltimore, MD 21228
443-498-5557
jwbrakeb@usgs.gov

Chris Braun
U.S. Geological Survey
1505 Ferguson Ln.
Austin, TX 78754
512-927-3521
clbraun@usgs.gov

Gregory Brewster
U.S. Geological Survey
6000 J Street
Placer Hall
Sacramento, CA 95819
916-278-3132
gdbrews@usgs.gov

Mark Brigham
U.S. Geological Survey
2280 Woodale Drive
Mounds View, MN 55304
763-783-3274
mbrigham@usgs.gov

Geneva Brion
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-1169
brion.geneva@epa.gov

Myron Brooks
U.S. Geological Survey - HIF
Building 2101
Stennis Space Center, MS 39529
228-688-3631
mhbrooks@usgs.gov

Heidi Brow
Pala Band of Mission Indians
35008 Pala Temecula Road
PMB 50
Pala, CA 92059
760-891-3514
hbrow@palatribe.com

Jessie Brown
University of West Florida
Bldg. 58, Rm. 70
11000 University Pkwy
Pensacola, FL 32514
850-474-2060
jrb47@students.uwf.edu

Juliane Brown
U.S. Geological Survey
Denver Federal Center
PO Box 25046, MS 415
Lakewood, CO 80225
303-236-4882-308
jbbrown@usgs.gov

Kristopher Brown
Louisiana State University
Renewable Natural Resources Building
227 Highland Road
Baton Rouge, LA 70803
717-816-0974
brownkr3@gmail.com

Larry Brown
U.S. Geological Survey
Placer Hall
6000 J St.
Sacramento, CA 95819
916-278-3098
lrbrown@usgs.gov

Tom Brumett
Turner Designs
845 W Maude Avenue
Sunnyvale, CA 94085
408-749-0994
sales@turnerdesigns.com

Sarah Burger
Kaibab Paiute Tribe
HC 65 Box 2
Fredonia, AZ 86022
928-643-7245
dasburger@kaibabpaiute-nsn.gov

Thomas Burley
United States Geological Survey
1505 Ferguson Lane
Austin, TX 78754
512-927-3511
teburley@usgs.gov

Karla Burnley
USGS
Denver Federal Center
Bldg 53, MS 415
Lakewood, CO 80225
303-236-4882
kburnley@usgs.gov

Robert Burns
Satlantic Inc.
3481 North Marginal Road
Halifax, NS B3K 5X8
Canada
902-492-4780
robert.burns@satlantic.com

Erick Burres
SWRCB
320 West 4th Street
Suite 200
Los Angeles, CA 90013
213-712-6862
eburres@waterboards.ca.gov

Herbert Buxton
U.S. Geological Survey
810 Bear Tavern Road
W. Trenton, NJ 08628
609-771-3944
hbuxton@usgs.gov

Jane Caffrey
University of West Florida
Bldg. 58, Rm. 70
11000 University Pkwy
Pensacola, FL 32514
850-857-6089
jcaffrey@uwf.edu

Carol Cain
Maryland Coastal Bays Program
9919 Stephen Decatur Highway
Suite 4
Ocean City, MD 21842
410-213-2297
technical@mdcoastalbays.org

Daniel Cain
U.S. Geological Survey
345 Middlefield Rd.
MS 496
Menlo Park, CA 94025
650-329-4478
djcain@usgs.gov

Judy Campbell Bird
USGS Consultant
4831 Langdrum Lane
Chevy Chase, MD 20815
301-652-1317
jcb416@aol.com

Michael Canova
US Geological Survey
1505 Ferguson Lane
Austin, TX 78754
512-927-3536
mcanova@usgs.gov

Kara Capelli
U.S. Geological Survey
12201 Sunrise Valley Drive
119 National Center
Reston, VA 20192
703-648-5086
kcapelli@usgs.gov

Christopher Carlson
USDA Forest Service
201 14th Street SW
Washington, DC 20250
202-205-1481
ccarlson@fs.fed.us

Joan Carlson
US Forest Service
740 Simms St
Golden, CO 80401
303-275-5097
jycarlson@fs.fed.us

Michael Carlson
U. S. Geological Survey
5338 Montgomery Blvd
Albuquerque, NM 87109
505-830-7961
mcarlson@usgs.gov

Tim Carney
USDA - NRCS
655 Parfet Street
Room E200C
Lakewood, CO 80215
720-544-2805
tim.carney@co.usda.gov

David Carter
City of Westminster
Big Dry Creek WWTF
13150 N. Huron Street
Westminster, CO 80234
303-658-2377
dcarter@cityofwestminster.us

Dick Cartwright
U.S. Geological Survey
2045 Route 112, Blg.4
Coram, NY 11727
631-736-0783
racart@usgs.gov

Randy Carver
Blue Otter Software
PO Box 1731
Granby, CO 80446
970-531-0420
randy@blueottersoftware.com

Anne Castle
U.S. Department of the Interior
1849 C Street, NW, MS 6640
Washington, DC 20240
202-208-3136
Cheryl_Stewart@ios.doi.gov

Aisa Ceric
St. Johns River Water Management District
4049 Reid St., PO Box 1429
Palatka, FL 32178
386-329-4339
aceric@sjrwmd.com

Ed Chadd
Streamkeepers of Clallam County
223 E 4th St
Suite 5
Port Angeles, WA 98362
360-417-2281
streamkeepers@co.clallam.wa.us

Brian Chalfant
Pennsylvania Department of Environmental Protection
Rachel Carson State Office Building
400 Market Street, 11th Floor
P.O. Box 8467
Harrisburg, PA 17105-8467
717-787-9639
bchalfant@state.pa.us

Doug Chambers
USGS West Virginia Water Science Center
11 Dunbar Street
Charleston, WV 25301
304-590-1276
dbchambe@usgs.gov

Thomas Chapin
U.S. Geological Survey
Denver Federal Center
Box 25046, MS 964D
Denver, CO 80225
303-236-5795
tchapin@usgs.gov

Andy Chappell
YSI, Inc.
1725 Brannum Ln.
Yellow Springs, OH 45387
937-767-7241

Lia Chasar
US Geological Survey
2639 N.Monroe
Suite A-200
Tallahasssee, FL 32303
850-553-3649
lchasar@usgs.gov

Cheryl Cheadle
Oklahoma Conservation Commission
128 East 3rd Avenue
Bristow, OK 74010
918-398-1804
cheryl.cheadle@conservation.ok.gov

Tracy Chellis
US EPA
1200 6th Avenue
Suite 900
Seattle, WA 98101
206-553-6326
chellis.tracy@epa.gov

Zeke Chen
General Green International
8915 W. 127th Terrace
Overland Park, KS 66213
913-488-1688
zeke.z.chen@generalgreenintl.com

Soumya Chennapragada
San Diego Coastkeeper
2825 Dewey Road, Suite 200
San Diego, CA 92106
619-758-7743
soumya@sdcoastkeeper.org

David Chestnut
SC DHEC
Bureau of Water
2600 Bull Street
Columbia, SC 29201
803-898-4066
chestnde@dhec.sc.gov

Chao-An Chiu
Arizona State University
ECG 252
Tempe, AZ 85281
410-207-5590
cchiu8@asu.edu

Eric Christensen
U.S. Geological Survey
401 NW Capital Drive
Lees Summit, MO 64086
816-554-3489
echriste@usgs.gov

Kevin Christian
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-1180
christian.kevin@epa.gov

Arlene Chun
Riverside County Flood Control and WCD
1995 Market St
Riverside, CA 92501
951-955-1330
abchun@rcflood.org

Tom Cilke
NEON Inc.
5340 Airport Blvd.
Boulder, CO 80301
720-746-4923
tcilke@neoninc.org

Greg Clark
USGS
230 Collins Rd
Boise, ID 83709
208-387-1324
gmclark@usgs.gov

Melanie Clark
U.S. Geological Survey
2617 E Lincolnway Ste B
Cheyenne, WY 82009
307-775-9163
mlclark@usgs.gov

Nicolas Clercin
IUPUI
723 West Michigan Street
Indianapolis, IN 46202
317-278-6951
nclercin@iupui.edu

Kelly Cline
City of Westminster
8900 Pierce St
Westminster, CO 80021
303-658-2576
kcline@cityofwestminster.us

Clint Coates
U.S. Geological Survey
12703 Research Parkway
Orlando, FL 32826
407-803-5542
tcoates@usgs.gov

Alissa Coes
USGS
520 N Park Ave
Suite 221
Tucson, AZ 85704
520-670-6671
alcoes@usgs.gov

Kevin Cole
USDA ARS NLAE
2110 University Blvd.
Ames, IA 50011
515-294-5724
kevin.j.cole@ars.usda.gov

Gregory Colianni
EPA
EPA West
1301 Constitution Ave.
Washington, DC 20006
202-566-1249
colianni.gregory@epa.gov

Deanna Collier
EPA
901 N 5th St
Kansas City, KS 66101
913-551-7472
collier.deanna@epa.gov

Brooke Connor
USGS
PO Box 25046
DFC, MS 401, Bldg 95
Lakewood, CO 80225
303-236-1877
bfconnor@usgs.gov

Valerie Connor
CA State Water Resources Control Board
1001 I St., 15th Floor
Sacramento, CA 95814
916-341-5573
vconnor@waterboards.ca.gov

Alice Conovitz
Integral Consulting
12303 Airport Way
Suite 370
Broomfield, CO 80021
303-404-2944 ext 13
awconovitz@integral-corp.com

Leslie Cook
Teton Science Schools
700 Coyote Canyon Road
Jackson, WY 83001
307-734-3736
leslie.cook@tetonscience.org

Kirsten Cooper
Solinst Canada Ltd
35 Todd Rd.
Georgetown, ON L7G 4R8
Canada
905-873-2255
kirsten.cooper@solinst.com

Richard Copeland
Florida Geological Survey
903 W. Tennessee Street
Tallahassee, FL 32304
850-487-9455 ext 166
rick.copeland@dep.state.fl.us

John Copp
Primodal Inc.
122 Leland St.
Hamilton, ON L8S 3A4
Canada
905-523-8958
copp@primodal.com

Chris Couch
ChemWare
900 Ridgefield Drive
Suite 150
Raleigh, NC 27609
919-855-8716
ccouch@chemware.com

Dave Courtemanch
Maine DEP
17 State House Station
Augusta, ME 04333
207-592-3157
dave.l.courtemanch@maine.gov

Timothy Craddock
WV Save Our Streams Program
601 57th Street, SE
Charleston, WV 25304
304-926-0499
timothy.d.craddock@wv.gov

Bea Craig
U.S. Geological Survey - HIF
Building 2101
Stennis Space Center, MS 39529
228-688-1532
fbcraig@usgs.gov

Maggie Craig
Tetra Tech, Inc.
400 Red Brook Blvd.
Suite 200
Owings Mills, MD 21117
410-356-8993
maggie.craig@tetratech.com

Jeff Crane
Colorado Watershed Assembly
29163 Stingley Gulch Road
Hotchkiss, CO 81419
970-872-2433
jeffcrane@coloradowater.org

Charles Crawford
US Geological Survey
5957 Lakeside Blvd.
Indianapolis, IN 46278
317-290-3333 X176
cgcrawfo@usgs.gov

Andrew Cross
City of Westminster
8900 Pierce St
Westminster, CO 80021
303-658-2577
across@cityofwestminster.us

Josh Crow
GFS Chemicals Inc
PO Box 245
Powell, OH 43065
614-224-5345
jcrow@gfschemicals.com

Bill Cunningham
ACWI Subcommittee on Ground Water
411 National Center
Reston, VA 20192-0001
703-648-5005
wcunning@usgs.gov

Mark Curran
Battelle
397 Washington Street
Duxbury, MA 02332
781-952-5231
curran@battelle.org

Paul Currier
NH Dept. of Environmental Services
29 Hazen Drive
PO Box 95
Concord, NH 03302-0095
603-271-3289
paul.currier@des.nh.gov

Thomas Danielson
Maine DEP
17 State House Station
Augusta, ME 04333
207-441-7430
thomas.j.danielson@maine.gov

Douglas Dasher
Alaska Department of Environmental Conservation
610 University Avenue
Fairbanks, AK 99709
907-451-2172
doug.dasher@alaska.gov

Thomas Davenport
US EPA
77 W. Jackson Blvd. (W-16J)
Chicago, IL 60604
312-886-0209
davenport.thomas@epa.gov

Susan Davies
Maine Dept Environmental Protection
SHS 17
MDEP
Augusta, ME 04333
207-441-9271
susan.p.davies@maine.gov

David L. Davis
Virginia Dept. of Environmental Quality
629 East Main Street
Richmond, VA 23219
804-698-4105
david.davis@deq.virginia.gov

Den Davis
Louisiana State University
RNR Building Room #317
227 Highland Road
Baton Rouge, LA 70803
225-578-0783
davisden76@yahoo.com

Jerri Davis
U.S. Geological Survey
1400 Independence Road
Mail Stop 100
Rolla, MO 65401
573-308-3829
jdavis@usgs.gov

Wayne Davis
US EPA
701 Mapes Road
Ft. Meade, MD 20755
410-305-3030
davis.wayne@epa.gov

Barbara Dawson
U.S. Geological Survey
6000 J St
Placer Hall
Sacramento, CA 95819
916-278-3082
bjdawson@usgs.gov

Stacey Day
Oklahoma Conservation Commission
4545 N. Lincoln Blvd., Ste.11A
Oklahoma City, OK 73105
405-522-4735
stacey.day@conservation.ok.gov

Olivia De Leon
University of Rizal System
Office of the President
Morong Campus
Morong, Rizal, 1960
Philippines
632-6531735
olive_deleon@yahoo.com

Jeff Deacon
USGS
331 Commerce Way
Pembroke, NH 03275
603-226-7812
jrdeacon@usgs.gov

David Deardorff
Abraxis LLC
54 Steamwhistle Drive
Warminster, PA 18974-1450
215-357-3911
ddeardorff@abraxiskits.com

Julia DeGagne
Willamette Riverkeeper
1515 SE Water Ave. Ste. 102
Portland, OR 97214
503-223-6418
julia@willametteriverkeeper.org

Katie DeGoosh
RI DEM
RIDEM OWR - Room 200
235 Promenade Street
Providence, RI 02908
401-222-4700 x 7211
katie.degoosh@dem.ri.gov

Mick DeGraeve
Great Lakes Environmental Center
739 Hastings Street
Traverse City, MI 49686
mick@glec.com

Greg Delzer
U.S. Geological Survey
1608 Mt View Rd
Rapid City, SD 57702
605-394-3230
gcdelzer@usgs.gov

Melissa Dempsey
US Forest Service
2014 N. Main
Spearfish, SD 57783
605-642-4622
mdempsey@fs.fed.us

Judy Denver
USGS
1289 McD Drive
Dover, DE 19901
302-734-2506 x229
jmdenver@usgs.gov

Tommy Dewald
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-1178
dewald.tommy@epa.gov

Jerry Diamond
Tetra Tech, Inc
400 Red Brook Blvd
Suite 200
Owings Mills, MD 21117
410-356-8993
Jerry.Diamond@tetratech.com

Gil Dichter
IDEXX
1 IDEXX Drive
Westbrook, ME 04092
207-556-0300
gil-dichter@idexx.com

Eva DiDonato
National Park Service
1201 Oakridge Drive
Suite 250
Fort Collins, CO 80525
970-267-7291
eva_didonato@nps.gov

Jeanne DiFranco
Maine DEP
312 Canco Rd
Portland, ME 04103
207-822-6359
jeanne.l.difranco@maine.gov

Danielle Donkersloot
NJ DEP
Monitoring and Standards
PO Box 409
Trenton, NJ 08049
609-633-9241
danielle.donmkersloot@dep.state.nj.us

Jim Dorsch
Metro Wastewater Reclamation District
6450 York St.
Denver, CO 80229
303-286-3368
jdorsch@mwrd.dst.co.us

Jean Dupree
USGS, Colorado Water Science Center
Denver Federal Center, MS 415
P.O. Box 25046
Denver, CO 80225
303-236-4882 x376
dupree@usgs.gov

Joseph Duris
USGS MI-WSC
6520 Mercantile Way
Suite 5
Lansing, MI 48911
517-887-8942
jwduris@usgs.gov

Kate Dwire
USDA Forest Service
US Forest Service
Rocky Mountain Research Station
240 West Prospect Road
Fort Collins, CO 80526
970-498-1016
kadwire@fs.fed.us

Kevin Easley
Grand River Dam Authority
PO Box 409
Vinita, OK 74301
918-256-0692
cberry@grda.com

Kathy Echols
USGS CERC
4200 New Haven Rd
Columbia, MO 65201
573-876-1838
kechols@usgs.gov

Eugene Edwards
Sauk-Suiattle Indian Tribe
5318 Chief Brown Lane
Darrington, WA 98241
360-436 0347
hugebo72@sauk-suiattle.com

Pamela Edwards
USDA Forest Service
PO Box 404
Parsons, WV 26287
304-478-2000
pjedwards@fs.fed.us

Amanda Egler
U.S. Geological Survey
5957 Lakesid Blvd
Indianapolis, IN 46278
317-290-3333 x102
alegler@usgs.gov

Jo Eimers
USGS
409 National Center
USGS
Reston, VA 20192
703-648-5071
jleimers@usgs.gov

Christine Ellis
Winyah Rivers Foundation
1270 Atlantic Avenue
Conway, SC 29526
843-349-4007
wrk@coastal.edu

Rob Ellison
YSI, Inc.
1725 Brannum Ln.
Yellow Springs, OH 45387
937-767-7241

Adria Elskus
U.S. Geological Survey
School of Biology & Ecology
5751 Murray Hall
University of Maine
Orono, ME 04469
207-581-2579
aelskus@usgs.gov

Ellie Ely
The Volunteer Monitor
50 Benton Ave.
San Franciso, CA 94112
415-334-2284
ellieely@earthlink.net

Eric Embacher
FTS
1065 Henry Eng Place
Victoria, BC V9B 6B2
Canada
250-478-5561
eembacher@ftsinc.com

Diana Engle
Larry Walker Associates
2151 Alessandro Drive
Suite 100
Ventura, CA 93001
805-585-1835
dianae@lwa.com

Alexandra Etheridge
US Geological Survey
230 Collins Road
Boise, ID 83702
208-387-1357
aetherid@usgs.gov

Dennis Evans
USGS
401 Hardin Rd
Little Rock, AR 72211
501-228-3644
daevans@usgs.gov

Jim Eychaner
USGS Sacramento CA
3020 State University Drive East
Suite 3005
Sacramento, CA 95819
916-278-9555
eychaner@usgs.gov

Thomas Faber
US Environmental Protection Agency
Five Post Office Square
M/S ECA
Boston, MA 02109
617-918-8672
faber.tom@epa.gov

Blake Farnsworth
Campbell Scientific, Inc.
815 W. 1800 N.
Logan, UT 84321
435-753-2342
lruiz@campbellsci.com

Chris Faulkner
USEPA
1301 Constitution Ave., NW
7318 B (4502T)
Washington, DC 20004
202-566-1185
faulkner.chris@epa.gov

Lawrence Feinson
USGS
810 Bear Tavern Road
Suite 206
West Trenton, NJ 08628
609-771-3932
lsfeinso@usgs.gov

Suzanne Femmer
USGS - Missouri Water Science Center
1400 Independence Road
Mail Stop 100
Rolla, MO 65401
573-308-3667
sfemmer@usgs.gov

Katie Fendel
Leonard Rice Engineers, Inc.
2000 Clay Street
Suite 300
Denver, CO 80211
303-455-9589
katie.fendel@lrcwe.com

Rick Fielder
YSI, Inc.
1725 Brannum Ln.
Yellow Springs, OH 45387
937-767-7241
rfielder@ysi.com

Andrew Fisk
Maine DEP
17 State House Station
Augusta, ME 04333
207-287-7671
andrew.c.fisk@maine.gov

Terry Fleming
USEPA, Region 9
75 Hawthorne Street
San Francisco, CA 94105
415-972-3462
fleming.terrence@epa.gov

Camille Flinders
National Council for Air and Stream Improvement
PO Box 1259
Anacortes, WA 98221
360-293-4748
cflinders@ncasi.org

