Abstracts

NWQMC

Tuesday, April 29

Session C1: Innovative Condition Assessments

8:00 – 9:30 am | Room 263

Anti-degradation Protection of Water Quality for the Delaware River Basin: Expansion of the Control Point Approach to Monitoring and Assessment

Robert Limbeck and Eric Wentz
Delaware River Basin Commission, West Trenton, N.J.

Abstract
The Scenic Rivers Monitoring Program (SRMP) is a partnership between the Delaware River Basin Commission (DRBC) and the National Park Service (NPS). The primary mission of the SRMP is to implement the Special Protection Waters (SPW) regulations that provide anti-degradation protection to water quality of the interstate Delaware River. The first SPW regulations were approved in 1992, and almost immediately some problems were recognized concerning assessment of the reach-wide water quality targets established at that time. Since 2001, the SRMP has established baseline Existing Water Quality (EWQ) at Delaware River and near-confluence tributary sites along 210 miles of high-quality interstate river draining 6780 square miles of watershed. The non-tidal portion of the Delaware River is composed of three major segments: the Upper Delaware (UPDE), Middle Delaware (DEWA), and Lower Delaware (LDEL). Site-specific baseline EWQ targets for 24 locations were completed for the Lower Delaware in 2005, and were the subject of a previous presentation at this conference. Since that time, the 3-year first round of assessment of Lower Delaware measurable change to EWQ has been completed (2009-2011). Results are discussed here. Also, an additional 50 site-specific EWQ targets have been defined for the Upper and Middle Delaware River (2006-2011), and results are shown here. Advantages of site-specific over reach-wide water quality targets are discussed, as is a method for site-specific and longitudinal statistical assessment of measurable changes to water quality over time and under the full range of hydrologic conditions.

Status, Trend and Change Evaluation and Web Displays of Data for Healthy Watershed Assessments

David M. Paradies[1], Karen R. Worcester[2] and John W. Hunt[3]
[1]California Central Coast Ambient Monitoring Program, Los Osos, Calif., [2]Central Coast Regional Water Quality Control Board, San Luis Obispo, Calif., [3]University of California, Davis, Calif.

Abstract
Since 2001, the California Central Coast Water Board's Ambient Monitoring Program (CCAMP) has been collecting monthly trend data at our bottom of watershed "coastal confluence" monitoring sites. We have recently undertaken a comprehensive evaluation of status, trend and change in concentration and loading to support a "Healthy Watersheds" assessment of our Region. At some sites we see linear trends, where change is more or less continuous in a single direction. At other sites we see abrupt change, often in response to a management action, a land use change, or a natural event (fire, flood). We have employed both non-parametric trend analysis and Bayesian change point analysis to our time series to assess these changes, and have examined upstream land use characteristics to support our findings. Assessment tools are directly tied to our database to allow direct updating of website displays (www.ccamp.org) in innovative formats that support periodic staff site assessments and updates.

The Development and Application of a Temperature Assessment Methodology for Coldwater Streams in Maryland

Matthew Stover[1], Nicholai Francis-Lau[1], Anthony Prochaska[2] and Michael Kashiwagi[2]
[1]Maryland Dept. of the Environment, Baltimore, Md., [2]Maryland Dept. of Natural Resources, Annapolis, Md.

Abstract
Maryland has a limited number of coldwater streams capable of supporting coldwater obligates such as brook trout (*Salvelinus fontinalis*) and certain stoneflies like *Tallaperla* sp. and *Sweltsa* sp. MDE and DNR partnered to develop a stepwise assessment process that evaluates stream temperature and biological assemblages to determine if the applicable stream temperature standards are being met. Though Maryland has a numeric stream temperature criterion, it also uses qualitative conditions to determine if the coldwater designated use is being supported. This method appears to be a balanced and reasonable approach to assessing whether warm temperatures are an impairing stressor to Maryland's class III coldwater streams. It has also revealed some of the more vexing assessment scenarios that Maryland has yet to address. Maryland will be using this assessment methodology in its 2014 Integrated Report (303(d) List) to report new temperature impairment listings and it will ultimately serve as the basis for future TMDL development and implementation activities.

Extending Trophic State Assessments Using Volunteer-Collected Water Quality Data

Anthony Thorpe, Daniel Obrecht and John Jones
University of Missouri, Columbia, Mo.

Abstract
The University of Missouri has monitored reservoirs for the past 20 years via two projects. One project uses field staff while the other recruits volunteers to collect and process samples. Samples from both projects are analyzed in the same laboratory by university staff. We examine the reliability of data resulting from samples collected and processed by volunteers to data resulting from samples handled entirely by university staff. To evaluate volunteers' ability to process samples with precision, we examine chlorophyll filter duplicates from both projects. Long-term data show that paired filters from each project differ by less than 5%, on average. Additionally, we examine trophic state assessments of reservoirs in Missouri using chlorophyll, total phosphorus and total nitrogen data from both projects. In 220 cases a reservoir was sampled by both projects during the same year, though not necessarily on the same day. At 38 reservoir sites we have at least 4 years of data from each project, though not necessarily

from the same years. Data compare between the projects, especially when long-term means are used (r^2 = 0.72 to 0.94). Using citizen volunteers is an effective way to enhance existing monitoring programs. Including volunteer-collected data increases the number of Missouri reservoir sites with long-term data by nearly 50%.

Session C2: National Water Quality Portal: Lessons Learned

8:00 – 9:30 am | Room 262

The Water Quality Exchange: A Streamlined Way for Sharing Water Quality Data

Charles Kovatch, Kevin Christian, Michael Brennan and Dwane Young
US Environmental Protection Agency, Washington, D.C.

Abstract
The Water Quality Exchange (WQX) is a framework that makes it easier for States, Tribes, and others to submit and share water quality monitoring data over the Internet. States, Tribes and other organizations can now submit data directly to the publicly-accessible STORET Data Warehouse, making the data also available via the Water Quality Data Portal, using the WQX framework. WQX is designed to allow for the automated sharing of water quality data using a standard format (the WQX Extensible Markup Language (XML) schema) and using agreed upon exchange protocols (the Exchange Network). This standard approach for sharing water quality monitoring data was developed through a coordinated effort with the National Water Quality Monitoring Council (NWQMC), USGS, the States, several Tribes, and a number of volunteer organizations. The WQX Schema has also enabled the development of the Water Quality Data Portal which allows for the integration of USGS monitoring data and data provided to EPA to be made available via a common portal.

During this presentation, EPA will give an introduction to WQX, including a discussion on the types of data that can be shared and the mechanisms by which those data can be shared including an introduction to WQX Web which is an online tool that enables for the easy conversion of a data to the WQX Schema. EPA will also discuss the importance of sharing water quality data, and will discuss some EPA initiatives to increase the amount of data sharing by state, tribal, and volunteer partners.

Two Years of the Water Quality Portal: Improvements, Lessons, and Plans for the Future

James Kreft
US Geological Survey, Middleton, Wis.

Abstract
The Water Quality Portal (WQP) was launched in April of 2012 as a single point of access for discrete water quality samples stored in the US Geological Survey (USGS) NWIS system and the US Environmental Protection Agency (EPA) STORET system. Since then, thousands of users have visited the Water Quality Portal and used it to download hundreds of millions of results that are pertinent to their interests, and numerous tools have been developed that use WQP web services as a source of data for further analysis. Since the launch of the Portal, the WQP development team at the USGS Center for Data Analytics has worked with USGS and EPA stakeholders as well as a wider user group to add significant new features to the WQP. WQP users can now directly plot sites of interest on a web map based on any of the 14 WQP query parameters, and then download data of interest directly from that map. In addition, the WQP has expanded beyond just serving out USGS and EPA data and has begun providing data from the US Department of Agriculture's Agricultural Research Service STEWARDS system, and is working with others to bring in additional data. Finally, the WQP is now linked to another NWQMC-supported project, the National Environmental Methods Index (NEMI), so WQP users can easily find the method behind the data that they are using. Future work is focused on adding additional biological data and biologically relevant query parameters to broaden the scope of discrete water quality sample types that the WQP can provide. The WQP is also exploring ways to further integrate with other systems to facilitate the overarching goal of improving access to water quality data for all users.

A National Compilation of Water-Quality Monitoring Data to Support Local, Regional, and National Scale Water Quality Assessments

Denise Argue[1], Jeffrey Deacon[1] and Robert Gilliom[2]
[1]US Geological Survey, Pembroke, N.H., [2]US Geological Survey, Sacramento, Calif.

Abstract
A national inventory was initiated in 2011 by the U.S. Geological Survey's (USGS) National Water Quality Assessment (NAWQA) program to compile and assess available water-quality monitoring information in order to make full use of existing data to support local, regional, and national assessments of the quality of the Nation's waters. The compilation includes nutrients, pesticides, and a wide range of additional water-quality data collected by a variety of organizations focused on monitoring the conditions of surface water, groundwater, and macroinvertebrate communities. The data compilation brings together numerous partner data sets into a single consistent format, specifically focusing on historic and current ambient monitoring data that are readily accessible, including from federal, state, and regional government agencies; non-governmental organizations; and data publicly housed in the National Water Information System (NWIS) and the Storage and Retrieval (STORET) system. The initial purpose of the data compilation was to support an assessment by the Northeast-Midwest Institute of the existing water information system in the northeast and Midwestern U.S. in order to address priority environmental issues in the region, such as nutrient enrichment and hydrologic fracturing. As the compilation expanded to national scale, the purposes expanded to include: 1) application of compiled monitoring data to support national scale water-quality status assessments, trends assessments, watershed modeling, and ecological studies; and 2) evaluation of current monitoring activities for the purpose of designing efficient monitoring networks and partnerships. For pesticides, in particular, NAWQA and USEPA Office of Pesticides are working together to enhance the completeness of the compilation so that it can best support assessments of pesticide concentrations in the Nation's streams and groundwater.

Duplicate Water Data – Causes, Implications, Solutions

Dorinda Gellenbeck[1] and Jonathon Scott[2]
[1]US Geological Survey, Denver, Colo., [2]US Geological Survey, Oklahoma City, Okla.

Abstract
The duplication of water data between databases within an agency and among agencies can lead to incorrect data analyses if not properly handled. Such duplication has been widespread for decades to accomplish data aggregation tasks that serve analyses related to specific areal studies. Resources required to obtain water-quality data are high; therefore, many researchers increased the available data by copying relevant data from other sources. Researchers and agency personnel commonly obtain, reformat, and store all the available data for a particular study area in their separate and respective databases.

Data copies residing in multiple databases sometimes are inconsistent, because of reformatting errors or differences, lack of diligence in copying all associated metadata, and updates made to the original source after the copy was performed. Presently large aggregated database collections are accessible via the internet, which can result in saving time previously expended obtaining, reformatting, and combining data sources. However, these large aggregated

data collections also have exposed the duplicate data problem. These duplicate records potentially corrupt analyses with bias due to the inclusion of the same data more than once or with errors that propagate from inconsistent copies.

New duplication of data can be avoided now with the advent of the Water-Quality Portal, a joint effort of the National Water Quality Monitoring Council, U.S, Environmental Protection Agency, and the U.S. Geological Survey (USGS). Recently the USGS has used a heuristic scoring system to remove duplicate copies of water-quality and other types of data in a new centralized data repository. The task was too time-consuming and tedious to solve with database experts, so an automated process was devised to rank duplicate copies to select the most appropriate version. A similar technique could potentially be used to evaluate duplicated data among agency systems. Additional methods could be used to identify co-located data-collection sites, such as a shared site-identifier system, or a site-identifier alias database.

Session C4: Communicating Science for Action

8:00 – 9:30 am | Room 237

Fox River Low Flow Dissolved Oxygen Monitoring: A Collaborative Effort

Kip Stevenson[1], Jim Slowikowski[2] and Amy Russell[2]
[1]Illinios State Water Survey, Peoria, Ill., [2]Illinois State Water Survey, Champaign, Ill.

Abstract
The Fox River flows approximately 115 miles and drains 1,720 square miles after crossing the Wisconsin/Illinois border till its confluence with the Illinois River near Ottawa, Ill. The Fox has long been a working river with large portions of the middle reached now impounded by a series of low-head dams. Throughout its length the Fox is used extensively for recreation, provides critical wildlife habitat and is the public drinking water supply for several municipalities within the watershed. The Illinois Environmental Protection Agency lists the entire length of the Fox River in Illinois as well as several significant tributaries including; Nippersink, Poplar, Blackberry, and Somonauk Creeks, and part of Little Indian Creek as impaired. The current assessment shows aquatic algae listed as a cause of impairment for 60% of the assessed mainstem miles, dissolved oxygen for 29%, and total phosphorus for 32% of the assessed mainstem miles.

In 2002 the ISWS began working with the Fox River Study Group (FRSG), a stakeholder group representing the diverse interests utilizing the river, to prepare and execute a plan to investigate water quality in the surface waters of the watershed. The result was a coordinated modeling and monitoring program designed to develop the modeling tools that would allow stakeholders to investigate efficient methodologies to address water quality concerns within the watershed.

To support the QUAL2K modeling component an intensive 72-hour monitoring effort was conducted during low flow conditions in June 2012. This collaborative effort by the ISWS, Deuchler Environmental Inc., USGS, Fox Metro WRD and Fox River WRD sought to characterize the dissolved oxygen regime in a 70-mile reach of the Fox River. Data collected over the 72 hour period included continuous water quality monitoring, discrete water quality monitoring and sampling, benthic algae determinations, sediment oxygen demand measurements, discharge, and stage. Monitoring efforts included the Fox River mainstem, its tributaries, and major point sources. This presentation focuses on the logistics of the intensive monitoring conducted and the multiple datasets obtained by several collaborating institutions. Results for dissolved oxygen flux and SOD determinations and the challenges they represent will also be presented.

Visual Stream Monitoring: Exploring Georgia's Newly Developed Visual Monitoring Methods

Harold Harbert and Tara Muenz
Georgia Environmental Protection Division, Atlanta, Ga.

Abstract
Visual stream monitoring is one of the easiest and most important ways for citizens to assess stream health, but it's often the most overlooked. Recently, Georgia Adopt-A-Stream produced an updated version of their visual stream monitoring program including a revised manual, forms and procedures. The highlight of the forms is a newly developed rapid habitat assessment of instream conditions. This survey is Georgia specific and includes an evaluation of 10 parameters for both rocky and muddy bottom streams. Created for volunteers, this rapid assessment includes drawings of stream conditions, in-depth directions and a poster guide with descriptions and photographs. Additionally, the visual program includes taking photo points, cross-section measurements and pebble counts, as well as measuring flow and conducting a biological assessment. All data can be entered and viewed by the public in our online database. The database displays data in matrixes and graphs, producing time-lapse reproductions of some the surveys including the cross-section measurements. The new visual survey will compliment other monitoring activity, indicating the chemical and biological health of a stream. This presentation will describe the process Georgia Adopt-A-Stream went through to update the visual monitoring program, sharing lessons learned while demonstrating the value of these surveys in assessing stream health with our volunteers and our partners across the State.

EcoAtlas and CRAM: Online Resource Management Support Tools

Cristina Grosso, Patty Frontiera, Shira Bezalel, Kristen Cayce, Todd Featherston, Tony Hale, Andrew Smith and Meredith Williams
San Francisco Estuary Institute, Richmond, Calif.

Abstract
How can resource managers evaluate new and ongoing wetland restoration activities? Effective resource management requires the synthesis of multiple data types related to wetland extent and condition. Consideration of objectives for water supply, water quality, habitat, recreation, flood protection, agriculture, and industry requires timely access to environmental data and information to support management decisions at site-specific and landscape scales.

EcoAtlas provides a unique combination of information resources to meet these needs. EcoAtlas (ecoatlas.org) is an online tool developed through the California Wetland Monitoring Workgroup of the Water Quality Monitoring Council to integrate of a wide range of data to meet federal and state reporting requirements about wetland extent and condition, restoration activity, and water quality conditions in the ecosystem. The tool aggregates and synthesizes data needed to support specific planning, reporting and management actions, such as compensatory mitigation planning at the landscape scale, climate change planning, and 305(b) reporting. Its interactive maps and project tracking tools enable users to easily access, analyze, synthesize, and visualize different data sets within a spatial context.

Two important data layers provide information wetland extent and condition. The California Aquatic Resource Inventory (CARI) is a standardized statewide map of wetlands, streams, and riparian areas. This Geographic Information System (GIS) dataset provides accurate and detailed information about wetland and riparian distribution and abundance for management, planning, and research of the State's aquatic resources. California Rapid Assessment Method (CRAM: cramwetlands.org) is the second vital layer. CRAM assessments provide the data needed to inform managers on wetland condition. CRAM itself is a cost-effective, scientifically proven tool for assessing the health of wetlands and riparian habitats. It is designed for assessing ambient conditions within watersheds, regions, and throughout the State.

EcoAtlas' Landscape Profile tool allows users to explore a particular area of interest and summarize the salient information about the condition and extent of streams, wetlands, lakes, and their surrounding riparian areas. EcoAtlas can be used to create a more comprehensive picture of aquatic resources in the landscape by integrating information important to California's wetlands.

Iowa's Water Quality Index – From Data to Action

Mary Skopec
Iowa Dept. of Natural Resources, Iowa City, Ia.

Abstract
Iowa's Water Quality Index (IWQI) was created to adequately reflect the water quality conditions of Iowa and to help decision makers understand the condition of Iowa's water without becoming mired in the results of individual parameters. In Iowa, this WQI is calculated by using nine common water quality parameters (dissolved oxygen, *E. coli* bacteria, 5-day BOD, total phosphorus, nitrate + nitrite as N, total detected pesticides, pH, total dissolved solids, and total suspended solids). Values range from 0 to 100 and streams are classified as very poor (0-25), poor (25-50), fair (50-70), good (70-90), or excellent (90-100). WQIs were calculated on the streams monitored monthly as part of Iowa's Ambient Water Monitoring Program. This geographically specific index ensures that Iowa's unique geographical characteristics will be properly reflected in the water quality index. Since 2001, the IWQI has been reported to the Governor of Iowa as a tool to communicate progress on water quality goals. The IWQI has also been used by various non-governmental entities seeking to understand the impact of concentrated animal facilities in Iowa. This presentation will examine the role of the IWQI in communicating water quality status and trends and helping to focus efforts to improve Iowa's water resources.

Session C5: Nutrient Monitoring and Modeling to Restore and Protect Coastal Water Quality

8:00 – 9:30 am | Room 233

Hypoxia Forecast Models in Coastal Waters Used to Inform Nutrient Management

Alan Lewitus and David Kidwell
National Oceanic and Atmospheric Administration, Silver Spring, Md.

Abstract
NOAA administers national competitive programs aimed at assessing the causes and ecosystem impacts of coastal (including Great Lakes) hypoxia, and developing quantitative predictive models to inform coastal managers of the effectiveness of alternative management strategies for preventing or mitigating hypoxia. Development of predictive models has advanced hypoxia management capabilities in several systems where the magnitude of hypoxia is related to nutrient enrichment through anthropogenic activities, including the northern Gulf of Mexico, Narragansett Bay, Chesapeake Bay, Delaware Bay, Lake Erie, and Green Bay. Scenario-based forecast models in these regions are being used to improve the predictive understanding of the quantitative relationship between nutrient loading and hypoxic zone size, inform nutrient reduction targets to mitigate hypoxia, and monitor management progress toward achieving hypoxia mitigation through nutrient reduction. A comparison of hypoxia forecast modeling approaches and management applications in these regions will be presented, and remaining research needs to inform management decisions discussed.

New Web-Based Capabilities for Using Spatially Referenced Regression Models to Support Decisions Related to the Management of Nutrient Loads to the Nation's Estuaries

Stephen Preston
US Geological Survey, Dover, Del.

Abstract
Over the past decade, the U.S. Geological Survey (USGS) National Water Quality Assessment (NAWQA) program has developed models using the technique known as SPAtially Referenced Regressions On Watershed attributes (SPARROW) to assess the status of water-quality conditions throughout the conterminous United States (U.S.). SPARROW models use monitoring data combined with geospatial information describing contaminant sources (*e.g.*, land use) and loss processes (*e.g.*, stream attenuation) to consistently estimate levels of nutrients in all streams at national, regional or local spatial extents. Such information can be used for a variety of management objectives including: 1) identifying spatial patterns in nutrient sources and loading; 2) targeting and prioritizing management actions; and 3) improving monitoring networks. These models can be accessed using an online interactive decision support system (DSS) (http://water.usgs.gov/nawqa/sparrow/dss/). The DSS can be used to evaluate combinations of source reduction scenarios that target one or multiple sources of nutrients and see the change in the amount of nutrients transported to downstream waters – a capability that has not been widely available in the past. Recently added capabilities provide information regarding loads to estuaries and for relating upstream sources of nutrients to downstream estuarine loads. These new capabilities include maps of nutrient yields and summaries of nutrient sources for watersheds draining to most estuaries in the conterminous U.S. They also include preselected sets of stream reaches that drain to each estuary in the conterminous U.S. so that users can readily identify the areas draining to each estuary and easily develop maps that show the relative contributions of nutrients from areas of the watershed and from different source types. Lastly the new capabilities provide summaries of relative contributions of nutrients from sub-watersheds defined by HUCs and by states. These new features will allow users of the SPARROW DSS to quickly identify sources of nutrients to estuaries and use that information to allocate management resources where they are likely to have the greatest benefit.

Nutrient Threshold Development for Saint Louis Bay, Mississippi: Content and Context

Michael Paul[1], James Stribling[2], Kim Caviness[3], Rene Camacho[4] and Lei Zheng[2]
[1]Tetra Tech, Inc., Research Triangle Park, N.C., [2]Tetra Tech, Inc., Owings Mills, Md., [3]Mississippi Dept. of Environmental Quality, Jackson, Miss., [4]Tetra Tech, Inc., Atlanta, Ga.

Abstract
Nutrient pollution is a serious environmental issue for most regions of the US, and the Gulf of Mexico is no exception. Developing estuarine and coastal nutrient limits that protect valued ecological attributes is confounded by variability in developing clear target indicators and precise response models. One priority area of the Gulf of Mexico Alliance is reducing nutrients their impacts to the waters of the Gulf. As part of this initiative, a regional effort was undertaken to develop and strengthen procedures for deriving defensible and protective nutrient thresholds for estuaries and near-coastal waters. This presentation describes one project within that effort. The Mississippi Department of Environmental Quality performed a study of St. Louis Bay, Mississippi. This study combined mechanistic and empirical modeling to develop nutrient thresholds. Data and assessments from a monitoring program were used to calibrate a water quality model for the Bay, and included information on biological, chemical, hydrodynamic, physical, and climatic characteristics. The model was used to run various nutrient loading scenarios (forested, half of current loads, current loads, and a 50% increase in current loads) to evaluate ecological responses of the estuary to nutrient

enrichment. Simultaneously, the monitoring data and assessment results were used to develop empirical models relating nutrient concentrations to response conditions. These two approaches were then combined to inform selection of nutrient concentration thresholds designed to protect uses of the St. Louis Bay estuary from the effects of nutrient pollution. We describe the case study, the results of the two modeling approaches, how the results are being used for site specific application as well as state nutrient threshold development, and how they can contribute to a core framework to be used in other Gulf of Mexico estuaries. In addition, we will discuss selected similarities and differences with other nutrient criteria efforts in the Gulf of Mexico.

Monitoring Nutrient and Sediment Inputs to Texas Bays and Estuaries: A Comparison of Selected High Flow Events, 2009-13

Michael Lee
US Geological Survey, Houston, Tex.

Abstract
Since 2009, the U.S. Geological Survey (USGS) has been evaluating the variability of nutrient and sediment characteristics in the lower reaches of the rivers entering Texas bays and estuaries during a variety of hydrologic conditions. Discharge, sediment concentration, sand/fine break, and nutrient concentration data were collected to gain a better understanding of the hydrologic and water-quality characteristics for the coastal ecosystems. Four events of unique hydrologic conditions on the Trinity River entering the Galveston Bay estuary are evaluated to demonstrate the variability of sediment and nutrient characteristics caused by differences in flood-discharge magnitude, duration, origin of floodwater runoff, and timing of sample collection. Some differences in the nature of the sediment and nutrient characteristics of high flow events were evident. These events are also compared to the hydrologic response of the Colorado River entering the Matagorda Bay estuary in Texas during high flow events. Results indicate that it might be possible to better understand the extent of nutrient and sediment loading in Texas bay and estuaries using selected measurements of discrete and continuous water-quality data. Both optical and acoustic methods are evaluated and an apparent correlation was observed with the concentrations of selected nutrients and suspended sediment, and an apparent correlation was observed between suspended sediment and total nutrient concentration measured during these high flow events.

Session C6: Best Management Practices for Protecting Water Quality

8:00 – 9:30 am | Room 232

Monitoring Forest Service's BMPs – Assessing the First Year of National Program Implementation

Pam Edwards[1], Joan Carlson[2], Michael Eberle[3] and Liz Berger[3]
[1]USDA Forest Service, Parsons, W.Va., [2]USDA Forest Service, Denver, Colo., [3]USDA Forest Service, Washington, D.C.

Abstract
In 2012, the USDA Forest Service initiated a formalized National Best Management Practices (BMP) Program. The program provides a critical tool in the Agency's efforts to maintain and improve water quality. BMP Monitoring Protocols were developed as part of the overall National BMP Program, to provide a consistent approach for monitoring BMP implementation and effectiveness on all national forests and grasslands. These protocols support the adaptive management process that is integral to improving the application and refinement of BMPs. Monitoring data will be aggregated over time to provide national, regional and forest-scale evaluations of BMP performance. Monitoring using the National BMP protocols began in 2013 and all forests and grasslands were required to monitor at least two activities. Monitoring goals were assigned regionally to ensure that a diversity of land management and land disturbing activities were evaluated, including those associated with roads and trails, stream restoration, vegetation management, facilities management, and recreation. Altogether, over 280 projects or sites were monitored covering 39 activities. Results from the first year of BMP monitoring will be shared, including programmatic corrective actions needed, the type and location of projects monitored, summaries of metadata feedback, and initial monitoring costs.

Stormwater Monitoring in the Cherry Creek Basin, Colorado

Natalie Love, Craig Wolf and Jamie Nogle
GEI Consultants, Inc., Denver, Colo.

Abstract
Stormwater monitoring can have many different purposes from evaluating metals contamination to bacterial levels. For the Cherry Creek Watershed in Colorado, stormwater monitoring is in place to quantify the non-point source phosphorus and nitrogen loads that eventually flow into Cherry Creek Reservoir. Baseflow and stormflow monitoring has been conducted for 21 years on 3 tributary inputs to the reservoir to better understand the effects of the nutrient inputs from Colorado's variable rainfall events. This study quantifies the nutrient stormflow loads and compares these values to the baseflow load conditions in the watershed. The increase in nutrient and stormflow concentrations due solely to storm events is high. During the 2012 water year (October 2011 through September 2012), the total phosphorus concentration in stormflows ranged from 49% to 84% higher than baseflow conditions. Best management practices such as constructed wetlands and stream reclamation have become a key focus in the watershed to reduce the amount of nutrient loading into the reservoir. For the 2012 water year, a series of 2 constructed wetlands along 1 of the tributaries to Cherry Creek resulted in a total reduction of 65% total phosphorus and 68% total suspended solids concentrations during storm events. The effectiveness of these management practices at reducing nutrient loading is presented. The presentation will also evaluate impacts from major storm events such as the storm in June 2012 that resulted in estimated 10-year flood levels in the Cherry Creek basin and the disastrous storm event in September 2013 with estimates ranging from 10 to 25-year flood levels in the basin.

The Potential Importance of Conservation, Restoration and Altered Management Practices for Water Quality in the Wabash River Watershed

Guoxiang Yang[1] and Elly P.H. Best[2]
[1]US Environmental Protection Agency, Cincinnati, Oh., [2]US Environmental Protection Agency, Cincinnati, Oh.

Abstract
Nonpoint source (NPS) pollution is one of the leading causes of water quality impairment within the United States. Conservation, restoration and altered management (CRAM) practices may effectively reduce NPS pollutants discharge into receiving water bodies and enhance local and regional ecosystem services. Barriers for the implementation of CRAM include uncertainties related to the extent to which nutrients are removed at various spatial and temporal scales, longevity, optimal placement within the landscape, and implementation / operation / maintenance costs. We conduct a study to explore extent, geographical distribution, and spatial scale, determining load reduction in a relatively small watershed to a level below which an 'accepted' nutrient standard becomes insignificant relative to the overall nutrient load routed downstream through a far larger watershed. The study results are expected to provide information on local, regional, and national significance of CRAM implementation for water quality standard attainment. For this study, we use a recently developed screening-level modeling approach, WQM-TMDL-N,

running in the ArcGIS environment, to estimate annual total nitrogen(TN) loading and average TN concentration; and expanded this with a new option to explore CRAM effects on TN and concentration, and multi-objective algorithm optimizing load and cost. We apply this modeling approach to the Wabash River (WR, HUC 4) watershed, IN, where land use is predominated by agriculture and CRAM implementation is being planned and implemented. CRAM practices explored include buffer strips, nutrient management practices, and wetland restoration. Because the WR accounts for over 40% of the nutrient loads of the Ohio River, which in turn significantly contributes to the anoxic zone in the Gulf of Mexico, reduction in TN loading of the WR is expected to directly benefit downstream ecosystem services. Results of initial model applications indicate that the implementation of buffer strips and nutrient management practices may significantly contribute to local and regional water quality standard attainment, and wetland restoration may even exceed these effects - with the latter offering potential solutions for water quality issues. Decisions on CRAM implementation for water quality improvement take cost into consideration, and, therefore, our pollutant load-cost optimization algorithm is expected to facilitate the decision-making process.

How Paired Is Paired? Comparing Nitrate Concentrations in Three Iowa Drainage Districts

Anthony Seeman[1], Christopher Jones[1] and Keith Schilling[2]
[1]Iowa Soybean Association, Ankeny, Ia., [2]Iowa Geological and Water Survey, Iowa City, Ia.

Abstract
Quantifying the effectiveness of perceived best management practices (BMPs) at the field and landscape-scale is difficult, so paired watershed studies are used to detect water quality improvements. We evaluated concentrations of NO_3–N discharged from three tiled Iowa watersheds during a 5-yr period to assess their suitability for a paired watershed approach. Our objectives were to evaluate similarities in physical characteristics, concentration patterns, and correlation among the three paired sites and perform a minimum detectable change (MDC) analysis on paired site configurations. We also explore the effect of extreme hydrologic events (flood, drought) on concentration variability and its relevance to the paired watershed and MDC approach. The study results demonstrate that concentration variability within and between sample sites affected correlation among the paired basins, even though the physical characteristics of the basins are quite similar. High correlation between sites during normal and wet periods at the beginning of the calibration period was reduced with the onset of drought conditions. The lack of a suitable correlation may impair the ability to detect changes expected to result from BMP implementation. The MDC for NO_3–N concentration change detection varied from 6.9 to 12.9% and averaged 8% for the best control-treatment pair. To ensure that conservation resources are being used effectively, implemented BMPs should focus on practices capable of achieving at least this magnitude of change.

Session C7: Evaluating Changes and Trends Using Statistical Surveys

8:00 – 9:30 am | Room 231

Watershed-Scale Biological Monitoring and Assessment for Ecological Protection and Restoration Planning

James Stribling[1], Katharine Fritz[2], Russ Dudley[3] and Mow-Soung Cheng[4]
[1]Tetra Tech, Inc., Owings Mills, Md., [2]Maryland-National Capital Park and Planning Commission, Upper Marlboro, Md., [3]Tetra Tech, Inc., Fairfax, Va., [4]Prince George's County Dept. of Environmental Resources, Largo, Md.

Abstract
Watershed-scale biological monitoring has been ongoing for over 15 years in Prince George's County, Maryland, producing two complete rounds of county-wide assessments using a stratified random design with benthic macroinvertebrate and physical habitat indicators. The biological indicator is used to calculate percent degraded streams miles within each subwatershed, which is then used to inform watershed managers the priority sub-basins for protection and restoration. Round 1 sampling and analysis occurred over a 5-year period from 1999-2003, and Round 2 over three years from 2010-2013. Using consistent field sampling, laboratory, and data analysis procedures for each Round, 41 subwatersheds within the county were assessed with approximately 283 samples from 257 wadeable stream sites. The 257 sample locations were selected at the same frequency for each subwatershed, but for different specific locations. The overall percent degradation for the county remained relatively unchanged in the two rounds (52% vs. 49%), though, several individual subwatersheds had clear directional changes, either positive or negative. The County uses assessment results at various levels. First, results help communicate watershed conditions to broader audiences at multiple spatial scales. Secondly, the results are used to inform public policy and legislation toward the county's principal goals for improving the overall water quality, one of which is from the county's green infrastructure planning program: "By the year 2025, improve the water quality in each major watershed to elevate the Benthic Index of Biological Integrity (IBI) rating of the watershed by at least one category using the 1999-2003 biological assessment as a baseline." The 2014 update to the plan by the Planning Department will evaluate whether the land use actions of the last 10 years have helped improve water quality in priority watersheds. Third, recent legislation and neighborhood-scale master planning were informed by these monitoring results and the planning strategies. Another potential use of the monitoring results will be to help elevate the efficiency of the Watershed Implementation Planning process. Routine, county-wide watershed monitoring and assessment will continue to provide objective evidence of the effectiveness of restoration (=stressor source control or elimination) in enhancing or elevating biological conditions at all scales.

Using Probabilistic Monitoring Data to Recommend Stressor Risk Levels in Aquatic Life Use Total Maximum Daily Load Studies

Jason Hill, Mary Dail and Larry Willis
Virginia Dept. of Environmental Quality, Roanoke, Va.

Abstract
Virginia Department of Environmental Quality (VADEQ) has collected water quality, habitat, and benthic macroinvertebrates at freshwater probabilistic monitoring sites for over ten years. The freshwater probabilistic program's data collection has allowed VADEQ to establish baselines for water chemistry and habitat throughout Virginia by major basin, ecoregion, and stream size. VADEQ has documented the most common stressors to the aquatic community in several integrated reports and is now recommending risk levels for these stressors for use in aquatic life use total maximum daily load studies.

Looking at Statewide Trends in Water Quality through State-Scale Statistical Survey Data

David Chestnut
South Carolina Dept. of Health and Environmental Control, Columbia, S.C.

Abstract
In 2001 the South Carolina Department of Health and Environmental Control implemented discrete state-scale statistically-valid surveys for rivers and streams, lakes and reservoirs, and estuaries. SCDHEC worked closely with EPA ORD, Western Ecology Division staff in developing the designs.

The designs were built around the existing SCDHEC monitoring strategy and resource constraints, with new sites selected each year in each resource type. The primary intent is to make statements about statewide resource conditions, with confidence estimates, to satisfy §305(b) reporting requirements.

Multiple site visits to each site each year provide sufficient data to support SCDHEC's assessment methodology and allow §303(d) listing of impaired waters. Each site can be evaluated individually to determine classified use attainment and the need for inclusion on the §303(d) list of impaired waters.

With the program in place for over ten years, this presentation will focus on changes in water quality observed for the different resource types and discussion of some of the possible driving causes for those changes.

An Emerging Picture of Changes in Coastal Water Quality: Preliminary Results from the 2010 National Coastal Condition Assessment 2010

Treda Grayson
US Environmental Protection Agency, Washington, D.C.

Abstract
Tracking water quality over time is an important objective of the National Coastal Condition Assessment, one of a series of probabilistic surveys implemented as part of the National Aquatic Resource Surveys program. Since about 2000, EPA and states have been sampling U.S. coastal, estuarine waters using a statistical survey design and standardized indicators and sampling methods. With the recent drafting of the NCCA 2010 report, we can add to an emerging picture of changes in coastal water quality. This presentation will describe the NCCA and provide information on how select coastal water indicators have changed since 2000.

Session D1: Remote Sensing: Tools and Applications

1:30 – 3:00 pm | Room 263

Initial Results from the Workshop on Developing a Great Lakes Remote Sensing Community

Larry Liou[1], Robert Shuchman[2], Colin Brooks[2] and Amanda Grimm[2]
[1]National Aeronautics and Space Administration, Cleveland, Oh., [2]Michigan Tech Research Institute, Ann Arbor, Mich.

Abstract
This presentation unveils results from the workshop on remote sensing of inland water quality. The workshop is titled "Workshop on Developing a Great Lakes Remote Sensing Community."

Water quality is of vital importance to the nation and the Great Lakes region. The Great Lakes provide shipping, drinking water, and recreational opportunities for 40 million people and are home to some of the most productive freshwater fisheries in the world. The Great Lakes also make a valuable inland water laboratory in which to study forcing factors such as climate change and human influences that affect inland waters globally. The findings from this Great Lakes focused workshop can be applied worldwide.

State of the science of remote sensing of Inland waters, particularly the Great Lakes, has progressed significantly over the past decade in step with the next-generation satellite infrastructure; the improvement of freshwater optical algorithms; the aquatic radar and lidar data; and the increasingly capable unmanned aerial vehicles (UAVs) and autonomous underwater vehicles (AUVs). However, despite the above and the current efforts in coordinated research and facilitate data sharing, the evolution of a remote sensing community in the Great Lakes is still in its early stages. The current workshop aims to accelerate the forming of this community and thereby furthering the advancement of remote sensing of water quality.

This workshop has the objective to establishing a community consensus on the scientific and technical gaps in remote sensing of water quality. The community consists of data generators and data users from the federal and state agencies, academia, water monitoring programs, tribal and other stakeholder organizations, regulatory bodies, and the international organizations. The workshop will generate a summary white paper with recommendations for consideration by the 2017 NASA Earth Science Decadal Survey.

The workshop also sets up an accompanying interactive website to share summarized findings of three previously held, similar workshops on the same topic. Collaborated by academic, regulatory, and other community partners, this website also provides access to the current workshop documents and serves as a platform for collaboration on a continuing basis.

Use of MODIS Earth Observation Data in Regional-Scale Models of Reactive Nitrogen in Watersheds

R.A. Smith[1], J.S. Shih[2], J.W. Brakebill[1], A.W. Nolin[3], M.K. Macauley[2], G.E. Schwarz[1] and R.B. Alexander[1]
[1]US Geological Survey, Reston, Va., [2]Resources for the Future, Washington, D.C., [3]Oregon State University, Corvallis, Oreg.

Abstract
Reactive nitrogen (Nr) from agriculture and other human sources is transported hundreds to thousands of kilometers through river basins before reaching estuaries and the coastal margin. Continental and regional-scale models of (Nr) have become critical tools in the management of both coastal and inland water quality. Spatial and temporal sparseness and discontinuities in the data available for quantifying Nr sources, however, limit the usefulness of these large-scale models. Agriculture and natural resources data programs commonly report at annual or less frequent temporal cycles, and at a county (1000 km^2) spatial scale. By contrast, forecasting nutrient conditions and hypoxia risk in coastal and inland receiving waters often requires Nr source information at seasonal (or finer) time scales.

We tested the usefulness of seasonally-averaged 1-km observations of the Enhanced Vegetation Index and snow/ice cover data derived from the orbiting Moderate Resolution Imaging Spectroradiometer (MODIS) in augmenting ground-based Nr source inputs to SPARROW (spatially-referenced regression on watershed attributes) models of Nr for the Chesapeake Bay and the conterminous United States, both of which are currently used for water resources management purposes. SPARROW models are developed through statistical calibration of a mass balance equation relating Nr supply rates to Nr flux rates in streams and rivers measured via long-term network monitoring. The models accommodate spatially-detailed information for multiple Nr sources including leguminous crop acreage, fertilizer application rates, livestock manure production, forest and other natural vegetation coverage, atmospheric Nr deposition, and human population-related sources. The availability of spatially-detailed seasonal time series of EVI and snow/ice cover provide many options for modifying the Nr source terms to reflect seasonal vegetation

condition. Statistical calibration of the models provides an objective means for assessing the value of these modifications in terms of improved accuracy of predicted aquatic Nr flux.

Using Remote Sensing Tools to Target Stream Protection and Wastewater Treatment Management Practices in Rural Kentucky

Barry Tonning, Catherine Carter, Peter Cada and Gregory D. Sousa
Tetra Tech, Research Triangle Park, N.C.

Abstract
For the Hinkston Creek Watershed CWA 319 (Nonpoint Source Pollution) Project in east central Kentucky, Tetra Tech used remote sensing tools to produce an onsite wastewater system risk analysis, a riparian buffer assessment, and a focused study of two selected tributaries affected by livestock access to the stream corridor. Onsite wastewater treatment system potential risk to water quality was assessed via mapping analyses that considered system densities (*i.e.*, number per square mile), system age, and proximity to surface waters. Prioritization was based on level of household density, closeness to streams, and closeness to karst topography (to account for impacts to groundwater). Publicly serviced areas with centralized wastewater treatment were eliminated first; household density was calculated for areas outside of public sewer line boundaries in the areas surrounding the municipalities.

The riparian buffer assessment and deficiency analysis used aerial photography to determine canopy cover presence/absence and buffer zone widths. A 100-foot buffer was created along each side of the mainstem of Hinkston Creek, with a 50-foot buffer for the upper watershed and tributaries. A Multi-Resolution Land Characteristics Consortium (MRLC) geospatial dataset (LANDFIRE) was used to determine riparian buffer health status (impacted vs. intact). Using methodology from Roy *et al.*, 2005, any vegetated layers with less than 30 percent coverage were lumped together with other impacted riparian habitat LULCs (*e.g.*, developed, open space, pasture/hay, etc.). The percent buffer deficiency within each assessment subwatershed was estimated using GIS.

A broader, desktop analysis of high-risk stream channel areas was also conducted by analyzing riparian vegetation (*i.e.*, canopy cover), cattle access points, and property ownership records. The riparian deficiency data described above was overlaid with imagery from the National Agriculture Imagery Program to assess the intensity of impact on riparian areas within two impaired subwatersheds. Impacted riparian areas were divided into four levels of impact based on stress conditions observable from the aerial imagery, such as proximity of intense tilling and/or grazing to the stream edge, cattle access points, and lack of tree or shrub cover in the riparian buffer.

Session D2: Temporal Changes in Groundwater Quality

1:30 – 3:00 pm | Room 262

Trends in Groundwater Quality in Principal Aquifers of the United States, 1988-2012

Bruce Lindsey[1] and Michael Rupert[2]
[1]US Geological Survey, New Cumberland, Pa., [2]US Geological Survey, Pueblo, Colo.

Abstract
The U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program analyzed trends in groundwater quality throughout the nation for the sampling period of 1988-2012. Trends were determined for networks (sets of wells routinely monitored by the USGS) for a subset of constituents by statistical analysis of paired water-quality measurements collected on a near-decadal time scale. The data set for chloride, dissolved solids, and nitrate consisted of 1,511 wells in 67 networks, whereas the data set for methyl *tert*-butyl ether (MTBE) consisted of 1,013 wells in 46 networks. The 25 principal aquifers represented by these networks account for about 75 percent of withdrawals of groundwater used for drinking-water supply for the nation.

Statistically significant changes in chloride, dissolved-solids, or nitrate concentrations were found in many well networks over a decadal period. Concentrations increased significantly in 48 percent of networks for chloride, 42 percent of networks for dissolved solids, and 21 percent of networks for nitrate. Chloride, dissolved solids, and nitrate concentrations decreased significantly in 3, 3, and 10 percent of the networks, respectively. The magnitude of change in concentrations was typically small in most networks; however, the magnitude of change in networks with statistically significant increases was typically much larger than the magnitude of change in networks with statistically significant decreases. The largest increases of chloride concentrations were in urban areas in the northeastern and north central United States. The largest increases of nitrate concentrations were in networks in agricultural areas.

Statistical analysis showed 42 of the 46 networks had no statistically significant changes in MTBE concentrations. The four networks with statistically significant changes in MTBE concentrations were in the northeastern United States, where MTBE was widely used. Two networks had increasing concentrations, and two networks had decreasing concentrations. Production and use of MTBE peaked in about 2000 and has been effectively banned in many areas since about 2006. The two networks that had increasing concentrations were sampled for the second time close to the peak of MTBE production, whereas the two networks that had decreasing concentrations were sampled for the second time 10 years after the peak of MTBE production.

Pesticides in Groundwater of the United States: Decadal-Scale Changes, 1993-2011

Patricia Toccalino[1], Robert Gilliom[1], Bruce Lindsey[2] and Michael Rupert[3]
[1]US Geological Survey, Sacramento, Calif., [2]US Geological Survey, New Cumberland, Pa., [3]US Geological Survey, Pueblo, Colo.

Abstract
This study by the U.S. Geological Survey's National Water-Quality Assessment Program assessed (1) the occurrence of pesticides in groundwater and (2) decadal-scale changes in pesticide concentrations over a 20-year period. Samples were collected from 1,271 wells located in 58 nationally distributed well networks and analyzed for as many as 83 pesticide compounds. Wells were sampled once during 1993–2001 and once during 2002–2011. Well networks consisted of shallow (mostly monitoring) wells in agricultural and urban land-use areas and deeper (mostly domestic and public supply) wells in major aquifers in mixed land-use areas. Statistical analyses for identifying decadal-scale changes in pesticide concentrations incorporated adjustments to account for fluctuations in laboratory recovery. Pesticides were frequently detected (53% of all samples), but concentrations seldom (1.8% of all samples) exceeded human-health benchmarks. The five most frequently detected pesticide compounds—atrazine, deethylatrazine, simazine, metolachlor, and prometon – each had statistically significant changes in concentrations between decades in one or more land uses. For all agricultural networks combined, concentrations of atrazine, metolachlor, and prometon decreased from the first decade to the second decade. For urban networks, deethylatrazine concentrations increased and prometon concentrations decreased. For major aquifers, concentrations of deethylatrazine and simazine increased. The magnitudes of the median decadal-scale concentration changes were small – ranging from -0.09 to 0.03 µg/L – and were 35- to 230,000-fold less than human-health benchmarks. Altogether, 36 of the 58 well networks had statistically significant changes in one or more pesticide concentrations between decades. This is the most comprehensive

assessment of decadal-scale changes in pesticide concentrations in groundwater in the United States; such assessments are essential for tracking long-term responses to changes in pesticide use and land-management practices.

Chloride and Nitrate Trends in Ohio's Public Water System Wells

Michael Slattery
Ohio Environmental Protection Agency, Columbus, Oh.

Abstract
The assessment of trends in ground water quality is an important step in understanding the factors that affect water quality over time. Trends in ground water quality are driven by natural geochemical evolution, climate, land use activities, ground water extraction, groundwater-surface water interaction, and inter-aquifer leakage. Small aquifers may react quickly to changing conditions (days to weeks) under high recharge conditions, while larger, deeper aquifers with much greater storage may respond many times more slowly (decades to millennia). Here, changes over the last four decades in concentrations of two key water quality parameters, chloride and nitrate, are evaluated in the raw water of public supply wells using data from Ohio EPAs Ambient Ground Water Monitoring Network (AGWMP). This dataset comprises a rich, long-term archive of Public Water System (PWS) source water data with adequate spatial and depth coverage across the main aquifer types encountered in Ohio.

Estimates of trend are evaluated using standard methods such as the Mann-Kendall trend test and lowess regression to estimate the intra-well monotonic trends of chloride and nitrate (tendency of concentration to increase or decrease over time). While numerical estimates of slope and significance help to document variation over time, they do not imply cause and effect relationships to land use activity or contamination source, nor are they predictive in that regard. To help interpret the physical significance of the trend results, the slopes are evaluated by well depth, aquifer type, and land use category to determine if any spatial patterns emerge as significant, although such patterns are often difficult to discern in well networks. Based on the nature of PWS wells in general (deep and large), slower water quality changes over time might be expected in these wells than in networks of smaller, shallower wells.

Temporal Variations in Temperature, Water Level, and Specific Conductivity in Groundwater and Combined Storm Sewers in a Sustainable Streetscapes Best Management Practice (BMP) Area in Chicago, Illinois

William Morrow[1], James Duncker[1] and Kuldip Kumar[2]
[1]US Geological Survey, Urbana, Ill., [2]Metropolitan Water Reclamation District of Greater Chicago, Chicago, Ill.

Abstract
The City of Chicago's "Sustainable Streetscapes" program's hydrologic objective is to reduce storm runoff to combined sewers by increasing groundwater recharge capability. The infrastructure changes used to accomplish this goal are best management practices (BMPs) designed to divert 80 percent of the average rainfall runoff to groundwater recharge. This goal is to be accomplished through the use of permeable pavement along parking areas, bioswales, and infiltration planters along a 2.1 mile stretch of mixed commercial/light industrial area. Observation wells were installed and sewers were monitored to collect background/pre-construction data for groundwater water levels, sewer water-levels and discharge, temperature, and specific conductance. Data at this network of monitored sewers and observation wells are being used to determine the effectiveness of these BMPs.

Monitoring of sewers and groundwater originally was intended to address groundwater-surface water interactions, which preliminary data indicates is not occurring to a measurable extent. Changes in water levels, specific conductivity, and temperature indicate different factors are effecting changes in groundwater and sewers. Water level and specific conductivity changes, while generally synchronous during summer are not necessarily synchronous during winter months of salt application. During winter, interdependent factors including snow volume, salt application rates, and temperature affect the chronology and magnitude of temperature, water level, and specific conductivity peaks. Small changes in observed water level (near the resolution level of the meters) in sewers also correlated with diurnal fluctuations in specific conductivity and temperature.

Session D3: Continuous Monitoring: Innovations in Applications and Instrumentation, Part 1

1:30 – 3:00 pm | Room 261

Real-Time Nitrate Monitoring in Groundwater within a Mixed-Use Watershed in Central Illinois

Patrick Mills, Kelly Warner and Jacob Wikle
US Geological Survey, Urbana, Ill.

Abstract
Variability of nutrient concentrations in groundwater in response to seasonal or other temporal variability in nutrient applications and precipitation may play an important role in nutrient loading in streams. Collection of groundwater nitrate data at the frequency and duration necessary to best understand the mechanics and significance of the groundwater contribution to stream loads has been hampered by the approaches of typical data collection. Samples must be collected by a manually or automatically operated pump, often followed by laboratory analysis. Among other issues, manual collection can be labor and/or travel intensive; automated collection can be restricted by limits on number of samples and holding times for analysis. Recent availability of an automated photometric sensor that can provide long-term, near-continuous groundwater nitrate data with real-time broadcast through satellite telemetry should greatly advance groundwater nitrate monitoring capabilities. The sensor determines concentrations by measurement of ultraviolet light adsorption by nitrate.

The capability of the automated sensor in a groundwater application is under evaluation at a 640 acre, agricultural/residential/prairie-wetland parcel at the lower end of a 9,000 acre, predominantly agricultural watershed near Bloomington, Illinois. The timing and stressors driving periodic fluctuations in groundwater nitrate concentrations are not well understood, nor the relation of these fluctuations to the variability of nitrate loads in the nearby streams. The largest nitrate loads in the streams occur in conjunction with larger precipitation events, particularly when near the time of field nutrient applications. The automated sensor has initially been installed in a site well that is located between the newly establishing residential neighborhood and the stream; subsequent installation is planned at a location downgradient of a field cultivated in row crops. Along with assessment of the performance and maintenance requirements of the sensor, it is anticipated that its use will prove valuable to better understanding of nitrating loading in the watershed.

Using Continuous Real-Time Water-Quality Data to Estimate Organic Carbon Export from an Urban Stream

Jami Goldman, Stewart Rounds, Mackenzie Keith and Steven Sobieszczyk
US Geological Survey, Portland, Oreg.

Abstract
Organic matter (OM) is a critical component of food webs and biogeochemical cycles, and an important factor in the dissolved-oxygen budget of a stream, as oxygen is consumed when OM decomposes. Identifying and quantifying the sources and transport of OM is essential for crafting effective management

strategies to protect or restore stream water quality. Sources of OM to Fanno Creek, an urban stream near Portland, OR, were estimated and compared to instream loads of organic carbon to better understand the contributions, variability, and characteristics of those sources.

Continuous measurements of fluorescent dissolved organic matter (FDOM), light scattering (turbidity), and streamflow were used to estimate instream concentrations and loads of organic carbon near the mouth of Fanno Creek. Concentrations of dissolved organic carbon (DOC) were estimated from regressions of DOC and FDOM data. Particulate organic carbon (POC) concentrations were estimated from a multiple linear regression of POC data against FDOM and turbidity data. Regressions were linear and predicted DOC and total organic carbon (DOC + POC) concentrations with median errors of +/- 10 and 15 percent, respectively. Loads were computed by multiplying carbon concentrations by measured streamflows.

Roughly 340,000 kg of organic carbon was exported during March 2012 to March 2013. Isotope and fluorescence data indicate that Fanno Creek OM was primarily of terrestrial origin. The export load was consistent with a dominant OM source from riparian litterfall and a minor contribution from bank erosion. Most of the OM in Fanno Creek was dissolved (72 percent) and present year-round at concentrations exceeding 3-4 milligrams carbon per liter. POC typically was mobilized and transported only episodically by higher-flow conditions. The first high flows of the rainy season in autumn produced the highest concentrations of OM, and the resulting load of mobilized and decomposing OM expressed a significant oxygen demand immediately downstream. Continued monitoring of OM characteristics and their rate of export will be useful as watershed managers continue restoration activities, enhance stormwater management, and modify riparian plantings to decrease OM loadings.

Characterization of Water-Quality Gradients in an Urban Midwestern Stream Using a Floating Sensor Platform Developed for Lagrangian Data Collection

Guy Foster, Jennifer Graham and Mandy Stone
US Geological Survey, Lawrence, Kans.

Abstract
Indian Creek, in Johnson County, Kansas, is an urban stream that receives discharge from two wastewater treatment facilities. To more fully characterize nutrient dynamics, fate, and transport, high-resolution water-quality data (including specific conductance, pH, temperature, dissolved oxygen, turbidity, and nitrate) were collected using a Lagrangian sampling strategy. A floating sensor platform equipped with water quality sensors coupled with a global positioning system was deployed from upstream to downstream maintaining equal velocity with streamflow by allowing the unit to travel with the current. The onboard sensors collected data at 30 second intervals to provide high resolution spatiotemporal data. These data were then compiled and integrated using geographic information systems to provide a visual means to assess longitudinal gradients in water-quality data. Data collected using this approach was used to characterize nutrient dynamics, fate, and transport by coupling the data with constituent models developed over two years of recent continuous monitoring on Indian Creek. Understanding the dynamics, fate, and transport of nitrate in Indian Creek will help document the efficacy of wastewater treatment processes and the development of effective nutrient reduction strategies, watershed management plans, and best management practices. Future applications of this approach could include a wide range of water bodies, including both streams and lakes.

The Application and Utility of Continuous Instream Monitoring as Part of a Large River Assessment of the Susquehanna River, Pennsylvania

Dustin Shull and Tony Shaw
Pennsylvania Dept. of Environmental Protection, Harrisburg, Pa.

Abstract
The Pennsylvania Continuous Instream Monitoring (CIM) program was developed and solidified over the past four years in order to better characterize pre-drilling water quality in the Marcellus shale gas region of Pennsylvania. However, the utility of this CIM methodology was recently expanded, due to the decline of what had been a world-class smallmouth bass (SMB) fishery in the Susquehanna River – Pennsylvania's larger river basin. An existing network of fixed station data recorders (sondes) in the large and wide Susquehanna River cannot accurately characterize localized SMB habitat water quality. To meet this challenge, 30 sondes were deployed in several sections and tributaries of the Susquehanna River and other out-of-basin major river systems (to serve as controls). These sondes were intended to characterize the summer critical season where water quality parameters such as temperature, DO, and pH were most likely to exceed Pennsylvania's water quality criteria. The placement and sampling period of these sondes were not intended to give an all-encompassing assessment of the river, but rather to better understanding of these water quality influences on local habitats and from major tributary confluences that create long distance, non-mixing flow channels within the Susquehanna River. This style of sonde deployment allowed for water source tracking when critical water quality conditions were observed. Additionally, the assessment utility of continuous data required a new perspective on the interpretation of water quality criteria. Here we discuss the results, challenges, and lessons learned over two years of this river project.

Session E1: Building Capacity with the National Aquatic Resource Surveys (NARS)

3:30 – 5:00 pm | Room 263

The aquamet Package for R: A Tool for Use with the National Rivers and Streams Assessment

Karen A Blocksom and Thomas M. Kincaid
US Environmental Protection Agency, Corvallis, Oreg.

Abstract
The use of R software in environmental data analysis has become increasingly common because it is very powerful, versatile and available free of charge, with hundreds of contributed add-on packages available that perform almost every conceivable type of analysis or task. The Environmental Protection Agency has developed a new package for R, aquamet, which calculates metrics and indices for indicators used in the 2008-2009 National Rivers and Streams Assessment (NRSA). The package uses raw data collected using NRSA methods for physical habitat, fish, and macroinvertebrates to calculate a variety of metrics. For fish and macroinvertebrates, the user can also calculate multimetric indices for fish and macroinvertebrates, as well as assign condition based on these indices. This presentation will provide an overview of the package functionality, with details on the types of data required and options available. A secondary goal is to identify R users who may be interested in testing the package and providing feedback on ease of use and compatibility of outputs provided with user needs. This is an abstract and does not necessarily reflect EPA policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Implementation of Oklahoma's Statewide Probabilistic Survey Design for Surface Waters: Considerations, Implications, and Results

Monty Porter and Julie Chambers
Oklahoma Water Resources Board, Oklahoma City, Okla.

Abstract
Since 2004, Oklahoma has worked to build a comprehensive, statewide probabilistic survey for surface waters, including lakes, rivers, and streams. Since initially participating in the 2004 Wadeable Streams Assessment, the state has been through several design iterations for flowing waters, including a 3-year REMAP study from 2005-2007, the 2008-2009 National Rivers and Streams Assessment, and a third study from 2010-2011. Moreover, Oklahoma participated in the inaugural National Lakes Assessment (NLA) in 2007, and has since implemented a 5-year statewide study in lakes that incorporated the 2011 NLA. An evaluation of both design and outcomes has occurred from study to study to ensure adaptive program maturity that considers short and long-term questions, for both ecology and water quality management. Specifically, designs have attempted to properly account for ecological diversity, disparate size classes, historical continuity, appropriate indicators, indicator development, and broader availability of results. Oklahoma has 12 distinct level III Omernik ecoregions supporting everything from warm water prairie streams and shallow, municipal lakes to cool water Ozarkian streams and large, deep dendritic reservoirs, as well several major river systems, including the Red and Arkansas Rivers. Additionally, much consideration has been given to survey designs that complement well developed long-standing trend monitoring programs for all three waterbody types. Results from the surveys have included traditional extent estimates for Clean Water Act 305(b) reporting requirements, but have also utilized relative and attributable risk to pose questions for water quality management scenarios, stressor-indicator relationships, and development/improvement of biological indices for biological indicators.

Assessing the Ecologic Condition of Wetlands at National and Regional Scales: Results from the National Wetland Condition Assessment

Gregg Serenbetz
US Environmental Protection Agency, Washington, D.C.

Abstract
The ecologic condition of wetland resources across the conterminous United States is poorly understood. To address the issue, the U.S. Environmental Protection Agency (USEPA), in collaboration with states, tribes, and other federal partners, conducted the first-ever National Wetland Condition Assessment (NWCA). The fifth in a series of National Aquatic Resources Surveys by USEPA to improve understanding of the quality of the Nation's waters, the NWCA identified and developed indicators of ecologic condition and evaluated these in relation to measures of stress, disturbance, and reference condition. Understanding these relationships facilitates identification of potential causes of decline in, or threats to, ecologic condition. The results of the national assessment will be valuable in informing decision-making regarding the use, management, and protection of wetland resources.

Session E2: Successful Collaborative Monitoring Approaches

3:30 – 5:00 pm | Room 262

Rural Action Watershed Restoration Program: Partnering to Improve the Future

Nathan Schlater
Rural Action, The Plains, Oh.

Abstract
Rural Action has been working to restore Appalachian Ohio's watersheds for over 15 years. Primarily working to restore streams that have been impacted by our regions vast history of coal mining, Rural Action and many partners have improved water quality for local communities allowing fish and insects to return to streams where they could not live before because of pollution.

The Rural Action Watershed Restoration Program is committed to restoring and preserving water quality through collaboration, community engagement, conservation, and education in pursuit of a healthy ecosystem capable of supporting people and nature. Currently, four watersheds are being restored: Monday Creek, Sunday Creek, Huff Run and Mud Run. These watersheds are located in six Ohio counties: Athens, Hocking, Perry, Morgan, Tuscarawas and Carroll.

Collaboration with local residents, history groups, universities and state and federal agencies has led to the installation of twenty-six treatment systems, over 110 subsidence hole closures and 55 acres of gob piles reclaimed throughout the four watersheds. Over 23 million dollars has been leveraged by the Rural Action Watershed Restoration Program to improve watershed health and provide educational opportunities within the watershed communities.

Water quality monitoring is necessary to determine impacts on the watersheds as a result of the restoration efforts and to plan for the installation of treatment systems and reclamation projects in the future. Numerous chemical and biological samples are collected annually. These samples are collected through a partnership between Rural Action Watershed Restoration Program, Ohio Department of Natural Resources (ODNR), Ohio Environmental Protection Agency (OEPA), Ohio University and volunteers. The samples are collected and analyzed by Rural Action, ODNR and OEPA. The monitoring results are housed in a public database (watersheddata.com) that is managed by Ohio University Voinovich School of Leadership and Public Affairs.

More than 20 partners are involved with the Rural Action Watershed Restoration Program. This partnership has resulted in: 26 native species of fish now living in Monday Creek, a stream that was once considered dead; prevention of more than 455 tons of acid from entering our streams annually; improvement of 72 stream miles within the four Rural Action Watersheds.

The Role of Collaborations in Volunteer Monitoring for Shale Gas Impacts

Kathryn Tomsho
Dickinson College/Alliance for Aquatic Resource Monitoring, Carlisle, Pa.

Abstract
In 2010, the Alliance for Aquatic Resource Monitoring (ALLARM) developed a volunteer based protocol with the goal of monitoring streams and their watersheds for early detection of the impacts from Marcellus and Utica Shale gas extraction in Pennsylvania. To date, ALLARM has conducted 55 workshops – training over 1,100 individuals, which has resulted in a network of over 500 volunteer monitors spread throughout Pennsylvania, New York, and West Virginia.

The success of this program is rooted in collaboration. The shale gas monitoring program has matured over the past three years through unique collaborations among diverse parties, including county conservation districts, service providers, governmental agencies, and nonprofit entities. With an issue as complex and geographically expansive as shale gas extraction, no one organization can do it all. ALLARM works with a variety of players to coordinate pollution event response, data management, and dissemination of information.

Attendees will learn about the volunteer shale gas monitoring program, and the integral role that collaboration has played in its success. Stories will be shared about the coordinated efforts that have helped bolster and maintain the success of this program.

Butler County Stream Team: A Unique and Effective Partnership

Donna McCollum[1], Lynn White[2], Robert Lentz[3], Alex Del Valle[1] and Kevin Zacharyasz[1]
[1]Miami University, Oxford, Oh., [2]Butler County Storm Water District, Hamilton, Oh., [3]Butler Soil and Water Conservation District, Hamilton, Oh.

Abstract
The Butler County Stream Team, in Butler County, Ohio, was founded in May of 2006 as a partnership of Butler County Storm Water District, Butler Soil and Water Conservation District, and the Institute for the Environment and Sustainability at Miami University (IES). It is a vibrant and evolving effort, currently involving 40+ community volunteers each month in sampling or analyzing county stream samples. Growth of the program has been relatively steady, rising from ~25 samples/month to ~140. The Stream Team was initiated as an effort to meet NPDES permit minimum control measures of 1) public education and outreach and 2) public participation/involvement in a meaningful way by combining the strengths of three organizations interested in clean streams. Each organization gives to and gets from the program according to its abilities and needs. Among other things, the IES provides a laboratory for monthly use and gains opportunities for research and training its environmental science graduate students. Butler Storm Water provides consumable supplies and incentives for volunteers while meeting its NPDES permitting goals. Butler Soil and Water provides public outreach and the Stream Team's website and gains opportunities for community residents to participate and learn about steams and their issues. Volunteers are helping to provide a database of fairly reliable information about the state of Butler County Streams that could be helpful in regulatory or restoration actions, while learning about and becoming advocates for individual behaviors that can help protect their local streams. This report will outline the progress of the Stream Team and the challenges it has faced in making this volunteer water monitoring partnership work.

Incorporating Citizen Volunteer Monitoring into Regional Water Quality Management

Thomas Herron[1] and Janet Conlin[2]
[1]Idaho Dept. of Environmental Quality, Coeur d'Alene, Id., [2]Idaho Farm Bureau, Sandpoint, Id.

Abstract
With the increased importance of Quality Assurance Program Planning, what are the challenges of continued use of volunteer monitoring, and how can this monitoring be facilitated to provide relevant data while continuing to meet quality assurance needs, and support interstate legal and environmental needs. An important aspect of Citizen's Voluntary Monitoring is to gain public awareness and involvement to preserve water quality and to guide water quality decisions involving implementation, restoration, effectiveness monitoring, and long term trend detection. In the face of declining budgets for monitoring and project implementation, how does the Department of Environmental Quality maintain the basic flow of data to characterize rivers, streams, and lakes and identify needed investigations to protect and assess water quality? Partnerships with citizen's groups including Lake Associations, Conservation Groups, Land Management Agencies, Soil Conservation Commissions, Idaho Farm Bureau, Municipal Dischargers, University of Idaho, Watershed Advisory Groups, and local government provide critical monitoring and communication pathways to stimulate awareness of water quality conditions and innovative solutions to water quality challenges. In managing Idaho's highest density and volume of high quality waters, the waters of Northern Idaho, it has become essential to prioritize monitoring resources to meet the need for basic trend identification to augment TMDL development and watershed characterization as well as water body assessments. Data is used to characterize directed monitoring needed to develop load allocations, provide water quality certification parameters and NPDES permit conditions. Also to assess effectiveness of implementation efforts on waters that were not previously supporting beneficial uses.

Session E3: Continuous Monitoring: Innovations in Applications and Instrumentation, Part 2

3:30 – 5:00 pm | Room 261

Results from a National Monitoring Network Lake Michigan Pilot Study: Integrated Surveys of Water Quality and Hydrodynamics in Two Rivermouth Mixing Zones Using an Autonomous Underwater Vehicle

Ryan Jackson[1] and Paul Reneau[2]
[1]US Geological Survey, Urbana, Ill., [2]US Geological Survey, Middleton, Wis.

Abstract
In response to a call for rivermouth research that includes study domains that envelop both the fluvial and lacustrine boundaries of the rivermouth mixing zone, the U.S. Geological Survey in cooperation with the National Monitoring Network for U.S. Coastal Waters and Tributaries launched a pilot project in 2010 to determine the value of integrated synoptic surveys of rivermouths using autonomous vehicle technology. Such surveys can allow researchers collecting continuous point samples at disparate locations to interpret their data and provides modelers with valuable dataset for model calibration and validation.

The pilot project was implemented at two Lake Michigan rivermouths with largely different scales, hydrodynamics, and settings, but employing primarily the same survey methods. The Milwaukee River estuary Area of Concern (AOC) survey included measurements in the lower 2 to 3 miles of the Milwaukee, the Menomonee, and the Kinnickinnick Rivers and inner and outer Milwaukee Harbor. This estuary is situated in downtown Milwaukee, Wisconsin, and is the most populated basin that flows directly into Lake Michigan. In contrast, the Manitowoc rivermouth has a relatively small harbor separating the rivermouth from Lake Michigan and the Manitowoc River watershed is primarily agricultural.