Lee Flores
IDEXX
1 IDEXX Drive
Westbrook, ME 04092
207-556-0300

Mike Focazio
USGS
12201 Sunrise Valley Dr
Reston, VA 20192
703-648-6808
mfocazio@usgs.gov

Lisa Fogarty
US Geological Survey
6520 Mercantile Way Suite 5
Lansing, MI 48911
517-887-8968
lrfogart@usgs.gov

Don Forehope
Timbisha Shoshone Tribe
P.O. Box 206
Death Valley, CA 92328
760-786-9063
dforehope@netzero.net

William Foreman
U. S. Geological Survey, NWQL
PO Box 25585
Lakewood, CO 80225-0585
303-236-3942
wforeman@ugs.gov

Sandi Formica
Watershed Conservation Resource Center
380 W Rock Street
Fayetteville, AR 72701
479-442-1916
formica@watershedconservation.org

Philip Forsberg
NALMS
PO Box 5443
Madison, WI 53705-0443
608-233-2836
forsberg@nalms.org

Miranda Fram
USGS - CAWSC
6000 J Street, Placer Hall
Sacramento, CA 95819-6129
916-278-3088
mfram@usgs.gov

Jill Frankforter
U.S. Geological Survey
3162 Bozeman Ave.
Helena, MT 59601
406-457-5917
jdfrankf@usgs.gov

Jessica Franks
US Environmental Protection Agency
1445 Ross Avenue
Dallas, TX 75202
214-665-8335
franks.jessica@epa.gov

Michael Freeman
USGS
2329 W. Orton Cir
Salt Lake City, UT, UT 84119
801-908-5012
mfreeman@usgs.gov

Chris French
Alliance for the Chesapeake Bay
530 East Mmain Street
Suite 200
Richmond, VA 23219
804-775-0951
cfrench@acb-online.org

Greg Fuhrer
USGS
2130 SW Fifth Avenue
Portland, OR 97201
503-251-3231
gjfuhrer@usgs.gov

Janice Fulford
US Geological Survey
Building 2101
Stennis Space Center, MS 39529
228-688-1501
jfulford@usgs.gov

David Fuller
Port Gamble S'Klallam Tribe
31912 Little Boston Road NE
Natural Resources Dept
Kingston, WA 98346
360-297-6323
drfuller.rg@gmail.com

Lori Fuller
U.S. Geological Survey
6520 Mercantile Way Suite 5
Lansing, MI 48911
517-887-8911
lmfuller@usgs.gov

Edward Furlong
U. S. Geological Survey, NWQL
PO Box 25585
Lakewood, CO 80225-0585
303-236-3941
efurlong@usgs.gov

Joel Galloway
USGS
821 East Interstate Ave
Bismarck, ND 58503
701-250-7402
jgallowa@usgs.gov

Adrian Garcia
Santa Clara Pueblo-Office of Environmental Affairs
P.O. Box 580
Espanola, NM 87532
505-753-7326
agarcia@santaclarapueblo.org

Ana Maria Garcia
USGS
3916 Sunset Ridge Rd
Raleigh, NC 27606
919-571-4058
agarcia@usgs.gov

Bradley Garner
U.S. Geological Survey
520 N. Park Ave.
Tucson, AZ 85719
520-670-6671x283
bdgarner@usgs.gov

Jessica Garrett
US Geological Survey
400 S. Clinton St. Rm. 269
Iowa City, IA 52240
319-358-3625
jgarrett@usgs.gov

Paul Garrison
Wisconsin Dept. of Natural Resources
2801 Progress Rd
Madison, WI 53716
608-221-6365
paul.garrison@wisconsin.gov

David Gay
Illinois State Water Survey
National Atmospheric Deposition Program
2204 Griffith Drive
Champaign, IL 61820
217-244-0468
dgay@illinois.edu

Jeremy Geist
Clinton River Watershed Council
101 Main St.
Suite, 100
Rochester, MI 48307
248-601-0606
jeremy@crwc.org

Dorrie Gellenbeck
U.S. Geological Survey
Denver Federal Center
MS 406
Denver, CO 80225
303-236-1458
djgell@usgs.gov

Jeroen Gerritsen
Tetra Tech, Inc.
400 Red Brook Blvd., Ste. 200
Owings Mills, MD 21117
410-356-8993
jeroen.gerritsen@tetratech.com

Jacob Gibs
U.S. Geological Survey
810 Bear Tavern Road
Suite 206
West Trenton, NJ 08628
609-771-3945
jgibs@usgs.gov

Annie Gillespie
Morro Bay National Estuary Program
601 Embarcadero, Suite 11
Morro Bay, CA 93442
805-772-3834 ext. 15
annieg@mbnep.org

David Gillett
Satlantic Inc.
3481 North Marginal Road
Halifax, NS B3K 5X8
Canada
902-492-4780
david.gillett@satlantic.com

Ed Gilroy
Practical Stats
9278 Lark Sparrow Dr.
Highlands Ranch, CO 80126-5232
edgilroy@earthlink.net

Mary Giorgino
US Geological Survey
3916 Sunset Ridge Rd
Raleigh, NC 27607
919-571-4087
giorgino@usgs.gov

Gary Girolimon
Ted Miller Associates, Inc
4700 Superior Street
Lincoln, NE 68504
303-989-7737
sales@tdma-inc.com

Gary A. Girolimon
Ted D Miller Associates
2525 S. Wadsworth Boulevard
Suite 300
Lakewood, CO 80227
303-989-7737
gary@tdma-inc.com

Steve Glazer
Upper Gunnison River Water Conservancy District
P.O. Box 1330
Gunnison, CO 81230
970-641-6065
steve@hccaonline.org

Doug Glysson
US Geological Survey
412 National Center
Reston, VA 20192
703-648-5019
gglysson@usgs.gov

Corey Godfrey
The Cadmus Group, Inc.
57 Water Street
Watertown, MA 02472
617-673-7147
corey.godfrey@cadmusgroup.com

Dean Goggles
W.R.E,Q.C.
Box 217
Washakie Street
Fort Washakie, WY 82514
307-332-3164
dgoggles@hotmail.com

Robert Goldstein
Technical Associates
7051 Eton Avenue
Canoga Park, CA 91303
818-883-7043
tagold@nwc.net

Les Gonyer
USDA Forest Service - Black Hills National Forest
8221 S Highway 16
Rapid City, SD 57702
605-716-1884
lgonyer@fs.fed.us

Jacquelyn Gonzales
San Manuel Band of Mission Indians
26569 Community Center Dr
Highland, CA 92346
909-864-8933 ext. 3248
jgonzales@sanmauel-nsn.gov

Gregg Good
Illinois Environmental Protection Agency
P.O. Box 19276
Springfield, IL 62794-9276
217-787-7405
Gregg.Good@illinois.gov

David Graczyk
U.S. Geological Survey
8505 Research Way
Middleton, WI 53705
608-821-3840
dgraczyk@usgs.gov

Jennifer Graham
U.S. Geological Survey
4821 Quail Crest Place
Lawrence, KS 66049
785-832-3511
jlgraham@usgs.gov

James Gray
U. S. Geological Survey, NWQL
PO Box 25585
Lakewood, CO 80225-0585
303-236-3776
jlgray@usgs.gov

Treda Grayson
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-0916
grayson.treda@epa.gov

Effie Greathouse
Oregon State University
5025 SW Corbett Ave #2
Portland, OR 97239
541-740-0811
effieg@gmail.com

Steven Greb
WI Dept of Natural Resources
2801 Progress rd
Madison, WI 53716
608-221-6362
steven.greb@wi.gov

Linda Green
Univ. of Rhode Island Cooperative Extension
C1K 1 Greenhouse Rd.
Kingston, RI 02881
401-874-2905
lgreen@uri.edu

Sarah Green
Alpine Watershed Group
P.O. Box 296
Markleeville, CA 96120
530-694-2327
watershed@alpinecountyca.gov

Alyse Greenberg
Stony Brook-millstone Watershed Assoc
31 Titus Mill Road
Pennington, NJ 08534
609-737-3735
agreenberg@thewatershed.org

Mark Gress
USGS
10500 University Center Dr
Tampa, FL 33612
813-918-8783
magress@usgs.gov

Lindsay Griffith
Brown and Caldwell
1697 Cole Blvd.
Suite 200
Golden, CO 80401
303-239-5445
lgriffith@brwncald.com

Kevin Grimsley
USGS
10500 University Center Dr
Suite 215
Tampa, FL 33612
813-975-8620
kjgrims@usgs.gov

Cristina Grosso
San Francisco Estuary Institute
7770 Pardee Lane
2nd Floor
Oakland, CA 94621
510-746-7334
cristina@sfei.org

Grant Grover
City of Longmont
1100 S. Sherman St.
Longmont, CO 80501
303-651-8744
grant.grover@ci.longmont.co.us

Senen Guzman-Rios
US Geological Survey
GSA Center
651 Federal Drive
Suite 400-15
Guaynabo, PR 00965
787-749-4346 ext 261
sgguzman@usgs.gov

Robert Hackett
Elon University
Princeton Environmental Institute
Princeton, NJ 08544
609-258-3698
rhackett@elon.edu

Brian Haggard
Arkansas Water Resources Center
203 Engineering Hall
University of Arkansas
Fayetteville, AR 72701
479-575-2879
haggard@uark.edu

James Hagy
US EPA
1 Sabine Island Drive
Gulf Breeze, FL 32561
850-934-2455
hagy.jim@epa.gov

Angela Hahn
WET Labs, Inc
PO Box 518
620 Applegate Street
Philomath, OR 97370
541-929-5650 ext 43
Angela@wetlabs.com

Seth Haines
USGS
Box 25046 MS 939
Denver, CO 80225
303-236-5709
shaines@usgs.gov

Bruce Hale
Denver Water
Water Quality Lab
6100 W Quincy Ave
Denver, CO 80235
303-628-5991
bruce.hale@denverwater.org

Basil Hamdan
City Of Fort Collins
700 Wood Street
Fort Collins, CO 80525
970-207-1577
bhamdan@fcgov.com

Timmarie Hamill
Big Chico Creek Watershed Citizen Monitoring Program
1282 Filbert Ave.
Chico, CA 95926
530-342-6620
thamill@sunset.net

Pixie Hamilton
U.S. Geological Survey
1730 East Parham Road
Richmond, VA 23228
804-261-2602
pahamilt@usgs.gov

Ed Hammer
US EPA Region 5
77 West Jackson
Chicago, IL 60604
312-886-3019
hammer.edward@epa.gov

Ben Hammond
Woolpert Inc.
2000 Center Point Dr.
Suite 2200
Columbia, SC 29210
803-214-5910
benjamin.hammond@woolpert.com

Debra Hammond
NJ Department Of Environmental Protection
NJ Water Monitoring Coordinating Council
P.O. BOX 409
Trenton, NJ 08625-0409
609-292-1623
Debra.Hammond@dep.state.nj.us

Chris Harbourt
Waterborne Environmental, Inc
2001 S 1st Street
Ste 109
Champaign, IL 61820
217-378-5148
harbourtc@waterborne-env.com

Mark Hardy
USGS
230 Collins Road
Boise, ID 83702
208-387-1352
mhardy@usgs.gov

Christina Hargiss
North Dakota State University
NDSU Dept 7050
PO Box 6050
Fargo, ND 58108
701-231-8451
christina.hargiss@ndsu.edu

Daren Harmel
USDA-ARS
808 E. Blacklnad Rd.
Temple, TX 76502
254-770-6521
daren.harmel@ars.usda.gov

Douglas Harned
U.S. Geological Survey
3916 Sunset Ridge Road
Raleigh, NC 27607
919-571-4024
daharned@usgs.gov

Grady Harper
North Fork River Improvement Association
122A E.Bridge St.
Hotchkiss, CO 81419
9
grady@nfria.org

James Harrington
California Dept of Fish and Game
2005 Nimbus Rd.
Rancho Cordova, CA 95670
916-258-2862
jharring@ospr.dfg.ca.gov

Jason Harrington
Greenspan Analytical
c/o Goyen Valve Corp.
1195 Airport Rd.
Lakewood, NJ 08701
732-364-7800
lsheridan@goyen.com

Jim Harrison
US Epa Region 4
Sam Nunn Atlanta Federal Center
61 Forsyth St
Atlanta, GA 30303
404-562-9271
harrison.jim@epa.gov

Bob Hart
U.S. Geological Survey
2255 N. Gemini Dr
Flagstaff, AZ 86001
928-556-7137
bhart@usgs.gov

Sue Hartley
USGS
DFC, MS415
Bldg 53, Room E-2312
Denver, CO 80225
303-236-4882
shartley@usgs.gov

Hilda Hatzell
USEPA - Region 4
61 Forsyth St., SW
Atlanta, GA 30303
404-562-9445
hatzell.hilda@epa.gov

Charles Hawkins
Utah State University
5210 Old Main Hill
Dept Watershed Sciences
Utah State University
Logan, UT 84322-5210
435-797-2280
chuck.hawkins@usu.edu

Polly Hays
US Forest Service
740 Simms Street
Golden, CO 80401
303-275-5096
pehays@fs.fed.us

Gail Heath
Idaho National Laboratory
P.O. Box 1625
Idaho Falls, ID 83415-3695
208-526-7009
Gail.Heath@inl.gov

Kari Hedin
Fond du Lac Reservation
1720 Big Lake Road
Cloquet, MN 55720
218-878-8009
karihedin@fdlrez.com

Dennis Helsel
Practical Stats
9278 Lark Sparrow Dr.
Highlands Ranch, CO 80126-5232
303-870-4921
dhelsel@practicalstats.com

Shawn Henderson
Environmental Protection Agency
901 N 5th St
Kansas City, KS 66101
913-551-7508
henderson.shawn@epa.gov

Paul Hendley
Syngenta Crop Protection Inc
410 Swing Road
Greensboro, NC 27409
336-632-6112
paul.hendley@syngenta.com

Michelle Henicheck
Virginia Dept. of Environmental Quality
629 East Main Street
Richmond, VA 23219
804-698-4052
michelle.henicheck@deq.virginia.gov

Rob Henrion
USGS
5338 Montgomery Blvd
Suite 400
Albuquerque, NM 87109
505-830-7926
rhenrion@usgs.gov

Audra Henry
ATSDR
4770 Buford Hwy
F-59
Atlantas, GA 30341
770-488-3758
ate1@cdc.gov

Brent Hepner
Aqualytical
11760 Commonwealth Drive
Louisville, KY 40299
303-893-3333
b.hepner@aqualytical.com

Lillian Herger
U.S. EPA
1200 Sixth Avenue, Ste 900
Mail Code: OEA-095
Seattle, WA 98101
206 553-1074
herger.lillian@epa.gov

Alan Herlihy
Oregon State University
OSU - Nash 104
Department of Fisheries &Wildlife
Corvallis, OR 97331
541-737-1975
alan.herlihy@oregonstate.edu

Karl Hermann
US EPA Region 8
1595 Wynkoop Street
Denver, CO 80202
303-312-6628
Hermann.Karl@epa.gov

Elizabeth Herron
URI Cooperative Extension
RM 105 NRS CIK
1 Greenhouse Rd
Kingston, RI 02881
401-874-4552
emh@uri.edu

Andy Hickey
U.S. Geological Survey
3039 Amwiler Road Suite 130
Atlanta, GA 30360
770-903-9157
achickey@usgs.gov

Margaret Hill
LaMotte Company
PO Box 329
802 Washington Ave.
Chestertown, MD 21620
800-344-3100, Ext. 7015
mhill@lamotte.com

Ryan Hill
Utah State University
5210 Old Main Hill
Logan, UT 84322
435-770-0906
ryan.hill@usu.edu

Robert Hillegas
CDPHE
4300 Cherry Creek Dr. S
Denver, CO 80246
303-692-3137
Robert.Hillegas@state.co.us

Bob Hirsch
USGS
432 National Center
U.S. Geological Survey
Reston, VA 20192
703-648-5888
rhirsch@usgs.gov

Michelle Hladik
U.S. Geological Survey
6000 J Street
Placer Hall
Sacramento, CA 95819
916-278-3183
mhladik@usgs.gov

Jennifer Hoffman
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102
717-238-0426 ext 111
jhoffman@srbc.net

Justin Hohn
San Diego Coastkeeper
2825 Dewey Rd., Ste. 200
San Diego, CA 92106
619 723 4590
justhohn@gmail.com

Susan Holdsworth
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-1187
holdsworth.susan@epa.gov

Daniel Holmberg
US Army Corps of Engineers, Sacramento District
1325 J Street
CESPK-ED-EC
Sacramento, CA 95814
916-557-6834
Daniel.T.Holmberg@usace.army.mil

Anne Hoos
US Geological Survey
640 Grassmere Park, Ste. 100
Nashville, TN 37211
615-837-4760
abhoos@usgs.gov

Jessica Hopple
U.S. Geological Survey
810 Bear Tavern Rd.
Suite 206
West Trenton, NJ 08628
609-771-3950
jahopple@usgs.gov

Barb Horn
Colorado Division of Wildlife
151 East 16th Avenue
Durango, CO 81301
970-382-6667
barb.horn@state.co.us

Paul Horvatin
US Environmental Protection Agency
77 W Jackson St G-17J
Chicago, IL 60604
312-353-3612
horvatin.paul@epa.gov

Erik Host Steen
Hach Hydromet
PO Box 389
Loveland, CO 80539
970-669-3050
ehostste@hach.com

Seth Hothem
Northeast Ohio Regional Sewer District
3900 Euclid Ave
Cleveland, OH 44115
216-881-6600
byrdv@neorsd.org

Eric Howe
Lake Champlain Basin Program
54 West Shore Rd.
Grand Isle, VT 05458
802-372-3213
ehowe@lcbp.org

Dorothy Yu Huang
Alberta Centre for Toxicology
HM-B19, 3330 Hospital Drive NW
Calgary, AB T2N 4N1
Canada
403-220-4551
yhuang@ucalgary.ca

Janice Huang
USEPA Region 5
77 W Jackson Blvd. (WQ-16J)
Chicago, IL 60604
312-353-8228
huang.janice@epa.gov

Laura Hubbard
U.S. Geological Survey
400 S. Clinton St.
Room 269
Iowa City, IA 52240
319-358-3638
lhubbard@usgs.gov

Laura Hubbard
City & County of Broomfield
4395 W. 144th Ave.
Broomfield, CO 80023
303-464-5606
lhubbard@broomfield.org

Shannon Hubler
Oregon Department of Environmental Quality
3150 NW 229th Ave.
Portland, OR 97124
503-693-5728
hubler.shannon@deq.state.or.us

Allison Hughes
Georgia Adopt-A-Stream
4220 International Parkway
Suite 101
Atlanta, GA 30354
404-675-1636
allison.hughes@dnr.state.ga.us

Brian Hughes
U.S. Geological Survey
3039 Amwiler Rd. STE 130
Atlanta, GA 30360
770-903-9162
wbhughes@usgs.gov

John Hummer
Great Lakes Commission
2805 S Industrial Hwy Suite 100
Ann Arbor, MI 48104-6791
734-971-9135
jhummer@glc.org

Charles Hunt
USGS
677 Ala Moana Blvd Suite 415
Honolulu, HI 96813
808-587-2414
cdhunt@usgs.gov

John Hunt
University of California, Davis
21 Benito Avenue
La Selva Beach, CA 95076
831-684-1203
jwhunt@ucdavis.edu

Laura Hunt
Environmental Protection Agency
1445 Ross Avenue
Dallas, TX 75202
214-665-9729
hunt.laura@epa.gov
Kasey Hutchinson
United States Geological Survey
400 S. Clinton St.
Iowa City, IA 52240
319-358-3617
khutchin@usgs.gov

Ken Hyer
USGS
1730 E. Parham Rd.
Richmond, VA 23228
804-261-2636
kenhyer@usgs.gov

Jeff Hyland
NOAA National Ocean Service
219 Fort Johnson Road
Charleston, SC 29412
843-762-8652
jeff.hyland@noaa.gov

George Ice
NCASI
PO Box 458
Corvallis, OR 97339
541-752-8801
Gice@wcrc-ncasi.org

Thomas Imbrigiotta
US Geological Survey
810 Bear Tavern Road
Suite 206
West Trenton, NJ 08628
609-771-3914
timbrig@usgs.gov