This pilot study using an autonomous underwater vehicle (AUV) paired with a manned survey boat resulted in high spatial and temporal resolution datasets of basic water-quality parameter distributions and hydrodynamics. The AUV performed well in these environments and was found primarily well-suited for harbor and nearshore surveys of three-dimensional water-quality distributions. Both case studies found that use of a manned boat equipped with an ADCP and multiparameter sonde (and optionally a flow-through water-quality sampling system) was the best option for riverine surveys.

Overall, this pilot study was successful and the methods employed in this pilot study should be transferrable to other sites with similar success. The integrated datasets resulting from the AUV and manned survey boat are of high value and present a picture of the mixing and hydrodynamics of these highly dynamic,

highly variable rivermouth mixing zones from the relatively well-mixed fluvial environment though the rivermouth to the stratified lacustrine receiving body of Lake Michigan.

Use of High Frequency Water Quality Data to Scale Ecological Processes in Estuaries

Michael Murrell[1], John Lehrter[1], James Hagy[1] and Chengfeng Le[2]
[1]US Environmental Protection Agency, Gulf Breeze, Fla., [2]ORISE Research Participation Program, Gulf Breeze, Fla.

Abstract
Advances in *in situ* instrument technology have increased the feasibility of collecting water quality time series data in aquatic systems. The data derived from such instrument deployments can serve a role in monitoring temporal changes in aquatic systems. However, such datasets are typically available at a few fixed sites in any given ecosystem, thus limiting the ability to make inferences at larger spatial scales relevant to resource managers. A means of expanding both the spatial and temporal scales is to combine fixed site monitoring datasets with satellite remote sensing data products. A further challenge is to derive ecosystem rates from these data sources, because such information is critical for understanding mechanisms of water quality impairment and, thus, informing resource management decisions. Thus, our overarching goal is to develop tools and models that translate water quality monitoring datasets from in situ sensors, satellite remote sensing, and ecosystem simulation models into integrated measures of ecosystem function or condition. In this study, we developed integrated ecosystem measures (gross production, respiration, and net ecosystem metabolism) in the Pensacola Bay estuary, using a combination of instrument deployments and plankton metabolism experiments. The instruments measured temperature, salinity, dissolved oxygen (DO), depth, chlorophyll fluorescence and CDOM fluorescence, and PAR at 2 depths per site to characterize water column light attenuation. Estimates of ecosystem production and respiration derived from the high frequency DO data using the open water method will be empirically related to other water quality measures to explore the possibility of "scaling up" using measurements from satellite remote sensing and other sources of water quality information, including coupled hydrodynamic-water quality simulation models.

Relations between Continuous Real-Time and Discrete Water-Quality Constituents in the Little Arkansas River, South-Central Kansas, 1995–2011

Patrick Rasmussen and Andrew Zeigler
US Geological Survey, Lawrence, Kans.

Abstract
Water from the Little Arkansas River is used as source water for artificial recharge of the Equus Beds aquifer. The U.S. Geological Survey has operated two continuous real-time water-quality monitoring station since 1995 on the Little Arkansas River. Continuously measured water-quality physical properties include streamflow, specific conductance, pH, water temperature, dissolved oxygen, and turbidity. Discrete water-quality samples were collected during 1995 through 2011 and analyzed for sediment, nutrients, bacteria, atrazine, and other water-quality constituents. Regression models were developed to establish relations between discretely sampled constituent concentrations and continuously measured physical properties to compute concentrations of those constituents of interest that are not easily measured in real time because of limitations in sensor technology and fiscal constraints.

Site-specific regression models were originally published in 2000 and were updated in 2003. This report updates those models using discrete and continuous data collected during January 1995 through December 2011. This report documents the regression models. The real-time computations of water-quality concentrations and loads are available at http://nrtwq.usgs.gov. The water-quality information in this report is important to the city of Wichita because it allows for real-time quantification and characterization of chemicals of concern (including chloride), nutrients, sediment, bacteria, and atrazine transported in the Little Arkansas River. The water-quality information aids in the decision-making of water treatment before artificial recharge.

Sound Science: Sediment Monitoring Using Acoustic Surrogates in the U.S. Geological Survey

Mark Landers, Molly Wood and Tim Straub
US Geological Survey, Atlanta, Ga.

Abstract
Acoustics is a compelling technology that can provide surrogate measurements of suspended-sediment concentration with improved spatial and temporal resolution, after calibration to physically sampled concentrations in rivers and streams. The advantages of acoustic metrics as surrogates of suspended-sediment – compared to today's manually intensive techniques that originated in the 1940s – include greater accuracy and information due to high temporal resolution, large sample volumes, potential for simultaneous velocity measurements, and environmental robustness. Acoustic surrogates of sediment also hold great potential because of the near-ubiquitous usage of acoustic instruments for streamflow velocity measurement.

The Sediment Acoustic Leadership Team (SALT) was formed in May 2012 by the U.S. Geological Survey (USGS), Office of Surface Water and the Federal Interagency Sedimentation Project. The purpose of the SALT is to provide a focal point for research, methods development, monitoring, and program development in the field of acoustic surrogate metrics of sediment characteristics. This group is made up of experts engaged in sediment-acoustic studies from the USGS and other Federal Agencies. In addition to the activities of the SALT, many USGS scientists are developing sediment-acoustic monitoring sites and programs. The growing number of sites where suspended sediment is being continuously monitored demonstrates the importance and potential of this technology for high resolution sediment data.

This presentation will describe objectives and progress of the SALT to develop interim guidance and software, to develop a sediment-acoustic monitoring network, and to facilitate real-time availability of sediment data estimated by acoustic surrogates. The presentation also will overview selected USGS case studies where acoustic surrogates have been used to monitor suspended sediment characteristics.

Session E4: Assessing Effects of Climate Change

3:30 – 5:00 pm | Room 237

Regional Vulnerability Assessments to Detect Climate Change Effects in Streams

Britta Bierwagen[1], Anna Hamilton[2], Jen Stamp[3], Jonathan Witt[4], Angelica Murdukhayeva[4] and Margaret Passmore[5]
[1]US Environmental Protection Agency, Washington, D.C., [2]Tetra Tech, Inc., Santa Fe, N.M., [3]Tetra Tech, Inc., Montpelier, Vt., [4]ORISE, Washington, D.C., [5]US Environmental Protection Agency, Wheeling, W.Va.

Abstract
Climate change effects on stream ecosystems will vary throughout the United States, influenced by many factors across spatial and temporal scales. The degree to which climate change impacts a specific aquatic community depends on its exposure and its sensitivity to these changes. The capacity for a community to adapt further modifies this impact, leading to an overall vulnerability. While assessments of vulnerability are conceptually straightforward, quantifying

vulnerability is challenging due to data gaps for both current conditions and future trajectories, as well as the ecological interactions and processes that characterize sensitivity and adaptation. Despite these obstacles, the United States Environmental Protection Agency (US EPA) has been collaborating with states and US EPA regional offices in the northeast, mid-Atlantic and southeast to collect available data in order to assess which ecoregions, watersheds, or other stream classes may be more vulnerable to effects of climate change. We selected three exposure scenarios relevant to stream communities: increasing water temperature, increases in heavy precipitation events, and extended periods of low flow. This presentation discusses current data needs, the methodology used to conduct the assessments, how climate scenarios and environmental variables were selected, expected ecological impacts related to each scenario, and how results are being applied could be expanded to other parts of the US.

Stream Classification in Support of Regional Monitoring to Detect Climate Change Effects

Jonathan Witt[1], Jennifer Stamp[3], Maggie Passmore[2], Anna Hamilton[4] and Britta Bierwagen[1]
[1]US Environmental Protection Agency, Arlington, Va., [2]US Environmental Protection Agency, Wheeling, W.Va., [3]Tetra Tech, Montpelier, Vt., [4]Tetra Tech, Santa Fe, N.M.

Abstract
Climate-related impacts on streams are occurring now and are predicted to increase. Expected impacts include rising temperatures, changes in the timing, intensity, and frequency of precipitation, and extended summer low flows. A number of state biomonitoring programs have expressed an interest in incorporating annual monitoring at minimally disturbed sites to detect temporal, climate driven stream changes and to better distinguish these effects from other stressors. The United States Environmental Protection Agency (US EPA) has been collaborating with states and US EPA regional offices to develop connected regional monitoring networks in the northeast, mid-Atlantic and southeast. To inform the design of these networks, survey data from the National Aquatic Resource Surveys have been used to identify aquatic communities along environmental gradients to create a stream classification that can be applied across the three regions. Here, we describe the classification groups that have been developed for the monitoring networks, methods that were used to identify them, and their expected vulnerability to potential climate scenarios.

Coastal Monitoring Network to Study Effects of Climate Change on Ecosystem Processes

Patricia Cunningham[1], Kimberly Matthews[1], Susan Cohen[2], Michael Piehler[3], Craig Tobias[4] and Norm Christensen[5]
[1]RTI International, Research Triangle Institute, N.C., [2]Marine Corps Base Camp Lejeune, Jacksonville, N.C., [3]University of North Carolina at Chapel Hill, Morehead City, N.C., [4]University of Connecticut, Groton, Conn., [5]Duke University, Durham, N.C.

Abstract
Military installations and other facilities in estuarine/coastal areas are at particular risk from climate change associated with changes in extreme weather (*i.e.*, severe droughts, heavy rainfall events, warming temperatures, and increased storms) and rising sea level compounded by storm surge. Installation managers need to understand the trade-offs between military training sustainability, ecosystem resilience, and other ecosystem service dependencies in a changed climate. The Defense Coastal/Estuarine Research Program (DCERP) was created to conduct basic and applied research on the coastal ecosystems. This 10-year program was initiated in 2007 with the development of a network of monitoring stations across the aquatic/estuarine, coastal marshes, coastal barrier, and terrestrial ecosystems. The first five years of DCERP focused on understanding chemical, biological, and physical processes and stressors regulating these ecosystems of the New River Estuary in North Carolina. The second five years of the program are focusing on how these ecosystem processes including nutrient and carbon cycling may respond to climate change through the use of predictive models and to assess opportunities for management of carbon in these coastal ecosystems.

The DCERP monitoring network includes systematic, time-series observations of drivers to determine the status, trends, and natural variations of measured parameters in these ecosystems. Data and outcomes from research and monitoring efforts feed into modeling and assessment tools which provide the ability to identify synergies and conflicts among carbon management strategies amidst other priorities such as military mission sustainability, natural resource conservation, and water quality management. Collectively, research and monitoring efforts encompass an integrated continuum of ecosystem response to changing climate with respect to carbon storage, ecosystem services, and managed habitat sustainability. Research results and transfer of management-focused, decision-support and predictive modeling tools will form the basis for adaptive management recommendations to managers to sustain these coastal habitats. This presentation will focus on how the monitoring network supports scaling of field measurements for relatively small dimensions to the watershed and climate change scales of the predictive modeling tools.

Rising Air and Stream-Water Temperatures in Chesapeake Bay Region, USA

Karen Rice[1,2] and John Jastram[1]
[1]US Geological Survey, Richmond, Va., [2]University of Virginia, Charlottesville, Va.

Abstract
Trends in monthly mean air temperature (AT) at 85 sites and instantaneous stream-water temperature (WT) at 129 sites for the period 1960-2010 were determined for the mid-Atlantic region of the eastern USA. The study area includes 85% of the Chesapeake Bay watershed; previous work indicates the bay is warming. Statistically significant regional trends with means of 0.019 °C yr-1 for AT and of 0.011 °C yr-1 for WT were detected. Temperature anomalies for two periods, 1961-1985 and 1985-2010, relative to the climate normal period of 1971-2000, indicated that the latter period was statistically significantly warmer than the former period for both mean AT and mean WT. Relations between 190 landscape factors and significant WT trends were examined. Measures of watershed elevation, relief, and slope were inversely correlated with WT trends, suggesting that warming trends are damped in higher-elevation settings. The mean WT trend for watersheds with southeastern aspects was three times greater than the trend for those without such aspects; the increasing WT trends for both groups were statistically significant, suggesting that both solar radiation and AT contribute to warming streams in the region. Inverse correlations were found for measures of developed land cover, including population density, suggesting that urbanization is not a strong driver of stream warming. Continued warming of Chesapeake Bay and its contributing streams will likely lead to changes in water quality and will result in shifts in the distributions of aquatic biota.

Session E5: Nutrient Monitoring and Modeling to Restore and Protect Freshwaters

3:30 – 5:00 pm | Room 233

Total Phosphorus Mass Balance Modeling in the Lower Boise River, Southwestern, Idaho

Alexandra Etheridge
US Geological Survey, Boise, Id.

Abstract
The U.S. Geological Survey (USGS), in cooperation with Idaho Department of Environmental Quality, developed two mass-balance models for total phosphorus (TP) in the lower Boise River. The models will inform the development of a TP total maximum daily load (TMDL) for the lower Boise River. USGS collected water samples and measured streamflow at 25 main-stem, tributary, and irrigation return sites during 3 synoptic sampling events. The City of Boise coordinated sample collection from effluent at 6 wastewater treatment facilities (WWTFs) and the Idaho Department of Water Resources provided discharge information for diversions. The timing of synoptic sampling events allowed the USGS to evaluate TP loading in the Boise River during irrigation season, shortly after irrigation season ended, and shortly before the subsequent irrigation season began.

Effluent from municipal WWTFs represented the largest source of phosphorus in the watershed during each sampling event. However, it is unknown how much phosphorus from point sources is diverted from the river in irrigation supply water and subsequently returned to the Boise River through drains, tributaries, or shallow groundwater. During irrigation season in August, substantial groundwater discharge to the Boise River was measured in the downstream end of the study reach, and phosphorus loading from groundwater represented 57 percent of the measured load in the river near the mouth. Sensitivity analyses indicated that phosphorus reductions from both point and non-point sources are necessary to meet the TMDL during the compliance period (May 1 to September 30). During the non-irrigation season in late October and early March, shallow groundwater discharge to tributaries and drains comprised the majority of groundwater gains in the Boise River, and represented 31 and 15 percent of the load in the river near the mouth, respectively. Although mass balance models do not account for biological or depositional processes both the October and the March models indicated that phosphorus cycling through aquatic plants and/or bed sediment may influence phosphorus loading in the Boise River. Sensitivity analyses of the October and March models show that point-source reductions will have a greater effect on lowering phosphorus concentrations in the river during the non-irrigation season.

Continuous Nitrate Measurements in an Urban Stream Affected by Wastewater

Jennifer Graham and Mandy Stone
US Geological Survey, Lawrence, Kans.

Abstract
Indian Creek, in Johnson County, Kansas, is an urban stream that receives discharge from two wastewater treatment facilities. As part of a larger study to assess the effects of wastewater discharge and treatment facility upgrades on the environmental and biological conditions of Indian Creek, nitrate was monitored continuously (every 15 minutes) using a *in situ* UV photometer from March 2012 to June 2013 at six sites along a 13.2 kilometer reach of the creek. The relation between sensor and laboratory-measured nitrate concentrations was linear over a range of streamflow and environmental conditions (R^2=0.97, n=132), but sensor-measured concentrations generally were about 15% higher than laboratory-measured concentrations. The difference between sensor and laboratory-measured concentrations was not consistently related to other measured variables such as streamflow, temperature, specific conductance, turbidity, and dissolved organic carbon. The nitrate sensors in Indian Creek provide a reliable estimate of concentrations in the stream at a much greater frequency than discretely-collected data and with less error than surrogate models previously used to estimate continuous concentrations at one of the Indian Creek study sites (R^2=0.79). Continuous nitrate measurements can be used to quantify among-site differences, diurnal and seasonal variability, and loads from point and non-point sources and be related to in-stream processes such as primary production and respiration. Understanding the dynamics, fate, and transport of nitrate in Indian Creek will help document the efficacy of wastewater treatment processes and the development of effective nutrient reduction strategies, watershed management plans, and best management practices.

Identifying Nutrient Reference Sites in Nutrient-Enriched Regions: Using Algal, Invertebrate, and Fish-Community Measures to Identify Stressor-Breakpoint Thresholds in Indiana Rivers and Streams, 2005–9

Shivi Selvaratnam[1], Jeffrey Frey[2], Robert Miltner[3], Aubrey Bunch[2] and Megan Shoda[2]
[1]Indiana Dept. of Environmental Management, Indianapolis, Ind., [2]US Geological Survey, Indianapolis, Ind., [3]Ohio Environmental Protection Agency, Groveport, Oh.

Abstract
In this study, nutrients, periphyton chlorophyll *a* (Chl-*a*), invertebrate- and fish-community data collected during 2005-9 were analyzed from 318 sites on Indiana rivers and streams. Study objective was to determine which invertebrate and fish taxa attributes best reflect the conditions of Indiana streams along a gradient of nutrient concentrations by (1) determining statistically and ecologically significant relations among the stressor (TN, TP and Chl-*a*) and response (invertebrate and fish community) variables; and (2) determining the levels at which invertebrate- and fish-community measures change in response to stressor variables.

Recursive partitioning identified statistically significant low and high breakpoint thresholds for invertebrate and fish measures. Combined community mean low and high TN breakpoint thresholds were 1.03 and 2.61 mg/L, respectively. Mean low and high breakpoint thresholds for TP were 0.083 and 0.144 mg/L, respectively. Mean low and high breakpoint thresholds for periphyton Chl-*a* were 20.9 and 98.6 (mg/m^2), respectively. Additive quantile regression analysis found similar thresholds to those determined by breakpoint analysis for some stressor variables.

TN and TP concentrations in the study showed a nutrient gradient that spanned three orders of magnitude. Sites were divided into Low, Medium, and High nutrient groups based on the 10th and 75th percentiles. Using an analysis of similarity, invertebrate and fish communities were similar along the nutrient gradient, demonstrating there was not a species trophic gradient. Within all nutrient groups, invertebrate and fish communities were dominated by nutrient tolerant taxa.

To determine if low nutrient concentrations at some sites were caused by algal uptake and not oligotrophic conditions, sites with low nutrient concentrations (< 10th percentile for TN or TP) were examined based on the Low (< to 10th percentile) and High (> 75th percentile) periphyton Chl-*a* concentrations. Within low nutrient sites, invertebrate and fish communities were statistically different between Low and High periphyton Chl-*a* categories. High periphyton Chl-*a* group was dominated by tolerant herbivore and omnivore taxa indicating that low nutrient concentrations are a result of nutrient uptake and increased algal growth. The study highlights the importance of assessing multiple lines of evidence when attempting to identify the trophic condition of a site.

Publicly Accessible Decision Support System of the SPAtially Referenced Regressions on Watershed Attributes (SPARROW) Model and Model Enhancements in South Carolina

Celeste Journey[1], Anne Hoos[2], David Ladd[2], John Brakebill[3] and Richard Smith[4]
[1]US Geological Survey, Columbia, S.C., [2]US Geological Survey, Nashville, Tenn., [3]US Geological Survey, Baltimore, Md., [4]US Geological Survey, Reston, Va.

Abstract
The U.S. Geological Survey (USGS) National Water Quality Assessment program has developed a web-based decision support system (DSS) to provide free public access to the steady-state SPAtially Referenced Regressions On Watershed attributes (SPARROW) model simulation results on nutrient conditions in streams and rivers and to offer scenario testing capabilities for research and water-quality planning. Access to the decision support system is through a graphical user interface available online at http://cida.usgs.gov/sparrow. Nationally, the SPARROW DSS models are based on the modified digital versions of the 1:500,000-scale River Reach File and 1:100,000-scale National Hydrography Dataset stream networks.

For South Carolina, the DSS has total nitrogen and total phosphorus models for the South Atlantic-Gulf and Tennessee Region based on the Enhanced River Reach File 2.0. The system can be used to estimate nutrient conditions in unmonitored streams in South Carolina and to produce estimates of yield, flow-weighted concentration, or load of nutrients in water under various land-use conditions, changes, or resource management scenarios. This model divides larger river basins into stream catchments and models nutrient contributions by source inputs and land use within each of those catchments. The model information, reported by stream reach and catchment, provides contrasting views of the spatial patterns of nutrient source contributions, including those from urban (wastewater effluent and diffuse runoff from developed land), agricultural (farm fertilizers and animal manure), and specific background sources (atmospheric nitrogen deposition, soil phosphorus, forest nitrogen fixation, and channel erosion). However, the large scale and static nature of the model (modeled only for the 2002 water year) have produced some limitations on the application of the decision support system on the state level.

To address those limitations, the USGS is working cooperatively with the Resources for the Future program to adapt the steady-state model for South Carolina to a dynamic model that will simulate seasonal-average loads, yields, and concentrations during the period 2001-2003. Temperature and an Enhanced Vegetation Index from Moderate Resolution Imaging Spectroradiometer (MODIS), a National Aeronautics and Space Administration Terra-satellite-borne sensor, will be used as input to the dynamic model to characterize seasonal uptake and release of nitrogen during land-to-water transport.

Session E6: Monitoring the Benefits of Green Infrastructure on Water Quality

3:30 – 5:00 pm | Room 232

Evaluation of Soil Media, Vegetative Diversity, and Projected Precipitation Effects on Bioretention Performance and Emission of Greenhouse Gases

Amanda Cording, Stephanie Hurley and Carol Adair
University of Vermont, Burlington, Vt.

Abstract
Inflow and outflow water quality (nitrate, phosphate, total nitrogen, total phosphorus, total suspended solids), volumetric flow rate, soil moisture, temperature, conductivity and greenhouse gas emissions (nitrous oxide and methane) were monitored in eight newly constructed bioretention systems at the University of Vermont Bioretention Laboratory. Three treatments were employed to evaluate the response of the bioretention cells 1) under current ambient precipitation patterns compared with simulated climate change driven enhanced rainfall events in the Lake Champlain Basin by mid-late century 2) with two vegetative pallets, one being low in diversity having two salt tolerant species compared with high diversity pallet having seven species 3) with traditional soil media of gravel, pea stone, sand and compost compared with the traditional mix with the addition of a proprietary media called SorbtiveMedia from Imbrium Solutions, Inc. The water quality and volumetric flow rate were measured using an ISCO Model 6712, Teledyne Company automated water sampler equipped with a 720 pressure transducer, clipped into a customized 90° v-notch weir box and an in-pipe Thel-Mar weir four feet underground at the inflow and outflow respectively. The outflow probe was accessible via a water tight sump surrounding a t-pipe. Discrete water samples were taken every 2 minutes for 24 minutes to focus on the first flush of pollutant being mobilized during a storm event.

Greenhouse gas fluxes (N_2O, and CH_4) from soils were measured bi-weekly from October – December. These fluxes were measured in three locations per cell using the vented closed chamber method (Hutchinson and Mosier 1981), where gas concentration within the chamber is measured by withdrawing samples from the chamber by syringe at 3-4 time periods and analyzing gas concentrations by gas chromatography (Shimadzu GC-17A equipped with a Flame Ionization Detector for quantifying CH_4 and with an Electron Capture Detector for quantifying N_2O). Inorganic soil N was measured concurrently, as a covariate for N_2O fluxes.

Multimetric Evaluation of Detention Basin Retrofit to Reduce Hydrologic Alteration of Urbanization and Restore Stream Stability

Robert Hawley[1], James Goodrich[2], Jake Beaulieu[2], Katherine MacMannis[1], Matthew Wooten[3], Craig Frye[3], Elizabeth Fet[3] and Mark Jacobs[4]
[1]Sustainable Streams, LLC, Louisville, Ky., [2]US Environmental Protection Agency, Cincinnati, Oh., [3]SD1 of Northern Kentucky, Fort Wright, Ky., [4]Boone County Conservation District, Burlington, Ky.

Abstract
Conventional stormwater detention basins are ubiquitous in the developed portions of U.S., particularly those areas developed since the 1980s. Because most detention basins were designed exclusively for flood control, they are not being utilized to their fullest potential and do not include measures to mitigate erosive flows from small, but frequent storm events, that are often amplified by urbanization. These underutilized detention basins present a retrofit opportunity to mitigate the erosive energy of small and intermediate storm events without adversely impacting flood control capacity.

The purpose of this research was to develop a cost-effective detention basin retrofit device that provides for a more controlled release of storm flows, ultimately mimicking a more natural flow regime. The benefits of this approach can include stream channel protection and water quality improvements (*e.g.*, TSS reductions), as well as stabilization of aquatic habitat in receiving channels. The device is designed to throttle stormwater flow, temporarily detain it, and gradually discharge it to the downstream channel at a more appropriate rate for the receiving stream. To monitor the effectiveness of the retrofit, the project measured an array of multidimensional parameters including:

1) time series rainfall data
2) time series flow data in the detention basin and receiving streams
3) hydrogeomorphic surveys in receiving streams pre- and post- retrofit installation
4) water quality grab samples

Preliminary modeling suggests that detention basin residence times will double during the typical year, and that the cumulative duration of flows that cause bed material disturbance in the receiving stream will be reduced by 50% relative to existing conditions. The simple retrofit technology is projected to fully restore the pre-developed disturbance regime, which should improve downstream channel stability and have cascading benefits for water quality, habitat, and ecosystem function.

This project is a collaborative partnership between multiple government agencies (Federal, regional, and local) and private businesses. Monitoring costs were contained by capitalizing on existing data collection efforts by project partners focused on documenting the impacts of urbanization on stream condition, as well as evaluating the performance of green infrastructure and other stormwater BMPs at improving stream health.

Application of Automatic Stormwater Monitoring Systems for Integrated Management of Urban Streams in Daejoen, Korea

Dongil Seo[1], Yanghee Han[1], Dongeun Lee[1] and Eunhyung Lee[2]
[1]Chungnam National University, Daejeon, Republic of Korea, [2]M-Cubic, Inc., Daejeon, Republic of Korea

Abstract
An automatic monitoring station was developed for an urban stream to collect information on flow rate and water quality changes during storm events. Major objective of this study is to provide accurate information for urban watershed model (SWMM) calibration for the purpose of development of integrated urban river management plan. Rainfall gauge, water quality sensors, automatic water sampler and ultra-sonic water level meter were used to provide data on real time basis. The system was installed at the Donghwa Bridge in Gwanpyung Stream in Daejeon Korea that can be considered as the border between developed downstream areas and underdeveloped upstream area of the basin. Flow rates were estimated using water depth measured by ultra sound level meter attached to the bridge along with weir equation. Measured flow rate were verified with field measurements. While water quality sensors can provide real time data, automatic water sampler was used for laboratory analyses for more accurate measurements. The sampler can be programmed to start by using signal from rain gage, ultra sound water meter or manually from remote control. SWMM urban watershed model was applied and calibrated for single and continuous events. While flow modeling showed relatively good agreement for all events, water quality modeling results showed less accurate agreements. This suggests that pollutant build up and washoff effects of the study site need be investigated further. It is expected that his study can be used effectively to evaluate LID (Low Impact Developemnt) or GIS (Green Infra Structure) for sustainable management of basins and urban streams.

Tracking the Recovery of Onondaga Lake, NY: Monitoring the Effect of Gray and Green Infrastructure Improvements in Achieving Phosphorus TMDL Numerical Water Quality Targets

Janaki Suryadevara[1], Jeanne Powers[1], Elizabeth Moran[2] and David Matthews[3]
[1]Onondaga County Dept. of Water Environment Protection, Syracuse, N.Y., [2]EcoLogic LLC, Cazenovia N.Y., [3]Upstate Freshwater Institute, Syracuse, N.Y.

Abstract
Onondaga Lake NY is a small urban lake with a long history of municipal and industrial pollution; since 1998, the lake has been at the top of state and federal priority lists of impaired waters due to nutrient enrichment, habitat degradation, and mercury contamination. Major investments in wastewater collection and treatment (gray infrastructure), coupled with an innovative focus on managing storm water (green infrastructure) and remediation of legacy industrial contamination, have brought about a remarkable recovery of the lake ecosystem. A suite of metrics were developed to help turn monitoring data into information that can support management decisions.

In 1998, New York State Department of Environmental Conservation (NYSDEC) promulgated a Phase I Phosphorus TMDL (Total Maximum Daily Load) for Onondaga Lake focusing primarily on load reductions from the Metropolitan Syracuse Wastewater Treatment Plant (Metro). An Amended Consent Judgment (ACJ), also issued in 1998, allowed NYSDEC to revise the phosphorus TMDL for Onondaga Lake based on monitoring and modeling. In 2012, EPA approved the final phosphorus TMDL for Onondaga Lake. The final allocation incorporates the use of Green Infrastructure (GI), in combination with other strategies, to meet water quality targets and assure that future growth does not increase nonpoint phosphorus loads to Onondaga Lake. The use of GI is a central component of reducing the inflow of untreated combined sewage into Onondaga Lake and its tributaries. To meet this new goal, the County initiated the "Save the Rain" program, designed to reduce stormwater inflows to the combined sewer system through a combination of gray infrastructure (such as storage) and multiple GI approaches distributed across the urban landscape of Syracuse.

This presentation highlights the monitoring program underway and the collaboration among the public sector, private engineering firms, and university and research institutions. With these efforts Onondaga County has developed effective ways to monitor and report progress toward ecosystem recovery.

Session E7: Century Scale Trends in Water Quality

3:30 – 5:00 pm | Room 231

The Perennial Value of Water-Quality Data for Long-Term Trend Analysis

Donna Myers
US Geological Survey, Reston, Va.

Abstract
Recent publications have demonstrated the irreplaceable value of historical water-quality data when united with contemporary data for century-scale trend analyses. Often, historical data are discounted for trend analysis for two reasons; data availability and perceived shortcomings in quality compared to modern standards. These challenges limit our ability to detect long-term trends. To address the availability and original quality of historical data for trend analysis, a review was made to summarize through 1965 the major data sources, purposes of collection, analyses provided, and quality relative to widely accepted standardized methods used today. Historically, the two most common purposes for water-quality monitoring were to address issues related

to sanitation or to address water availability and water quality. Constituents measured at part per million levels-such as inorganic ions, nitrate, suspended and dissolved solids, dissolved oxygen (DO), biochemical oxygen demand (BOD), and colonies of indicator bacteria per milliliter, when produced by "standardized methods"-were found to be of sufficient quality to meet the historical purposes for their collection. For example, the use of chemical and microbiological data to document water pollution and pollution sources for "sanitary surveys" led to improved drinking water quality and by 1920 a precipitous decline in typhoid fever. High-quality DO, BOD, indicator bacteria, and hydrologic data collected for stream surveys and models of natural stream purification were valuable in documenting the assimilative capacity of rivers for sewage discharges and by 1948 contributed to passage of the first federal water-pollution control legislation. From the earliest decade through the 20th century, data on water availability and quality collected using standardized and consistent methods provided for the "orderly" development of public and industrial supplies and irrigation. For long-term trend analysis, the challenge of data availability is considerable because most data are preserved only in paper reports or in relatively inaccessible archives and are in danger of deterioration and loss. The challenge of data quality requires an evaluation of the quality of original and contemporary data in order to interpret signal from noise in long-term trends. When properly rescued and recovered, high-quality historical water-quality data have demonstrated their perennial value for century-scale trend analyses.

Acidifying Processes in Watersheds Inferred from Century-scale Changes in Alkalinity and Major Ion Ratios

Edward Stets
US Geological Survey, Boulder, Colo.

Abstract
Weathering of silicate and carbonate rocks proceeds from interactions with acid in the soil environment. Dissolution of these minerals mobilizes soil alkalinity, primarily in the form of bicarbonate, which can be delivered to streams and influence river chemistry. Carbonic acid derived from microbial and root respiration is most commonly responsible for chemical weathering. However, inputs of ammonium-containing fertilizers or acidic deposition can induce weathering by nitric or sulfuric acid. Recent studies suggest that the concentration and flux of alkalinity in U.S. rivers is changing due to acidic inputs to the soil environment. Acidifying processes can be inferred from temporal trends in the ratios of major ions in rivers. In this study we use water quality data collected throughout the 20th century from 22 monitoring stations in the U.S. and examine the development of acidification as agricultural fertilizers and industrial processes became prevalent. Some of the monitoring stations also show recent recovery due to greatly reduced acid precipitation and recovery from the effects of acid mine drainage.

Using a Century of Carbon and Nitrogen Records to Quantify Social-ecological Relationships in Watersheds of the Continental U.S.

Whitney Broussard[1], R. Eugene Turner[2] and Peter Raymond[3]
[1]University of Louisiana at Lafayette, Lafayette, La., [2]Louisiana State University, Baton Rouge, La., [3]Yale University, New Haven, Conn.

Abstract
Centennial trends in riverine carbon and nitrogen are being increasingly demonstrated through the recovery and use of early 20th Century water chemistry records coupled with socio-economic records of the same era. Two studies will be presented here that compare nitrate, bicarbonate, and land use records in the beginning and end of the 1900s to quantify complex social and environmental interactions that determine the spatial and temporal context of nitrogen and carbon export to coastal systems. Nitrate records from Dole and Stabler's national water quality monitoring efforts through the U.S. Geological Survey (1905-1912) were compared with contemporary data retrieved from the USGS National Water Information System. Bicarbonate data for the Mississippi River were collected by the Carrollton and Algiers Water Purification Plants (1902 to present), operated by the Sewage and Water Board of New Orleans, where alkalinity is measured while processing drinking water for the city. Ten of thousands of measurements over 100 years are compiled here and represent some of the most complete high-temporal-resolution, long-term data sets of nitrogen and carbon in major rivers of the Continental U.S. In both studies, Census of Agriculture records were compiled by watershed to demonstrate historical trends in changing land use patterns. Centennial changes in the nitrate and bicarbonate data reveal substantial increases that are clearly anthropogenically driven. Cropland cover is linearly related to the nitrate concentration that exits a watershed at both the beginning and end of the 20th century, and the slope of the relationship is higher at the end of the century. These findings imply that agriculture was already affecting nitrate export by the early 1900s and that intensive management practices in modern agriculture have significantly increased the nitrate export per hectare of cropland. Furthermore, an increase in bicarbonate and water fluxes from the Mississippi River Basin is caused mainly by an increase in discharge from agricultural watersheds that have not been balanced by a rise in precipitation, which is also relevant to nutrient and pesticide fluxes to coastal systems.

Laboratory Analysis Rescue: Preserving Water-Quality Records from the Early 20th Century

Robert Swanson[1] and Robert Baskin[2]
[1]US Geological Survey, Lincoln, Nebr., [2]US Geological Survey, Salt Lake City, Ut.

Abstract
Original water-quality records from many of the earliest national hydrologic surveys of streams, lakes, and groundwaters by the U.S. Geological Survey (USGS) in the first half of the 20th century are susceptible to deterioration and possible loss. These laboratory records, if recovered, digitized, and stored electronically, greatly improve the Nation's ability to robustly document baseline conditions for trend analysis of chemical, physical, fluvial sediment, and biological conditions. When coupled with more recent readily available electronic records, these early records fill a major gap in our understanding of century-scale trends, allow for a more complete synthesis of changes in water quality and their causes and could enhance the understanding of water-resources changes related to climate, land use, and energy development.

During the period 1918-73, the former Water Resources Division of USGS operated 22 District-based water-quality laboratories throughout the US. Total annual analytical production averaged about 480 "complete analyses" per year during 1919-28, rising to about 7,800 in 1946, and about 50,000 in 1970. These laboratories produced some of the highest quality data of their time. Unfortunately, the metadata, or data that describe the primary data, have become disconnected from the original analyses. Although many of the analyses were entered decades ago into a predecessor of the modern National Water Information System (NWIS), the legacy computerized information system lacked the ability to store metadata that identified the sample provenance and recorded how samples were collected and analyzed.

In June 2013, the USGS began a two-year "Laboratory Records Data Rescue Project" designed to locate, preserve, and digitally archive all available water-quality records from the original District laboratories and reconnect the analytical results to their metadata. Procedures for preserving this legacy of water-quality data are in development and include a thorough records search, digital scans of original paper records, entering water-quality data and associated metadata into NWIS, and linking imagery of the original records to the analyses in NWIS. This project provides an example from which other agencies may gauge the level of effort required to rescue (*i.e.*, recover, convert, and electronically archive) and re-integrate complete historical water quality records for the Nation.

Wednesday, April 30

Session F1: State Applications of Statistical Surveys

8:00 – 9:30 am | Room 263

Lakeshore Habitat Condition of Wisconsin Lakes across Gradients in Land Use and Lake Area: Building on the National Lake Assessment

Catherine Hein, Caitlin Carlson, Paul Garrison and Timothy Asplund
Wisconsin Dept. of Natural Resources, Madison, Wis.

Abstract
Nearshore lake habitat degradation has resulted in lower species diversity and altered species composition of macrophytes, macroinvertebrates, and fish in lakes across the nation. Although the biological impacts of habitat loss on lakes have been well-documented, state-level monitoring efforts still focus on trophic status indicators (*e.g.*, Secchi depth, total phosphorus, and chlorophyll). Poor lakeshore habitat can be predicted in part by high levels of agricultural and urban land use in the watershed, but these correlations leave much of the variance in habitat condition unexplained, indicating that lakeshore habitat monitoring is needed to assess local, within-lake habitat. The state of Wisconsin aims to initiate a lakeshore habitat monitoring program to improve its assessment of the state's ~15,000 lakes. As part of the National Lake Assessment, 39 randomly selected lakes were monitored for lakeshore habitat condition in 2007 and 50 additional lakes in 2012. In 2013, the Wisconsin Department of Natural Resources (DNR) monitored 100 randomly selected lakes stratified by lake area and land use within a 100 m buffer of the lakeshore. The goals of the 2013 monitoring efforts were to: 1) expand the assessment of lakeshore habitat condition across Wisconsin, 2) analyze lakeshore habitat condition in terms of lake area and surrounding land use, 3) develop ecoregion-specific lakeshore habitat metrics for Wisconsin, 4) introduce lakeshore habitat assessments to the monitoring programs of both the DNR and Citizen Lake Monitoring, and 5) use lakeshore habitat metrics in addition to trophic status to assess lake health. This paper will summarize the results of the lakeshore habitat monitoring effort across 189 lakes in Wisconsin and will discuss the DNR's efforts to initiate routine lakeshore habitat monitoring.

The Use of Probabilistic and Targeted Least Impacted and Severely Impacted Sites to Assess the Quality of Wisconsin's Wadeable Streams

Michael Shupryt, Brian Weigel, Tim Asplund and Michael Miller
Wisconsin Dept. of Natural Resources, Madison, Wis.

Abstract
The Wisconsin Department of Natural Resources (DNR) has been using a strategy that combines a probabilistic monitoring design combined with a targeted site design to assess the State's wadeable streams. Wisconsin DNR biologists sampled nearly 600 sites using a probabilistic sampling design for water quality, macroinvertebrates, fish and physical habitat condition from 2010 to 2013. Probabilistic sites were stratified by Omernik Level 3 Ecoregion and stream natural community type in order to achieve resource balance. Wisconsin assigns all of the State's wadeable streams to one of ten natural communities based on predicted stream flow and temperature developed to predict fish community assemblages. During the 2010-2013 time frame, biologists also sampled 200 least impacted and 200 severely impacted sites with the same field protocols to act as bookends to the randomly selected sites. We analyzed the nearly 1,000 site dataset to 1) assess the condition of wadeable streams statewide, including the extent and risk of stressors; 2) determine the number of probabilistic sites needed to assess condition; 3) determine the response of macroinvertebrate and fish IBIs to environmental stressors at the local and watershed scale; and 4) derive expectations for each natural community type. Preliminary analyses suggest that approximately 55% of the wadeable streams in Wisconsin are in poor condition for total phosphorus. Biologic assessments of macroinvertebrates and fish assemblages indicate that the majority of streams (~75%) are in fair to excellent condition. We will present findings and discuss implications for Wisconsin's ongoing wadeable stream monitoring and assessment strategy.

Using R to Analyze Data from Probabilistic Monitoring in Oklahoma

Jean Lemmon
Oklahoma Conservation Commission, Oklahoma City, Okla.

Abstract
The Oklahoma Conservation Commission (OCC) manages an extensive monitoring program to determine the extent, nature, and probable sources of nonpoint source pollution. Through its statewide Rotating Basin Program, initiated in 2001, OCC monitors a total of 245 fixed sites at the outlets of most 11 digit watersheds on a staggered, rotational schedule by basin every five years. In 2008, the OCC added a probabilistic component to its monitoring strategy to more fully characterize basin water quality condition and attainment of water quality standards. In this monitoring design, fifty randomly chosen sites each year within a basin are visited once to collect water quality, habitat, and biological data.

Preliminary analyses of the initial rounds of probabilistic monitoring showed very similar overall results to the more intensive fixed site monitoring. The statistical program "R" has been used to more fully examine the probabilistic data. Relative and attributable risk analyses have been completed for three of the five basins, allowing statistically robust determination of the health of streams for more than half of the state. The results of this data exploration will be discussed in this talk.

Evaluation of a Geometric Sampling Design Used to Assess Stream Resources and Identify Environmental Stressors in Watersheds

Michael Miller[1], Lori Tate[1], Ruth Person[1], Chris Yoder[2], Ed Rankin[2] and Bob Miltner[3]
[1]Wisconsin Dept. of Natural Resources, Madison, Wis., [2]Midwest Biodiversity Institute, Columbus, Oh., [3]Ohio Environmental Protection Agency, Groveport, Oh.

Abstract
A goal of the Wisconsin Department of Natural Resources is to refine its stream monitoring strategy to gain sampling efficiencies and generate more robust information. WDNR partnered with USEPA Region 5 and the Midwest Biodiversity Institute, to evaluate the use of a "geometric" watershed sampling design. Two pilot study watersheds, each approximately 220 sq. mi. in size, were sampled at their pour points. Additional upstream sampling sites within each watershed were systematically chosen based on the drainage area of each sampling site. A geometric progression of watersheds sizes was selected: 110 sq. mi., 55 sq. mi., 27 sq. mi. and so-forth until the pour points for the smallest (2 sq. mi.) drainage areas were identified. Physical, chemical, and biological data collected at each sampling site were used to assess stream quality. A battery of statistical tests was then used to investigate which physical and chemical factors were most responsible for biological degradation, and to determine if stressor thresholds resulting in biological decline were evident. Bray-Curtis analyses identified biologically-distinct groups of stream sites based on fish

or invertebrate assemblages. Non-metric multidimensional scaling, canonical correspondence analysis, classification and regression trees, and structural equation modeling were used to identify key physical and chemical factors influencing the integrity of stream biota. Quantile regression analyses helped identify thresholds for pollutant concentrations and physical stressors that resulted in declines in the biological integrity of streams.

Session F2: Bridging the Gap: Diverse Strategies for Better Decision-Making

8:00 – 9:30 am | Room 262

Toward Sustainable Water Information: Are Existing Water Monitoring Data Sufficient to Make Scientifically Sound Water Policy Decisions?

Elin Betanzo[1], Erik Hagen[1], Anne Choquette[2], John Wilson[3], Denise Argue[4] and Kenneth Reckhow[5]

[1]Northeast-Midwest Institute, Washington, D.C., [2]US Geological Survey, Nashville, Tenn., [3]US Geological Survey, Indianapolis, Ind., [4]US Geological Survey, Pembroke, N.H., [5]Duke University, Durham, N.C.

Abstract

Public concern over development issues that could affect water resources, such as hydraulic fracturing, agricultural runoff and urban development raise an important question: is the Northeast-Midwest region's water monitoring system adequate to support decision making? "Toward Sustainable Water Information", a cooperative partnership between the Northeast-Midwest Institute and the United States Geological Survey, is exploring the availability of multi-agency water monitoring data to support decision-making in the Northeast-Midwest region of the United States. The study focuses on stream and groundwater quality, streamflow, and macroinvertebrate monitoring data collected by Federal, state, and local programs, and addresses water issues of interest to policy makers in two case study regions. The case studies will describe the water quality data necessary to inform a specific policy question for each issue, assess whether those data are currently available, and identify any additional data that may be needed to address the policy questions. The first case study looks at nutrient enrichment in the Lake Erie basin (MI, IN, OH, PA, NY), which has resulted in large-scale harmful algal blooms. It is investigating data needed to address the policy question "How effective are Best Management Practices (BMPs) at reducing nutrients from nonpoint sources at the watershed scale?" The second case study looks at shale gas extraction in the Susquehanna River basin (NY, PA, MD), which has raised questions about potential impact on water quality. This case study investigates data needed to address the question "Do shale gas development activities contaminate ground water or surface water?" This objective and science-based analysis will provide insight into the types of data the Northeast-Midwest region as a whole might need and describes the extent to which available data in the network of Federal, state, and local monitoring programs might be collectively used to support decision making. The project ultimately seeks innovative, feasible and science-based monitoring approaches that will support regional policy decisions and safeguard the region's water resources into the future.

Partnering to Establish a Sustainable Biological Monitoring Program

Julie Wood[1], Alan Christian[2] and Christina Ciarfella[2]

[1]Charles River Watershed Association, Weston, Mass., [2]University of Massachusetts Boston, Boston, Mass.

Abstract

Since 1995, the Charles River Watershed Association (CRWA) has successfully employed citizen scientists to collect water quality samples and take field measurements on a monthly basis. This program played an integral part in the successful Charles River cleanup by helping to locate major pollution sources, track restoration efforts, and measure seasonal and weather influences on water quality. In a time of shrinking budgets, it is challenging to find funds simply to maintain this program, let alone expand and sustain it. However, in 2013, CRWA was able to add a low-cost, sustainable biological monitoring component to our existing volunteer program through a successful partnership with the Freshwater Ecology Lab at the University of Massachusetts Boston (UMB). By capitalizing on CRWA's strong network of volunteers, intimate knowledge of the watershed, and deep background in water quality investigation and UMB's technical knowledge and expertise in biological monitoring, our team was able to use minimal resources to establish a program that can successfully be maintained by CRWA.

The CRWA/UMB biological monitoring program uses volunteers to conduct the EPA Rapid Bioassessment habitat sampling methodology and a citizen science [Stream biotic index (SBI)] biomonitoring index to measure water quality of wadeable streams. UMB is analyzing samples according to the State of Massachusetts (MA) biomonitoring index protocol which involves identifying invertebrates below family taxonomic level. UMB will compare the volunteer SBI results with the higher level MA protocol analysis to provide a basis of comparison between the two. This will help CRWA assess the accuracy, usability and comparability of volunteer-collected data. Through this project, our team has also been able to successfully connect with officials at the Massachusetts Department of Environmental Protection to discuss use of volunteer data in state watershed assessments. CRWA and UMB will share their experience in working together, describing the roles each group played and how the strengths and weaknesses of both a small non-profit and a large university can be combined to build a strong and successful partnership. This successful collaboration can serve as a model for many other organizations looking to do more with less.

The Water Quality Framework

Dwane Young[1], Charles Kovatch[1], Shera Reems[1], Wendy Reid[1], Tommy Dewald[1] and Tatyana DiMascio[2]

[1]US Environmental Protection Agency, Washington, D.C., [2]ORISE, Washington, D.C.

Abstract

The Clean Water Act Sections 303(d) and 305(b) require the states to assess and report to EPA every other year on the water quality within the state. As part of these reports, states must also identify waters that are impaired (not meeting water quality standards) and identify which pollutants are causing those impairments. For these waters that are listed as impaired, EPA and the states also develop pollution budgets or Total Maximum Daily Loads (TMDLs). EPA and the states invest a significant amount of resources in meeting these requirements using a combination of paper and electronic submissions. In the most recent ICR for the 303(d)/305(b) program, it is estimated that the state burden alone is $193 million a year.

The Water Quality Framework (Framework) is a new way of thinking about how EPA's water quality data and information systems can be better integrated to more effectively support water quality managers and meet program goals. The Framework will streamline water quality assessment and reporting, eliminate paper reporting and provide a more complete picture of the nation's

water quality by allowing for tighter integration with data at the local, state, and national scale. The Framework will start by focusing on better integrating three systems: 1) EPA's water quality monitoring repository (STORET and the Water Quality Exchange), 2) EPA's Assessment TMDL Tracking and Implementation System (ATTAINS), and 3) EPA's surface water mapping tool (the National Hydrography Dataset Plus -NHDPlus). Following the integration of these systems, further integration is possible with other water programs such as: water quality permits, enforcement and compliance, source water protection, and nonpoint source projects.

EPA has already taken steps to improve this process by developing automated approaches for capturing water quality monitoring data via the Exchange Network and subsequently publishing that data in coordination with the USGS via web services in the Water Quality Data Portal (http://www.waterqualitydata.us/). The next step is to evaluate the assessment process to improve automation and alignment with the program priorities.

Evaluating the Representative, Accuracy and Potential Use of Facility Wastewater Discharge Information for Toxic Chemicals in the Mid-Atlantic Region

Wayne Davis[1], Carey Johnston[2], Eva Knoth[3] and Meghan Camp[3]
[1]US Environmental Protection Agency, Fort Meade, Md., [2]US Environmental Protection Agency, Washington, D.C., [3]Eastern Research Group, Inc., Chantilly, Va.

Abstract
The two major sources of information on US facility discharges of toxic chemicals to surface waters are the Discharge Monitoring Reports (DMR) required under the National Pollutant Discharge Elimination System in the Clean Water Act and the Toxics Release Inventory (TRI) required under the Emergency Planning and Right to Know Act (EPRCA). A pilot study was conducted in the Mid-Atlantic Region of the US to evaluate the precision, accuracy, representativeness, completeness, and potential use of information submitted to the DMR and TRI data systems using an online analytical tool.

The DMR Pollutant Loading Tool allows comparisons of DMR and TRI data, identifying omissions of information under each system for further follow-up, and highlighting pollutant releases to impaired waterbodies as well as the pollutants contributing to waterbody impairment.

This study identified large data quality submission errors, substantial differences in reporting of the same chemicals by the same facilities to the DMR and TRI Programs, potential omission of reporting under the DMR or TRI program, and potential industry sectors reporting large quantities of toxic chemicals in the DMRs that are not currently required to report under TRI. In most cases, toxic pollutant discharges calculated using the DMR data are higher than those in TRI which may indicate an under-reporting in TRI, but may also be due to data quality issues or different reporting requirements.

We identified several uses for this tool including to 1) improve quality of the DMR and TRI data, 2) identify potential compliance and enforcement actions under each program, 3) recommend additional chemicals and industry sectors for the TRI program, 4) provide a voice for stakeholders and citizens to correct data errors, and 5) gain understanding of the sources of point source pollution in US waterways and the relationship with sources and causes of impairment.

Session F3: Continuous Monitoring: Regulatory Applications

8:00 – 9:30 am | Room 261

Adapting Methods of Near Real Time Water-quality Monitoring to Meet Scientific and Regulatory Needs

Michael Canova
US Geological Survey, Austin, Tex.

Abstract
The US Geological Survey (USGS) in cooperation with the Texas Commission on Environmental Quality (TCEQ) continuously monitors water-quality at selected sites on the Rio Grande in near real time. The Rio Grande presents unique monitoring challenges to overcome, such as the continuous build-up of calcium carbonate precipitate on submerged equipment and the frequent occurrence of sediment laden high-flow events that can bury equipment installed in the river. These challenges occasionally result in periods of lost or invalid data. USGS follows well-defined and widely-accepted guidelines for monitoring real-time water quality, but the methods did not meet certain requirements of TCEQ. The TCEQ outlined their concerns during an extensive audit of the water-quality monitoring activities on the Rio Grande. In February 2013, a three-day workshop was convened to bring together State, Federal, and private entities to reach a consensus on the methods used to validate and apply corrections to the data. Cooperatively, the overall validity of the methods in use was agreed upon, along with ways to better overcome the challenges previously mentioned. Through joint site visits, the difficulties presented by the environmental conditions at each site became apparent and a greater appreciation for the effort required to maintain water-quality monitors in challenging environments was gained by all parties. The workshop resulted in a collaborative resolution to the way corrections are applied to the data as well as key points to consider in site relocation. The agreed upon methodology has since been expanded to sites on other rivers, such as sites on the Pecos River and a new site on the Arroyo Colorado near Rio Hondo, Tex.

Utilizing Continuous Water Quality Monitoring Data for Regulatory Assessment and Discharge Permit Development along an Effluent-Dominated Segment of the South Platte River

Jordan Parman and Jim Dorsch
Metro Wastewater Reclamation District, Denver, Colo.

Abstract
The Metro Wastewater Reclamation District (District) has been actively engaged in assessing the water quality of the South Platte River downstream of Denver for 50 years. Sampling of the river has varied over the years, adapting to address regulatory concerns of the District with a large, scientifically-derived dataset. District staff currently sample 18 sites along the river, 22 groundwater monitoring wells, and two lakes that receive substantial amounts of effluent flows. The long-term water quality dataset is combined with continuous flow records in the South Platte Water Quality Model to address current regulations and to assist in the development of new regulations for a segment of the South Platte River that is effluent-dominated and influenced by a heavily managed water rights flow regime. For the past five years, the District has utilized In-Situ Multiparameter 9500 water quality probes to collect both discrete and continuously logged water quality data for the purposes of regulatory assessment (pH and dissolved oxygen) and discharge permit development. In addition, Hobo® thermisters are used to log continuous temperature records at multiple sites downstream of the District's outfalls to determine compliance with temperature standards adopted by the Colorado Water Quality Control Commission.

While the multiparameter probes and thermisters provide valuable information concerning diel variations in parameters of concern that cannot be captured during biweekly discrete monitoring events, it is critically important to conduct thorough quality control/assurance methods to ensure validity of the continuous data, especially given that the data is utilized in a regulatory and compliance context. Here, we present calibration and end-calibration data, along with statistical methods that suggest deployment time limitations due to biofouling of sensors and exposure to a wide variation of hydrologic flows conditions. However, after careful and methodical elimination of anomalous data, these continuous datasets can still be valuable in the development of site-specific water quality standards that are appropriate for the unique conditions of the South Platte River downstream of Denver.

Adaptive Management for Low Dissolved Oxygen in Grand and Hudson Lake

Lance Phillips[1], Monty Porter[1] and Darrel Townsend[2]
[1]Oklahoma Water Resources Board, Oklahoma City, Okla., [2]Grand River Dam Authority, Vinita, Okla.

Abstract
A comprehensive monitoring and remediation effort is currently ongoing in the Grand River Basin. These efforts are necessary to meet the requirements outlined in the Grand River Dam Authority (GRDA) Federal Energy Regulatory Commission (FERC) permit (FERC, 2006). As part of the GRDA FERC re-licensing process, the GRDA has agreed to implement a water quality improvement plan intended to achieve compliance with applicable water quality standards in the tailraces of both Hudson Lake (Markham Ferry Project) and Grand Lake (Pensacola Project).

Adaptive management approaches to mitigate low downstream DO concentrations have been tested in both the Grand and Hudson tailraces since 2009. Using continuous, near real-time monitoring platforms to gather data, testing has included both pulsing from the powerhouse as well as spillage from Lake Hudson. Furthermore, DO mapping has been used to quantify spatial effects of mitigation scenarios. Based on 2011-12 testing results, a mitigation scenario has been adopted for both tailraces. At Grand Lake, using real-time water quality sensors, an email alarm system has been created to notify the powerhouse operations of lower DO conditions. Once notified, a 6 hr. reduced generation pulse coupled with turbine aeration produces enhances DO values above the water quality criterion, this will continue to be tested as a long-term solution for periods of low DO in the tailrace. Conversely, at Lake Hudson, continuous spillage from one of the Tainter gates has been implemented for mitigation of acute DO problems, and increased spillage will continue to be tested as a means to raise the stilling basin above the water quality criterion.

Session F4: Harmful Algal Bloom and Cyanotoxin Reconnaissance

8:00 – 9:30 am | Room 237

Harmful Algal Bloom Monitoring by Citizen Scientists to Protect Human Health and Strengthen Stewardship

Dana Oleskiewicz[1], Robert D. Davic[1], John Beaver[2] and Erin Manis[2]
[1]Ohio Lake Management Society, Chagrin Falls, Oh., [2]BSA Environmental Services, Inc., Beachwood, Oh.

Abstract
Harmful Algal Blooms (HABs) have recently emerged as a human health issue in the United States. In 2011, the Citizen Lake Awareness and Monitoring (CLAM) program, sponsored by the Ohio Lake Management Society (OLMS), developed and field tested monitoring protocols for citizen volunteers to collect cyanobacteria and HAB toxin information on Ohio lakes. For three seasons, CLAM Lake Keepers have collected composite water samples from beach areas along a transect using modified Ohio EPA procedures twice a month, July through September. 'Hot spot' areas identified by Lake Keepers are also targeted for sampling. Samples are cooled with ice packs and sent through the mail for analysis within 48 hours to BSA Environmental Services, Inc., Beachwood, Ohio. CLAM Lake Keepers gather additional water quality data, such as seasonal Secchi transparency, nutrients, and Chlorophyll a. This water quality information is submitted into an innovative and interactive online database that can generate immediate graphs and lake summary reports; www.eyesonthewater.org/olms. HAB toxin data are shared weekly with project collaborators to protect lake communities from potentially harmful situations for human health. Cyanobacteria cell counts are used to determine which toxin should be measured based on species present. Side-by-side testing with Lake Keepers by CLAM staff occurs regularly to ensure quality assurance. Lessons learned have led to improvements in sampling protocols for citizen scientists and in overall program delivery. Monitoring done by local residents provides a cost effective means of watching Ohio's water resources for HABs. Strong multi-agency partnerships have emerged from program objectives, while citizen participation in the CLAM program has cultivated local stewardship yielding more effective water management efforts.

Indiana's Cyanobacteria Monitoring Program: Analyzing Cyanobacteria and Cyanotoxins

Cyndi Wagner, Kristen Arnold, Myra McShane, John Prast, Betty Ratcliff and Jessica Trensey
Indiana Dept. of Environmental Management, Indianapolis, Ind.

Abstract
Cyanobacteria or blue-green algae are a common constituent of algal communities in lakes and rivers. Many common cyanobacteria are known to produce potent toxins under certain environmental conditions, particularly during blooms, die-offs and other stressful conditions. The Indiana Department of Environmental Management (IDEM) developed a targeted monitoring program for cyanobacteria and toxins. Public swimming beaches owned or managed by the Indiana Department of Natural Resources (IDNR) were the focus of this project. Water column integrated composite samples were collected once per month from June until Labor Day unless the cyanobacteria cell count exceeded 100,000 cells/mL, then the sampling frequency increased to biweekly. Sampling frequency increased to weekly if toxins were present at or above 6.0 parts per billion (ppb). Cyanobacterial density was determined through microscopic identification and enumeration for cell counts. Each sample was analyzed for microcystins and cylindrospermopsin hepatotoxins using the Abraxis Enzyme-Linked Immunosorbent Assay test kits. Samples were also analyzed for nutrient constituents including orthophosphate, total phosphorus, nitrate plus nitrite, ammonia nitrogen and total Kjeldahl nitrogen. We will present an overview of results from cyanobacteria counts and cyanotoxin determinations, explore nutrient relationships, discuss lessons learned along the way, and program modifications.

Cyanobacteria and Associated Toxins in Illinois

Paul Terrio[1], Gregg Good[2] and Kelly Warner[1]
[1]US Geological Survey, Urbana, Ill., [2]Illinois Environmental Protection Agency, Springfield, Ill.

Abstract
A study by the U.S. Geological Survey and the Illinois Environmental Protection Agency identified potentially harmful levels of cyanobacteria and associated toxins in over half of the lakes and rivers sampled in Illinois during the drought of 2012. Multiple reports and observations of algal blooms identified ten lakes and two rivers in Illinois that were sampled once from August to October 2012 to determine the concentrations and changes in distribution of cyanobacteria and associated cyanotoxins. Illinois EPA field screening for cyanotoxins earlier in 2012 and in previous years detected few

concentrations of concern. An extended drought in 2012 and accompanying high temperatures might have provided conditions facilitating cyanobacterial dominance and associated cyanotoxin production.

Sample results indicated that concentrations of both total cyanobacterial cells and Microcystin were commonly at levels likely to result in adverse human health effects, according to World Health Organization guidance values. Results from the October 2012 samples indicated that both Microcystin concentrations and total cyanobacterial cell counts decreased approximately one order of magnitude from late August or early September to October following precipitation events and lower temperatures. Additional samples are being collected and analyzed in the fall of 2013.

Determination of Algal Toxin Concentrations in Surface Waters at Isle Royale National Park (ISRO), Sleeping Bear Dunes National Lakeshore (SLBE), and Pictured Rocks National Lakeshore (PIRO)

Joseph Duris
US Geological Survey, Lansing, Mich.

Abstract
The Laurentian Great Lakes are an important ecological, recreational, and economical resource in the United States. Cyanotoxins are an emerging lacustrine water quality issue, not only in the Great Lakes region but throughout the country, and these toxins are capable of causing illness and even death in humans, domestic animals, and wildlife. Michigan's Northern Lower Peninsula and Upper Peninsula are home to three units of the National Park Service (NPS): ISRO, SLBE, and PIRO. These parks serve more than 1.6 million visitors annually; many of whom swim, canoe, and camp in the backcountry where the most common source of drinking water is filtered surface water. Recent research performed outside of park boundaries in Michigan found detectable levels of algal toxins in 22 out of 41 lakes sampled, yet no data exists regarding the presence and types of cyanotoxins within these three National Parks. For this study, a total of 214 samples were collected at 16 inland lakes and 4 sites on Lake Michigan during the recreational seasons in 2012 and 2013. Sites were selected based on proximity to recreational activities, locations where water is commonly filtered for drinking, or where cyanobacterial blooms have been observed. Samples were analyzed for the presence of microcystin, cylindrospermopsin, and saxitoxin using ELISA, and a subset of samples was analyzed by LC/MS/MS for a suite of cyanotoxins. Preliminary results from the ELISA method revealed microcystin levels greater than the detection limit (0.10 µg/L) in at least one sample at 9 out of 16 inland lakes and at 2 out of 4 beaches on Lake Michigan. Multiple detections occurred at both SLBE and PIRO above the World Health Organization maximum allowable concentration for microcystin in drinking water (1.0 µg/L). It is important to note that microcystin detections occurred in the absence of a visible bloom of cyanobacteria. There were no detections of cylindrospermopsin (detection limit 0.05 µg/L) and saxitoxin (detection limit 0.02 µg/L). This project has provided insight into the types and levels of cyanotoxins present at the three National Parks, and informed NPS managers of lakes or beaches that may need more frequent monitoring for cyanotoxins.

Session F5: Best Management Practices in Urban and Suburban Landscapes

8:00 – 9:30 am | Room 233

Digesting Multiple Lines of Evidence to Evaluate Possible Designated Use Impairments and Promising Restoration Options – Western Bays, Long Island, NY

Thomas Gulbransen
Battelle Memorial Institute, Stony Brook, N.Y.

Abstract
Nutrient over-enrichment in the Western Bays south of Long Island, NY causes periodic eutrophic conditions. Problematic blooms of phytoplankton and macroalgae dominate segments of the bays. Sea grasses, desirable fish/shellfish species, and intertidal wetlands have declined from historic levels. Parts of the waterbody were added to the NYSDEC 303(d) list of impaired waterbodies in 2006 based on nitrogen from municipal WWTP and urban/stormwater runoff. USEPA Region 2, New England Interstate Water Pollution Control Commission and NYSDEC supported an investigation of the complex relationships between nutrient loads, regional geomorphology, ambient nutrient concentrations, and environmental fate and effects in order to develop alternative nutrient criteria and nitrogen management options.

Multiple lines of evidence about existing conditions in the bays were advanced to inform four main questions: (1) Is waterbody impairment evidence consistent? (2) Which are best endpoints to document impairments? (3) Are impairments linked to excess nitrogen? (4) Which nitrogen management options are most promising?

Reviews of historical water quality data from the municipality and USGS yielded few trends. Hydrodynamic modeling simulations revealed significant surprises in water column transport. Watershed nitrogen loading models established an updated context to evaluate restoration targets. Seven field surveys and two lab experiments were performed. The nitrogen loading budget integrated past work from USGS, surface and groundwater monitoring, plus projections based on land use characteristics and literature coefficients for nitrogen application and uptake.

Nitrogen Management Plan (NMP) options were assembled into a simple, interactive, spreadsheet-based decision model to compare 19 basic approaches to managing nitrogen as it cascades through the ecosystem. NMP options aimed at source reduction/import into watershed, waste minimization/release onto watershed, enhance processing in bays, or remediation/removal of nitrogen from bays. Relative ranking of net potential efficacy for each NMP reflected best professional judgment scoring against 11 criteria, such as magnitude addressed, cost guestimates, likelihood of success, and timing.

WWTP effluent relocation ranked highest based on a preliminary scenario of criteria scores and weights constrained within the Western Bays study area. A campaign to improve watershed residents' nutrition and digestion via pre/probiotic health emerged as second most promising means to reduce nitrogen loads.

Assessing Watershed Scale Responses to BMP Implementation in Urban Watersheds

John Jastram
US Geological Survey, Richmond, Va.

Abstract
The USGS Virginia Water Science Center, in cooperation with the Fairfax County Stormwater Planning Division, is conducting a study of urban/suburban watersheds in Fairfax County, Virginia to assess watershed-scale

water-quality responses to implementation of Best Management Practices (BMPs) and stream restoration activities. Specifically, the objectives of the study are to: 1.) Describe current conditions and trends in both water quality and water quantity, compute loads in water-quality constituents, and use these data to evaluate water-quality improvements that are associated with BMP implementation and stream restoration activities, and 2.) Evaluate the transferability of results from intensively monitored watersheds to other watersheds with less-intensive monitoring. This unique study is reliant upon a long-term (10+ year) data collection effort in 20 small (1-6 mi^2) watersheds that represent the range of land-use conditions in suburban Fairfax County. The study was designed to include a mix of intensively monitored watersheds (n=5), for which continuous streamflow and water-quality parameters are measured and over 100 routine and storm event samples are collected, and less intensively monitored watersheds (n=15), for which periodic streamflow and water-quality measurements are made. This presentation will include critical elements of the study design, the novel monitoring methods employed, and a discussion of preliminary results.

Evaluation of Pollutants in Wastewater Generated by Mobile Commercial Car Washing Operations in Durham, NC

Maverick Raber, John Cox and Michelle Woolfolk
City of Durham, Durham, N.C.

Abstract
The City of Durham has a Stormwater Management and Pollution Control Ordinance that prohibits the discharge of non-stormwater to the drainage system, including commercial vehicle washing wastewater. In order to comply, mobile car washing companies are required to contain, collect, and properly dispose of their wastewater to the sanitary sewer. In 2011, thirty-seven businesses actively operating in the City had previously demonstrated compliance with the ordinance. The goal of this study was to quantify pollutant load reductions to the stormwater drainage system by mobile car washing companies operating in compliance with the ordinance. To quantify these load reductions, wastewater was collected and composited from two local mobile car washing companies that agreed to participate in the study. Each composite contained wastewater from 3-5 vehicles (25 vehicles total) and was sampled for total organic carbon (TOC), 5-day biochemical oxygen demand (BOD5), metals, nutrients, and polycyclic aromatic hydrocarbons (PAHs). Analyses indicate hundreds of pounds of pollution are prevented from reaching the City's stormwater drainage system by implementation and enforcement of the ordinance on an annual basis.

Enumerating the Return on Investment for Restoration Projects in an Urban Watershed through Successful Partnerships and Volunteer Monitoring Efforts

Kara Scheerhorn
Mill Creek Watershed Council of Communities, Cincinnati, Oh.

Abstract
The Mill Creek Volunteer Water Quality Monitoring Program is an outlet for citizen scientists, residents, and volunteers to be the eyes and ears of the Mill Creek Watershed. It is the goal of the Mill Creek Watershed Council of Communities (Council) to advance research and knowledge in our urban watershed with volunteer participation through programs like the water quality monitoring program. When we can track how the stream system functions throughout the year and understand when and where water quality is of concern, we are able to implement successful restoration projects.