Chris Ingersoll
USGS
4200 New Haven Rd
Columbia, MO 65201
573-876-1819
cingersoll@usgs.gov

Roy Irwin
National Park Service
1201 Oakridge Drive
Fort Collins, CO 80525
970-225-3520
roy_irwin@nps.gov

Don Ivy
Thermo Scientific
166 Cummings Center
ATTN: Sokhom Bin
Beverly, MA 01915
978-232-6034
don.ivy@thermofisher.com

Heather Jackson
US Army Corps of Engineers, Ssacramento District
1325 J Street
CESPK-ED-EC
Sacramento, CA 95814
916-557-6886
Heather.A.Jackson@usace.army.mil

Pete Jackson
U.S. EPA
77 W. jackson Blvd.
Mail Code WQ-16J
Chicago, IL 60604
312-886-3894
jackson.peter@epa.gov

Don James
Smith River Rancheria
140 Rowdy Creek Rd.
Smith River, CA 95567
707-487-9255
don.james@tolowa.com

Travis A. James
USDA-NRCS
Bennett Federal Building
125 S. State Street, Rm 4402
Salt Lake City, UT 84138
801-524-3831
tjames@usbr.gov

Marcael Jamison
USGS Pacific Water Science Center
677 Ala Moana Blvd. #415
Honolulu, HI 96813
808-587-2437
mjamison@usgs.gov

Scott Janson
Hach Hydromet
PO Box 389
Loveland, CO 80539
970-669-3050
sjanson@hach.com

John Jastram
USGS
1730 E Parham Rd
Richmond, VA 23228
804-261-2648
jdjastra@usgs.gov

Drew Jeffers
City of Longmont
WQ Lab
501 East 1st Ave
Longmont, CO 80501
303-774-4598
drew.jeffers@ci.longmont.co.us

Jim Jenkins
ChemWare
900 Ridgefield Drive
Suite 150
Raleigh, NC 27609
919-855-8716
jjenkins@chemware.com

Denise Jensen
Winnebago Tribe of Nebraska
PO Box 687
Winnebago, NE 68071
402-878-4060
winnewater@huntel.net

Kris Jensen
U.S. EPA
1595 Wynkoop Street
Denver, CO 80304
303-317-6237
jensen.kris@epa.gov

Ben Jessup
Tetra Tech, Inc.
73 Main Street
Suite 38
Montpelier, VT 05602
802-229-1059
benjamin.jessup@tetratech.com

Ann Jochens
GCOOS Regional Association
Texas A&M University
3146 TAMU
College Station, TX 77843-3146
979-845-6714
ajochens@tamu.edu

Forrest John
United States Environmental Protection Agency
1445 Ross Avenue
Dallas, TX 75202
214-665-8368
john.forrest@epa.gov

Bill Johnson
Agilent Technologies
2553 Thunderbird Lane
Evergreen, CO 80439
303-662-4268
bill_c_johnson@agilent.com

Cindy Johnson
Virginia Dept. of Environmental Quality
629 East Main Street
Richmond, VA 23219
804-698-4385
cindy.johnson@deq.virginia.gov

Kim Johnson
Thermo Scientific
166 Cummings Center
ATTN: Sokhom Bin
Beverly, MA 01915
978-232-6034
Kim.johnson@thermofisher.com

Roxanne Johnson
North Dakota State University
Agriculture & Biosystems Engineering
NDSU, Dept 7620
P O Box 6050
Fargo, ND 58108-6050
701-231-8926
roxanne.m.johnson@ndsu.edu

Scott Johnson
Aquatic Bioassay & Consulting Labs
29 N. Olive St.
Ventura, CA 93001
805-643-5621
scott@aquabio.org

Thomas Johnson
USEPA Region 8 8EPR-EP
1595 Wynkoop Street
Denver, CO 80202-1129
303-312-6226
johnson.tom@epa.gov

Jason Jones
Arizona Department of Environmental Quality
1110 W Washington St
Phoenix, AZ 85007
602-771-2235
jdj@azdeq.gov

Ryan Jorgensen
Gold Systems
3330 South 700 East, Ste. C
Salt Lake City, UT 84106
801-456-6105
ryanj@goldsystems.com

Celeste Journey
U.S. Geological Survey
Suite 129, 720 Gracern Road
Columbia, SC 29210
803-750-6141
cjourney@usgs.gov

Billy Justus
U.S. Geological Survey
401 Hardin Road
Little Rock, AR 72211
501-228-3626
bjustus@usgs.gov

Stephen Kalkhoff
U.S. Geological Survey
PO Box 1230
Iowa City, IA 52240
319-358-3611
sjkalkho@usgs.gov

Neil Kamman
VT Agency of Natural Resouces
103 S Main 10N
Waterbury, VT 05671-0408
802-241-3795
neil.kamman@state.vt.us

Revital Katznelson
UC Berkeley Extension
1825 Vine St. Apt. 4
Berkeley, CA 94703
510-406-8514
revitalk@sbcglobal.net

Hylon Kaufmann
GfK Kynetec
1175 Shaw Ave #104 PMB 366
Clovis, CA 93612
559-250-1070
hylon.kaufmann@gfk.com

Philip Kaufmann
US EPA
200 SW 35th St
Corvallis, OR 97333
541-754-4451
kaufmann.phil@epa.gov

Nancy Keller
City of Pueblo
211 East D Street
Pueblo, CO 81007
719-553-2278
nkeller@pueblo.us

Vince Kelly
Green Eyes LLC
28034 Holly Road
Easton, MD 21601
410-221-8242
vince@greeneyesobserving.com

Carol Kendall
USGS
345 Middlefield Road, MS434
Menlo Park, CA 94025
650-329-4576
ckendall@usgs.gov

Eloise Kendy
The Nature Conservancy
656 N. Ewiing
Helena, MT 59601
406-495-9910
ekendy@tnc.org

Terry Kenney
U.S. Geological Survey
2329 Orton Circle
Salt Lake City, UT 84119
801-908-5046
tkenney@usgs.gov

Kristen Keteles
U.S. Environmental Protection Agency
1595 Wynkoop St.
Denver, CO 80202
303-312-6039
keteles.kristen@epa.gov

John Kiddon
USEPA
27 Tarzwell Drive
Narragansett, RI 02882
401-782-3044
kiddon.john@epa.gov

Richard Kiesling
USGS
2280 Woodale Drive
Mounds View, MN 55112
763-783-3131
kiesling@usgs.gov

Won Kim
Oregon DEQ
811 SW 6TH AVE
Portland, OR 97204
503-229-6086
kim.won@deq.state.or.us

Briant Kimball
U.S. Geological Survey
2329 W Orton Cir
Salt Lake City, UT 84119
801-908-5047
bkimball@usgs.gov

Warren Kimball
Ma. DEP/CERO
621 Main Street
Worcester, MA 01608
508-727-2879
Warren.Kimball@state.ma.us

Jim Kingsbury
U.S. Geological Survey
640 Grassmere Park Road
Suite 100
Nashville, TN 37211
615-837-4762
jakingsb@usgs.gov

David Kinniburgh
Alberta Centre for Toxicology
HM B19
3330 Hospital Drive NW
Calgary, AB T2N 4N1
Canada
403-220-5762
dkinnibu@ucalgary.ca

Holm Kipka
Friedrich Schiller University of Jena
Löbdergraben 32
Jena, D-07743
Germany
0049 3641 948898
holm.kipka@uni-jena.de

Jim Kircher
USGS
Denver Federal Center
BPO Box25046, Mail Stop 415
Lakewood, CO 80225
303-236-4882 x258
jkircher@usgs.gov

Ronald Klauda
Maryland Department of Natural Resources
580 Taylor Avenue
C-2
Annapolis, MD 21401
410-260-8615
rklauda@dnr.state.md.us

Paul Klawunn
Environment Canada
867 Lakeshore Rd.
Burlington, ON L7M 3V7
Canada
905-336-4965
paul.klawunn@ec.gc.ca

Karla Knoop
JBR Environmental Consultants, Inc.
8160 S Highland Dr.
Sandy, UT 84093
801-943-4144
kknoop@jbrenv.com

Gary Kohlhepp
Michigan Department of Natural Resources and Environment
MDNRE - Water Bureau
Constitution Hall, 2nd Floor South
525 West Allegan
Lansing, MI 48909
517-335-1289
kohlheppg@michigan.gov

Randy Kolka
USDA Forest Service
Forestry Sciences Lab
1831 Hwy 169 E.
Grand Rapids, MN 55744
218-326-7115
rkolka@fs.fed.us

Aimee Konowal
CDPHE
4300 Cherry Creek Dr. South
Denver, CO 80246
303-692-3530
aimee.konowal@state.co.us

Dan Koons
C.I.Agent Solutions
11760 Commonwealth Drive
Louisville, KY 40299
502-314-0319
Dank@ciagent.com

Phil Koontz
Galena Village
PO Box 244
Galena, AK 99741
907-656-1711
phil.koontz@gmail.com

Charles Kovatch
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-0399
kovatch.charles@epa.gov

Don Kozlowski
University of Nevada, Reno
Mail Stop 186
1000 Valley Rd
Reno, NV 89512
775-784-1449
donfkozlowski@gmail.com

Tim Kresse
U.S. Geological Survey
401 Hardin Rd
Little Rock, AR 72211
501-228-3616
tkresse@usgs.gov

Kelly Krock
U.S. EPA Region 3
1060 Chapline Street
Suite 303
Wheeling, WV 26003
304-234-0242
krock.kelly@epa.gov

Dan Kroll
Hach
5600 Lindbergh Drive
Loveland, CO 80539
970-443-2436
Dkroll@hach.com

Jen Krstolic
US Geological Survey Virginia Water Science Center
1730 E. Parham Road
Richmond, VA 23228
804-261-2635
jkrstoli@usgs.gov

Kathryn Kuivila
US Geological Survey
USGS
6000 J Street
Placer Hall
Sacramento, CA 95819-6129
916-278-3054
kkuivila@usgs.gov

James Kurtenbach
USEPA Region II
2890 Woodbridge Ave.
BLDG. 209
Edison, NJ 08837
732-321-6695
kurtenbach.james@epa.gov

Victoria Kurtz
Fluid Imaging Technologies
65 Forest Falls Dr.
Yarmouth, ME 04096
207-846-6100
victoria@fluidimaging.com

Jacob LaFontaine
USGS
3039 Amwiler Road
Suite 130
Atlanta, GA 30360
770-903-9192
jlafonta@usgs.gov

Monica Laina
U.S. Geological Survey
1505 Ferguson Lane
Austin, TX 78754
512-927-3532
mllaina@usgs.gov

Jim Laine
WV Dept of Environmental Protection
601 57th Street S.E.
Charleston, WV 25304
304-926-0499 Ext 1061
James.C.Laine@wv.gov

Jeanette Lamb
Oklahoma Conservation Commission
4545 N. Lincoln Blvd., Ste.11A
Oklahoma City, OK 73105
405-522-4836
jeanette.lamb@conservation.ok.gov

Bob Lange
Bureau of Land Management
220 E. Market St.
Meeker, CO 81641
970-878-3831
langeh2o@yahoo.com

Dave Langill
EcoAnalysts, Inc.
1420 S. Blaine St
Suite 14
Moscow, ID 83843-2876
208-882-2588
dlangill@ecoanalysts.com

Wayne Lapham
USGS
413 National Center
12201 Sunrise Valley Dr
Reston, VA 20192
703-648-5805
wlapham@usgs.gov

Erik Larsen
ACZ Laboratories, Inc
2773 Downhill Dr.
Steamboat Springs, CO 80487
800-334-5493
erikl@acz.com

Karen Larsen
California State Water Board
Office of Information Mgmt & Analysis
1001 I Street
Sacramento, CA 95814
916-319-9769
klarsen@waterboards.ca.gov

Matthew Larsen
USGS
408 National Center
12201 Sunrise Valley drive
Reston, VA 20192
703-648-5215
mclarsen@usgs.gov

April Laverriere
IDEXX
1 IDEXX Drive
Westbrook, ME 04092
207-556-3533
april-laverriere@idexx.com

Jason Law
City of Portland
6543 N Burlington Ave
Portland, OR 97203
503-823-1038
jason.law@portlandoregon.gov

Neely Law
Center for Watershed Protection
8390 Main St
Ellicott City, MD 21043
703-966-8786
nll@cwp.org

Casey Lee
USGS
4821 Quail Crest Place
Lawrence, KS 66049
913-209-8605
cjlee@usgs.gov

Kathy Lee
USGS
2280 Woodale Drive
Mounds View, MN 55112
763-783-3254
klee@usgs.gov

Michael Lee
U.S. Geological Survey
19241 David Memorial Drive
Suite 180
Conroe, TX 77385
936-271-5313
mtlee@usgs.gov

Sarah Lehmann
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-1379
lehmann.sarah@epa.gov

Joanna Lemly
Colorado Natural Heritage Program
254 General Services Building
Colorado State University
1474 Campus Delivery
Fort Collins, CO 80523-1474
970-491-2127
joanna.lemly@colostate.edu

Jean Lemmon
Oklahoma Conservation Commission
128 East 3rd Avenue
Bristow, OK 74010
918-521-9535
jean.lemmon@conservation.ok.gov

Kevin Lenon
Sauk-Suiattle Indian Tribe
5318 Chief Brown Lane
Darrington, WA 98241
360-436-0347
kevinlenon@sauk-suiattle.com

Fred Leslie
ADEM
PO Box 301463
Montgomery, AL 36130-1463
334-260-2748
FAL@adem.state.al.us

Michael Lewis
USGS Colorado WSC
USGS, Denver Federal Center
MS 415, Box 25046
Lakewood, CO 80228
303-236-4882
mlewis@usgs.gov

Robert Limbeck
Delaware River Basin Commission
PO Box 7360
25 State Police Drive
West Trenton, NJ 08628
609-883-9500
Robert.Limbeck@drbc.state.nj.us

Jennifer Linder
Tetra Tech
400 Red Brook Blvd, Ste 200
Owings Mills, MD 21117
410-356-8993
jennifer.linder@tetratech.com

Bruce Lindsey
USGS
215 Limekiln Road
New Cumberland, PA 17070
717-730-6964
blindsey@usgs.gov

Katherine Lins
US Geological Survey
12201 Sunrise Valley Drive
Reston, VA 20192
703-648-5014
klins@usgs.gov

Mike Lizotte
YSI, Inc.
1725 Brannum Ln.
Yellow Springs, OH 45387
937-767-7241

Ganzorig Lkhagvajav
National Water Committee Mongolia
UN str-5/1 Government Bldg -2 Ministry
of Nature Enviroment and Tourism
Room -206 Ulaanbaatar, Mongolia
Ulaanbaatar 976
Mongolia
976-51-266426
info.water8@gmail.com

Keith Loftin
US Geological Survey
4821 Quail Crest Place
Lawrence, KS 66049
785-832-3543
kloftin@usgs.gov

Terri Lomax
State of Alaska
555 Cordova St
Anchorage, AK 99501
907-269-7635
terri.lomax@alaska.gov

Barry Long
USDA Forest Service
201 14th St., SW
Washington, DC 20250
202-205-1093
barry.long@nps.gov

Rachel Lord
Cook Inletkeeper
3734 Ben Walters Ln
Suite 201
Homer, AK 99603
907-235-4068 x29
rachel@inletkeeper.org

Dave Lorenz
U.S. Geological Survey
2280 Woodale Dr.
Mounds View, MN 55112
763-783-3271
lorenz@usgs.gov

Chris Lowry
Hach Hydromet
PO Box 389
Loveland, CO 80539
970-669-3050
clowry@hach.com

Matthew Loyas
Capitol Region Watershed District
1410 Energy Park Drive
Suite 4
Saint Paul, MN 55108
651-644-8888
matt@capitolregionwd.org

Jodi Lozier
Ridinger Lake Association
4 EMS R4H Lane
Pierceton, IN 46562
574-594-3433
jodilozier@aol.com

Amy Ludtke
US Geological Survey
PO Box25046, MS-401
DFC
Lakewood, CO 80225
303-236-1876
asludtke@usgs.gov

Angel Luke
Teledyne Isco, Inc.
4700 Superior Street
Lincoln, NE 68504
402-464-0231
aluke@teledyne.com

Roberto Luna
City of Longmont WQ Lab
WQ Lab
501 East 1st Ave
Longmont, CO 80501
303-651-8666
roberto.luna@ci.longmont.co.us

Matthew Lyman
Connecticut Department of Environmental
Protection
79 Elm St
Hartford, CT 06106
860-424-3158
matthew.lyman@ct.gov

Don Mabe
Aqualytical
11760 Commonwealth Drive
Louisville, KY 40299
714-898-9036
don@ciagent.com

Dorene MacCoy
US Geological Survey
230 Collins Road
Boise, ID 83702
208-387-1354
demaccoy@usgs.gov

Teresa Magee
USEPA, Office of Research and Development,
Western Ecology Division
NHEERL Laboratory, WED
200 SW 35th Street
Corvallis, OR 97333
541-754-4385
magee.teresa@epa.gov

Barbara Mahler
U.S. Geological Survey
1505 Ferguson Ln
Austin, TX 78754
512-927-3566
bjmahler@usgs.gov

Bryan Maracle
Yukon River Inter-Tribal Watershed Council
815 2nd Ave. Suite 201
Fairbanks, AK 99701
907-451-2546
bmaracle@yritwc.org

Terry Maret
USGS
Idaho Water Science Center
230 Collins Road
Boise, ID 83702
208-387-1328
trmaret@usgs.gov

Kathryne Marko
City of Longmont
1100 S. Sherman St.
Longmont, CO 80501
303-651-8906
kathryne.marko@ci.longmont.co.us

Jon Marshack
State of California, Water Resources Control
Board
Office of Information Mgmt & Analysis
1001 I Street 15th Floor
P.O. Box 100
Sacramento, CA 95812-0100
916-341-5514
jmarshack@waterboards.ca.gov

Hugh Martin
Blue Water Satellite
440 E. Poe Rd
Suite 203
Bowling Green, OH 43402
248-592-1422
hmartin@bluewatersatellite.com

Jeff Martin
U.S. Geological Survey
5957 Lakeside Boulevard
Indianapolis, IN 46258
317-290-3333 ext. 148
jdmartin@usgs.gov

Becker Mary
CT DEP
79 Elm Street
Hartford, CT 06106
860-424-3744
mary.becker@ct.gov

Alisa Mast
USGS
POB 25046
Denver Federal Center
Denver, CO 80225
303-236-4882 x314
mamast@usgs.gov

Kimberly Matthews
RTI International
3040 Cornwallis Road
RTP, NC 27709
919-316-3366
kmatthews@rti.org

David Mau
USGS
201 E. 9th St
Pueblo, CO 81003
719-544-7155
dpmau@usgs.gov

Karl Mauch
Colorado Department of Agriculture
700 Kipling St
Suite 4000
Lakewood, CO 80215
303-239-5713
karl.mauch@ag.state.co.us

Molly Maupin
USGS
230 Collins Rd
Boise, ID 83702
208-387-1307
mamaupin@usgs.gov

Bob Maxey
EPA
1200 Pennsylvania Ave., N.W.
Mail Code 5303P
Washington, DC 20460
703-308-7273
maxey.bob@epa.gov

John Mayo
USGS
764 Horizon Dr.
Room 125
Grand Junction, CO 81527-8734
970-245-5257 ext 32
jwmayo@usgs.gov

Cecilia Mazza
Waters Corporation
34 Maple Street
Milford, MA 01757
508-482-3613
cecilia_mazza@waters.com

Dennis McCauley
Great Lakes Environmental Center
739 Hastings Street
Traverse City, MI 49686
231-941-2230
dmccauley@glec.com

Stephen McCord
Larry Walker Associates
707 4th Street
Suite 200
Davis, CA 95616
530-753-6400
sam@lwa.com

Jeff McCoy
U. S. Geological Survey, NWQL
PO Box 25585
Lakewood, CO 80225-0585
303-236-3940
jefmccoy@usgs.gov

Cary McElhinney
US EPA Region 5
77 W. Jackson Blvd
WG-15J
Chicago, IL 60604
312-886-4313
mcelhinney.cary@epa.gov

Leslie McGeorge
NJ Dept. of Environmental Protection
Water Monitoring and Standards
P.O. Box 409
Trenton, NJ 08625-0409
609-292-1623
leslie.mcgeorge@dep.state.nj.us