From stream restoration to wetland construction to innovative stormwater management, the Council puts projects in the ground that deliver environmental and economic benefits in the Mill Creek Watershed. With the implementation of past and present restoration projects, and plans for more improvements with direction from State of Ohio-endorsed Watershed Action Plans, it is important for us to track the benefits our investments make. It is valuable to have publishable data that give us the confidence to articulate to communities, stakeholders, and grant funders the specific environmental and economic benefits achieved by implementation of proposed projects. We want to know what works, why it works, and be confident about enumerating return on investment not just in terms of water quality improvement, but also economic vitality and community development.

The first year of our program began in 2013, and we completed 8 months of successful sampling and lab analysis. In 2014, we anticipate gaining momentum and increasing our volunteer base. By reaching out to other watershed stakeholders in the community we have gained valuable partnerships that will allow our program to grow and continue. In our second year of the program, volunteers in the field and in the lab will collect and record data through our mobile water quality application using tablets and smart phones. It is our intent to make this program sustainable and to be able to tie it into other aspects of our work and mission.

Session F6: Integrating Remote Sensing into Assessment Programs

8:00 – 9:30 am | Room 232

Remote Sensing of Wintertime Groundcover on Agricultural Fields within the Chesapeake Bay Watershed: Performance of Winter Cover Crops for Water Quality Protection

W. Dean Hively[1], Greg McCarty[2] and Kusuma Prabhakara[3]
[1]US Geological Survey, Beltsville, Md., [2]US Dept. of Agriculture, Beltsville, Md., [3]University of Maryland, College Park, Md.

Abstract
Winter cover crops are used to reduce soil erosion and nutrient leaching from agricultural fields, particularly during the winter months. However, cover crop performance is highly variable, depending on species choice, planting date, and other agronomic management factors. This project has developed a geospatial toolkit that uses well-calibrated multiband satellite imagery to map wintertime groundcover on agricultural fields, and then uses the NASS National Cropland Data Layer to segment the fields by crop type. The resulting reports can be used by conservation managers to promote adaptive management of winter cover crops to maximize soil protection in critical areas of the landscape. This presentation will detail the methods used to map wintertime groundcover, and will present selected results from a four-year analysis of Showcase Watersheds in the Chesapeake Bay region.

Satellite Remote Sensing and Crowd Sourcing to Monitor and Predict Cyanobacteria Blooms

Blake Schaeffer[1], Ross Lunetta[1] and Richard Stumpf[2]
[1]US Environmental Protection Agency, Research Triangle Park, N.C., [2]National Oceanic and Atmospheric Administration, Silver Spring, Md.

Abstract
Cyanobacterial blooms occur worldwide and are associated with human respiratory irritation, undesirable taste and odor of potable water, increased drinking water treatment costs, loss of revenue from recreational use, and human illness as a result of ingestion or skin exposure during recreational activities. Satellite technology allows for the development of harmful algal bloom indicators at the local scale with national coverage. Cyanobacteria can successfully be monitored using remote sensing technologies based on algorithms to retrieve chlorophyll *a* and phycocyanin. In this project, cyanobacteria cell count data from Ohio, Florida, New Hampshire, Vermont,

Rhode Island, Connecticut, and Massachusetts were derived with data from the Medium Resolution Imaging Spectrometer (MERIS). MERIS data on the European Space Agency's Envisat-1 satellite were used in a case study with 300 m data available in the region from 2009 to 2012. The goal of this project was to develop a stakeholder tool with the capability to monitor cyanobacteria blooms near real-time, and potentially provide predictive capability. Crowd sourcing was a unique opportunity to pool the problem solving skills of >500,000 people worldwide to develop these capabilities. The predictive algorithm was targeted to forecast the status of cyanobacteria bloom events in 7, 14, and 28 day intervals. First, the model identified lakes likely to attain cyanobacteria cell counts greater than 10,000 cells/mL during the forecast period. Next, the model focused on freshwater systems identified by satellite observations to have low cell counts (10,000 – 109,999 cells/mL) and predicted the potential for future development to either Medium (109,000 – 299,999), High (300,000 – 1,000,000), or Very High (> 1,000,000) cell count ranges. The combined use of satellite technology with crowd sourcing provided a sophisticated stakeholder tool that may allow for more holistic management to reduce exposure risk to the public.

Multispectral Monitoring of New England Freshwater Resources to Assess Turbidity, Algal Blooms and Water Quality for Enhanced Natural Resource Management

Tiffani Orne[1], Sam Weber[1] and Hayley Solak[2,1]
[1]National Aeronautics and Space Administration, Hampton, Va., [2]Clark University, Worcester, Mass.

Abstract
Centered between New York, Vermont, and Quebec, Lake Champlain is a critical water resource for the surrounding area. Approximately 145,000 people rely on the lake for drinking water and it is a major stopping point and breeding ground for migrating birds. Development in the Lake Champlain watershed has led to an increase in nutrients in the lake. Algae in the water thrive on the nutrient flux and reproduce exponentially, causing hazards to both human and environmental health. Interested organizations, including the Lake Champlain Basin Program (LCBP), the Lake Champlain Committee (LCC), and the Vermont Department of Environmental Conservation (VTDEC), mobilize citizen volunteers to collect water samples in various parts of the lake in order to monitor water quality. However, this process requires a large number of volunteers, can be inconsistent, does not account for the quality of the entire lake, and requires the cost of laboratories to test the water samples. Using data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor aboard the Aqua satellite, Landsat 7's Enhanced Thematic Mapper Plus (ETM+) and Landsat 8's Operational Land Imager (OLI) sensors, this project generated a sustainable methodology for partner-use to monitor changes in chlorophyll *a*, cyanobacteria, phycocyanin, and total suspended sediment (TSS) over time in Lake Champlain. These results and methods were then transferred to project partners for continued use of remote sensing to monitor water quality and the creation of visual tools to support public policy decision making.

Predicting Algal Concentrations from Landsat Satellite Imagery in Kentucky Lakes

Mark Martin and Garrett Stillings
Kentucky Dept. of Environmental Protection, Frankfort, Ky.

Abstract
Several public agencies are currently employing remote sensing to monitor environmental conditions. Faced with both staffing limitations and financial constraints, we have developed a method by which we can satisfy the reporting of warm water habitat quality as well as locating specific areas of lakes to be sampled for primary contact recreation. Satellite imagery has been employed in many studies to predict the trophic state, chlorophyll *a* concentration (Chl-*a*), phycocyanin concentration as well as total phosphorous. By utilizing Landsat 8 imagery and georeferenced *in situ* measurements we were able to derive a model which allows us to predict Chl-*a* concentrations in Kentucky lakes. We are then able to calculate trophic state for reporting purposes and to predict locations within lakes that may contain harmful algal blooms. Kentucky has adopted a policy in which a water body will receive a health advisory if any area has an elevated risk to human health. With over 600 reservoirs and seasonal limitations, our method is an effective way to identify high risk locations where trained staff can make quality observations.

Session F7: Pollutant Trading: Overviews and Perspectives at Different Scales

8:00 – 9:30 am | Room 231

Water Quality Trading in the US: National Overview under the Clean Water Act

Bob Rose
US Environmental Protection Agency, Washington, D.C.

Abstract
Water Quality Trading is the common term used to describe a process by which permitted entities under the US Clean Water Act may apply off-site pollution reductions towards their permit compliance. This paper provides an overview of water quality trading in the US, legal authority under the Clean Water Act, and the role of US Environmental Protection Agency and the states. Challenges and opportunities facing water quality trading going forward will also be discussed. Example water quality trading programs across the US will be presented as way to highlight the extent to which states may and do take fundamentally different approaches. Stakeholder motivation and citizen concerns will be raised as issues necessary for inclusion when considering water quality trading opportunities.

Point/Nonpoint Water Quality Trading: How Data and Monitoring Can Reduce Market Impediments

Marc Ribaudo
US Dept. of Agriculture, Washington, D.C.

Abstract
Water quality trading between point and nonpoint sources is of great interest as an alternative to strict command and control regulations on point sources for achieving water quality goals. The expectation is that trading will reduce the costs of water quality protection, and may speed up compliance. EPA has issued guidance to the States on developing point/nonpoint trading programs, and USDA is encouraging farmer participation. However, existing point/nonpoint trading programs have resulted in very few trades. Supply side and demand side impediments seem to be preventing trades from occurring in most trading programs. These include uncertainty over the number of discharge allowances different management practices can produce, high transactions costs of identifying trading partners, baseline requirements that eliminate low-cost credits, the reluctance of point sources to trade with unfamiliar agents, and the perception of some farmers that entering contracts with regulated point sources leads to greater scrutiny and potential future regulation. Uncertainty in the amount and timing of abatement delivered by conservation practices at different points in a watershed is a major detriment to trading. Uncertainty in the amount of abatement delivered by conservation measures is often addressed through ad hoc trading ratios that may unnecessarily hinder trading. Time lags in delivery are not considered in trading programs, which can lead to a failure to achieve water quality goals. Improved monitoring and modeling can allow for site-specific trading ratios that favor sites with a higher certainty of performance. A better understanding of lags in delivery can be used to target particular regions for inclusion in trading programs, and allow the design of trading rules that can accommodate lags.

Nutrient Trading: How Farmers and Chesapeake Bay TMDL Efforts Can Find "Value" in Trading Tool Inventories – A Success Story of the Early Use of the Maryland Nutrient Trading Tool

Dana York[1] and Robert Ensor[2]
[1]Green Earth Connection LLC, Centreville, Md., [2]Howard Soil Conservation District, Woodbine, Md.

Abstract
Under the Chesapeake Bay's "pollution diet, each sector, urban and agriculture has a Total Maximum Daily Load (TMDL) baseline to meet. Once baselines are met, when additional growth causes additional pollution, new "best management practices" (BMPs) must be deployed to stay within the TMDL baselines.

The emerging practice of "nutrient trading" allows sectors needing additional BMPs to purchase offset from another sector. This trade provides the purchasing sector with a "credits" that can be used to allow further growth.

In Maryland, the Maryland Department of Agriculture and the Maryland Department of Environment have developed a nutrient trading program, under tight scrutiny and regulation. This allows everyone to be a winner:

- The urban sector can continue to grow and provide funds to implement BMP's on farms.
- The agriculture sector can receive payments of private money for BMP's that might not have installed without additional funding; and
- Taxpayers don't have to pony up additional tax money.

To participate in nutrient trading, agricultural landowners in Maryland must utilize a web-based Maryland Nutrient Trading Tool (MDNTT) to calculate their baseline and credit potential.

In this session, the presenters will share the results of a project conducted by the Howard Soil Conservation District. The objective of the District project was to collect all the BMP data on farms in the Agricultural Preservation Program, to determine individual farm TMDL baselines and potential N and P credits.

Results of the District Project show:

- How the District developed a process to collect farm BMPs through an on farm inventory process with 3rd Party Vendors.
- The Maryland NTT is a new innovative approach to determine if farms meet the TMDL baseline.
- There are numerous BMPs on the Maryland farms, with opportunities and funding for installation of new BMPs, and when evaluated using the MDNTT, show that farms can meet the TMDL baseline and have credits to trade.

Nutrient trading is an exciting development. It can; reward Maryland farmers for good stewardship; help framers understand the nutrient processes on their farm; provide access to significant new sources of annual revenue for farms; and, accelerate BMP implementation in the Bay watershed.

The Ohio River Basin Water Quality Trading Project

Jessica Fox[1] and Greg Youngstrom[2]
[1]Electric Power Research Institute, Palo Alto, Calif., [2]Ohio River Valley Water Sanitation Commission, Cincinnati, Oh.

Abstract
Nutrient trading has long been viewed by agricultural, industrial and environmental stakeholders as a possible solution to controlling nutrient pollution on a large scale. Farmers and other nonpoint sources can implement best management practices (BMPs) – such as installing buffer zones, cover crops and other measures – to reduce nutrient pollution at a fraction of the cost and with greater impact than point sources, allowing point sources to offset their nutrient loads by buying credits from farmers could hasten the reduction of nutrients in a watershed.

The Electric Power Research Institute (EPRI) is leading an effort to develop an interstate water quality trading program for the Ohio River Basin. Partners in the effort include American Farmland Trust, the Ohio River Valley Water Sanitation Commission (ORSANCO), and the Ohio Farm Bureau. The project partners are facilitating "pilot trades" of nutrients between point and nonpoint sources, marking the first trades in what could provide a model for dischargers to comply with emerging requirements in many watersheds facing high nutrient levels. If successful, the project could provide a market-based cap-and-trade system to help dischargers comply with the regulatory requirements.

The pilot trades will involve at least three National Pollution Discharge Elimination System (NPDES) permit holders and at least 30 farms implementing agricultural conservation best management practices across Ohio, Indiana, and Kentucky. The pilot trades are expected to result in reductions of up to 66,000 pounds of nitrogen 22,000 pounds of phosphorus over 5 years. The conservation practices have the potential for ecological benefits such as improved wetlands and restored habitats, with the credit trading program offering new revenues for farmers and a potentially cost-effective alternative for power companies and other industries to meet nutrient effluent permit obligations.

Using scientific research and a sophisticated watershed model, this project could result in a multi-industry market that may accelerate water quality improvements in the Ohio River Basin and establish a model for other domestic regional trading markets. EPRI and collaborators began developing its Ohio River Basin nutrient trading program in 2009, with the intention of developing a large-scale, mutually accepted interstate trading market for nutrient reduction credits.

Session G1: National Lake Assessment: National and State Perspectives

10:00 – 11:30 am | Room 263

National Lakes Assessment: Project Overview, Status Update, and Preliminary Results

Amina Pollard
US Environmental Protection Agency, Washington, D.C.

Abstract
The National Lakes Assessment (NLA), one in a series of National Aquatic Resource Surveys, is designed to assess the biological, chemical, physical, and recreational condition of lakes in the conterminous United States. This assessment uses a statistically-based design to represent the condition of all lakes in similar regions sharing similar ecological characteristics. States, Tribes, and Federal partners used consistent collection and analytical procedures to ensure that the results can be compared across the country. This presentation is offered in two sections. First, I will provide a brief overview

of the National Lakes Assessment and a status update of the 2012 assessment effort. Approximately 1100 lakes were sampled by 90 field crews across the United States in the summer of 2012. The samples have been processed and we are starting our data analysis efforts. Second, I will present a first look at preliminary results from our assessment. I will discuss the preliminary findings of the screening-level occurrence and distribution of an important algal toxin, microcystins, and a common pesticide, atrazine, in lakes. Algal toxins are a common concern for the public and a challenge for lake managers. We do not attempt to capture specific events or target lakes where we expect particularly high or low concentrations; as such, the NLA data set provides unique information about baseline concentrations in lakes. I will highlight the NLA findings with respect to the occurrence and distribution within a lake (microcystins only) and among lakes across the US from the 2012 NLA effort.

Minnesota's 2012 National Lakes Assessment: National, State and Ecoregion-based Approach

Steven Heiskary
Minnesota Pollution Control Agency, St. Paul, Minn.

Abstract
Minnesota's participation in the 2012 National Lakes Assessment (NLA) involved a collaborative approach that included USEPA, USFS, MN Department of Natural Resources (MDNR), MN Department of Health (MDH), MN Department of Agriculture (MDA) and the Red Lake and White Earth Native American Bands. A total of 1,000 lakes were included in this survey. Minnesota drew 42 lakes as a part of the initial draw for this statistically-based national survey effort and added 8 lakes to allow for state-based assessment. All 50 lakes received the national level of assessment so these lakes contributed not only to state-based assessment, but the overall national assessment. In addition, 100 lakes were added from the overdraw pool to allow for ecoregion-based assessments (50 per aggregated ecoregion) in Minnesota.

This collaboration and the various survey add-ons provided several "value-added" elements to the NLA survey. Examples include:

- Emerging contaminant analysis in 50 lakes;
- Pesticide analysis in 50 lakes and triazine analysis in all 150 lakes;
- Zooplankton analysis in all 150 lakes;
- Microcystin analysis in all 150 lakes;
- Water chemistry and profiles in all 150 lakes; and
- Comparisons among 2007 and 2010 results.

The presentation will provide a brief overview of Minnesota's 2012 NLA effort, describe roles of collaborators, and share available results to date, including examples at the state, ecoregion, and individual lake basis.

Comparison of Wisconsin's Results from National Lake Assessments in 2007 and 2012

Paul Garrison and Caitlin Carlson
Wisconsin Dept. of Natural Resources, Madison, Wis.

Abstract
Wisconsin participated in the National Lake Assessment in 2007 and 2012. The sampling design is probability based so that it provides statistically valid estimates of all lakes in the state. A total of 50 lakes were sampled to strengthen the statistical inferences. Various indicators and stressors were sampled from each lake. The 2007 assessment indicated that nationally the most widespread stressor was lakeshore habitat. Wisconsin had more lakes in the good category compared with nationally. Nationally more lakes were classified as having good physical habitat complexity and shallow water habitat than in Wisconsin. Phosphorus levels were lower in Wisconsin compared with the national average. The biological conditions of Wisconsin lakes were better than nationally but not as good as the neighboring states of Minnesota and Michigan. Recreational indicators indicated Wisconsin lakes were at lower risk than lakes nationally and generally lower than neighboring states.

The 2012 assessment found that trophic variables were higher compared to the 2007 survey. The average phosphorus concentration was twice as high in 2012 at 26 $\mu g\ L^{-1}$ and water clarity was worse by 1 meter at 1.6 m. Recreational indicators were also worse in 2012 with the algal toxin microcystin more common and the chlorophyll risk greater. It is not clear what the reason for these differences is. The weather in 2012 was much warmer and drier compared with 2007. The minimum lake size was smaller in 2012 but this does not seem to be the reason.

Using the Results of the 2007 National Lakes Assessment to Influence Lake Management Policy in Vermont

Kellie Merrell
Vermont Dept. of Environmental Conservation, Montpelier, Vt.

Abstract
A purpose of EPA's National Aquatic Resource Surveys is to assess the condition of the nation's waters in a manner that allows one to rank which stressors are more widespread than others and to summarize findings in a simple report card manner. The utility of such a sampling design is that it can be used to inform policy decisions as resource managers, politicians and the public decide where to apply limited funding available for protecting, maintaining and restoring water resources. By surveying fifty-one lakes in Vermont using the same methods used by the National Lakes Assessment for the first time it was possible to directly compare the condition of Vermont's lakes to the Ecoregion and to the Nation. The most worrisome finding in this assessment was that only 18% of Vermont lakes are in good condition for lakeshore disturbance. In this stressor category, Vermont is lagging behind both the region and the nation. These findings were presented to the Vermont Legislature during the 2013 legislative session. This finding corroborated results from another study conducted by the Vermont Department of Environmental Conservation. While the VTDEC specific study and studies from the scientific literature were compelling reasons for the legislature to act, seeing Vermont lakes rate so poorly against lakes in the region and nation was even more so. While Vermont was right behind Wisconsin and Minnesota at being one of the first states to pass a statewide shoreland protection law in 1970, it was repealed before it ever went into effect. So over the last 42 years, while other states in the region and nation went on to pass some sort of shoreland protection laws, Vermont did not. While the lake scientists at VTDEC have known this has been a major stress to Vermont's lakes, efforts and interest by the public and legislature have focused on tackling the stressors of phosphorus and aquatic invasive species. The results of the National Lakes Assessment have helped to restart the conversation on lakeshore protection. The Vermont House passed a bill and over the summer the Vermont Senate held public meetings to get input.

Session G2: Groundwater Monitoring and Protection

10:00 – 11:30 am | Room 262

Relationships between Discharge and Water Quality in Florida Springs

Ann Shortelle and Erich Marzolf
Suwannee River Water Management District, Live Oak, Fla.

Abstract
The health of Florida springs are challenged by nutrient enrichment, primarily nitrate, and declining discharge. Elevated nitrate levels have been implicated in ecological changes in springs, primarily proliferation of filamentous and epiphytic algae. In addition, many Florida springs are experiencing declining discharge during periods of drought with some ceasing to flow completely. Many are considered impaired based upon a specific nutrient criterion (nitrate > 0.35 mg N-NO_x/L). Changes in discharge are primarily governed by rainfall, but may also be influenced by groundwater withdrawals from the Upper Floridan aquifer. The existence of long-term temporal trends in nitrate concentrations and discharge in some springs is well established, however less is known about potential interactions between time, nitrate, other water quality constituents and discharge. Here we present evidence that Florida springs exhibit a variety of relationships between time, discharge and chemistry. Springs within the Suwannee River Water Management District exhibited positive, negative and no trend in nitrate while also showing a positive correlation between nitrate concentration and discharge. Similarly, there were springs which showed positive, negative and no trend in nitrate concentration while exhibiting no correlation with discharge. Similar patterns exist between concentrations of nitrate and potassium, an indicator of inorganic fertilizer, indicating variable inputs of fertilizer nitrogen among springs. Cost-effective nutrient and/or flow impairment remediation will be more easily implemented when proximal causes of declining health are accurately determined.

Determining the Sources of Water for Conduit "Sandboil" Springs at the Nature Conservancy's Nachusa Grasslands Preserve, Franklin Grove, Illinois

Clinton Bailey[1,2]
[1]US Geological Survey, DeKalb, Ill., [2]Northern Illinois University, DeKalb, Ill.

Abstract
The Nachusa grasslands conservation area in north-central Illinois overlies a variety of heterogeneous structural and hydrogeologic systems, resulting from the close proximity of several major structural features, including the Sandwich Fault Zone and the Kankakee and LaSalle Anticlines. The resulting regional uplift and deformation produced a series of sandstone outcrops and conduit "sandboil" springs, spanning various sections of the approximately 5 km^2 study area. The "sandboils" are nicknamed for the extremely pure quartz sand the springs bring to the surface. The purpose of this research is to determine the source of water generating the Nachusa Grasslands "sandboil" springs by utilizing geochemical and stable isotope groundwater and surface water analyses, as well as determine the presence or absence of mixing between hydrologic systems. The source of the springs has long been assumed to originate from the infiltration and interflow of meteoric water through the sandstone outcrops, which are located in close proximity to a majority of the Nachusa springs. However, the goal of the study is to provide sufficient evidence showing the spring water originates from a deeper groundwater source. Residential well logs, along with geophysical studies and sediment core analyses adjacent to the sandboil study sites, show the geology beneath the study area to consist of fractured St. Peter Sandstone overlying the Shakopee and New Richmond Limestone-Dolostone formations. Major ion analyses show the spring water is dominated by a calcium-bicarbonate and magnesium hydrochemical facies consistent with water originating from a limestone aquifer unit. Water samples collected from monitoring wells and surface water sites near the sandboil springs also show a strong connection to a calcareous hydrologic unit, with some meteoric influence. Groundwater samples collected from the Shakopee-New Richmond formation yielded high concentrations of nitrates and nitrites, indicating agricultural contamination and a rapid connection between the surface and subsurface hydrologic systems. Stable Isotope analysis for d^2H and $d^{18}O$ also showed a well-mixed system between two hydrologic units, both of which are dominated by young water.

The Ohio Ambient Ground Water Quality Monitoring Program Documents Water Quality Impacts

Christopher Kenah
Ohio Environmental Protection Agency, Columbus, Oh.

Abstract
The Ohio Ambient Ground Water Quality Monitoring Program (AGWQMP) samples raw water from 200 wells across Ohio to monitor general water quality of the source water for ground water-based public water systems. AGWQMP wells are mostly public water system wells with moderate to large production capacities. Some of the AGWQMP wells document water quality impacts that threaten the utility of the local aquifer including chloride, nitrate and sodium. In some cases, the use of the ground water resource has been lost because the water quality impact resulted in the abandonment of the wellfield. Several examples of water quality impacts will be selected, and variation in secondary parameters will be illustrated and utilized as additional lines of evidence to identify the source of the contamination.

These examples illustrate the frequency of local ground water quality impacts. The AGWQMP wells are not the most sensitive subset of wells in Ohio, so these ground water quality impacts present reasons for concern about the sustainability of the ground water resource. Every time a wellfield is lost to water quality impacts, it documents reduced ground water resources. When the wells are abandoned, we also lose monitoring points for the resource. It is true that Ohio is a water-rich state with significant rainfall that recharges widespread regional aquifers and that water tables are generally stable across Ohio. Nevertheless, we are losing ground water resources, and the data presented documents local impacts on the long term sustainability of Ohio's ground water resources.

Efforts to Characterize Ground Water Quality in Indiana through the Statewide Ground Water Monitoring Network

Kevin Spindler, Mitt Denney and James Sullivan
Indiana Dept. of Environmental Management, Indianapolis, Ind.

Abstract
Since 2008, the Indiana Department of Environmental Management (IDEM) Drinking Water Branch, Ground Water Section has collected ground water samples across the State of Indiana as part of a Statewide Ground Water Monitoring Network (GWMN). The GWMN, which is made possible by Clean Water Act Section 106 funding, seeks to statistically determine background ground water quality in hydrogeologically-defined settings of the state. The sites sampled as part of the GWMN consist of public water supply and private residential drinking water wells. The GWMN site locations were selected in an effort to represent geographic areas of the state, as well as hydrogeologic sensitivities and generalized geologic settings. Typically, samples are analyzed for over 400 parameters; including alkalinity, anions/cations, metals, nitrate-nitrite, synthetic organic compounds, volatile organic compounds, and unregulated pesticide degradates. Of the 326 samples collected in 2012, the analytes that occurred above the drinking water Maximum Contaminant Limit (MCL) included Arsenic (23 samples/7.1%) and Nitrogen, Nitrate-Nitrite (17 samples/5.2%); the most occurrences above a Secondary MCL or EPA recommendation included Iron (180 samples/55.2%), Sulfate (15 samples/4.6%), and Strontium (35 samples/10.7%). The majority of Nitrogen,

Nitrate-Nitrite exceedances occurred in shallow wells located in vulnerable settings that had shallow water tables. Beginning in 2013, the GWMN's design was improved to address the distribution and clustering of sample sites. Under the new design, the total number of samples needed to statistically represent the total sample population of located well logs was estimated using a simplified version of the Yamane (1967) formula. Sample sites are randomly distributed within the twenty generalized hydrogeologic settings across the state, based on a stratified sampling procedure. Once the ground water quality in the general hydrogeologic settings has been statistically characterized, the data can be used to compare ground water quality between generalized settings; evaluate ground water/surface water relationships; and assist in the protection and utilization of source water and drinking water supplies. The data will also be distributed to interested parties. In addition to highlighting the evolution of the GWMN, this presentation will focus on the utility of ground water data collected and collaborative efforts underway maximizing knowledge gained.

Session G3: Continuous Monitoring: Uncertainty and Bias and Precision…Oh My!

10:00 – 11:30 am | Room 261

Sensor Signal Integrity and Data Quality Management: Who is Doing What?

Revital Katznelson
University of California Extension, Berkeley, Calif.

Abstract
Using water quality sensors to collect data of known and documented quality is a process that involves multiple people operating at different levels. Sensor performance testing is common at all levels, but each level has its own role and requirements. At the Technology Development level (*e.g.*, fluorescent quenching for measuring dissolved oxygen), researchers run myriad of tests to prove that the measurement idea actually works and can produce a reliable signal that correlates well with the monitored characteristic. At the sensor Model level, manufacturers working on building a specific sensor model need to prove the functionality of that model as an established measurement system and conduct comprehensive tests to derive the specifications for that model. At the level of an individual Instrument, the Project person who opens the shipment box and prepares the instrument for use needs to go through a series of tests to assure that this instrument is functional and to establish its performance criteria as manifested in the environment relevant to his/her Project. The fourth level is the Measurement (Activity in STORET language), *e.g.*, a batch of data from one deployment episode. At this level, the field operator is implementing actions to Affect, Check, Record, and Report the quality of each data batch. This fourth level also involves a sequence of Data Quality Management functions, using sensor's diagnostic tests (*i.e.*, physical and electronic operating conditions) to prove signal integrity, and using quality check outcomes to validate the data and to evaluate the extent of error and/or uncertainty. This paper reviews the major roles and the helpful tools that have been introduced by the Aquatic Sensors Workgroup, a workgroup of the Methods and Data Comparability Board affiliated with the National Water Quality Monitoring Council.

High Quality Monitoring at the Water's Edge Using In Situ *Automatic Measurement Stations That Incorporate Real-Time Data Quality Analysis Tools*

Janelcy Alferes[1], John B. Copp[2] and Peter Vanrolleghem[1]
[1]Université Laval, Québec, Que., Canada, [2]Primodal Systems Inc., Hamilton, Ont., Canada

Abstract
To guarantee the ecological quality of a water body, the development of a management plan is crucial and the application of a consistent monitoring strategy is a key component of such a plan. With this in mind, there has been increased interest in and application of *in situ* water quality sensors that enable the continuous monitoring at high frequency irrespective of the goal (describe pollution dynamics, identify trends ...). In theory, continuous monitoring enables the timely detection of disturbances and provides an opportunity to take remedial action when necessary. However, in real world applications, the data collected with those continuous systems is not without errors due to the intrinsically challenging measurement conditions. Consequently, the reality is that these systems tend to collect vast amounts of data, but not all the data will have sufficient quality and poor quality data can drastically affect the use of the data (*e.g.*, river basin management models, occasional discharge detection, process understanding, cause-effect relationships between water quality and quantity variables ...). Manual data evaluation and validation is tedious and becomes unrealistic when huge data sets need to be analyzed and interpreted. Therefore, automatic data quality assessment tools become crucial to ensure that the data quality is sufficient for the intended application. Such tools should consider sensor status/diagnosis data, reference samples and time series information.

The development and practical application of software tools for automatic data quality assessment are the focus of this work. In contrast to traditional model-based academic approaches, the presented data-driven tools attempt to extract useful information from the time series of individual and multiple measurement signals in the absence of exact process knowledge. It is the goal of these tools to detect corrupt, doubtful and/or unreliable data, outliers, noise, missing values and potential sensor faults. The proposed tools have been successfully tested on water quality time series data obtained from *in situ* monitoring stations collecting a large amount of data in different water systems with point and diffuse pollution loads (raw wastewater, overflows, storm and river water quality). Improved data reliability has been achieved and is the objective of ongoing developments.

Quantifying Uncertainty: Adding Value to USGS Time-Series Water-Quality Data

Stewart Rounds[1], Stacey Archfield[2], Rob Ellison[3], Janice Fulford[4], Brian Gouge[5], Stuart Hamilton[5], David Holtschlag[6], Brian Pellerin[7], Pat Rasmussen[8] and Susan Wherry[1]
[1]US Geological Survey, Portland, Oreg., [2]US Geological Survey, Reston, Va., [3]YSI, Inc., Boston, Mass., [4]US Geological Survey, Stennis Space Center, Miss., [5]Aquatic Informatics, Inc., Vancouver, B.C., Canada, [6]US Geological Survey, Lansing, Mich., [7]US Geological Survey, Sacramento, Calif., [8]US Geological Survey, Lawrence, Kans.

Abstract
The U.S. Geological Survey (USGS) collects large quantities of data at thousands of sites nationwide, but does not yet have procedures to calculate, store, and communicate uncertainties associated with those data. Current USGS methods for processing time-series data include a qualitative assessment of data quality (ratings of Excellent, Good, Fair, and Poor), but that assessment is not quantitative, not stored in the USGS database, and not communicated to data users. Simply rounding the value of a reported result is insufficient as a characterization of uncertainty, as data collected by a freshly cleaned and

calibrated water-quality probe inherently have a lower uncertainty than data from a fouled probe with a drifting calibration, yet both results are reported in the same way.

At the same time, USGS is working to find new and innovative ways to add value to its data. Applying defensible methods of computing uncertainty for every data point would increase the value of USGS data to almost all data users. Knowing the uncertainty of data would allow modelers, regulators, and resource managers to make better decisions and create better and more accurate products and tools. With a known and quantitative data uncertainty, USGS data not only could be compared to standards and criteria for the protection of human health and the environment, but the probability that such a standard or criterion is exceeded could be computed.

A team of scientists from USGS and private companies is working to recommend methods and guidelines that can be used to quantify the uncertainty associated with time-series water-quality data, with the aim of storing that information in the USGS database and communicating it to data users. The team is drawing upon a wealth of published research and reports regarding methods for assessing and propagating uncertainty. All sources of uncertainty associated with the collection and processing of time-series water-quality data are being identified, and methods will be recommended to assess the uncertainty of each. A framework for quantifying data uncertainty that can be applied to all USGS data will be proposed, as well as specific methods for quantifying data uncertainty for time-series water-quality data.

Estimating the Uncertainty of Mean Daily Water Temperature Using the GUM

Janice Fulford
US Geological Survey, Stennis Space Center, Miss.

Abstract
A group of USGS scientists and private companies are collaborating to recommend methods and guidelines for quantifying the uncertainty of hydrologic measurements. One uncertainty method being considered by the group is the "Guide to the Expression of Uncertainty in Measurement" or GUM by the Joint Committee for Guides in Metrology. The GUM is used to estimate the uncertainty of the daily mean computed from water temperatures collected at set time intervals using continuous monitors to explore the method. A data reduction equation is proposed for use with the GUM. Sources of measurement uncertainty for the mean daily water temperature are identified and estimates of the uncertainty contributed by each source are discussed. The method is then demonstrated with water temperature data collected with a continuous water temperature sensor that has weekly check measurements available for comparison.

Session G4: Detecting and Predicting Cyanotoxins

10:00 – 11:30 am | Room 237

Long-term and Seasonal Trends in Phosphorus Loading to Lake Erie: Links to Harmful Algal Blooms with Insights from 2011 and 2012

Laura Johnson[1], David Baker[1], R. Peter Richards[1], Richard Stumpf[2], Aaron Roerdink[1], Remegio Confesor[1], Jack Kramer[1], Ellen Ewing[1] and Barbara Merryfield[1]
[1]Heidelberg University, Tiffin, Oh., [2]National Oceanic and Atmospheric Administration, Silver Spring, Md.

Abstract
Historically, cultural eutrophication of Lake Erie was a major concern, and through efforts by the United States and Canada starting with the Great Lakes Water Quality Agreement, western Lake Erie became less eutrophic by the mid-1990s. However, over the past decade Lake Erie has been experiencing a recurrence of harmful algal blooms (HABs) in the western basin and an increase in hypoxia in the central basin. The National Center for Water Quality Research at Heidelberg University has been monitoring major tributaries to Lake Erie for up to 38 years. In the agricultural watersheds (*e.g.*, Maumee and Sandusky rivers), long-term trends in loads and concentrations indicate that total phosphorus (TP), which consists of particulate and dissolved P, has decreased since the mid-1970s, whereas dissolved reactive P (DRP) has been increasing drastically since the mid-1990s. Trends in the Cuyahoga River, which is dominated by point-source inputs of P, are quite different - TP and DRP decreased in the mid-1980s and have since leveled off. Thus, increased DRP and HABs appear to be associated with recent patterns in agriculture such as surface broadcasting of fertilizers, build-up of P at the soil surface, unnecessary fertilizer application, increased soil compaction from large equipment, and increased tile drainage intensity. By comparing P loading and HABs in 2011 and 2012, we've gained insight into the potential response of Lake Erie to reduced P loading. In 2011, the HAB in Lake Erie was the largest on record, largely attributed to record-breaking spring P export from the Maumee River followed by abnormally warm and calm lake conditions. In contrast, 2012 had one of the worst droughts in decades. Subsequently, spring P loading from the Maumee River was very low and the 2012 HAB in Lake Erie was minor. On an annual timescale, DRP loading was similar between 2011 and 2012, indicating that timing of DRP loading drives Lake Erie HAB formation. The 2011/2012 comparison also indicates that the Western Basin can respond rapidly to decreased P inputs. Thus, management practices that decrease P runoff (*e.g.*, the 4R concept) should help reduce the occurrence of HABs in Lake Erie.

Understanding and Predicting Harmful Cyanobacterial Algal Blooms at Lake Erie and Ohio Inland Beaches

Erin A. Stelzer, Chris D. Ecker and Donna S. Francy
US Geological Survey, Columbus, Oh.

Abstract
Harmful algal blooms (HABs) have become a water-quality issue at some of Ohio's inland lakes and along the Lake Erie shoreline. The HABs are caused by cyanobacteria (blue-green algae) that produce microcystin and other toxins. For toxin production to occur, the microcystin synthetase genes (*mcy*) must be present in the genome of toxic strains. Monitoring for cyanobacteria genes and the *mcy* genes, which can be detected by molecular methods such as quantitative polymerase chain reaction (qPCR), and for algal pigments using optical sensors may provide an early warning system for HABs. These include sensors based on the fluorescent properties of chlorophyll (indicative of total phytoplankton abundance) and phycocyanin (indicative of cyanobacterial abundance).

The U.S. Geological Survey (USGS), in cooperation with state and local agencies, collected data over a recreational season (May–October, 2013) to better understand the links among cyanobacteria community structure, environmental and water-quality factors, and HAB toxicity. Samples were collected at 8 Lake Erie and inland lake beaches weekly to monthly from several locations within each designated swimming area. Field crews measured specific conductance, dissolved oxygen, pH, temperature, chlorophyll, phycocyanin, and Secchi depth at the time of sampling. Composite samples were preserved and subsequently analyzed for dissolved and total nutrients, cyanotoxins, phytoplankton abundance and community structure, and cyanobacteria and *mcy* genes by qPCR. Preliminary results from 2013 will be presented including information on what genera of cyanobacteria cause HABs and the concentrations of various toxins produced by cyanobacteria at Ohio beaches. Comparisons between DNA-based qPCR methods (which reveal the presence of toxin genes) and RNA-based methods (which can detect microcystin-producing cyanobacteria that are actively expressing the toxin genes) will also be presented. This project will provide data on the potential use of qPCR assays, sensor measurements, or other water-quality or environmental variables to provide an early warning of HAB development in freshwater lakes.

Development of a Molecular Toolbox for Analyses of Bloom-Forming and Toxin-Producing Cyanobacteria in Upper Klamath Lake, Oregon

Sara Eldridge
US Geological Survey, Klamath Falls, Oreg.

Abstract
Upper Klamath Lake (UKL), Oregon, experiences a seasonal progression of cyanobacteria-dominated and toxic blooms, creating poor water quality that may be detrimental to endangered fish species. A recent U.S. Geological Survey (USGS) study of microcystin concentrations, produced primarily by *Microcystis aeruginosa*, and associated nutrient concentrations and ratios, indicated that microcystin occurrence in UKL was associated with the decline of the first major bloom of non-toxin-producing *Aphanizomenon flos-aquae* during the 2007 through 2009 field seasons and highlighted the importance of understanding the ecological interactions between phytoplankton species for predicting periods of elevated cyanotoxin concentrations. Since 2010, the USGS long-term water quality monitoring program has also included sample collection for the identification and enumeration of phytoplankton species to support microcystin monitoring in the lake and to provide data necessary for validating phycocyanin probe data. Analysis of these samples has been only through microscopic counts, which is time-consuming, subject to a high degree of error for certain groups (particularly *Microcystis* because of the low frequency and irregular morphology of the colonies in UKL), and cannot be used to determine which cells are potentially toxigenic. DNA-based molecular methods provide rapid and sensitive diagnoses for the presence of toxigenic or potentially toxigenic cyanobacteria and are valuable tools for biomass estimations and general ecological studies. Molecular methods can also be used to simultaneously address spatial and temporal variation and under different conditions. The UKL molecular toolbox includes a multilevel approach for the rapid analysis of the cyanobacterial community structure and the detection of microcystin-producing strains in water samples with the following levels of sensitivity: 1) quantitative analysis of the cyanobacterial community structure using DNA sequencing, 2) rapid detection and quantification of toxic and nontoxic strains of *Microcystis aeruginosa* using PCR and qPCR, and 3) quantification of total cyanobacteria and species of interest using qPCR, and determination of the relative abundance ratios of total cyanobacteria to specific taxonomic groups, species of interest, and toxin producers. With modification, these techniques can be applied to different sample types (water, sediment, tissue) and, overall, provide a more cost-effective means of surveying phytoplankton species for routine monitoring than by microscopy alone.

Estimating Geosmin and Microcystin Occurrences with Real-Time Water-Quality Monitors, Cheney Reservoir, Kansas, 2001-2012

Jennifer Graham and Mandy Stone
US Geological Survey, Lawrence, Kans.

Abstract
Cheney Reservoir, a primary source-water supply for the city of Wichita, Kansas, routinely experiences cyanobacterial blooms that cause drinking-water treatment concerns associated with taste-and-odor compounds (geosmin) and cyanotoxins (microcystin). Discrete and continuously-measured data were collected in Cheney Reservoir during 2001-2012 for developing reliable tools to estimate geosmin and microcystin occurrence in real-time. Model development related geosmin and microcystin to environmental variables measured easily in real-time (temperature, pH, specific conductance, turbidity, dissolved oxygen, chlorophyll, cyanobacteria, and light). A preliminary linear-regression model using turbidity and specific conductance (R^2=0.71, n=18) that estimated geosmin concentration met with some success, but was not robust over time. Logistic-regression models that estimated probabilities that geosmin would exceed a 5 ng/L threshold and microcystin would exceed a 0.1 µg/L threshold were more robust. The geosmin model included turbidity and a seasonal component (sensitivity=70%, n=127) and the microcystin model included chlorophyll and a seasonal component (sensitivity=89%, n=94). The logistic models performed well under a range of environmental conditions, including some of the most extreme hydrologic events and cyanobacterial blooms observed during the 13-year study. Logistic models indicate the probability of event occurrence, but not magnitude, and allow the user to define the probability at which geosmin and microcystin become a concern. Current models provide hourly probability estimates of geosmin and microcystin exceeding designated thresholds and are available on the internet at http://nrtwq.usgs.gov/ks/. Hourly probability estimates of geosmin and microcystin occurrence will aid the City of Wichita in source-water management and drinking-water treatment decisions.

Session G5: Quantifying the Source and Fate of Nutrients

10:00 – 11:30 am | Room 233

Evaluation of Nitrogen Sources and Transport Processes in the Smith Creek Watershed, an Agricultural Basin in Virginia

Kenneth Hyer
US Geological Survey, Richmond, Va.

Abstract
The Smith Creek watershed is an agricultural basin in the Shenandoah Valley of Virginia that is undergoing considerable implementation of agricultural conservation practices. To better inform decision making associated with the implementation of these conservation practices, an intensive water quality monitoring effort was initiated to determine the nitrogen sources and transport processes within the Smith Creek watershed. Results will be presented from intensive water-quality monitoring at the basin outlet which includes collection of monthly and stormflow water-quality samples, continuous monitoring of field parameters (turbidity, specific conductance, water temperature, pH, and dissolved oxygen), as well as continuous monitoring of nitrate concentrations. Additionally, spatial patterns in nitrogen concentrations were monitored throughout the watershed to better understand which areas contributed the highest nitrogen concentrations and loads; these spatial patterns seem largely controlled by basin geology and land use. Environmental tracer results (including geochemistry, nitrate isotopes, and emerging contaminants) have been used to identify nitrogen sources within the watershed. By understanding

nitrogen transport processes and sources, water-resource managers can better target the implementation of best-management practices and more effectively improve water-quality conditions in the Smith Creek watershed.

Development of Statistical Models to Quantify Sediment and Phosphorus Loads in Small, Rural Watersheds

Amy Russell[1,2] and Richard Cooke[2]
[1]Illinois State Water Survey, Champaign, Ill., [2]University of Illinois at Urbana-Champaign, Urbana, Ill.

Abstract
In small, rural watersheds in western Illinois, the overwhelming majority of sediment and phosphorus loads are delivered during storm flow events. Due to the short duration of the storms, the collection and analysis of data during these runoff events must be done on a sub-daily time step. To investigate the role of individual runoff events on loads, a load calculation method must be selected that allows for investigating small time scales.

Statistical models with residuals-based error correction (*i.e.*, the composite method) have become an increasingly popular technique for load calculations. This study is an application of error-corrected regression models to compute continuous records of suspended sediment concentration and total phosphorus concentration. Due to the small drainage areas of the studied streams, all regression models were developed and applied using a 15-minute time-step. Four methods of constructing continuous concentration records were compared, and the best method was selected in order to compute sediment and phosphorus loads for a 10-year period of study. Comparison of accuracies of the four estimation techniques will be presented for both suspended sediment and total phosphorus load calculations.

During the ten-year study period, 5% of the record accounted for approximately 50% of the flow, 91% of the total phosphorus load and more than 96% of the sediment load. On average, the 1-day maximum accounted for 10% of annual flow and more than 30% of annual sediment and phosphorus load.

Lessons learned from this intensive monitoring effort will be presented, along with recommendations for monitoring design and load calculation techniques for small, rural watersheds.

Connecting the Dots – Continuous Nitrate, Phosphorus, and Sediment Loads in the Illinois River

Kelly Warner, Paul Terrio, Timothy Straub and Nicholas Siudyla
US Geological Survey, Urbana, Ill.

Abstract
The Illinois River basin is an urban and agricultural watershed, including the Chicago metropolitan area and some of the most productive corn and soybean acreage in the nation. The Illinois River contributes approximately one-half of the total flow and the majority of nitrogen and phosphorus load from Illinois to the Mississippi River. There is an extensive historical record of streamflow (since 1939), suspended-sediment (since 1980), and water-quality (since 1974) data for the downstream reach of the Illinois River at Valley City, Illinois, in Scott County. The U.S. Geological Survey has installed a suite of instruments at the Illinois River at Florence station (station 05586300), which is 5.2 river miles downstream from the Valley City station, in May 2011 to measure flow and collect continuous real-time data for stream velocity, nitrate, phosphate, temperature, specific conductance, pH, dissolved oxygen, and turbidity. The continuous data are compared to ongoing discrete water-quality and sediment data collection funded by several agencies, including the USGS and IEPA. The continuous data record provides information that allows for a better understanding and more accurate calculation of baseline loadings, seasonal loadings, and storm-event loadings of nutrients and sediment. Continuous data is also being collected for sediment surrogate evaluation using three different frequencies of acoustic velocity meters and a Laser *In Situ* Scattering and Transmissometry (LISST) during selected time periods. The evaluation of different real-time water-quality and sediment constituents and surrogates, as well as, loads calculation at the Illinois River at Florence provides information required to assess the degree of success and the downstream effects of best-management practices, regulatory changes, and source reductions of nutrients and sediment in the Illinois River basin.

Nitrogen in Minnesota Rivers: Conditions, Trends, Sources, and Reductions

David Wall[1], David Mulla[2], David Lorenz[3], William Lazarus[2], David Christopherson[1], Thomas Pearson[1], Steve Weiss[1] and Dennis Wasley[1]
[1]Minnesota Pollution Control Agency, St. Paul, Minn., [2]University of Minnesota, St. Paul, Minn., [3]US Geological Survey, Moundsview, Minn.

Abstract
Minnesota recently completed a comprehensive report on river nitrogen conditions, trends, sources, and options for reducing loads. River and stream monitoring results from over 700 sites (50,000 water samples) were analyzed to characterize recent surface water nitrogen conditions across Minnesota. The findings, when combined with other river monitoring and modeling results, provide a clear picture of how nitrogen concentrations and loads vary in Minnesota. Nitrogen concentrations and loads are high throughout most of southern Minnesota (exceeding 5 mg/l) and are low in northern Minnesota. Fifteen southern Minnesota watersheds contribute 74% of the load to the Mississippi River, with the highest loads coming from the Minnesota River Basin in south-central Minnesota.

Statistical trend analyses at 51 river sites show how flow-adjusted nitrate concentrations have changed over time between 1976 and 2010. Mississippi River nitrate concentrations have more than doubled since the mid-1970s and are still increasing. The Minnesota River nitrate levels remain very high, but show some recent signs of stability or improvement.

Nitrogen reaches rivers from a variety of sources. The largest source is cropland, contributing an estimated 73% of the statewide load during an average precipitation year. The largest pathway to surface waters is row-crop tile drainage, followed by groundwater baseflow that originates under cropland. Cropland runoff contributes much less nitrate to surface waters compared to the subsurface pathways. Wastewater point sources of nitrogen, dominated by municipal wastewater, contribute an estimated 9% of the load. The estimated sources correlated reasonably well with river monitoring results.

Progress can be made to reduce nitrate through widespread adoption of a series of best management practices, including optimal fertilizer rates and timing, tile drainage management and treatment, and strategic use of perennial vegetation. Minnesota state planning authorities have been using a spreadsheet tool (NBMP) that enables watershed planners to evaluate expected nitrogen reductions to rivers when different combinations of cropland BMPs and BMP adoption rates are considered.

Session G6: Challenging and Innovative Networks, Models, and Application of Conservation Information that Support the Chesapeake Bay TMDL

10:00 – 11:30 am | Room 232

Give and Take: Building and Sustaining Integrated Long-term Water Quality Monitoring Networks in the Chesapeake Bay and Basin.

Peter Tango
US Geological Survey, Annapolis, Md.

Abstract
Long-term data are important for many reasons including documenting change over time, evaluating ecosystem response to disturbance or evaluating ecosystem structure and function in response to management actions. The Chesapeake Bay Program established its tidal bay long-term water quality network in 1984 to document status and track trends in Bay habitat health in response to management activities. A Chesapeake Bay Nontidal Water Quality monitoring network was further established in 2003 under a memorandum of understanding with Chesapeake Bay jurisdictions across the watershed. The Chesapeake Bay Program Partnership provides leadership in the monitoring effort with input from representatives from across the region and working through an organizational structure that includes a Management Board, Goal Implementation Teams, a Science, Technical Assessment and Reporting Team with workgroups and a Chesapeake Bay Program Science and Technical Advisory Committee. The business model supporting monitoring network operations knits and leverages funding, effort and expertise across federal, state, and local agencies, interstate river commissions, academic institutions and citizen monitoring organizations. The operational model supporting monitoring and analysis needs has involved a degree of flexibility in implementing a common set of Bay and Basin-wide monitoring strategies. The monitoring strategies support the acquisition of data and completion of analyses that lead to the presentation of decision-making products for the Chesapeake Bay Program Partnership. It is important to recognize that since the start of the monitoring networks nearly three decades ago, the long-term water quality monitoring programming has not remained static in structure, function and funding. The program has undergone phases of adjustment, building and sustaining monitoring program elements by adapting to the evolving scientific understanding of water quality and its drivers, availability of new technologies for measuring chemical, physical and biological parameters of interest, shifts in funding support, and accounting for management needs of the Chesapeake Bay Program partners. This presentation will review key challenges that led to monitoring program reviews, the collective, strategic community-based processes that led to decisions about financial resource distributions to support network operations, and the incorporation of recommendations that have revised and sustained network operations.

Recording Progress in Agricultural Conservation on Chesapeake Bay Farms Using USDA Data Records: Balancing Privacy with Useful Information

W. Dean Hively
US Geological Survey, Beltsville, Md.

Abstract
In response to the Executive Order for Chesapeake Bay Protection and Restoration (E.O. #13508, May 12, 2009), the United States Geological Survey (USGS) took on the task of acquiring, assessing and evaluating agricultural conservation practice data records for United States Department of Agriculture (USDA) programs, and transferred those datasets in aggregated format to State jurisdictional agencies for use in reporting conservation progress to the Chesapeake Bay Program Partnership's Annual Progress Review. The site-specific USDA data records are privacy protected under section 1619 of the 2008 Farm Bill, but the data can be released whenever information from five or more farms is aggregated together. In 2012, the USGS used its USDA Conservation Cooperator status to obtain site-specific implementation data for conservation programs sponsored by the USDA Natural Resources Conservation Service (NRCS) and the USDA Farm Services Administration (FSA) for all farms within the Chesapeake Bay watershed, documented the methods that were used by the Chesapeake Bay jurisdictions to integrate Federal and State data records and report conservation data to the Annual Progress Review, and supplied the jurisdictions with a USDA dataset aggregated to county scale. A similar tracking, reporting, and assessment will occur in 2013 and future years, as State and Federal governments and non-governmental organizations continue to work with farmers and conservation districts to reduce the impacts of agriculture on water quality. In addition to supporting the Annual Progress Review, the USGS is using the site-specific dataset to support scientific investigations in three USDA Showcase Watersheds (Conewago Creek, PA, Upper Chester, MD, Smith Creek, VA) where USGS researchers are seeking to link land management to water quality monitoring data. In 2014 the project will aggregate the USDA dataset to the small watershed scale (HUC-12) to support watershed management decisions and water quality initiatives associated with Chesapeake Bay TMDLs, EPA 319 programs, and the NRCS Chesapeake Bay Initiative. The information could also be used to investigate water quality response to conservation practices by processing the data through models such Mapshed (Penn State) or Sparrow (USGS) to derive estimations of conservation effects (reduced nutrient and sediment loading from farmland).

Linking Models of the Atmosphere, Watershed, and Estuary to Inform the Chesapeake Bay TMDL

Gary Shenk
US Environmental Protection Agency, Annapolis, Md.

Abstract
The Chesapeake Bay Total Maximum Daily Load (TMDL) requires significant reductions in nitrogen, phosphorus, and sediment to meet water quality standards. The federal government, the six states in the watershed, and Washington. D.C. all have separate commitments under the TMDL to make these reductions. The Chesapeake Bay Program Partnership used linked atmospheric, watershed, and estuarine models along with input from stakeholders to arrive at an allocation method. This allocation method took into account the ability of each jurisdiction and sector to make load reductions, the relative position of each jurisdiction in the watershed, the relative position of the point of entry of the loads to the estuary from each jurisdiction, and the benefits derived from a restored bay.

Application of the Chesapeake Bay Program Partnership's Watershed Model in Support of the Chesapeake Bay TMDL

Gary Shenk[1], Olivia Devereux[2] and Matt Johnston[3]
[1]US Environmental Protection Agency, Annapolis, Md., [2]Devereux Environmental Consulting, Silver Spring, Md., [3]University of Maryland, Annapolis, Md.

Abstract
The Chesapeake Bay Program Partnership's (CBP) Watershed Model (CBWM) has been in continual use and development since 1985. The CBWM estimates the amount of nitrogen, phosphorus, and sediment that are delivered to the tidal waters of the Chesapeake from the 64,000 square mile watershed for current, past, and future scenarios. The CBP uses the CBWM to estimate load from point and nonpoint sources, from basins, and form jurisdictions within the watershed. The CBWM is comprised of a model of watershed inputs (Scenario Builder), a dynamic model of the watershed (the Phase 5 watershed model), and a web based tool that predicts the output of the other two tools (CAST). The current version of the CBWM has been developed with extensive partnership and scientific input specifically for use in the TMDL. The CBWM is extensively calibrated to hundreds of monitoring stations.

Session G7: Developing and Using Local and Regional Water Quality Data Exchanges

10:00 – 11:30 am | Room 231

The AL-MS-KY Multi-State Configurable System: Promoting Data Consistency and Comparability, Improving Efficiency, and Reducing Costs of Managing State Agency Water Quality Monitoring Data

Lisa Huff[1], Lara Panayotoff[2], Valerie Alley[3], Vickie Hulcher[1], Melissa Miracle[2], Gina Curvin[1], Natalie Segrest[3] and Jon Becker[4]
[1]Alabama Dept. of Environmental Management, Montgomery, Ala., [2]Kentucky Dept. of Water, Lexington, Ky., [3]Mississippi Dept. of Environmental Quality, Jackson, Miss., [4]US Environmental Protection Agency, Atlanta, Ga.

Abstract
Management of water quality data is a significant challenge for state agencies dealing with ever-changing needs for compiling, reviewing, and analyzing data to support decision-making with increasingly limited resources and staff. In 2008, Alabama Department of Environmental Management (ADEM) demonstrated their newly developed data management system, ALAWADR, at a regional state biologists meeting. After discussions and further demonstrations, Mississippi (MDEQ) and Kentucky (KDOW) decided to adopt this system to meet similar needs to bring water quality data from different state programs into a single comprehensive data management system. Both states have been able to focus efforts and money on state-specific requirements and new capabilities, such as more tools for data assessment and incorporating more types of biological data. ADEM began benefitting when the other states enhanced the system and reported back on what they had done. In 2013, EPA Region 4 became involved in supporting and facilitating a more formal collaborative structure for the group and the "Multi-State Configurable System" was born. A formal structure and a direct line communication with EPA data management personnel has allowed the group to work with better focus on sharing system enhancements and planning for the future. The collaboration also allows the states to benefit from a collective set of skills and expertise not found in any one state. ADEM was able to successfully write a grant for system enhancements that included funding for multiple in-person work meetings of the MSCS, the first of which was held in October 2013. Three posters in this session show the basic details of the state systems and selected features developed by each of the states.

WaDE: An Interoperable Data Exchange Network for Sharing Water Planning and Use Data

Sara Larsen
Western States Water Council, Murray, Ut.

Abstract
Whether addressing population growth, national security, drought, climate change, or meeting our growing energy needs, questions surrounding water availability in the West will only increase and become more important in the coming years. The Water Data Exchange (WaDE) is a project initiated to assist state water agencies to answer these kinds of local, regional, and national water availability questions more easily, more sustainably, and more cost effectively. In 2011, the Western States Water Council (WSWC), in coordination with the Western Governors' Association (WGA), the Department of Energy (DOE) National Laboratories, and the Western States Federal Agency Support Team (WestFAST), initiated the WaDE project to enable the exchange of water planning, water use and water allocation data between state water agencies, federal agencies, and the public. The goals of the project include the establishment of a governance structure, the evaluation of the current capabilities and methods used within the states, the design of a common format (*i.e.*, data schema) that specifically targets derived water data products and/or water-quantity type information, database and web service design and development, and implementation within state IT environments.

WaDE employs an innovative, distributed data framework, wherein partners control and maintain datasets locally (ensuring that published data are the best available), while making them discoverable via a centralized web mapping application and web service requests. The data are transferred using platform-independent eXtensible Markup Language (XML), which can be automatically incorporated into other models or products. The implementation of WaDE will dramatically increase the availability of water quantity-related information, both from state and eventually federal partners. It will also directly support national water security efforts and better decision-making by agencies pursuing an integrated water resource management approach. The project itself serves as a model for other parties interested in developing and sharing specific datasets using a distributed, real-time retrieval mechanism.

Calamari or Compliance? New Mexico Combines Water Quality and CWA 303(d)/305(b) Reporting to Make "SQUID"

Lynette Guevara, Meghan Bell, Dan Gandhi and Tom McMichael
New Mexico Environment Department, Santa Fe, N.M.

Abstract
Surface water quality monitoring consists of a wide variety of field and laboratory data, which can be received in numerous formats, but ultimately must be reported to national databases for 303(d) and 305(b) purposes. Data collected by New Mexico Environment Department's (NMED) Surface Water Quality Bureau (SWQB) during rotational watershed surveys includes field and laboratory physical/chemical data; flow data; long-term data sets using thermographs and sondes; fish, benthic macroinvertebrates, periphyton, and phytoplankton; and habitat and geomorphic data. For many organizations that collect water quality data, multiple databases are used to house these data, resulting in duplication of work and wasted time, or the need for such a system prioritized.

In 2009, NMED's SWQB and IT Department developed a water quality database (called NMEDAS) to improve internal data storage and reporting, as well as to streamline uploading data to the US Environmental Protection Agency' s (EPA) Water Quality Exchange (WQX). Using EPA Exchange Network Grant funds, NMED combined NMEDAS and NM's version of the Assessment Database (ADB) in 2013 to create New Mexico's Surface water QUality Information Database (SQUID). SQUID houses both water quality data and associated 303(d)/305(b) designated use attainment conclusions based on the water quality data in one Oracle® database schema. A variety of custom reports have been built into SQUID to assist with data verification and validation, assessment, and preparation of NM's CWA 303(d)/305(b) Integrated List. Using SQUID, NM is now able to electronically report assessment conclusions to ATTAINs via the OWIR Central Data Exchange (CDX) data flow.

SQUID has resulted in improved uniformity and consistency in data management and reporting and is an essential tool for NMED SWQB's Monitoring, Assessment, and Standards Section in order to meet CWA 106 grant deliverables. The combined database allows monitoring staff to upload data which can be directly accessed by assessment staff. With all staff working within the same system, and electronic reporting of assessment conclusions, errors due to crossing between separate databases are limited, or altogether avoided, saving time and energy.

Using Cloud Computing to protect Ecology, Economy, and Tradition through the Wild Rice Wetlands Water Quality Data Sharing Project

Nancy Schuldt[1], Mark LeBaron[2] and Dave Wilcox[2]
[1]Fond du Lac Band of Lake Superior Chippewa Reservation, Cloquet, Minn., [2]Gold Systems, Inc., Salt Lake City, Ut.

Abstract
For many tribes in the upper Great Lakes Basin, wild rice is a very important resource from traditional, economical, and ecological viewpoints. Tribes have various programs and methodologies for monitoring the water quality and the rice production in the wetlands where wild rice is found. However, tribes don't necessarily use common procedures resulting in common metrics that can be compared and/or aggregated. Furthermore, tribes don't have a good way to share and analyze data and have almost no mechanisms for collaborating regarding the data. Many tribes have no effective way to show water quality changes over time compared to a baseline data set.

The Wild Rice Wetlands Water Quality Data Sharing Project is designed to address these problems. Using a combination of agreed-upon procedures and Information Technology, the project will establish common measures and will employ a web-based database application for capturing, analyzing, and sharing the data. Consortium members will be able to use the web-based system to consult with their peers regarding their data without having to email files of data back and forth. With the data in a single database, researchers will be able to view and analyze the data from an aggregate perspective; thus giving them the tools they need to obtain a broader perspective of the wild rice situation over time. Members will be able to include each other's data when performing analysis with reports, graphs, and maps.

The key enabling IT technology for this project is the Ambient Water Quality Monitoring System (AWQMS), which has been used by the Fond du Lac Environmental Program for several years. A major task of the project will be to aggregate historical datasets and import them into the AWQMS database. The web-based AWQMS application will be provided via "the cloud" for consortium members. Using AWQMS, members will be able to collaborate with and assist one another to load, analyze, and interpret their water quality information. Furthermore, members will be able to share data outside of the consortium via the EPA's Water Quality eXchange (WQX) on the exchange network.

Session H1: Monitoring and Assessing Large River Ecosystems

1:30 – 3:00 pm | Room 263

Creation of a Multi-metric Macroinvertebrate Index and Implications for Annual Ohio River Assessments

Ryan Argo
Ohio River Valley Water Sanitation Commission (ORSANCO), Cincinnati, Oh.

Abstract
A central task of the ORSANCO Biological Programs is to ensure that the Ohio River is capable of maintaining healthy wildlife populations. Our program currently employs a multi-metric fish index to assess the overall quality of the Ohio River as part of a biannual report to congress to fulfill 305(b) requirements. In 2007, a macroinvertebrate collection method comparison study was initiated to determine which method, or combination of methods, is the most appropriate for characterizing Ohio River macroinvertebrate communities. This study was completed in 2012 by comparing the results of multiple indices derived from three macroinvertebrate collection methods (*e.g.*, two Hester-Dendy deployments and a multi-habitat sweep) and four abiotic gradients identified from various environmental measures (*e.g.*, water and sediment chemistry, sestonic and sedimentary nutrients). Data used to generate the abiotic gradients was obtained via our involvement in a cooperative Environmental Monitoring and Assessment Program (EMAP) project. As the ultimate goal of this study was to facilitate the creation of a second biological indicator, our last task was to determine how to incorporate the new index into our annual assessments of Ohio River segments. There are two common approaches, independent application and weight of evidence, employed by regulatory agencies when interpreting the results of multiple biological indicators. We held a discussion of these two approaches with agency representatives of our consignatory states and the federal government before arriving at the appropriate approach for our Ohio River assessments.

A Multi-Disciplinary Large River Assessment of the Susquehanna River, Pennsylvania

Michael Lookenbill and Tony Shaw
Pennsylvania Dept. of Environmental Protection, Harrisburg, Pa.

Abstract
The Susquehanna River basin is the largest river system in Pennsylvania and is the largest tributary to the Chesapeake Bay; providing about 50% of the Bay's fresh water. The lower Susquehanna River and its larger tributaries were well known for its world-class smallmouth bass (SMB) fishery. The health and vitality of the Susquehanna River's SMB population fishery has declined in recent years as evidenced by wide-scale, disease-related young-of-year (YOY) mortality, and occurrence of intersex SMB male fish.

This declining health of the River's SMB fishery prompted many local stakeholders to call for listing the River as impaired in Pennsylvania's 305(b) & 303(d) report to EPA. After some initial water quality pilot studies, the Pennsylvania Department of Environmental Protection (PA-DEP) is implementing a rigorous three year study of the River and its major tributaries to support a sound, scientifically defensible assessment of the Susquehanna River and its SMB fishery. The study incorporates a wide array of protocols and analytical methods to examine both natural and anthropogenic stressors as possible sources and causes of the River's SMB decline. These sampling protocols and analytical methods include inorganic water chemistry sampling; continuous instream physical chemistry monitoring; biological sampling (benthic macroinvertebrates, fish, mollusks, and periphyton); nutrients and fatty acid analysis (algae and SMB); fish histo-pathology; storm event sampling; sediment and organic water grab and passive Polar Organic Chemical Integrative Sampler/Semi-Permeable Membrane sampling for pharmaceuticals, antibiotics, hormones, organic wastewater compounds, and pesticides; and flow.

Much of the River's larger segments exhibit very wide and shallow stream channels that inhibit mixing and effectively splits the Lower Susquehanna into three characteristically different river flow channels. Because of this lack of mixing, sampling locations for the larger mainstem segments are being sampled in separate transects across the three flow channels while those on the narrower Juniata River tributary are being transect sampled across two channels.

In addition to PA-DEP staff, USGS, Susquehanna River Basin Commission, and Pennsylvania Fish & Boat Commission are assisting with field sampling and laboratory efforts. This multi-disciplinary study will continue through 2015. This presentation will summarize findings and progress made through 2013.

Ranking Relative Effects of Environmental Factors at Various Spatial Scales on Ohio River Biotic Condition

Jeff Thomas
Ohio River Valley Water Sanitation Commission, Cincinnati, Oh.

Abstract
With recent increased availability of accurate land use and hydrology datasets, it has become almost common place to use a geographical information system (GIS) to conduct detailed analyses of various factors affecting biotic condition of small streams. Due to the complexity of large rivers, and a relative shortfall of comprehensive biological datasets, very few similar efforts have been undertaken on these systems. Operating under a cooperative agreement with USEPA as an extension of the Environmental Monitoring and Assessment Program - Great Rivers Ecosystems, the Ohio River Valley Water Sanitation Commission (ORSANCO) recently completed an investigation of environmental stressors on the condition of Ohio River fish and macroinvertebrates. As part of the study, which ran from 2007 to 2012, fish and macroinvertebrate population surveys were conducted at 336 unique 0.5 km long locations along the main stem shoreline of the Ohio River. Along with biotic community data, at each location within the same sampling season, water and sediment chemistry parameters were also collected, along with field estimates of local and neighborhood (upsteam two miles and downstream one mile) riparian condition. Using a GIS, land use characteristics were summarized at various scales relating to each of the biological sampling locations. In this way, data were derived for the entire catchment basin upstream of each navigational pool (distance between two high-lift dams) that the sites fell into, as well as for the lateral inputs draining into each pool individually. Using these parameters, ORSANCO biologists were able to rank the relative influence of multiple stressors at several scales on the biotic condition of 18 of the 19 Ohio River navigational pools.

The New England Non-Wadeable Rivers Fish Assemblage Assessment Project

Chris Yoder
Midwest Biodiversity Institute, Columbus, Oh.