Mike McGinty
IDEXX
1 IDEXX Drive
Westbrook, ME 04092
207-556-0300
mike-mcginty@idexx.com

Catherine McIntyre
Montana Natural Heritage Program
1515 East Sixth Avenue
Helena, MT 59601
406-444-5381
cmcintyre@mt.gov

Sharon McKinney
USGS
417 National Center
12201 Sunrise Valley Drive
Reston, VA 20192
703-648-5259
slmckinn@usgs.gov

Douglas McLaughlin
NCASI
Western Michigan University
A-114 Parkview Campus
Kalamazoo, MI 49071
269-276-3545
douglas.mclaughlin@wmich.edu

Jerry McMahon
U.S. Geological survey
3916 Sunset Ridge Road
Raleigh, NC 27607
919-571-4068
gmcmahon@usgs.gov

Mike McManus
U.S. Environmental Protection Agency
NCEA (MS-A110)
26 W. Martin Luther King Drive
Cincinnati, OH 45268
513-569-7994
McManus.Michael@epa.gov

Thomas McNabb
Clean Lakes, Inc.
PO Box 3548
Coeur d'Alene, ID 83816
208-665-1475
tmcnabb@cleanlake.com

Tracy Mehan
The Cadmus Group, Inc.
1600 Wilson Boulevard
Suite 500
Arlington, VA 22209
703-247-6106
tracy.mehan@cadmusgroup.com

Amy Meier
Missouri Department of Conservation
Streams Unit
P.O. Box 180
Jefferson City, MO 65102
573-522-4115 x3166
amy.meier@mdc.mo.gov

Justin Mercer
Parsons Brinckerhoff
303 Second Street, Suite 700 N
San Francisco, CA 94107
415-243-4677
mercerj@pbworld.com

Kellie Merrell
VT DEC
103 S. Main St., Bldg 10N
Waterbury, VT 05671
802-241-4242
kellie.merrell@state.vt.us

Ray Merry
Eagle County
PO Box 179
Eagle, CO 81631
970-328-8757
ray.merry@eaglecounty.us

Ryan Mesmer
Louisiana State University
RNR Bldg.
Baton Rouge, LA 70803
732-216-4081
ryan.mesmer@gmail.com

Mike Meyer
US Geological Survey
4821 Quail Crest Place
Lawrence, KS 66049
785-832-3544
mmeyer@usgs.gov

Mick Micacchion
Ohio EPA, Wetland Ecology Group
4675 Homer Ohio Lane
Groveport, OH 43215
614-836-8779
mick.micacchion@epa.state.oh.us

Rob Middlemis-Brown
US Geological Survey
PO Box 1230
Iowa City, IA 52240
319-358-3600
rgbrown@usgs.gov

Amy Miguel
Salt River Pima-Maricopa Indian Community
10005 East Osborn Road
Scottsdale, AZ 85256
480-362-7631
Amy.Miguel@srpmic-nsn.gov

Ole Mikkelsen
Sequoia Scientific, Inc.
2700 Richards Rd Ste 107
Bellevue, WA 98005-4200
425-641-0944
ole.mikkelsen@sequoiasci.com

Lynn Milberg
MO Dept Of Natural Resources
PO Box 176
Jefferson City, MO 65102
573-526-3315
lynn.milberg@dnr.mo.gov

Kimberly Miller
Soboba Band of Luiseño Indians
PO Box 487
San Jacinto, CA 92581
951-654-2765
kmiller@soboba-nsn.gov

Leah Miller
Izaak Walton League
707 Conservation Lane
Gaithersburg, MD 20878
301-548-0150 X219
leah@iwla.org

Michael Miller
Wisconsin Dept. of Natural Resources
101 S. Webster St.
Madison, WI 53704
608-267-2753
michaela.miller@wisconsin.gov

Paul Miller
Waterborne Environmental, Inc
2001 S 1st Street
Ste 109
Champaign, IL 61820
217-378-5148
millerp@waterborne-env.com

Sarah Miller
Penn State University
302 Walker Building
University Park, PA 16802
814-863-2567
sjm20@psu.edu

Bryan Milstead
Environmental Protection Agency
27 Tarzwell Drive
Narragansett, RI 02882
401-782-3015
milstead.bryan@epa.gov

Robert Miltner
Ohio EPA
4675 Homer-Ohio Lane
Groveport, OH 43125
614-836-8796
bob.miltner@epa.state.oh.us

Jill Minter
U.S. EPA Region 8
(8EPR-EP)
1595 Wynkoop Street
Denver, CO 80202
303-666-1293
minter.jill@epa.gov

Richard Mitchell
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
4503-T
Washington, DC 20460
202-566-0644
mitchell.richard@epa.gov

Craig Mobley
U.S. Geological Survey
2775 Alta Mesa Blvd.
Fort Worth, TX 76133
817-253-1000
camobley@usgs.gov

Gregory Mohrman
U.S. Geological Survey
P.O. Box 25585, Denver Federal Center
Mail Stop 407
Lakewood, CO 80225
303-236-3500
gmohrman@usgs.gov

Megan Monroe
Tetra Tech
350 Indiana Street
Golden, CO 80401
303-217-5700
megan.monroe@tetratech.com

Colin Moore
bbe Moldaenke GmbH
Wildrosenweg 3
Kronshagen, 24119
Germany
+49 431 3804016
cmoore@bbe-moldaenke.de

Joel Moore
Metro Wastewater Reclamation District
6450 York St.
Denver, CO 80229
303-286-3368
jmoore@mwrd.dst.co.us

Rich Moore
US Geological Survey
331 Commerce Way
Pembroke, NH 03275
603-226-7825
rmoore@usgs.gov

Thomas Moorhouse
Clean Lakes, Inc.
PO Box 3548
Coeur d'Alene, ID 83816
818-889-8691
tmoorhouse@cleanlake.com

Jennifer Morace
USGS
Oregon Water Science Center
2130 SW Fifth Ave
Portland, OR 97201
503-251-3229
jlmorace@usgs.gov

Robert Morgan
Beaver Water District
P.O. Box 400
Lowell, AR 72745
479-756-3651
rmorgan@bwdh2o.org

Katherine Morris
Grand County
PO Box 264
Hot Sulphur Springs, CO 80451
970-725-3347
kmorris@co.grand.co.us

Kristy Morris
Los Angeles and San Gabriel Rivers Watershed Council
700 N Alameda Street
Los Angeles, CA 90012
213-229-9960
kristy@lasgrwc.org

Scott Morris
Sauk-Suiattle Indian Tribe
5318 Chief Brown Lane
Darrington, WA 98241
360-436-0347
smorris@sauk-suiattle.com

Jon Morrison
USGS
101 Pitkin Street
East Hartford, CT 06108
860-291-6761
jmorriso@usgs.gov

Ru Morrison
NERACOOS
570 Ocean Blvd
Rye, NH 03870
603-319-1785
Ru.Morrison@neracoos.org

Paul Morton
NJ Department of Environmental Protection
Water Monitoring & Standards
PO Box 409
401 East State Streeet
Trenton, NJ 08625-0409
609-292-1623
paul.morton@dep.state.nj.us

Steve Moulton
U.S. Geological Survey
12201 Sunrise Valley Drive
MS 413
Reston, VA 20192
703-648-6874
smoulto@usgs.gov

Dave Mueller
USGS
PO Box 25046, MS-406
Denver, CO 80225
303-236-1470
mueller@usgs.gov

Kathryn Muldoon
Florida Dept. of Environmental Protection
2600 Blair Stone Rd.
Tallahassee, FL 32399-2400
850-245-8579
kathryn.muldoon@dep.state.fl.us

Michael Mulvey
Oregon Dept of Environmental Quality
Laboratory and Environmental Assessment
3150 NW 229th Avenue, Suite 150
Hillsboro, OR 97223
503-693-5732
Mulvey.Michael@DEQ.state.or.us

Lorraine Murphy
United States Geological Survey
8505 Research Way
Middleton, WI 53562
608-821-3858
lmurphy@usgs.gov

Carol Murray
ESSA Technologies Ltd.
1765 West 8th Avenue
Suite 300
Vancouver, BC V6J 5C6
Canada
250-230-2020
cmurray@essa.com

Donna Myers
U.S. Geological Survey
MS413 National Center
12201 Sunrise Valley Drive
Reston, VA 20192
703-648-5012
dnmyers@usgs.gov

David Naftz
USGS
2329 West Orton Circle
Salt Lake City, UT 84119
801-908-5053
dlnaftz@usgs.gov

David Neils
NH Dept. Env. Services
29 Hazen Dr.
Concord, NH 03302
603-271-8865
david.neils@des.nh.gov

Kathy Neitzert
USGS
111 Kansas Ave SE
Huron, SD 57350
605-352-4241 x 226
kmneitze@usgs.gov

Harry Nelson
Fluid Imaging Technologies, Inc.
65 Forest Falls Dr.
Yarmouth, ME 04096
207-846-6100
harry@fluidimaging.com

Walt Nelson
U.S. EPA
2111 SE Marine Science Dr
Newport, OR 97365
541-867-4041
nelson.walt@epa.gov

Grant Neuharth
North Dakota Dept. of Health
918 E Divide Ave
Bismarck, ND 58501
701-328-5253
gdneuharth@nd.gov

Toomas Neuman
Biotap, LLC
Akadeemia tee 15A
Tallinn, 12618
Estonia
37255535771
toomasneuman@hotmail.com

Brian Newgent
Pine Environmental Serives
7332 S Alton Way
Bldg 13, Suite E
Centennial, CO 80112
303-741-3800
bnewgent@pine-environmental.com

Karen Newlon
Montana Natural Heritage Program
1515 East Sixth Ave
Helena, MT 59620
406-444-0915
knewlon@mt.gov

Duane Nichols
Upper Monongahela River Association
330 Dream Catcher Circle
Morgantown, WV 26508
304-216-5535
duane330@aol.com

Mark Nilles
U.S. Geological Survey
Box 25046, MS-401
Denver, CO 80225
303-236-1878
manilles@usgs.gov

Rachel Noble
UNC Chapel Hill
3431 Arendell Street
Morehead City, NC 28557
252-726-6841
rtnoble@email.unc.edu

Caitrin Noel
Friends of the Mad River
PO Box 255
Waitsfield, VT 05673
802-496-9127
friends@madriver.com

Tom Nolan
U.S. Geological Survey
431 National Center
Reston, VA 20191
703-476-4000
btnolan@usgs.gov

Mari Nord
US EPA Region 5 - WD
77 W. Jackson St
WQ-16J
Chicago, IL 60604
312-886-3017
nord.mari@epa.gov

Julia Norman
USGS
3427 Broken T Drive
Hood River, OR 97031
541-490-4245
jnorman@usgs.gov

Ginger North
Delaware Nature Society
PO Box 700
Hockessin, DE 19707
302-239-2334 ext.100
ginger@delawarenaturesociety.org

Sheila North
Dynamac Corp
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
513-569-7302
north.sheila@epa.gov

Doug Norton
EPA Office of Water
1200 Pennsylvania Ave NW
Washington, DC 20003
202-566-1221
norton.douglas@epa.gov

Wendy Norton
USGS
417 National Center
12201 Sunrise Valley Dr
Reston, VA 20192
703-548-6845
wenorton@usgs.gov

Jon Novick
City and County of Denver
200 W 14th Ave, Suite 310
Denver, CO 80014
720-865-5468
Jon.Novick@denvergov.org

Joni Nuttle
Colo DPHE
4300 Cherry Creek Drive S.
WQCD-RP-B1
Denver, CO 80246
303-692-3533
joni.nuttle@state.co.us

Callie Oblinger
U.S. Geological Survey
433 National Center
12201 Sunrise Valley Dr.
Reston, VA 20192
703-648-5803
oblinger@usgs.gov

Daniel Obrecht
University of Missouri
302 A.B. Natural Resources Bldg
Columbia, MO 65211
573-884-4060
obrechtd@missouri.edu

Timothy Oden
US Geological Survey
19241 David Memorial Drive
Suite 180
The Woodlands, TX 77385
936-271-5325
toden@usgs.gov

Osa Odum
Northwest Indian Fisheries Commission
6730 Martin Way E
Olympia, WA 98516
360-528-4371
oodum@nwifc.org

Gretchen Oelsner
U.S. Environmental Protection Agency
Western Ecology Division
200 SW 35th Street
Corvallis, OR 97333
541-754-4425
oelsner.gretchen@epa.gov

Erik Oerter
Colorado Geological Survey
1313 Sherman Street
Room 715
Denver, CO 80203
303-866-2611
erik.oerter@state.co.us

John O'Leary
Suquamish Tribe
PO Box 767
Suquamish, WA 98392
360-394-8602
spondelick@suquamish.nsn.us

Lisa Olsen
U.S. Geological Survey
California Water Science Center
6000 J Street - Placer Hall
Sacramento, CA 95819
916-278-3084
ldolsen@usgs.gov

Tony Olsen
USEPA Western Ecology Division
200 Sw 35th Street
Corvallis, OR 97333
541-754-4790
olsen.tony@epa.gov

John Olson
Utah State University
Watershed Sciences Dept
5210 Old Main Hill
Logan, UT 84322
435-770-4533
john.olson@usu.edu

Ronan O'Maitiu
Hach Hydromet
PO Box 389
Loveland, CO 80539
clowry@hach.com

Wayne O'Neal
Carnet Technology
6097 Oakley Palestine Road
Terry, MS 39170
601-857-8641
wayne.oneal@carnettechnology.com

Steve O'Neill
Tyco Environmental Systems
c/o Goyen Valve Corp.
1195 Airport Rd.
Lakewood, NJ 08701
lsheridan@goyen.com

Raymundo Ong
Ang Taga Lawa, Inc.
107-Ninth Avenue
between 3rd and 4th Streets
Caloocan City, 1400
Philippines
+63 9216033387
bhy_kubo@yahoo.com

James Orlando
U.S. Geological Survey
6000 J St
Placer Hall
Sacramento, CA 95819
916-278-3271
jorlando@usgs.gov

Patricia Orlando
U.S. Geological Survey
6000 J Street, Placer Hall
Sacramento, CA 95819
916-278-3110
porlando@usgs.gov

Jill Oropeza
City of Fort Collins
4316 W. Laporte Ave.
Fort Collins, CO 80521
970-416-2529
joropeza@fcgov.com

Ginger Paige
University of Wyoming
Dept. of Renewable Resources
1000 E. University Ave.
Laramie, WY 82071
307-766-2200
gpaige@uwyo.edu

Dave Paradies
The Bay Foundation
875 Santa Ysabel #16
Baywood Park, CA 93402
805-801-2095
dave_paradies@thegrid.net

Denis Parent
Environment Canada
45 Alderney Drive
16th Floor
Dartmouth, NS B3L 3H8
Canada
902-426-7629
denis.parent@ec.gc.ca

Suzanne Paschke
U.S. Geological Survey
Denver Federal Center MS415
PO Box 25046
Lakewood, CO 80225
303-236-4882 X352
spaschke@usgs.gov

Anil Patel
10200,Park Meadows drive
Apt 1814
Lone tree, CO 80124
720-292-0459
anilguru@hotmail.com

Renee Paterson
Newfoundland & Labrador Department of
Environment and Conservation
PO Box 8700
4th Fl Confederation Building
St. John's, NL A1B 4J6
Canada
709-729-1159
reneepaterson@gov.nl.ca

Glenn Patterson
Colorado State University
1201 Oakridge Drive
Suite 250
Fort Collins, CO 80525
970-267-2120
glenn_patterson@partner.nps.gov

Charles Patton
U. S. Geological Survey, NWQL
PO Box 25585
Lakewood, CO 80225-0585
303-236-3956
cjpatton@usgs.gov

Deborah Patton
Rural Community Assistance Corporation
1158 E. Beryl Avenue
Suite 8
Phoenix, AZ 85020
602-501-6696
dpatton@rcac.org

Lauren Patton
City of Portland
6543 N Burlington Ave
Portland, OR 97203
503-823-7746
laurenp@bes.ci.portland.or.us

Erik Paulk
Pine Environmental Services
7332 S Alton Way
Bldg 13, Suite E
Centennial, CO 80112
303-741-3800
epaulk@pine-environmental.com

Carey Pauquette-Schalm
Saginaw Chippewa Indian Tribe of Michigan
7070 E Broadway
Mt. Pleasant, MI 48858
989-775-4016
cpschalm@sagchip.org

Kenneth Pearsall
US Geological Survey
425 Jordan Rd
Troy, NY 12180-8349
518-285-5669
pearsall@usgs.gov

Sara Peel
Wabash River Enhancement Corporation
200 N. 2nd Street
Lafayette, IN 47901
765-337-9100
speel@lafayette.in.gov

Brian Pellerin
US Geological Survey
6000 J Street, Placer Hall
Sacramento, CA 95819
bpeller@usgs.gov

Pete Penoyer
National Park Service
1201 Oakridge Drive
Fort Collins, CO 80525
970-225-3535
pete_penoyer@nps.gov

John (Tab) Peryam
State of Tennessee: DOE Oversight Division
761 Emory Valley Road
Oak Ridge, TN 37830
865-481-0995
tab.peryam@tn.gov

Charlie Peters
USGS
2020 Chamberlain Ave
Madison, WI 53562
608-238-8343
capeters@usgs.gov

Joyce Peterson
Washoe Environmental Protection Department
919 Hwy. 395 South
Gardnerville, NV 89410
775-265-8680
gwen.james@washoetribe.us

Sally Petrella
Friends of the Rouge
4901 Evergreen Road
220 Academic Support Center
Dearborn, MI 48228
313-792-9621
monitoring@therouge.org

Kelli Petrick
Teton Science Schools
700 Coyote Canyon Road
Jackson, WY 83001
307-734-3749
kelli.petrick@tetonscience.org

Greg Pettit
Oregon Department of Environmental Quality
3150 NW 229th Suite 150
Hillsboro, OR 97124
503-693-5705
pettit.greg@deq.state.or.us

Cassandra Pfeifle
U.S. Geological Survey
3916 Sunset Ridge Rd.
Raleigh, NC 27607
919-571-4078
cmendoza@usgs.gov

Ann-Marie Phalen-Hartman
In-Situ Inc.
221 E. Lincoln Ave.
Fort Collins, CO 80524-2533
970-498-1500
ahartman@in-situ.com

Nejma Piagentini
Princeton University
Princeton Environmental Institute
Washington Rd, Guyot Hall M172
Princeton, NJ 08544
609-258-2004
npiagent@princeton.edu

Chris Piehler
Louisiana Dept Of Environmental Quality
PO Box 4314
Baton Rouge, LA 70821
225-219-3483
chris.piehler@la.gov

Maggie Pierce
Colorado Dept of Public Health & Environment
4300 Cherry Creek Drive S
WQCD-B1
Denver, CO 80246
303-692-3577
maggie.pierce@state.co.us

Jaclyn Pitt
Abraxis LLC
54 Steamwhistle Drive
Warminster, PA 18974-1450
215-357-3911
jpitt@abraxiskits.com

Holly Piza
Urban Drainage and Flood Control District
2480 W 26th Ave.
Suite 156-B
Denver, CO 80033
303-455-6277
hpiza@udfcd.org

Alison Plant
US Army Corps of Engineers, Sacramento District
1325 J Street
CESPK-ED-EC
Sacramento, CA 95814
916-557-7473
Alison.B.Plant@usace.army.mil

Regina Poeske
U.S. EPA Region 3
1650 Arch Street
Philadelphia, PA 19103-2029
215-814-2725
poeske.regina@epa.gov

Amina Pollard
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-1167
pollard.amina@epa.gov

Alan Polonsky
City and County of Denver
200 W 14th Ave
Suite 310
Denver, CO 80204
720-865-5480
alan.polonsky@denvergov.org

Jerry Popiel
Geotech Environmental Equipment
2650 East 40th Ave.
Denver, CO 80205
303-320-4764
jerryp@geotechenv.com

Chuck Pottsmith
Sequoia Scientific, Inc.
2700 Richards Rd., Ste. 107
Bellevue, WA 98005-4200
425-641-0944
pottsmith@sequoiasci.com

Durga D. Poudel
University of Louisiana at Lafayette
P.O. Box 44650
Dept. of Renewable Resources
Lafayette, LA 70504
337-482-6163
ddpoudel@louisiana.edu

Bart Powaukee
Ute Tribe Water Quality
PO Box 460
Ft Duchesne, UT 84026
435-725-4821
bartp@utetribe.com

Sarah Powers
Indiana Clean Lakes Program
1315 East 10th Street, Rm. 347
Indiana Clean Lakes Program, SPEA
Bloomington, IN 47405
812-855-1600
sarah.r.powers@gmail.com

Todd Presley
U.S. Geological Survey
677 Ala Moana Blvd.
Suite 415
Honolulu, HI 96813
808-587-2413
tkpresle@usgs.gov

Stephen Preston
US Geological Survey
1289 MCD Drive
Dover, DE 19901
302-734-2506
spreston@usgs.gov

Nancy Rabalais
Louisiana Universities Marine Consortium
8124 Hwy 56
Chauvin, LA 70344
985-851-2801
nrabalais@lumcon.edu

Robert Radtke
Bureau of Reclamation
125 S State Street, RM 6107
SLC, UT 84138
801-524-3719
rradtke@usbr.gov

Rob Ragsdale
NOAA/ERT
1100 Wayne Ave.
Suite 1225
Silver Spring, MD 20910
301-427-2439
Rob.Ragsdale@noaa.gov

Nicole Rahman
South Branch Watershed Association
Lechner House, 41 Lilac Drive
Flemington, NJ 08822
908-782-0422 ext 14
nicolerahman@sbwa.org

Suzette Ramirez
US Army Corps of Engineers, Sacramento District
1325 J Street
CESPK-ED-EE
Sacramento, CA 95814
916-557-6985
Suzette.M.Ramirez@usace.army.mil

Tony Ranalli
U.S. Geological Survey
Denver Federal Center
PO Box 25046
MS 415
Lakewood, CO 80225
303-236-4882 ext. 313
tranalli@usgs.gov

Julie Randall
Santa Ynez Band of Chumash Indians
Santa Ynez, CA 93460
805-688-7997
jrandall@santaynezchumash.org

Penny Randall
Technical Associates
7051 Eton Avenue
Canoga Park, CA 91303
818-883-7043
tagold@nwc.net

Patrick Rasmussen
USGS
4821 Quail Crest Place
Lawrence, KS 66049
785-832-3542
pras@usgs.gov

Ryan Rasmussen
USGS
3916 Sunset Ridge Road
Raleigh, NC 27607
919-571-4093
rbrasmus@usgs.gov

Mark Rawlinson
EnviroTech Instruments LLC
1517 Technology Drive
Suite 101
Chesapeake, VA 23320
757-549-8474
mark@envirotechinstruments.com

Mary Ray
USGS
4165 Spruance Rd
Suite 200
San Diego, CA 92101
619-225-6100
mray@usgs.gov

Richard Rebich
U.S. Geological Survey
308 South Airport Road
Jackson, MS 39208-6649
601-933-2928
rarebich@usgs.gov

Janice Redford
WAV-Wisconsin
2062 Hillside Road
Cambridge, WI 53523
608-423-4438
redfordfarm@gmail.com

Jason Redwood
Solinst Canada Ltd.
35 Todd Rd.
Georgetown, ON L7G 4R8
Canada
905/873-2255
jason.redwood@solinst.com

Sharon Reedyk
Agriculture and Agri-Food Canada
AAFC-AESB
Room 945
9700 Jasper Avenue
Edmonton, AB T5J 4C3
Canada
780-495-5965
sharon.reedyk@agr.gc.ca

Timothy Reilly
US Geological Survey
810 Bear Tavern Road
Suite 206
West Trenton, NJ 08628
609-771-3962
tjreilly@usgs.gov

Christine Reimer
National Ground Water Association
601 Dempsey Road
Westerville, OH 43081
880-551-7379
creimer@ngwa.org

David Reppert
U.S. Geological Survey
P.O. Box 25585
Denver Federal Center
Lakewood, CO 80225
303-236-3548
dreppert@usgs.gov

Tabbatha Revas
Cherokee Nation Environmental Programs
208 East Allen Road
Tahlequah, OK 74464
918-316-1071
tabbatha-revas@cherokee.org

Charles Rhoades
USDA Forest Service
Rocky Mountain Research Station
240 W. Prospect
Fort Collins, CO 80526
970-498-1250
crhoades@fs.fed.us

Karl Rhynas
FTS
1065 Henry Eng Place
Victoria, BC V9B 6B2
Canada
250-478-5561
eembacher@ftsinc.com

Matthew Rich
MACTEC Engineering and Consulting, Inc.
9177 Sky Park Court
San Diego, CA 92123
858-514-6478
mrrich@mactec.com

Kevin Richards
US Geological Survey
8505 Research Way
Middleton, WI 53562
608-821-3861
krichard@usgs.gov

Amanda Richardson
Prescott Creeks
PO Box 3004
Prescott, AZ 86302
928-445-5669
ARichardson@PrescottCreeks.org

Kat Ridolfi
San Francisco Estuary Institute
7770 Pardee Lane
2nd Floor
Oakland, CA 94621
510-746-7334
kat@sfei.org

Trish Rielly
Missouri Department Of Natural Resources
P.O. Box 176
1101 Riverside Drive
Jefferson City, MO 65101
573-751-1300
candace.buford@dnr.mo.gov

Scott Rietsema
SJE-Rhombus
P.O. Box 1708
Detroit Lakes, MN 56502
218-847-1317
scott.rietsema@sjerhombus.com

Chris Riggert
Missouri Department of Conservation
MDC - Streams Unit
P.O. Box 180
Jefferson City, MO 65102-0180
573-522-4115 x3167
Chris.Riggert@mdc.mo.gov

Elizabeth Riley
US Environmental Protection Agency
1200 Pennsylvania ave
Mailcode 4802T
Washington, DC 20460
202-566-0437
riley.elizabeth@epa.gov

Martin Risch
U.S. Geological Survey
5957 Lakeside Blvd.
Indianapolis, IN 46278
317-290-3333 x163
mrrisch@usgs.gov

Karen Riva-Murray
U.S. Geological Survey
425 Jordan Road
Troy, NY 12180
518-285-5617
krmurray@usgs.gov

Dale Robertson
U.S. Geological Survey
8505 Research Way
Middleton, WI 53562
608-821-3867
dzrobert@usgs.gov

Sandra Robertson
Tennessee Valley Authority
1101 Market Street
PSC 1X
Chattanooga, TN 37402
423-876-6744
ssrobertson@tva.gov

Jeffery Robichaud
US EPA R-7
901 N 5th St
Kansas City, KS 66101
913-551-7146
robichaud.jeffery@epa.gov

Armando Robledo
U.S. Geological Survey
944 Arroyo Street
San Angelo, TX 76903
325-3-944-4600 ex 26
Arobledo@usgs.gov

Channah Rock
University of Arizona
37860 W. Smith-Enke Rd
Maricopa, AZ 85138
520-381-2258
channah@cals.arizona.edu

Julie Rodriguez
WET Labs, Inc
PO Box 518
620 Applegate Street
Philomath, OR 97370
541-929-5650 ext 44
julie@wetlabs.com

Anne Rogers
Texas Commission on Environmental Quality
TCEQ
PO Box 13087
MC-234
Austin, TX 78711-3087
512-239-4597
anrogers@tceq.state.tx.us

Liz Rogers
US EPA
1595 Wynkoop St.
Denver, CO 80202-1129
303-312-6974
rogers.liz@epa.gov

Gayle Rominger
YSI, Inc.
1725 Brannum Ln.
Yellow Springs, OH 45387
937-767-7241
grominger@ysi.com

Patsy Root
IDEXX
1 IDEXX Drive
Westbrook, ME 04092
207-556-0300
patsy-root@idexx.com

Jim Rosa
BioMap
5802 McIntyre Ct
Golden, CO 80403
303-7043374
jim_rosa@hotmail.com

Linda Rosales
Denver Water
Water Quality Lab
6100 W Quincy Ave
Denver, CO 80235
303-628-5986
lindaandben@msn.com

Barry Rosen
USGS
12703 Research Parkway
Orlando, FL 32826
407-803-5508
brosen@usgs.gov

Michael Rosen
US Geological Survey
2730 N. Deer Run Road
Carson City, NV 89701
775-887-7683
mrosen@usgs.gov

Gary Rosenlieb
National Park Service
1201 Oakridge Drive
Fort Collins, CO 80538
970-225-3518
gary_rosenlieb@nps.gov

Colleen Rostad
USGS, WRD, NRP
Box 25046, Bldg 95, MS 408
Denver Federal Center
Denver, CO 80225
303-236-3971
cerostad@usgs.gov

Stewart Rounds
U.S. Geological Survey
Oregon Water Science Center
2130 SW 5th Avenue
Portland, OR 97201
503-251-3280
sarounds@usgs.gov

Gary Rowe
US Geological Survey
Denver Federal Center, Bldg. 53
PO Box 25046, MS 406
Denver, CO 80225-0046
303-445-4645
glrowe@usgs.gov

Timothy Rowe
U.S. Geological Survey
2730 N. Deer Run Rd.
Carson City, NV 89701
775-887-7627
tgrowe@usgs.gov

Ryan Rowland
USGS
2329 Orton Circle
Salt Lake City, UT 84119-2047
801-908-5036
rrowland@usgs.gov

Fernando Rubio
Abraxis LLC
54 Steamwhistle Drive
Warminster, PA 18974-1450
215-357-3911
frubio@abraxiskits.com

John Rudolph
Nautilus Environmental
5550 Morehouse Drive
San Diego, CA 92121
858-587-7010
john@nautilusenvironmental.com

Peter Ruhl
U.S. Geological Survey
12201 Sunrise Valley Drive, MS 413
Reston, VA 20192
703-421-7891
pmruhl@usgs.gov

Donna Runkle
U.S. Geological Survey
6480 Doubletree Ave
Columbus, OH 43229-1111
614-430-7733
dlrunkle@usgs.gov

March Runner
Galena Village
PO Box 244
Galena, AK 99741
907-656-1711
March_runner@Yahoo.com

Mike Rupert
U.S. Geological Survey
201 East 9th Street
Pueblo, CO 81003
719-544-7155 x113
mgrupert@usgs.gov

David Rus
USGS - Nebraska
5231 South 19th
Lincoln, NE 68512
402-328-4127
dlrus@usgs.gov

Philip Russell
LEWWTP
2900 S Platter River Drive
Englewood, CO 80110
303-762-2611
prussell@englewoodgov.org

Karen Ryberg
U.S. Geological Survey
821 E Interstate Ave
Bismarck, ND 58503
701-250-7422
kryberg@usgs.gov

David Saad
U.S. Geological Survey
8505 Research Way
Middleton, WI 53562
608-821-3865
dasaad@usgs.gov

Gregg Sablak
Ohio Environmental Protection Agency
50 West Town Street
Suite 700
Columbus, OH 43215
614-644-4132
gregg.sablak@epa.state.oh.us

Michael Sadar
Hach Company
5600 Lindbergh Drive
Loveland, CO 80539
970-663-1377
msadar@hach.com

Steven Sagstad
Civil & Environmental Consultants, Inc
11811 North Tatum Blvd, #3057
Phoenix, AZ 85028
602-760-2324
ssagstad@cecinc.com

John Salinas
Rogue Community College
3345 Redwood Highway
Grants Pass, OR 97527
541-956-7069
JohnSalinas@charter.net

Bob Salter
Charm Sciences, Inc.
659 Andover Street
Lawrence, MA 01843
978-687-9200
bobs@charm.com

Thomas Sanders
Colorado State University
Dept. of Civil & Environ. Engineering
Fort Collins, CO 80523
970-491-5448
tgs@engr.colostate.edu

Mark Sandstrom
U. S. Geological Survey, NWQL
PO Box 25585
Lakewood, CO 80225-0585
303-236-3943
sandstro@usgs.gov

Rick Savage
NC Division of Water Quality
2321 Crabtree Blvd.
Suite 250
Raleigh, NC 27604
919-715-3479
rick.savage@ncdenr.gov

Steve Schaff
U. S. EPA - Region 7
901 N 5th Street
Kansas City, KS 66101
913-551-7447
schaff.steve@epa.gov

Keelin Schaffrath
USGS
764 Horizon Dr. Room 125
Grand Junction, CO 81506
970-245-5257 x23
keelin@usgs.gov

Mike Schaub
US EPA Region 6
1445 Ross Avenue
Suite 1200 (6WQ-EA)
Dallas, TX 75202
214-665-7314
schaub.mike@epa.gov

Terry Schertz
USGS
12201 Sunrise Valley Dr
Reston, VA 20190
703-648-6864
tschertz@usgs.gov

Jon Schiller
Hach Company
5600 Lindbergh Drive
Loveland, CO 80538
970-663-1377
jschille@hach.com

Don Schloesser
U S Geological Survey, Great Lakes Science Center
1451 Green Road
Ann Arbor, MI 48105
734-214-7223
dschloesser@usgs.gov

Jeffrey Schloss
University of New Hampshire
133 Spaulding Hall
38 Academic Way
Durham, NH 03824
603-862-3848
jeff.schloss@unh.edu

Christopher Schmitt
U.S. Geological Survey - CERC
4200 New Haven Rd.
Columbia, MO 65201
573-876-1846
cjschmitt@usgs.gov

David Schoellhamer
US Geological Survey
6000 J Street
Placer Hall
Sacramento, CA 95819
916-278-3126
dschoell@usgs.gov

Tara Schraga
US Geological Survey
345 Middlefield Rd
MS 496
Menlo Park, CA 94025
650-329-4381
tschraga@usgs.gov

Bob Schreiber
CDM
50 Hampshire Street
Cambridge, MA 02139-1548
617-452-6251
schreiberRP@cdm.com

Nancy Schuldt
Fond du Lac Reservation
1720 Big Lake Road
Cloquet, MN 55720
218-878-8010
nancyschuldt@fdlrez.com

Eric Schwab
U. S. Geological Survey, NWQL
PO Box 25585
Lakewood, CO 80225-0585
303-236-3178
easchwab@usgs.gov

Greg Schwarz
USGS
12201 Sunrise Valley Dr.
MS 413
Reston, VA 20192
703-648-5718
gschwarz@usgs.gov

Barbara Scott
Kentucky Division of Water
200 Fair Oaks Lane
Frankfort, KY 40601
502-564-3410
barbara.scott@ky.gov

Janet Scott
University of Alberta
Department of Renewable Resources
751 General Services Building
Edmonton, AB T6G 2H1
Canada
780-492-8392
janet.scott@ualberta.ca

Mindy Scott
Sanitation District No 1
1045 Eaton Drive
Ft Wright, KY 41017
859-578-6743
mscott@sd1.org

Michael Scozzafava
US EPA, Office of Wetlands Oceans & Watersheds
1200 Pennsylvania Ave NW
MC# 4502T
Washington, DC 20460
202-566-1376
scozzafava.michaele@epa.gov

Barb Scudder
US Geological Survey
8505 Research Way
Middleton, WI 53562
608-821-3832
bscudder@usgs.gov

Stephen Sebestyen
USDA Forest Service
Northern Research Station
Grand Rapids, MN 55744-3399
218-326-7108
ssebestyen@fs.fed.us

Anthony Seeman
Iowa Soybean Association
1255 SW Prairie Trail Pkwy
Ankeny, IA 50023
515-251-8640
aseeman@iasoybeans.com

Ralph Seiler
US Geological Survey
2730 N. Deer Run Road
Carson City, NV 89701
775-887-7674
rseiler@usgs.gov

Joseph Seo
Aquatic Informatics
Suite 1100 – 570 Granville Street
Vancouver, BC V6C 3P1
Canada
604-873-2782 ext. 41
joseph@aquaticinformatics.com

Gregg Serenbetz
U.S. EPA
1200 Pennsylvania Ave., NW
MC 4502T
Washignton, DC 20460
202-566-1253
serenbetz.gregg@epa.gov

Erin Sewell
US Geological Survey
1505 Furgeson Lane
Austin, TX 78756
512-461-8680
ecsewell@usgs.gov

Laurie Shafer
Fort Peck Tribes-Office of Envrionmental Protection
603 Court Ave.
P.O. Box 1027
Poplar, MT 59255
406-768-2323
laurieshafer@nemontel.net

Jonathan Sharp
University of Delaware
School of Marine Science and Policy
University of Delaware
Lewes, DE 19958
302-645-4259
jsharp@udel.edu

Tony Shaw
Pennsylvania DEP
400 Market St
Harrisburg, PA 17105-8467
717-787-9637
tshaw@state.pa.us

Jeff Shearer
National Park Service
240 W. 5th Ave.
Southwest Alaska Network
Anchorage, AK 99501
907-644-3682
Jeff_Shearer@nps.gov

Jim Shelley
City of Boulder
5605 N. 63rd St
Boulder, CO 80301
303-413-7402
shelleyj@bouldercolorado.gov

Fraser Shilling
University of California, Davis
Department of Environmental Sci. & Pol.
One Shields Ave.
Davis, CA 95616
530-752-7859
fmshilling@ucdavis.edu

Ann Shortelle
MACTEC Engineering and Consulting, Inc.
404 140th Terrace
Newberry, FL 32669-3000
352-333-2623
abshortelle@mactec.com

Adam Sigler
Montana State University
Leon Johnson Hall rm 334
Bozeman, MT 59717
406-994-7381
asigler@montana.edu

Maifan Silitonga
Alcorn State University
1000 Alcorn Drive #209
Lorman, MS 39096
601-877-6534
msilitonga@alcorn.edu

Jay Silvanima
Florida Dept. Environmental Protection
2600 Blair Stone Rd.
Tallahassee, FL 32399-2400
850-245-8507
James.silvanima@dep.state.fl.us

TJ Sisson
Hach Hydromet
PO Pox 389
Loveland, CO 80539
208-543-6697
tsisson@hach.com

Ken Skach
USGS
2130 SW 5th Avenue
Portland, OR 97201
503-251-3285
kaskach@usgs.gov

Mary Skopec
Iowa DNR
109 Trowbridge Hall
Iowa City, IA 52242
319-335-1579
mary.skopec@dnr.iowa.gov

Stan Skrobialowski
USGS
412 National Center
Reston, VA 20192
703-648-6902
sski@usgs.gov

Gail M. Sloane
Florida Department of Environmental Protection
2600 Blair Stone Road
Mail Station 3525
Tallahassee, FL 32399-2400
850-245-8512
gail.sloane@dep.state.fl.us

Jenifer Sluga
Turner Designs
845 W Maude Avenue
Sunnyvale, CA 94085
408-749-0994
marketing@turnerdesigns.com

Kelly Smalling
US Geological Survey
6000 J St.
Placer Hall
Sacramento, CA 95819
916-278-3052
ksmall@usgs.gov

Casey Smith
Idaho National Laboratory
P.O. Box 1625
Idaho Falls, ID 83415-3695
208-526-0471
Casey.Smith@inl.gov

David G Smith
NYC DEP (Retired)
14 Old English Way
Wappingers Falls, NY 12590
845-297-6821
waterdave1@msn.com

Elizabeth Smith
Kansas Dept. of Health & Environment
1000 SW Jackson, Ste. 430
Topeka, KS 66612
785-296-4332
esmith@kdheks.gov

Kathleen Smith
U.S. Geological Survey
M.S. 964D
Denver Federal Center
Denver, CO 80225-0046
303-236-5788
ksmith@usgs.gov

Blaine Snyder
Tetra Tech, Inc.
400 Red Brook Blvd.
Suite 200
Owings Mills, MD 21117
410-356-8993
blaine.snyder@tetratech.com

Trisha Solberg
U.S. Geological Survey
764 Horizon Drive
Rm 126
Grand Junction, CO 81506
970-245-5257
psolberg@usgs.gov

Jeanne Spaur
Fort Peck Tribes
PO Box 1027
Poplar, MT 59255
406-768-2329
jeannespaur@yahoo.com

Rick Spear
PA Department of Environmental Protection
400 Waterfront Drive
Pittsburgh, PA 15222-4745
412-442-5874
rspear@state.pa.us

Sandra Spence
US EPA Region 8
1595 Wynkoop
Denver, CO 80202
303-312-6947
spence.sandra@epa.gov