Abstract
An assessment of the fish assemblages of the large rivers in New England occurred in 2008-9. A standardized raft and boat mounted electrofishing method that was previously developed and tested in Maine during 2002-7 was used to sample the fish assemblages of non-wadeable rivers. A probabilistic sampling design derived from the 2008-9 National Rivers and Streams Assessment (NRSA) was employed. An intensive survey design was embedded alongside and provided the opportunity to compare the assessment outcomes of the two sampling designs on a river-specific and regional basis. In terms of survey logistics, less than 10% of the probabilistic sites were rejected. Reasons for rejection included sites being wadeable (the target was for raftable and boatable sites) and either access or safety issues. The break point between wadeable and non-wadeable generally occurred at the Strahler order IV-V boundary with most order IV sites being wadeable and most order V sites being non-wadeable, although a few exceptions did occur. A comparison of the assessment outcomes for both spatial designs was accomplished regionally and for the non-tidal portion of the Connecticut River mainstem. The probabilistic and intensive survey designs produced roughly comparable median Maine River IBI results for the regional and the Connecticut River cases. However, in both comparisons the intensive survey design uniquely revealed the highest quality sites and river segments in New England based on Maine River IBI scores and an accompanying scaling to a Biological Condition Gradient (BCG). BCG Level II (highest quality found) scores were evident only from the intensive survey design and most were located in northern and western Maine. No probabilistic sites had IBI scores above BCG Level III. A first order analysis of regional stressors was also accomplished and limiting factors included hydrological, local habitat, location and number of barriers, and land use related factors. These gradients of disturbance generally increased from north to south across New England and it corresponded to Maine IBI scores and other fish assemblage indicators. An initial examination of signals in the biological data revealed significant weaknesses in both the coverage and relevance of the regional scale stressor gradients.

Session H2: Monitoring Councils and Coalitions: Examples and Lessons

1:30 – 3:00 pm | Room 262

The Pacific Northwest Aquatic Monitoring Partnership: A Forum Regional Coordination

Gretchen Hayslip[1] and Jennifer Bayer[2]
[1]US Environmental Protection Agency, Seattle, Wash., [2]US Geological Survey, Cook, Wash.

Abstract
Federal, state, tribal, local, and private aquatic monitoring programs in the Pacific Northwest evolved independently in response to different organizational and jurisdictional mandates and needs. To enhance efficiency and effectiveness of their monitoring efforts, the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) provides a forum that supports collaboration and coordination among organizations and across jurisdictions. PNAMP consists of federal, tribal, and state partners from both fisheries and water quality agencies; other interested participants; and a coordinating staff. Activities are conducted by participant working groups and teams as endorsed by the partner-based steering committee. PNAMP receives significant policy support and direction by member organizations, commitments of technical resources and staff time and funding for the coordination itself.

Topics of interest to partners include monitoring methods and design; the management and exchange of data; status and trends and species abundance distribution; and habitat assessment (with emphasis on review of methods across monitoring programs). To sustain the results of our collaboration and assist practitioners, PNAMP has developed online resources to create a network of information and tools to support many facets of monitoring. PNAMP's www.MonitoringResources.org, available free online, is intended to promote better documentation and enable more efficiency in collaboration and data sharing between programs and includes PNAMP's protocol and methods library, a community forum, Sample Designer, monitoring Site Manager, Monitoring Advisor, and data management resources. All tools and resources are available via the web and could be used to support monitoring in other regions of the country. PNAMP is seeking to collaborate with additional partners and at scales beyond the Pacific Northwest.

Measuring the Effectiveness of California's Water Quality Monitoring Council

Jon Marshack
California Water Quality Monitoring Council, Sacramento, Calif.

Abstract
In December 2010, in response to state legislation and a formal agreement between the state's environmental protection and natural resource management agencies, the newly formed California Water Quality Monitoring Council delivered its recommended Comprehensive Monitoring Program Strategy for California. The strategy was mandated to improve the efficiency and effectiveness of the state's water quality and associated ecosystem monitoring, assessment, and reporting through increasing collaboration between a myriad of governmental agencies and non-governmental organizations that currently monitor California waters. The Council's strategy focuses on delivering water quality and ecosystem health information to decision makers and the public through a set of theme-specific internet portals. Each portal is developed by

a collaborative workgroup composed of stakeholders with specific expertise in a particular theme. "Is it safe to swim in our waters?" "Are our wetland ecosystems healthy?" These portals bring together data and information in a readily understandable manner that directly addresses users' questions. In order to design, construct, and maintain these portals each workgroup is challenged to review existing monitoring and assessment efforts, data management procedures, and web reporting technologies and to make specific improvements. To succeed, the workgroups endeavor to standardize methods and procedures only to the degree necessary to deliver data and information to the user.

The Council's enabling legislation requires that the Secretaries of California's environmental protection and natural resource management agencies conduct a triennial audit of the effectiveness of the Comprehensive Monitoring Program Strategy. The time for that audit is now. Mainly through grass-roots efforts convincing individual stakeholders that it is in their own best interest to invest in collaboration, the strategy has made considerable progress. Newly standardized procedures are poised for the first time to be able to determine the extent and health of California's wetlands and changes over time. Clean Water Act water quality assessment and impaired waters listing procedures now benefit from improved synchronicity of available data, data integration, and communication. The audit will answer fundamental questions: Are users satisfied with access to data? Are we better able to answer key management questions? Have these improvements allowed better use of data in management decisions?

Partnerships for Communication and Cost Savings

Carrie Ruhlman
North Carolina Division of Water Resources, Raleigh, N.C.

Abstract
With over 63,000 miles of streams and 260,000 acres of freshwater lakes in North Carolina, the Division of Water Resources (DWR) lacks the means to characterize all waters of the State, as required by Section 305(b) of the Clean Water Act. To address this issue, North Carolina supports a monitoring coalition program by which NPDES permittees voluntary partner with the DWR, stakeholders and each other and engage in basin-wide water quality sampling that provides high-quality data and other tangible benefits to all parties.

North Carolina has seven monitoring coalitions in five of its river basins. In addition to water quality monitoring, coalitions address watershed-based goals, such as TMDL compliance, nutrient reduction, stream restoration and non-point source pollution identification.

For members with NPDES permits, the DWR waives their individual in-stream monitoring requirements in exchange for participation. For other members, the program provides the opportunity to participate in watershed management with minimal financial investment. The Coalition Program produces quality ambient data that are readily available in a consistent electronic format. The data are used by both coalition members and the DWR for compliance assessment, trend analyses, modeling, planning and permitting.

Coordination of the Program is performed by a single DWR position, serving as a liaison between the coalitions and the DWR. This position facilitates the collection and reporting of water quality data at over 260 monitoring locations on a monthly basis, in accordance with each individual coalition's Memorandum of Agreement.

The DWR utilizes coalition partnerships to meet the challenges of improving communication, expanding monitoring coverage, maximizing limited resources and bolstering confidence in monitoring methodologies and water quality data. Cooperative monitoring encourages productive working relationships and ownership of one of the State's most valuable resources...its water.

The Evolution of the Virginia Water Monitoring Council: Becoming a 501(c)(3) Nonprofit Organization

Chris French[1,2]
[1]Virginia Water Monitoring Council, Blacksburg, Va., [2]Filterra Bioretention Systems, Ashland, Va.

Abstract
The Virginia Water Monitoring Council (VWMC) began in 1999 as a collaborative network of interested government, nonprofit, and private entities that had an interest in promoting and coordinating water quality monitoring efforts throughout Virginia. The VWMC has operated as a loose-knit organization since its inception, following guidelines and operational procedures. However, like many volunteer led efforts, the VWMC has been challenged with resource constraints.

This presentation will provide a review of key historical organizational objectives and discuss the current effort to transition the VWMC into a recognized 501(c)(3) organization. VWMC products and program outcomes will be discussed as well as the organization challenges that led the VWMC leadership to determine that becoming a non-profit professional organization was necessary in order to maintain and grow the organization's capacity.

Session H4: Contaminants of Emerging Concern

1:30 – 3:00 pm | Room 237

Bottoms up? Chemical and Microbial Contaminants of Emerging Concern in Source Water and Treated Drinking Water of the United States

Susan Glassmeyer[1], Edward Furlong[2], Dana Kolpin[3], Angela Batt[1], Bob Benson[4], Scott Boone[5], Octavia Conerly[6], Maura Donohue[1], Dawn King[1], Mitch Kostich[1], Heath Mash[1], Stacy Pfaller[1], Kathleen Schenck[1], Jane Ellen Simmons[7], Eunice Varughese[1], Stephen Vesper[1], Eric Villegas[1] and Vickie Wilson[7]
[1]US Environmental Protection Agency, Cincinnati, Oh., [2]US Geological Survey, Denver, Colo., [3]US Geological Survey, Iowa City, Ia., [4]US Environmental Protection Agency, Denver, Colo., [5]US Environmental Protection Agency, Stennis Space Port, Miss., [6]US Environmental Protection Agency, Washington, D.C., [7]US Environmental Protection Agency, Research Triangle Park, N.C.

Abstract
The drinking water and wastewater cycles are integrally linked. Chemicals that are present in household wastewater may be sufficiently mobile and persistent to survive on-site or municipal wastewater treatment and post-discharge environmental processes. Such compounds have the potential to reach surface and ground waters which can be the sources of drinking water. The US Environmental Protection Agency (USEPA) and the US Geological Survey (USGS) have collaborated on two sampling campaigns assessing untreated and treated drinking water sources in the United States. In Phase I (2007), samples from nine drinking water treatment plants (DWTPs) were analyzed for over 80 contaminants of emerging concern (CECs). In Phase II (2010-2012), samples from 25 DWTPs were analyzed for over 250 organic, inorganic and microbial analytes (which includes the Phase I analytes). Five DWTPs were sampled in both Phase I and II. Sampled DWTPs utilized a mix of surface and ground water sources, and used a variety of disinfectants (*e.g.*, chlorine, chloramine, and advanced treatments such as ozone and UV). Of the organic and microbial analytes in Phase II, 135 were detected at least once in the source water, and 104 were detected at least once in the treated water. In a single DWTP, the maximum number of analytes detected was 96 in the source water and 59 in the treated water; the median number of analytes across the 25 DWTPs was 33 in the source water and 21 in the treated drinking water. An examination of the source water data suggests that CEC frequency may be associated with season of sample collection, watershed land use, waterbody type, and total organic

carbon. When the source water data is compared to their corresponding treated drinking water samples, the qualitative efficacy of various treatment practices can be examined.

Pharmaceuticals and Other Contaminants of Emerging Concern (CECs) in Source and Treated Drinking Waters from 25 Drinking Water Treatment Plants: Compositions, Concentrations, and Reductions

Edward Furlong[1], Angela Batt[2], Susan Glassmeyer[2] and Dana Kolpin[3]
[1]US Geological Survey, Denver, Colo., [2]US Environmental Protection Agency, Cincinnati, Oh., [3]US Geological Survey, Iowa City, Ia.

Abstract
The widespread presence and distribution of pharmaceuticals & anthropogenic waste indicators (AWIs) in surface and ground water has created substantial scientific and public interest in their presence and distribution in water supplies and potential consumer exposure in drinking water. Thus, a comprehensive assessment of a wide range of CEC classes is necessary to assess potential for exposure to mixtures of these compounds.

In response, the U.S. Geological Survey and the U.S. Environmental Protection Agency jointly conducted a study of CECs in water from 25 drinking water treatment (DWTP) plants across the United States, sampling ground- and surface-water sources prior to and after treatment processes commonly used to produce drinking water. The DWTPs studied reflected diverse geographic locations, water sources, disinfectants, and plant sizes. Five complementary methods were used to determine 199 CECs, including 134 pharmaceuticals. Subsets of compounds common to two or more methods were used to verify detections.

Pharmaceuticals were detected in both source and treated water samples, ranging in concentration from 2.5 to 940 ng/L, with more frequent and higher concentrations generally occurring in source water samples. Metformin, tramadol, and carbamazepine were the most frequently detected pharmaceuticals in source water samples at maximum concentrations of 730, 42, and 40 ng/L, respectively. Metformin, carbamazepine and cotinine were most frequently detected in treated water samples at maximum concentrations of 92, 17, and 16 ng/L, respectively. Concentrations of carbamazepine, frequently detected in source and treated waters and measured in four methods, were significantly correlated.

The AWIs caffeine, N,N-diethyl-meta-toluamide (DEET) , and tri(2-butoxyethyl) phosphate were most frequently detected in source water at maximum concentrations of 130, 98, and 470 ng/L, respectively. Bromoform, caffeine, and DEET were the most commonly detected AWIs in treated water samples at maximum concentrations of 3300, 75, and 25 ng/L, respectively. Frequent high concentrations of bromoform likely are due to formation as a disinfection by-product (DBP). These results suggest that multiple pharmaceuticals and AWIs are present at concentrations below 1000 ng/L in both source and treated drinking water. Treatment processes evaluated in this study reduce detections and maximum concentrations of many, but not all, measured CECs.

Effects of Treated Wastewater Effluent on Water-Quality, Sediment-Quality, and Biological Condition in Spirit Creek, Fort Gordon, Georgia

Paul Bradley and Celeste Journey
US Geological Survey, Columbia, S.C.

Abstract
Fort Gordon is a U.S. Department of the Army (Army) facility located in east-central Georgia, near Augusta. A wastewater treatment plant on Spirit Creek was closed prior to 2012. The U.S. Geological Survey, in cooperation with the Fort Gordon's Environmental and Natural Resources Management Office, has been conducting a two-phase study to assess the water quality, sediment quality, and biological conditions of Spirit Creek at sites upstream and downstream from the wastewater treatment plant outfall prior to (phase 1) and after (phase 2) closure of the plant. Specifically, concentrations of major ions, trace elements, nutrients, and contaminants of emerging concern (for example, fragrances, detergent agents, pharmaceuticals, and hormones) in water and sediment and benthic macroinvertebrate community structure were assessed and compared among sites and between phases. In phase 1, several types of contaminants of emerging concern were detected in water and sediment at sites downstream from the treated effluent outfall, including detergent agents, flame retardants, fragrances, and hormones. Many of the detected contaminants also are known endocrine disruptors. However, the frequency of detection and concentrations varied between the sediment and water. In the water column of Spirit Creek, total nitrogen and phosphorus concentrations increased by more than an order of magnitude downstream from the wastewater effluent discharge. Inorganic constituents, including metals and major ions, also demonstrated higher concentrations in water at downstream sites relative to the upstream site. Benthic macroinvertebrate richness and diversity metrics were determined at the upstream and one downstream site. The computed metrics demonstrated reduced richness and diversity at the downstream site, which indicated a cumulative negative effect on the biological community by environmental stressors at the downstream site. The post-closure ecosystem response will be presented.

Development of Indicators for Emerging Trace Organic Compounds

Drew McAvoy[1], Carrie Turner[2], John Wolfe[2] and Allen Burton[3]
[1]University of Cincinnati, Cincinnati, Oh., [2]LimnoTech, Ann Arbor, Mich., [3]University of Michigan, Ann Arbor, Mich.

Abstract
Trace organic compounds (TOrCs), such as pharmaceuticals and personal care products, are emerging pollutants of concern because of documented adverse effects on aquatic life. However, the effects and corresponding exposure levels of many TOrCs and mixtures of TOrCs are not well understood. Sampling and analyzing TOrCs is challenging because their physical and chemical properties are often quite different from conventional pollutants. In addition, highly sensitive analytical methodologies are needed to measure quantifiable amounts of TOrCs and to relate exposure levels to aquatic effects. These methods require the use of multiple preparatory and analysis procedures. As a result, the costs and equipment needed for sample collection, preparation, and analysis can exceed the resources of the typical municipal utility. A simpler and smaller list of compounds to function as indicators has been developed as part of a Water Environment Research Foundation (WERF) study (CEC6R12) to develop screening tools for evaluating the impact from TOrCs. The indicator list of TOrCs was developed to add clarity to the prioritization process, to facilitate the use of the site screening framework, and to potentially reduce analytical costs. This paper presents the development of the list of indicator TOrCs, the analytical methodology to measure the indicator TOrCs, and the factors used to develop the list, including ubiquitousness, chemical properties, fate and transport, toxicity, treatability through conventional wastewater treatment processes, reliability as an indicator, and aquatic effects.

Session H5: Methods and Management of Dissolved Oxygen Issues

1:30 – 3:00 pm | Room 233

Maximizing the Value of Existing Monitoring Technologies: Stream Temperature and Dissolved Oxygen as Best Case Examples

Bob Rose
US Environmental Protection Agency, Washington, D.C.

Abstract
It is proposed that maximizing the value of any given water quality monitoring technology requires uniquely addressing technology dissemination, field labor logistics, data handling, and data analysis for each unique monitoring technology. As result there is likely a significant gap between the volume, quality, cost, and use of monitoring data versus the true potential, even for current technologies. As a best case example a stream temperature monitoring pilot in 2012 demonstrated the potential for a very low cost technology to create statistically robust (high certainty) baselines within three months. The pilot exemplified the value and need to correlate water quality data against climatic variables where possible. A second water quality parameter, dissolved oxygen, was explored using publicly available data. An analysis technique is proposed for dissolved oxygen in free flowing streams, which was found to provide the most statistically reliable results for the data analyzed. Based on these two experiences, conceptual discussion of potential information technology solutions is provided with the goal of minimized cost and maximized value.

Coming Up for Air: Perspectives from Five Years of DO Monitoring in Illinois

James Slowikowski, Rachel Higgins and Amy Russell
Illinois State Water Survey, Champaign, Ill.

Abstract
In 2009 the Illinois State Water Survey (ISWS) began a five year project in conjunction with the Illinois Environmental Protection Agency (IEPA) to collect continuous water quality information throughout the State of Illinois. These data are being collected through the deployment of water quality sondes as well as in situ sampling and discharge measurements when sondes are deployed and retrieved. Standard deployments are for a minimum of seven consecutive days with each site being monitored once during the period of June 1st – July 31st and again during the period of August 1st – September 30th. Continuous monitoring parameters include; dissolved oxygen, pH, temperature, conductivity and turbidity. Sampling sites and schedules are coordinated with other monitoring efforts associated with the IEPA Intensive Basin Survey program such as mussel, fish and invertebrate surveys. To date, through this effort the ISWS has performed approximately one thousand sonde deployments at five hundred sites throughout the State.

This presentation will provide an overview of the project goals and objectives, equipment and methodologies that the ISWS are using for our monitoring and data management efforts as well as interesting results and lessons learned during our first five years of data collection.

Causes of Low Dissolved Oxygen in the Smithland Pool of the Ohio River

Gregory Youngstrom and Jamie Wisenall
Ohio River Valley Water Sanitation Commission, Cincinnati, Oh.

Abstract
The Ohio River has failed to meet the water quality standard for dissolved oxygen in the Smithland Pool, downstream of the Wabash River. Ohio River Valley Water Sanitation Commission (ORSANCO) is 3 years into a 5 year study to determine the Wabash River's contribution and causes of low dissolved oxygen levels in the Ohio River Smithland pool.

To accomplish these goals, a monitoring station was placed on the Wabash River at New Harmony, Indiana and operated continuously since August of 2010. A datasonde was used to measure DO, temperature, pH, conductivity, turbidity, and chlorophyll *a* every 30 minutes. Every two weeks, water samples were collected and analyzed for nitrate/nitrite, Total Kjeldahl Nitrogen, ammonia, total phosphorus, biochemical oxygen demand, and total suspended solids. Monitoring stations were also placed on the Ohio River, both upstream and downstream of the Wabash River confluence.

Low DO levels in Smithland pool do not seem to be associated with a diurnal DO fluctuation, indicating that these results are not caused by an influx of algae. Based on chlorophyll *a* results, the Wabash River has much greater concentrations of algae, but this does not appear to affect the amount of algae on the Ohio River. Also, the algae community structure shows a limited effect of the Wabash River on that of the Ohio. Nutrient concentrations at the upper end of Smithland pool were never exhausted, indicating they are not a limiting factor of algae growth on the Ohio River.

The Wabash River provides a large load of BOD, but sampling results indicate very little BOD on the Ohio River. The concentration of BOD on the Wabash tends to be highest during low flow periods which is also when low DO levels are commonly observed on the Ohio River.

BOD measurements in Smithland pool are collected at Smithland locks and dam, which is 70 miles downstream of the Wabash River. It may be that the influx of BOD is consumed prior to arriving at the Ohio River sampling point, resulting in low DO at Smithland locks and dam.

Hopkins Pond Restoration Using Underwater Aeration and Artificial Floating Wetlands

Mike Haberland[1] and Craig McGee[2]
[1]Rutgers University, Cherry Hill, N.J., [2]Camden County Soil Conservation District, West Berlin, N.J.

Abstract
In eutrophic lakes and ponds, conditions of warm, calm water, low inflow, and with elevated nutrients, can cause photosynthetic blue-green algae (cyanobacteria) to increase dramatically. These "blooms" may be visible as floating scum that resembles blue, green or even red paint on the surface of the water. Hopkins Pond, Haddonfield, New Jersey, experiences intense cyanobacteria blooms due to thermal stratification, and eutrophication caused by excessive phosphorous and nitrogen levels. In the spring of 2013, the pond was fitted with a Hydro Logic "Airlift" diffused aeration system designed to maximize water lift rate and transfer rate of dissolved oxygen by the release of bubbles along the pond bottom. The rising bubbles draw bottom water along with them to the surface creating an artificial circulation. This circulation mixes water that otherwise would thermally stratify, and increases the dissolved oxygen content throughout the water column. Oxygenating deeper waters near the pond bottom may result in a decrease in the release of phosphorous from the sediment. The circulation also keeps blue-green algae moving through the water column and helps reduce nuisance conditions. In addition to the aeration system, as a demonstration project, we designed and installed several low cost

DIY artificial floating wetlands (AFWs) using an artificial substrate and plants for nutrient removal. AFWs reduce nitrogen and phosphorous in a water body using natural microbial action in the substrate and uptake by obligate aquatic vegetation. Microbiological activity plays a major role in nutrient removal in wetland systems and the large surface area of the woven floating wetland material provides a tremendous amount of substrate for the growth of bacteria. The AFWs are anchored offshore in water depths that exceed the normal habitat requirements of the plant material and yet are able to continue to provide the same water treatment ecosystem services as their land based counterparts.

Session H6: Monitoring the Effectiveness of Stream Restoration

1:30 – 3:00 pm | Room 232

Water Quality Benefits of Stream Reclamation – Cherry Creek Basin, Colorado

Craig Wolf
GEI Consultants, Inc., Denver, Colo.

Abstract
Stream bank erosion is a natural part of a dynamic alluvial stream channel; however, when the stream is located in an urban setting, the increased impervious landscape often accelerates the rate of runoff and stream bank erosion. As a result, sediment and other pollutant loads increase in the stream and settle out in detention basins or reservoirs further downstream reducing water quality. Stream reclamation has been extensively used throughout the country to protect and enhance water quality, although quantifying the benefits has received little attention. The Cherry Creek Basin Water Quality Authority has long recognized stream stabilization/reclamation as an effective management tool, and in 2007, the Authority completed the Cottonwood Creek Reclamation project that reclaimed 2.3 miles of stream reach. Since the completion of the Cottonwood Creek Stream Reclamation, the flow weighted total phosphorus concentration has been reduced from a pre-project average of 143 µg/L to a post-project average of 79 µg/L, approximately a 45 % reduction. Similar reductions in phosphorus concentrations have been observed downstream of the reclamation reach on McMurdo Gulch, a tributary to Cherry Creek. In 2013, the Authority expanded stream reclamation to Cherry Creek as a management strategy to improve water quality conditions. By evaluating the effectiveness of stream reclamation on a cost-per-pound of phosphorus basis, the Authority can select the most cost effective project for implementing their nutrient reduction management strategies throughout the Cherry Creek Basin.

Bloomington's EPA National Monitoring Project Found Significant Water Quality Improvement with Nutrient Reduction and Enhanced Biotic Response with the Restoration of a Prairie Stream/Slough

Don Roseboom[1], Amy Walkenbach[2] and Tim Straub[1]
[1]US Geological Survey, Urbana, Ill., [2]Illinois Environmental Protection Agency, Springfield, Ill.

Abstract
The U.S. Environmental Protection Agency National Non-Point Pollution Monitoring Project is located at The Grove housing development near Bloomington, Illinois. The City of Bloomington restored Kickapoo Creek to a more natural state by incorporating green infrastructure – specifically flood-plain reconnection, riparian wetlands, meanders, and rock riffles – at a 90-acre park within The Grove residential development. The Grove Park receives the agricultural runoff from 9,000 acres of farmlands.

A team of State and Federal agencies staff with consultants continue to collect environmental data to monitor the effectiveness of this stream restoration in improving water-quality and stream habitat under the precipitation extremes of flood and drought.

The water quality improvements from nutrient reduction by instream during normal stream flows are demonstrated by a 24 percent reduction in nitrate concentration and nitrate load in 2013. Stream fisheries also increased by 50 percent per year until the extreme Midwest drought of 2012.

The placement of fixed nitrate probes at three U.S. Geological Survey (USGS) stream gaging stations and a portable nitrate probe allowed the determination of agricultural watershed processes that create the largest nitrate loading during major floods.

The Grove watershed lies in the Illinois River Basin which underwent record flooding in the last two weeks of April, 2013. This record flooding is typical of the agricultural floods which creates hypoxia in the Gulf of Mexico near New Orleans. Surface water runoff from agricultural waterways created the greatest nitrate loading at the peak flood flows on April 18th, 2013. While the tile nitrates concentrations were greater (20 mg/l) than the waterway surface runoff nitrate concentrations (11.8 mg/L), the waterway had much greater flow rates.

Stream nitrate loadings and sediment loadings increased with runoff from crop fields – peaking as floodwaters peaked when surface waters dominated the stream flow. Although the flood peak discharges and sediment of large floods overflow into wetlands during the rising limb, the smaller channel forming flood discharges passes much of the sediment load downstream.

The sediment transport capacity is determined by both standard USGS sediment gaging technology with multiple flood samples and by the recently developed technology based on the strength of the sonar return signals during acoustic flow measurement and continuous turbidity measurements. This approach allows a more natural stream and riparian form in both residential and agricultural watersheds – more natural streams in very non-natural watersheds.

Both sediment and nitrate monitoring has been enhanced by the continuing development of new USGS technologies, which allow real time monitoring of Illinois stream water quality at the Illinois EPA and USGS websites.

Watershed Restoration Using In-Stream Lime Dosing for Treating Acid Mine Drainage

Sheila Vukovich
West Virginia Dept. of Environmental Protection, Bridgeport, W.Va.

Abstract
Passive at-source acid mine drainage (AMD) treatment systems have been constructed by the West Virginia Abandoned Mine Lands and Reclamation (WV AML) Program since 1980. Numerous variations of at-source treatment systems ranging from simple limestone channels to combinations of anoxic limestone drains, successive alkaline producing systems, and wetlands were constructed with the intent of effectively treating AMD. While the majority of these systems initially improved source water quality, the quality often reverted to pre-treatment conditions after just a few years. Even while working, the systems did not produce watershed-wide improvements.

With more than 12,000 miles of impaired streams in West Virginia, the reclamation philosophy changed toward finding a more effective means of treating AMD to achieve watershed restoration. WV AML elected to move in a new direction and utilize in-stream lime dosing in tributaries impaired by AMD instead of treating individual AMD sources scattered throughout a watershed. Due to the severity of impairment and the number of contributing AMD sources, Three Fork Creek was selected for this pilot project. The goal of the project was to return Three Fork Creek mainstem to its designated

stream usages by decreasing the water quality impairment due to multiple AMD discharges within the watershed. The objectives were to: improve water chemistry and aesthetics to support recreational water activities, and restore benthic macro-invertebrates and fish in Three Fork Creek mainstem.

Construction of four lime dosers on the most severely impaired headwater tributaries began in spring of 2011 and was completed the following spring. The dosers utilize hydrated lime (Calcium Hydroxide) or pelletized lime (Calcium Oxide). Three dosers operate on a water wheel and auger system, while the fourth operates on a tipping bucket system.

Although not aesthetically pleasing, in-stream lime dosing resulted in measurable water chemistry improvements in the "sacrificial treatment zone" downstream of each doser. Chemical and biological sampling conducted since implementing in-stream lime dosing shows the goal and objectives of restoring Three Fork Creek mainstem were achieved.

Top 5 Tips for Working on Stream Projects with Teens: Lessons from Austin Youth River Watch

Brent Lyles
Austin Youth River Watch, Austin, Tex.

Abstract
Teaching the next generation about stream restoration is something we can all feel good about, and involving them in our projects is even better. It's also true that working with teens is not as easy as it sounds! In this session, we'll give you practical tools to make your next stream- or river-related project even more successful because of teen involvement.

For the last 21 years, the high-school students in Austin Youth River Watch have monitored water quality at stream and river sites all over the Austin metro area. Data sets from these 23 sites (and counting) are submitted to and reviewed by local and statewide agencies. Our work benefits the community, and the kids are learning science -- plus, they love it. Now, in the last two years, we've begun adding stream-restoration service projects to our repertoire of student programs. We've learned some lessons the hard way, and we're here to share those lessons.

In this session, we'll talk about the benefits of working with teens, and we'll share information about Austin Youth River Watch's model. We'll give you our Top 5 Tips for working with teens, and we'll answer your questions about how to build competitive proposals in this growing field of "youth engagement."

Session H7: Tracking Water Quality Trends

1:30 – 3:00 pm | Room 231

Evaluation of Stream Chemistry Trends in U.S. Geological Survey Reference Watersheds, 1970-2010

Alisa Mast[1], Mark Nilles[1], Michael McHale[2] and David Clow[1]
[1]US Geological Survey, Denver, Colo., [2]US Geological Survey, Troy, N.Y.

Abstract
The Hydrologic Benchmark Network (HBN) is a long-term monitoring program established by the U.S. Geological Survey in the 1960s to track changes in the streamflow and stream chemistry in undeveloped watersheds across the US. Trends in stream chemistry were tested at 15 HBN stations over two periods (1970-2010 and 1990-2010) using the parametric LOADEST model and the nonparametric seasonal Kendall test. Trends in annual streamflow and precipitation chemistry also were tested to help identify likely drivers of changes in stream chemistry. At stations in the northeastern US, there were significant declines in stream sulfate, which were consistent with declines in sulfate deposition resulting from the reductions in SO_2 emissions mandated under the Clean Air Act Amendments. Sulfate declines in stream water were smaller than declines in deposition suggesting sulfate may be accumulating in watershed soils and thereby delaying the stream response to improvements in deposition. Trends in stream chemistry at stations in other part of the country generally were attributed to climate variability or land disturbance. Despite declines in deposition, increasing stream sulfate was observed at several stations and appeared to be linked to periods of drought or declining streamflow. Falling water tables might have enhanced oxidation of organic matter in wetlands or pyrite in mineralized bedrock thereby increasing sulfate export in surface water. Increasing sulfate and nitrate at a station in the western US were attributed to release of soluble salts and nutrients from soils following a large wildfire in the watershed.

The Triangle Area Water Supply Monitoring Project: Tracking Water-Quality Trends and Emerging Issues for 25 Years

Mary Giorgino
US Geological Survey, Raleigh, N.C.

Abstract
The Triangle, a region in central North Carolina that is anchored by the cities of Raleigh, Durham, and Chapel Hill, is one of the fastest growing areas in the United States. Growth continues to increase demand for public drinking water, which primarily is supplied by local reservoirs. At the same time, urbanization is altering the landscape in ways that might alter loads of nutrients and other pollutants. In 1988, several local governments initiated the Triangle Area Water Supply Monitoring Project (TAWSMP) to systematically evaluate the quality of water-supply sources in the region. With assistance from the U.S. Geological Survey, the TAWSMP has collected and analyzed water-quality samples from reservoirs and streams and collected continuous records of streamflow in the study area for more than 25 years. Monitoring stations, sampling priorities, and partners have evolved over time. A core monitoring network of streamflow gages and water-quality sampling sites provides a stable dataset for analyzing long-term trends. Special investigations supplement the core monitoring by focusing on emerging issues such as pharmaceuticals, mercury, and cyanotoxins in area water supplies.

Analysis of land-cover change from the mid-1970s through the mid-2000s indicates that developed lands increased upstream from all sites in the monitoring network; however, the amount of increase varied considerably among sites, ranging from 2 to 34 percent. Likewise, population growth in project watersheds ranged from 27 to 915 percent during 1990 through 2010. Trends in streamflow, nitrogen, phosphorus, and selected major ions illustrate how water-quality has changed in response to water-management activities, climatological variations, and growth. Lessons learned for interpreting trends will be discussed, including how to identify false trends, when to analyze for step trends, and the importance of streamflow data for interpreting water-quality trends under varying hydrologic conditions.

Nitrogen and Phosphorus Concentrations and Loads in the Great Miami River Basin, Ohio

Michael Ekberg
Miami Conservancy District, Dayton, Oh.

Abstract
To evaluate baseline water quality conditions in the Great Miami River Watershed the Miami Conservancy District conducted a six year study of nutrient concentrations, loads, and yields in surface water from 2006–2011. Nutrient monitoring stations were installed at four locations on the Great Miami River and its tributary rivers to collect data on nitrogen and phosphorus concentrations and loads. Each station was located near the mouth of a

major subwatershed within the Great Miami River Basin such that nutrient concentrations, loads, and yields could be compared between the drainage areas.

The results from this study show that nutrient concentrations in the water column of the Great Miami River and its major tributaries are highly variable with flow and season. Concentrations of nitrate - nitrogen tend to be highest during winter and spring runoff events. Like nitrate - nitrogen, concentrations of total phosphorus and orthophosphate tend to be high during winter and spring runoff events at all monitoring stations. However, data collected at three of the four stations also show increases in total phosphorus and orthophosphate during summer low flow conditions suggesting that both point and nonpoint sources of phosphorus play important roles in controlling phosphorus concentration in the water column.

Winter and spring runoff events tend to deliver most of the annual nitrogen and phosphorus load to the Ohio River each year. Our data suggests nonpoint sources of nutrients as the dominant source of annual nutrient loads. Total nitrogen and phosphorus yields for the Great Miami River Basin in 2007, 2008, and 2011 exceeded published mean nutrient yields for the years 1980–1996. Our findings suggest that the Great Miami River Basin has some of the highest mean nutrient yields in the entire Mississippi River Basin and could be an excellent target area for future multi-state water quality credit trading programs designed to reduce export of nutrients to the Gulf of Mexico.

Long-term Trends in Concentrations of Selected Constituents in Indiana Streams

Martin Risch[1], Skip Vecchia[2] and Aubrey Bunch[1]
[1]US Geological Survey, Indianapolis, Ind., [2]US Geological Survey, Bismarck, N.D.

Abstract
The Indiana Fixed Station Monitoring Program (FSMP) has a long-term water-quality data record from monthly stream samples. Some sites have been in the program since 1957 and in 2012, 163 sites were monitored to support a variety of purposes. Compilation and analysis of all available water-quality data from the Indiana FSMP and all streamflow data from U.S. Geological Survey (USGS) gages in Indiana provided a data set for analysis of trends in concentrations of selected constituents.

For the time period 1999 to 2010, a total of 57 FSMP stream sites were found to have a complete annual record for at least 12 water-quality constituents and to have an associated USGS gage with a complete annual streamflow record. The model QWTRENDS was used for data analysis. This model accounts for variability of streamflow at different time scales to identify trends in constituent concentrations not caused by streamflow variability.

Statistically significant trends were identified for all 12 constituents during the study period. The number of sites with significant trends varied by constituent, and ranged from 13 of 57 sites for suspended solids to a maximum of 30 of 57 sites for chloride and sulfate. For all constituents, there were more significant decreases in concentrations than increases. The spatial distribution of the sites with significant trends was uneven. A total of 54 sites out of the 57 stream sites in the FSMP assessment had at least one constituent with a significant trend. Some watersheds showed groups of constituents with trends that may be explained with ancillary data such as nearby point sources or land use.

Some legacy FSMP sites have long-term water-quality and associated USGS gage streamflow records of more than 30 years. Analysis of these data indicated both similar and different trends in constituents than those from the more recent 1990 to 2010 time period. Annual constituent loads and watershed yields computed with these data provide additional information. The data analysis from this study underscores the value of maintaining complete, long-term monitoring data for understanding and managing water resources.

Session I1: Implementing EPA's Healthy Watersheds Program

3:30 – 5:00 pm | Room 263

Using Integrated Assessments to Identify Healthy Watersheds at the State Scale

Laura Gabanski and Owen McDonough
US Environmental Protection Agency, Washington, D.C.

Abstract
The goal of EPA's Healthy Watersheds Program is to protect healthy aquatic ecosystems and the natural landscapes, hydrologic and geomorphic processes, and natural disturbance regimes that support them. EPA is providing technical assistance to states to identify healthy watersheds by conducting integrated assessments of watershed health. Integrated assessments bring together disparate datasets to examine the connectivity, dynamics, and interrelationships between landscape characteristics, hydrologic and geomorphic processes, physical habitat, water chemistry, and biology. Natural land cover and landscape statistical models are used to estimate relative watershed health across a state. Additionally, watershed vulnerability to future changes in climate, land use, and water use is assessed to inform healthy watershed protection efforts. Participating states use the assessment results to strategically target resources towards protection and restoration. A comparative analysis and lessons learned from applying the Healthy Watersheds Program assessment framework in California, Wisconsin, and Alabama will be presented.

Application of EPA's Healthy Watersheds Initiative Concepts Enhances Protection of California's Streams and Watersheds

Peter Ode[1], Eric Stein[2], Lori Webber[3] and Terrence Fleming[4]
[1]California Dept. of Fish and Wildlife, Rancho Cordova, Calif., [2]Southern California Coastal Water Research Project, Costa Mesa, Calif., [3]California State Water Resources Control Board, Sacramento, Calif., [4]US Environmental Protection Agency, San Francisco, Calif.

Abstract
California's freshwater resources face tremendous pressures from population growth and uncertain water availability that are expected to increase over the coming decades. To make effective resource allocation decisions, agencies need objective tools to help prioritize protection and remediation. Ecological condition indicators have great potential to fill this role.

California has made steady progress over the last decade to integrate biological condition indicators into its water resource assessment and management. However, the potential of biological condition indicators to transform water resource management would be greatly enhanced by the ability to interpret patterns of biological condition in the context of non-biological watershed features and processes. California's Healthy Streams Partnership recently collaborated with the US EPA's Healthy Watersheds Initiative (HWI) to adapt the HWI's watershed assessment approach for integrating diverse measures of watershed condition (*e.g.*, hydrology, geomorphology, water quality, landscape) in California streams. The California effort built on previous work by the HWI and its partners, but adapted the framework to take advantage of other related statewide efforts. The California implementation of HWI had two key modifications, a focus on parameters related to fundamental ecological processes (not strictly condition based) and the differentiation of structural indicators (*e.g.*, landscape condition, hydrologic condition) from ecological condition indicators (biological condition, habitat condition, water quality). This allows a broad scale assessment of potential function, restoration opportunity, and vulnerability. California's adaptation also explicitly incorporated indicators of the relative confidence of the different measures of watershed condition and excluded portions of the state that did not meet

minimum criteria for applicability of biological indicators. The resulting framework provides California's water resource managers with a tool for predicting general watershed health throughout the state. These predictions can serve as the basis for monitoring resource allocation, prioritization of watersheds for restoration and protection (*e.g.*, 305(b)/303(d) integrated report Category 1 waters), more informed permitting and enforcement decisions and more effective communication among resource agencies and stakeholders. The approach allows users to selectively emphasize different components of watershed health depending on the application of the data and components of the framework can be updated/upgraded as our knowledge and data accuracy improves.

Wisconsin's Healthy Watersheds Initiative: Ranking Watersheds to Inform Management Actions

Kristi Minahan[1] and Corey Godfrey[2]
[1]Wisconsin Dept. of Natural Resources, Madison, Wis., [2]The Cadmus Group, Inc., Chicago, Ill.

Abstract
Wisconsin is conducting a Healthy Watersheds Initiative (HWI) in conjunction with EPA's national effort. The goal of the HWI is to assess a range of statewide, watershed-level datasets to rank each watershed in the state on scales of "health" and "vulnerability." These rankings can then be used to prioritize and target appropriate funding and management practices to specific watersheds. While other EPA programs focus on restoring impaired waters, the Healthy Watersheds Initiative uses the watershed approach for proactive protection and restoration, to avoid additional water quality impairments in the future. Wisconsin is one of the early states to adopt such a framework. This talk will describe the intent of the project, the data sets used for ranking, project results, and lessons learned. It will also discuss potential uses of the watershed rankings by state agencies, watershed organizations, and other partners.

Alabama's Healthy Watersheds Initiative and Biological Condition Gradient: Two Tools for Prioritizing Restoration and Protection Efforts

Lisa Huff[1], Susan Jackson[2], Jeroen Gerritsen[3] and Ben Jessup[3]
[1]Alabama Dept. of Environmental Management, Montgomery, Ala., [2]US Environmental Protection Agency, Washington, D.C., [3]Tetra Tech, Inc., Owings Mills, Md.

Abstract
Alabama completed both a Healthy Watersheds Initiative (HWI) integrated assessment and a Biological Condition Gradient (BCG) calibration in 2013. Each was based on the collaborative efforts of state and regional experts to define conditions of ecological endpoints. The purpose of the HWI was to generate technical information and tools for freshwater aquatic resource protection in Alabama and the Mobile Bay Basin for use by state agencies, local governments, citizen groups, and other organizations. The HWI identified watershed health indicators that reflect a holistic view of watershed health, as well as watershed vulnerability indicators to characterize the vulnerability of watersheds to future degradation. A Healthy Watersheds Database with indicator values for the entire state of Alabama and the Mobile Bay was developed. With these data, a Healthy Watersheds Index and a Watershed Vulnerability Index for assessing relative levels of health and vulnerability were developed at three separate tiers: 1) statewide; 2) the entire Mobile Bay basin; and 3) the Mobile Bay and Mobile-Tensaw sub-watersheds in Baldwin and Mobile counties. An important component of the HWI was to evaluate connectivity throughout the Mobile Bay Basin to highlight key areas for protecting Bay health.

The BCG is a scientific framework for characterizing biological response to anthropogenic stress. The AL BCG was developed primarily through expert consensus, focusing on the biological expectations for the fish and benthic macroinvertebrate assemblages in the higher gradient streams of north Alabama. While Alabama's macroinvertebrate and fish multi-metric indices are calibrated to least-impaired reference conditions statewide, the AL BCG provides a framework for understanding current conditions relative to natural, undisturbed conditions. Together, the HWI and the BCG provide tools for prioritizing and targeting specific watersheds for protection and restoration, as well as a method for setting achievable restoration goals.

Session I2: Assessing the Effects of Prolonged Drought and Wildfires on Water Quality and Habitat

3:30 – 5:00 pm | Room 262

Application of Continuous and Periodic Monitoring to the Assessment of the Impacts of the 2012-2013 Drought on Groundwater Conditions in Illinois

Robert Kay
US Geological Survey, DeKalb, Ill.

Abstract
Continuous measurement of groundwater levels in performed at more than 70 wells in Illinois have enabled assessment of the timing and magnitude of the 2012-2013 drought, and the recovery from the drought, on selected aquifers. Data indicate water-level declines in drift deposits typically began in about late April to early May 2012, reached minimum in February 2013, and rose to maximum (slightly higher than pre-drought) values by late April to early May 2013. Water-level declines in the drift deposits from May 2012 through February 2013 typically ranged from about 3 to 12 feet in areas not clearly impacted by high-capacity pumping. These trends were consistent throughout the state with the exception of wells in the city of Chicago, where groundwater levels did not clearly respond to the drought. Drought effects may not have been observed in Chicago because sewers and water lines may the most substantial portion of the groundwater recharge. Periodic water-level measurements from wells with a period of record of 5 years or more indicate that the 2012-2013 drought typically had either the lowest, of second lowest water levels.

Water-level declines in the drift deposits from May 2012 through February 2013 typically ranged from about 8 to 35 ft in areas impacted by high-capacity pumping, with these large declines occurring during the summer months. Comparison of continuous water-level data from wells open to the Cambrian-Ordovician aquifer system in northeast Illinois during the summer of 2012 with water-level data from 20011 and 2013 indicates substantially a larger decline during the summer of 2012, presumably due to increased pumping from the aquifer in response to the drought.

Dedicated Volunteers Test Water during Extreme Drought in Texas

Jacob Apodaca
Lower Colorado River Authority, Austin, Tex.

Abstract
The Colorado River Watch Network (CRWN) is the largest volunteer water quality monitoring program in Texas. About 100 volunteers monitor more than 100 sites along a 600-mile stretch of the lower Colorado River between San Saba and Matagorda Bay. The Colorado River empties into the Gulf of Mexico. Volunteers began monitoring the river in 1988 and the Lower Colorado River

Authority (LCRA) has supported this effort since 1992. CRWN volunteers sign on to monitor one or more sites once a month for two years. Many of the volunteers continue to monitor well beyond their initial commitment.

Today's volunteers are monitoring the river under extreme drought conditions. Texas experienced its Drought of Record in the 1950s. Currently, the combined storage of the two water supply reservoirs in the Highland Lakes above Austin is 38 percent full of capacity. If combined storage falls below 30 percent or reaches 600,000 acre-feet, this drought will officially become the Drought Worse than the Drought of Record.

CRWN volunteers continue to visit their sites each month and document the drought's impact through photographs. Aside from the obvious sight of the lakes and tributaries drying up, the impact is most apparent downstream of Austin where the flow has reached historic lows. Due to the drought, LCRA has reduced the amount of water released below Austin to about 50 cubic feet per second per day – a flow that helps protect the environmental integrity of the river. Besides the water released for environmental flows, treated effluent from the City of Austin provides the river with water. CRWN monitors have found increased levels of nitrates that produced an abundance of aquatic plants. In some parts of the river, about 80 percent of the surface is covered with algae and aquatic plants. CRWN monitors also have detected wide swings in dissolved oxygen levels, with lows that sometimes dip below 4 mg/L. The drought already has had a significant impact on water quality, but it could become much worse, and the CRWN volunteers will be there to document the impact.

Effect of Drought on the Transport of Nitrate in a Midwest Stream

Stephen Kalkhoff[1], Jessica Garrett[1] and Katherine Holt[2]
[1]US Geological Survey, Iowa City, Ia., [2]US Geological Survey, Council Bluffs, Ia.

Abstract
Data were collected as part of study partially funded by The Nature Conservancy and the U.S. Geological Survey to better quantify the impact of rainfall on nitrate concentrations and transport in the Boone River watershed in north central Iowa. Nitrate-nitrogen concentrations were measured continuously (15-minute intervals) in 2012 when rainfall and runoff was substantially below normal and in the spring and early summer of 2013 when rainfall was greater than normal. Nitrate loads were calculated using continuous nitrate concentrations and streamflow measurements to increase the accuracy of the load estimates.

Runoff during the 2012 growing season (April through September) in the Boone River was about 50,000 acre feet during the 2012 growing season. The dry 2012 growing season was followed by a wetter 2013 growing season when more than 380,000 acre feet flowed from the Boone River watershed.

The average daily nitrate concentration through the growing season was more than 10 mg/L greater in 2013 than in 2012. During dry conditions in 2012, daily mean nitrate concentrations peaked in May at 20.9 mg/l and then decreased rapidly to less than 1.0 mg/l by the middle of July. Nitrate concentrations in 2013 also peaked in May but the maximum daily concentration (29.8 mg/L) was not only greater in 2012, but elevated nitrate concentrations greater than 10 mg/L persisted for an extended period of time(March through July) before decreasing to less than 1.0 mg/L in mid-August.

A combination of greater streamflow and nitrate concentrations resulted in greater than 10 times more nitrate being transported from the Boone River watershed in 2013 than in 2012 even though the amount of runoff was only 7 times greater in 2013 than in 2012. Although a number of factors may be responsible for the disproportionate nitrate transport in relation to runoff, these results suggest that accumulation of residual nitrogen in the watershed in 2012 was available to be flushed from the soil by spring and summer rains in 2013.

Fish Consumption and Contaminants in Fish from the Los Angeles and San Gabriel Rivers Watersheds

Karin Patrick[1], Kristy Morris[2], Scott Johnson[1], Phil Markle[3] and Gerald McGown[4]
[1]Aquatic Bioassay & Consulting Laboratories, Inc., Ventura, Calif., [2]Council for Watershed Health, Los Angeles, Calif., [3]Los Angeles County Sanitation District, Whittier, Calif., [4]City of Los Angeles, Playa del Rey, Calif.

Abstract
The highly urbanized Los Angeles and San Gabriel River watersheds provide a wide range of beneficial uses to a population of over five million people. However, prior to 2007, little was known regarding the safety of consuming recreational sport fish from local rivers, streams and lakes. Sampling contaminants in fish tissues from urban lakes and streams was begun by the Stakeholders of the San Gabriel River Watershed Monitoring Program (SGRRMP) and Los Angeles River Watershed Monitoring Program (LARWMP) in 2006 and 2009, respectively. These programs were designed to answer the question, 'Is it safe to eat fish?'

Fish consumption safety was assessed by measuring tissue concentrations of mercury, selenium, DDT and PCB from composites of fish collected at popular angling sites. Consistent with findings statewide, mercury concentrations in largemouth bass consistently exceeded the Office of Environmental Health Hazard Assessment (OEHHA) no consumption threshold in numerous lakes throughout the Los Angeles and San Gabriel River watersheds. The concentrations of PCBs were elevated in fish from the estuaries and in some lakes, and DDT concentrations were low in all fish. Anglers were surveyed between 2010 and 2012 at popular fishing locations in the watersheds to understand their catch and consumption habits. The results of these surveys indicate that while consumption levels of the most heavily contaminated fish are relatively low and overall fish consumption in these lakes were lower compared to pier anglers, the potential exists that some anglers may be consuming contaminated fish with limited knowledge of the health risks.

Session I4: Contaminants of Emerging Concern: Perfluorinated Compounds (PFCs)

3:30 – 5:00 pm | Room 237

Occurrence of Perfluorinated Compounds in New Jersey Public Water Supplies

Gloria Post, Judith Louis, Nicholas Procopio and R. Lee Lippincott
New Jersey Dept. of Environmental Protection, Trenton, N.J.

Abstract
Perfluorinated chemicals (PFCs), a group of anthropogenic chemicals with many commercial and industrial applications, are of interest as emerging drinking water contaminants because of their frequent detection in surface and ground water sources of drinking water, extreme environmental persistence, and potential health effects. Several PFCs have human half-lives of several years and are detected ubiquitously in human serum; drinking water is an important human exposure source. PFCsare currently unregulated in water, and nationwide drinking water monitoring for 6 PFCs required by USEPA is currently underway. To our knowledge, New Jersey is the first state to have conducted statewide monitoring for PFCs. In 60 NJ public water supplies (PWS) tested in 2005-13, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) were found in 60% and 43%, respectively, at up to 280 ng/L and 48 ng/L, respectively. Raw water from 31 of these PWS was also monitored for eight additional PFCs. Between one and eight PFCs were detected (>5 ng/L) in raw water from 74% of these PWS, at totals of 5-330 ng/L. Although PFOA was the most commonly detected PFC and was found at the highest maximum concentration, some of the higher levels of other PFCs were at sites with little or no PFOA. PFNA was detected more frequently

(35%) and at higher concentrations (up to 96 ng/L) than in drinking water studies from other locations; PFNA was often the sole or predominant PFC, a pattern not reported elsewhere. PFOS, perfluoropentanoic acid (PFPeA), and perfluorohexanoic acid (PFHxA) were each detected in more than 20% of samples, while perfluoroheptanoic acid (PFHpA), perfluorobutane sulfonic acid (PFBS), and perfluorohexane sulfonic acid (PFHxS) were detected less frequently. Perfluorobutanoic acid (PFBA) was found only once (6 ng/L), and perfluorodecanoic acid (PFDA) was not detected. Possible sources of PFCs were identified at some PWS but are unknown for others. Total PFCs were not associated with percent developed land use near the monitoring sites. These results show that multiple PFCs are commonly found in raw water from NJ PWS. Future work is needed to develop approaches for assessing risks from mixtures of PFCs found in drinking water.

Presence of Perfluorinated Compounds in Source and Treated Drinking Waters from 25 Drinking Water Treatment Plants in the United States

Scott Boone[1], Susan Glassmeyer[2], Edward Furlong[3], Dana Kolpin[4] and Christian Byrne[1]
[1]US Environmental Protection Agency, Stennis Space Center, Miss., [2]US Environmental Protection Agency, Cincinnati, Oh., [3]US Geological Survey, Denver, Colo., [4]US Geological Survey, Iowa City, Ia.

Abstract
The USEPA and USGS conducted a national study sampling source and treated water from 25 drinking water treatment plants (DWTPs) in the US for the detection of over 200 contaminants of emerging concern (CECs). The source waters from these facilities included aquifers, reservoirs, and rivers. Seventeen perfluorinated compounds (PFCs) were analyzed in both source and treated water by the current method developed by the USEPA Environmental Chemistry Laboratory using LC/MS/MS detection. At least one PFC was detected at all sampling locations. Based upon the mean concentration in both source and treated water from the 25 sites, the most abundant PFCs in descending order were: PFPeA > PFOA > PFBA > PFHpA > PFHxA > PFOS > PFHxS > PFNA = PFDA = PFBS > PFUnDA > PFDoDA; and upon detection frequency, the most prevalent PFCs in descending order were: PFHxA > PFBS > PFBA = PFPeA = PFHpA > PFNA > PFHxS > PFOS > PFOA > PFDA > PFUnDA > PFDoDA. Five PFCs were never detected: PFTrDA, PFTeDA, PFHxDA, PFOcDA, and PFDS. The highest individual level of detected PFCs (ng/L: ppt) were: PFPeA (510), PFHpA (180), PFOA (110), PFBA (100), PFHxA (60), PFOS (50), PFHxS (50), PFNA (40), and PFDA (30). The concentrations of individual PFCs in treated waters were similar to their source waters at all sites tested but one. At that site, powdered and granular activated carbon (PAC and GAC) was used, and the PFCs detected were measurably reduced: PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFHxS, and PFOS (>96%), PFHxA (75%), PFPeA (40%), and PFBA (20%). This DWTP had the highest amount of GAC, with the longest reportable empty bed contact time (EBCT), and the shortest activated carbon replacement time. Six other DWTPs used PAC, and eleven other DWTPs used GAC. In most cases, the levels of PFCs were not affected by the more commonly used drinking water treatment processes. While this study was designed to provide important baseline information on CECs in source and treated drinking waters, it was not designed to be representative of all such sources and drinking waters throughout the United States.

PFC Contamination at the Former Wurtsmith Air Force Base; Extent, Sources, Fish Uptake, Human Exposure, Fate and Transport

Robert Delaney
State of Michigan, Lansing, Mich.

Abstract
Perfluoroalkyl Chemical (PFC) contamination in the environment, food supplies, and human populations is raising concern around the world. Recent epidemiological studies of various human populations have increased alarm that PFCs are causing population-wide adverse health effects at background levels in the general population. The State of Michigan, in cooperation with the United States Air Force, has been investigating widespread PFC contamination at the former Wurtsmith Air Force Base in Oscoda, Michigan associated with historical use of Aqueous Fire Fighting Foam (AFFF). Although AFFF was only released in a relatively small area, contamination is now widespread suggesting that there are numerous other sources of PFC contamination at the base. Approximately 4.6 square miles of aquifer, 9.4 miles of the Au Sable River, two square miles of swamp, and three miles of Van Etten Lake shoreline are impacted. All surface water samples and fish tissue samples downgradient of the site are impacted, to varying degrees, with PFCs.

Fish tissue contaminant levels are some of the highest recorded in the literature. Maximum fish tissue levels of PFOS, PFOA and PFOSA have been measured at 73,200 ppb, 8.52 ppb, and 182 ppb respectively. Sufficient data has been collected to develop preliminary site conceptual models, tracing contaminant fate and transport, likely source identification, treatment effectiveness, fish uptake, and pathways to human receptors.

The data and analysis generated at the former Wurtsmith Air Force Base is valuable for anyone addressing PFC contamination at military bases, urban areas, and airports.

Session I5: Indicator Bacteria and Predictive Modeling

3:30 – 5:00 pm | Room 233

A Comprehensive Assessment of the Occurrence and Distribution of Pathogenic Bacteria in Great Lakes Tributaries, March-September 2011

Angela K. Brennan, Heather E. Johnson, Alex R. Totten and Joseph W. Duris
US Geological Survey, Lansing, Mich.

Abstract
From March through October 2011, the U.S. Geological Survey (USGS) Michigan Water Science, in conjunction with USGS Water Science Centers in Indiana, Minnesota, Ohio, New York, and Wisconsin, conducted a study to determine the frequency of occurrence of genetic markers of bacterial pathogens and concentrations of fecal indicator bacteria (FIB) in tributaries to the Great Lakes. As part of the Great Lakes Restoration Initiative (GLRI), this effort was one of the first large-scale studies designed to evaluate bacterial pathogen gene occurrence in major Great Lakes tributaries. A total of 160 water samples were collected at 21 USGS streamgaging locations during a range of flow conditions, and analyzed by the Michigan Bacteriological Research Laboratory located at the MI-WSC. Water samples were analyzed for fecal indicator bacteria concentrations (*Escherichia coli* (*E. coli*) and enterococci), as well as the occurrence of pathogen gene markers for *Shigella spp.*, Campylobacter, Salmonella, and pathogenic *E. coli* including Shiga toxin-producing *E. coli* (STEC). FIB concentrations and bacterial pathogen gene frequencies were analyzed with respect to land use and hydrologic conditions

in an effort to describe variability in concentrations. Overall, there was a greater occurrence of pathogen gene markers in samples which exceeded the USEPA (1986) Recreational Water Quality Criteria for both *E. coli* and enterococci. The median densities of FIB were significantly higher in samples collected during high flow conditions than in those collected during normal flow conditions across different land cover classifications. The flow related gene frequencies were affected variably by land cover. Results of this study will be used to improve the understanding of microbiological water quality in Great Lakes tributaries with the future goal of determining the relations between the occurrence of bacterial pathogen genes, FIB, seasonality, water chemistry, and hydrology. Resource managers may use the results of this study to determine the potential risks to human health.

Assessing Enteroccoci in the Nation's Lakes, Reservoirs, Streams and Rivers: Results from the National Aquatic Resource Surveys

Sarah Lehmann[1] and Jack Paar[2]
[1]US Environmental Protection Agency, Washington, D.C., [2]US Environmental Protection Agency, North Chelmsford, Mass.

Abstract
Pathogens are disease-causing microbes (bacteria, viruses and protozoa) that usually come from human or animal waste. These microbes enter waterways from both human-caused and natural sources, and can affect human and animal health. Understanding the extent of potential risk to human health from pathogens across the country is important in our efforts to address water quality issues. The National Aquatic Resource Surveys (NARS) are a series of statistical surveys designed to assess the nation's waters. Two of the NARS surveys, the National Lakes Assessment 2007 and the National Rivers and Streams Assessment 2008/09, included collection and analyses of enterococci at a nation-wide scale. EPA recommends enterococci as the best available indicator of health risk in marine water used for recreation and as a useful indicator in fresh water as well. For these surveys, enterococci were analyzed using the quantitative polymerase chain reaction (qPCR) method. In December 2012, EPA issued new recreational criteria which included supplementary values including Statistical Threshold Values and Beach Action Values for enterococci using qPCR. Using the data from these two surveys, we can provide information about the relationships between enterococci levels across the United States and these values. This presentation will discuss the national and regional results from each of these statistical surveys, including some important considerations related to analysis and interpretation of the data. The presentation will also provide information on additional work being done on enterococci through the NARS.

Improving Predictions of Bacterial Water Quality with Real-Time Networked Sensors and Online Models

Benjamen Wetherill[1], Robert F. Chen[1], Julie Wood[2] and Francesco Peri[1]
[1]University of Massachusetts Boston, Boston, Mass., [2]Charles River Watershed Association, Weston, Mass.

Abstract
The EPA has provided guidelines for the safety of recreational contact with river and beach water based on concentrations of the fecal indicator bacteria *E. coli* and enterococci. However, it generally takes 24 hours to analyze water samples for these bacteria, and concentrations of the bacteria are known to fluctuate dramatically in timeframes of hours. Therefore, water quality warnings based on water sampling are inherently associated with timing mismatches, and are not as effective as they could be. Some monitoring organizations have tried to predict bacteria concentrations by modeling the correlation of bacteria levels with easily measurable hydro-meteorological conditions. This often results in reasonable forecasts that are 80-90% accurate, but this method is still plagued by timing issues because it depends on personnel to measure the variables daily. In this study, we have tested how predictions and public warning systems can be improved by networking real-time continuous hydro-meteorological sensors with online automated water quality reports. Two sites have been studied, the Charles River basin in Boston, MA, and Wollaston Beach in Quincy Bay, MA, both of which are located in populous urban centers and used heavily for recreation. Hydro-meteorological sensors were deployed at both locations. Data from these sensors were combined with data from other real-time sensors, such as USGS flow gauges and NOAA tide gauges, to feed an automated online model and warning system. The results of the study indicate that real-time data can dramatically improve statistical sensitivity of the model, and that the automation delivers powerful improvements in temporal coverage and significance to the public.

Advancing the Use of Predictive Models for Estimating Recreational Water Quality at Beaches

Donna Francy and Amie Brady
US Geological Survey, Columbus, Oh.

Abstract
Concentrations of indicator bacteria, such as *Escherichia coli* and enterococci, are used in recreational water-quality monitoring programs to determine whether to post a health advisory or beach closing. Because traditional culture methods for indicator bacteria take at least 18 hours to obtain results, water quality can change during that time. Instead, predictive models have been used at beaches to improve the timeliness and accuracy of recreational water-quality assessments. Beach-specific predictive models use environmental and water-quality variables that are easily and quickly measured, such as turbidity and rainfall, to estimate concentrations of indicator bacteria or to provide the probability that a State recreational water-quality standard will be exceeded. When predictive models are used for beach closure or advisory decisions, they are referred to as "nowcasts."

During the recreational seasons of 2010-12, the U.S. Geological Survey (USGS), in cooperation with 23 local and State agencies, collected data to improve existing nowcasts at 4 beaches, validate predictive models at another 38 beaches, and collect data for predictive-model development at 7 beaches throughout the Great Lakes. Local agencies measured field variables, compiled environmental data, and measured *E. coli* concentrations. Software programs, designed specifically to compile and process data for predictive model development, were used to compile data and develop models by means of multiple linear regression techniques. The models were validated and compared to the current method for assessing recreational water quality-using the previous day's *E. coli* concentration (persistence model). The predictive models performed better than persistence models at most beaches, especially in terms of sensitivity (predicting an exceedance of the standard).

Gaining knowledge of each beach and the factors that affect *E. coli* concentrations is important for developing reliable predictive models. Several years of data spanning a wide range of environmental conditions helps to improve predictive model performance. The USGS is committed to helping water-resource managers collect appropriate data, develop predictive models, and implement nowcast programs at beaches throughout the United States.

Session I6: Data Management Approaches for Diverse Monitoring Groups

3:30 – 5:00 pm | Room 232

Using an Environment Information Lifecycle Framework to Improve the Quality and Sharing of Data and Information

Wayne Davis[1] and Roy Chaudet[2]
[1]US Environmental Protection Agency, Fort Meade, Md., [2]US Environmental Protection Agency, Washington, D.C.

Abstract
An Environmental Information (EI) Lifecycle has been used to provide a framework to identify opportunities to improve the quality, exchange and sharing, access, and use of environmental information for tracking environmental progress, decision-making, and setting policy for water quality management. Realizing that it takes many different types of professionals (*i.e.*, citizens, lawyers, bureaucrats, policy makers, scientists, chemists, IT specialists, etc.) to turn data into information will uncover opportunities to improve the quality, access, and use of the information. The general elements of the lifecycle include Program and Policy Planning, Data Collection, Information Exchange and Management, Information Access and Use, and Public/Stakeholder Feedback. An example for water quality programs will be provided.

Program and Policy Planning is one of the lifecycle elements and sets the direction for any information collected, exchanged, accessed, and used. This set of activities is typically based on regulations and guidance to carry out regulatory requirements for each environmental program. Data Collection is the second element and includes a data collection program plan that identifies quality objectives and major activities, methods, and procedures for collecting key environmental indicators. Information Exchange and Management include data that is transmitted or exchanged and managed in data systems where it may be accessed and used by all pertinent stakeholders. This allows stakeholders to access, share, and more fully use environmental information. Information Access and Use involves stakeholders finding, understanding and using environmental information. Electronic interfaces may be used to retrieve information that is stored and made accessible to pertinent stakeholders to ensure agencies fulfill their obligation to make sure their data and information is well documented, clearly understood, and can be used by stakeholders to further their participation in decision making. Public/Stakeholder Feedback and participation in all aspects of the environmental information life cycle will facilitate cooperation and improvements in the quality and use of the data. In fact, allowing the public to question the data and information, provide their own data for consideration, and receive a response to each of the requests, will ultimately result in greater accountability, reduction in pollutant releases and improvements in data quality.

The Kentucky Interagency Groundwater Monitoring Network: A Collaborative Effort in Groundwater Resource Characterization

Bart Davidson[1] and Robert Blair[2]
[1]Kentucky Geological Survey, Lexington, Ky., [2]Kentucky Division of Water, Frankfort, Ky.

Abstract
The Kentucky Interagency Groundwater Monitoring Network (hereafter referred to as "Network") had its early beginnings in June of 1995 with a series of meetings held by several members of state, local, academic and federal agencies that were involved in collecting groundwater information for Kentucky. These meetings resulted in the establishment of what is now known as the Interagency Technical Advisory Committee (ITAC), a group of 12 agencies that assist with oversight of the Network. A detailed framework document was compiled by ITAC in April of 1996, outlining a plan to characterize the groundwater resources of Kentucky by obtaining ambient or baseline sample data from wells and springs, review and summarize the data collected, and distribute the results by various means, including the Kentucky Groundwater Data Repository (KGDR).

Legislation for the Network and the ITAC committee was enacted in 1998, through KRS 151.625 and KRS 151.629, respectively. The Kentucky Division of Water (KDOW) obtained funding from the Clean Water Act House Bill 319 to sample about 60 sites (wells and springs) on a regular basis for bulk parameters, nutrients, major and minor inorganic ions, metals, volatile organics and caffeine. These sites are considered ambient groundwater sites, representative of background (or baseline) water quality values. Other regional groundwater-quality studies have been conducted by KDOW and the Kentucky Geological Survey (KGS) and are considered part of the Network initiative.

The KGDR, initiated in 1990 by the Kentucky Geological Survey under mandate from the Kentucky legislature (KRS 151:035), was established to archive and disseminate groundwater data collected by State agencies, other organizations, and independent researchers. All data gathered through the Network is entered on a quarterly basis. The KGDR database currently contains information for over 92,000 water wells, 5,100 springs, and over 58,000 suites of water-quality analyses. It features two main search engines, one for water well and spring data, and another for groundwater-quality data. All data can be displayed on topographic or aerial photography base maps.

This presentation will review the history of the Network and how Network data are disseminated online via the KGDR.

Developing an Interactive Database for Volunteer Stream Monitoring Results

Justin Stratton[1], Bob Lentz[2], Donna McCollum[3] and Lynn White[4]
[1]Davey Resource Group, Kent, Oh., [2]Butler County Storm Water District, Hamilton, Oh., [3]Miami University, Oxford, Oh., [4]Butler Soil and Water Conservation District, Hamilton, Oh.