Patrice Spindler
AZ Dept of Environmental Quality
1110 W. Washington St
Phoenix, AZ 85007
602-771-4543
phs@azdeq.gov

Charles Spooner
USEPA
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-1174
spooner.charles@epa.gov

Lori Sprague
U.S. Geological Survey
P.O. Box 25046, MS 415
Denver Federal Center
Denver, CO 80225
303-236-4882
lsprague@usgs.gov

Ann St Amand
PhycoTech, Inc
620 Broad Street
Ste 100
St. Joseph, MI 49085
269-983-3654
info@phycotech.com

Paul Stackelberg
U.S. Geological Survey
425 Jordan Road
USGS
Troy, NY 12180
518-285 5652
pestack@usgs.gov

Leanne Stahl
U.S. EPA
OW/OST, Mail Code: 4305T
1200 Pennsylvania Ave., NW
Washington, DC 20460
202-566-0404
stahl.leanne@epa.gov

Julie Stahli
Metro Wastewater Reclamation District
6450 York St.
Denver, CO 80229
303-286-3255
jstahli@mwrd.dst.co.us

Shelley Stanley
City of Northglenn
2350 W. 112th Ave.
Northglenn, CO 80234
303-450-4067
sstanley@northglenn.org

Jeff Starn
USGS
101 Pikin Street
East Hartford, CT 06108
860-291-6746
jjstarn@usgs.gov

Dawn Stead
Charm Sciences, Inc.
659 Andover Street
Lawrence, MA 01843
818-624-8701
dawn@charm.com

Mark Stead
USEPA
1445 Ross Ave
Suite 12000
Dallas, TX 75202
214-665-2271
stead.mark@epa.gov

Timothy D. Steele
TDS Consulting Inc.
783 Lafayette Street
Denver, CO 80218-3502
303-674-0266
TDSConsult@aol.com

Kris Stepenuck
University of Wisconsin-Extension and Dept. of Natural Resources
445 Henry Mall, Rm 202
Madison, WI 53706
608-265-3887
kfstepenuck@wisc.edu

Jen Stephenson
Northern Water
220 Water ave
Berthoud, CO 80513
970-622-2334
jstephenson@ncwcd.org

Jana Stewart
USGS
8505 Research Way
Middleton, WI 53562
608-821-3855
jsstewar@usgs.gov

Don Stoeckel
Don Stoeckel Environmental
3199 Indianola Avenue
Columbus, OH 43202
614-670-9302
don@dsh2o.com

Yvonne Stoker
USGS
10500 University Center Drive
Suite 215
Tampa, FL 33612
813-975-8620 x133
ystoker@usgs.gov

Peter Stoks
Assoc'n Of Rhine Water Works RIWA
Groenendael 6
Nieuwegein 3439LV
Netherlands
31 306009036
stoks@riwa.org

Wesley Stone
U.S. Geological Survey
5957 Lakeside Boulevard
Indianapolis, IN 46278
wwstone@usgs.gov

Sylvia Stork
USGS, CAWSC
USGS, Placer Hall
6000 J Street
Sacramento, CA 95819
916-278-3115
svstork@usgs.gov

Keri Stout
Bureau of Reclamation
125 S State Street, Rm 6107
Salt Lake City, UT 84138
801-524-3677
kstout@usbr.gov

James Stribling
Tetra Tech, Inc.
Center for Ecological Sciences
400 Red Brook Blvd., Ste. 200
Owings Mills, MD 21117
410-356-8993
james.stribling@tetratech.com

Kerry Strout
NEIWPCC
116 John Street
Lowell, MA 01852
978-323-7929
kstrout@neiwpcc.org

Tedmund Struzeski
U.S. Geological Survey
USGS/BQS
DFC, Bldg 95, MS401
Denver, CO 80225
303-236-1872
struzesk@usgs.gov

Brian Suazo
Santa Clara Pueblo-Office of Environmental Affairs
P.O. Box 580
Espanola, NM 87532
505-753-7326
bsuazo@santaclarapueblo.org

Dan Sullivan
US Geological Survey
8505 Research Way
Middleton, WI 53562
608-821-3869
djsulliv@usgs.gov

Michael Suplee
MT Dept of Environmental Quality
1520 E 6th Ave
Helena, MT 59601
406-444-0831
msuplee@mt.gov

Mike Sweat
US Geological Survey
2617 E Lincolnway
Suite B
Cheyenne, WY 82001
307-421-5462
mjsweat@usgs.gov

Anna Szynkiewicz
University of Texas at El Paso
The University of Texas at El Paso
500 W. University Avenue
El Paso, TX 79968
915-747-5503
aaszynkiewicz@utep.edu

Karen Taberski
San Francisco Bay Regional Water Quality Control Bd
1515 Clay St 14th Floor
Oakland, CA 94612
510-622-2424
ktaberski@waterboards.ca.gov

Pam Taheri
Shakopee Mdewakanton Sioux Community
2330 Sioux Trail NW
Prior Lake, MN 55372
952-233-4237
pamela.taheri@shakopeedakota.org

Mario Tamburri
Alliance for Coastal Technologies
Univ. of MD-CES/CBL
1 Williams Street
P.O. Box 38
Solomons, MD 20688
410-326-7440
tamburri@umces.edu

Peter Tango
USGS @ CBPO
410 Severn Ave. Suite 109
Annapolis, MD 21403
410-267-9875
ptango@chesapeakebay.net

Ellen Tarquinio
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-2267
tarquinio.ellen@epa.gov

Cathy Tate
U.S. Geological Survey
PO Box 25046, MS 415
Denver Federal Center
Lakewood, CO 80225
303-236-4882 x287
cmtate@usgs.gov

Bob Tawa
NEON Inc.
5340 Airport Blvd.
Boulder, CO 80301
720-746-4923
sspetter@neoninc.org

Andy Taylor
City of Boulder
4049 N. 75th St.
Boulder, CO 80301
303-413-7367
taylorand@bouldercolorado.gov

Michaela Taylor
Colorado Watershed Assembly
PO BOX 211729
Denver, CO 80221
303-291-7322
michaela@coloradowatershed.org

Lenore Tedesco
IUPUI
723 W. Michigan St
Indianapolis, IN 46202
317-627-7939
ltedesco@iupui.edu

Peter Tennant
ORSANCO
5735 Kellogg Avenue
Cincinnati, OH 45228
513-231-7719
ptennant@orsanco.org

Paul Terrio
U.S. Geological Survey
1201 W. University Avenue
Suite 100
Urbana, IL 61801
217-328-9736
pjterrio@usgs.gov

Chris Theel
Colorado Dept of Public Health & Environment
4300 Cherry Creek Drive S
WQCD-B1
Denver, CO 80246
303-692-3558
christopher.theel@state.co.us

Anna Thelen
City of Everett
3200 Cedar Street
Everett, WA 98201
425-257-7726
jmarks@ci.everett.wa.us

Susan Thiros
US Geological Survey
2329 Orton Circle
Salt Lake City, UT 84119
801-908-5063
sthiros@usgs.gov

Jean Thomas
USDA Forest Service
201 14th St., SW
Washington, DC 20250
202-205-1172
jathomas02@fs.fed.us

Kristin Thomas
Michigan Trout Unlimited
P.O. Box 442
Dewitt, MI 48820
616-460-0477
kthomas@michigantu.org

Steph Thomas
USDA Forest Service - Black Hills National Forest
8221 S Highway 16
Rapid City, SD 57702
605-716-2016
stephthomas@fs.fed.us

Craig Thompson
Environmental Protection Agency
901 N 5th St
Kansas City, KS 66101
913-551-7266
thompson.craig@epa.gov

Jessica Thompson
USGS
8505 Research Way
Middleton, WI 53562
608-821-3886
jlthomps@usgs.gov

Anu Thorat
City of Boulder
6505 N 63rd street
boulder, CO 80602
303-413-7406
thorata@bouldercolorado.gov

Tony Thorpe
University Of Missouri
302 ABNR
Columbia, MO 65211
573-882-5430
tony@lmvp.org

Tom Tidwell
United States Forest Service
201 14th Street SW
Yates Building, 4th Floor NW
Washington, DC 20250
202-205-8439
kjhawley@fs.fed.us

Evan Tillman
USGS, HIF
Building 2101
Stennis Space Center, MS 39529
228-688-1513
etillman@usgs.gov

Patty Toccalino
USGS
6000 J Street
Placer Hall
Sacramento, CA 95819
916-278-3090
ptocca@usgs.gov

Andrew Todd
USGS
Box 25046, MS 964D
Denver, CO 80225
303-236-1426
atodd@usgs.gov

Sarah Tolan
Colorado Watershed Assembly
PO BOX 211729
Denver, CO 80221
303-291-7340
saraht@coloradowater.org

Michael Tomlinson
University of Hawaii at Manoa
Department of Oceanography
7800 N Rain Valley Rd
Flagstaff, AZ 86004
928-266-2236
tomlinson86@q.com

Douglas Towne
Arizona Department of Environmental Quality
1110 W. Washington St.
Phoenix, AZ 85007
602-771-4412
dct@azdeq.gov

Andy Tranmer
U.S. Geological Survey
230 Collins Rd
Boise, ID 83702
208-387-1342
atranmer@usgs.gov

Maya Trotz
University of South Florida and Engineers for A Sustainable World USF
Department of Civil & Envi Engineering
4202 E Fowler Ave ENB118
Tampa, FL 33620
813-974-3172
matrotz@usf.edu

Teferi Tsegaye
Alabama A&M University
P.O. Box 1208
Normal, AL 35811
256-372-4219
teferi.tsegaye@aamu.edu

David Tucker
City of San Jose
Environmental Services Dept.
200 E. Santa Clara St., 10th Floor
San Jose, CA 95113
408-975-2553
david.tucker@sanjoseca.gov

Dean Tucker
National Park Service
1201 Oakridge Drive
Suite 250
Fort Collins, CO 80525
970-225-3516
Dean_Tucker@nps.gov

Michael Turco
USGS
19241 David Memorial Drive
Suite 180
Houston, TX 77385
936-271-5300
mjturco@usgs.gov

William Turnbull
Energy Laboratories, Inc.
PO Box 30916
Billings, MT 59107
406-869-6259
dchirrick@energylab.com

Kent Turner
Lake Mead National Recreation Area
601 Nevada Way
Boulder City, NV 89005
702-293-8941
kent_turner@nps.gov

Christa Tyrrell
Fort Peck Tribes Office of Environmental Protection
603 Court Avenue
Box 1027
Poplar, MT 59255
406-768-2326
tyrrell@nemont.net

Khuchitbaatar Ulambayar
Water Resource and Research Society
Alfa center No - 202 peace avenue
Ulaanbaatar Mongolia
Ulaanbaatar 976
Mongolia
976-11-319014
kate@emongolia.net

Jason Ulseth
Upper Chattahoochee Riverkeeper
916 Joseph Lowery Blvd
Suite 3
Atlanta, GA 30318
404-352-9828
julseth@ucriverkeeper.org

Sarah Unz
NALMS
PO Box 5443
Madison, WI 53705-0443
608-233-2836
slunz@nalms.org

Christel Valentine
Hach Hydromet
PO Box 389
Loveland, CO 80539
970-669-3050
cvalenti@hach.com

Bob Van Dolah
SC Department of Natural Resources
217 Ft. Johnson Rd.
P.O. Box 12559
Charleston, SC 29412
843-953-9819
vandolahr@dnr.sc.gov

Peter Van Metre
U.S. Geological Survey
1505 Ferguson Lane
Austin, TX 78754
512-927-3506
pcvanmet@usgs.gov

John Van Sickle
US Environmental Protection Agency
200 SW 35th Street
Corvallis, OR 97333-4902
541-754-4314
vansickle.john@epa.gov

Brian Van Wye
District Department of the Environment
1200 First St. NE - 6th Flr
Washington, DC 20002
202-741-2121
brian.vanwye@dc.gov

Linda Vance
Montana Natural Heritage Program
1515 E. 6th Ave
Helena, MT 59602
406-444-3380
livance@mt.gov

Tim VanWyngarden
ACZ Laboratories, Inc.
2773 Downhill Dr.
Steamboat Springs, CO 80487
800-334-5493
timv@acz.com

Julie Vastine
Alliance for Aquatic Resource Monitoring
Dickinson College
PO Box 1773
Carlisle, PA 17013
717-245-1135
vastine@dickinson.edu

BryAnna Vaughan
Bishop Paiute Tribe
50 Tu Su Lane
Bishop, CA 93514
760-784-5761
bryanna.vaughan@bishoppaiute.org

Douglas Vaughn
Lockheed Martin
1010 North Glebe Road
Suite 800
Arlington, VA 22201
703-647-5719
douglas.vaughn@lmco.com

Skip Vecchia
USGS
U.S. Geological Survey
821 E. Interstate Ave.
Bismarck, ND 58503
701-250-7412
avecchia@usgs.gov

Kirsten Verburg
CSIRO
GPO Box 1666
Canberra ACT, 2601
Australia
+61 2 6246 5954
Kirsten.verburg@csiro.au

Esther Vincent
Northern Water
220 Water ave
Berthoud, CO 80513
970-622-2356
evincent@ncwcd.org

Dave Vlasin
Ramsey-Washington Metro Watershed District
2665 Noel Drive
Little Canada, MN 55117
651-792-7950
david.vlasin@rwmwd.org

Jeanne Voorhees
EPA New England
5 Post Office Square
Suite 100 Mail Stop OES05-2
Boston, MA 02109-3912
617-918-1686
voorhees.jeanne@epa.gov

Jeff Vowell
Florida Division of Forestry
3125 Conner Blvd
Tallahassee, FL 32399-1650
850-414-9969
vowellj@doacs.state.fl.us

Eric Vowinkel
USGS New Jersey Water Science Center
810 Bear Tavern Road, Suite 206
Ewing, NJ 08628-1099
609-771-3931
vowinkel@usgs.gov

Sheila Vukovich
WV Dept of Environmental Protection
105 S Railroad Street
Philippi, WV 26416
304-457-3219
Sheila.M.Vukovich@wv.gov

Richard Wagner
U.S. Geological Survey
934 Broadway
Suite 300
Tacoma, WA 98402
253-552-1685
rjwagner@usgs.gov

Henry Walker
U.S. EPA, ORD NHEERL AED
27 Tarzwell Drive
Wakefield, RI 02879
401-782-3134
walker.henry@epa.gov

Jeffrey Walker
Larry Walker Associates
707 4th St.
Ste 200
Davis, CA 95616
530-753-6400
jeffw@lwa.com

Joseph Walksalong, Jr.
Northern Cheyenne Tribe
P.O. Box 128
Lame Deer, MT 59043
406-477-6506
joe.walksalong@cheyennenation.com

Katie Walton-Day
U.S. Geological Survey
Box 25046, MS 415
Denver Federal Center
Denver, CO 80225
303-236-4882 x 366
kwaltond@usgs.gov

Robert Ward
Colostate State University
1558 Arroyo Drive
Windsor, CO 80550
970-686-7372
twowards66@yahoo.com

Glenn Warren
USEPA GLNPO
77 W Jackson Blvd
Chicago, IL 60604
312-886-2405
warren.glenn@epa.gov

Joan Warren
USEPA Office of Water
1200 Pennsylvania Ave NW 4503T
Washington, DC 20460
202-566-1215
warren.joan@epa.gov

Jon Waterhouse
Yukon River Inter-Tribal Watershed Council
725 Christensen Suite 3
Anchorage, AK 99501
907-258-3337
jwaterhuse@yritwc.org

Erna Waterman
U.S. Environmental Protection Agency
1595 Wynkoop St.
Denver, CO 80202
303-312-6762
waterman.erna@epa.gov

Gretchen Watkins
Lac du Flambeau Band of Lake Superior Chippewa Indians
PO Box 67
Lac du Flambeau, WI 54538
715-588-3303 ex5316
gwsurfacewater@gmail.com

Alison Watts
University of New Hampshire
35 Colovos Rd.
Durham, NH 03824
603-862-0585
alison.watts@unh.edu

Laura Webb
US EPA R-7
901 N 5th St
Kansas City, KS 66101
913-551-7435
webb.laura@epa.gov

Sara Weglein
Maryland Department of Natural Resources
580 Taylor Avenue C-2
Annapolis, MD 21401
410-260-8621
sweglein@dnr.state.md.us

Stephen Weisberg
Southern California Coastal Water Research Project Authority
3535 Harbor Blvd
Costa Mesa, CA 92626
714-755-3203
stevew@sccwrp.org

Gary Welker
US EPA R-7
901 N 5th St
Kansas City, KS 66101
913-551-7177
welker.gary@epa.gov

Dennis Wentz
US Geological Survey
2130 SW 5th Avenue
Portland, OR 97201
503-251-3296
dawentz@usgs.gov

Marcel Wetzel
Friedrich Schiller University of Jena
Löbdergraben 32
Jena 7743
Germany
marcel.wetzel@uni-jena.de

Sarah Wheeler
Colorado Dept. of Public Health and Environment
4300 Cherry Creek Drive South
Denver, CO 80246
303-692-3436
sarah.wheeler@state.co.us

Jeffrey White
Tetra Tech
400 Red Brook Blvd., Ste 200
Owings Mills, MD 21117
410-356-8993
jeffrey.white@tetratech.com

Ron Wiederholt
North Dakota State University
663 Hwy 281 N
Carrington, ND 58421
701-652-5391
ron.wiederholt@ndsu.edu

Jim Wiener
University of Wisconsin-La Crosse
River Studies Center
1725 State Street
La Crosse, WI 54601
608-785-6454
wiener.jame@uwlax.edu

Brent Wiescamp
Forston Labs
4098 Trouble Trail
Fort Collins, CO 80524
800-301-1259 x105
bwiescamp@forstonlabs.com

Aaron Wieting
City of Portland
6543 N Burlington Ave
Portland, OR 97203
503-823-5437
aaron.wieting@portlandoregon.gov

Bill Wilber
U.S. Geological Survey
413 National Center
Reston, VA 20192
703-648-6878
wgwilber@usgs.gov

Dave Wilcox
Gold Systems Inc.
3330 S. 700 E.,
Suite C
Salt Lake City, UT 84106-4627
801-456-6104
dwilcox@goldsystems.com

Franceska Wilde
US Geological Survey
12201 Sunrise Valley Drive
412 National Center
Reston, VA 20192
703-648-6866
fwilde@usgs.gov

Candie Wilderman
Dickinson College
PO Box 1773
Carlisle, PA 17013
717-245-1573
wilderma@dickinson.edu

Jesse Wilkens
James River Water Development District
PO Box 849
Huron, SD 57350
605-352-0600
jessewilkens@midconetwork.com

Chris Wilkowske
U.S. Geological Survey
121 W 200 S
Moab, UT 84532
435-259-4430
wilkowsk@usgs.gov

Brian Williams
Forston Labs
4098 Trouble Trail
Fort Collins, CO 80524
800-301-1259 x101
bwilliams@forstonlabs.com

Heather Williams
Pomona College Politics Department
425 N. College Avenue
Claremont, CA 91711
909-607-3088
hwilliams@pomona.edu

Marty Williams
Georgia Lakes Society
171 Sumter Dr., NE
Marietta, GA 30066-3441
678-920-8266
gls@georgialakes.org

Nicholas Williams
Bureau of Reclamation
125 S State Street, RM 6107
SLC, UT 84138
801-524-3888
nwilliams@usbr.gov

Tony Williams
Coalition for Buzzards Bay
620 Belleville Avenue
New Bedford, MA 02745
508-999-6363
williams@savebuzzardsbay.org

Sandy Williamson
US Geological Survey
934 Broadway #300
Tacoma, WA 98402
253-552-1683
akwill@usgs.gov

Jennifer Wilson
USGS Texas Water Science Center
1505 Ferguson Ln.
Austin, TX 78754
512-927-3527
jenwilso@usgs.gov

Rick Wilson
USGS
5231 S. 19th Street
Lincoln, NE 68512
402-328-4120
rrrrrwilson@usgs.gov

Cristina Windsor
In-Situ Inc.
221 E. Lincoln Ave.
Fort Collins, CO 80524-2533

Mike Wireman
US EPA
1595 Wynkoop St
Denver, CO 80202
303-312-6719
wireman.mike@epa.gov

John Wirts
WV DEP
601 57th St SE
Charleston, WV 25304
304-926-0495
john.c.wirts@wv.gov

Loretta Wolfe
FL Dept of Environmental Protection
2902 Abbotsford Way
Tallahassee, FL 32312
850-545-5908
arcturus512@comcast.net

Steve Wolfe
Florida Dept. of Envir. Protection
3900 Commonwealth Blvd.
Tallahassee, FL 32399
850-245-2102
Steven.Wolfe@dep.state.fl.us

Mike Woodside
U.S. Geological Survey
640 Grassmere Park, Suite 100
Nashville, TN 37211
615-837-4706
mdwoodsi@usgs.gov

Brenda Woodward
U.S. Geological Survey
5231 S 19th St
Lincoln, NE 68512
402-328-4145
bkwoodwa@usgs.gov

Jinnie Woodward
Alliance for Aquatic Resource Monitoring
Dickinson College
PO Box 1773
Carlisle, PA 17013
717-245-1021
woodwarj@dickinson.edu

Peter Wright
U.S. Geological Survey
1728 Lampman Drive
Suite D
Billings, MT 59102
406-656-1444
prwright@usgs.gov

Douglas Yeskis
U.S. Geological Survey
1201 W. University Ave.
Suite 100
Urbana, IL 61801
217-328-9706
djyeskis@usgs.gov

Dwane Young
US EPA OSWER
1200 Pennsylvania Ave NW MC-4503T
Washington, DC 20460
703-347-8578
young.dwane@epa.gov

Megan Young
US Geological Survey
345 Middlefield Rd. MS434
Menlo Park, CA 94025
650-329-4544
mbyoung@usgs.gov

Xiaoli Yuan
USGS
2630 Fanta Reed Rd
La Crosse, WI 54603
608-781-6302
xyuan@usgs.gov

Mike Yurewicz
USGS National Center
Mail Stop 433
Reston, VA 20192
703-648-5811
mcyurewi@usgs.gov

Mark Zavislak
Riverside County Flood Control
1995 Market Street
Riverside, CA 92501
951-955-4348
MZAVISLA@rcflood.org

Steve Zelenak
Forston Labs
4098 Trouble Trail
Fort Collins, CO 80524
800-301-1259 x100
szelenak@forstonlabs.com

Eileen Zerba
Princeton University
Princeton Environmental Institute
Washington Rd., Guyot Hall M172
Princeton, NJ 08544
609-258-3698
ezerba@princeton.edu

Andy Ziegler
U.S. Geological Survey
4821 Quail Crest Place
Lawrence, KS 66049
785-832-3539
aziegler@usgs.gov

John Zogorski
U.S. Geological Survey
1608 Mt View Rd
Rapid City, SD 57702
605-394-3210
jszorgors@usgs.gov

Lea Ann Zuellig
Hach Hydromet
PO Box 389
Loveland, CO 80539
970-669-3050
lzuellig@hach.com

Michael Zumwalt
Agilent Technologies
2553 Thunderbird Lane
Evergreen, CO 80439
303-662-3532
michael.zumwalt@agilent.com

An Index of Council Priorities and Related Conference Sessions

Conference sessions are mapped to Council priorities, which were established to meet goals for improved data comparability; monitoring and assessment strategies and tools; data management , sharing, and reporting; and enhanced partnerships and collaboration.

Collaboration and Partnerships

- **Session A5:** Strategies for Growing a Volunteer Monitoring Program
- **Sessions A7 and B7:** Building Successful State, Regional, and Tribal Water Monitoring Councils, Parts 1 & 2
- **Session E5:** Volunteer Monitoring: Strengthening Collaboration through Partnership
- **Session F5:** Innovation and Longevity in Volunteer Monitoring Programs
- **Session G2:** Biological Monitoring with Volunteers
- **Session J4:** Overcoming Barriers to Monitoring Collaboration and Partnerships
- **Session K4:** Monitoring Partnerships: Promoting Water Resource Stewardship and Protection
- **Session L4:** Unique Collaborative Approaches for Successful Outcomes

Data Management and Sharing and Information Dissemination and Reporting

- **Session F3:** Water Quality Exchanges Improve Data Access and Sharing
- **Session H3:** Using Data Sharing as a Pathway to Collaboration
- **Session D2:** New Tools and Approaches in Data Analysis and Reporting
- **Session D5:** Effective Communication Leads to Action
- **Session H7:** Science-Based Environmental Report Cards & Indicators from the Watershed to the National Scale
- **Sessions K7 and L7:** Working with Watershed Tools and Data to Get (and Show) Results, Parts 1 and 2

Continuous and Real-Time Monitoring with Sensors

- **Extended Session:** Plenary Seminar for Continuous Real-Time Monitoring: Direct Measures and Surrogates
- **Session A1:** Continuous Real-Time Monitoring: Operation and Data Evaluation
- **Session B1:** Evaluation and Application of New Technologies for Real-time Monitoring
- **Sessions C7 and D7:** Sensors Basics: Tools to Enhance the Quality and Comparability of Sensors Data for Continuous Real-Time Monitoring, Parts 1 and 2
- **Session E1:** Continuous Real-Time Monitoring: Applications in Lakes and Estuaries
- **Session F1:** Continuous Real-Time Monitoring: Applications in Rivers and Streams
- **Session G1:** Continuous Real-Time Monitoring: Regulatory Perspectives
- **Session H8:** Closing Interactive Panel Discussions for Continuous Real-Time Monitoring

Improving Monitoring Designs for Different Objectives

- **Extended Session:** Using NHD & State GIS to Improve National Aquatic Resource Survey Designs
- **Session C1:** Monitoring Stressors and Impacts to Lakes and Reservoirs
- **Session C2:** Monitoring for Stormwater Management Effectiveness
- **Session D3:** Elements of a Long-Term National Ground-Water Monitoring Network
- **Session F4:** Using Probabilistic Monitoring to Support State and Tribal Programs
- **Session H2:** Your Stream Overfloweth: Case Studies in Monitoring Stormwater Quality
- **Session H4:** Monitoring Network Design: Implementing Large Scale Solutions
- **Sessions I7 and J7:** Is Your Monitoring Program Producing Measurable Results and How Do You Know?, Parts 1 and 2
- **Session K6:** Agrochemical Monitoring
- **"Monitoring Framework" – Parts 1,2 and 3** (Sampling to the lab to the public – includes field trips and sessions)

Integrating Monitoring and Assessments

- **Session A4:** Lessons Learned from National Assessments
- **Session B4:** Monitoring the Effects of Development on Hydrology and Water Quality
- **Sessions C4 and D4:** Downstream Impacts from Mined Lands, Parts1 and 2
- **Session C5:** National Monitoring Network: Monitoring Water Quality from Inland to Coastal Ecosystems
- **Session E3:** Integrating Probabilistic and Targeted Monitoring
- **Session I4:** Integrated Land-to-Sea Assessments Based on Multiple Networks

- **Session J1:** Coastal and Estuarine Assessments
- **Session K1:** Water Quality Monitoring in Coastal and Marine Environments

Models and Other Statistical Tools

- **Sessions A8 and B8:** Man vs. Stats, Parts 1 and 2
- **Session B5:** Modeling Ecological Conditions
- **Session C3:** Interpreting Water Quality Data
- **Session E4:** Modeling at a Regional Scale
- **Sessions E7 and F7:** Emerging New Approaches to Water Quality Trend Analysis, Parts 1 and 2
- **Session G5:** Results and Importance of Comparability Studies
- **Session G6:** Evaluating Contaminant Trends in Surface-Water Quality: Streams and Rivers
- **Session H6:** Evaluating Contaminant Trends in Lakes and Reservoirs using Sediment Cores
- **Session I2:** Tracking What Flows Downhill: Microbial Source Tracking
- **Session I3:** 21st Century Technical Tools for Water Quality Assessments
- **Session J5:** Evaluating Contaminant Trends in Groundwater Quality
- **Session K3:** Modeling of Nutrient Transport and Loadings

Assessment and Management—Applications and Tools

- **Session A2:** Indices of Biotic Integrity for Wetlands
- **Session J3:** Integrating Water Quality Indicators to Support Monitoring and Assessment Decisions
- **Session B2:** Developing New Biological Assessment Tools
- **Session C8:** Emerging Applications of the Biological Condition Gradient (BCG)
- **Session D8:** Biological Condition Gradient (BCG) Development and Calibration at State, Regional, and National Levels
- **Session F8:** Using the Biological Condition Gradient (BCG) and Stressor-Response in an Urbanizing Setting
- **Session H1:** Statewide Bioassessment
- **Session I1:** Biological Assessments - Survey Design and Sampling Considerations
- **Extended Session:** Building a Case for Causes of Biological Impairment
- **Sessions I8 and J8:** The National Lakes Assessment – Just How Good are the Nation's Lakes and Reservoirs – Technical Underpinnings of the NLA and Applications for Statewide Lakes Surveys, Parts 1 and 2
- **Sessions K8 and L8:** Enhancing National Aquatic Resource Surveys through Enhanced Partnerships and Updated Approaches, Parts 1 and 2
- **Session J2:** Development of Reference Condition for Different Purposes and at Different Scales
- **Session D1:** Wetlands Condition Monitoring and Assessment
- **Session F2:** Regional Scale Wetlands Monitoring and Assessment
- **Session G3:** Watershed Scale Protection and Restoration Assessments
- **Sessions A3 and B3:** Developing Nutrient Criteria, Parts 1 and 2
- **Session E8:** Using Stressor-Response Relationships to Address Hydrological and Nutrient Issues
- **Session G4:** Examining Nutrient Processing at Multiple Scales
- **Session E2:** Monitoring BMP Effectiveness
- **Sessions A6 and B6:** Monitoring and Assessing Groundwater Vulnerability, Parts 1 and 2
- **Session I5:** Contaminants in Groundwater
- **Session D6:** Emerging Contaminants in Water
- **Sessions E6 and F6:** Contaminant Effects on Aquatic Ecosystem Health, Parts 1 and 2
- **Session L6:** Contaminant Threats to Drinking Water
- **Session J6:** Endocrine Disrupting Compounds - Identification, Sources, and Effects
- **Session C6:** PAHs and Coal-Tar-Based Pavement Sealcoat: Stormwater Management, Toxicology, and Public Policy
- **Session K5:** Transport and Distribution of Mercury through Aquatic Ecosystems
- **Session L5:** Biomagnification of Mercury through Food Webs
- **Session H5:** Harmful Algal Blooms and Cyanotoxins: How (Blue) Green is my Water?
- **Extended Session:** Guidelines for Design, Sampling, Analysis, and Interpretation for Cyanobacterial Toxin and Taste-And-Odor Studies in Lakes and Reservoirs
- **Session L1:** Monitoring Hydrology: Critical for Interpretation of Water Quality and Biological Assessment Data
- **Session L2:** Climate Change: Monitoring Impacts on Water Quality and Quantity
- **Session L3:** Linking Sources and Stressors to Water Quality
- **Session I6:** Prioritization of Chemicals for New Methods Development
- **Session K2:** Geospatial Assessments of Water Quality

Presenter Directory

George Aiken, USGS, *Session K5*
Timothy Asplund, Wisconsin Department of Natural Resources, *Session A4*
Scott Ator, USGS, *Poster*
Lara Autry, US EPA, *Session G1*
Joseph Ayotte, USGS, *Session I5*

Lorraine Backer, National Center for Environmental Health, CDC, *Session H5*
Melissa Baker, Capitol Region Watershed District, Saint Paul, MN, *Session C2*
Virginia Baker, North Carolina Department of Environment and Natural Resources, *Session A2*
Jerad Bales, USGS, *Session G4*
Thomas Ballestero, University of New Hampshire, *Session C2*
Larry Barber, USGS, *Session J6*
Miya Barr, USGS, *Poster*
Roy Bartholomay, USGS, *Poster*
Krishna Baskota, Navajo Nation, *Poster*
William Battaglin, USGS, *Session E6*
Nancy Bauch, USGS, *Session B4*
John Baum, US Army Corps of Engineers, *Poster*
Chris Bellucci, Connecticut Department of Environmental Protection, *Session B2*
Mike Benedict, Milwaukee Metropolitan Sewerage District, *Session D2*
Trudy Bennett, USGS, *Session A1*
Thomas Bernthal, Wisconsin Department of Natural Resources, *Session G3*
Jenny Biddle, George Mason University, *Session L4*
Donald Bills, USGS, *Session C4*
Bryan Bjorndal, Assure Controls, Inc., *Poster*
Rob Blair, Mountain Studies Institute, Colorado, *Poster*
Joel Blomquist, USGS, *Poster*
Nathaniel Booth, USGS, *Session E4*, *Session F3*
Mark Borchardt, Marshfield Clinic Research Foundation, WI, *Session I5*
David Borrok, University of Texas at El Paso, *Session H6*
Paul Bradley, USGS, *Session D6*, *Poster*
John Brakebill, USGS, *Session E4*
Christopher Braun, USGS, *Poster*
Mark Brigham, USGS, *Session K5*, *Session L5 Moderator*, *Poster*
Juliane Brown, USGS, *Session G4*
Kristopher Brown, Louisiana State University, *Session L1*
Thomas Burley, USGS, *Session D2*
Erick Burres, California State Water Resources Control Board, *Session L4 Moderator*
Herb Buxton, USGS, *Session I6 Moderator*

Jane Caffrey, University of West Florida, *Session G4 Moderator*, *Poster*
Daniel Cain, USGS, *Session D4*
Ellen R. Campbell, Nitrate Elimination Co., Inc., *Poster*
Kara Capelli, USGS, *Session D5*
Daren Carlisle, USGS, *Session B5*, *Session B5 Moderator*, *Session I1*
Christopher Carlson, US Forest Service, *Session J5 Moderator*
Thomas Carpenter, US EPA, *Session L6*
Richard Cartwright, USGS, *Session L1*
Aisa Ceric, St. Johns River Water Management District, *Poster*
Thomas Chapin, USGS, *Poster*
Lia Chasar, USGS, *Session K5 Moderator*, *Session L5*
Cheryl Cheadle, Oklahoma Conservation Commission, *Poster*
Soumya Chennapragada, San Diego Coastkeeper, *Session H3*
Dave Chestnut, South Carolina Department of Health and Environmental Control, *Session E3 Moderator*, *Session I2 Moderator*
Chao-An Chiu, Arizona State University, *Session D6*
Eric Christensen, USGS, *Poster*
Kevin Christian, US EPA, *Poster*
Ricardo Cisneros, US Forest Service, *Poster*
Alissa Coes, USGS, *Poster*
Greg Colianni, US EPA, *Session J1 Moderator*
Val Connor, California State Water Resources Control Board, *Session L5*, *Poster*
Alice Conovitz, Integral Consulting Inc., *Session C4*, *Poster*
Rick Copeland, Florida Geological Survey, *Session D3*, *Session J4*, *Poster*
Susan Cormier, US EPA, *Extended Session 5*
Dave Courtemanch, ME, *Extended Session 9*
Charlie Crawford, USGS, *Session E4 Moderator*
Andrew Cross, City of Westminster, Colorado, *Session F1*
William Cunningham, USGS, *Session D3*
Paul Currier, New Hampshire Department of Environmental Services, *Session F3*
Cynthia Curtis, US EPA, *Extended Session 15*

Fernanda Dalcanale, Colorado State University, *Poster*
Tom Danielson, Maine Department of Environmental Protection, *Session B2*
Douglas Dasher, Alaska Department of Environmental Conservation, *Session A4*
David Davis, Virginia Department of Environmental Quality, *Session D1*
Den Davis, Louisiana State University, *Poster*
Jerri Davis, USGS, *Session I2*
Stacey Day, Oklahoma Conservation Commission, *Session E2*
Greg Delzer, USGS, *Session L6 Moderator*
Leslie DeSimone, USGS, *Poster*
Marc Desmet, ENTPE, France, *Session H6*
Mark Deutschman, Houston Engineeering, Inc., *Session B3*
Tommy Dewald, US EPA, *Session K2*
Jerry Diamond, Tetra Tech, Inc. , *Session F6*, *Session F6 Moderator*

Eva DiDonato, National Park Service, *Session J1*
Jeanne DiFranco, Maine Department of Environmental Protection, *Session D1*
Danielle Donkersloot, New Jersey Department of Environmental Protection, *Session A5*, *Session F3 Moderator*
Jean Dupree, USGS, *Poster*
Joseph Duris, USGS, *Poster*
Chuck Dvorsky, Texas Commission on Environmental Quality, *Session A1*
Kathleen Dwire, US Forest Service, *Poster*

Kathy Echols, USGS, *Poster*
Pamela Edwards, US Forest Service, *Session E2*
Amanda Egler, USGS, *Poster*
Jo Leslie Eimers, USGS, *Session K4*
William Elliot, US Forest Service, *Poster*
Robert Ellison, YSI, *Session A1*, *Session A1 Moderator*
Adria Elskus, USGS, *Session F6*, *Poster*
Alexandra Etheridge, USGS, *Poster*

Tom Faber, US EPA, *Session A5*
Mary Fabisiak, City of Westminster, Colorado, *Poster*
Anne Farahi, National Park Service, *Session J3*
Lawrence Feinson, USGS, *Session B1*
Suzanne Femmer, USGS, *Poster*
Camille Flinders, National Council for Air and Stream Improvement, *Session D5*, *Session E6*
Sandi Formica, Watershed Conservation Resource Center, AR, *Session G3*, *Session H2*
Miranda Fram, USGS, *Session I5*
Mike Freeman, USGS, *Session D4*
Chris French, Alliance for the Chesapeake Bay, *Session E5*
Jeffrey Frey, USGS, *Poster*
Janice Fulford, USGS, *Session B1*, *Session B1 Moderator*
Lori Fuller, USGS, *Poster*
Edward Furlong, USGS, *Session I6*, *Poster*

Laura Gabanski, US EPA and Corey Godfrey, The Cadmus Group, *Session G3*
Bradley Garner, USGS, *Session A1*
Paul Garrison, Wisconsin Department of Natural Resources, *Session A4*, *Poster*
David Gay, University of Illinois, *Poster*
Mary Giorgino, USGS, *Poster*
Doug Glysson, USGS, *Session D4 Moderator*
Gregg Good, Illinois Environmental Protection Agency, *Session H2 Moderator*
David Graczyk, USGS, *Session F1*
Jennifer Graham, USGS, *Session H5 Moderator*, *Extended Session 4*
James Gray, USGS, *Session J6*, *Poster*
Treda Grayson, US EPA, *Session J1*
Effie Greathouse, Oregon State University, *Poster*
Steven Greb, Wisconsin Department of Natural Resources, *Session K2*, *Poster*
Linda Green, University of Rhode Island, *Session D5 Moderator*, *Session F5*, *Poster*
Reed Green, USGS, *Session E1*, *Session E1 Moderator*
Alyse Greenberg, Stony Brook-Millstone Watershed Association, NJ, *Session K4*
Lindsay Griffith, Brown and Caldwell, *Poster*
Cristina Grosso, San Francisco Estuary Institute, *Session H3*
Robert Hackett, Elon University, *Poster*
Brian Haggard, Arkansas Water Resources Center, *Poster*
James Hagy, US EPA, *Session B3*
Seth Haines, USGS, *Poster*
Pixie Hamilton, USGS, *Session C5*, *Session C5 Moderator*, *Session I4 Moderator*, *Session K1 Moderator*
Debra Hammond, New Jersey Department of Environmental Protection, *Session B3*, *Poster*
Tracy Hancock, USGS, *Session J4 Moderator*, *Extended Session 6*, *Extended Session 12*
Christopher Harbourt, Waterborne Environmental Inc., *Poster*
Christina Hargiss, North Dakota State University, *Session D1*
Daren Harmel, USDA-ARS, *Session C3*
Douglas Harned, USGS, *Poster*
Grady Harper, North Fork River Improvement Association (AmeriCorps*VISTA), *Poster*
James Harrington, California Department of Fish and Game, *Session H1*
Jim Harrison, US EPA, *Session J2*
Robert Hart, USGS, *Session C1*
Sherry Hazelhurst, US Forest Service, *Session D1 Moderator*
Dennis Helsel, Practical Stats, *Session C3*, *Extended Session 7*
Paul Hendley, Syngenta Crop Protection Inc, *Session K6*
Michelle Henicheck, Virginia Department of Environmental Quality, *Session D1*
Brent Hepner, Aqualytical Services Inc., *Poster*
Lillian Herger, US EPA, *Poster*
Alan Herlihy, Oregon State University, *Session H4*
Karl Hermann, US EPA, *Session B4 Moderator*, *Session I1 Moderator*
Elizabeth Herron, University of Rhode Island, *Session E5 Moderator*, *Session G2*
Troy Hertog, Siemens Water Technologies, *Poster*
Jason Hill, Virginia Department of Environmental Quality, *Session F4*
Ryan Hill, Utah State University, *Session B5*
Bob Hirsch, USGS, *Extended Session 10*
Michelle Hladik, USGS, *Session I6*, *Session K6*
Jennifer Hoffman, Susquehanna River Basin Commission, *Session J3*
Justin Hohn, San Diego Coastkeeper, *Session G2*
Daniel Holmberg, US Army Corps of Engineers, *Poster*
Anne Hoos, USGS, *Session K3*
Barb Horn, Colorado Division of Wildlife, *Session D5*, *Session F5 Moderator*, *Session H3 Moderator*, *Extended Session 13*
Paul Horvatin, US EPA, *Session J4*
Dorothy Yu Huang, University of Calgary, *Poster*
Laura Hubbard, USGS, *Session L1*
Shannon Hubler, Oregon Department of Environmental Quality, *Session E2*
Allison Hughes, Georgia Department of Natural Resources, *Session L4*
Brian Hughes, USGS, *Session G6*
John Hummer, Great Lakes Commission, *Poster*, *Extended Session 6*
Charles D. Hunt, Jr, USGS, *Poster*
John Hunt, University of California, Davis, *Session E3*
Laura Hunt, University of Texas at Arlington, *Poster*
Kasey Hutchinson, USGS, *Poster*
Ken Hyer, USGS, *Session F1 Moderator*
Jeff Hyland, NOAA, *Session L3*