Abstract
The Butler County Stream Team is a volunteer water monitoring group that collects and analyzes stream samples from ~140 sites in Butler County each month. The group is jointly organized by Butler Soil and Water Conservations District, Butler County Storm Water District and Miami University's Institute for the Environment and Sustainability, but relies heavily on community volunteers for collection and analysis of water samples. Because volunteers are involved, timely feedback on sampling results are important as they want to see the results of "their" sites. Through the Davey Resource Group, a searchable database program has been made available on the Stream Team's website. The website presents all sample sites on a Google map, which allows volunteers to find a site, as well as learn more about neighboring sites. Once at a sample site, the user can view the comprehensive sample history for the site as well as generate a variety of graphs. The system includes data entry mechanisms, so the data set is dynamic, and can be updated moving into the future. Initial reaction of the volunteers has been very positive, and we hope the visualization of their data will help them appreciate the importance of their contribution to this ongoing effort. Our presentation will include a demonstration of the website, some example reports and graphs that have come from sample histories, as well as some thoughts on our experience on implementing this interactive database.

Managing Spatial Data: The FlexiGrid Experience

Revital Katznelson
University of California Extension, Berkeley, Calif.

Abstract
The FlexiGrid concept was introduced in 2008 as embodied in a simple, MS Excel based spreadsheet that maps all the components of a spatial, multi-dimensional flexible sampling frame and connects each monitoring Result to the exact spatial component wherein it was measured (Katznelson, R., 2008. The FlexiGrid: a universal spatial sampling frame. *in: Proceedings of the sixth National Monitoring Conference of the National Water Quality Monitoring Council*, "Monitoring: Key to Understanding our Waters", May 18-22, 2008, Atlantic City, NJ.). The FlexiGrid system can serve different kinds of protocols from any area of inquiry that requires spatial representation of a monitoring Result, and it can easily derive most types of calculated Endpoints (*i.e.*, metrics, indices, and descriptive statistics). The FlexiGrid concept can be implemented in a data structure that allows for reporting of (1) any type of Result (raw data or calculated Endpoint) that were generated for (2) any spatial component (or any aggregate of identical spatial components) at (3) any scale, even on a single database table. Unlike the rigid data management systems currently in use by major Agencies, the FlexiGrid system is extremely adaptable to changes in data collection protocols, even within the course of a single project. Moreover, FlexiGrid spreadsheets can be easily 'crosswalked' to the language and business-rules of any receiving database. The FlexiGrid system has been used by the San Francisco Bay Region and the North Coast Region of the Surface Water Ambient Monitoring Program (SWAMP) in a number of stream bioassessment studies over the years. It provided an easily-adapted, small-scale tool for management of physical habitat data and for derivation of multiple Endpoints by project personnel, independently of any IT support. This paper describes the tools developed for the following functions: (a) data entry into a template that captures all raw data; (b) streamlined calculation of Endpoints; and (c) data transfer using a "crosswalk" built into the Data Entry template that provides for seamless migration of raw physical habitat data, via a recently-developed upload template, into the SWAMP database. The potential use of the FlexiGrid tools by citizen monitoring groups and other small entities will also be discussed.

Session I7: Measuring Invertebrates to Quantify Lake and Reservoir Conditions

3:30 – 5:00 pm | Room 231

*Impact of Invasive Dreissenid Mussels (*Dreissena polymorpha *and* Dreissena rostriformis bugensis*) and Invasive Round Goby (*Neogobius melanostomus*) on the Benthic Macroinvertebrate Community and Ecological State of Lake Simcoe (Ontario, Canada)*

Brian Ginn[1,2] and Amanda Conway[2]
[1]Lake Simcoe Region Conservation Authority, Newmarket, Ont., Canada, [2]University of Waterloo, Waterloo, Ont., Canada

Abstract
The invasion of zebra mussels in the Laurentian Great Lakes Region resulted in a profound shift in the ecological state of nutrient-enriched lakes from algal-dominated turbid systems to a clearwater state dominated by aquatic plants. Subsequent invasions by quagga mussels introduced resource competition, while the spread of round goby resulted in predation on zebra mussels and a shift in dominance toward quagga mussels. The changing dominance of these "ecosystem engineers" is having a direct impact on both the benthic community and the ecological state of invaded lakes.

As part of our lake monitoring program, benthic macroinvertebrate samples are collected annually at 52 sites in Lake Simcoe for tracking community trends and inferring lake environmental health. While invasion by *Dreissena* spp. resulted in an overall increase in benthic biomass, the community showed relatively stable trends in species diversity and abundance in 2005 and 2008-2009. With the rapid expansion of round gobies in 2010, there was a sharp decrease in the abundance of prey species: zebra mussels and amphipods (Gammaridae). Shoreside (0-1 m depth) habitats changed from dominance by amphipods (2005, 2008-9) to chironomids (2010-11), although amphipods have since rebounded (2012). At littoral sites (3-15 m depth), dominance shifted from zebra mussels (2005, 2008-9) to chironomids (2010-11). In 2012, quagga mussels became dominant in many littoral habitats and have mostly replaced zebra mussels, likely due to a tolerance of cooler water temperatures; better access to food with longer siphons; and long byssal threads to colonize less ideal substrates. This pattern of dreissenid succession has been recorded in other systems such as Lake Erie and Lake Ontario: a decrease in algal biomass, increased water clarity, phosphorus uptake by an increasing macrophyte biomass, and increased complexity of the benthic environment (phosphorus dispersal on substrate, increased macroinvertebrate abundance and diversity). The ecological implications of a shift away from dominance by zebra mussels is a question needing further study in Lake Simcoe: Will the current clearwater state continue with filtering by quagga mussels (*e.g.*, Lake Ontario)? Or will a new state arise with algal and cyanobacterial blooms (*e.g.*, Lake Erie)?

Late Summer Crustacean Zooplankton Communities in Western US Reservoirs Reflect Ecoregion, Temperature and Latitude

John R. Beaver[1], Claudia E. Tausz[1], Thomas R. Renicker[1], G. Chris Holdren[2], Denise M. Hosler[2], Erin E. Manis[1], Kyle C. Scotese[1], Catherine E. Teacher[1] and Benjamin T. Vitanye[1]
[1]BSA Environmental Services, Inc., Beachwood, Oh., [2]US Bureau of Reclamation, Denver, Colo.

Abstract
We tested whether crustacean zooplankton community composition and size structure in western US reservoirs would be related to ecoregion designations, catchment land use, and temperature/latitude. We also examined whether the predictions for decreasing cladoceran body size with decreasing latitude as has been observed for natural lakes would be valid for western US reservoir systems. 318 zooplankton samples were collected in late summer 2010 from 102 western US reservoirs distributed over three major ecoregions from 32.5-48.6 °N latitude.

Large-bodied cladocerans and cyclopoid copepods were found in deeper, cooler reservoirs with forested catchments (Northwestern Forested Mountains). Small-bodied cladocerans and cyclopoid copepods were more important in reservoirs located in catchments influenced by agriculture (Great Plains). Increasing water temperature was associated with decreased mean Daphnia and cladoceran lengths and lower absolute Daphnia biomass. Mean cladoceran length increased with increasing latitude. Daphnids were rare or absent in warmer waters. Large-bodied daphnids dominated zooplankton community biomass in unproductive reservoirs at high elevations with cooler water temperature while smaller bodied daphnids were associated with more productive reservoirs at lower elevations with warmer water temperatures. Our study suggested that the interrelated attributes of ecoregion, catchment land use, temperature and latitude can be valuable in explaining the taxonomic and size structure of crustacean zooplankton community structure in reservoirs. In addition, our results underscore the influence of catchment setting on plankton assemblages and indicate that abiotic factors are more important determinants than biotic factors for crustacean zooplankton community composition when considered over large geographical scales.

Water Quality and Biological Assessment of the Lower Reservoirs of the Susquehanna River

Luanne Steffy and Aaron Henning
Susquehanna River Basin Commission, Harrisburg, Pa.

Abstract
During 2012 the Susquehanna River Basin Commission (SRBC) completed an initial exploratory monitoring and assessment study on the lower 45 river miles of the Susquehanna River. This section of river is characterized by three large reservoirs formed to serve multiple power generation facilities, both nuclear and hydroelectric. The hydrologic and water availability aspects of hydroelectric power generation in the lower Susquehanna River are fairly well understood but the long term impacts of the hydrologic alteration on water quality and river ecosystems has not been well documented. This complex dam and reservoir system presented a variety of challenges and required alternate sampling methodologies from those used to assess the free-flowing portion of the Susquehanna River. Seasonal water quality sampling at three locations along nine transects spaced throughout the reservoirs provided insight into horizontal and vertical mixing. Nitrogen and phosphorus pose the primary water quality threats. Macroinvertebrate communities were assessed using both multi-habitat composite sampling in shoreline habitats and artificial substrate colonization methods using Hester-Dendy (H-D) samplers. Chironomid genera heavily dominated the H-D samplers while multi-habitat assemblages were much more diverse, with between 26-36 taxa. These data represent some of the only recent macroinvertebrate data available for this portion of the Susquehanna River. A fish community survey in the each of reservoirs and below the most downstream dam was also completed using a combination of benthic trawling and boat electrofishing. This assessment supplied significant information about species presence, abundance and distribution, as well as data for the invasive flathead catfish, the catadromous American eel, and PA threatened Chesapeake logperch. Catch rate and overall health condition of smallmouth bass, a declining species of recent concern within the Susquehanna River Watershed, was also documented. The constant yet irregular hydrologic alterations in the reservoirs, a consequence of power generation, result in a lack of persistent shallow, near-shore habitat and compromise the quality of these ecologically critical areas. The data collected and lessons learned during this pilot study will be valuable as SRBC seeks to incorporate monitoring of the lower reservoirs into its routine monitoring program.

Assessing Water Quality Effects of the Taum Sauk Hydroelectric Facility Reservoir Breach and Evaluating Recovery and Restoration Efforts

Lynn Milberg, David Gullic and Dave Michaelson
Missouri Dept. of Natural Resources, Jefferson City, Mo.

Abstract
On December 14, 2005 the Upper Reservoir of the AmerenUE Taum Sauk Hydroelectric Facility in rural Reynolds County, Missouri suffered a catastrophic failure. This resulted in the release of 1.3 billion gallons of water within the span of roughly 15 minutes. An estimated 20 foot wall of water from the 680-foot-wide reservoir breach, scoured a 1.6 mile channel along the western slope of Proffit Mountain, completely removing trees, boulders and topsoil. The wall of water and debris entered the East Fork Black River, a biological criteria reference stream, in Johnson's Shut-Ins State Park sweeping away the park superintendent's home and family and burying the state park and stream under several feet of debris and sediment.

At the point of impact with the East Fork Black River, eroded debris was deposited as a debris dam, redirecting flow from the main channel to a high water channel and depositing up to four vertical feet of sand sized sediment in the original channel. The majority of flood water and debris was captured by the Lower Reservoir, approximately 2 miles downstream of the point of impact. However, sedimentation, turbidity and other water quality concerns extended an additional 30 miles. Assessment included parameters such as pH, specific conductivity, dissolved oxygen, temperature and turbidity, as well as, both quantitative and semi-quantitative biological assessment using macroinvertebrates.

The developed recovery and restoration plan included multiple agencies and private contractors and was the largest of its kind in Missouri, perhaps the nation. It included removal of thousands of cubic yards of woody debris, uncovering a buried nine acre fen, and removing boulders, some the size of vans, from the park grounds and stream's geologic features. The most challenging phase of restoration included complete reconstruction of a 0.5 mile stretch of stream.

Water quality monitoring played a crucial role in assessing damages, determining recovery steps and gauging restoration efforts. Eight years later restoration work still continues. This presentation will discuss monitoring efforts and how water quality and the aquatic community in the East Fork Black River have rebounded since the disaster.

Thursday, May 1

Session J1: National-Scale Water Quality Assessments

8:00 – 9:30 am | Room 263

The National Network of Reference Watersheds

Michael McHale[1], Jeffrey Deacon[2] and William Wilber[3]
[1]US Geological Survey, Troy, N.Y., [2]US Geological Survey, Pembroke, N.H., [3]US Geological Survey, Reston, Va.

Abstract
A significant challenge faced by water-resource scientists in the public and private sectors is to determine how much of the change measured in the environment is caused by humans and how much is caused by nature. This question requires a baseline or reference against which changes can be compared. Reference conditions can also be used to measure the subtle natural changes that occur over long time periods as well as to quantify the variability of natural ecosystems across large spatial scales. A variety of agencies and organizations monitor minimally disturbed watersheds across the country. However, there is no central location where data from these reference sites can be accessed, and generally there are no consistent and commonly accepted criteria that define watershed reference conditions. In 2011, the Advisory Committee for Water Information (ACWI) authorized the National Water Quality Monitoring Council to form a work group to provide the leadership and technical guidance to establish a collaborative and multipurpose National Network of Reference Watersheds (NNRW) and monitoring sites for freshwater streams in the United States. The goal of the NNRW is to provide a web-based resource that allows users to access reference watershed information collected by federal, state, local, and non-governmental organizations in one centralized location. The NNRW is envisioned as a collaboration among organizations involved in monitoring and research in reference watersheds. This presentation will introduce the NNRW web resource and demonstrate how users can define their own reference criteria to select sites and download data that meet their specific needs.

A Multi-Scale Monitoring and Modeling Approach for Assessing the Quality of the Nation's Groundwater: Perspectives from the USGS National Water Quality Assessment Program (NAWQA)

Kenneth Belitz
US Geological Survey, San Diego, Calif.

Abstract
In 2013 NAWQA began its third decade (Cycle 3) of assessing the Nation's water quality. In the first decade (1991–2001), NAWQA assessments were implemented at the scale of Study Units – typically, large watersheds. Data and findings regarding important water-quality issues collected by the Study Units, such as the occurrence of pesticides in streams and aquifers, were then synthesized at the national scale. In the second decade (2002–2012), NAWQA continued to collect data at the study-unit scale, and in addition, implemented topical studies to better understand the factors affecting water quality. For groundwater, this included local- and regional-scale studies that examined the transport of natural and anthropogenic contaminants to public supply wells, and synthesis of NAWQA groundwater-quality data at the Principal Aquifer scale.

In Cycle 3, Principal Aquifers will be the primary scale for NAWQA's groundwater studies. In addition to addressing decadal-scale trends in groundwater quality, NAWQA will focus on assessing the quality of deep groundwater used for drinking supply and on groundwater loading of nutrients and other contaminants to streams. NAWQA will continue to collect samples from previously established networks (Flow Path Studies, Land Use Surveys, Major Aquifer Surveys), and from newly established networks at larger (Principle Aquifer Surveys) and smaller scales (Enhanced Trends Networks). Samples collected by NAWQA have been, and will continue to be, analyzed for a broad suite of constituents including regulated and unregulated contaminants, contaminants of emerging concern, tracers of groundwater age, and indicators of geochemical condition. NAWQA will also acquire data from other sources. Water-quality data will be combined with results from statistical and groundwater flow models to map the quality of groundwater at depths used for domestic and public supply, to estimate the loading of contaminants to streams, and at scales ranging from local to National. The multi-scale monitoring and modeling approach will be used to improve understanding of the factors affecting groundwater quality, to map groundwater quality in areas of sparse data, and to forecast changes in groundwater quality that might occur in response to broad-scale changes in land use, water use, or climate.

Status and Trends of the Nation's Surface-Water Quality: The U.S. Geological Survey's National Fixed Site Network

Charles Crawford[1], Michael Yurewicz[2], William Wilber[2], Robert Gilliom[3], Jeffrey Deacon[4] and David Reutter[5]
[1]US Geological Survey, Indianapolis, Ind., [2]US Geological Survey, Reston, Va., [3]US Geological Survey, Sacramento, Calif., [4]US Geological Survey, Pembroke, N.H., [5]US Geological Survey, Columbus, Oh.

Abstract
A strategic Science Plan for the National Water-Quality Assessment (NAWQA) Program has been developed by the U.S. Geological Survey (USGS), which includes integration of three national water-quality monitoring networks, as well as additional new sites, to form a 313-site USGS National Fixed Site Network (NFSN). Initial implementation of the recommended NFSN is a 100-site design that conforms to current budget constraints, but forms the core for the much larger national network that is ultimately needed. The 100-site NFSN is comprised of selected sites from: (1) the NAWQA Program; (2) the National Stream Quality Accounting Network (NASQAN); and (3) the National Water Quality Monitoring Network for U.S. Coastal Waters and Their Tributaries (NMN). By unifying approaches and methods across the three networks to form the NFSN, key shared objectives are more effectively met. The 100-site NFSN focuses on assessing nutrient, sediment, and contaminant concentrations and transport in rivers and streams of major river basins throughout the Nation, particularly the Mississippi River basin, and also watersheds of critical estuaries such as Chesapeake Bay and San Francisco Bay. The NFSN includes 61 large-river sites used to assess the status and trends in regional conditions and coastal discharges, and 39 sites on smaller rivers and streams that are used to track trends in water-quality and ecosystem conditions in urban, agricultural, and undeveloped watersheds selected to represent the national diversity of environmental settings. Continuous monitoring of key water properties, including nitrate, salinity, and turbidity has begun at 6 sites equipped with state-of-the-art water-quality sensors. These continuous data greatly improve estimates of nutrient and sediment loads for selected critical sites, including the mouth of the Mississippi River before discharging to the Gulf of Mexico. To provide timely statistical summary information, annual web-based reports are being developed which will present concentrations and loads of nutrients, sediment, and other contaminants for all sites. The long-term goal for the USGS

NFSN is to build toward the scale recommended in the NAWQA Science Plan, and ideally much larger, by developing partnerships with other federal, state, and regional agencies that monitor compatible sites.

Assessing the Nation's Waters: Accomplishments of the First Ten Years of the National Aquatic Resource Surveys (NARS) and Challenges for the Next Ten

Sarah Lehmann
US Environmental Protection Agency, Washington, D.C.

Abstract
In 2004, EPA and our State/Tribal partners embarked on a joint effort to assess comprehensively and consistently the quality of the Nation's rivers, streams, lakes, reservoirs, coastal waters and wetlands. Basing the effort on years of scientific research and a number of pilot projects implemented as part of the Environmental Monitoring and Assessment Program, we began implementing a series of national statistical surveys. This presentation will briefly describe the objective of the National Aquatic Resource Surveys and discuss accomplishments – including assessment results for all waterbody types – achieved over the first ten years of implementation. Additionally, the presentation will look forward to consider some of the opportunities and challenges that NARS will be facing and working to address in the next ten years.

During the first 10 years, EPA and our state/tribal and other partners assessed the chemical, physical and biological condition of waters in the continental 48 states as well as worked on assessments in Alaska, Hawaii, and the territories. This work has confirmed our understanding that nutrients and sediment are widespread problems for our waters. It has also highlighted the importance of other factors such riparian habitat in protecting our waters. As we look to the future, there are a number of challenges and opportunities that NARS program will face in order to sustain the current momentum and to improve the program. These include technical and programmatic challenges; as well as numerous opportunities to build on lessons learned and foster further data analysis at multiple scales. Additionally, despite the many successes, the NARS program, like most monitoring programs, faces challenges from limited resources. In particular, we recognize that sustaining and improving NARS will require that we build on, strengthen, and expand our collaborative efforts in transferring information from and about statistical surveys.

Session J2: Novel Biotic Indices

8:00 – 9:30 am | Room 262

Upper Mississippi River Mussel Community Assessment Tool

Heidi Dunn[1], Steve Zigler[2], Teresa Newton[2] and Jon Duyvejonck[3]
[1]Ecological Specialists, Inc., O'Fallon, Mo., [2]US Geological Survey, LaCrosse, Wis., [3]US Fish and Wildlife Service, Moline, Ill.

Abstract
Managers in the Upper Mississippi River (UMR) need a quantitative means of evaluating the relative health or value of a mussel bed for identifying and preserving mussel resources, assessing anthropogenic impacts, assessing the efficacy of restoration techniques, and other regulatory tasks. We evaluated a series of statistically derived curves that plot the frequency distribution of different mussel metrics representing the categories conservation status/sensitivity, taxonomic composition, population processes, abundance, and diversity. Multiple metrics in each category were calculated using existing quantitative data from 25 surveys that spanned low to high quality mussel communities from Navigation Pools 2 to 25. Metrics in each category were evaluated for range, ecological significance, sampling bias, and redundancy. Of the 50 metrics initially evaluated, 10 were selected; percent listed species, percent tolerant taxa, percent tribe Lampsilini, percent freshly dead shells, percent ≤5 years old, percent ≥15 years old, density at the 75th quartile, species evenness, tribe level evenness, and rarefaction species richness. Frequency distributions of these metrics were plotted using the 25 test data sets. Distributions were divided into good, fair, and poor categories based largely on quartile analysis. Scoring categories for metrics assumed that a healthy freshwater mussel community consists of species with a variety of reproductive and life history strategies, a low percentage of tolerant species and a high percentage of sensitive species; has evidence of recruitment, a variety of age classes, and low mortality; and has high abundance, high species richness, and high species evenness. The 25 data sets analyzed in this study provide a preliminary range of values for the selected metrics within the UMR. Although data gaps exist, testing with additional data sets is needed, and categories need refining with additional data, selected metrics appear to provide a tool to assess mussel communities in the UMR.

Implementation of a Long-term Quantitative Mussel Monitoring Program in Kentucky

Jacob Culp, Sue Bruenderman and Ryan Evans
Kentucky Dept. for Environmental Protection, Frankfort, Ky.

Abstract
Because freshwater mussels are extremely long-lived and sensitive to changes in their physical and chemical environment, they are excellent water quality monitoring organisms. The Kentucky Division of Water (KDOW) has begun designing and will implement its first mussel monitoring program in 2014. This network will be added to an existing biological monitoring program tied to KDOW's Ambient Water Quality Monitoring Program, which tracks long-term water quality trends in larger streams and rivers throughout the state. At select fixed ambient stations on approximately 12 rivers representing Kentucky's various bioregions, where monthly surface water chemistry is analyzed, long-term mussel monitoring sites will be established. Mussel assemblages at these stations will be quantitatively sampled and statistically analyzed for mussel population and community trends. We expect that the addition of mussel community monitoring, combined with traditional fish community, habitat and water chemistry assessments, will greatly enhance our ability, and with greater accuracy, to evaluate and identify trends in both the biological and ecological integrity of Kentucky's flowing waters.

Validation of a Headwater Index of Biotic Integrity for New Jersey's High Gradient Streams

Brian Henning
New Jersey Dept. of Environmental Protection, Trenton, N.J.

Abstract
The New Jersey Department of Environmental Protection (NJDEP) collaborated with the Academy of Natural Sciences of Drexel University (ANSDU) to develop an index of biotic integrity (IBI) for high gradient headwater streams to provide a rapid, cost effective assessment of the water quality and condition of New Jersey's high gradient headwater streams. The NJDEP has had an active fish based index of biotic integrity monitoring program since 2000 to assess the condition of streams and small rivers with drainage areas greater than five square miles. However, an estimated 81 % of the non-tidal stream miles north of the fall line in NJ are less than five square miles in watershed size, and 38% of those streams are protected through antidegradation designation. Therefore, an effective tool was sought to monitor these important resources and to expand our biological monitoring in more waters of the state. The Headwater IBI developed by ANSDU was composed of metrics based on the assemblage of fish, crayfish, salamanders and frogs present at a sampling location. The IBI developed by ANSDU was tested against independent data from 30 sites collected by NJDEP in 2013 to validate its ability and effectiveness to classify the quality of high gradient headwater streams

based on biotic assemblages. Proposed HIBI metrics were evaluated to test the ability of the multimetric index to discriminate between reference and degraded conditions using classification efficiencies.

Investigating a Rapid Floristic Quality Assessment Method for Mid-Atlantic Wetlands or What's a Nice Intensive Assessment Method Like You Doing in a Rapid Assessment World Like This?

Sarah Chamberlain
Penn State University, University Park, Pa.

Abstract
Floristic Quality Assessment (FQA) has recently emerged as one of the best tools available to evaluate wetland condition. With the completion of the Mid-Atlantic Regional FQA in 2009, it is now possible to deploy the method region-wide. Despite its efficacy as an assessment tool, FQA is an intensive method that requires specialized expertise and an additional commitment of both time and resources. As States move to institutionalize wetland monitoring and assessment programs, most are building their programs around rapid site assessments. This, in turn, has led to an increased interest in developing rapid versions of intensive tools, particularly those that use floristic metrics. We investigated the efficacy of a rapid version of the Floristic Quality Index (FQI) by first conducting a sensitivity analyses on the index to determine which variable(s) drive the model. Using reference wetland plant species lists, we will next examine the behavior of the model when in situ species lists are systematically reduced in richness and floristic quality. This exercise tests the resiliency of the model and simulates how the model will respond as one moves from a comprehensive plant species list to more typical lists with less taxonomic detail, such as those from rapid assessments. Finally, we will test the index using plant lists from Routine Wetland Determination Forms to evaluate if wetland condition could also be ascertained from information gathered during wetland delineations. The ability to effectively deploy FQA in a rapid context would be an important advance in wetland monitoring and assessment in the region.

Session J3: Continuous Monitoring: Tools and Tricks for Data Management

8:00 – 9:30 am | Room 261

Database Design for In Situ Water Quality Data

Amy Russell and Jennifer Hill
Illinois State Water Survey, Champaign, Ill.

Abstract
The Water Quality Section at the Illinois State Water Survey (ISWS) has collected large amounts of in situ water quality data from locations across the state of Illinois. The data are of three types: continuous monitoring (CM) data from sondes collecting on 1-30 minute intervals, stream profile data collected using spot meters, and singular spot meter measurements collected during site visits, typically on a weekly basis.

The volume of data collected is very large and the data are currently archived separately based on project and data type. We propose a database schema where all in situ data collected for varying purposes can be combined and stored for easy analysis and retrieval by ISWS researchers, with the potential of publishing the data set online for public access. The proposed structure favors efficiency of storing CM data over other considerations because with more than 7 million existing CM observations, these measurements will constitute the bulk of the content and this type of data collection is expected to continue.

The proposed database was developed by incorporating favored elements from CUAHSI's ODM Database and EPA's WQX database, then restructuring tables and fields to reduce duplication of continuous monitoring data.

This presentation will compare the resulting database with both ODM and WQX schemas using metrics such as number of records, file size, complexity of database structure, and resulting complexity of data import and querying.

Combining Monitoring Data Spanning Multiple Temporal and Spatial Scales To Evaluate Water Quality Affecting Seagrass Habitat Extent In Northwest Florida Estuaries

James Hagy[1], Michael Murrell[1], John Lehrter[1] and Chengfeng Le[2]
[1]US Environmental Protection Agency, Gulf Breeze, Fla., [2]ORISE Research Participation Program, Gulf Breeze, Fla.

Abstract
The ability to understand and manage ecological changes caused by anthropogenic stressors is often impeded by a lack of sufficient information to resolve pattern and change with sufficient resolution and extent. Increasingly, different types of environmental data are available that describe temporal and spatial patterns in great detail, opening the door to better relating changes to their causes. However, information from different sources is often difficult to utilize due to constraints imposed by mismatches in scales, technological and data processing hurdles, and a lack of data analysis methods and examples applied to environmental decision-making. In this presentation, part of a study seeking to demonstrate application of satellite remote sensing data in environmental decision making, we address the task of understanding causes of changes in seagrass habitats in northwest Florida estuaries, which have been declining in spatial extent and depth of colonization since at least 1960 and continuing through 2010. Based on global patterns and trends related to seagrass loss, changes in optical properties are likely important. The data that were considered included: (1) digitized aerial surveys of seagrass extent, (2) water quality indicators from satellite remote sensing, (3) boat-based surveys, and (4) high-frequency continuous monitoring of optical properties. We evaluate the relative strengths and weaknesses of each in the context of a conceptual model of ecological processes affecting seagrass. We also examine how each type of data could be used to better inform interpretation of the other types, with the final purpose of using them together to improve our conceptual and quantitative understanding of factors affecting the seagrass habitats. The approach includes the use of coupled hydrodynamic-water quality models to facilitate synthesis and extrapolation of information across scales. Finally, we discuss how these different kinds of information can inform development of numeric nutrient criteria and other aspects of nutrient management in estuaries.

ODM Tools Python: Open Source Software for Managing Hydrologic and Water Quality Time Series Data

Jeffery Horsburgh, Stephanie Reeder, James Patton and Amber Jones
Utah State University, Logan, Ut.

Abstract
Hydrologic and water quality data is being collected at high frequencies, for extended durations, and with spatial distributions that require infrastructure for data storage and management. The Observations Data Model (ODM), which is part of the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Hydrologic Information System (HIS), was developed as a framework in which to organize, store, and describe point observations data. This presentation will describe ODM Tools Python, which is an open source software application that allows ODM users to query and export, visualize, and edit data stored in an ODM database. Previous versions of ODM Tools have included the functionality to export data series and associated metadata, plot and summarize single data series, generate derivative data series,

and edit data series using a set of simple tools. We have developed a new version of ODM Tools in Python that adds a modernized graphical user interface, multiple platform support (Windows, Linux, and Mac), multiple database support (Microsoft SQL Server and MySQL), and support for automated scripting of quality control edits performed on data series through an integrated Python script editor and console. Scripting records the corrections and adjustments made to data series in the quality control process, ensuring that the steps are traceable and reproducible. Additional improvements to ODM Tools Python include customizable queries for data selection and export, the ability to plot multiple data series simultaneously with various plot types, and user-defined functions for data series editing and derivation.

Temporally Dynamic Representations of Continuous Monitor Data through Animated Graphing

John Yagecic
Delaware River Basin Commission, West Trenton, N.J.

Abstract
The proliferation of continuous real-time monitors across diverse monitoring organizations and web hosting platforms is making high frequency data widely available to water resource managers. The defining feature of the resultant data sets is a nearly continuous stream of observations at all times of day and under conditions that would be inaccessible to manned vessels. Traditional static representations seem incomplete and limiting when applied to these high density data streams.

The author has developed a method of cycling data sets in standard graphing applications, to exploit the temporal nature of continuous data. The resulting animated graphs provide an intuitive, information rich experience of the data, and allow for integration and synchronization of data sets from different sources to better understand estuary and watershed processes being measured.

This presentation will highlight several applications including progression of the storm surge from hurricane Sandy into the Delaware estuary, development of terrestrial flooding in the non-tidal Delaware River, and dissolved oxygen fluctuations as a function of time-of-day and tidal cycle.

Session J4: Monitoring Methods and Effects of Floods on Water Quality and Human and Ecological Health

8:00 – 9:30 am | Room 237

Concentrations and Transport of Nutrients and Suspended Sediment in the Lower Mississippi-Atchafalaya River Basin During the 2011 Mississippi River Flood, April through July

Heather Welch[1], Richard Coupe[1] and Brent Aulenbach[2]
[1]US Geological Survey, Jackson, Miss., [2]US Geological Survey, Atlanta, Ga.

Abstract
In April through July 2011, the lower Mississippi-Atchafalaya River Basin (MARB) experienced a flood of historic proportions. Since the flood occurred at a time of year when agricultural fields were being tilled, agricultural lands were thought to be more susceptible to overland runoff of sediment and agricultural chemicals. In order to characterize the suspended sediment and nutrient concentrations and fluxes in the river during the flood, the U.S. Geological Survey collected water samples at eight sites on the main stem of the lower Mississippi River, three sites on the Atchafalaya River, and the three major flood-control structures.

Suspended-sediment, total nitrogen, nitrate, and total phosphorus concentrations measured during the flood were similar to concentrations that had been measured historically in the lower MARB; however, fluxes were quite high because of the high streamflow. The majority of the suspended-sediment and nutrient species flux introduced into the basin during the flood was from the upper Mississippi River Basin despite that more flow came into the lower MARB from the more forested, less agricultural Ohio River Basin (March through July). Forty-nine percent of the 2011 total suspended sediment flux was delivered to the Gulf of Mexico during the flood period (51.7 million metric tons). When comparing the suspended sediment flux inputs into the lower MARB with the suspended sediment flux outputs to the Gulf of Mexico, 13 percent less sediment left the lower MARB than entered from the confluence of the Upper Mississippi with the Ohio River. Between the confluence of the Upper Mississippi with the Ohio River and the outlets to the Gulf of Mexico, there was a 5.2 percent loss in nitrate flux, an 8.8 percent loss in total nitrogen flux, and a 1.7 percent loss in total phosphorus flux. The flux losses in nitrogen and total phosphorus species are within the standard error of the estimation method, and the lack of significant changes in nitrate, total nitrogen, and total phosphorus flux between water-quality stations in the lower MARB indicate that these constituents are behaving conservatively within the basin.

The Occurrence and Transport of Pesticides in the Lower Mississippi River during the 2011 Flood

Richard Coupe[1], Heather Welch[1] and Brent Aulenbach[2]
[1]US Geological Survey, Jackson, Miss., [2]US Geological Survey, Atlanta, Ga.

Abstract
In April through July 2011, the lower Mississippi-Atchafalaya River Basin experienced a flood of historic proportions. This flood marked the first time in history that three of the major flood control structures (Bird's Point-New Madrid Floodway, Morganza Floodway, and Bonnet Carré Spillway) were operated simultaneously. Because the source water for the flood came from agricultural areas of the Midwest and agricultural land was inundated by opening the Morganza and Bird's Point-New Madrid Floodways, there was concern that the Mississippi River would export unprecedented amounts of pesticides into the Gulf of Mexico.

In order to characterize the occurrence and transport of pesticides in the lower Mississippi-Atchafalaya River Basin during the flood, the U.S. Geological Survey collected water samples for analysis of pesticides at 11 stations on the Mississippi, Ohio, Yazoo, Arkansas, and Atchafalaya Rivers. Additional water samples were also collected in the two floodways.

Water samples were analyzed for up to 136 pesticides and pesticide degradates. Of the 136 compounds, 118 were not detected above the method reporting level. The remaining 18 compounds fall into several categories: (1) compounds that were frequently detected and showed an increase in concentration during the flood, (2) compounds that were detected almost all of the time at every site, but usually in very low concentrations, (3) and compounds that were infrequently detected. The first group included acetochlor, atrazine and its 3 degradates (deisopropylatrazine, deethylatrazine, and hydroxyatrazine), metolachlor, and simazine. The second group include 2,4-D, 3-4-dichloroanline, alachlor, diuron, metribuzin, prometon, and prometryn. Compounds that were infrequently detected included the fungicides cis-propiconazole, trans-propiconazole, and metalaxyl, and the herbicide, trifluralin.

The fluxes during April through July of 2011 for the most frequently detected pesticides (atrazine, metolachlor, acetochlor, and simazine) were in the mid to low range of historic fluxes. This indicates that the 2011 flood, although of historic proportions concerning flow, did not carry a similarly historic amount of pesticides into the Gulf of Mexico.

Long Term Contaminant Threats to Ecosystems and Humans Due to Hurricane Sandy

Michael Focazio, Terry Schertz, Tim Reilly, Kelly Smalling, Pat Phillips, Shawn Fisher, Geoff Plumlee, Irene Fisher, Jeff Fischer, Jack Monti and Terry Slonecker
US Geological Survey, Reston, Va.

Abstract
In late October 2012, Hurricane Sandy made landfall during a spring high tide on the New Jersey and New York coastline, delivering hurricane-force winds, storm tides exceeding 19 feet, driving rain, and plummeting temperatures. Hurricane Sandy resulted in 72 direct fatalities in the mid-Atlantic and northeastern United States, and widespread and substantial physical, environmental, ecological, social, and economic impacts estimated at $50 billion. In the immediate aftermath of the storm, first responders focused efforts on minimizing public-health risks due to a wide array of chemical and pathogenic contaminants released by damaged municipal, residential, and industrial infrastructure.

Because most contaminant-related mitigation and restoration activities are necessarily focused on the immediate aftermath of storms, much less is known about the longer term risks due to persistent contaminants in the environment. Samples of sediment and fish tissue will be analyzed for a wide array of contaminants including trace organic compounds, wastewater indicators, hormones, metals, and toxicity, prioritizing sites where pre-storm data is available. The research effort is a collaboration between USGS, NOAA, USEPA, USACE, and a number of state and local agencies and institutions to maximize the use of existing resources, data, and capability. This study will provide unique benefits to future decisions by increasing our understanding of longer-term contaminant threats to ecosystems and humans and results in an important baseline dataset for many previously unmonitored contaminants in the region. In particular, identification of the associations between contaminant sources and specific contaminant threats to aquatic organisms and humans will inform decisions about the management of priority contaminant sources (*e.g.*, municipal wastewater, oil and gas spills, etc.) and the protection of critical living resources.

Training and Equipment Required to Collect Water-Quality Samples on Large Rivers during High Flows

Stan Skrobialowski[1] and Mark Landers[2]
[1]US Geological Survey, Reston, Va., [2]US Geological Survey, Norcross, Ga.

Abstract
Epic flooding in the Mississippi and Columbia River basins in 2011 signaled the need for the U.S. Geological Survey (USGS) to train and equip field sample crews to safely collect water quality samples and data. As a result of the flooding, the USGS Office of Water Quality commissioned the fabrication of 3 additional D-99 collapsible bag samplers for water and suspended sediment and strategically positioned them for deployment on short notice. Heavy, large-volume collapsible-bag isokinetic samplers such as the D-99 and D-96 are required to properly collect a variety of water quality samples in streams and rivers where depths commonly exceed 15 feet such as some of those in the USGS National Fixed Site Network and Cooperative Program. USGS Water Science Centers contribute substantially toward training personnel and infrastructure in order for field sample crews to properly and safely deploy these samplers. Field crews must be familiar with a combination and variety of boats, vehicles, booms, reels, cranes and hydrologic conditions to safely deploy and recover the samplers. The isokinetic performance of bag samplers varies according to stream velocity, depth, and stream temperature and, therefore, the performance must be tested and documented before each sample is collected. The performance data and the results from the samples are stored in the National Water Information System (NWIS). Laboratory results from the samples are essential for calibrating and verifying watershed models and surrogates of water quality (such as optical and acoustic metrics) for continuous monitoring; results also are used to report concentrations, loads, and trends of nutrients, pesticides, sediment, and other contaminants in large rivers.

Session J5: Pesticide Monitoring, Modeling, and Risk Assessment

8:00 – 9:30 am | Room 233

Integration of Surface and Groundwater Modeling and Monitoring Data in Pesticide Ecological Risk Assessments

Mark Corbin, Nelson Thurman and Tracy Perry
US Environmental Protection Agency, Washington, D.C.

Abstract
Under the Federal Insecticide, Fungicide, and Rodenticide Act, the United States Environmental Protection Agency's (USEPA) Office of Pesticide Programs (OPP) is responsible for the regulation of pesticides. As part of the process for assessing risks to aquatic organisms exposed to pesticides , OPP's Environmental Fate and Effects Division (EFED) conducts aquatic exposure assessments that utilize a combination of modeling and monitoring data. Pesticide risk assessments rely principally on modeling for estimates of risk and use a tiered modeling approach for estimating both surface water and groundwater concentrations.

As needed, the tiered approach integrates increasing levels of refinement based on risk conclusions. Modeling begins at a national scale using assumptions about the predominant factors that influence pesticide concentrations in water (*e.g.*, runoff vulnerability). This initial estimation provides a conservative upper-bound estimate of potential pesticide concentrations. Pesticides that exceed screening levels of concern (LOC) for either human health or ecological effects are assessed at the next level of refinement, using Tier II models and an evaluation of available monitoring data. As the tiers increase, the level of sophistication increases as does the spatial and temporal relevance to the estimated exposures.

Since most monitoring data are not targeted to pesticide applications, monitoring data are typically used to characterize modeling estimates. When monitoring data are targeted both temporally and spatially to a specific pesticide use pattern, they can be used as a quantitative measure of exposure provided that the sampling frequency aligns with the duration of concern, and sufficient ancillary data are available to describe the study objectives. In cases where monitoring data are not specifically targeted to a pesticide's use pattern, the data can be used qualitatively to provide context to estimated values derived from aquatic exposure modeling. Monitoring data can also provide information that is lacking in modeling, such as the identification of vulnerable and/or non-vulnerable areas, depending on the spatial extent of the data.

Use of the Co-occurrence Pesticide Species Tool (CoPST) to Model Seasonal and Temporal Patterns of Pesticide Presence to Guide Water Quality Monitoring Timing and Location

Richard Breuer[1], Debra Denton[2], Gerco Hoogeweg[3] and W. Martin Williams[3]
[1]California Water Resources Control Board, Sacramento, Calif., [2]US Environmental Protection Agency, Sacramento, Calif., [3]Waterborne Environmental, Inc., Leesburg, Va.

Abstract
A decline in pelagic species has been observed in the San Francisco Bay-Delta, triggering questions as to whether contaminants are contributing to the decline. To help address these questions, Waterborne Environmental, Inc. (Waterborne), in conjunction with University of California Davis, the U.S. Environmental Protection Agency Region 9, and the California Department Water Resources, developed the CoPST (Co-occurrence of Pesticide and Species Tool), which is a GIS/modeling framework that incorporates 40 high-risk pesticides and aquatic endangered species presence to identify areas and timing of greatest risk.

This presentation describes the first application of the tool. In this application, the co-occurrence of endangered species module was not utilized. The question was "when and where monitoring should be focused for specific pesticides, based on historical use application and available monitoring data." Although many monitoring efforts are ongoing in the California Central Valley and Bay-Delta, research has shown that the current temporal and spatial sampling of pesticides may be insufficient to capture the complete profile of water quality. Coordination was necessary with existing monitoring surveys and regulatory programs such as the Central Valley Regional Water Quality Control Board's Irrigated Lands Regulatory Program (ILRP), Surface Water Ambient Monitoring Program (SWAMP), and Delta Regional Monitoring Program (RMP).

The analyses output was a GIS layer using heat map style representation for predicted pesticide edge of field loading indexes, along with layers of actual monitoring results in a monthly time step. The results layer also incorporates a lookup feature by section (640 acres), allowing users to pass their cursor over the indexed sections, showing the individual pesticides that contributed to the modeled index, as well as the corresponding pesticides if present in the actual monitoring data.

Next steps include connecting the model output to current watershed improvement planning efforts, and determining best management practices placement and monitoring priorities.

Pesticide Surface Water Monitoring: Bias Factors to Estimate Peak Concentrations and PRZM-Hybrid to Complete Measured Chemographs

Wenlin Chen[1], Clint Truman[1], Paul Mosquin[2], Paul Miller[3] and Mike Leggett[4]
[1]Syngenta Crop Protection, LLC, Greensboro, N.C., [2]RTI, Research Triangle Park, N.C., [3]Waterborne Environmental, Inc., Leesburg, Va., [4]CropLife America, Washington, D.C.

Abstract
Daily sampling for water quality monitoring at multiple sites is operationally challenging. Consequently, most monitored datasets do not have daily samples. We use bias factors (BFs) to address the following question: If less frequent monitoring datasets are used to estimate exposure, what is the probability or uncertainty of missing potential peak concentrations and/or maximum rolling average concentrations? Bias factors estimate the error in predicting the true peak concentration and/or maximum rolling average concentration from non-daily samples or sampling frequencies. We will present BFs calculated from two datasets representing multiple site-year-chemical combinations for selected sampling frequencies and relate them to watershed characteristics (hydrology, size). Calculated BF results will be compared to measured data for selected site-year-chemical combinations. We will also demonstrate how PRZM-Hybrid output can be used along with calculated BFs and less than daily monitoring data to estimate daily chemographs. This work demonstrates how lower frequency monitoring data can be coupled with model output to estimate potential maximum shorter duration concentrations to address water monitoring management needs.

Pesticide Toxicity Index – A Tool for Assessing Complex Mixtures of Pesticides in Streams

L.H. Nowell[1], J.E. Norman[2], P.W. Moran[3], J.D. Martin[4] and W.W. Stone[4]
[1]US Geological Survey, Sacramento, Calif., [2]US Geological Survey, Portland, Oreg., [3]US Geological Survey, Tacoma, Wash., [4]US Geological Survey, Indianapolis, Ind.

Abstract
Pesticide mixtures commonly occur in streams with agricultural or urban land in the watershed. The Pesticide Toxicity Index (PTI) is a tool to assess the potential aquatic toxicity of complex pesticide mixtures by combining measures of pesticide exposure and acute toxicity in an additive toxic-unit model. The PTI for pesticides in water is determined separately for fish, cladocerans, and benthic invertebrates on the basis of toxicity data from publicly available databases and documents, consisting of 10,837 bioassays representing 492 pesticides and degradates and 559 species. Two types of PTI values can be computed for use in different applications. The Median-PTI is calculated from median toxicity concentrations for individual pesticides, so is robust to outliers and is appropriate for comparing relative potential toxicity among samples, sites, or pesticides. The Sensitive-PTI uses the 5th percentile of available toxicity concentrations, so is a more sensitive screening-level indicator of potential aquatic toxicity. PTI predictions of toxicity in environmental samples were tested using data aggregated from published field studies that measured pesticide concentrations and toxicity to *Ceriodaphnia dubia* in ambient stream water. *C. dubia* survival was reduced to ≤50% of controls in 44% of samples with Median-PTI values of 0.1–1, and to 0% in 96% of samples with Median-PTI values >1. Empirical 50%-mortality thresholds that correctly predicted toxicity or nontoxicity in 90% of samples in an aggregated dataset were determined to be 0.3 for the Median-PTI and 1 for the Sensitive-PTI. These thresholds are not necessarily applicable to future studies because they are based on a limited number of pesticides and studies. An effort is underway to develop a PTI for hydrophobic pesticides in sediment based on toxicity to benthic invertebrates. The PTI is a relative indicator of potential toxicity that can be used to interpret water-quality data, relate pesticide exposure to biological condition in multi-stressor systems, and prioritize future assessments.

Session J6: Web and Smart Phone Apps for Collecting and Presenting Data

8:00 – 9:30 am | Room 232

Better Public Access and Integration of Point Source Wastewater Pollutant Discharge Information and Receiving Waterbody Quality and Assessment Data

Carey Johnston[1], Wayne Davis[1] and Meghan Camp[2]
[1]US Environmental Protection Agency, Washington, D.C., [2]Eastern Research Group, Inc., Chantilly, Va.

Abstract
EPA has developed a new web tool, DMR Pollutant Loading Tool ("Loading Tool" at http://www.epa.gov/pollutantdischarges), to provide increased access to wastewater pollutant discharge data and receiving waterbody data, which will

allow for better transparency of wastewater pollutant discharges and enhanced utility of these data. Specifically, technical users of the new tool can enhance their development of NPDES permit effluent limits, better identify and target violations of effluent discharge permit limits, improve their watershed pollution budget plans (Total Maximum Daily Loads, or "TMDLs"), and refine their watershed modeling.

The Loading Tool is a significant improvement in making more information about pollutant discharges available to the public. Through the Loading Tool interface, users can easily find who is discharging into their local watershed, and can sort the information by specific pollutants. The Loading Tool calculates facility pollutant discharges based on reported discharge monitoring data. The tool also weights chemicals by their relative toxicity and calculates the toxic-weighted equivalent amount of each chemical released. With this tool users can rank facilities and pollutants by total amount of each pollutant released each year and by the total amount of toxic-weighted pounds released each year.

This tool also links these point source data to water quality data in EPA's STORET database, state waterbody assessment and impairment data in EPA's ATTAINS database, and with U.S. Fish and Wildlife data on aquatic species listed by the Endangered Species Act. This integration allows users to examine the potential impacts point source pollution on impaired waterbodies. This presentation will provide an overview of the tool and a demonstration on how to use the tool from a variety of perspectives.

Recr8OhioRiver: A Water Quality Recreation Management Application to Have a Safe and Enjoyable Time on the Ohio River

Laith Alfaqih[1,3], Sudhir Kshirsagar[2] and MaryLynn Lodor[1]
[1]Metropolitan Sewer District of Greater Cincinnati, Cincinnati, Oh., [2]Global Quality Corp, Convington, Ky., [3]CH2MHILL, Cincinnati, Oh.

Abstract
The Metropolitan Sewer District of Greater Cincinnati (MSDGC) and its partners, the Ohio River Valley Water Sanitation Commission (ORSANCO), and Sanitation District No. 1 of Northern Kentucky (SD1) developed a recreational management toolset consisting of a mobile application and a website to help recreational users such as boaters, paddlers, swimmers, jet skiers, and fishermen make informed decisions about where and when to recreate on the Ohio River. The coverage area in the Ohio River is mainly between Meldahl and Markland dams in the tri-state area. The name of application is "Recr8OhioRiverand it was developed for smartphone users and desktop users.

The toolset was developed as part of the Recreation Management Program. It focuses on water quality (*E. coli* levels), hydrology and other ambient conditions. The E. coli levels are based on a predictive model that was developed using artificial neural network (ANN) techniques. The river segment between Coney Island (I-275 East) and Lawrenceburg, IN (I-275 West) is has been sampled frequently by all three partners during 2010 and 2011 and that data was utilized in developing the ANN.

The hydrology and ambient conditions include river stage, velocity, current and forecasted weather conditions, Doppler radar, real time marine traffic, fish advisories, locations of marinas, boat ramps and attractions along the river, and emergency alerts/announcements. This information will allow the users to plan their Ohio River recreational activities and make it an enjoyable and safe one.

TestTheWater.org – A Digital Water Data Management Solution

Lee Tremblay, Luke Warren, Glen Warren and Helen Fletcher
4Marbles Inc., New York, N.Y.

Abstract
TestTheWater.org is a water data management solution, which allows water monitoring programs to leverage digital tools to coordinate in-the-field sample/data collection, data analysis and data submission to CEDEN and thereby to the EPA in a single integrated web-based platform. Quality Assurance and Data Validation are presented in a simplified user interface for the ease of metadata entry. Our MobileLabBook web app is designed to support in-the-field activities, by digitally assisting water sample collection and measurement record keeping. The MobileLabBook is operational on any mobile smart-phone, Pad, or Computer running the Chrome web browser and maintains operations and data integrity, even in the absence of Internet connection. Samples and in-the-field measurements alike can be precisely positioned with GPS coordinates and timestamped offering highly accurate geospacial and time coordinate positioning of samples and data results. After review, digital records are synchronized with the TTW central database. The records can then be accessed by the data owner via the TTW DataCenter. The DataCenter allows you to view, edit, and validate all of the parameters surrounding your data including Quality Assurance fields for equipment and protocol metadata of the digital records. TTW data management system has been designed to integrate seamlessly with CEDEN, California's water monitoring database, and leads users through an easy data validation process prior to data submission. Data submission compliance with the EPA is maintained via TTW data submission to CEDEN. In addition, the TTW Report Tool and website empowers community outreach messages by providing data analysis tools along with the TTW Forum for asking questions, sharing insights, and results. These tools will help you stay connected, making it easy to share your observations and experiences with other members. TTW is a project of 4Marbles Inc. a 501(c)(3) scientific research and education non-profit.

A High Quality Cellphone-Based Portable Microscope for Stream Side Data Collection

Steven Steinberg and Betty Fetscher
Southern California Coastal Water Research Project, Costa Mesa, Calif.

Abstract
Collection of biological samples in the field often presents issues of specimen damage or degradation caused by preservation methods, handling and transport to laboratory facilities for identification. Traditionally, the collection of high quality microscopic images in the field has not been a realistic possibility due to the size, weight and fragility of sufficiently high quality hardware. The Fletcher Lab in the Department of Bioengineering at the University of California Berkeley has developed a mobile microscope called the Cellscope to expand access to basic healthcare in remote regions. In collaboration with the Fletcher lab, the Southern California Coastal Water Research Project (SCCWRP) is modifying and applying this clinical tool for use in microscopic imaging for stream-side data collection. Initial field tests have proven successful. Building on this collaboration we will work to modify and embark on more extensive testing in 2014. Ultimately, imagery collected with the Cellscope will be integrated with other cell-phone based applications and tools under development to provide an easy-to-use, affordable, lightweight, professional quality data collection platform for water quality monitoring.

Session J7: Using Volunteer Data to Meet State Clean Water Act Goals

8:00 – 9:30 am | Room 231

Monitoring Rhode Island's Waters

Elizabeth Herron and Linda Green
University of Rhode Island, Kingston, R.I.

Abstract
Volunteer monitors are an integral component of the Rhode Island (RI) water quality monitoring data system. Engaging volunteers not only expands the scope and magnitude of available data, but also enhances the understanding and support of water quality monitoring. The URI Watershed Watch (URIWW) program is the largest volunteer water quality monitoring program in RI with over 350 trained volunteers monitoring more than 250 lake, pond, river, stream, salt pond and marine sites throughout RI and into southeastern Connecticut. Having started with fourteen lakes in the Wood-Pawcatuck watershed in 1988, we now have over 25 years of comprehensive water quality data on a dozen sites, and more than three years data for hundreds more. This presentation will provide a brief overview of URIWW and highlight some of the diverse ways the data have been used, including in the development of total daily maximum loads, and in assessing the effectiveness of restoration activities, the impact of watershed development and the susceptibility of a lake to invasion by invasive species. Trends, impact s from climate change and emerging concerns for Rhode Island's waters, in particular cyanobacteria (blue-green algae) blooms and the proliferation of non-native species, will also be addressed.

Citizen Monitoring Programs Helping to Keep Tahoe Blue: Locating Aquatic Invasive Species and Prioritizing Storm Water Point Sources

Jesse Patterson
League to Save Lake Tahoe, South Lake Tahoe, Calif.

Abstract
Lake Tahoe is one of the largest and clearest lakes in the nation and because of its ease of accessibility is also one of the most visited. With these millions of annual visitors come environmental impacts such as increased fine sediment runoff and the introduction of aquatic invasive species. These impacts have led to an almost one foot per year loss in average deep water clarity since it was first recorded in the 1960s and nearshore conditions are markedly worse. Although work is being done to address these impacts and curb clarity loss there is still a lack of resources to adequately monitor, prioritize and implement the needed solutions to restore and increase deep water clarity as well as tackle declining nearshore conditions. This is where the uniquely large number of Tahoe community members (residents and visitors) can help be part of the solution to Keep Tahoe Blue.

The League to Save Lake Tahoe, an environmental nonprofit, has recently introduced two new citizen monitoring programs in collaboration with local, state and federal agencies working in the Tahoe Basin. Pipe Keepers began in October 2012 and trains community members on how to collect water samples and visual observations at many of the nearly 100 pipes and outfalls that drain directly into Lake Tahoe and its surrounding tributaries. This data is made available to the public and other agencies on our website and can be used to prioritize the most polluting point sources that should be addressed. A steering committee made up of storm water management agency staff help guide the program to ensure effectiveness. Eyes on the Lake engages water recreationists at Tahoe to educate them on how to identify and report on the locations of aquatic invasive plant species currently infesting Lake Tahoe as well as keep an eye out for any new introductions. This monitoring program is part of the Lake Tahoe Aquatic Invasive Species Program made up of 40 agencies and organizations in the area. Data is used to locate new infestations and implement rapid response to more effectively treat them before they can become established and spread.

Using Biological Monitoring Data for Assessment-Our "A-Ha" Moment

Danielle Donkersloot
New Jersey Dept. of Environmental Protection, Trenton, N.J.

Abstract
Most of the volunteer monitoring community in New Jersey collects macroinvertebrate biological monitoring data. This type of data is easy for the volunteers to collect and cost effective for watershed associations. Watershed associations identify the organisms to the order, family or genius/species level depending on their program's own needs. In the past, the Department of Environmental Protection would only consider data collected at the genius/species level until we had our "A-Ha" moment, when we realized we could consider data at the order or family level for assessment purposes as well. The associations with quality assurance project plans, well documented field procedures, and trained volunteers can also submit data for consideration for the assessment process. Using a list of 20+ organisms, we determined when a stream is healthy certain organisms will always be there and when a stream is in poor condition, certain organisms will always be absent from the sample. Using this presence/absence approach we can classify a stream as healthy/excellent condition or unhealthy/poor condition when there is no other available biological data.

Utilizing Volunteer Monitoring to Meet Local Stormwater Program Objectives

James Beckley[1,2] and Chris French[2,3]
[1]Virginia Dept. of Environmental Quality, Richmond, Va., [2]Virginia Water Monitoring Council, Blacksburg, Va., [3]Filterra Bioretention Systems, Ashland, Va.

Abstract
The Commonwealth of Virginia has a large and diverse number of water quality monitoring organizations consisting of soil and water conservation districts, colleges and universities, and citizen volunteer organizations. This wealth of volunteer based monitoring groups is due in part to the Virginia Department of Environmental Quality (VADEQ) recognizing volunteer generated data can be of sufficient quality to provide accurate and reliable information to state and local resource managers. This has resulted in Virginia including a significant amount of 'non-agency' data as part of the 305(b)/303(d) Water Quality Integrated Report and supplemental data to support the development and implementation of TMDLs.

A number of Virginia localities have been partnering with volunteer groups to assist with local water quality monitoring efforts, which a growing focus on stormwater management and TMDL issues,. Volunteer monitoring has been successful at identifying illicit discharges, identify broken sewer and potable water lines, as well as track the impact of stormwater to local streams and rivers. This presentation will cover several examples where localities have partnered with volunteer monitors to provide a low cost, and effective water quality monitoring program.

Session K1: Monitoring and Modeling to Restore and Protect Coastal Water Quality

10:00 – 11:30 am | Room 263

Adaptation of a Weighted Regression Approach to Evaluate Water Quality Trends in Tampa Bay, Florida

Marcus Beck and James Hagy
[1]ORISE Research Participation Program, Gulf Breeze, Fla., [2]US Environmental Protection Agency, Gulf Breeze, Fla.

Abstract
The increasing availability of long-term monitoring data can improve resolution of temporal and spatial changes in water quality. In many cases, the fact that changes have occurred is no longer a matter of debate. However, the relatively simple methods that have been used to evaluate trends in environmental monitoring data in estuaries are often not sufficient to disaggregate the complex effects of multiple environmental drivers, limiting the potential to relate changes to possible causes. To improve the description of long-term changes in water quality, we adapted a weighted regression approach developed to describe trends in pollutant transport in streams and rivers to analyze a long-term water quality dataset from Tampa Bay, Florida. The weighted regression approach allows for changes in the relationships between water quality and explanatory variables by using dynamic model parameters and can more clearly resolve the effects of both natural and anthropogenic drivers of ecosystem response. The model resolved changes in chlorophyll *a* from 1974 to 2012 at seasonal and multi-annual time scales while considering variation associated with changes in freshwater influence. Separate models were developed for each of 4 Bay segments to evaluate spatial differences in patterns of long-term change. Observed trends reflected the known long term decrease in nitrogen loading to Tampa Bay since the 1970s, however, more subtle changes in seasonal variability and unexplained variance were resolved in ways that have not been described previously. Significant variation in the model residuals was explained by considering additional covariates such as the El Niño-Southern Oscillation patterns and estimated nutrient loading. Results from our analyses have allowed additional insight into drivers of water quality change in Tampa Bay that has not been possible with traditional modeling approaches and could help monitor and sustain the progress of the successful nitrogen management program. The method could also be applied to water quality management in other estuarine systems where long-term monitoring data are available.

Albemarle Sound Demonstration Study of the National Monitoring Network for U.S. Coastal Waters and Their Tributaries

Michelle Moorman
US Geological Survey, Raleigh, N.C.

Abstract
The U.S. Geological Survey's (USGS) North Carolina Water Science Center is implementing a demonstration project in the Albemarle Sound for the National Monitoring Network for U.S. coastal waters and their tributaries. The goal of the National Monitoring Network is to provide information about the health of our oceans and coastal ecosystems and inland influences on coastal waters for improved resource management. The network integrates biological, chemical, and physical features and links uplands to the coastal ocean. The purpose of the Albemarle Sound pilot study is to:

1) Inventory current monitoring programs in the Albemarle Sound,

2) Conduct a gap analysis to determine current monitoring needs,

3) Implement a monitoring program to address data gaps, and

4) Create a web-based map portal of monitoring activities.

As part of the project, the USGS worked with stakeholders to inventory current programs and design a monitoring program. This presentation will provide more information about the project including a demonstration of the shapefile and database compiled as part of the monitoring inventory, and results from the first year of data collection.

Suspended Sediment-Bound Toxic Chemical Loads from Large Rivers to Puget Sound, Washington

Kathy Conn, Rick Dinicola, Bob Black, Rich Sheibley and James Foreman
US Geological Survey, Tacoma, Wash.

Abstract
In 2012, Puget Sound was selected as a demonstration area for the National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries (National Network). The primary objective of this project is to summarize monitoring efforts in the context of the National Network design. The Puget Sound Partnership initiated an assessment of current monitoring activities and data gaps in the region through numerous interagency workgroups of the Puget Sound Ecosystem Monitoring Program. One major data gap that was identified included developing an improved understanding of sediment and toxic chemical loads to Puget Sound from large rivers.

As part of the Puget Sound demonstration project, we are sampling large rivers during a range of flow and turbidity conditions to assess variability in sediment loads and associated toxic chemical loads. The sampling effort is utilizing innovative technologies including 1) continuous, real-time turbidity monitoring, 2) discharge-weighted, depth-integrated sampling for water and suspended sediment, and 3) a field-portable flow-through centrifugation technique for suspended sediment chemical analysis that is being refined and documented. The resulting data is being used to develop regression relationships between discrete samples and continuous turbidity, stage, and discharge to improve estimates of event, seasonal, and annual chemical loadings from large rivers to Puget Sound.

Preliminary results suggest that sediment loads and associated chemical loads vary spatially and temporally within Puget Sound. For example, in the Green River near Seattle, WA, which receives commercial, industrial, and residential runoff through an extensive storm drain network, a suspended sediment-associated loading of approximately 200 mg/hr of polychlorinated biphenyls (PCBs) was estimated during a storm event, which was more than 50 times higher than low-flow loading estimates. In contrast, in the Puyallup River near Tacoma, WA, which receives berry farming agricultural runoff, a suspended sediment-associated loading of approximately 50 mg/hr of the fungicide pentachloronitrobenzene was estimated during a storm event, while PCB levels were low. This presentation will provide additional results from the first year of data collection and describe the current monitoring activities in the context of the National Network design.

Evaluating Water and Sediment Quality in the Gulf of Mexico Coastal National Parks

Jane M. Caffrey[1], Eva DiDonato[2] and Melissa Hagy[1]
[1]University of West Florida, Pensacola, Fla., [2]National Park Service, Fort Collins, Colo.

Abstract
National Parks play a vital role in protecting natural and cultural resources for current and future generations. A critical goal of the Ocean and Coastal Resources program in the Natural Resources Stewardship and Science directorate is to integrate local and regional water quality data collected beyond park boundaries into useful information for informing decision-making by park management. Poor water quality in coastal areas often results from

regional population growth and local development. Water quality monitoring data collected by I&M networks and coastal parks allow the NPS to evaluate conditions and track trends within park boundaries. However, effective management of estuarine and marine resources requires understanding water quality issues beyond park boundaries. Coastal parks are located at the downstream boundaries of watersheds; most of their water quality problems originate upstream. Understanding local and regional water quality issues is a critical step in the successful management of NPS coastal waters.

Water and sediment quality data were assembled from a variety of local, state and federal agencies. Water quality parameters used in the analysis include temperature, salinity, dissolved oxygen, chlorophyll *a*, nutrients, pH and turbidity. Trace metal and organic contaminants are also included in this analysis. We compare conditions inside and nearby eight national parks in the Gulf of Mexico region: Padre Island, Big Thicket, Jean Lafitte, Gulf Islands, De Soto, Big Cypress, Everglades and Dry Tortugas. The parks range in character from coastal and estuarine environments such as Padre Island, Gulf Islands, De Soto and Dry Tortugas to more brackish systems such as Big Thicket, Jean Lafitte, Big Cypress and the Everglades. Water quality and sediment conditions within the coastal parks are influenced by both local and regional anthropogenic stressors, as well as climatology, particularly freshwater input.

Session K2: Characterization of Regional Groundwater Systems

10:00 – 11:30 am | Room 262

Measuring Hydrostratigraphy in Two Minnesota Bedrock Wells; a Case Study of Methods for Better Understanding Ground-Water/Surface-Water Interaction, Water Quality, and Well Productivity

James Berglund and Tom Alvarez
Minnesota Dept. of Health, St. Paul, Minn.

Abstract
The use of continuously-logging instruments in open wells provides valuable insights into local hydrogeology which may not be apparent from driller's logs or water samples collected from pumping wells. Borehole data loggers record changes with depth in physicochemical water properties such as temperature, pH, specific conductance, redox and dissolved oxygen. Video cameras record changes in the rock formation, the presence of fractures and caverns, and the movement of particles indicating water flow. Combining these data with results from calipers, gamma and drill logs, supports the selection of depth intervals to be targeted for discrete-depth water sampling. The Minnesota Department of Health, along with the Minnesota Geological Survey, conducts studies of this kind to better understand local hydrogeologic conditions relative to issues of water quality and quantity, as well as basic aquifer characterization for source water protection efforts. We discuss examples from two different bedrock aquifer systems; the Prairie du Chien-Jordan (Ordovician-Cambrian carbonate and sandstone) and the Biwabik Iron Formation (Early Proterozoic chemical sediment). In both cases, borehole logging and discrete-depth water sampling detected stratification of the water column, related to either distinct hydrostratigraphic horizons or fractures. At one of these sites, we gleaned important information about surface-water/ground water interaction, which is important for the protection of drinking water quality and quantity.

Factors Affecting Public-Supply-Well Vulnerability to Contamination: Understanding Observed Water Quality and Anticipating Future Water Quality

Sandra Eberts, MaryAnn Thomas and Martha Jagucki
US Geological Survey, Columbus, Oh.

Abstract
As part of the U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program, a national study was conducted from 2001 to 2011 to shed light on factors that affect the vulnerability of water from public-supply wells to contamination. The study was designed as a follow-up to earlier NAWQA studies that found mixtures of contaminants at low concentrations in groundwater near the water table in urban areas across the Nation and, less frequently, in deeper groundwater typically used for public supply.

The vulnerability of the water from public-supply wells to contamination is a function of contaminant input within the area that contributes water to a well, the mobility and persistence of a contaminant once released to the groundwater, and the ease of groundwater and contaminant movement from the point of recharge to the open interval of a well. The following measures, which are described in newly released USGS Circular 1385, are particularly useful for indicating which contaminants in an aquifer might reach an individual public-supply well and when, how, and at what concentration they might arrive:

- Sources of recharge – Information on the sources of recharge for a well provides insight into contaminants that might enter the aquifer with the recharge water and potentially reach the well.
- Geochemical conditions – Information on the geochemical conditions encountered by groundwater traveling to a well provides insight into contaminants that might persist in the water all the way to the well.
- Groundwater-age mixtures – Information on the ages of the different waters that mix in a well provides insight into the time lag between contaminant input at the water table and contaminant arrival at the well. It also provides insight into the potential for in-well dilution of contaminated water by unaffected groundwater of a different age that simultaneously enters the well.

Preferential flow pathways-pathways that provide little resistance to flow-can influence how all other factors affect public-supply-well vulnerability to contamination. Methods for recognizing the influence of preferential flow pathways on the quality of water from a public-supply well are presented in the Circular and will be discussed.

The Kentucky Interagency Groundwater Monitoring Network: Expanded Monitoring Programs

Robert Blair[1] and Bart Davidson[2]
[1]Kentucky Division of Water, Frankfort, Ky., [2]Kentucky Geological Survey, Lexington, Ky.

Abstract
Systematic groundwater monitoring in Kentucky was initiated through a consortium of academic and government agencies in the mid-1990s. This body eventually became the Interagency Technical Advisory Committee (ITAC) on Groundwater and established the Interagency Groundwater Monitoring Network ("the Network") in Kentucky.