George Ice, National Council for Air and Stream Improvement, *Session A3*
Thomas Imbrigiotta, USGS, *Poster*
Chris Ingersoll, USGS, *Session F6*
Roy Irwin, National Park Service, *Session C3*

Heather Jackson, US Army Corps of Engineers, *Poster*
Susan Jackson, US EPA, *Extended Session 9*
Travis James, USDA-Natural Resources Conservation Service, *Session E4*
Ben Jessup, Tetra Tech, Inc., *Poster*
Ann Jochens, Texas A&M University, *Session H5*
Roxanne Johnson, North Dakota State University, *Session L2*
Scott Johnson, Aquatic Bioassay and Consulting Laboratories, *Session L3*
Jason Jones, Arizona Department of Environmental Quality, *Session A4*, *Session A4 Moderator*, *Session F4*
Tahzay Jones, National Park Service, *Session K1*
Celeste Journey, USGS, *Poster*
Billy Justus, USGS, *Poster*

Neil Kamman, Vermont Department of Environmental Conservation, *Session B3*, *Session C1 Moderator*, *Extended Session 14*
Kamalaporn Kanongdate, Brandenburg University of Technology, Germany, *Poster*
David Kanzer, Gunnison/Grand Valley Selenium Task Forces, CO, *Poster*
Hamid Karimi, District of Columbia Department of the Environment, *Session C6*
Revital Katznelson, UC Berkeley Extension, *Poster*
Philip Kaufmann, US EPA, *Session B5*
Carol Kendall, USGS, *Poster*
Terry Kenney, USGS, *Session D4*
Briant Kimball, USGS, *Session C4*
Warren Kimball, Massachusetts Department of Environmental Protection, *Session D2*
James Kingsbury, USGS, *Session L6*
David Kinniburgh, University of Calgary, *Poster*
Holm Kipka, Friedrich-Schiller-University Jena, Germany, *Poster*
Ronald Klauda, Maryland Department of Natural Resources, *Session H1*
Gary Kohlhepp, Michigan Department of Natural Resources and Environment, *Session A2 Moderator*, *Session H4 Moderator*, *Session J4*
Randy Kolka, US Forest Service, *Session K5*
Charles Kovatch, US EPA, *Session I3*, *Poster*
Don Kozlowski, University of Nevada, Reno, *Poster*
Dan Kroll, Hach Company, *Poster*
Jennifer Krstolic, USGS, *Session F6*
Kathy Kuivila, USGS, *Session E6 Moderator*, *Session K6*
James Kurtenbach, US EPA, *Session F4*

Jacob LaFontaine, USGS, *Session B4*
Jim Laine, West Virginia Department of Environmental Protection, *Session D6 Moderator*
Jeanette Lamb, Oklahoma Conservation Commission, *Poster*
Michael Land, USGS, *Poster*
Robert Lange, Bureau of Land Management, *Poster*
Wayne Lapham, USGS, *Session A6 Moderator*
Karen Larsen, California State Water Resources Control Board, *Poster*
Casey Lee, USGS, *Session H2*
Kathy Lee, USGS, *Session J6*, *Session J6 Moderator*, *Poster*
Michael Lee, USGS, *Session I4*, *Poster*
Sarah Lehmann, US EPA, *Session F4 Moderator*, *Extended Session 16*
Ken Leib, USGS, *Session F1*
Joanna Lemly, Colorado Natural Heritage Program, *Session A2*, *Session F2*
Jean Lemmon, Oklahoma Conservation Commission, *Poster*
Fred Leslie, Alabama Department of Environmental Management, *Session I1*
Robert Limbeck, Delaware River Basin Commission, *Session G1*, *Session J2*
Jennifer Linder, Tetra Tech, Inc., *Poster*
Bruce Lindsey, USGS, *Session J5*
Regina Linville, California Office of Environmental Health Hazard Assessment, *Session H5*
Keith Loftin, USGS, *Session H5 Moderator*, *Extended Session 4*
Terri Lomax, Alaska Department of Environmental Conservation, *Poster*
Barry Long, National Park Service, *Session D2*, *Session K4 Moderator*, *Session L2 Moderator*, *Poster*
Rachel Lord, Cook Inletkeeper, Homer, AK, *Session K4*
Matthew Loyas, Capitol Region Watershed District, Saint Paul, MN, *Session H2*
Matthew Lyman, Connecticut Department of Environmental Protection, *Session K1*

Dorene MacCoy, USGS, *Poster*
Jennifer MacDonald, Environment Canada, *Session E1*
Kathleen Macek-Rowland, USGS, *Poster*
Christopher Magruder, Milwaukee Metropolitan Sewerage District, *Session D2*
Barbara Mahler, USGS, *Session C6*, *Session C6 Moderator*, *Session H6*, *Poster*
Terry Maret, USGS, *Poster*
Abby Markowitz, Condatus Consulting, *Extended Session 6*
Jon Marshack, California State Water Resources Control Board, *Poster*
Alisa Mast, USGS, *Poster*
Kimberly Matthews, RTI International, *Poster*
Karl Mauch, Colorado Department of Agriculture, *Session K6*
Cecilia Mazza, Waters Corporation, *Poster*
Stephen McCord, Larry Walker Associates, *Poster*
Michael McDonald, US EPA, *Session I3*
Leslie McGeorge, New Jersey Department of Environmental Protection, *Session B3 Moderator*, *Poster*
Douglas McLaughlin, National Council for Air and Stream Improvement, *Session C3*
Gerard McMahon, USGS, *Extended Session 9*
Peter McMahon, USGS, *Session A6*
Christopher Mebane, USGS, *Session G4*
Amy Meier, Missouri Department of Conservation, *Session G2*
Edmund Merem, Jackson State University, *Session K2*
Kellie Merrell, Vermont Department of Environmental Conservation, *Session C1*
Ray Merry, Eagle County Department of Environmental Health, Colorado, *Session B6*
Ryan Mesmer, Louisiana State University, *Poster*
Michael Meyer, USGS, *Poster*
Mick Micacchion, Ohio Environmental Protection Agency, *Session A2*
Rob Middlemis-Brown, USGS, *Session B1*

Michael Miller, Wisconsin Department of Natural Resources, *Session E3*
Paul Miller, Waterborne Environmental Inc., *Poster*
Sarah Miller, Pennsylvania State University, *Session F2*
Robert Miltner, Ohio Environmental Protection Agency, *Session E3*
Richard Mitchell, US EPA, *Session C3 Moderator*
Megan Monroe, Tetra Tech, Inc., *Session I2*
Richard Moore, USGS, *Session G4*
Jennifer Morace, USGS, *Session D6*
Ru Morrison, NERACOOS, NH, *Session I4*
Paul Morton, New Jersey Department of Environmental Protection, *Session F3*
Dave Mueller, USGS, *Extended Session 11*
Tara Muenz, Georgia Environmental Protection Division, *Session G2*
Michael Mulvey, Oregon Department of Environmental Quality, *Session H1*

David Naftz, USGS, *Session H6*
David Neils, New Hampshire Department of Environmental Services, *Session G5*
Walter Nelson, US EPA, *Session J1*
Toomas Neuman, Biotap LLC, *Session B2*
Karen Newlon, Montana Natural Heritage Program, *Session D1*
Duane Nichols, Upper Monongahela River Association, *Poster*
Mark Nilles, USGS, *Session K4*
Bernard Nolan, USGS, *Session B6*
Julia Norman, USGS, *Session I6*
Ginger North, Delaware Nature Society, *Session E5*
Sheila North, Dynamac Corp co/US EPA, *Session G5*, *Poster*
Douglas Norton, US EPA, *Session G3*, *Session K2*, *Session K2 Moderator*
Jon Novick, Denver Department of Environmental Health, *Session B4*, *Session L2*

Daniel Obrecht, University of Missouri, *Poster*
Osa Odum, Northwest Indian Fisheries Commission, *Session F3*
Gretchen Oelsner, US EPA, *Session A4*
Erik Oerter, Colorado Geological Survey, *Session C4*
Tony Olsen, US EPA, *Extended Session 3*
John Olson, Utah State University, *Session B5*
James Orlando, USGS, *Session C1*
Jill Oropeza, City of Fort Collins Utilities, CO, *Session H5*

Ginger Paige, University of Wyoming, *Poster*
Denis Parent, Environment Canada, *Poster*
Suzanne Paschke, USGS, *Session A6*
Renée Paterson, Newfoundland and Labrador Department of Environment and Conservation, *Session G1*
Charles Patton, USGS, *Poster*
Deborah Patton, Rural Community Assistance Corporation, *Session L2*
Sara Peel, Wabash River Enhancement Corporation, *Poster*
Brian Pellerin, USGS, *Session B1*
Pete Penoyer, National Park Service, *Poster*
Charles Peters, USGS, *Session C5*, *Poster*
Greg Pettit, Oregon Department of Environmental Quality, *Session E2 Moderator*
Cassandra Pfeifle, USGS, *Poster*
Patrick Phillips, USGS, *Session D6*

Chris Piehler, Louisiana Department of Environmental Quality, *Session L3 Moderator*
Maggie Pierce, Colorado Department of Public Health and Environment, *Poster*
Jason Pinchback, Texas Stream Team, River Systems Institute, *Session A5 Moderator*, *Session E5*
Jaclyn Pitt, Abraxis LLC, *Poster*
Holly Piza, Urban Drainage and Flood Control District, Denver, CO, *Session C2*
Alison Plant, US Army Corps of Engineers, *Poster*
Amina Pollard, US EPA, *Session L3*
Durga Poudel, University of Louisiana at Lafayette, *Session L3*
Todd Presley, USGS, *Poster*
Steve Preston, *Session K3*, USGS, *Session K3*
Deepti Puri, US EPA, *Poster*

Nancy Rabalais, Louisiana Universities Marine Consortium, *Session J1*
Anthony Ranalli, USGS, *Poster*
Patrick Rasmussen, USGS, *Session F1*
Timothy Reilly, USGS, *Poster*
Lisa Reynolds Fogarty, USGS, *Session H2*
Charles Rhoades, US Forest Service, *Session A3*, *Session A3 Moderator*, *Poster*
Matthew Rich, MACTEC Engineering and Consulting, Inc., *Session E6*
Kevin Richards, USGS, *Session A1*
Susan Richardson, US EPA, *Session L6*
Kat Ridolfi, San Francisco Estuary Institute, *Session L5*
Chris Riggert, Missouri Department of Conservation, *Session E5*
Martin Risch, USGS, *Poster*
Karen Riva-Murray, USGS, *Poster*
Dale Robertson, USGS, *Session K3*
Jeffery Robichaud, US EPA, *Session H3*
Channah Rock, University of Arizona, *Session L4*
Anne Rogers, Texas Commission on Environmental Quality, *Session F4*
Michael Rosen, USGS, *Poster*
Colleen Rostad, USGS, *Poster*
Gwenaelle Roux, ENTPE, France, *Poster*
Gary Rowe, USGS, *Session I5 Moderator*
Timothy Rowe, USGS, *Session C1*, *Session L1 Moderator*
Ryan Rowland, USGS, *Poster*
Fernando Rubio, Abraxis LLC, *Poster*
Michael Rupert, USGS, *Session B6*, *Session B6 Moderator*, *Session J5*
Philip Russell, Littleton/Englewood Wastewater Treatment Plant, Colorado, *Session G1*
Karen Ryberg, USGS, *Session L1*

Gregg Sablak, Ohio Environmental Protection Agency, *Session A4*
Steven Sagstad, Civil & Environmental Consultants, *Session L2*
Tom Sanders, Colorado State University, *Session J2 Moderator*
Mark Sandstrom, USGS, *Poster*
Rick Savage, North Carolina Department of Environment and Natural Resources, *Session F2*
Jon Schiller, Hach Company, *Poster*
Don Schloesser, USGS, *Poster*
David Schmeltz, US EPA, *Poster*
Christopher Schmitt, USGS, *Poster*
David Schoellhamer, USGS, *Session E1*

Tara Schraga, USGS, *Session C5*
Robert Schreiber, Camp Dresser & McKee, *Session D3*
Robert Schuster, New Jersey Department of Environmental Protection, *Session B2*, *Session I2*
Eric Schwab, USGS, *Poster*
Gregory Schwarz, USGS, *Session K3*
Don Schweizer, US Forest Service, *Poster*
Barbara Scott, Kentucky Division of Water, *Session F2 Moderator*
Janet Scott, University of Alberta, *Session E2*
Michael Scozzafava, US EPA, *Session F2*, *Session G3 Moderator*
Barbara Scudder, USGS, *Poster*
Anthony Seeman, Iowa Soybean Association, *Poster*
Ralph Seiler, USGS, *Session I5*
Laurie Shafer, Fort Peck Assiniboine & Sioux Tribes Office of Environmental Protection, Montana, *Poster*
Jonathan Sharp, University of Delaware, *Session K1*
Tony Shaw, Pennsylvania Department of Environmental Protection, *Session H4*, *Session J3 Moderator*
Jeff Shearer, National Park Service, *Session L2*
Adam Sigler, Montana State University, *Poster*
Mary Skopec, Iowa Department of Natural Resources, *Session K6 Moderator*
Kelly Smalling, USGS, *Session E6*
David Smith, New York City Department of Environmental Protection (retired), *Session H4*
Elizabeth Smith, Kansas Department of Health and Environment, *Session H1*
Kathleen Smith, USGS, *Session D4*
Rick Spear, Pennsylvania Department of Environmental Protection, *Session J3*, *Poster*
Chuck Spooner, US EPA, *Session G1 Moderator*
Leanne Stahl, US EPA, *Poster*
Shelley Stanley, City of Northglenn, CO, *Session D5*
Jeffrey Starn, USGS, *Session J5*, *Poster*
Timothy D. Steele, TDS Consulting Inc., *Session G6*, *Poster*
Kristine Stepenuck, University of Wisconsin-Extension, *Session A5*, *Session G2 Moderator*, *Poster*
Jana Stewart, USGS, *Session J2*
Don Stoeckel, Don Stoeckel Environmental, *Session I2*
Yvonne Stoker, USGS, *Session I3*
Peter Stoks, Association of Rhine River Water Works, Netherlands, *Session G6*
James Stribling, Tetra Tech, Inc., *Session E3*
Dan Sullivan, USGS, *Extended Session 8*
Michael Suplee, Montana Department of Environmental Quality, *Session A3*
Anna Szynkiewicz, University of Texas at El Paso, *Poster*

Peter Tango, USGS, *Session J4*
Ellen Tarquinio, US EPA, *Session B2 Moderator*, *Session G5 Moderator*, *Extended Session 9*
Cathy Tate, USGS, *Session H1 Moderator*
Lenore Tedesco, Indiana University, *Poster*
Peter Tennant, ORSANCO, *Session C2 Moderator*, *Session G5*
Susan Thiros, USGS, *Session J5*
Anthony Thorpe, University of Missouri, *Poster*
Evan Tillman, USGS, *Poster*
Patricia Toccalino, USGS, *Session L6*
Andrew Todd, USGS, *Poster*
Sarah Tolan, Colorado River Watch, *Session F5*
Michael Tomlinson, University of Hawaii at Manoa, *Session K1*
Lan Tornes, Houston Engineering, Inc., *Session B3*
Douglas Towne, Arizona Department of Environmental Quality, *Session B6*
Andrew Tranmer, USGS, *Poster*
Maya Trotz, University of South Florida, *Session C2*
Mike Turco, USGS, *Poster*

Alan Vajda, University of Colorado, Denver, *Session J6*
Linda Vance, Montana Natural Heritage Program, *Session J2*
Robert VanDolah, South Carolina Department of Natural Resources, *Session I1*
Peter Van Metre, USGS, *Session C6*, *Session H6 Moderator*, *Session K5*, *Poster*
Brian Van Wye, District of Columbia Department of the Environment, *Session C6*
Julie Vastine, Dickinson College, *Session F5*
Aldo Vecchia, USGS, *Session G6*
Kirsten Verburg, CSIRO Land and Water, *Poster*
Jeffery Vowell, Florida Division of Forestry, *Session A3*
Eric Vowinkel, USGS, *Session C5*

Henry Walker, US EPA, *Session I4*
Katie Walton-Day, USGS, *Session C4 Moderator*, *Poster*
Robert Ward, Professor Emeritus, Colorado State University, *Session G6 Moderator*
Glenn Warren, US EPA, *Session E1*
Erna Waterman, US EPA, *Session D4*
Gretchen Watkins, Lac du Flambeau Band of Lake Superior Chippewa Indians, *Poster*
Alison Watts, University of New Hampshire, *Session C6*
Laura Webb, US EPA, *Session H4*, *Poster*
Stephen Weisburg, Southern California Coastal Water Research Project, *Session I4*
Gary Welker, US EPA, *Session B4*, *Poster*
Tristan Wellman, USGS, *Session A6*
Alisha Wenzel, California Regional Water Quality Control Board, Central Valley Region, *Poster*
Marcel Wetzel, Friedrich-Schiller-University, Germany, *Session E4*
Jeffrey White, Tetra Tech, Inc., *Poster*
James Wiener, University of Wisconsin-La Crosse, *Session L5*
Dave Wilcox, Gold Systems, Inc., *Session A5*, *Session D2 Moderator*, *Session I3*
Candie Wilderman, Dickinson College, *Session L4*
Tony Williams, The Coalition for Buzzards Bay, MA, *Poster*
Sandy Williamson, USGS, *Session H3*, *Session I3 Moderator*
Cristina Windsor, In-Situ Inc., *Poster*
Mike Wireman, US EPA, *Session A6*
Daniel Wise, USGS, *Poster*
Jinnieth Woodward, Alliance for Aquatic Resource Monitoring (ALLARM), Dickinson College, *Poster*, *Extended Session 1*
David Wunsch, New Hampshire Geological Survey, *Session D3 Moderator*, *Session F5*

Douglas Yeskis, USGS, *Session J3*
Megan Young, USGS, *Poster*

Eileen Zerba, Princeton University, *Poster*
Andy Ziegler, USGS, *Extended Session 2*
John Zogorski, USGS, *Session I6*

Seventh National Monitoring Conference

Monitoring from the Summit to the Sea

Thank you to our sponsors!

NWQMC
NATIONAL WATER QUALITY MONITORING COUNCIL
Working Together for Clean Water

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

USGS
science for a changing world

NALMS

YSI

Water Environment Federation
the water quality people

Practical Stats
Statistics, down to earth

TETRA TECH

FLUID IMAGING TECHNOLOGIES
FlowCAM