ITAC made several recommendations for the Network's design, including representation of Kentucky's aquifer types and physiographic regions, spatial distribution of sites and parameters to be analyzed. Following the recommendations, the Network was established with the Kentucky Division of Water (KDOW) collecting samples at approximately 60 sites on a quarterly basis. Although the parameters, aquifer types and physiographic regions have

been represented as designed, the spatial distribution and site density are only a fraction of what was proposed – due to resource constraints. To fill these data gaps, one-time sampling sites were selected based on proximity to permanent sites and requests by groundwater users. Additionally, after several years the sampling frequency at some sites was decreased once they were considered to be well-characterized so that new sites could be added to the Network. Finally, expanded monitoring has been conducted through various programs and grants, which have allowed for regional and watershed-based groundwater projects led by KDOW and the Kentucky Geological Survey (KGS).

Expanded groundwater monitoring projects by KDOW and KGS were initially conducted within the individual boundaries of major river basins, or Basin Management Units (BMUs). These studies covered large areas and, similar to the Network, focused on characterizing ambient groundwater quality throughout the BMU. Follow up studies then focused on smaller watersheds within various BMUs where surface streams had been assessed and deemed impaired. The goal with these projects was to determine the influence of groundwater on surface water quality. Additionally, some follow up studies focused on regions previously not assessed, or under represented by monitoring efforts to date. Recent monitoring projects in karst regions have utilized an approach to integrate surface water assessment protocols to better define the relationship of these conjunctive systems.

This presentation will highlight field activities, expanded groundwater monitoring programs and interagency coordination utilized for the success of the Network.

Assessing the Quality of Groundwater Used for Public Supply in Principal Aquifers of the Western United States

Laura Bexfield
US Geological Survey, Albuquerque, N.M.

Abstract
In 2013, the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey began a 10-year assessment of the quality of groundwater used for public supply in principal aquifers across the United States. Public-supply wells are being selected for sampling in a subset of principal aquifers under a nationally consistent design that uses equal-area grids to achieve a spatially unbiased dataset. The wells are being sampled for a comprehensive suite of analytes to characterize the occurrence of contaminants of concern for human health and to improve understanding of groundwater processes that are important to management of water resources. Analytes include nutrients, volatile organic compounds, pharmaceuticals, hormones, pesticides, major elements, trace elements, radionuclides, microbial indicators, and tracers of groundwater age. Among principal aquifers in the western United States, the first NAWQA sampling effort of this type was conducted in 2013 in the Basin and Range basin-fill aquifers; future sampling efforts are planned for the Rio Grande aquifer system, the High Plains aquifer, and the Columbia Plateau basaltic-rock and valley-fill aquifers.

The Basin and Range basin-fill aquifers extend through large areas of Arizona, California, Nevada, and Utah. They consist primarily of unconsolidated to semi-consolidated gravel, sand, silt, and clay deposits in alluvial basins bounded by mountain ranges. The 1,010 million gallons of groundwater withdrawn for public supply across the Basin and Range basin-fill aquifers in 2000 ranked fourth among all principal aquifers in the nation; however, little or no groundwater is withdrawn for public supply in several alluvial basins. To focus the water-quality assessment on the extent of the groundwater resource actually used for public supply, the NAWQA study area was defined based on 20-kilometer buffers placed around each known public-supply well. Eighty public-supply wells were selected for sampling using equal-area grids within the targeted study area. Preliminary results for groundwater samples collected from these wells will be presented.

Session K3: Continuous Monitoring: Sensor Developments in Energy Production/Hydrofracking

10:00 – 11:30 am | Room 261

Application of an Aqueous Methane Sensor to Evaluate Spatial and Temporal Changes in Dissolved Methane Concentrations in a Groundwater Monitoring Well

Andrew Barton[1], Jason Schaefer[1], Tom Wagner[2], David Burnett[3], Susan Stuver[3] and Rich Haut[4]
[1]Battelle Memorial Institute, Columbus, Oh., [2]Cabot Oil and Gas, Inc., Pittsburgh, Pa., [3]Texas A&M University, San Antonio, Tex., [4]Houston Advanced Research Center, Houston, Tex.

Abstract
Conventional dissolved methane groundwater monitoring methods are expensive, labor and resource intensive, as well as time consuming. In addition, these methods can often be inaccurate due to inconsistencies associated with sampling methods, handling, transport, and laboratory analytical analysis. Recent advances in sensor technology have reduced the need for conventional groundwater sampling, and can provide continuous, accurate chemical concentration values in near real-time. This paper describes the development of a low cost real-time aqueous sensor for detecting dissolved methane concentrations in groundwater in response to projected increased monitoring requirements associated with conventional and unconventional oil and gas exploration and development. The dissolved methane sensor is 1.75-in in diameter and 8-in in length and can be deployed in conventional 2-inch groundwater monitoring wells. The sensor also has the capability to monitor dissolved ethane and propane. The dissolved methane sensor has many applications, including monitoring of temporal and spatial variation in background dissolved methane concentrations, providing continuous monitoring of groundwater associated with oil and gas development or other activities, minimizing groundwater monitoring costs, and reducing the environmental footprint of dissolved methane monitoring activities. Extensive laboratory testing has been performed to validate dissolved methane sensor operation under expected field conditions. The methane sensor was deployed in a groundwater monitoring well in northeast Pennsylvania where background dissolved methane concentrations above 10 ppm have been shown to exist. The methane sensor was used to prepare a vertical profile of dissolved methane concentrations within the >100-ft thick water column within the well. The sensor was subsequently deployed at a depth where elevated dissolved methane concentrations were observed to collect dissolved methane readings at 15 minute increments for several days to evaluate the daily fluctuation in dissolved methane concentrations at the desired depth. Methane sensor readings were compared to conventional methane sample concentrations collected immediately after sensor deployment. Results of the field test will be used to understand the spatial and temporal variation of dissolved methane in a groundwater monitoring well and subsequently optimize the baseline dissolved methane monitoring program.

Continuous Monitoring of Methanol Concentration in Water Treatment Processes Associated with Hydrofracturing

Kenneth Reardon, Brian Heinze, Kyle Smith, Jonathan Vickers and Stephen Witt
OptiEnz Sensors, LLC, Fort Collins, Colo.

Abstract
Methanol is widely used in hydrofracturing fluids as a corrosion inhibitor and winterizing agent. It is present in the flowback water, which is sometimes mixed with produced water for treatment. Currently, plants designed to treat these waters are not able to monitor methanol or other contaminant concentrations

continuously, quantitatively, and specifically; instead, they rely on infrequent samples sent to off-site analytical laboratories. The lack of continuous measurements means that treatment systems operate inefficiently and risk under-treating water.

We have developed a sensor system for the continuous, direct, quantitative measurement of methanol in aqueous streams. The sensor system has three parts: a replaceable sensor tip, an opto-electronic hardware unit, and an optical fiber with a length appropriate for the application. The sensor tip includes a two-layer detection element – one layer containing a detection enzyme affixed to another fluorophore-containing layer. The change in fluorescence characteristics depends on the methanol concentration, and these sensors can be designed to provide quantitative output over different ranges of methanol concentration. Performance metrics including the limit of detection, impact of environmental factors such as pH and temperature, and lifetime have been determined.

Testing of these methanol sensors in commercial produced/flowback water treatment systems is underway. The sensors could also be deployed in monitoring wells to provide an alert in the event that methanol-contaminated water was migrating off-site.

Preliminary Findings from Continuous Water Chemistry Monitoring in Watersheds Impacted by Shale Gas Drilling in the Susquehanna River Basin

Dawn Hintz
Susquehanna River Basin Commission, Harrisburg, Pa.

Abstract
The Susquehanna River Basin Commission (SRBC) continuously monitors water chemistry in select watersheds in the Susquehanna River Basin undergoing shale gas drilling activity. Initiated in 2010, 58 monitoring stations are included in the Remote Water Quality Monitoring Network (RWQMN). Specific conductance, pH, turbidity, dissolved oxygen, and temperature are continuously monitored and additional water chemistry parameters (metals, nutrients, radionuclides, etc.) are collected at least four times a year. These data provide a baseline dataset for smaller streams in the basin, which previously had little or no data.

The two parameters most commonly used as indicators of shale gas drilling activities are specific conductance and turbidity. Any spills or leaks of flowback water from the drilling process can impact the specific conductance of a stream, while the infrastructure (roads and pipelines) needed to make drilling possible in remote watersheds may adversely impact stream sediment loads. The monitoring stations were grouped by Level III ecoregion with specific conductance and turbidity analyzed using box plots. Based on available data, land use, permitted dischargers, and geology appear to play the greatest role with influencing turbidity and specific conductance.

In order to determine if shale gas drilling and the associated development activities are impacting monitored streams, SRBC completed trend analyses on three stations with three years of continuous monitoring data. The analyses showed mixed results, with specific conductance and turbidity showing a decreasing trend at Choconut Creek, and pH and temperature showing an increasing trend at Hammond Creek. Dissolved oxygen did not show a trend at any of the stations and Meshoppen Creek did not show a trend with any parameters. The natural gas well density varies within the watersheds; Choconut Creek has no drilling activity, the Hammond Creek Watershed has less than one well per square mile, and the well density in the Meshoppen Creek Watershed is almost three times that of Hammond Creek. Although the analyses were only performed on three stations, the results show the importance of collecting enough data to properly characterize conditions in these previously un-monitored watersheds, recognizing the range of factors that can influence water quality conditions.

Natural Variation of Specific Conductivity and Major Ions in Wadeable Streams of the Conterminous United States

Michael B. Griffith
US Environmental Protection Agency, Cincinnati, Oh.

Abstract
To assess the effects of changes in ionic strength and salinity on streams, we need to understand natural variation in the levels of specific conductivity and major ions. I compiled data for randomly selected sites from stream surveys conducted from 1985 to 2009 by the U.S. Environmental Protection Agency (EPA). I followed EPA methods to estimate current reference values, for specific conductivity (60 ecoregions) and individual major ions (34 ecoregions) as the 25th percentile of values in wadeable streams in Level III ecoregions with data from ≥25 sites. These reference values estimate current ambient concentrations for these ions in the absence of newer anthropogenic sources of salts to these waters. The 25th percentiles of specific conductivity were less than 200 µS/cm for most eastern and western montane ecoregions. Arid western ecoregions had higher specific conductivities (*e.g.*, 557-693 µS/cm). Ca^{2+} was generally the most abundant cation followed by Mg^{2+}, Na^{+} and K^{+}. HCO^{3-} was generally the most abundant anion followed by SO_4^{2-} and Cl^{-}. Ecoregions where SO_4^{2-} or Cl^{-} concentrations were greater than the HCO_3^{-} concentration have been affected by acidic precipitation or are influenced by marine air masses, respectively, and have very low specific conductivities. Patterns of variation appear to be associated with the 3 processes controlling major ions in freshwaters: underlying geology, concentration and crystallization associated with water evaporation, and precipitation ion content.

Session K4: Microbial Source Tracking and Health Effects

10:00 – 11:30 am | Room 237

Location of E. coli Bacteria Sources in an Urban Watershed in Seattle, Washington Using a Combination of Repeat In-Stream Sampling, Rapid Bio-assessment, IDDE Sampling of Storm Drains, CCTV of Sanitary Drains, Bacteroides Analysis and Information on Urban Homeless Encampments

Jonathan D. Frodge
Seattle Public Utilities, Seattle, Wash.

Abstract
Urbanized Thornton Creek consistently has high bacteria counts at the mouth of the creek. The study design used to locate bacteria sources within this watershed relied on forty-five samples collected during a morning and afternoon sample collections. Samples were collected during both dry weather and wet weather. Bacteria count differences between adjacent upstream and downstream sites and differences between morning and afternoon were used to identify sub basins where the bacteria potentially enter Thornton Creek. Several sub basins have been identified as priority areas to evaluate for bacteria sources.

Multiple *E. coli* and fecal coliform samples exceeded criteria by one to two orders of magnitude. The upper mainstem of Thornton Creek frequently met or only slightly exceeded criteria. In the lower watershed there was degradation in water quality and higher bacterial loads. Even though *E.coli* and fecal coliform counts in the lower mainstem of Thornton Creek were consistently above criteria, the initial focus is on locating and controlling the upstream and tributary bacteria sources with the assumption that a decrease in upstream bacteria counts will make it easier to discern downstream sources from the current background.

Based on *Bacteroides* sampling in Thornton Creek it is highly probable that human sources of bacteria are prevalent. The *Bacteroides* technique provides reliable information that human sources are present, but the lack of epidemiological studies or a correlation between *Bacteroides*, *E.coli* or fecal coliform bacteria make any quantification of these results beyond the capability of the current study.

Suspect human contributions are the drainage network, the sanitary system and direct human contribution. IDDE techniques are used to investigate the drainage network, CCTV for the sanitary system. Uncontained sources of sewage have been associated with individuals living in vehicles or camping in portions of the watershed. Protocols have been developed in consultation with the Housing Authority to identify and eliminate contribution from transient and homeless encampments in the watershed while protecting both field crews and the rights of the homeless.

Examining Indicator Bacteria at Freshwater Swim Sites in the Los Angeles River Watershed, California

Kristy Morris[1], Christine Lee[2,4], Nancy L.C. Steele[1] and Kate Johnstone[3]
[1]Council for Watershed Health, Los Angeles, Calif., [2]American Association for the Advancement of Science/National Aeronautics and Space Administration, Washington, D.C., [3]Duke University, Durham, N.C., [4]California Institute of Technology, Pasadena, Calif.

Abstract
Multiple popular freshwater swimming sites in the upper Los Angeles River Watershed were sampled during summer 2012 to compare the relative extent of bacterial contamination as measured by conventional culture-based methods and qPCR methods. Samples were analyzed for *Escherichia coli*, enterococci, and *Clostridium perfringens* (vegetative cells and spores) to characterize how well indicators correlated with each other, with respect to ambient levels and to "elevations" from background, possibly indicative of a pollution input. A secondary objective was to evaluate the economic impact of implementing qPCR at our study sites for rapid water quality monitoring. Results showed that indicator species did not correlate well with each other ($R^2 < 0.1$) both spatially and temporally, though *C. perfringens* vegetative cells and spores were moderately correlated ($R^2 = 0.31$, $p = 0.07$). Elevated concentrations were most common on holidays and weekends, although these were not strongly correlated to the number of bathers. *Clostridium perfringens* may be a useful indicator at our study sites, as a comparison of vegetative to endospore forms of this organism may be used to understand how recently a contamination event or input occurred. Results from the economic analysis demonstrate that qPCR should be allocated to swimming sites where public health costs exceed the public's willingness to pay to use that site and to identify the source of contamination. This is the first study evaluating the utility and economic viability of employing qPCR in freshwater systems in an urban watershed of the western United States.

Epidemiology Studies of Swimming-Associated Illness at Beaches with Non-Point Sources of Fecal Pollution: Evaluating the Predictability of Traditional and Non-Traditional Monitoring Methods for Protecting Public Health

Ken Schiff[1], Jack Colford[2], John Griffith[1] and Ben Arnold[2]
[1]SCCWRP, Costa Mesa, Calif., [2]Univiversity of California Berkeley, Berkeley, Calif.

Abstract
Monitoring fecal indicator bacteria (FIB), such as *Enterococcus* or fecal and total coliforms, for protecting public health dates back more than 50 years. Several epidemiology studies have verified the relationships between FIB and swimmer illness, including gastrointestinal symptoms, and these studies have formed the foundation of the US EPA's current water quality standards for FIB. However, virtually all of the epidemiology studies to date have been focused on freshwater or marine beaches impacted by known human sewage inputs. In California, a huge investment has been made in resolving most sewage impacted beaches, but inputs from non-point and non-human sources of FIB continue to impact beach water quality. The goal of this talk is to describe a series of three epidemiology studies conducted in California that assessed: 1) the risk of illness in swimmers compared to non-swimmers at non-point source impacted beaches; 2) the relationship between illness and traditional FIB monitoring methods, and; 3) the relationship between illness and non-traditional monitoring methods for measuring FIB, human markers of fecal pollution, and human pathogens. Across the three studies, common themes emerged for beach managers to consider as they interpret beach monitoring data. First, there was a risk to swimmers at non-point source beaches that increased with increasing swimmer exposure. The relationship of gastrointestinal illness with traditional FIB methods varied strongly as a function of source strength, with several "effect modifiers" based on transport of the non-point source to the beach. These factors play a role in beach monitoring and public health management decisions. New monitoring methods, such as genetic testing (QPCR) of FIB that take less than one hour, human fecal markers (*i.e.*, Bacteroidales), and human pathogens (norovirus), also generated relationships with swimmer illness. However, the relationships were not dramatically better than traditional FIB when the source inputs were strong and the relationships were equally poor to FIB when effect modifiers were at play. Given the similarity in predictability, the new methods offer other advantages that beach mangers may desire.

Implementing a Fecal Coliform TMDL Using Volunteer and Shellfish Sanitation Program Data to Identify Sources and Transport Pathways

Susan Libes[1], Heather Young[1], Daniel Newquist[2] and Sue Sledz[3]
[1]Coastal Carolina University, Conway, S.C., [2]Waccamaw Council of Governments, Georgetown, S.C., [3]Murrells Inlet 2020, Murrells Inlet, S.C.

Abstract
Murrells Inlet is a 14.55-mi^2 watershed located in South Carolina along the southern boundary of the densely developed Grand Strand, whose economy is based on coastal tourism. The watershed drains into the Atlantic Ocean through a high-salinity microtidal estuary that provides 3108 acres of habitat suitable for shellfish production. The majority is approved (71%) for shellfish harvesting with 24% classified as restricted and 5% as prohibited. A fecal coliform TMDL was approved in 2005 to address the long-term and increasing extent of shellfish bed closures. It requires an 80% load reduction, but does not identify the source(s) of the microbes. Since 2007, most of the watershed became regulated under the NPDES Phase II stormwater program.

The 2011 annual shellfish sanitation report included an expansion in the acreage of closed shellfish beds. A local volunteer monitoring program, initiated in 2008, had already demonstrated that the headwaters of several of the 20 or so tidal creeks discharging into the inlet had consistently elevated levels of fecal indicator bacteria. These findings galvanized the local community, which describes itself as the seafood capital of South Carolina, to take action.

USEPA Section 319 funding was obtained to develop a watershed-based plan. Work began using data from the state shellfish and volunteer monitoring programs to elucidate spatial and temporal trends in bacteria levels and their causative drivers, including rain, tidal flushing, and land-use change. Coastal Carolina University's Waccamaw Watershed Academy (WWA) was engaged to lead this effort. The 319 project's steering committee participated in selection of appropriate statistical tests, reasonable assumptions, and modes of data presentation including GIS mapping. A technical advisory committee provided peer review. Additional data collection has included efforts by the volunteers to track upstream sources and by the WWA to identify host animal sources using genotypic and chemical markers. The most important bacterial sources identified thus far are urbanized wildlife and canines.

Results from the data analyses were used to prioritize subwatersheds for remediation. This has led to proposed treatment strategies that focus on volume reduction of stormwater runoff, dredging of tidal creek sediments, and outreach education for pet waste control.

Session K5: Monitoring to Reflect Water Quality Changes from Management Actions

10:00 – 11:30 am | Room 233

Water Quality and Biological Trends in Ohio: Pre-Construction Grants Program to the Present

Robert Miltner
Ohio Environmental Protection Agency, Groveport, Oh.

Abstract
The Ohio Environmental Protection Agency has employed an integrated biological and water quality monitoring program since the early 1980s, and thus has information on surface water conditions before and after implementation of the Construction Grants Program. Prior to the Construction Grants, near all larger rivers and the majority of wadeable streams, in terms of linear stream miles, did not attain the basic Clean Water Act goal of fishable and swimmable. Fish species highly sensitive to pollution were restricted to a handful of refugia, and many other sensitive species had either reduced distributions or were rare. Recent monitoring has demonstrated that ninety percent of the linear miles of Ohio's large rivers now have an acceptable condition status, and over sixty percent of smaller rivers and streams are in an acceptable condition. Furthermore, several highly sensitive species have recovered nearly all of their historic ranges, or are expanding in distribution and abundance. The effect of the Construction Grants Program on water quality is especially evident in trends in ammonia-nitrogen concentrations. During the decade of the 1980s, ammonia concentrations measured from surface waters were significantly higher than those measured in 2000s. Biological and water quality monitoring has also revealed trends that appear related to efforts to abate pollution from diffuse sources, especially sediment from agriculture, as evidenced by decreasing concentrations of suspended sediment and total phosphorus coincidental with increasing abundances and distributions of several sediment-sensitive fish species.

Monitoring and Analyzing the Effectiveness of the Lower Minnesota River Low Dissolved Oxygen Total Maximum Daily Load Study's Wastewater Phosphorus Permitting Implementation Activities

Glenn Skuta and Katrina Kessler
Minnesota Pollution Control Agency, St. Paul, Minn.

Abstract
In August 2012, the Minnesota Pollution Control Agency (MPCA) completed a monitoring survey of the lower Minnesota River, one of the largest rivers in Minnesota. Data collected since the 1980s have shown that the river did not meet the dissolved oxygen (DO) water quality standard during the critical condition of low flow and high summer temperatures. The lower 22 miles of the river were listed as impaired in 1992. A total maximum daily load (TMDL) study and implementation plan were completed in 2004 and 2005 to address the impairment. The TMDL largely focused on reducing the discharge of phosphorus from wastewater treatment plants in the basin, since the impact of their discharges was most strongly manifested during low flow conditions. A basin-wide general phosphorus overlay wastewater permit was issued in 2005 that required phosphorus discharge reductions and facilitated pollutant trading to meet phosphorus discharge limits. The collective phosphorus reductions from wastewater treatment plant discharges called for in the basin-wide permit were achieved in 2012.

In August of 2012, flows below the 1,500 cfs TMDL monitoring trigger and elevated air temperatures were observed, causing the MPCA to initiate the monitoring survey. The survey ran for 3 weeks and included water chemistry data collection via sondes suspended by buoys and grab sampling at 7 sites along the length of the channel. Artificial substrates to monitor invertebrates were also deployed. While the statistical low flow critical condition (7Q10 of ~200 cfs) was not reached, flows were about half of the median daily level for much of the survey, and as low as ~850 cfs. High water temperatures were also observed, as high as 27.8 °C on the day of the lowest DO reading. Despite the stressed conditions, analysis of the data showed no violations of the DO standard. Further, concentrations of total phosphorus and chlorophyll a were substantially lower than seen in previous studies.

Farms, Fish, Phosphorus and Phytoplankton: Long-Term Dynamics of a Reservoir Ecosystem Associated with Changes in Watershed Agricultural Practices

Michael Vanni, María González and William Renwick
Miami University, Oxford, Oh.

Abstract
Many agricultural practices are changing rapidly, but few studies have assessed the response of downstream lakes to such changes. We quantified the dynamics of a eutrophic reservoir ecosystem (Acton Lake, Ohio) over 20 years, during which watershed agricultural practices changed substantially. Changes include a pronounced increase in conservation tillage, and decreases in P fertilizers and the number of hogs in the watershed. Over the first 13 years (1994-2006), when agricultural changes were most pronounced, discharge-standardized loads of suspended sediment (SS) and phosphorus (P) from the watershed to the lake decreased substantially. Despite the decrease in external inputs of P (the limiting nutrient), phytoplankton biomass (chlorophyll) increased ~40% over this period. Over the same period, the concentration of non-volatile SS in the lake also declined substantially; this apparently alleviated light limitation of phytoplankton, allowing their biomass to increase. Internal P supply via excretion by sediment feeding fish (gizzard shad, *Dorosoma cepedianum*) also increased over this period, because of an increase in fish biomass. These fish consume sediment-bound P and excrete some P into the water column, thereby functioning as nutrient pumps that sustain ~30% of phytoplankton production. Thus, internal P supply by fish apparently compensated for the decline in watershed-derived P over the first 13 years. However, over the past 6-7 years, P and SS loading rates from the watershed, and in-lake NVSS concentrations, have remained relatively constant. Gizzard shad biomass has also stabilized. Over this latter period, phytoplankton biomass has not shown a significant change. Using all years in a multiple regression, P excretion by fish and NVSS concentration explain over 60% of the variance in annual mean phytoplankton biomass (chlorophyll).

Our results strongly suggest that annual mean phytoplankton biomass in this eutrophic reservoir is regulated by the combined effect of suspended sediments and P excretion by fish. P loading from the watershed is not related to phytoplankton biomass within a year, but plays a role at longer time scales by providing P for internal cycling. These results suggest that reversal of eutrophication in agriculturally-impacted reservoirs will be most effective if both external P inputs and fish biomass are reduced.

Multiple Uses of Data from an Automated Monitoring Network in a 6-Mile Urban Stormwater Tunnel

Britta Suppes and Bob Fossum
Capitol Region Watershed District, St. Paul, Minn.

Abstract
Since 2004, Capitol Region Watershed District in St. Paul, Minnesota has operated a comprehensive network of automated stormwater monitoring sites to evaluate stormwater flow through the Trout Brook Storm Sewer Interceptor (TBI), a 6-mile stormwater tunnel draining over 5,000 acres of a fully urbanized area to the Mississippi River. At its largest, the TBI stormwater tunnel is over 12 feet in diameter.

The goal of the TBI monitoring network is to measure and characterize water quantity and quality of stormwater flowing through the tunnel from the upper reaches of the watershed to the outflow location at the Mississippi River. Monitoring stations include: three deep stormwater tunnel flow and water quality measuring sites; two flow-only stations located at lake outlets; four level-only loggers in stormwater ponds; and three automatic precipitation gauges.

TBI water quantity and quality data has been continuously collected, recorded, and analyzed by CRWD from 2004 to 2013, creating a lengthy and robust dataset characterizing trends in total discharge, pollutant loading, and climatic patterns. The data is reported annually in CRWD Monitoring Reports and available to the public and local partners. In addition, the data has been utilized to inform a variety of projects, including: Hydrologic and Hydraulic model calibration for flood prediction and improved operation and maintenance of the TBI; loading calculations for the South Metro Mississippi River Turbidity TMDL; and loading calculations for minor subwatersheds of TBI to inform management decisions, such as the identification of optimal locations for stormwater best management practices. The data has informed major project design, including the replacement and rehabilitation of three large sections of the TBI stormwater tunnel and the recreation of a 3,000-foot natural stream channel in the former Trout Brook Valley.

Session K6: Statistical Analysis Tools

10:00 – 11:30 am | Room 232

Linked Micromaps: Statistical Summaries of Monitoring Data in a Spatial Context

Michael G. McManus[1], Quinn C. Payton[2], Marc H. Weber[3], Thomas M. Kincaid[3] and Anthony R. Olsen[3]
[1]US Environmental Protection Agency, Cincinnati, Oh., [2]Oregon State University, Corvallis, Oreg., [3]US Environmental Protection Agency, Corvallis, Oreg.

Abstract
Communicating summaries of spatial data to decision makers and the public are challenging. Linked micromap plots (LMplots) provide a way to simultaneously summarize and display both statistical and geographic distributions of data from surveys such as the National Aquatic Resource Surveys (NARS). The production of LMplots to display statistical summaries associated with areal units or polygons, such as watersheds or ecoregions, can be cumbersome. We identify four steps that streamline the process for making LMplots and incorporate those steps in the R package micromap. Those steps include: smoothing complex boundaries of polygons to just convey regional identity and neighbor relationships, linking the spatial and statistical data, making a draft LMplot, and refining that plot. As an example we make an LMplot summarizing pH data over nine regions from the National Lakes Assessment, with that display showing interquartile ranges and confidences limits. Being able to incorporate such measures of variation is an advantage LMplots have over pin or choropleth maps. For an example of exploratory spatial data analysis, we make an LMplot using stream conductivity and condition from a spatially balanced probabilistic survey of streams in West Virginia to identify local and global outliers. LMplots can also be applied to statistical summaries for administrative units, such as counties, states, or countries, and have been used with public health, demographics, and agricultural data. The ability for viewers to discern both statistical and spatial patterns is a strength of these plots, and we hope that visualizing georeferenced statistics in this manner will become more common. The views in this abstract are those of the authors and do not necessarily represent the views or policies of the U.S. EPA.

STORET Analytical Tools

Amy Wesley-Snider, Megan Tulloch, Danette Boezio, Peter Ilieve and Michele Eddy
RTI International, RTP, N.C.

Abstract
The U.S. Environmental Protection Agency's (EPA's) modernized STOrage and RETrieval (STORET) Data Warehouse provides a central location for the storage of observational data affecting water quality on a national scale. Existing web services can call on the STORET warehouse and provide data access but no analytical tools are currently available to users. RTI completed a pilot project that created an analytical tool to work with STORET Data. Under the STORET Trends Analysis Tool Project RTI obtained a static copy of the STORET database and for 22 characteristic types at all STORET stations executed, in R, the Seasonal Kendall Trend analysis for each characteristic type. Two approaches were used to develop these analytical tools: geospatial and tabular. The geospatial tools are targeted to more advanced users. The tabular solutions provide easier analysis for all levels of users. Both approaches would utilize open source "R" for statistical analysis. A large source of data in the STORET warehouse stems from the National Aquatic Resource Surveys (NARS). These probabilistic survey data from wadeable streams, rivers, lakes, and wetlands provide millions of monitoring results that span the nation. This tool is being expanded to include the capability to do national level screening, in particular against Clean Water Act Section 304(a) national criteria, and/or allow for the entry of state specific water quality criteria. Another tool under development could be used to estimate the extent of stressors and their impact in aquatic biological conditions essential for determining the general and regional condition of aquatic resources. This additional analytical functionality could be targeted directly to the National Aquatic Resource Surveys (NARS) data. These STORET Analytical Tools will assist states with integrating STORET with other data systems such as ATTAINS. This integration will allow states to easily utilize STORET data in assessment decisions.

Disaggregation of Pollutant Sources through the Implementation of Continuous, Surrogate-Based Regression Equations

James Riddle and Ben Hammond
Woolpert Inc., Columbia, S.C.

Abstract
Watershed pollutant loadings are commonly assessed using computer models that include many assumptions (point discharge data), lumped parameters (*e.g.*, EMCs and CNs), and limited climate data that can be sources of error that lead to misrepresentation of pollutant loading dynamics inherent to nearly every watershed in the country. A more direct and practical approach, which is consistent with research conducted by the USGS office in Kansas, to watershed nutrient loading analysis is to define/establish site-specific relationships between the pollutant of concern (POC) and a continuous water quality parameter that would allow watershed stakeholders to more accurately measure pollutant loads. Woolpert has taken this approach with multiple communities facing major fiscal ramifications of implementing a TMDL that does not

accurately disaggregate pollutant loadings. The result of misrepresenting loading rates to a watershed could be wasted resources and little or no improvement of water body conditions.

In 2008 Woolpert, established a continuous monitoring network within a 200 square mile impaired watershed. The six stations, installed along the river, divide the watershed into subwatersheds that have established baseline main stem conditions that allow for the identification of areas with elevated loadings. Woolpert has used site-specific regression equations to estimate these pollutant loads throughout the watershed since July 2010. These equations have been successfully validated each year with as many as 30 additional grab samples. In 2012, Woolpert installed three additional temporary monitoring stations for the purposes of characterizing areas with elevated loadings and specifically urban and rural land uses in smaller sub-watersheds. This allowed Woolpert to approximate specific contributions with a land use based approach to further identify primary pollutant contributors. POC loadings from the three stations will be applied to similar land uses throughout the watershed to approximate loadings for the entire watershed.

The results of Woolpert's continuous, regression-based approach to assessing watershed loads over the past three years indicate that the current regulatory model for total phosphorus is inaccurate. The consistency that Woolpert has observed in regression based loading trends estimated for varying rainfall years supports the use of this approach for approximating pollutant loads and potential sources.

Accounting for Confounders Leads to Clearer Effects-Thresholds for Some Stressors

Claire Buchanan[1], Jacqueline Johnson[2], Carlton Haywood[1] and Adam Griggs[1]
[1]Interstate Commission on the Potomac River Basin, Rockville, Md., [2]Independent, Crofton, Md.

Abstract
Multiple stressors generally confound (mix up, conceal) relationships between individual stressors and aquatic communities. We have used a number of analysis techniques to untangle the confounding influences of several anthropogenic stressors in Chesapeake basin fresh and estuarine waters. The result has been clearer effects-thresholds for individual stressors, including nutrients, light attenuation, conductivity, flow alteration, and habitat degradation. The analyses strongly indicate the need to account for natural environmental differences, which are most evident in reference-quality habitats. Once these differences are accounted for, there is convergence in how aquatic communities respond to increasing stress regardless of the stressor. This supports the Biological Condition Gradient concept.

Session K7: Research and Achievements in Community-Based Science

10:00 – 11:30 am | Room 231

Assessing the Needs of US Volunteer Monitoring Programs: Recent Survey Results and Implications

Linda Green[1], Kristine Stepenuck[2], Elizabeth Herron[1], William Deutsch[3] and Adam Sigler[4]
[1]University of Rhode Island Cooperative Extension, Kingston, R.I., [2]University of Wisconsin-Extension, Madison, Wis., [3]Auburn University, Auburn, Ala., [4]Montana State University Extension, Bozeman, Mont.

Abstract
Volunteer water monitoring programs can educate and build awareness of water quality issues in local communities, motivate citizens to take action for natural resources protection, effect change in natural resources policies, and protect and preserve valued waters. However, current information has been sorely lacking about needs of existing programs in order to enable strategic support, especially in these times of tight budgets and changing priorities. This presentation summarizes the results of a 2011-2012 web-based characterization and needs assessment survey of volunteer water monitoring programs across the country. (The most recent nationwide assessment of volunteer water quality monitoring programs was in 1997). This survey included queries on program staffing, size, scope, volunteer numbers, what is monitored and where, how data and results are used, as well as concerns such as funding, training, data sharing, and outreach tools. Over 130 surveys were received, from the estimated 360 "parent" and stand-alone volunteer monitoring & service provider programs across the country.

"I Want to Help Whoever Can Help the Water": Explaining Citizen Involvement in Volunteer Water Quality Monitoring Programs

Jaime McCauley
Northern Kentucky University, Highland Heights Ky.

Abstract
Most research on volunteer water quality monitoring programs focuses on whether volunteers produce quality data. There is scant research on the factors that influence individuals to participate in these programs in the first place. This study draws on interview and survey data from individuals who participate in citizens' water quality monitoring organizations in the Greater Cincinnati / Northern Kentucky metropolitan area. Key findings indicate that participants are primarily driven to protect their local waters by providing data to local and state agencies, or to other experts who can use the data to protect the waterway. Secondarily, a key component of respondents' ongoing motivation to participate in these programs is related to the social relationships built within water quality monitoring groups. To the extent that water quality monitoring programs can incorporate the noted motivations and goals of volunteer water quality monitoring participants into their recruitment and retention efforts, these organizations will be more likely to sustain volunteer participation. A stable pool of dedicated volunteers aids in producing the consistent quality data necessary to protect our most precious natural resource – water.

Improving Understanding of Impacts of Volunteer Water Monitoring Programs on Natural Resource Policy and Management

Kristine Stepenuck[1,2]
[1]University of Wisconsin-Extension, Madison, Wis., [2]Wisconsin Dept. of Natural Resources, Madison, Wis.

Abstract
A survey of 345 volunteer water monitoring program coordinators in the United States was conducted to learn about the types and breadth of impacts these programs have had on natural resources policy and management. Eighty-six percent of coordinators replied to the survey. They shared information about program characteristics such as geographic scope, age, budget size, and level of quality assurance, along with anecdotes about the types of impacts on policy and management that have resulted from their volunteers' efforts. A wide variety of impacts on water bodies, policies and on organizations were described. Those most commonly reported were indirect impacts on policy and management expressed through volunteer actions to attend public meetings, serve on natural resource-related boards, and write letters to support or refute natural resource policies. The majority of reported impacts were at the town or city level, though state level impacts were also common. Multiple regression models comparing program characteristics to reported impacts revealed several characteristics that were significantly related to the number of impacts programs reported. These characteristics as well as examples of the impacts volunteer water monitoring programs have made on natural resources policy and management will be shared.

Citizen Science and the Management of Natural Resources and Environments: A Systems Approach

Pierre Glynn, Harry Jenter, Carl Shapiro and David Govoni
US Geological Survey, Reston, Va.

Abstract
We describe a new approach to Citizen Science. For our purpose, Citizen Science represents an engagement from members of the public, usually volunteers, in collaboration with credentialed technical experts to observe and understand natural resources and environments for the benefit of science and society. (This includes Volunteer Monitoring of watersheds.) Our approach seeks a much greater level of engagement, not only from volunteers but also from paid professionals, than is present in current Citizen Science efforts. The approach provides new opportunities for the lay public but also solicits community and policy interactions by scientific experts and stakeholders. The characteristics of individual engagement are described by a modern version of Maslow's hierarchy of needs and are documented in current Citizen Science efforts. On the science side, observations and monitoring provide a foundation that supports critical analysis (process research) and that builds up to information syntheses (*e.g.*, spatial & temporal assessments). As citizens (and experts) move up this pyramid of science needs, the potential exists for more intense engagement and participation. At the same time, there are increased challenges associated with educational and information needs. Knowledge generation is often accompanied by individual and community biases, involving both experts and the lay public. A diversity of perspectives from volunteers, stakeholders and experts can help counter these biases. Other benefits include scientific and educational benefits and the use of Citizen Science as a social force. The approach depends on recognition by communities and organizations of the need for long-term multidisciplinary science in support of an improved management of natural resources and environments. It also depends on recognition of individual human needs. We examine our approach in the context of Garrett Hardin's "Tragedy of the Commons." We seek insights from indigenous societies and from the perspective of numerical modelers and other experts. We do not prescribe how our approach might be implemented, but we suggest that implementation might be facilitated through the involvement of integrating entities, including institutions of learning and agencies with broad science responsibilities. Our approach empowers and encourages individuals to participate in active learning and to transcend their own immediate and local needs for the benefit of a larger community.

Session L1: The Big Picture: Holistic Approaches to Water Quality Assessments

1:30 – 3:00 pm | Room 263

Determining How Much Algae is too Much Algae in West Virginia Streams

Kevin Coyne[1], Mike Arcuri[1], James Summers[1] and Mark Duda[2]
[1]West Virginia Dept. of Environmental Protection, Charleston, W.Va., [2]Responsive Management, Harrisonburg, Va.

Abstract
While there is much discussion on the impacts of increased nutrients on the aquatic community, there is little information available on the impacts to recreational uses. In West Virginia, there are numerous large rivers impacted by filamentous algae during the summer recreational season, which are often attributed to excessive nutrients. Biological data on these rivers is not showing significant impacts to the aquatic community that would warrant listing as impaired, and many of these rivers contain some of the best recreational fishing in the state. Conversely, WV DEP has received many complaints from citizens that recreational uses are being impacted by the excessive algae. In 2007, DEP initiated efforts to better understand and address excessive algae in the state. Part of that effort identified the need to better understand what levels of algae are deemed excessive and would impact recreational activities. In 2011, DEP initiated a statewide public opinion survey to determine what levels of filamentous algae would impact recreation in state rivers. The firm Responsive Management was contracted to develop and implement the survey and working with DEP, was able to get responses from over a thousand state residents. The results of the survey showed that levels of filamentous algae cover greater than 25-30% impacted recreational uses. DEP was able to get a significant amount of demographic information concerning recreational stream use in the state which will be discussed in detail. The presentation will also discuss how the findings will be utilized in the nutrient criteria development process.

Projected Economic Benefits Associated with the Removal of Excess Nitrogen and Phosphorous from Utah's Lakes and Streams

Jeff Ostermiller, N. von Stackelberg, P. Jakus, M.J. Kealy, N. Nielson, J. Loomis and C. Stanger
Utah Dept. of Environmental Quality, Salt Lake City, Ut.

Abstract
The Utah Division of Water Quality (DWQ) recently completed a study to quantify the projected economic benefits and costs associated with implementation of nutrient criteria and associated efforts to remove excess N and P from Utah's surface waters. This presentation will focuses on the methods and results of the economic benefit investigations, specifically: total economic value, water-based and near shore recreational use value, non-use existence value, property values adjacent to waterbodies, and reduced drinking water treatment costs. We evaluated the benefits in couple of ways. First, a state-wide survey was used to estimate willingness to pay (WTP) for both participants and nonparticipants of water-based recreation. These WTP estimates were subsequently adjusted to account for the propensity of these methods to overestimate economic value. We also used econometric models to evaluate the benefits of water recreation by coupling results of a second state-wide recreation use survey with ambient water quality and nutrient response (*i.e.*, chlorophyll concentrations, TSI values) data. Together, these methods essentially allowed

us to compare stated preferences (valuations) against actual preferences – the relative nutrient status of where people chose to recreate. Utah households report that they are willing to pay from $70 million to $271 million a year to protect and improve from the deleterious effects of excess nutrients. Households who visit lakes, rivers and streams in Utah stated, and showed through their trip choices, a clear preference for recreating at cleaner waterbodies. The study also found, from current recreation choices, that improving water quality would enhance recreation resulting in approximately $48 million of the total economic value annually. Overall, these economic benefits are fairly balanced with projected costs associated with nutrient removal from Utah's wastewater treatment plants.

Collaborative Science and Monitoring to Support Integrated Watershed Planning

Alison Watts[1], Robert Roseen[2], Paul Stacey[3] and Renee Bourdeau[2]
[1]University of New Hampshire, Durham, N.H., [2]GeoSyntec, Hampton, N.H., [3]Great Bay Research Reserve, Greenland, N.H.

Abstract
We will present the foundation for an Exeter-Squamscott Watershed Integrated Plan for three communities in southern New Hampshire. This research project engages the end users from the initial stages to identify research priorities that will directly support the municipality's ability to make science-based decisions about the value and impact of specific monitoring, planning and implementation actions. Of particular importance is the development of information to inform strategies to deal with uncertainty of ecosystem response in relation to adaptive management actions. The communities have regulatory requirements to meet strict nutrient criteria associated with impairment in the Great Bay estuary; a highly valued resource which hosts a National Estuarine Research Reserve and is a National Estuaries Program Estuary of National Significance. Long term monitoring under these federal programs is augmented by municipalities to meet specific regulatory needs. This project explores a multi-town subwatershed application of integrated planning across jurisdictional boundaries that will address some of today's highest priority water quality issues: wastewater treatment plant upgrades for nutrient removal; improved stormwater management for developing and re-developing areas; and regional monitoring of ecosystem indicators in support of adaptive management to achieve nutrient reduction and other water quality goals in local and downstream waters. The project outcome will be a collaboratively-developed inter-municipal integrated plan, and a monitoring framework to support cross jurisdictional planning, and adaptive management for water quality goals.

Next-Generation of Urban Water Systems

Xin (Cissy) Ma
US Environmental Protection Agency, Cincinnati, Oh.

Abstract
To address the complexities associated with municipal water issues there is a need to change from our traditional "siloed" (drinking water, wastewater, stormwater, etc.) management approach. In a water-connected world, sustainable solutions require a system-based approach, in which water services (traditionally within wastewater, stormwater, and drinking water) are integrated with options to maximize the recovery of resources (energy, nutrients, materials, and water). Water system managers require science-based assessment of the broader system to aid in such decision-making. One system-based approach is emergy synthesis, a process previously used for various systems at multiple scales to incorporate environmental, social, and economic aspects into a common unit of nonmonetary measure (solar energy equivalents). Further, an emergy approach may provide an objective metric to assess the sustainability of systems, when compared with other metrics. It not only quantitatively assesses the direct and indirect energy required to produce goods and services but also provides managers a decision criterion (metric) to evaluate the efficacy of alternatives that specifically includes ecosystem services.

Here we present an emergy analysis that provides a system-wide evaluation, including water resource, drinking water treatment, wastewater treatment, and stormwater management, as well as the distribution and collection systems. The traditional centralized services (including drinking water supply and wastewater) are compared against alternative systems that include wetland treatment and urine-diversion toilets, so as to specifically address coastal eutrophication issues. As a preliminary study we aim to 1) provide a decision-support framework that employs emergy analysis to support integrated water system management; 2) pinpoint the major emergy expenditures for each system; 3) compare water balances; and 4) identify total emergy embedded in the systems examined.

Session L2: Assessment of Stream Condition with Macroinvertebrates, Part 1

1:30 – 3:00 pm | Room 262

Evaluation of an Alternate Benthic Macroinvertebrate Sampling Method for Low Gradient Streams Sampled in the National Rivers and Streams Assessment

Karen A. Blocksom[1] and Joseph E. Flotemersch[2]
[1]US Environmental Protection Agency, Corvallis, Oreg., [2]US Environmental Protection Agency, Cincinnati, Oh.

Abstract
Benthic macroinvertebrates are one of the primary biological indicators of condition used in the U.S. Environmental Protection Agency's National Rivers and Streams Assessment. Following EPA's Wadeable Streams Assessment, States recommended that a different yet comparable method be evaluated for low gradient streams. Consequently, the 2008-2009 National Rivers and Streams Assessment included a research element to conduct a side-by-side comparison of the standard reachwide macroinvertebrate sampling method with an alternate method specifically designed for low-gradient wadeable streams and rivers that focused more on stream edge habitat. Five of nine aggregate ecoregions (AOEs) sampled in the conterminous United States contained high proportions of low-gradient streams. However, because there was not a defined stream slope cutoff for "low-gradient", crews collected samples using each method across the range of stream gradients at 525 wadeable sites in these AOEs. We compared methods based on estimated numbers of organisms collected, the benthic macroinvertebrate multimetric index (MMI) developed for the 2006 Wadeable Streams Assessment, and its component metrics, using paired nonparametric tests. We used McNemar's test of symmetry to determine whether one method more often provided at least 300 organisms, the minimum sample size desired for the MMI. Relationships between method differences and stream gradient were evaluated using generalized linear models across all sites and for sites with a gradient < 1%. Analyses were conducted overall and for each AOE, and some small differences were detected for certain ecoregions and specific metrics. However, statistical analyses did not reveal any biases or trends with stream gradient that would suggest the overall assessment of low-gradient streams on a regional or national scale would change if the alternate method was used rather than the standard sampling method, regardless of the gradient cut-off used to define low-gradient streams. Based on these results, we conclude that incorporating the alternate method into the National Rivers and Streams Survey is unnecessary, and that the survey should continue to use the standard field method for sampling all wadeable streams. This is an abstract and does not necessarily reflect EPA policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

A Credible Water Quality Assessment Using Citizen-Collected Macroinvertebrate Data

Alene Onion[1], Alexander Smith[2] and Margaret Novak[2]
[1]NEIWPCC c/o New York State Dept. of Environmental Conservation, Albany, N.Y., [2]New York State Dept. of Environmental Conservation, Albany, N.Y.

Abstract
For citizen science data to be valuable for decision making, it must be credible. Citizen science macroinvertebrate sampling is particularly vulnerable to credibility concerns because there are many potential sampling and identification errors that could occur. Traditional quality assurance procedures include frequent training, project specific quality assurance plans and audits. Although these methods can be effective, they are very time consuming for both the citizen scientist and the coordinating organization.

We present an alternate water quality assessment using citizen-collected macroinvertebrate data which is resilient to sampling and identification errors and which requires a greatly reduced time commitment both on the part of the citizen scientist and the coordinating organization. It is based, in part, on the method used by Connecticut's River Bioassessment by Volunteers and relies on the presence (and not the absence) of key macro invertebrate families in a voucher collection to define stream quality. This strategy produces data that are both credible and reliable with a low risk of false positives and can be easily scaled to large monitoring programs with minimal full-time staff. The disadvantage of this method is that it only defines approximately 50% of the total samples collected, as not every sample contains sufficient indicator species. Citizen monitoring programs must find the balance between data quality and data needs that allotted time and resources allow. This method provides a useful alternative for those programs with limited resources but still a need for highly reliable data.

Overview of the Biological and Water Quality Assessment Program for Metropolitan Sewer District of Greater Cincinnati Service Area, Cincinnati, Ohio

Laith Alfaqih[1,3], Chris Yoder[2] and MaryLynn Lodor[1]
[1]Metropolitan Sewer District of Greater Cincinnati, Cincinnati, Oh., [2]Midwest Biodiversity Institute, Columbus, Oh., [3]CH2MHILL, Cincinnati, Oh.

Abstract
MSDGC initiated a biological and water quality assessment program for its service area in 2011. This monitoring and planning program was conducted following the design of a comprehensive assessment of the MSDGC service area. The emphasis of these assessments is on determining the status of aquatic life and recreational uses as they are defined by the Ohio Water Quality Standards (WQS) and as assessed in practice by Ohio EPA. The sampling and analysis was performed by Level 3 Qualified Data Collectors and under a biological Project Study Plan approved by Ohio EPA under the specifications of the Ohio Credible Data Law.

The principal objectives of the assessment is to evaluate and determine associated causes and sources of any impairments and potentially use such information in watershed planning efforts to improve or reduce SSO/CSO and overall system performance. The results of this study will be incorporated in an ongoing and more detailed assessment of stressors and their root causes and sources across the MSDGC service area. Termed the Integrated Prioritization System (IPS) it will include more detailed analyses of regional patterns in these stressors and will range from sampled data generated by these surveys to ancillary data available in GIS coverages.

Environmental Drivers of Biological Stability and Persistence at Reference and Managed Sites within the Interior Columbia River Basin, USA

Scott Miller[1], Robert Al-Chokhachy[2], Jennifer Courtwright[1], Charles Hawkins[3] and Brett Roper[4]
[1]Bureau of Land Management/ Utah State University, Logan, Ut., [2]US Geological Survey, Bozeman, Mont. [3]Utah State University, Logan, Ut., [4]US Forest Service, Logan, Ut.

Abstract
Lotic macroinvertebrates inhabit temporally variable environments; however, studies of assemblage dynamics disproportionately focus on short-time scales. Understanding long-term macroinvertebrate assemblage dynamics is critical to status and trend monitoring, because biological assessments assume that estimates of the range of natural temporal variation in assemblage composition at reference sites are stable. The range of natural variation at reference sites is typically estimated via a space for time substitution. We quantified 12 years of macroinvertebrate inter-annual variability for 19 reference and 29 managed sites within the Interior Columbia Basin, USA. We then related assemblage temporal dynamics to environmental variability and watershed attributes. Preliminary results suggest that macroinvertebrate stability and persistence were relatively high for reference sites, with only 9% of reference sites changing condition class over 12 years. The coefficient of variation for reference site O/E scores was less than 15%. In contrast, macroinvertebrate stability and persistence decreased as O/E scores deviated from one. The increased variability at managed sites resulted in greater than 25% of sites changing condition class over 12 years, and the direction of change was not concordant among sites or years.

The environmental drivers of macroinvertebrate stability and persistence differed between reference and managed sites. Reference site variability was best explained by natural environmental variability. Temporal variation in precipitation and ambient air temperature accounted for 41% of macroinvertebrate variability. In contrast, the interannual variability of managed sites was most strongly related to changes in fine sediment levels and bank stability (R^2 = 34%). Our results suggest that current estimates of the range of natural biotic variation at reference sites are reasonably precise, but these estimates could be significantly affected by climate change. In contrast, the relatively high interannual variability in index values observed at managed sites implies that one-time sampling is unlikely to provide a robust estimate of site status.

Session L3: Energy Production Impacts

1:30 – 3:00 pm | Room 261

Assessment of GHG (Greenhouse Gas) Emissions in a Tropical Brazilian Reservoir

Guilherme S. D. Andrade, Nelson A. S. T. Mello, José F. B. Neto, Gilberto C.B. Melo, Cláudio L. Souza and Eduardo von Sperling
Universidade Federal de Minas Gerais, Brazil

Abstract
Although thermoelectricity is still the most used technology to obtain energy worldwide, hydroelectricity has been largely employed as an alternative source for energy generation. This tendency becomes evident due to the amount of dams that has been built around the world, especially in developing countries. Unlike thermoelectricity, hydroelectricity had been considered to provide GHG free energy. However, recent studies have pointed out the role of reservoirs in terms of GHG emissions. In this sense, reservoirs can be either emitters or absorbers of carbon, depending on the local conditions.

The production and subsequent emission of these gases varies largely, as a function of several factors, such as soil usage, water quality, morphology and hydrology of the reservoir and other characteristics of the water basin. Moreover, the production and emission of GHGs varies within the reservoir, due to different depths or local discharges. Therefore, it is important to monitor limnological parameters and GHG emissions to better understand this phenomenon as well as to draw conclusions applicable for a sound management of reservoirs.

Volta Grande (River Grande., Brazil) is a run-of-the-river reservoir, with a short residence time (17 days) and low nutrient (nitrogen and phosphorus) concentrations. It is located in a humid tropical climate, in a savanna biome.

CO_2 flux ranged from 2.35 to 58.35 $mmol \bullet m^{-2} \bullet d^{-1}$ and CH_4 ranged from 90.32 to 649.53 $\mu mol \bullet m^{-2} \bullet d^{-1}$. Our results for both CO_2 and CH_4 fluxes are lower compared to other studies carried out in tropical reservoirs.

Despite the initial presence of flooded biomass, most of it was already oxidized in the early years following the filling of the reservoir. Additionally, the input of organic matter that would be oxidized is apparently low since the water level does not change significantly throughout the year. Therefore, although located in a tropical area, Volta Grande Reservoir emits less CO_2 and CH_4 than other similar impoundments.

Disinfection By-products Formed during the Treatment of Produced Waters at Wastewater Treatment Plants

Michelle Hladik[1] and Michael Focazio[2]
[1]US Geological Survey, Sacramento, Calif., [2]US Geological Survey, Reston, Va.

Abstract
Disinfection by-products (DBPs) are routinely measured in drinking water but less frequently in other treated waters such as wastewater. Produced waters are fluids that are co-produced with oil and gas production, and include brines with elevated concentrations of bromide (up to thousands of mg/L), an important inorganic precursor of several toxic DBPs. To determine if wastewater treatment plants in Pennsylvania that accept produced waters discharge greater amounts of brominated DBPs, water samples were collected from below outfalls of both commercial wastewater treatment plants (CWT) and publicly owned wastewater treatment plants (POTW) and analyzed for 29 DBPs (both regulated and non-regulated). Sites below CWTs had elevated concentrations (up to 8.5 µg/L) of dibromochloronitromethane. The water at one of the CWT outfalls was also analyzed for DBP precursors and had elevated concentrations of bromide (75 mg/L) and other organic DBP precursors (phenol at 15 µg/L). Waters below POTW outfalls had elevated numbers (up to 15) and concentrations of DBPs, especially brominated and iodinated trihalomethanes (THMs) (up to 12 µg/L total THM concentration) and brominated haloacetonitriles (up to 0.91 µg/L total haloacetonitriles). The resulting data indicate that higher concentrations of brominated DBPs are discharged in the effluents of CWTs or POTWs that treat produced waters than POTWs that do not treat produced waters. This finding is important to water quality because there are hundreds of known, or suspected, DBPs many of which are toxic or presumed to be toxic to humans and aquatic organisms. To date, however, there are few occurrence studies conducted on DBPs as contaminants of environmental concern (in addition to DBPs being a drinking water/human health issue).

Wheeling, West Virginia Experience with Frackwater: What "Brinewater" and "Residual Waste" Trucks are Really Carrying

Benjamin Stout
Wheeling Jesuit University, Wheeling, W.Va.

Abstract
Failure of aerobic digesters and reports that workers fell ill at the Wheeling, West Virginia sewage treatment plant lead to an investigation by West Virginia Department of Environmental Protection. The WVDEP has the authority to regulate industrial users of municipal sewage treatment plants. Trucks carrying Marcellus Shale "brinewater" or "residual waste" were sampled as they entered one such industrial facility. Data from brinewater trucks sampled by WVDEP was obtained by a citizen group via a Freedom of Information Act request. Of the 13 trucks sampled 5 (38%) would be considered Hazardous Waste if not for federal exemptions from the Resource Conservation and Recovery Act (RCRA). One truck carried approximately 5,000 gallons of pH 1.5 liquids, and another truck had 600 ppb of benzene. Three trucks had excessive radiation, including one truck which registered 1,483+/- 287 pCi/L radium, and 4,846+/- 994 pCi of gross alpha radiation. The WVDEP investigation led to a Consent Decree with $400,000 fine levied by the state against the City and the company was ordered to stop dumping "treated" brinewater into the municipal sewage treatment system. Since then another application for a frackwater treatment plant was received by the City. This plant, 2 km upstream of Wheeling's Ohio River water intake, is purported to "recycle" frackwater thus requiring no air or water quality permits. Frackwater samples compared with primary drinking water standards revealed 1 of 13 samples (8%) met standards. Standards were exceeded 30 times in 12 samples including arsenic (2 samples), barium (7), selenium (1), benzene (4), gross alpha (7), and radium (9). Secondary standards were exceeded in all samples a total of 80 times. Some samples were worse than others. For instance, brinewater trucked from an open pit in Pennsylvania contained 834 mg/L of barium, or 417 times the primary drinking standard, while another sample from a compressor station in West Virginia had benzene at 1320 µg/L, exceeding the 5 µg/L standard by a factor of 262X. First responders and citizens should know that "brinewater" and "residual waste" can contain hazardous waste and toxic substances. Local ordinances may be the only means of preventing communities from becoming hazardous waste destinations.

Preliminary Interpretation of the Impacts of Marcellus Shale Extraction Activities on Small Streams, Based on Volunteer Collected Data

Candie Wilderman and Jinnieth Monismith
Alliance for Aquatic Resource Monitoring @ Dickinson College, Carlisle, Pa.

Abstract
Shale gas monitoring efforts have multiplied in Pennsylvania and the surrounding region as concerned individuals and organizations seek to learn more about how shale gas development may impact their local streams. In 2010, the Alliance for Aquatic Resource Monitoring (ALLARM), an organization based out of Dickinson College's Environmental Studies Department, developed a protocol for volunteers to monitor small streams for shale gas extraction impacts, specifically to detect pollution events. Since then, ALLARM has trained over 1,000 volunteers in Pennsylvania, New York, and West Virginia to monitor water quality (conductivity, barium, strontium, and total dissolved solids) and physical (stream stage and visual observations) parameters prior to, during, and after shale gas wells have been developed.

Volunteers have a good sense of the status of their individual monitoring sites; however broader implications of regional shale gas extraction can only be determined by looking at the cumulative dataset. This talk with examine three years of water quality results from hundreds of monitoring sites in Pennsylvania, New York, and West Virginia, and suggest possible relationships

between the water quality results and other contributing factors, such as watershed size, geology, landscape and land use, and well development characteristics. The implications of these results in regard to sampling design and the detection of a shale gas impact signature in small streams will be discussed.

Session L4: Integrated Monitoring and Modeling to Restore and Protect a National Estuary – Barnegat Bay

1:30 – 3:00 pm | Room 237

Collaborative Water Quality Monitoring Program to Support Modeling and Restoration of Barnegat Bay

Hui (Helen) Pang, Patricia Ingelido, Barbara Hirst, Leslie McGeorge, Chris Kunz, Robert Schuster and Jill Lipoti
New Jersey Dept. of Environmental Protection, Trenton, N.J.

Abstract
As part of Governor Christie's 10 point plan to address the ecological health of Barnegat Bay, the Barnegat Bay Ambient Monitoring Program was designed and conducted from June 2011 to June 2013. The objectives of the program were to evaluate the water quality impairments and to construct the modeling tool to establish the linkages between stressors and responses, to identify the water quality targets, and to direct the water quality restoration or potential TMDL development. Using a unique collaborative monitoring network, a total of 15 in-bay stations and 13 tributary stations were sampled and analyzed by multiple partner organizations under the direction of the New Jersey Department of Environmental Protection (NJDEP). Besides the field parameters, laboratory analyzed parameters included: TSS, Chlorophyll *a*, BOD5, CBOD5, CBOD20, dissolved and total nutrients, alkalinity, silica, TOC and DOC. Weekly samples were collected over the growing season, while bi-weekly samples were collected during the non-growing season. Two intensive sampling events were conducted in July and August of 2012, respectively. During the 4-day intensive sampling, the in-bay stations were sampled 6 times per day for all 4 days. Tributary stations were sampled twice per day on the first and last day of the event, and monitored continuously with data sondes throughout the event. The results showed the separation of the bay into different sections and that the distribution of in-bay concentrations varied by parameters, such as higher nitrogen in the northern part of the Bay, with higher phosphorus concentrations in the southern part of the Bay. Toms River and Metedeconk River are the two major tributary nutrient loading sources to the Bay, given the high flow and high concentrations observed. The intensive and continuous samples showed the daily variation of water quality, which is critical to appropriately calibrate the water quality model. The model is being constructed /calibrated based on the monitoring data, along with other information. The calibrated modeling tool will be used, together with the findings from ten ecological research projects sponsored by NJDEP's Office of Science, to set water quality targets for the Bay, which may vary by section of the bay.

Hydrodynamic Modeling of Temperature-Salinity Dynamics in Barnegat Bay-Little Egg Harbor Estuary, NJ

Zafer Defne and Neil Ganju
US Geological Survey, Woods Hole, Mass.

Abstract
A 3-D hydrodynamic model has been used to simulate currents, water levels, salinity and temperature in the Barnegat Bay-Little Egg Harbor Estuary (BB-LEH). BB-LEH is a shallow, back-barrier system of bays with restricted connection to the ocean through Little Egg Inlet to the south, Barnegat Inlet on the east, and Point Pleasant Canal to the north. The model is forced with tidal water level and currents from the Western North Atlantic tidal database. Additional subtidal water levels and currents, and temperature and salinity climate from a Mid-Atlantic Bight model are imposed at the open boundaries. Fresh water inputs are defined as point sources at the gauged tributaries. Meteorological forcing is derived from the North American Mesoscale Atmospheric Model. Water levels and current velocities are reproduced with good agreement (Brier Skill Score between 0.5 and 0.9). The modeled temperature has a higher skill score than the modeled salinity at the Mantoloking station (0.8 vs. 0.4). Model results indicate that the average temperature in the estuary is about 2 degrees Celsius higher than the coastal ocean during the March 1-May 1, 2012 simulation period. Salinity is lower in the northern half of the estuary as a result of fresh water input from the Toms and Metedeconk rivers, restricted connectivity with the ocean on the north, and diminished tidal forcing. Most of the domain is well-mixed vertically with minimal salinity stratification. Stronger stratification is observed in the Point Pleasant Canal, and near river mouths, and extending upstream in the Toms and Metedeconk Rivers. Additionally, the recycled cooling water from Oyster Creek Nuclear Generation Station causes thermal stratification with a sharp front halfway across the estuary from Barnegat Inlet. The difference between the average surface and bottom temperatures is on the order of one degree Celsius within an area that stretches a few kilometers north and south of Oyster Creek with an average depth of 3 meters.

Modeling of Water-quality Dynamics and Responses to Nutrient and Other Stresses in Barnegat Bay-Little Egg Harbor, New Jersey

Vincent dePaul and Frederick Spitz,
US Geological Survey, Lawrenceville, N.J.

Abstract
Increased development of Atlantic coastal watersheds in recent decades and associated transport of nutrients to adjacent waters have accelerated estuarine eutrophication. Barnegat Bay-Little Egg Harbor, part of the National Estuary Program, is a shallow, lagoonal estuary located along the central New Jersey coast that has been classified as highly eutrophic due to nutrient over-enrichment and concomitant degradation of water quality. The estuary is particularly vulnerable to the effects of nutrient loading due to restricted circulation and poor flushing rates, and exhibits symptoms of eutrophication such as increases in micro- and macro-algae, harmful algal blooms, degraded seagrass habitat, oxygen depletion, and elevated turbidity. To better understand the impacts of nutrient dynamics in the estuary, a three-dimensional coupled hydrodynamic and water-quality model is being developed. The hydrodynamic model is discussed in a separate abstract.

The water quality model is developed using the Water Quality Analysis Simulation Program (WASP), a dynamic compartment model widely applied to estuarine environments. The water quality model integrates nutrient sources from the watershed, ocean, and atmosphere and considers climatic conditions, sediment transport, sediment diagenesis and benthic exchange, and a range of algal processes to simulate nutrient, dissolved oxygen, and chlorophyll *a* dynamics in the estuary. A linkage is being developed to pass the necessary flow, salinity, temperature and sediment information from the hydrodynamic model to the water quality model. Boundary conditions in the water quality model are derived from continuous and discrete field measurements and enhanced using statistical analysis. The model is calibrated and validated to spring and summer 2012 conditions. Estimated model inputs and kinetic coefficients are adjusted to achieve the best match between simulated concentrations and measured data.

The coupled models will be used to further investigate causes of eutrophication of the estuary and to assess the feasibility of management alternatives for water-quality restoration. Potential alternatives include nutrient-load reduction, engineered circulation enhancement, and change in power plant operation. The models will provide the foundation for addressing current and future water-quality issues in the estuary.

Monitoring and Assessing the Restoration and Protection of the Barnegat Bay: Quo vadimus?

L. Stanton Hales Jr., Martha Maxwell-Doyle and James M. Vasslides
Barnegat Bay Partnership, Toms River, N.J.

Abstract
The Barnegat Bay was identified as an "estuary of national significance" by the USEPA with its acceptance into the National Estuary Program in 1995. Periodic snapshots of the bay over the following decade concluded that the bay was in fair overall condition in comparison to other coastal ecosystems. In 2003, the Barnegat Bay Partnership (BBP) established a Monitoring Program Plan which identified nine primary indicators for the bay, including metrics for (1) submerged aquatic vegetation, (2) land use and land cover, (3) signature species, (4) watershed integrity, (5) shellfish beds, (6) bathing beaches, (7) water supply wells, (8) harmful algal blooms, and (9) freshwater flows. Since that time, two BBP State-of-the-Bay reports (2005 and 2011) made various use of available components to assess the bay's conditions. The BBP, with support from EPA, NJDEP, the Partnership for the Delaware Estuary (another NEP) and others, also initiated an integrated assessment of NJ's coastal wetlands for water quality, habitat management, and restoration planning. Over that same period, studies funded by the Barnegat Bay Partnership and its state and federal partners increasingly documented moderate eutrophication and other deteriorating conditions (*e.g.*, harmful algal blooms, eelgrass declines, localized hypoxia) in the bay ecosystem. In response to widespread concern about the bay's declining health, the NJ Department of Environmental Protection committed to an intensive water quality monitoring study and other comprehensive studies to assess the bay's condition and trends. Thus, over the past 20 years, monitoring and assessment efforts have increased but remained inconsistent. The purpose of this talk is to explore various local, state, and national perspectives on the bay's monitoring and assessment, and to help coalesce and guide future monitoring efforts toward a unified vision for the restoration and protection of the bay.

Session L5: Multiple Stressors and Water Quality Impairments

1:30 – 3:00 pm | Room 233

Software for Analysis of Chemical Mixtures: Composition, Occurrence, Distribution, and Possible Toxicity

Jonathon Scott[1], Kenneth Skach[2] and Patricia Toccalino[3]
[1]US Geological Survey (retired), Oklahoma City, Okla., [2]US Geological Survey, Portland, Oreg., [3]US Geological Survey, Sacramento, Calif.

Abstract
The composition, occurrence, distribution, and possible toxicity of chemical mixtures in the environment are research concerns of the U.S. Geological Survey and others. The presence of specific chemical mixtures may serve as indicators of natural phenomena or human-caused events. Chemical mixtures may also have ecological, industrial, geochemical, or toxicological effects. Chemical-mixture occurrences vary by analyte composition and concentration. Four related computer programs have been developed by the National Water-Quality Assessment Program of the U.S. Geological Survey for research of chemical-mixture compositions, occurrences, distributions, and possible toxicities. The compositions and occurrences are identified for the user-supplied data, and therefore the resultant counts are constrained by the user's choices for the selection of chemicals, reporting limits for the analytical methods, spatial coverage, and time span for the data supplied. The distribution of chemical mixtures may be spatial, temporal, and (or) related to some other variable, such as chemical usage. Possible toxicities can be optionally estimated from user-supplied benchmark data.

The software for the analysis of chemical mixtures described in this presentation is designed to work with chemical-analysis data files retrieved from the U.S. Geological Survey National Water Information System but can also be used with appropriately formatted data from other sources. Use and functionalities of the mixture software will be presented. This software was designed to function with minimal changes on a variety of computer-operating systems. To obtain the software presented here and other U.S. Geological Survey software, visit http://water.usgs.gov/software/.

Headwaters Stressor Identification Study for the Central Great Plains Ecoregion of Kansas and Nebraska

Brenda Morgan[1], Kim Matthews[2], Lisa Metheratta[1], Breda Munoz[2], Phillip Jones[2] and Mark Southerland[1]
[1]Versar, Inc., Columbia, Md., [2]RTI International, RTI, N.C.

Abstract
The purpose of this study was to identify potential pollutants contributing to biological impairment in headwater streams of the Central Great Plains Ecoregion by targeting 16 waterbodies in northern Kansas and southern Nebraska. Four of the 16 waterbodies were listed as impaired and identified by EPA. Using the available GIS layers, the remaining 12 waterbodies were selected to provide a reference condition where there is minimal human disturbance. Locating sites with minimal human disturbance was challenging due to widespread agricultural land use and difficulty obtaining landowner permission for access to many streams. Waterbodies were sampled for ambient water quality, biology, and habitat in both the spring and fall seasons. However, severe drought conditions throughout the study area prevented sampling the full number of stations selected. In total, only eight of the 16 waterbodies were sampled, but additional samples within these waterbodies were taken to improve their characterization

We applied EPA's CADDIS framework to identify potential stressors in the reference and impaired streams and analyzed the data using a range of statistical approaches from simple descriptive statistics and box plots to complex Bayesian models. Datasets with low sample size tend to violate the assumptions of parametric statistical methods. For example, the data are unlikely to be normally distributed or have homogeneous variances. For this reason, we used simple data exploration methods and non-parametric statistical methods to evaluate the distribution of the data and to make comparisons between the reference and impaired condition and among land use types. Likewise, we applied Bayesian approaches because they are able to handle small or incomplete datasets and incorporate data from a variety of sources to inform modeled relationships. In consultation with the EPA and our external partners, we revised our technical approach to enhance the primary monitoring data with state-collected data and leverage similar data sets for parameter relationships. We also conducted a literature review on the effect of drought and water use on stream base flow, and the biological recovery of streams after droughts. The approaches explored in this study provide a methodology that could be applied if more data were to become available.

Drowning in Data: Leveraging Multi-Parameter Datasets to Inform Adaptive Management-Based Restoration in the Long Creek Watershed, a Small Urban-Impaired Freshwater Stream in Coastal Cumberland County, Maine

Katherine McDonald[1], Frederik Schuele[2] and Karen Savage[2]
[1]Cumberland County Soil & Water Conservation District, Windham, Me., [2]URS Corporation, Portland, Me.

Abstract
Long Creek is a small urban-impaired stream in a commercial/retail district in the greater Portland, Maine area. Anthropogenic disturbances within the watershed have resulted in degraded water quality, habitat loss, and

sedimentation. Long Creek fails state water quality standards due to elevated concentrations of metals, chloride, phosphorus, nitrogen, PAHs, and low dissolved oxygen. Altered hydrological conditions and increased water temperatures further contribute to stream impairment. These stressors manifest themselves differently throughout the watershed and may not impact stream reaches equally. Understanding how stressors collectively impact the overall system is critical when considering policy and best management practices to restore streams.

In 2009 the United States Environmental Protection Agency exercised its Residual Designation Authority (RDA) in the Long Creek Watershed. This precedent-setting use of RDA led to the establishment of the Long Creek Watershed Management District (LCWMD), which implements stormwater permit requirements for 70% of the watershed's impervious cover using the Long Creek Watershed Management Plan. The plan includes pollution prevention practices, stormwater retrofits, riparian corridor restoration, and a monitoring assessment program. The Plan relies on an adaptive management approach utilizing structural and nonstructural best management practices to attain water quality classification standards by 2020.

The Long Creek project is approaching the end of its first 5-year permit cycle. Prior to negotiating the next 5-year permit, LCWMD is reviewing progress of restoration efforts using water chemistry, stream flow, and channel geomorphology data collected since 2010. This presentation will provide an overview of the Long Creek monitoring program and describe how adaptive management has yielded a comprehensive program integrating GIS, chemical, meteorological, riparian corridor, macroinvertebrate, hydraulic, and hydrologic datasets to inform permit negotiations. This dataset has led LCWMD to consider stressor identification and management as a model for urban stream restoration rather than the criteria-based model that is common to point-source discharges or the TMDL model that is being implemented in other watersheds in the region. By using this model, LCWMD will attempt to identify the highest priority (or most challenging) stressors within the watershed, and focus limited resources on solutions that are more likely to yield improvements to water quality.

Session L6: Spatial and Temporal Approaches for Monitoring

1:30 – 3:00 pm | Room 232

USGS Tributary Monitoring Network to Support Great Lakes Restoration Efforts

Dan Sullivan
US Geological Survey, Middleton, Wis.

Abstract
In support of Great Lakes Restoration Initiative (GLRI) goals, the USGS is collecting inorganic and organic contaminant data from tributaries and nearshore embayments of the Great Lakes. These data are providing baseline information to assess progress towards restoration goals and to identify new contaminant threats. A total of fifty-nine tributary sites are included in the National Monitoring Network for Coastal Waters (NMN) design for the Great Lakes basin; of these, 30 are being monitored on an ongoing basis.

The 30 Great Lakes NMN sites are equipped with automatic sampling systems and multi-parameter sondes. The automatic samplers collect water-quality samples during storm events to supplement monthly manual sampling for estimating loading of nutrients, sediment, and chloride. The sondes provide continuous monitoring of specific conductance, pH, temperature, turbidity, and dissolved oxygen. Regression models to predict concentrations of analytes not directly measured by the mulit-parameter sondes have been developed. Using a combination of the continuous data and discrete constituent measurements, the regression models allow for a more cost-effective long-term water-quality monitoring approach for Great Lakes tributaries.

Long-Duration High-Frequency Monitoring of Nutrients and Sediments in an Agricultural Watershed

William Renwick, Michael Vanni and Lesley Knoll
Miami University, Oxford, Oh.

Abstract
Land use and land management have major impacts on water quality, and watershed management programs focus on promoting good practices. However, monitoring water quality responses to land use and land management is costly and time-consuming, and it can be difficult to demonstrate the effects of land management efforts.

In the early 1990s a watershed management plan was put in place in the Upper Four Mile Creek watershed in southwest Ohio. The 260 km^2 watershed is predominantly agricultural (~90% cropland), and nutrients and sediment in agricultural runoff significantly impact Acton Lake, an important recreational resource within Hueston Woods State Park. In the early 1990s ~15% of cropland in the watershed was in conservation tillage, but by 2000 it had reached ~70%. Since 1994 we have monitored stream flow, ammonium (NH4), nitrate (NO_3), soluble reactive phosphorus (SRP), and suspended sediment (SS) concentrations on three streams tributary to Acton Lake. The streams range in drainage area from 12 to 129 km^2, and together represent 85% of the area tributary to the lake. Our sampling is flow-dependent, generating a daily record of concentration and load for NH_4, NO_3, SRP and SS, and by extrapolation total dissolved and particulate N and P for each stream.

Despite the high resolution of the data, noise obscures long-term trends. Nonetheless, by 2006 discharge-standardized concentrations of NH_4, SRP, and SS had decreased 40-60%, while trends in NO_3 concentrations were small or negligible. Recent change point analyses of the 19-year record indicate a complex history with several instances of trend reversals, *e.g.*, concentrations of some constituents declined for some years and then increased. These changes are likely caused by a combination of weather and land management effects.

Using Critical Timing to Couple Continuous Water Quality Monitoring Data and Proposed Nitrate Reduction Strategies

Jessica Garrett
US Geological Survey, Iowa City, Ia.

Abstract
Nitrate runoff contributes to loss of agricultural productivity, degradation of local streams, and hypoxia in the Gulf of Mexico. The critical event and seasonal timing vary for environmental concerns for nitrate concentrations and transport for relevant spatial scales – from fields, to local streams, and to the Gulf. Systems of watershed management strategies are commonly targeted in small basins for the best chance of measurable improvements. The effective timing of some strategies and implementation scale do not always match the critical timing or scale of the environmental concern. Monitoring nitrate loads at times and scales relevant to the environmental issues or watershed management strategies is challenging due to flashy streamflow and complex interactions between streamflow and concentrations.

Continuous nitrate and streamflow monitoring data, including optical nitrate sensors, are assessed for concentrations and loads during critical timing and at several sites for a broad range of scales. Critical timing for environmental issues include peak nitrate concentrations for drinking water supplies, cumulative annual loads, spring loads contributing to Gulf hypoxia, and periods of peak

crop nutrient-uptake demand. Additionally, continuous nitrate and streamflow data are assessed relative to effective timing and implementation scales for several nutrient management strategies.

For example, nitrate concentrations greater than the 10 mg/l maximum contaminant level commonly occur in the Midwest during spring and early summer high-streamflow events. A restored floodplain connection (decommissioned levee) near the mouth of the Maquoketa River in Iowa allows partial flow diversion into the floodplain. For storm events in 2013 that generated river levels high enough to enter the floodplain, three of four events had stream nitrate concentrations in one major tributary with continuous nitrate monitoring greater than 10 mg/L. Management strategies, such as this restored floodplain connection or cover crops, potentially reduce stream nitrate transport during high streamflow, when a large part of the annual load is transported downstream. Conversely, reduction strategies which rely on residence time and biological removal of nitrate, such as bioreactors and wetlands, are not as effective during storm events in spring and early summer, but may reduce baseflow, warm-season nitrate contributions more efficiently.

Dissolved Organic Matter as an Indicator of Watershed Processes

George Aiken[1], Kenna Butler[1] and Robert Spencer[2]
[1]US Geological Survey, Boulder, Colo., [2]Woods Hole Research Center, Falmouth, Mass.

Abstract
Assessment of DOM concentration, composition, flux, and yield provides a basis for understanding watershed processes and biogeochemistry of rivers and streams. Examples demonstrating of the interpretational utility provided by deriving DOM metrics will be presented based on multi-year studies designed to assess seasonal and spatial variations in DOM quantity and quality for 18 large North American rivers. DOM concentration and composition varied greatly between sites and seasonally at a given site. Generally, DOM optical parameters correlated strongly with DOM concentration and aquatic humic substances content. These relationships vary between rivers and were weak for rivers draining arid regions and those heavily influenced by impoundments. Similar trends were not as robust for DO^{14}C, which better reflected irrigation, ground water and waste-water contributions to the DOM pools. There was a significant positive correlation between basin wetland-cover and average DOM concentrations (R^2 = 0.78; $p<0.0001$) and composition ($SUVA_{254}$; R^2=0.91; $p<0.0001$) demonstrating the importance of wetlands in the export of terrestrially-derived DOM in rivers. While individual watershed characteristics controlled DOM concentrations and composition, overall discharge dominated the flux of DOM to coastal waters.

Session L7: Making it Clear for the Public: Techniques in Data Communication, Part 1

1:30 – 3:00 pm | Room 231

Promoting Recreation in the Willamette River Post CSO Control

Peter Abrams
City of Portland, Portland, Oreg.

Abstract
Portland's first sewers, constructed in the late 19th century, combined sewage and stormwater in the same pipes and carried the wastewater directly to the Willamette River without treatment. In 1952, new interceptor pipes began collecting sewage from the combined sewers for conveyance to Portland's first sewage treatment plant.

The City of Portland and the Oregon Department of Environmental Quality (DEQ) agreed on a CSO control plan in 1991, and an amended plan in 1994. That plan, the Amended Stipulation and Final Order (ASFO), required Portland to control CSOs to the Willamette River by 2011. The city finished CSO construction and activated the Willamette River CSO tunnel system before its December 1, 2011 deadline.

Before the CSO program began, Portland's combined sewers overflowed an average of 50 times a year, spilling about six billion gallons of combined sewage into the Willamette River every year. The CSO program reduced overflows to the river by 94%. Today, combined sewers overflow to the river no more than four times per winter and once every three summers.

As you might expect, many citizens of Portland are convinced that the Willamette River is contaminated and unfit for swimming or other recreation. With the completion of the CSO project the Bureau of Environmental Services (BES) would like to change this perception, as well as promote further water quality protection.

Weekly summer bacteria monitoring was initiated in 2012 at five recreation points along the Willamette River and the results are posted on the city web page. There are organized events in the summer such as The Big Float, the Portland Triathlon and the Portland Bridge Swim, which provide the link to our bacteria results on their web sites for reference by their participants. The field sampling crew also provides information regarding the completed CSO program when approached by citizens.

The Willamette River is considered one of the greatest assets of Portland. Over time citizens will recreate in the river on a more regular basis and there will be a change in attitude towards the river, creating a greater sense of responsibility to protect the water quality.

Turning Monitoring Data from Numbers into Watershed Priorities

Mindy Scott[1], Carrie Turner[2] and James Gibson[1]
[1]SD1, Ft. Wright, Ky., [2]LimnoTech, Ann Arbor, Mich.

Abstract
Sound science is the foundation for successfully managing and improving conditions in our watersheds. Interactions with regulatory agencies and communication with the public are also more effective when grounded in sound science. Water quality monitoring is a key element in forming this foundation.

In general, more data provide more understanding of watershed conditions. Given the potential pitfalls and challenges that can occur in each step of water quality sampling and analysis, successfully executing a substantial monitoring program can feel like a major victory and generate a sense of relief when the last sample is collected. However, the completion of a monitoring program is only half the battle. Managing and interpreting data to tell the "story" about the watershed and form the foundation for effective management decision-making can be challenging when working with a voluminous dataset from an extensive water quality monitoring program.

SD1, which is responsible for wastewater and regional storm water management in Northern Kentucky (NKY), undertook a six-year water quality sampling program in sixteen local watersheds from 2006-2011. This program included base flow and intensive wet weather monitoring for more than 20 parameters at over 75 locations. SD1 also sampled 80 locations in the Ohio River for a reduced parameter list over the same six-year period. Over 40,000 measurements were made during the sampling program. SD1 developed a comprehensive approach and methods to evaluate the data in the context of the monitoring program objectives and Watershed Plan goals. The data analysis and resulting water quality "story" for each watershed were documented in a Water Quality Report.

This paper will present the scope of the sampling, the objectives of the program, the innovative approaches used to analyze the data, the insights gleaned from the data and how the results were and will continue to be used to prioritize, address and track water quality improvements in NKY's local waterways.

Volunteer Monitoring for Science and Action

Tony Williams
Buzzards Bay Coalition, New Bedford, Mass.

Abstract
Excessive nutrient inputs from land use, sprawl impacts to the surrounding watershed are resulting in changes in habitat health and water quality along the coastline. At greatest risk are the Bay's more than 30 harbors, coves and rivers which receive the bulk of the nutrient load from the watershed. The program task is collecting data on nutrient overloading. Nutrient pollution (eutrophication) is mostly rooted in the watershed's ever-growing population with development and land use changes. Management is often challenging and difficult because of its widespread distribution from a wide array of sources-runoff, septic, sewage, agriculture. Involving more than 700 citizen volunteers since 1992 allows the Buzzards Bay Coalition to monitor all of Buzzards Bay's major embayments – an area covering more than ¼ of the Massachusetts coast. The program has the dual benefit of collecting comprehensive water quality data while educating and empowering people. This program's success relies in getting citizens involved with monitoring, management and restoration of the Bay's resources at the local level. The program is recognized for providing water quality data to both the Local and State Environmental Managers as a cost effective alternative where other resources are absent for initiating 303(d) listing and TMDL reporting.

The monitoring objective is to collect data to better understand the Bay ecosystem and its response to human- related impacts, in order to guide restoration and protection. This citizen's monitoring program has documented and evaluated nitrogen-related water quality going on 23 years. The data is then represented in a Bay Health Index, showing long-term ecological trends and as method to improve the public and town elected officials understanding of current local water quality.

The program is applying consistent methods while building collaborations and long-term data for watershed and ecosystem health.

How to Turn 3000 Water Quality Measures from 11 Sources into an 8 Page Report Written for the General Public

Daniel Obrecht and Anthony Thorpe
University of Missouri, Columbia, Mo.

Abstract
The Upper White River Basin is a large drainage (36,260 square kilometers) located in northwestern Arkansas and southwestern Missouri. Along with a network of clear-water streams and rivers, the area contains a chain of four large reservoirs: Beaver Lake, Table Rock Lake, Lake Taneycomo, and Bull Shoals Lake. The number of tourist visiting the area has increased over time, as has the number of year-round residents. This increased stress on water resources relating to the proliferation of human activity in the basin, combined with the importance of these resources to the economy of the region, has led to a focused effort to educate the general public about water quality. Ozark Water Watch, a non-profit group operating in the basin, has produced a Status of the Watershed Report for five consecutive years. The goal of the report is to answer the question "How is the water?" Past reports focused on water quality data generated by the USGS and a limited number of stream invertebrate samples collected under an agreement with University of Arkansas. While the quality of these data was very good, the spatial coverage within this large basin was limited. In an attempt to include data from more sites, as well as highlight volunteer efforts, the report was reworked for 2012. Water quality data was gathered from 11 different sources that included: federal and state agencies, local governments, and five different volunteer programs. Altogether over 3000 water quality measures taken from 160 sites within the basin were included in the 2012 report. This presentation will review the transition to utilizing the copious and varied data set, and how the data were condensed into a colorful eight page report that targeted the general public.

Session M1: Regional Scale Monitoring Strategies

3:30 – 5:00 pm | Room 263

Assessing the Quality of Groundwater used for Public Supply across the Glacial Aquifer System

Paul Stackelberg
US Geological Survey, Troy, N.Y.

Abstract
The Glacial Aquifer System (GAS) consists of unconsolidated sediments of glacial origin that overlie bedrock or older, unconsolidated sediments north of the line of glaciation. The GAS is the largest principal aquifer in areal extent and volume of water withdrawn for public and domestic supplies in the United States. In 2000, 3,560 million gallons per day were withdrawn from the GAS to meet the water-supply needs of about 41 million people. Since 1993, the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) program has assessed the chemical quality of groundwater across the GAS, and has developed a framework for interpreting water quality based on two primary characteristics - aquifer intrinsic susceptibility and vulnerability to contamination. During the first two decades of the program, emphasis was placed on sampling both monitoring and domestic-supply wells to better understand the chemical quality of recently recharged water underlying specific hydrogeologic and land use settings as well as deeper groundwater used for domestic supply. As the NAWQA program enters its third decade, sampling of monitoring and domestic wells will continue in order to assess trends in water quality. In addition, a new objective is to assess the quality of groundwater at depths used for public supply across selected principal aquifers. To meet this objective in the GAS, a stratified-random sampling design that utilized equal-area grid cells was used to select 90 public-supply wells for sampling – providing a spatially unbiased assessment of water-quality conditions across the GAS. An additional 30 public-supply wells were selected within the mid-west region of the GAS to provide an enhanced understanding of water-quality conditions in an area with large population centers and intensive applications of agrichemicals. Samples from all public-supply wells are being analyzed for a comprehensive suite of chemical constituents including nutrients, volatile organic compounds, pharmaceuticals, hormones, pesticides, trace elements, radionuclides, microbial indicators and age-tracers. This assessment of the quality of groundwater withdrawn for public supply has implications for human health and economic development and will provide vital data for managing this water resource. Preliminary results from sampling public-supply wells across the GAS will be presented.

The Midwest Stream Quality Assessment: A Collaboration between the U.S. Environmental Protection Agency and the U.S Geological Survey

Jeffrey Frey[1] and Peter Van Metre[2]
[1]US Geological Survey, Indianapolis, Ind., [2]US Geological Survey, Austin, Tex.

Abstract
In 2013, the U.S. Geological Survey (USGS) National Water-Quality Assessment Program (NAWQA) and USGS Columbia Environmental Research Center (CERC) collaborated with the U.S. Environmental Protection Agency (USEPA) National Rivers and Streams Assessment (NRSA) to assess stream quality across the Midwestern United States. The goals of the Midwest Stream

Quality Assessment (MSQA) are to characterize major water-quality stressors-contaminants, nutrients, and suspended sediment-and ecological conditions in streams throughout the Midwest and to determine the relative effects of these stressors on aquatic organisms in the streams. The joint study builds upon the ongoing NRSA study and attempts to incorporate the strengths of the USEPA and USGS programs and improve the effectiveness of both programmatic designs. This collaborative study enhances information provided to the public and policymakers and minimizes costs by leveraging and sharing data gathered under existing programs.

A total of 100 sites were sampled jointly by MSQA study partners across the region between early May and early August 2013. These sites included 50 random sites selected by the USEPA using a probabilistic design, which are a subset of the approximately 150 NRSA sites in the Temperate Plains ecoregion, and about 50 sites selected by the USGS using a targeted design to ensure coverage of a wide range of land-use conditions. In combination, the sites sampled provide the data necessary to assess the water quality and ecological condition of streams and to support empirical modeling of factors affecting those conditions for extrapolation to unsampled streams in the region. The 50 USGS targeted sites were added to complete coverage of stressor levels found in the region, mainly by adding reference sites, low-intensity agricultural sites, and urban sites. The NRSA study samples sites one time for water chemistry, biological community (algae, invertebrates, and fish), and stream habitat. The USGS sampled these same 100 sites 12 times over three months for pesticides, nutrients, and suspended sediment to better assess the stressors affecting the biological communities. Additionally, bed sediment was collected and analyzed for contaminants at all 100 sites to assess another environmental compartment that can dramatically impact biological communities.

Design Basis for the Gulf Monitoring Network (GMN): Integrating Key Elements of Remote Sensing, Sampling, and Modeling

Steven H. Wolfe[1,2]
[1]Florida Institute of Oceanography, St. Petersburg, Fla., [2]Gulf of Mexico Alliance, Tallahassee, Fla.

Abstract
The Gulf of Mexico Alliance (GOMA) was formed by the five U.S. Gulf state Governors to identify and work on resolving issues identified as most important. One of these priorities is improving the integration of water quality monitoring in the estuarine, coastal, and offshore waters of the Gulf. The GOMA Water Quality Team has worked over the last five years with state, federal, private, and NGO monitoring entities to develop an integrated water quality monitoring program to support a wide range of Gulf needs, including management, regulation, and oil-spill restoration. The result is the Gulf Monitoring Network (GMN). We will lay out the process and rationale that evolved. The design revolves around the combination of remote sensing, modeling, and *in situ* sampling. Because of the wide range of scale required of the monitoring and the necessity for cost effectiveness, the GMN relies upon all three elements working together. These are 1) in-situ measurements (both continuous and periodic) and the collection of analytical samples to provide "anchor points" for continuous truthing and feedback to 2) hydrodynamic and water quality models that provide estimates of conditions both spatially (between the sample points) and temporally (between the sampling events). 3) Remote sensing serves the dual role of providing initial data for model development, and then serves to continually validate model output and provide input for model adjustment. Remote sensing also directly provides spatial and temporal information to better estimate water quality between the in-situ sampling locations. The combination of the three approaches will provide the best information at the lowest cost in support of the Gulf priorities.

Design and Implementation of Regional Monitoring Networks to Detect Climate Change Effects in Freshwater Streams

Jen Stamp[1], Margaret Passmore[2], Anna Hamilton[3], Britta Bierwagen[4] and Jonathan Witt[4]
[1]Tetra Tech Center for Ecological Sciences, Montpelier, Vt., [2]US Environmental Protection Agency, Wheeling, W.Va., [3]Tetra Tech Center for Ecological Sciences, Santa Fe, N.M., [4]US Environmental Protection Agency, Washington D.C.

Abstract
Few monitoring agencies have collected adequate time-series data to support analyses of long-term trends or shifts in the biological, thermal, and hydrological regimes of minimally disturbed, unregulated freshwater streams. Such data are necessary to further our understanding of how changing conditions will affect these sites, their ability to be used in assessments, and to inform state and federal agencies on the relative importance of climate change compared to other stressors. To help address these data gaps, the United States Environmental Protection Agency (US EPA) has been collaborating with states and US EPA regional offices to develop connected regional monitoring networks in the northeast, mid-Atlantic and southeast. Here, we describe how the monitoring network sites were selected, the biological, temperature and flow data that are being collected at these sites, the methods being used to collect the data, plans for housing and sharing the data, and possible avenues for future research.

Session M2: Assessment of Stream Condition with Macroinvertebrates, Part 2

3:30 – 5:00 pm | Room 262

Tracking Macroinvertebrate Trends in Water Quality With Respect to Flow Conditions and Other Variables

Jim Martin
Adrian College, Adrian, Mich.

Abstract
The River Raisin is an important tributary of the western Lake Erie basin. This system has been regularly sampled for invertebrates for 12 years. While about 65% of the basin is agricultural, a good portion of the upper stream is of good biological health. Three reference sites, one from a relatively pristine upriver location, one from near the mouth of the river, and one from one of the more heavily farmed locations, are compared for macroinvertebrate findings with respect to precipitation patterns and stream flow. The greatest variability we have seen in our data through the years is from the more agricultural sites; sometimes searches have yielded insects that are known to be sensitive to disturbance, yet most years they are completely absent. Precipitation patterns are known to strongly influence runoff of sediment and nutrients into the river, and as such influence not only the patterns of macroinvertebrates that we find in this basin, but the amount of nutrients that later find their way into Lake Erie. Knowing the effect of stream flow intensity and duration on macroinvertebrate communities could be useful in the context of implementing best management practices when considering water flow management structures that are abundant in a tiled and drained agricultural landscape.

Stream Characteristics and Other Considerations for Macroinvertebrate Bioassessment of Puerto Rico Streams

James Kurtenbach
US Environmental Protection Agency, Edison, N.J.

Abstract
Until very recently, macroinvertebrate bioassessment studies of Puerto Rico streams have been limited. This is partly attributed to a lack of development of biological assessment protocols applicable to Caribbean streams. Macroinvertebrate data collected between 1994 - 2011 from 210 stream sites, including the addition of water chemistry, physical habitat, and landscape information have improved the understanding of stream conditions in Puerto Rico. However, information gaps remain on water chemistry, physical habitat, and landscape (natural and anthropogenic) factors which can confound the interpretation of biological condition as determined by macroinvertebrate community data. Also, information associated with invertebrate taxonomy, functional feeding groups, pollution sensitivity, and freshwater-marine linkages continues to be meager. In this paper, the key components of natural stream characteristics and invertebrate biology that are not well understood or unique to Puerto Rico streams are examined. These study objectives have implications for not only current macroinvertebrate bioassessments, but future refinements necessary to achieve more definitive assessments of stream condition in Puerto Rico. Findings from existing Puerto Rico stream survey data could be expanded to guide bioassessment for streams in other Caribbean islands.

Evaluating the Effects of Spawning Bed Enhancement on Salmon Habitat, Water Quality, and Benthic Communities in a Yuba River Tributary in Northern California

Justin Wood, Rachel Durben, Jeff Lauder and Joanne Hild
Sierra Streams Institute, Nevada City, Calif.

Abstract
Deer Creek flows for thirty-four miles in the Sierra Nevada foothills to its confluence with the lower Yuba River. As the last tributary of the Yuba River before the impassable Englebright Dam, Deer Creek provides critical habitat for Central Valley Spring-run, Fall-run, and late Fall-run Chinook salmon and Central Valley Steelhead. There is a lack of suitable spawning gravels and cobbles in Deer Creek due to the presence of upstream dams. Since 2010, Sierra Streams Institute has been undertaking projects to augment the supply of spawning material in Deer Creek, including a spawning bed enhancement effort in 2012. In total, SSI placed approximately 250 tons of spawning material into Deer Creek at three locations spanning 1400 feet of creek. To evaluate how the placed spawning materials are incorporated into the aquatic system, we monitored benthic macroinvertebrates and algae, Chinook salmon and steelhead, water quality, and habitat conditions in three enhanced areas and three unenhanced areas. We observed benthic macroinvertebrates rapidly colonizing the newly placed substrates, and after 10 weeks of monitoring, we observed no difference in algal cover between enhanced and unmanipulated areas. The median pebble size (d_{50}) in each of the enhanced areas was reduced from 77 mm to 22 mm in work area 1, 100 mm to 15 mm in work area 2, and 100 mm to 13 mm in work area 3. Over 75% of the spawning activity occurred in the enhanced work areas, with over three times as many salmon redds in 2012 than in 2011. The data suggest that the stream's spawning capacity had been severely limited by lack of suitable habitat materials. In addition, spawning gravels can be quickly incorporated into the aquatic system by benthic organisms.

Session M3: Training and Coordinating for Better Results

3:30 – 5:00 pm | Room 261

Training and Educating Digitally – How YouTube is Revolutionizing Water Quality Monitoring

James Beckley
Virginia Dept. of Environmental Quality, Richmond, Va.

Abstract
With the advent of low cost video production equipment and free distribution services like YouTube, government and volunteer organizations can now produce inexpensive, high quality training and educational videos.

The Virginia Department of Environmental Quality is developing a series of online training videos on popular methods to monitor water quality for organizations like citizen volunteer groups, local government agencies, and the general public interested in performing water quality monitoring. This resource allows the agency to ensure organizations submitting water quality data are familiar with quality assurance and proper test protocols while reducing the need for in-person training while helping to standardize monitoring methods.

Citizen volunteer organizations such as the Virginia Citizens for Water Quality and the Chickahominy Swamp Rats are producing short educational movies about water quality topics for the general public to view. The videos are an effective primer on why issues like fecal bacteria, sediment, and other pollutants are worth monitoring for and ways people can reduce such pollutants from entering their local waters.

This session will outline what is necessary to develop a good training video and the amount of time and expense an organization would expect in developing similar videos. If time permits, this session will show some examples of videos produced and editing tricks to make a polished and well received video.

The Maryland Biological Stream Survey Training and Certification Program

Daniel Boward, Scott Stranko, Jay Kilian, Andrew Becker and Ronald Klauda
Maryland Dept. of Natural Resources, Annapolis, Md.

Abstract
The Maryland Biological Stream Survey (MBSS) is a statewide, freshwater stream monitoring and assessment program begun in 1995 by the Maryland Department of Natural Resources (DNR) in partnership with staff from the University of Maryland Appalachian Laboratory. Fish, benthic macroinvertebrates, water chemistry, physical habitat and land use are evaluated at about 250 sites per year. Uses of MBSS data include status and trends in stream condition across various spatial scales, evaluation of stream restoration effectiveness, rare threatened and endangered species distributions, and water quality regulations. Since the inception of the MBSS, several state and county agencies and consultants have adopted MBSS sampling methods. To ensure consistent data quality and facilitate data sharing, DNR established an MBSS methods Training and Certification Program in 2012. Five certifications are currently offered: 1) benthic macroinvertebrate sampling, 2) benthic macroinvertebrate laboratory processing and subsampling, 3) fish sampling, 4) fish sampling crew leader, and 5) fish taxonomy. A field audit is required for benthic macroinvertebrate sampling, fish sampling crew leader, and fish taxonomy certification. Seventy-one individuals were certified in one or more protocols across both years (2012 and 2013). Benthic macroinvertebrate sampling and fish sampling were the most "popular" certifications. Twenty applicants received two or more certifications. Most applicants (56%) worked for consulting firms, 23% for local/regional governments, and 18% for state

agencies. DNR staff plan to offer these certifications again in 2014 and may also expand to offer certifications in other protocols depending on demand. The MBSS Certification Program will continue to address the need for high quality stream ecological data for years to come.

Coaching Volunteers to Obtain Meaningful and Useful Data

Susan Higgins
Missouri Dept. of Natural Resources, Jefferson City, Mo.

Abstract
Training Volunteer Water Quality Monitors does not end with the workshop. In order to obtain the highest quality data possible, it is important to coach new (and experienced) volunteers to improve their data submission skills. Our volunteers come from all walks of life and many do not have a science background, but all seem to have a sincere desire to learn to submit useful data to the program. At Missouri Stream Team Volunteer Water Quality Monitoring Program each data submission is reviewed for data quality before and after it is entered into our database. Many times, errors can be caught and corrected early in the process. In this way volunteers are assured that someone is reviewing their data and helping them reach their goal of submitting useful information to the program. Successful coaching together with the tiered structure of volunteer workshops and mandatory validation training for more experienced volunteers have all combined to make big improvements to water quality data received and create more agency interest in using volunteer data. Learn how we coach volunteers, QC data and ensure that erroneous data is not included in data request fulfillment.

Large-Scale Sampling Events: Using Volunteers to Monitor at the Watershed Level

Tara Muenz and Harold Harbert
Georgia Adopt-A-Stream, Atlanta, Ga.

Abstract
Georgia Adopt-Adopt-A-Stream partners annually with many organizations, universities and watershed groups to conduct sampling events with volunteers on a watershed level, ranging from one-day snapshots to week-long paddle trips. One-day sampling events, also called 'Blitzs, River Adventures, and River Rendezvous,' target 20-30 sites within a watershed. The longer week-long events involve sampling anywhere from 80-120 sites and are a part of a larger momentum called 'Paddle Georgia.' This annual event, coordinated by the Georgia River Network, is located on a different Georgia river each year and brings along over 350 citizens on the adventure. Partners for these events include local governments, watershed organizations, Adopt-A-Stream groups and many other entities which provide sampling equipment, technical support and sponsorship. Depending on the objectives of the event, data can be collected on many parameters including chemistries, bacteria, macroinvertebrates, amphibians, and physical characteristics in addition to conducting river cleanups at certain sites. Data is posted on our website/database and is available for citizens and partners to view and download for analysis. In addition to collecting and sharing the data, small reports are written and shared with the community. During this presentation we will discuss the logistics of organizing a watershed-wide sampling event, including the partnerships involved, data display, successes and lessons learned.

Session M4: Mercury in Air, Water, and Fish Tissue

3:30 – 5:00 pm | Room 237

The Atmospheric Mercury Network: Measurement of Atmospheric Mercury Fractions across North America

David Gay[1], David Schmeltz[2], Eric Prestbo[3], Mark Olson[1], Timothy Sharac[2] and Robert Tordon[4]
[1]University of Illinois, Urbana Champaign, Ill., [2]US Environmental Protection Agency, Washington, D.C., [3]Tekran Research and Development, Seattle, Wash., [4]Environment Canada, Dartmouth, N.S., Canada

Abstract
The National Atmospheric Deposition Program (NADP) has developed and is currently operating a collaborative network of atmospheric mercury (Hg) monitoring sites based in North America – the Atmospheric Mercury Network (AMNet).

The goal of this network is to develop a robust database of Hg fraction measurements to improve model development, assess policies and programs, and improve estimates of mercury dry deposition. Many different agencies and groups support the network, including federal, state, tribal, and international governments, academic institutions, and private companies. Network sites measure concentrations of atmospheric Hg fractions using automated, continuous mercury speciation systems. The procedures that NADP developed for field operations, data management, and quality assurance ensure that the network makes scientifically valid and consistent measurements.

AMNet reports concentrations of hourly gaseous elemental mercury (GEM), two-hour gaseous oxidized mercury (GOM), and two-hour particulate-bound mercury less than 2.5 microns in size ($PBM_{2.5}$). As of January 2013, over 600,000 valid observations are available from 30 stations. All data and methods are publically available through an online database on the NADP website (http://nadp.sws.uiuc.edu/amn/). The data available from this network will allow for in-depth analysis and modeling studies for the mercury community, which also could have important policy implications for future mercury regulation.

For this talk, we will present an overview of the network, review the quality assurance aspects of the data review, and provide initial observations of individual sites and over space.

Future network directions are to foster new network partnerships and continue to collect, quality assure, and post data, including dry deposition estimates to compliment currently available wet deposition measurements.

The Great Lakes Atmospheric Mercury Monitoring Network

Martin Risch[1], Donna Kenski[2] and David Gay[3]
[1]US Geological Survey, Indianapolis, Ind., [2]Lake Michigan Air Directors Consortium, Rosemont, Ill., [3]Illinois State Water Survey, Champaign, Ill.

Abstract
As many as 51 mercury (Hg) wet-deposition-monitoring sites from 4 networks were operated in 8 USA states and Ontario in the Great Lakes Region from 1996-2010. By 2013, 20 of those sites were no longer in operation and approximately half the geographic area of the Region was represented by a single Hg-monitoring site. In response, a Great Lakes Atmospheric Mercury Monitoring (GLAMM) network has been developed as a framework for regional collaboration in Hg-deposition monitoring. The purpose of the GLAMM network is to detect changes in regional atmospheric Hg deposition related to changes in Hg emissions.

The development and funding of this network is a successful example of federal, state, and regional partnerships. A majority of the active and historic Hg-monitoring sites in the Great Lakes Region are part of the National

Atmospheric Deposition Program (NADP) Mercury Deposition Network (MDN) and the GLAMM network will be part of the MDN. Sites in the MDN have comparable data because of uniform equipment and procedures and a central laboratory.

An important component in the development of the GLAMM was an optimized design for a regional network. This design was based on a relatively complex evaluation that determined a representative and approximately uniform geographic distribution of Hg-monitoring sites for the Region. In the past, each state or other funding entity determined the location of Hg-monitoring sites for their own purposes.

Implementation of the network design offers improved monitoring coverage and increased efficiency in monitoring operations. A regional planning agency will use federal funding to start or re-start a total of 9 Hg-monitoring sites in the network to fill gaps in the geographic distribution of sites in 4 states. Four states and Ontario will continue to support operation of 12 MDN sites that were still active in 2013. The network design evaluation criteria can be used by states to identify monitoring sites that are important for understanding regional trends and spatial patterns in Hg deposition. In addition, Hg-monitoring sites in the GLAMM are co-located with NADP acid-rain monitoring and Hg-in-air monitoring sites to increase efficiency in monitoring operations and to add opportunities for data comparison.

Results of EPA's Assessment of Fish Tissue from U.S. Rivers for Mercury and Legacy Organic Compounds with implications for Aquatic Life and Human Health

John Wathen[1], Leanne Stahl[1], James Lazorchak[2], Angela Batt[2], Blaine Snyder[3] and Harry McCarty[4]
[1]US Environmental Protection Agency, Washington, D.C., [2]US Environmental Protection Agency, Cincinnati, Oh., [3]Tetra Tech, Inc., Owings Mills, Md., [4]CSC, Alexandria, Va.

Abstract
Mercury and persistent halogenated organic compounds occur in fish tissue in U.S. lakes, rivers, and streams. Mercury, PCBs, and DDT occurring in fish tissue are the leading cause of fish consumption advisories. In a continuing effort to characterize the extent of contamination in the Nation's waters, EPA's Office of Water and Office of Research and Development collaborated to conduct the first statistically based survey of persistent and bio-accumulative contaminants in fish from U.S. rivers. This national fish survey was conducted June through October in 2008 and 2009 within EPA's National Rivers and Streams Assessment (NRSA), a probability-based survey designed to assess the condition of the Nation's streams and rivers. Field teams applied consistent methods nationwide to collect samples of fish species of sizes consumed by humans at 541 randomly selected river locations (≥ 5th order) in the lower 48 states during June through October. They collected one composite fish sample consisting of five similarly sized adult fish of the same species at every sampling location. Largemouth and smallmouth bass were the primary species collected for the study, accounting for 34% and 24% of all fish composites, respectively. Homogenate samples were analyzed for Hg by AA and a suite of ~50 organo-halogen compounds including PCBs (21 congeners), PBDEs (8 congeners), Chlordane, and DDT compounds and degradation products, and other pesticides, (Aldrin, Dieldrin, Mirex, and Endosulfan) by GC-ECD. Samples were collected from both non-urban (379 sites) and urban locations (162 sites). All samples contained Mercury above the quantitation level, and study data indicate that PCBs, PBDEs, Chlordane, and DDT compounds occur at quantifiable levels in almost every fish sample collected for the study. Ongoing analysis of the data from this study will apply both human health and aquatic life thresholds to fish tissue concentrations of Mercury and these four organo-halogen contaminant groups from both urban and non-urban sites. In addition, we are examining the percentages of co-occurrence of Mercury and these four compound groups at concentrations above the respective contaminant group medians.

Mercury Monitoring and Assessment in the Ohio River

Jason Heath, Eben Hobbins and Jeff Thomas
Ohio River Valley Water Sanitation Commission, Cincinnati, Oh.

Abstract
Control of mercury in the Ohio River has become a highly controversial issue in the Ohio Valley. The Ohio River Valley Water Sanitation Commission (ORSANCO) is an interstate agency for water pollution control which sets water quality standards for the Ohio River. The discharge of mercury is regulated with a total mercury water quality criterion of 0.012 µg/L and a fish tissue methyl mercury criterion of 0.3 mg/Kg. In addition, elimination of mixing zones for bioaccumulative chemicals of concern (including mercury) is set to take effect in the near future which would require discharges to meet the 0.012 µg/L total mercury criterion end-of-pipe. In addition, the US EPA has dropped the 0.012 µg/L criterion from their national recommended criteria list. ORSANCO's criterion is listed as "not to be exceeded", while it was established to protect against undesirable bioaccumulation in fish tissue which occurs over a much longer timeframe.

Questions to be addressed in this paper, through monitoring efforts, include: Is the "not to be exceeded" total mercury criterion of 0.012 µg/L the correct criterion to protect against methyl mercury bioaccumulation in fish? How should methyl mercury fish tissue data and total mercury water quality data be used to determine if the Ohio River is impaired for mercury?

Results will be presented of a special one-year monitoring study to compare total mercury in the water column to methyl mercury in fish tissue. Evaluation of the total mercury water quality criterion based on the study will be presented. The commission collects a substantial amount of water samples for total mercury and fish tissue samples from multiple species for methyl mercury for its 305(b) assessment of the Ohio River. These data frequently give conflicting indications of impairment. The challenges and resolution associated with such conflicting data will be discussed in depth.

The Ohio River borders six states and three US EPA regions. The Commission itself is comprised of three Commissioners from each state appointed by the governor and three federal Commissioners appoint by the President. All technical work is coordinated through state/federal workgroups.

Session M5: Quantifying Agricultural Nonpoint Sources and Controls

3:30 – 5:00 pm | Room 233

A Regional Assessment of the Effects of Conservation Practices on In-Stream Water Quality

Ana Maria Garcia[1], Richard Alexander[2], Jeff Arnold[3], Dale Robertson[4], Mike White[3], David Saad[4] and Lee Norfleet[5]
[1]US Geological Survey, Raleigh, N.C., [2]US Geological Survey, Reston, Va., [3]Agricultural Research Service, Temple, Tex., [4]US Geological Survey, Middleton, Wis., [5]Natural Resources Conservation Service, Temple, Tex.

Abstract
The Conservation Effects Assessment Program (CEAP), initiated by USDA Natural Resources Conservation Service (NRCS), has the goal of quantifying the environmental benefits of agricultural conservation practices. As part of this effort, detailed farmer surveys were compiled to document the adoption of conservation practices. Survey data showed that up to 38 percent of cropland in the Upper Mississippi River basin is managed to reduce sediment, nutrient and pesticide loads from agricultural activities. The broader effects of these practices on downstream water quality are challenging to quantify. The USDA-NRCS recently reported results of a study that combined farmer surveys with process-based models to deduce the effect of conservation practices on sediment

and chemical loads in farm runoff and downstream waters. As a follow-up collaboration, USGS and USDA scientists conducted a semi-empirical assessment of the same suite of practices using the USGS SPARROW (SPAtially Referenced Regression On Watershed attributes) modeling framework. SPARROW is a hybrid statistical and mechanistic stream water quality model of annual conditions that has been used extensively in studies of nutrient sources and delivery. In this assessment, the USDA simulations of the effects of conservation practices on loads in farm runoff were used as an explanatory variable (*i.e.*, change in farm loads per unit area) in a component of an existing a SPARROW model of the Upper Midwest. The model was then re-calibrated and tested to determine whether the USDA estimate of conservation adoption intensity explained a statistically significant proportion of the spatial variability in stream nutrient loads in the Upper Mississippi River basin. The results showed that the suite of conservation practices that NRCS has catalogued as complete nutrient and sediment management are a statistically significant feature in the Midwestern landscape associated with phosphorous runoff and delivery to downstream waters. Estimates of the magnitude of this effect using SPARROW indicated that conservation practices have played a significant role in reducing nutrient pollution from agricultural activities to downstream receiving water bodies.

Monitoring Methods Used to Improve Agricultural Best Management Practices Evaluations at the Edge-of-Field Scale

Matt Komiskey[1], Cyndi Rachol[2], Todd Stuntebeck[1] and Dave Owens[1]
[1]US Geological Survey, Middleton, Wis., [2]US Geological Survey, Lansing, Mich.

Abstract
The Great Lakes Restoration Initiative (GLRI) is an interagency effort that seeks to accelerate ecosystem restoration in the Great Lakes by confronting threats to the region, such as nonpoint source pollution. Three Priority Watersheds having a high density of agricultural land use and clearly identified ecosystem impairments have been targeted: Fox River/Green Bay in Wisconsin, Saginaw River in Michigan, and Maumee River in Ohio. As part of GLRI, the U.S. Department of Agriculture Natural Resources Conservation Service, U.S. Environmental Protection Agency, and the U.S. Geological Survey (USGS) have partnered to conduct environmental research on privately owned farms applying agricultural conservation practices. Monitoring methods are modeled after previous USGS studies in which locations were targeted within study watersheds that were directly affected by conservation efforts. This method allows for a rapid assessment of water-quality changes due to conservation efforts and focuses on the major pathways for nonpoint source pollution to enter the stream.

The principal objective of this study is to develop an understanding of the effect of differing agriculture practices on the quantity and quality of runoff water from monitored farms, including edges of fields and subsurface drains, and the effect of this water on receiving streams and agricultural drains. To meet this objective, study tasks include: quantifying annual and event-by-event runoff volumes and losses of sediment, nutrients, and chloride; collecting meteorological data to help establish cause-and-effect relations between agricultural practices and water quantity and quality; and ensuring that the data are accurate and made available in USGS reports and databases.

This presentation will review the study design utilized and describe the unique settings in which edge-of-field and subsurface tile monitoring exist. In addition, the challenging conditions that exist for year-round monitoring in the Upper Midwest will be identified and approaches to overcome them will be suggested.

Neonicotinoid Insecticide Occurrence in Iowa Streams during the 2013 Growing Season

Michelle Hladik[1], Dana Kolpin[2] and Kathryn Kuivila[3]
[1]US Geological Survey, Sacramento, Calif., [2]US Geological Survey, Iowa City, Ia., [3]US Geological Survey, Portland, Oreg.

Abstract
Neonicotinoid insecticides are of environmental concern, especially because of potential adverse effects to pollinators, but little is known about their overall occurrence in surface water. Neonicotinoids are commonly used in both agricultural and urban settings. Most current research has focused on their fate near the point of application ("edge of field"). These compounds are water soluble (log Kow <1) and have aqueous half-lives on the order of months, so they have the potential for offsite transport. Iowa was chosen as the study location because of the high agricultural use of neonicotinoids for both seed treatment (corn and soybeans) and in aerial applications. Water samples were collected monthly from nine sites during the growing season from pre-plant to harvest (March to October, 2013) with additional storm-runoff samples collected when possible. All samples were analyzed for six neonicotinoids (acetamiprid, clothianidin, dinotefuran, imidacloprid, thiacloprid and thiamethoxam). Clothianidin (detected in 90% of the samples), thiamethoxam (67%), and imidacloprid (33%) were the most frequently detected compounds in the samples collected to date (March-August). During the 2013 planting season (May-June), clothianidin and thiamethoxam were both detected in nearly all samples (>97%) while imidacloprid was detected in 61% of samples. Detections and concentrations of all neonicotinoids decreased later in the growing season (July-October) most likely because of a combination of time since planting and applications, and also lack of rainfall. Additional samples were collected at a wastewater-impacted stream (above, at the outfall, and below a wastewater treatment plant) in central Iowa during winter low-flow conditions (streamflow approximately 99% effluent) and spring flow conditions (11% effluent). Results document generally conservative transport of clothianidin and imidacloprid over an 8 km reach. Concentrations during such winter conditions indicate that these compounds can persist long after initial application and are also present in wastewater effluent. Clothianidin concentrations were lower in the wastewater effluent than the corresponding upstream samples (predominantly agriculture), while imidacloprid concentrations were higher in the wastewater effluent than the corresponding upstream samples indicating a potential urban signature for imidacloprid.

The National Water Quality Initiative's Monitoring Framework

Erika Larsen[1,2] and Stuart Lehman[2]
[1]Oak Ridge Institute of Science and Education, Washington, D.C., [2]US Environmental Protection Agency, Washington, D.C.

Abstract
In 2012, the United States Department of Agriculture (USDA) launched a National Water Quality Initiative (NWQI). The Natural Resources Conservation Service (NRCS) is collaborating with the Environmental Protection Agency (EPA) and state water quality agencies to reduce nonpoint sources of nutrients, sediment, and pathogens related to agriculture in small priority watersheds in each state. These priority watersheds are selected by NRCS State Conservationists in consultation with state water quality agencies and NRCS State Technical Committees. NWQI provides a means to accelerate voluntary, private lands conservation investments to improve water quality and to focus water quality monitoring and assessment funds where they are most needed. USDA is designating approximately five percent of EQIP financial assistance to targeted agricultural conservation practice implementation in 165 HUC 12 NWQI watersheds. NRCS has dedicated funding for Edge-of-Field monitoring of conservation systems in approximately six NWQI watersheds. EPA is working with the state water quality agencies to track progress through instream water quality monitoring, that also helps support NRCS' future modeling efforts. State agencies are using Clean Water Act 319 or other funds

to conduct water quality monitoring in at least one priority watershed per state. The goal of NWQI instream monitoring in selected watersheds is to assess whether water quality conditions for nutrients, sediments, and/or pathogens (from livestock) have changed in NWQI watersheds and if so, whether it can be associated with agricultural conservation practices in the watershed. This initiative enhances partnerships at the local, state, and federal level to address nonpoint sources of pollution in priority watersheds across the US.

Session M6: Geospatial Tools for Data Integration

3:30 – 5:00 pm | Room 232

The National Hydrography Dataset: A Geospatial Tool for Data Integration

Jeff Simley and Steve Aichele
US Geological Survey, Denver, Colo.

Abstract
The National Hydrography Dataset (NHD) is a geospatial infrastructure for surface water adopted by many state and federal agencies dealing with water monitoring in the United States. The NHD is a comprehensive set of digital spatial data that represents the surface water using common features such as lakes, ponds, streams, rivers, canals, and ditches. It consists of 7.5-million miles of flow network and 6.5-million lakes. A companion dataset, the Watershed Boundary Dataset (WBD) defines a hierarchical set of drainage areas of the United States ranging from major river systems down to local streams. In analysis, the NHD and WBD are used by scientists study surface water using geographic information system technology. Scientists and resource managers can take advantage of a rich set of embedded attributes that can be processed to generate specialized information. Many of these analyses are possible because the NHD contains a flow direction network that traces the water downstream or upstream. The NHD also uses an addressing system to integrate specific information about the water such as water discharge, water quality, and fish population. Using the basic water features, flow network, linked information, and other characteristics, it is possible to study cause and effect relationships, such as how a source of poor water quality upstream might affect a fish population downstream. A key characteristic on the NHD is the ability to link all types of water quality monitoring data in a common geospatial infrastructure. Virtually all water data has a geographic component and can be mapped. Mapping this data to the NHD allows for the integration of all water data by the common element of geography, or more specifically by surface water geography. This makes the NHD/WBD an excellent integration platform.

Innovative Applications of the New National Hydrography Dataset Plus (NHDPlus Version 2) – A National Surfacewater Geofabric

Tommy Dewald[1] and Lucinda McKay[2]
[1]US Environmental Protection Agency, Washington, D.C., [2]Horizon Systems Corporation, Herndon, Va.

Abstract
The National Hydrography Dataset Plus is a suite of geospatial products that build upon and extend the capabilities of the NHD by integrating it with the National Elevation Dataset and the Watershed Boundary Dataset. Interest in estimating stream flow volume and velocity to support pollutant fate-and-transport modeling was the driver behind the joint U.S. Environmental Protection Agency and U.S. Geological Survey effort to develop NHDPlus. Conceptually, NHDPlus is a national surface water 'geofabric' that uses the NHD stream network to weave together the local drainage areas (catchments) for individual stream segments. This comprehensive connectivity enables users to associate any location on the landscape with the stream it flows into and any location downstream (or upstream). NHDPlus also includes a diverse set of stream attributes, such as stream order, and catchment attributes, such as temperature, precipitation and land cover. The availability of this geofabric has also spurred users to develop their own catchment attributes that can be shared with the larger water resources community. NHDPlus has been used in a wide variety of applications since its initial release in the fall of 2006.

This widespread positive response prompted the multi-agency NHDPlus team to develop an enhanced NHDPlus Version 2 that was completed in October 2012, culminating a 2-year national production effort that incorporated many improvements identified by users of NHDPlus Version 1. The latest NHD stream network and WBD hydrologic boundaries were integrated with a much-improved National Elevation Dataset to produce a more-capable NHDPlus that is supporting a new generation of applications. In addition, a more robust stream flow estimation process was applied to model improved mean annual and mean monthly flows for un-gaged streams. Learn about NHDPlus Version 2 concepts, improvements and selected applications, including sample and analysis frameworks for the EPA National Rivers and Streams Assessment and the National Lakes Assessment, georeferencing State water quality assessments and impairments to NHDPlus catchments, Healthy Watershed Initiative state pilot projects, and recent USGS regional SPARROW water quality modeling activities.

Georeferencing Water Quality Assessments to NHDPlus Catchments – A New Approach to Evaluating and Measuring Progress in Surface Water Quality

Wendy Reid[1], Dwane Young[1], Tommy Dewald[1], Tatyana DiMascio[2], Tim Blum[3] and Lucinda McKay[4]
[1]US Environmental Protection Agency, Washington, D.C., [2]Oak Ridge Institute for Science and Education (ORISE), Oak Ridge, Tenn., [3]INDUS Corporation, Vienna, Va., [4]Horizon Systems Corporation, White Stone, Va.

Abstract
The US EPA collects water quality assessment decisions and the associated geospatial information from states and compiles the data into a national database, the Assessment Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS), and the associated geospatial repository. States submit geospatial data using various resolutions and reference hydrography layers. Traditionally, EPA has manually converted the state geospatial files to a single reference layer, the medium resolution (1:100,000 scale) National Hydrography Dataset Plus (NHDPlus), which is a costly and time consuming process.

EPA explored alternatives for compiling and georeferencing water quality assessment data as part of an Integrated Reporting (IR) Georeferencing Pilot. After exploring several options, the pilot focused on georeferencing state data files to NHDPlus catchments using automated methods. Rather than migrating the state data to a specific scale of hydrography, the state can maintain their original resolutions while EPA applies the catchments as an overlay framework to state data. This new approach allows EPA to apply a consistent structure for analyses, including evaluating and measuring progress in improving surface water quality.

Re-envisioning the National Hydrography Dataset

Stephen Aichele[1] and Jeffrey Simley[2]
[1]US Geological Survey, Lansing, Mich., [2]US Geological Survey, Lakewood, Colo.

Abstract
The National Hydrography Dataset (NHD) has been a critical tool for integrating hydrologic information for two decades. Dozens of agencies have indexed millions of discharge, water quality, and biological observations to the NHD. However, over those decades technologies have changed, analysis techniques have changed, and most importantly the problems being addressed by water scientists and resource managers have changed. The US Geological

Survey National Geospatial Program is in the midst of redesigning the NHD to better meet your needs in the future. Central to this redesign is shifting the NHD from a mapping and inventory tool to a data analysis tool, incorporating or building linkages to other relevant datasets such as land cover; the National Wetland Inventory; meteorological and climate data; and other datasets. We welcome your input and suggestions.

Session M7: Making it Clear for the Public: Techniques in Data Communication, Part 2

3:30 – 5:00 pm | Room 231

Talk to Me: Generating Interest in Water Quality through Better Reporting

Sara Steiner
New Hampshire Dept. of Environmental Services, Concord, N.H.

Abstract
The New Hampshire Volunteer Lake Assessment Program (VLAP) has monitored lake water quality since 1985 through the use of trained volunteers. These citizen scientists collect data at approximately 175 lakes and 500 river/stream stations, generating over 13,000 data points annually. The NH Department of Environmental Services utilizes the data in federal 305(b)/303(d) reporting, TMDL development, Watershed Management Plans, and to provide an overall assessment of lake health. VLAP utilizes the data to generate annual and regional reports provided to participating lake groups summarizing lake health, water quality, and recommending actions to address potential pollution concerns. Through 2010, each participating group received a comprehensive annual report consisting of approximately 50 pages of various graphics, statistical analyses, data interpretation, observations and recommendations for future monitoring activities. Although comprehensive and informative, the message was not always reaching the audience. Working with a group of volunteer monitors, the reporting process was critiqued and new reports were developed. In 2012, comprehensive two-page reports were published for each lake providing water quality data, detailed graphics, trend analysis, observations and recommendations, plus detailed water body report cards, watershed and land use maps. Specific report sections are automatically generated and anticipated to shave weeks off of the old reporting process. These individual lake reports better inform lake associations, watershed residents, visitors, towns, conservation commissions, and even realtors about the overall health of the lake and efforts being made to maintain water quality. They are easily distributed, displayed and published on-line and are already sparking conversation, concern, interest and action to protect lake water quality.

Calculating Water Quality Indicator Scores for Ecosystem Health Report Cards

Caroline Wicks[1], Heath Kelsey[2], William Dennison[2], Christine Panko-Graff[3], Harald Jordahl[4] and Jonathan Higgins[5]
[1]University of Maryland, Annapolis, Md., [2]University of Maryland, Cambridge, Md., [3]Florida Dept. of Environmental Protection, Naples, Fla., [4]America's Watershed Initiative, Madison, Wis., [5]The Nature Conservancy, Chicago, Ill.

Abstract
Ecosystem health report cards can be a tool to communicate the status of and progress toward achieving water quality management objectives. They synthesize large amounts of information into public friendly communication products, which inform the general public, decision makers, and managers on current ecosystem health. Report cards use quantitatively robust data that link directly to management objectives. Management objectives are reflected in several aspects of the report card process, including indicator selection and the thresholds against which those indicators are scored, *e.g.*, do you want your river or stream to meet water quality criteria set through the Clean Water Act? Do you want the river to be swimmable (meet regulatory bacteria standards) and fishable (meet contaminant guidelines)? Two examples, from southwest Florida and the Mississippi River Basin, will be used to illustrate data analysis techniques for ecosystem health report cards. Both examples use straight forward and transparent data analysis methods so that stakeholders have a clear understanding of how report card scores are determined. Both examples also reflect the water quality management objectives of the agencies, partners, and stakeholders for their geographic location. In the Florida example (Rookery Bay National Estuarine Research Reserve), management objectives focus on maintaining good water quality to support healthy flora and fauna and mitigating the impacts of altered freshwater inflow on biota. For the Mississippi River Basin example (America's Watershed Initiative report card), management objectives focus on six goals, which address ecosystem health and water supply and quantity, but also goals related to flood risk, economics, recreation, and transportation.

Volunteer Stream Monitoring Data for Everyone: Making Information Publicly Accessible to the Community

Julie Powers
Mid-Michigan Environmental Action Council, East Lansing, Mich.

Abstract
The Mid-Michigan Environmental Action Council conducts benthic macroinvertebrate sampling in the Red Cedar River Watershed which is a sub-watershed of the Grand River Watershed, Michigan's longest river and second largest watershed. Publicly available data for local watersheds and waterways is generally presented in static tabulated formats where comprehension and retention is low. Translating this data into relevant and persuasive data requires the addition of a visual, geospatial dimension and community engagement strategy through an annual report, online mapping and stakeholder presentations to community leaders about the monitoring process in order to address the variance in learning styles (kinetic, visual, auditory).

Balancing innovation and traditional communications techniques, Mid-MEAC developed an interactive annual report, an online presentation of findings and a series of community workshops and educational materials about the Red Cedar Watershed as well as some relevant data for the Grand River. Building upon these efforts, MiCorps data was moved to the Google Fusion Table platform and made available to watershed residents as a Google Web Map. This facilitated comprehension of the geospatial relationships between monitoring sites and land use along with stream quality scores over time.

In October 2012, Mid-MEAC, along with a team of community leaders, was able to use this process to inform the charrette planning for regional economic development in order to ensure that the needs of the entire community and the adjoining watersheds.

Where Are Our Wetlands and How Are They Doing?

Jon Marshack[1] and Meredith Williams[2]
[1]California Water Quality Monitoring Council, Sacramento, Calif., [2]San Francisco Estuary Institute / Aquatic Science Center, Richmond, Calif.

Abstract
The California Water Quality Monitoring Council recently released a completely redesigned internet portal to connect decision makers and the public with water quality and ecosystem health information. The theme of this new portal is "Are Our Wetland Ecosystems Healthy?" The new portal is accessed from California's "My Water Quality" website (www.MyWaterQuality.ca.gov) under "Are Our Aquatic Ecosystems Healthy?" The new California Wetlands Portal includes interactive graphics, maps and monitoring data that focus on the location, extent and health of the state's wetland resources. A novel home page photo carousel provides insight into the many types of wetlands found in our state. The goal is to make this information as timely and user-

friendly as possible. Data presented in the portal are housed in another new web-based tool called EcoAtlas (www.ecoatlas.org). Targeted toward wetland practitioners, EcoAtlas provides an online resource for compiling maps and data about wetlands produced by numerous local, state and federal agencies and non-governmental organizations.

Formed in 2007 through cooperative agreement between California's environmental protection and natural resources agencies, the California Water Quality Monitoring Council brings together water quality and ecosystem health information from a variety of organizations with special expertise in wetland monitoring and assessment, coordinated through the California Wetland Monitoring Workgroup. This collaborative workgroup facilitates dialogue and coordination among twenty-three state, federal, and local agencies and non-governmental organizations that monitor and assess our state's wetlands. Their new portal provides a way to make the information collected as part of this monitoring investment more readily accessible so that it can inform policies and management decisions. Furthermore, it allows the general public to access information about local and statewide resources that were compiled by public agencies with public resources.

In 2009, the Monitoring Council released its first two internet portals, "Is it Safe to Swim in Our Waters?" and "Is it Safe to Eat Fish and Shellfish from Our Waters?" In 2010, the first California Wetlands Portal was added and in 2012 the Healthy Streams Portal was launched. Additional portals will highlight California's estuaries, ocean and coastal waters, and drinking water resources.

Poster Presentations

Addressing Emerging Contaminants and Threats to Human Health and Aquatic Ecosystems

Developing a Diatom Index for Indiana Rivers and Streams

Kristen Arnold
Indiana Dept. of Environmental Management, Indianapolis, Ind.

Abstract
In an effort to develop algal metrics for Indiana rivers and streams, the Indiana Department of Environmental Management (IDEM) is including diatom identification and enumeration as part of the Probabilistic Monitoring Program. Studies have shown that algal community metrics are a more precise indicator of nutrient enrichment compared to other response variables; thus, the goals of this additional work are to determine if periphyton diatom data will indicate a stronger correspondence with nutrients than fish or invertebrate metrics and to develop algal metrics which will be used to support nutrient criteria for Indiana's rivers and streams. Algal sampling is being conducted at the same sites from which aquatic macroinvertebrates, fish, habitat, chemical, and physical data are being collected as part of the Probabilistic Monitoring Program. This program is designed to assess all waters in the state on a nine year, rotating basin schedule. Sampling sites are generated by the United States Environmental Protection Agency (U.S. EPA), National Health Environmental Effects Research Laboratory (NHEERL), Western Ecology Division, in Corvallis, Oregon using Environmental Monitoring Assessment Program (EMAP) selection methods. The EMAP design uses a statistically valid number of randomly selected sites for assessing water quality of the target basin. To statistically estimate the percent of the basin attaining designated uses with a 95% confidence level, a minimum of 38 probabilistic sites are sampled in the basin of interest. Samples are collected from one of three different substrates: rocks, sticks, or sand/silt. Samples are digested under a fume hood using hydrogen peroxide and potassium dichromate and then permanently mounted onto microscope slides. Using a Nikon© Differential Interference Contrast (DIC) microscope with a Nikon DS-R1 shifting pixel imaging system, diatom valves are counted and identified to the lowest possible taxonomic level, which should be down to species and perhaps variety level. At least 600 valves (300 cells) are counted from each sample. To date, samples have been collected from five of the nine basins. Only the Ohio River Basin has been identified and enumerated.

Consideration of Monitoring Data in the Context of Human Health and Ecological Benchmarks for Pesticides

Mark Corbin, Nelson Thurman and Tracy Perry
1US Environmental Protection Agency, Washington, D.C.

Abstract
The United States Environmental Protection Agency's (USEPA) Office of Pesticide Programs (OPP) is responsible for the regulation of pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). As part of its responsibility, OPP assesses the risks of pesticides to both humans and non-target organisms. In order to increase the transparency of the pesticide risk assessment process and to provide stakeholders with better information to evaluate the condition of their waters, EPA has developed benchmarks for drinking water and aquatic life. These aquatic benchmarks enable states/tribes to prioritize future monitoring efforts and to evaluate whether pesticides detected in surface water and groundwater may pose a potential risk to humans and aquatic organisms.

EPA has developed 363 human health benchmarks that include both acute (one-day) and chronic (lifetime) exposures for the most sensitive populations exposed to pesticides that may be found in surface or ground water sources of drinking water. They also include benchmarks for 40 pesticides in drinking water that have the potential for cancer risk. The human benchmarks were developed using the Office of Water's (OW) methodology for derivation of health advisories (HA) as well as OPP's reference dose (RfD) and cancer slope factors (CSF) used in recent pesticide risk assessments. Human health benchmarks may be found at: http://iaspub.epa.gov/apex/pesticides/f?p=HHBP:HOME

EPA has also developed 326 benchmarks for aquatic taxa. An aquatic life benchmark is extracted from the most recent publicly available risk assessment for an individual pesticide and is based on the most sensitive aquatic toxicity data for each freshwater taxon (*i.e.*, freshwater fish, invertebrates). Each aquatic life benchmark is based on the most sensitive, scientifically acceptable toxicity endpoint for a given taxon, based on all scientifically acceptable toxicity data available to EPA. Aquatic life benchmarks may be found at: http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm

Stakeholders use both human health and aquatic life benchmarks for a variety of purposes, with the principal purpose of comparing these benchmarks to monitoring data. Comparing a measured concentration of a pesticide in water with an aquatic life benchmark can be helpful in interpreting monitoring data and in identifying and prioritizing sites and pesticides that may require further investigation.

Distinct Differences in Precipitation Mercury Concentrations between Urban and Rural Measurements

David Gay[1], Eric Prestbo[2] and Brian Kerchner[1]
[1]University of Illinois, Urbana Champaign, Ill., [2]Tekran Research and Development, Seattle, Wash.

Abstract
Mercury (Hg) is widely recognized as a toxic pollutant of global importance, with impacts on health for both humans and wildlife. Through the use of network data from the Mercury Deposition Network, we compared 15 urban and rural site pairs for differences in Hg concentration and wet deposition fluxes in precipitation. We postulated that urban environments have multiple small point and area sources resulting in higher local Hg emissions and thus higher deposition rates. Given the near proximity of these urban/rural pairs, precipitation is generally equal, allowing for a more direct comparison of wet deposition.

Data from the MDN for years 1996 through 2011 were used to compare precipitation concentration and deposition at 15 urban and rural locations typically within 100 miles of each other. For pairwise, week-to-week concentration and deposition comparisons, 2052 weeks were available for analysis. Several significant results were found including (1) urban sites have higher concentrations of Hg in precipitation than the corresponding rural site at 95% certainty, (2) that approximately two thirds of the time (with equal precipitation) an urban site has both higher Hg concentrations and higher deposition of Hg than a surrounding rural site, and (3) that the difference is typically about 1 and 2 ng/L across all U.S. sites (10 to 20%). Reasons for these differences will be discussed, including higher Hg emissions at urban locations. However, higher emissions are not always the case. Some observations suggest that urban photochemistry may be playing an important role in higher urban deposition. These results will have important policy ramifications for urban areas and mercury policy in general.

The National Atmospheric Deposition Program: Lessons from a Continental-scale Monitoring Network

David Gay
University of Illinois, Urbana Champaign, Ill.

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 more importantly, it monitors the addition of chemical compounds into the Biosphere and ecosystems of North America, and now with sites in Taiwan and in South America. Our primary charge has been to provide data for the determination of both spatial and temporal trends in chemical species and mercury wet-deposition fluxes for North America. And over the 35 years of monitoring, we have shown the value of consistent monitoring techniques, high quality assurance standards, and rigorous attention to procedures and data validation. This has allowed us to reliably quantify both small and large trends in several chemical species.

It is clear that the addition of acidic compounds to ecosystems has dropped drastically over the past three decades, but that certain regions are still experiencing high acidic compound loading. Our data also show that nitrogen deposition is increasing, and in particular to very sensitive ecosystems. Additionally, we are noting the heavy regional increases in nitrogen deposition are due to ammonium increases. Finally, we can now show the approximate distribution of mercury input to ecosystems over North America and slight but quantifiable trends in this deposition. While mercury deposition is not important to human health while in the atmosphere, it is of extreme importance to human health as it moves through ecosystems.

For this poster, we will explain the networks that make up the NADP, provide specifics of each network, and provide a few lessons learned for making networks operate and making data useful for scientists and policy makers.

Quality of Water in Public Supply Wells Located in the Southeastern Coastal Plain and Coastal Lowlands Aquifer Systems, Southeastern United States, 2013

Jeannie Barlow[1] and Bruce Lindsey[2]
[1]US Geological Survey, Jackson, Miss., [2]US Geological Survey, New Cumberland, Pa.

Abstract
Groundwater provides over one-third of the water used for public supply in the Unites States and nearly half of the water used for public water supply in the southeastern United States. In 2002, the U.S. Geological Survey's National Water Quality Assessment Program identified a network of 62 Principal Aquifer Systems and in 2013, began the Principal Aquifer Study program in an effort to provide nationally consistent water-quality data from principal aquifer systems that account for the majority of withdrawals for public supply throughout the United States. Two of these principal aquifers, the Southeastern Coastal Plain and Coastal Lowlands aquifer systems, were selected for sampling in 2013. These aquifer systems are located in the southeastern part of the country, and each consists of unconsolidated to semiconsolidated sand, silt, and clay deposits that thicken and dip coastward. The Southeastern Coastal Plain aquifer system covers approximately 90,000 sq miles and includes parts of 6 states, while the Coastal Lowlands aquifer system covers approximately 98,000 sq miles and includes parts of 5 states. Water-quality samples were collected from 80 wells in the Southeastern Coastal Plain aquifer system and 60 wells in the Coastal Lowlands aquifer system. Wells were selected using an equal area grid approach to assure a spatially unbiased sampling distribution. Water samples were analyzed for a comprehensive list of constituents, including field measurements, major inorganic constituents, nutrients, trace elements, pesticides, volatile organic compounds, pharmaceuticals, hormones, radionuclides, microbial indicators, and age dating constituents. These data will be used for regional and national assessments of the quality of groundwater used for public supply.

Ecoregion and Land Use Influence Microcystin Concentrations in Planktonic and Littoral Regions of Lakes and Reservoirs

Erin E. Manis[1], John R. Beaver[1], Keith A. Loftin[2], Jennifer L. Graham[2], Dana M. Oleskiewicz[3] and Robert D. Davic[4]
[1]BSA Environmental Services, Beachwood, Oh., [2]US Geological Survey, Lawrence, Kans., [3]Ohio Lake Management Society, Chagrin Falls, Oh., [4]Ohio State University, Columbus, Oh.

Abstract
The 2007 USEPA National Lakes Assessment sampled 1,156 water bodies from May to October and analyzed samples for total microcystin, total nitrogen, dissolved organic carbon, and temperature. A statistical relationship between microcystin concentration and agricultural land uses was found in the planktonic and littoral regions of lakes and reservoirs. Of the samples with microcystin concentrations ≥ 1.0 µg L^{-1} (n=126), 66% were distributed in three nutrient and water quality-based ecoregions dominated by agriculture (Corn Belt and Northern Great Plains, Mostly Glaciated Dairy Region, South Central Cultivated Great Plains). Canonical correlation analysis demonstrated a strong positive relationship with agricultural land use and microcystin concentration and specifically indicated that both microcystin concentration and cyanobacteria abundance were positively correlated with total nitrogen, dissolved organic carbon, and temperature. In order to assess potential cyanotoxin exposure in recreational areas, the relationship between ecoregion, land use, and microcystin concentration was further investigated using data collected from more than 1,300 sampling events from littoral regions of 145 lakes and reservoirs in the Midwestern United States. This study supports a number of regional lake studies that suggest that land use practices are related to cyanobacteria abundance, and extends the potential impacts of agricultural land use in watersheds to include the production of cyanotoxins in lakes.

A Drinking Water Standard for Cr-6?: What to Expect for Illinois

Patrick Mills[1], Richard Cobb[2] and Alan Fuhrmann[2]
[1]US Geological Survey, Urbana, Ill., [2]Illinois Environmental Protection Agency, Springfield, Ill.

Abstract
With the U.S. Environmental Protection Agency's recent review of the human health effects of hexavalent chromium (Cr-6) in public drinking water, the need for a specific regulation is being considered. Presently, only total chromium is regulated, at a Maximum Contaminant Level (MCL) of 100 micrograms per liter (µg/L). The presence of Cr-6 in groundwater and surface waters generally is attributed to industrial sources, but can be of natural origin. Water chemistry, principally oxygenation, enhances the transformation from non-toxic trivalent chromium (Cr-3) to more toxic Cr-6, which has implications regarding changes in concentration during treatment and distribution. The recently proposed standard for Cr-6 in California (10 µg/L) and that being considered in New Jersey (about 0.07 µg/L) suggest a possible federal drinking water standard in this range. To better understand the extent of the impact of a lowered, specific Cr-6 standard on management of Illinois' public drinking water, the U.S. Geological Survey, in cooperation with the Illinois Environmental Protection Agency, is undertaking an assessment of Cr-6 and total Cr in the State's public-water supplies.

During 2013, untreated water samples were collected at public-supply facilities from 119 groundwater wells and 32 surface-water intakes; also, 32 treated surface-water samples were collected near point of treatment, and 32 near

furthest point of distribution. Sample sites were selected by a stratified-random method. Samples were analyzed within 24 hours of collection at a reporting limit of 0.02 µg/L. The occurrence of Cr-6 will be evaluated along with selected physical and quality-assurance factors that might better explain its distribution and magnitude of concentrations.

Through August 2013, results were available from about two-thirds of the samples. Maximum concentrations in untreated and treated water were 2.1 and 2.4 µg/L, respectively. Cr-6 was undetected in 42 percent of untreated groundwater samples, with a mean of 0.21 and median of 0.04 µg/L, where detected. Essentially all treated and untreated surface-water samples had detections. In untreated water, mean and median concentrations were 0.08 and 0.07 µg/L, respectively, whereas in treated water they were 0.81 and 0.25 µg/L. Surface waters treated with lime typically had the highest concentrations (mean, 1.13; median, 1.15 µg/L).

Fish Consumption and Contaminants in Fish from the Los Angeles and San Gabriel Rivers Watersheds

Karin Patrick[1], Kristy Morris[2], Scott Johnson[1], Phil Markle[3] and Gerald McGown[4]
[1]Aquatic Bioassay & Consulting Laboratories, Inc., Ventura, Calif., [2]Council for Watershed Health, Los Angeles, Calif., [3]Los Angeles County Sanitation District, Whittier, Calif., [4]City of Los Angeles, Playa del Rey, Calif.

Abstract
The highly urbanized Los Angeles and San Gabriel River watersheds provide a wide range of beneficial uses to a population of over five million people. However, prior to 2007, little was known regarding the safety of consuming recreational sport fish from local rivers, streams and lakes. Sampling contaminants in fish tissues from urban lakes and streams was begun by the Stakeholders of the San Gabriel River Watershed Monitoring Program (SGRRMP) and Los Angeles River Watershed Monitoring Program (LARWMP) in 2006 and 2009, respectively. These programs were designed to answer the question, 'Is it safe to eat fish?'

Fish consumption safety was assessed by measuring tissue concentrations of mercury, selenium, DDT and PCB from composites of fish collected at popular angling sites. Consistent with findings statewide, mercury concentrations in largemouth bass consistently exceeded the Office of Environmental Health Hazard Assessment (OEHHA) no consumption threshold in numerous lakes throughout the Los Angeles and San Gabriel River watersheds. The concentrations of PCBs were elevated in fish from the estuaries and in some lakes, and DDT concentrations were low in all fish. Anglers were surveyed between 2010 and 2012 at popular fishing locations in the watersheds to understand their catch and consumption habits. The results of these surveys indicate that while consumption levels of the most heavily contaminated fish are relatively low and overall fish consumption in these lakes were lower compared to pier anglers, the potential exists that some anglers may be consuming contaminated fish with limited knowledge of the health risks.

Assessment of Perfluorinated Compounds (PFCs) in Fish from U.S. Rivers and the Great Lakes

Leanne Stahl[1], John Wathen[1], Blaine Snyder[2] and Harry McCarty[3]
[1]US Environmental Protection Agency, Washington, D.C., [2]Tetra Tech, Inc., Owings Mills, Md., 3CSC, Alexandria, Va.

Abstract
The chemical structure of PFCs gives them unique properties, such as thermal stability and the ability to repel both water and oil, which make them useful components in a wide variety of consumer and industrial products. Their high production volume led to widespread distribution in the environment, particularly in water where they are most readily transported. PFCs have emerged as contaminants of concern because they are broadly distributed, persistent in the environment, and linked to potential health effects. Recent modeling studies estimate that PFC contamination in food may account for most human exposure to perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA), with results from other studies suggesting that fish from contaminated waters may be the primary source of exposure to PFOS. EPA's Office of Science and Technology (OST) within the Office of Water identified the need for a comprehensive characterization of PFC contamination in U.S. fish. OST conducted a national-scale study of urban rivers and a regional-scale study of the Great Lakes to evaluate the extent of PFC contamination in freshwater fish. Both studies were conducted under the framework of EPA's National Rivers and Streams Assessment and EPA's National Coastal Condition Assessment in the Great Lakes. Fish were collected for PFC analysis from 162 randomly selected urban river locations throughout the lower 48 states (2008 and 2009) and from 157 randomly selected nearshore locations in the five Great Lakes (2010). Fish fillet composites were analyzed for 13 PFCs including PFOA and PFOS. Six PFCs dominated frequency of occurrence in the fillet samples from both studies. PFOA had a low frequency of occurrence (detected in <12% of all samples); however, PFOS was present in 73% and 100% of fish samples collected for the urban river and Great Lakes studies, respectively. Probability-based results indicated that the median concentration of PFOS is 10.7 ppb in fish from U.S. urban rivers and 15.2 ppb in fish from the Great Lakes. The maximum PFOS concentration measured in fillet tissue was 127 ppb in urban rivers and 80 ppb in the Great Lakes.

EPA's Assessment of Contaminants in Fish from U.S. Rivers

Leanne Stahl[1], John Wathen[1], Blaine Snyder[2] and Harry McCarty[3]
[1]US Environmental Protection Agency, Washington, D.C., [2]Tetra Tech, Inc., Owings Mills, Md., [3]CSC, Alexandria, Va.

Abstract
EPA's Office of Water and Office of Research and Development are collaborating to conduct a national study of fish tissue contamination in U.S. rivers. This study provides data for human health applications related to fish consumption, adding to the core ecological assessments EPA is conducting under the statistically designed National Rivers and Streams Assessment (NRSA). Results from the 2008-2009 NRSA fish tissue indicator generated a national baseline for fish contamination data including mercury, PCBs, and contaminants of emerging concern (*i.e.*, perfluorinated compounds and polybrominated diphenyl ethers) in rivers. EPA's inclusion of fish tissue analysis in the 2013-2014 NRSA will provide the first probability-based national fish contamination trends data for U.S. rivers. Sampling in 2013-2014 will involve the collection of fish tissue at a statistically representative subset of over 400 river locations (5th order or greater) assessed during the 2008-2009 NRSA. This subset provides sufficient sample size to develop national estimates of toxic chemical concentrations in fish with acceptable confidence intervals. Assessment of contaminants in river fish for this human health component involves collecting one fish composite sample from each of the river sites consisting of five similarly sized adult fish of the same species that are commonly consumed by humans. Fillet tissue from each 2013-2014 composite sample will be analyzed for mercury and 13 perfluorinated compounds (PFCs) including perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). Samples will also be archived for potential future analysis of polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs). Sample collection is proceeding in 2013 and 2014, fish tissue analysis and data quality review will be completed in 2015, and EPA anticipates having results available to report in 2016.

An Investigation of Mercury Concentration Trends in Fish Tissue in the Ohio River

Rob Tewes and Jeff Thomas
Ohio River Valley Water Sanitation Commission, Cincinnati, Oh.

Abstract
The Ohio River Valley Water Sanitation Commission (ORSANCO) is a multi-state pollution control agency formed in 1948 and charged primarily with pollution abatement in the basin, criteria and standard development and issuance, and environmental and biological monitoring. ORSANCO has been collecting fish tissue contaminant data from the Ohio River since the 1980s. The 6 main stem states (PA, OH, WV, KY, IN, IL) have been using these data to issue risk-based fish consumption advisories since the 1990's.

A comprehensive analysis of mercury trends in fish tissue is warranted at this time as recent air emission regulations could ultimately be responsible for directing more mercury into waterways. Additionally, mixing zones for bioaccumulating contaminants of concern, like mercury, are in the process of being eliminated on the Ohio River, potentially affecting permit renewals for many Ohio River dischargers. In addition to fish tissue contaminant data ORSANCO has gathered over the last three decades, we have also compiled contaminant data from other agencies (FDA, USGS) from as early as 1972. We conducted a data quality review to qualify all data to be used in comparisons and trend analyses. All data used in this investigation were derived from fillets only (not whole fish), multiple fish composites (unless otherwise noted), taken from fish of average size (within angling regulations unless otherwise noted) and multiple trophic levels, and analyzed using comparable methods with accompanying QAQC documentation.

Data that fell within qualification parameters were analyzed spatially and temporally by species, taxonomic family, trophic level and size range. We chose to compare mercury concentrations in individual species by river segment and by year to determine if concentrations were increasing or decreasing in any particular species in any river segment over time. Additionally we did a more gross analysis based on trophic level by river segment per year. We were able to determine the frequency and specificity of violations (>0.3 mg/kg) and denote differences in concentrations across species by river segment.

Advancing Innovation in Monitoring: Technology, Assessment, Modeling, and Methods

Application of Polyethyelne Devices (PEDs) for Monitoring PCBs at a Freshwater Sediment Remediation Site

Mark Benotti[1], Lisa Lefkovitz[1] and Marc Mills[2]
[1]Battelle, Duxbury, Mass., [2]US Environmental Protection Agency, Cincinnati, Oh.

Abstract
The use of passive samplers to assess the presence and distribution of hydrophobic organic contaminants (HOCs) in aquatic environments has increased markedly of late. While a number of different types of materials may be used as passive samples, low density polyethylene, or polyethylene devices (PEDs) have proven to be useful and cost effective tool for such applications. This presentation will describe the use of PEDs in an ongoing, multi-year, baseline study characterizing the distribution of PCBs in a riverine system and discuss different uses of the data that has been generated. Broadly speaking, utility and relevance of using PEDs a) to characterize distributions of HOCs, b) to determine integrated site water concentrations, and c) for source attribution studies will be discussed. PEDs were deployed in both the water column and in piezometers to characterize surface and pore water PCB concentrations. Waterborne concentrations can be calculated based on the loss of PRCs (performance reference compounds) during deployment. Alternative methods of determining water concentrations from the PEDs will be explored. Results from PEDs deployed in the water column will be compared to actual water concentrations measured in grab samples, and PEDs in the piezometers will be compared to groundwater concentrations measured in adjacent upland wells.

Using a Water Quality Monitor to Predict Recreational Water Quality in Near Real-Time in the Cuyahoga River, Cuyahoga Valley National Park

Amie Brady[1] and Meg Plona[2]
[1]US Geological Survey, Columbus, Oh., [2]National Park Service, Brecksville, Oh.

Abstract
Cuyahoga Valley National Park (CVNP) encompasses 33,000 acres along the Cuyahoga River between Cleveland and Akron, Ohio. Over 2.8 million people visit CVNP annually to enjoy the Park's historical, cultural, natural, and recreational activities all in one setting. Because of elevated concentrations of *Escherichia coli* (*E. coli*), a fecal-indicator bacterium, the Cuyahoga River within the Park does not often meet the state's water quality standard for primary contact recreational use. Sections of the river, including the 22 miles that flow through the Park, have been designated by the U.S. Environmental Protection Agency as one of the Great Lakes Areas of Concern due to beneficial-use impairments, including impairments caused by bacterial contamination.

Since 2004 the U.S. Geological Survey and the National Park Service have collaborated to develop a method to provide more timely results to park visitors regarding the condition of the recreational water quality (RWQ) of the river. In previous research, a predictive model, using turbidity measured in the lab for samples collected in the field, accurately predicted RWQ at one site on the river for over 80 percent of the samples collected. The traditional method of using the previous day's bacteria concentration to predict the current day's RWQ consistently was not as accurate as the predictive model. An in-stream turbidity sensor (with telemetry), installed in May 2012, permits the model to be run with minimal demand on staff time for field data collection. Daily model predictions are posted to a publicly-accessible Web site that provides Park visitors with information to assess recreational water-quality risks. Results from 2013 will presented.

Efficient Strategies for Sampling Edge-of-Field Runoff

Dave Braun
Stone Environmental, Montpelier, Vt.

Abstract
In 2012, the Vermont Agency of Agriculture, Food, and Markets (VAAFM), in cooperation with USDA-NRCS, initiated an edge-of-field monitoring study to evaluate several innovative agricultural conservation practices being promoted in the Lake Champlain Basin. A paired watershed study design is being used to test the effects of four conservation practices on event discharge and nutrient concentration and export in surface runoff from study fields. The study design and procedures are consistent with the NRCS monitoring practice standard (Code 799) in force at the time the study began. Six Lake Champlain Basin farms are participating. Practices being evaluated include: soil aeration on hayland, cover cropping on silage corn, reduced tillage and manure injection on cornland, and a water and sediment control basin treating runoff from a cornfield.

The monitoring program relies on commercially available flumes, flow meters, modems, autosamplers, and electronic rain gauges to collect representative runoff samples and provide accurate flow and precipitation data. Event composite samples are collected in proportion to runoff flow rate. Developing a monitoring system capable of producing representative samples from runoff events of greatly varying magnitude was a primary objective. A second objective was to simplify sampling procedures sufficiently to enable individuals with limited training to process samples and reset the stations after runoff events.

Several innovations were made in the installation and programming of the monitoring instruments to meet these objectives and they have proven reliable and cost effective. Using two-part sampling programs, a custom autosampler bottle manifold, and 10-L sample carboys, runoff events differing in magnitude by a factor of 400 can be representatively sampled. The sampler program settings can be adjusted (via remote command) to account for changes in field conditions and weather; however, this is rarely necessary given the inherent flexibility of the system. Flow and autosampler data are pushed to a remote server in near real time, eliminating the need to download instruments. Flow data from all 14 monitoring stations can be viewed quickly using a Web UI; this allows sampling personnel to better time field visits, avoiding premature and unnecessary visits.

The Use of Web-based and Digital Tools for Developing and Supporting Citizen Monitoring Programs Conducting Bioassessments in California

Erickson Burres
SWRCB-Clean Water Team, Los Angeles, Calif.

Abstract
Improving and protecting water quality for aquatic life depends on a solid framework for monitoring to protect and restore this beneficial uses. The task is not a simple one, especially consider a state as big and diverse as California is and its dwindling budgets. To fulfill stewardship missions, we have to find innovative ways to become more efficient, productive and expand our programs at a lower cost. Promoting and supporting citizen monitoring (citizen science + volunteer monitoring) with the use of wed-based and digital tools can be a huge asset.

Citizen monitors have great passion for the aquatic resources around them, including biodiversity. The state's citizen monitoring program, the Clean Water Team, has successfully supported bio-monitoring since 1999. A recent survey has demonstrated that 40% of the citizen monitoring groups in California are/ have conducted bioassessments. The bioassessment and physical habitat data these efforts have provided has been used by state agencies. Some local agencies have even used citizen monitoring programs to implement portions of their regulatory permits.

The use of internet based resources has been instrumental to the success of the Clean Water Team in helping volunteer monitors reach their goals. To meet the demand for supporting, educating and training volunteer staffed programs the Clean Water Team and its partners have been using and developing various web-based and digital tools (guidance documents, SOPs, QAPP advisor, virtual instruction modules, educational and training videos, digital reference collections, apps …). These new and emerging technologies offer ways to provide better services to citizen monitors so that aquatic biodiversity can be improved and protected. The program's efforts have supported the acquisition of usable data of known quality, expansion of agency databases, the continuation of government-NGO partnerships, and provided increased value to citizen monitoring efforts in California's watersheds.

Comparison of Volunteer and Automated Water Quality Data Suggesting Procedural Improvements

Jeffrey Campbell[1,2]
[1]Environmental Informatics, Columbia, Md., [2]Jug Bay Wetlands Sanctuary, Lothian, Md.

Abstract
The analysis recommends procedural improvements based on comparison of volunteer water quality data with an adjacent automated data logger. Parameters include dissolved oxygen (DO), water temperature, pH, and salinity. Air temperature was also available from a weather data logger. Based upon the time of each volunteer observation, a linear interpolation of the data logger's prior and next observation value was computed for each parameter. Almost 150 volunteer observations were matched to the data logger since it was installed in 2003. Manual sampling had begun at this tidal fresh water site on the Patuxent River in 1985.

Volunteer and automated water temperature observations were very close. Limitations in the sensitivity of volunteer pH and salinity equipment were apparent in the comparison. There were greater differences between volunteer and data logger values in air temperature than water temperature. The differences in DO values were further analyzed over time, by season, by volunteer, by equipment and various other factors.

Procedural recommendations include entering data stored in the meter used by the volunteers for comparison to data entered from the manual data sheets, improvements to some aspects of the sampling procedures manual, and greater attention to reducing "outliers." The plan had been to discontinue manual sampling adjacent to the data logger, but the analysis here shows that such sampling should be continued to compare individual volunteer results to the data logger to identify training needs or potential problems with the data logger.

MiniSipper: A New, High-Capacity, Long-Duration, Automated In situ *Water Sampler for Aquatic Monitoring*

Thomas Chapin
US Geological Survey, Denver, Colo.

Abstract
Most environmental water quality monitoring studies rely on hand-collected "grab" samples. However, grab sampling is expensive with significant costs for personnel, equipment, vehicles and travel. Field costs can be especially high if the sampling site is remote, dangerous to access, or snowbound for many months of the year. Grab sampling typically provides a few samples per year and rarely captures the details of transient hydrologic processes such as storm, flood, or seasonal runoff events. Automated samplers can be used to monitor transient events but these instruments are typically large, heavy, collect 24 samples, and are not well suited for operation in freezing conditions.

The USGS has developed a small, low-cost, high-capacity, *in situ* water sampler to overcome the limitations of current automated water samplers. The MiniSipper injects 2 to 10 mL discrete or integrated water samples into a 500' Telfon sample coil. Individual water samples are stabilized with HNO_3 and separated with a gas bubble. Over 250 five mL water samples can be collected with < 5% carryover. The MiniSipper collects samples *in situ* for up to 12 months unattended and even operates under ice for over-winter sampling. After recovery, samples are pumped out of the sample coil and analyzed by ICP-MS which only requires a few mL of sample.

The long-duration and high-resolution sampling capability of the MiniSipper provides a detailed record of hydrologic and geochemical processes that are almost impossible to observe with currently available sampling methods. This presentation will give an overview of the MiniSipper instrumentation and discuss applications for: 1) year-round, high-resolution surface and underground acid mine drainage monitoring; 2) post-wildfire runoff monitoring; and 3) year-round ground water monitoring of a 2" borehole. The MiniSipper has primarily been used for metal analysis but this technology is very flexible and should be applicable to other analytes of interest such as organics, pesticides, nutrients, etc. Applications currently under development include the Storm Response MiniSipper which changes sampling rate in response to storm events, and the Disaster MiniSipper, an armored instrument designed to sample in dangerous conditions such as flash floods, major river floods, and hurricanes.

STIC: A New Instrument for Rugged, Low-cost, Long-duration Stream Temperature, Intermittency and Conductivity Monitoring

Thomas Chapin and Andrew Todd
US Geological Survey, Denver, Colo.

Abstract
The Rio Grande cutthroat trout is the southern-most subspecies of cutthroat trout in the Western U.S. and was recently added to the Endangered Species Act Candidate List. Small streams comprise much of the Rio Grande cutthroat habitat and water temperature and stream flow intermittency are critical parameters for aquatic ecosystem health in these watersheds. During summer and fall, high water temperatures and low or intermittent stream flow can create very stressful conditions for trout and entire stream populations of Rio Grande cutthroat trout have died during severe drought.

Low-cost monitoring of stream temperature and stream intermittency in remote areas has become a priority for the U.S. Fish and Wildlife Service. Low-cost temperature loggers have made continuous temperature monitoring relatively simple but monitoring stream intermittency is much more difficult. High-resolution temperature data can be used to infer stream intermittency but this approach has had limited success since it requires significant data interpretation to distinguish between wet and dry periods. Electrical resistance (ER) sensors have recently been developed and provide an unambiguous 'wet' or 'dry' response which overcomes the major limitations of temperature based methods.

This paper introduces the STIC (Stream Temperature, Intermittency, and Conductivity) logger, a small, rugged, low-cost, sensor package. STICs are made by simple modifications to an off-the-shelf, waterproof data logger and provide: 1) unambiguous detection of wet/dry events; 2) high-resolution temperature readings; and 3) high-resolution semi-quantitative water conductivity readings. STICs operate for over 12 months unattended with 20 minute sampling resolution and can handle freezing conditions and burial by debris flows. Field data from long-duration, high-resolution monitoring of streamflow intermittency, temperature, and conductivity during over-winter freezes, spring runoff, and summer drying conditions demonstrates the utility and capability of the low-cost STIC instruments.

Development and Validation of a Colorimetric Microtiter Plate Based Receptor-Binding Assays for the Determination of Fresh Water and Marine Toxins Using the Nicotinic Cholinergic Receptor

Fernando Rubio[1], Lisa Kamp[1], Justin Carpino[1], Thomas Glaze[1], Erin Faltin[1], Keith Loftin[1,2], Jordi Molgo[3] and Romulo Araoz[3]
[1]Abraxis LLC, Warminster, Pa., [2]US Geological Survey, Lawrence, Kans., [3]CNRS, Institut de Neurobiologie Alfred Fessard, Gif sur Ivette, France

Abstract
Anatoxin-a, is an alkaloid neurotoxin produced by some species of cyanobacteria (blue-green algae). It is one of the most toxic of the cyanobacterial toxins found in the environment. In some lakes and rivers, several members of different cyanobacterial genera produce anatoxin-a and homoanatoxin-a, potent agonists of nicotinic acetylcholine receptors (nAChRs). The massive proliferation of benthic cyanobacteria producing anatoxin-a and/or homoanatoxin-a has been associated with the death of wild and domestic animals, indicating a need for monitoring in order to reduce potential threats to Public Health. In marine environments, toxins that act on nAChRs include spirolides, pinnatoxins and gymnodines. These toxins can be accumulated by shellfish and present an emerging public health risk.

Currently, the detection of freshwater and marine toxins targeting nAChRs is mainly based on mass spectrometry or the mouse bioassay. Many countries have banned the mouse bioassay and analysts have been forced to use liquid chromatography coupled to mass spectrometry to monitor toxins. We are presenting the development and validation of a microtiter plate receptor-binding assay based on the affinity of toxins for nAChRs. When present in a sample anatoxin-a or pinnatoxins/spirolides/gymnodines will compete with biotinylated alpha-bungarotoxin for the acetylcholine binding sites of nAChRs obtained from purified Torpedo electrocyte membranes, which are coated on the microtiter plate. After a washing step, streptavidin-HRP solution is added to allow for the colorimetric detection of the biotinylated alpha-bungarotoxin bound to the receptor. After a second washing step, substrate solution is added and a color signal is produced. The intensity of the blue color is inversely proportional to the concentration of the target toxins present in the sample. The color reaction is stopped after a specified time and the color (yellow) is evaluated at 450 nm using a microplate photometer. The concentrations of the samples are determined by interpolation using the standard curve constructed with each run. Stability of the reagents, cross-reactivity, assay sensitivity, recovery and precision will be presented.

Development of New Analytical Methods at the National Water Quality Laboratory to Meet the Needs of National and State Programs

Jeff McCoy and John Zogorski
US Geological Survey, Denver, Colo.

Abstract
The National Water Quality Laboratory (NWQL) was established by the U.S. Geological Survey (USGS) to provide chemical measurement results of high quality and consistency, and to conduct method development research for future needs. To that end, the NWQL's Method Research and Development Program (MRDP) provides in-house, modern method development capabilities. USGS national-level programs, including the National Water Quality Assessment (NAWQA) Program and the Toxic Substances Hydrology Program (Toxics) have long been major users of the capabilities of the NWQL, often in collaboration with USGS state Water Science Centers.

In the fall of 2010, program leadership from NAWQA and Toxics met with the NWQL science leadership to set priorities for methods research, resulting in an MRDP Five-Year Research Plan. The thrust of the plan was to meet the needs of the NAWQA Program as it entered its third decadal cycle at the beginning of FY2013 and to incorporate the needs of the Toxics Program as it embarked on its Chemical Mixtures Study. For NAWQA, the Five-Year Plan included as top priorities the development of a direct aqueous injection (DAI) method for analysis of pesticides in water by liquid chromatography with tandem mass spectrometry (LC/MS/MS), an additional DAI LC/MS/MS method for analysis of pharmaceuticals in water, and updates to the NWQL's volatile organic compounds methods to incorporate new analytes and streamline the purge and trap/gas chromatography/mass spectrometry methods.

The Toxics Chemical Mixtures Study emphases the development of advanced trace organic forensic analysis capabilities that can be applied to complex environmental matrices. This required a reassessment of existing in-house methodology for tentatively identified compounds (TICs) and the addition of accurate mass resolution MS capabilities.

This presentation will discuss the challenges faced during the development of new analytical methodology to meet these needs, and the capabilities and advantages of the new methods that are now in use at the NWQL. In addition, ongoing method development research to meet the next tier of method priorities will be summarized.

Continuous Groundwater Quality Parameters Enhance Groundwater Studies

Amy Gahala
US Geological Survey, DeKalb, Ill.

Abstract
Long-term continuous groundwater quality monitoring typically involves collecting measurements of water levels and water-quality parameters (such as specific conductance). Continuous water-quality monitoring has great potential for substantially enhancing groundwater characterization. Several monitoring wells in northern Illinois were continuously monitored for water level and specific conductance (SpC) from 2011 to 2013 and the data have helped to improve the understanding of the aquifer systems. During the 2012 drought, SpC in many of the wells throughout Illinois increased as groundwater levels decreased. The lack of precipitation reduced the recharge and dilution of the aquifers, thereby, increasing the concentration of ions by the principle of conservation of mass.

Additionally, the temporal trends in the SpC values can be used to indicate the trends in the concentration of chlorides (and other ions) within the groundwater. Quarterly groundwater samples were obtained to establish a relationship between specific conductance and chloride concentrations. As expected, higher chloride concentrations correspond to higher SpC values and lower chloride concentrations correspond to lower SpC values ($r = .91$, $p < .05$). SpC values were observed to increase sharply during the spring recharge following a wet winter. After some mild winters, SpC values tended to decrease, possibly reflecting a flush and dilution of the shallow aquifer due to reduced road salting.

Continuous monitoring of SpC can also be used to determine sources of groundwater. For example, two wells were monitored for SpC and water elevation in an ecologically sensitive area. One well is located on top of a seeping dolomite bluff and the other well is located at the bottom of the seep. The wells allow for easy and continuous comparison of chemical signatures of source water and flowpath determination. The original conceptual model assumed that the groundwater from the dolomite bluff was flowing towards the seep and recharging from the surface to the groundwater at the bottom of the seep. However, the SpC signature illustrated that the well at the bottom of the bluff has groundwater upwelling from the deeper dolomite and does not seem to be directly related to the nearby recharge.

Microbial Source Tracking Methodologies to Assess Human Contributions of Fecal Bacteria to a Freshwater Receiving Stream

David Graves[1], David Chestnut[1], Bryan Rabon[1], Joe Jones[2] and Chris Johnston[3]
[1]South Carolina Dept. of Health and Environmental Control, Columbia, S.C., [2]Selah Clinical Genomic Center at Innovista, Columbia, S.C., [3]National Oceanic and Atmospheric Administration, Charleston, S.C.

Abstract
The South Carolina, Department of Health and Environmental Control (SCDHEC) is charged with the responsibility to ensure that waters of the State support classified uses and are free from pollutants in excess of State standards. Crucial to any plan to achieve compliance with *E. coli* standards is an understanding of the probable sources of fecal bacteria (*i.e.*, human).

Metagenomics (sequencing and analysis of DNA from environmental samples) and quantitative polymerase chain reaction (qPCR) are genetic methodologies that can be used for microbial source tracking: the identification of microbial organisms specific to potential sources of fecal bacteria pollution. Metagenomic methods were used first to sequence DNA present in municipal wastewater and receiving stream water samples. The 16S rRNA amplicon was analyzed using BLAST, Greengenes, etc., to derive and contrast the microbial community composition. Then, qPCR methodology was used to quantify the presence of known genetic markers to substantiate and confirm the presence of potential human sources of fecal bacteria pollution. This assessment strategy was employed on an urban freshwater stream system, the Lower Saluda River, from its "origination" from a major impoundment, to its confluence with the Congaree River.

A preliminary study of three Lower Saluda River sites and one tributary site was conducted July – September 2010. The preliminary study demonstrated an increase in human markers in the Lower Saluda River, from upstream to downstream, indicating some level of human sources. The influence of tributary streams on the bacterial community composition of the Lower Saluda River was seen in the similarity of downstream stations.

A comprehensive study conducted July – September 2012 included eight Lower Saluda River sites, 10 sites on tributary streams with municipal wastewater treatment plant discharges and two sites on tributaries without discharges. A generally increasing trend in human markers downstream in the Lower Saluda River was again noted. The most specific human marker, *M. smithii*, was seen immediately downstream of two municipal wastewater treatment plants and also from an impoundment outfall. Community structure between tributaries appeared to be substantially different. The extent of these differences and their influence on the Lower Saluda River are being evaluated.

Time Integrative In Situ *Field Extraction Techniques and Advantages*

Brent Hepner
Aqualytical Services Inc., Maple Valley, Wash.

Abstract
A time integrative solid phase extraction (SPE) device has been developed to provide qualitative and quantitative extracts from fresh and marine environments. The device actively draws water in a submersed state through a unique SPE disk that functions as a extraction device, a self-contained shipping unit, and an elution holder. Its small footprint allows transport to remote areas sequestering hundreds of liters of water. The SPE disk is all that is sent to the laboratory for elution and analysis, as the water is left behind. The aforementioned extraction method and device has been used and studied by universities, state and federal agencies for several years.

One unique advantage the method offers to institutional and commercial laboratories is the ability to provide time integrative ultra-low detection levels by the use of large volume *in situ* field extraction. Sample holding time issues have also been resolved using this novel protocol, as the SPE disk itself is submitted for elution and analysis rather than a container of water. A six month study was conducted to compare the stability of sequestered target analytes on the SPE disks and liter samples at ambient, refrigerated, and frozen temperatures in bacterial contaminated and sterile states. The standard practice of collecting sample subsets from a large field container leaves a high percentage of non-polar analytes adhering to the container walls that cannot be solvent rinsed into the extract elutant volume. This problem is addressed through use of the field extracted SPE disk, which is solvent eluted. The elutant is then aliquoted into sample subsets for many analytical methods without analyte retention loss on container walls. This study validates this concept with the use of comparison testing.

U.S. EPA ETV Verification of a Coliform Detection Technology

Ryan James[1], Dan Lorch[1], Amy Dindal[1] and Peter Gallant[2]
[1]Battelle, Columbus, Oh., [2]Pathogen Detection Systems, Inc., Kingston, Ont., Canada

Abstract
The U.S. Environmental Protection Agency's (EPA) Environmental Technology Verification (ETV) Program's Advanced Monitoring Systems (AMS) Center, managed through a cooperative agreement between Battelle and EPA's National Risk Management Research Laboratory, verifies the performance of technologies that monitor, sample, detect, and characterize contaminants in a variety of environmental applications, including the matrices of air, water, and soil. ETV was established to accelerate the implementation of improved environmental technologies through third-party verification testing and reporting of the technologies' performance. The ETV process provides users with an independent assessment of technologies that can be utilized in technology purchase and use decisions. In addition, the ETV program involves stakeholder input during the planning and testing process so that the testing can be as comprehensive as possible.

During 2013, the AMS Center conducted a verification test of one coliform detection technology designed to indicate the presence or absence of total coliforms and/or *E.coli*. The tested technology was from Pathogen Detection Systems, Inc. (Automated Microbiology Platform). While this ETV test did not "certify" this technology (or corresponding method) as is required for regulatory use, the technology was tested according to a test plan that was similar to the experimental design outlined by EPA's Alternate Test Procedure (ATP) protocol. Formal testing which follows the ATP protocol is required in order for a method to become certified for use in performing measurements in support of EPA regulation. The ETV test included the generation of solutions containing approximately 1 organism per 100 milliliters of drinking water and then measuring 20 replicates of that drinking water sample. To make this testing even more applicable to the interests of water utilities, the testing was performed at a water utility laboratory by a water utility staff member that had not been trained or certified for microbiological analyses. The results from the PDS technology were compared to results from Colilert18. A summary of the verification test results will be presented.

Assessing Agent Concentration and Pressure in Water using Targeted Acoustic Frequency Ranges

John Keady
Innovation Labs LLC, Fairfax Station, Va.

Abstract
In contrast to the *in situ* measurements of surface acoustic wave devices, the present method uses specific acoustic ranges of waves passing through a medium of interest to determine the medium's gauge pressure and various agents that are within the medium. Molecular relaxation effects allow specific agent identification and varying pressures of the fluid sampled result in observable spectrum shifts. Results are presented that illustrate the use of a particular frequency range to identify agents and their concentrations with at least 10s of mg/liter resolution and another specific frequency range to determine the pressure with at least 5 mbar gauge pressure resolution. Results will be presented showing the identification of agents separately and in combination and the gauge pressure of the fluid medium sampled. The experimental system lends itself to modification for use on a smartphone platform, facilitating field use, as well as with inline piping systems for real time monitoring of water supplies.

Rapidly Deployable Real-Time Stream Flow Sensor Networks

Brandon Wong, Ho-Zhen Chen and Branko Kerkez
University of Michigan, Ann Arbor, Mich.

Abstract
We discuss the development and assess the performance of a sensor architecture to facilitate continuous, real-time measurements of stream flow across large, urbanized basins. Our system leverages ultra-low power cellular modules to enable IP-based, bi-directional communications between sensor nodes and cloud-based services. The optimization of hardware and software resources permits sensor nodes to be deployed years without the need to replace batteries. Our sensor network is located in a 2000 km^2 basin in southeastern Michigan. The cost-effective nature of the design permits nodes to be deployed rapidly without sacrificing the durability of the system during harsh wintertime conditions. We compare the performance of three separate flow measurement techniques, two of which are based on rating curve relationships, and one which uses modern Doppler technology to estimate flow. We validate the efficacy of the sensor nodes to provide reliable and accurate measurements of flow, while discussing the flexibility of the network in supporting future measurements of water quality.

Study Design for Comparative Study of Michigan's Rapid Bioassessment Methodology and National Rivers and Streams Assessment

Joseph Bohr, Kevin Goodwin, Sarah Holden, Tamara Lipsey and Dawn Roush
Michigan Dept. of Environmental Quality, Lansing, Mich.

Abstract
The Water Resources Division (WRD) of the Michigan Department of Environmental Quality uses a multi-metric indices (MMI) procedure (Procedure 51) to qualitatively assess habitat condition and macroinvertebrate and fish communities in wadeable streams and to assess designated uses and water quality standards attainment throughout Michigan. The United States Environmental Protection Agency National Rivers and Streams Assessment (NRSA) is taking place during 2013 and 2014 as part of the National Aquatic Resource Survey and also uses MMI to assess the quality of the nation's aquatic habitats. This WRD study performs Procedure 51 and the NRSA sampling methodology at 20 wadeable stream sites in Michigan and compares MMI scores results. The objectives of this study are to 1) Evaluate the comparability of these methodologies over a range of stream quality conditions, and 2) Identify inconsistencies between results and investigate possible causes of incomparability. We will discuss the study design, site selection process, and proposed analytical methods. Results will not be available until NRSA results have been reported.

GIS Assessment of the Ecological Impacts of Farm Landscape Change in South Carolina Lower Region

Edmund Merem, Peter Isokpehi, Joan Wesley, Sadigg Fageir, Chandra Richardson and Samu Iwehabura
Jackson State University, Jackson, Miss.

Abstract
Over the last several decades in the United States, the South Eastern region continues to experience changing agricultural landscape at an alarming proportion. This is having serious impacts on the stability of the surrounding ecology of these states. However, very little has been done to analyze the trends using a mix scale model of descriptive statistics and Geographic Information Systems (GIS) to visualize change across time and space. In absence of such a temporal-spatial framework, decision makers run the risk of prescribing

policy change using faulty blueprints. This paper will fill that void by focusing on the impacts of changing agricultural landscape in South Carolina low country using a mix-scale method of GIS and descriptive statistics. Emphasis is on the issues, environmental analysis of the trends, factors of change and current mitigations efforts. Being an area rich in biodiversity and natural resources with farming landscapes, the study area has experienced some changes in its acreage of farm land, number of farms, land devoted to cropland and host of other elements located within the larger agricultural sector across time and space. Accordingly, socio-economic elements linked change from market value of land to government transfer payment, and population posted notable variations along with fertilizer use. While preliminary results show gradual declines in farm land and land use elements with slight gains in some years, fertilizer use and water pollution stayed on the rise in areas adjacent to head waters of the region. With change attributed to a set of socio-economic variables, GIS mapping points to a gradual spreading of change and along with visible dispersal of ecological stressors across time and space in the region. Notwithstanding existing mitigation efforts, it is evident that the lower South Carolina agricultural landscape is an ecosystem under stress. To remedy the problem the paper suggests the need for effective land use planning and zoning ordinances, periodic monitoring and assessment of hazards on the landscape followed by a regular use of GIS, the design of a regional information system and a new data infrastructure to optimize access to information.

Using Emerging Mobile Technologies to Educate, Engage and Empower the Global Community on Water Quality Monitoring and Environmental Sustainability

Julie Moses[1], Aaron Corsi[1], Nate Shields[1], Alexus Rice[1], Madeline Walker[1], Daniel Wilcox-Netepczuk[1], Richard Durtsche[1], Miriam Steinitz-Kannan[1], Brad McCombs[1] and Heather Mayfield[2]
[1]Northern Kentucky University, Highland Heights, Ky., [2]Foundation for Ohio River Education (F.O.R.E), Cincinnati, Oh.

Abstract
The abundance of watershed streams impacted by agricultural runoff along with the inability of agency personnel to simultaneously bioassess the quality of all these streams provides a unique opportunity to educate, engage, and empower students and citizen science organizations in the sustainability practices of watershed monitoring. The goals of our research program are to combine the use of mobile technologies and stream bioassessment training for K-12 students, STEM undergraduates, and citizen scientists in the collection of credible data. The information collected would be databased for use by government agencies and professionals in the bioassessment of headwater and wadeable streams. The current concern by agencies is the credibility of the data collected by citizen scientists and educational groups, as well as the storage of such data prior to agency use. Our program has stimulated the innovation and expansion of a recently developed macro-invertebrate bioassessment mobile app. On a global basis, our water quality app quantifies the evaluation of water quality parameters, and supports the sustained development of such technologies through testing and quality control for use by non-agency people (*e.g.*, students, citizen scientists). In conjunction with research and development of this app, we have established a web-active database for storage of credible data that can be accessed by agency, educational, and citizen science groups alike. In addition, video demonstrations and training workshops have been established to ensure students and citizen scientists have a complete command of the instrumentation and software interface. Our continued efforts are progressing in the development of three additional stream bioassessment apps (one for habitat quality, one for algae and bacteria, and the other for fish) and subsequent training. These mobile technologies, while originally developed for use with research, education, or community engagement of environmental sustainability, can eventually stimulate product lines of small businesses that focus on environmental monitoring or sustainable use of the environment.

Identifying Canadian Priority Drainage Basins for Potential Risk to Water Quality and Aquatic Ecosystems Using a Risk Based Basin Analysis

Denis Parent, Genevieve Tardif, Francois Boudreault, Paul Klawunn, Myriam Rondeau, Beverly McNaughton, Vincent Mercier, Jasmine Waltho, Andrea Ryan, Christine Garron, Julie Boyer, Marcel Houle and Anita Gue
Environment Canada, Various locations across Canada, Canada

Abstract
In order to support the design of its national water quality monitoring network, Environment Canada's Water Quality Monitoring and Surveillance Division recently conducted a geospatial risk based basin analysis (RBBA) to help identify priority basins in terms of risk to water quality and aquatic ecosystems. Phase 1 of this analysis included all drainage basins within Canada as well as US trans-boundary basins, at a sub drainage basin scale (average surface area ~ 60,000 km^2). This project utilized twelve environmental stressor georeferenced data layers: roads, population, wastewater treatment systems, large dams, pollutant releases to surface water (metals, nutrients, organics), cropland, livestock manure, atmospheric deposition of nitrogen and sulfur, pipelines and stream crossings. Data layers were readily available from governmental organizations either through their websites or upon request. Stressor intensity metrics were identified and calculated per sub drainage area and an overall stressor index was aggregated by means of two methods. One method simply summed the stressor intensity data by sub drainage area while in the second method, the intensity data were weighted according to their relative contribution to overall variability as derived from principal component analysis. Results from both methods were very similar and consistent with expectations, i.e. the highest risk indices located in the most urbanized basins in Canada.

The RBBA now allows sub drainage areas to be ranked, mapped and compared according to relative levels of key stressors. Combining these results with monitoring locations and sampling frequencies provides a quick visual evaluation of monitoring intensity versus risk to water quality. Phase II of the risk based basin analysis is now underway and will include refining the analysis to a scale of sub sub drainage area (average surface area ~ 9,000 km^2) and the inclusion of information on basin linkages, geology, climate and ecoregions.

Continuous Imaging Flow Cytometer for the Automated Detection, Identification, and Enumeration of Cyanobacteria and Other Micro Algae

Brandon Rieff, Harry Nelson and Michael Leathem
Fluid Imaging Technologies, Scarborough, Me.

Abstract
Numerous technologies make use of fluorescence measurements to detect cyanobacteria and for the purpose of estimating biovolume or cell counts within water samples. While useful, results from these instruments can be significantly skewed by turbidity and the presence of other fluorescing pigments and particles. Fluid Imaging Technologies has recently adapted the technology of their imaging flow cytometer FlowCAM so that it can detect the presence of the phycocyanin pigment in cyanobacteria. By detecting the phycocyanin pigment of cyanobacteria cells using an appropriate laser and optical filters, the instrument can now distinguish cyanobacteria from other organisms in the water system, relying on pigment analysis in addition to image analysis of morphological parameters for the purpose of identification. Here we present an overview of the technology along with data demonstrating the efficacy of the instrument.

Performance Comparison of the Hach Nitratax, TriOS Props, Satlantic SUNA, and S::CAN Spectro::lyser in Waters with Low (<2 mg-N/L), Mid-Range (2-6 mg-N/L), and High (>6 mg-N/L) Nitrate Concentrations.

Teri Snazelle and Janice Fulford
US Geological Survey, Stennis Space Center, Miss.

Abstract
Four commercially available nitrate analyzers were evaluated for their accuracy in the field. The analyzers were deployed at three USGS sites, and were subjected to waters with low (<2 mg-N/L), mid-level (2-6 mg-N/L), and high (> 6 mg-N/L) nitrate concentrations. The analyzers were deployed adjacent to each other, and their measured nitrate values were compared to reference samples analyzed by the USGS National Water Quality Laboratory (NWQL), and the Illinois Environmental Protection Agency (EPA) laboratory. In addition to accuracy, the analyzers were also evaluated for the effectiveness of their anti-fouling mechanism(s), their ability to compensate for turbidity and other interferences, and their overall ruggedness in the environment.

An Evaluation of XYLEM EXO Water-Quality Sondes and Sensors

Teri Snazelle and Lisa Garcia
US Geological Survey, Stennis Space Center, Miss.

Abstract
The XYLEM multi-parameter sondes, EXO1 and EXO2, equipped with a panel of EXO water-quality sensors were evaluated by the USGS Hydrologic Instrumentation Facility (HIF). The EXO's ability to meet the manufacturing specifications was tested, and sensor accuracy was compared to the USGS recommended acceptance criteria using laboratory and field testing.

The U.S. Geological Survey Midwest Region River Sediments and Nutrients Investigations

Timothy Straub[1], Robert Swanson[2], Christopher Ellison[3], Jessica Garrett[4] and Austin Baldwin[5]
[1]US Geological Survey, Urbana, Ill., [2]US Geological Survey, Lincoln, Nebr., [3]US Geological Survey, Mounds View, Minn., [4]US Geological Survey, Iowa City, Ia., [5]US Geological Survey, Middleton, Wis.

Abstract
Sediment- and nutrient-enriched rivers and streams of the United States pose substantial environmental and economic challenges for Federal, State, and local governments. In 2012, the U.S. Geological Survey (USGS) Midwest Region, in collaboration with 17 USGS Science Centers in 12 States, established the River Sediments and Nutrients Investigations initiative with the objective to identify major sediment- and nutrient-related problems and issues facing the Midwestern United States. The initiative promotes advanced techniques and protocols that would enhance the ability of researchers to address these issues and the establishment of a sediment- and nutrient-monitoring network that employs state-of-the-science equipment and advanced monitoring techniques, consistent data-collection, and uses advanced analytical protocols. This initiative enables partner-driven science and collaboration among researchers and stakeholders from all science disciplines in order to provide insight into spatial and temporal variations of fluvial sediment and nutrient concentrations and how natural processes and human activities interact. Seven sites were initially instrumented in four states as demonstration platforms and development of advanced data processing tools is underway. In addition, this initiative has funded a literature review and publication of sediment fingerprinting science, software development to retrieve and process sediment acoustic data, and held workshops on emerging optical and acoustic monitoring technologies and advanced bedload measurements. This effort, which has become a component of a Large Rivers initiative, also hosted a stakeholder webinar in September 2013 to help advance understanding of science needs by the river management community.

Surrogate Analysis and Index Developer

Marian Domanski[1], Timothy Straub[1] and Mark Landers[2]
[1]US Geological Survey, Urbana, Ill., [2]US Geological Survey, Atlanta, Ga.

Abstract
Surrogates are becoming widely used to better understand physical and chemical processes in natural systems. The MATLAB based tool Surrogate Analysis and Index Developer (SAID) assists in the creation of regression models that relate response and explanatory variables by providing visual and quantitative diagnostics to the user. The tool also processes acoustic parameters to be used as explanatory variables for suspended-sediment concentrations. The sediment acoustic method utilizes acoustic parameters from fixed-mount stationary equipment. The background theory and method used by the tool have been described in recent publications, and the tool also serves to support sediment-acoustic-index guidelines being drafted by the multi-agency Sediment Acoustic Leadership Team (SALT), and other surrogate guidelines like the USGS Techniques and Methods 3-C4 for turbidity.

Using Remote Sensing Tools to Target Stream Protection and Wastewater Treatment Management Practices in Rural Kentucky

Barry Tonning, Catherine Carter, Peter Cada and Gregory D Sousa
Tetra Tech, Research Triangle Park, N.C.

Abstract
For the Hinkston Creek Watershed CWA 319 (Nonpoint Source Pollution) Project in east central Kentucky, Tetra Tech used remote sensing tools to produce an onsite wastewater system risk analysis, a riparian buffer assessment, and a focused study of two selected tributaries affected by livestock access to the stream corridor. Onsite wastewater treatment system potential risk to water quality was assessed via mapping analyses that considered system densities (*i.e.*, number per square mile), system age, and proximity to surface waters. Prioritization was based on level of household density, closeness to streams, and closeness to karst topography (to account for impacts to groundwater). Publicly serviced areas with centralized wastewater treatment were eliminated first; household density was calculated for areas outside of public sewer line boundaries in the areas surrounding the municipalities.

The riparian buffer assessment and deficiency analysis used aerial photography to determine canopy cover presence/absence and buffer zone widths. A 100-foot buffer was created along each side of the mainstem of Hinkston Creek, with a 50-foot buffer for the upper watershed and tributaries. A Multi-Resolution Land Characteristics Consortium (MRLC) geospatial dataset (LANDFIRE) was used to determine riparian buffer health status (impacted vs. intact). Using methodology from Roy *et al.*, 2005, any vegetated layers with less than 30 percent coverage were lumped together with other impacted riparian habitat LULCs (*e.g.*, developed, open space, pasture/hay, etc.). The percent buffer deficiency within each assessment subwatershed was estimated using GIS.

A broader, desktop analysis of high-risk stream channel areas was also conducted by analyzing riparian vegetation (*i.e.*, canopy cover), cattle access points, and property ownership records. The riparian deficiency data described above was overlaid with imagery from the National Agriculture Imagery Program to assess the intensity of impact on riparian areas within two impaired subwatersheds. Impacted riparian areas were divided into four levels of impact based on stress conditions observable from the aerial imagery, such as proximity of intense tilling and/or grazing to the stream edge, cattle access points, and lack of tree or shrub cover in the riparian buffer.

Real-Time Nitrate Monitoring in Groundwater within a Mixed-Use Watershed in Central Illinois

Patrick Mills, Kelly Warner and Jacob Wikle
US Geological Survey, Urbana, Ill.

Abstract
Variability of nutrient concentrations in groundwater in response to seasonal or other temporal variability in nutrient applications and precipitation may play an important role in nutrient loading in streams. Collection of groundwater nitrate data at the frequency and duration necessary to best understand the mechanics and significance of the groundwater contribution to stream loads has been hampered by the approaches of typical data collection. Samples must be collected by a manually or automatically operated pump, often followed by laboratory analysis. Among other issues, manual collection can be labor and/or travel intensive; automated collection can be restricted by limits on number of samples and holding times for analysis. Recent availability of an automated photometric sensor that can provide long-term, near-continuous groundwater nitrate data with real-time broadcast through satellite telemetry should greatly advance groundwater nitrate monitoring capabilities. The sensor determines concentrations by measurement of ultraviolet light adsorption by nitrate.

The capability of the automated sensor in a groundwater application is under evaluation at a 640 acre, agricultural/residential/prairie-wetland parcel at the lower end of a 9,000 acre, predominantly agricultural watershed near Bloomington, Illinois. The timing and stressors driving periodic fluctuations in groundwater nitrate concentrations are not well understood, nor the relation of these fluctuations to the variability of nitrate loads in the nearby streams. The largest nitrate loads in the streams occur in conjunction with larger precipitation events, particularly when near the time of field nutrient applications. The automated sensor has initially been installed in a site well that is located between the newly establishing residential neighborhood and the stream; subsequent installation is planned at a location downgradient of a field cultivated in row crops. Along with assessment of the performance and maintenance requirements of the sensor, it is anticipated that its use will prove valuable to better understanding of nitrating loading in the watershed.

Merging Water Quality Standards and Monitoring and Assessment Produces Better Management Outcomes

Chris Yoder
Midwest Biodiversity Institute, Columbus, Oh.

Abstract
A central concept in the effort to improve the rigor of State biological assessment programs has been the integration of water quality standards and monitoring and assessment as a critical supporting framework for water quality management. Specifically this includes enhancing the descriptions of aquatic life designated uses and their measurement via numerical biological criteria and biological assessment. Known as the "TALU" approach it includes tiered aquatic life uses (TALUs) based on numeric biological criteria and implementation via an adequate monitoring and assessment program that includes biological, chemical, and physical measures, parameters, indicators and a process for stressor identification. States that have developed the level of detail needed to have a linkage between their WQS and their monitoring and assessment programs have been successful in achieving water quality management outcomes that would not have occurred under a framework of general uses and monitoring for statewide condition. Essential components of this more developed framework include: 1) tiered aquatic life uses that are defined in accordance with how the numeric biocriteria for each have been developed, 2) a monitoring program that has sufficient spatial resolution to reveal degrees of quality along pollution continuums in rivers and streams and at the same scale at which management and regulatory programs are being applied, and 3) language in the WQS that specifically describes agency responses to impairment and attainment of tiered use biocriteria as revealed by a statewide watershed level monitoring program. Two recent court decisions concerning the imposition of NPDES effluent limits in Ohio specifically point out the utility of this framework adopted by Ohio in 1990. These results point up not only the utility of merging WQS and monitoring and assessment, but also legally define the level of types of data that are sufficient to implement such an approach in modernizing state WQS. Attaining the level of rigor to implement such an approach is consistent with the U.S. EPA guidelines specified in Biological Assessment Program review: Assessing Level of Technical Rigor to Support Water Quality Management (February 2013).

Connecting Science to Action – Communicating Science and Data in Ways that Influence Behavior

Web-Based Communication of Water Quality Issues and Potential Solution Exploration

Elly P.H. Best[1], Lilit Yeghiazarian[2], Tim Whiteaker[3], Allen Teklitz[2], Amr Safwat[2] and Guoxiang Yang[1]
[1]US Environmental Protection Agency, Cincinnati, Oh., [2]University of Cincinnati, Cincinnati, Oh., [3]University of Texas, Austin, Tex.

Abstract
Many United States water bodies are impaired, *i.e.*, do not meet applicable water quality standards. Pollutants enter water bodies from point sources (PS) and non-point sources (NPS). Loadings from PS are regulated by the Clean Water Act and permits limit them. Loadings from NPS are not regulated, and can be reduced by education and changes in human behavior. In rural areas, nutrients and sediments are the leading pollutants originating largely from NPS. Poorly quantified loads of nitrogen (N) and phosphorus (P) travel downstream to estuaries, enabling eutrophication, leading to anoxic zones and fish kills. We have developed a rapid and transferable modeling framework for estimating pollutant loadings and transport in watersheds, under various conditions of land use, using a minimum amount of monitoring data. This framework also enables the mapping of water quality standard exceedance risk, and estimating the potential effects of conservation/restoration/altered management (CRAM) implementation to decrease loads and standard exceedance risk. A probabilistic risk approach is followed. This framework runs within an ArcGIS environment. Initial applications to be presented include the watersheds of the East Fork of the Little Miami River, OH, and the Tippecanoe River, IN, where partnerships between EPA, State, and stakeholders work together to solve NPS-related water quality issues. The framework can be used in support of the TMDL process, *i.e.*, prioritization of watersheds for evaluation, the evaluation process itself, and for exploration of the potential benefits of CRAM type, areal coverage and geographical distribution to reduce loads. We expect that this framework will be useful to many users, because of its scientific basis and future accessibility as a web-based map and, later on, geoprocessing service-application, and availability as a downloadable package. Intended users are: (1) Staff of federal, state, and local agencies; (2) Decision-makers for municipalities, counties, states, and regions; (3) Students in schools, colleges and universities; (4) Interested public.

The Effectiveness of Floating Treatment Wetlands for Water Quality Best Management Practices

Richard Bretz[1] and Amy Cameron[2]
[1]Miami University, Oxford, Oh., [2]Butler Soil and Water Conservation District, Hamilton, Oh.

Abstract
This presentation will focus on the deployment of floating treatment wetlands (FTWs) which consist of a buoyant structure, or raft, which supports perennial, non-invasive, emergent macrophytes over the water column. FTWs can help control the amount of pollutants in ponds through nutrient uptake and entrapment by biofilms formed on the roots. Data from both field deployed

and greenhouse FTWs will be presented to show the effectiveness of the FTW in a natural as well as controlled environment to reduce nutrient levels. Due to the plant uptake of nutrients and rhizospheric zone entrapment, preliminary analysis is suggesting a decrease in nutrients in water for the greenhouse FTWs as well as the where the FTWs are deployed. If the preliminary analysis remains consistent, FTWs can be utilized for best management practices to increase water quality in surface waters.

The Role of Citizen Scientists in the Monitoring and Management of the Global Water System

Diana Eddowes[1], Rachel Borgatti[1], Charlotte Hall[2] and Steven Loiselle[2]
[1]Earthwatch Institute, Boston, Mass., [2]Earthwatch Institute, Oxford, UK

Abstract
Recent research clearly shows that aquatic ecosystems in urban environments have been significantly compromised. This is a direct result of modified land cover and infringement on buffer areas and an indirect result from changes in consumption patterns and population density. Globally, urban growth will add 1.5 billion people to cities by 2030, further increasing the need both for integrated management approaches and to engage new audiences to address issues of water quantity, quality and aquatic ecosystem services. In a new global research program, we have partnered directly with a corporate sponsor to train and direct over 7500 corporate employees to become Citizen Science Leaders in major cities in Europe, Asia-Pacific and the Americas. Participants follow a globally consistent training program and monitoring methodology to support research by local scientists. They perform regular monitoring of hydrological, ecological and chemical parameters in local ecosystems. The curriculum of the training day informs the participants on regional and global water quality and quantity issues to both encourage them to collect data for the research program and make changes in their lives and communities to improve water quality. Participants are also taught effective communication skills to further empower action within their sphere of influence and are provided with online tools for educating themselves and others. Local and global data control mechanisms insure that a consistent global database will allow an international team of scientists to explore controlling factors of freshwater ecosystem dynamics in urban environments. Our intention is for these datasets, collected by corporate employees and their wider communities will inform policymakers' water resource management plans both locally and globally. A broader focus on outreach, outside of the usual audiences, is needed to ensure the sustainable use of one of world's most valuable resources.

Big Chico Creek Watershed Citizen Monitoring Program

Timmarie Hamill
California Urban Streams Alliance – The Stream Team, Chico, Calif.

Abstract
This project focuses on providing opportunities for the public to increase their knowledge about the causes of storm water pollution while also informing them about effective stewardship practices. Integrating learning strategies based on the social constructivist theory, this Public Participatory Science Research (PPSR) program promotes collaborations between community groups, schools, and natural resource managers to achieve water quality goals. Efforts are centered on providing opportunities for the public to interact within their own community, learning about issues impacting their local creeks, and taking actions to implement solutions. Building strong bonds with natural places within one's community is an important prerequisite to taking an active role in protecting those areas, and this program serves an integral role in achieving natural resource management goals.

Approaches for Disseminating Water Quality Information: Development and Use of Applied Water Quality Indices and Report Cards

Brian Henning and Leslie McGeorge
New Jersey Dept. of Environmental Protection, Trenton, N.J.

Abstract
A questionnaire was developed with input from the National Water Quality Monitoring Council to gather available information on composite water quality indices and report cards used by both governmental environmental agencies and other water quality practitioners to disseminate results to various audiences. The goal of our survey was to better our understanding of the uses, pros and cons, development process and the applicability of each method to convey water monitoring information in an integrated manner. Several participants in the survey utilized water quality indices in freshwater rivers and streams, estuarine and coastal embayments, and Laurentian Great Lakes. The most popular parameters used in water quality indices were dissolved oxygen, pH, chlorophyll *a*, and total phosphorus. Some participants utilized a Water Quality Report Card approach in freshwater streams, rivers and lakes. The Water Quality Report Card concept was originally developed by Warren Kimball of the Massachusetts DEP, and is becoming a popular model used by a number of water resource agencies. The water quality report card uses 10 indicators pertaining to aquatic life, recreation, and fish edibility that are color coded to provide an assessment of a waterbody based on standardized 305(b) reporting procedures. While many organizations call their waterbody assessment a "report card," for example Baltimore's Annual Healthy Harbor Report Card, their overall assessment is often calculated using ecological indices based on defined thresholds and then transformed into a letter grade (A-F) to be more easily understood by the general public. Therefore, we considered any assessment that uses ecological indices to produce an overall score as a composite water quality index to distinguish from the Water Quality Report Card concept related to 305(b) reporting. Regardless of the approach, both water quality indices and Water Quality Report Cards appear to be useful tools to provide an overall evaluation of a water resource and present the data in a manner that is quickly and easily understood by multiple audiences.

Where Are Our Wetlands and How Are They Doing?

Jon Marshack[1] and Meredith Williams[2]
[1]California Water Quality Monitoring Council, Sacramento, Calif., [2]San Francisco Estuary Institute / Aquatic Science Center, Richmond, Calif.

Abstract
The California Water Quality Monitoring Council recently released a completely redesigned internet portal to connect decision makers and the public with water quality and ecosystem health information. The theme of this new portal is "Are Our Wetland Ecosystems Healthy?" The new portal is accessed from California's "My Water Quality" website (www.MyWaterQuality.ca.gov) under "Are Our Aquatic Ecosystems Healthy?" The new California Wetlands Portal includes interactive graphics, maps and monitoring data that focus on the location, extent and health of the state's wetland resources. A novel home page photo carousel provides insight into the many types of wetlands found in our state. The goal is to make this information as timely and user-friendly as possible. Data presented in the portal are housed in another new web-based tool called EcoAtlas (www.ecoatlas.org). Targeted toward wetland practitioners, EcoAtlas provides an online resource for compiling maps and data about wetlands produced by numerous local, state and federal agencies and non-governmental organizations.

Formed in 2007 through cooperative agreement between California's environmental protection and natural resources agencies, the California Water Quality Monitoring Council brings together water quality and ecosystem health information from a variety of organizations with special expertise in wetland monitoring and assessment, coordinated through the California Wetland Monitoring Workgroup. This collaborative workgroup facilitates dialogue and

coordination among twenty-three state, federal, and local agencies and non-governmental organizations that monitor and assess our state's wetlands. Their new portal provides a way to make the information collected as part of this monitoring investment more readily accessible so that it can inform policies and management decisions. Furthermore, it allows the general public to access information about local and statewide resources that were compiled by public agencies with public resources.

In 2009, the Monitoring Council released its first two internet portals, "Is it Safe to Swim in Our Waters?" and "Is it Safe to Eat Fish and Shellfish from Our Waters?" In 2010, the first California Wetlands Portal was added and in 2012 the Healthy Streams Portal was launched. Additional portals will highlight California's estuaries, ocean and coastal waters, and drinking water resources.

California Estuary Monitoring Workgroup – Using Web Portals to Improve Scientific Understanding

Jon Marshack[1] and Stephanie Fong[2]
[1]California Water Quality Monitoring Council, Sacramento, Calif., [2]State and Federal Contractors Water Agency, Sacramento, Calif.

Abstract
Creating collaborative, unified science in California's San Francisco Estuary will require an integration of science with policy and management action not only at the local level, but also at regional and state levels. Estuary water quality, biology and ecology, along with social, political, and economic considerations, can influence policy design and implementation. Decision-support tools can integrate these sciences and facilitate discussion by organizing and simplifying often complex information into a format that scientists, the public, policy makers, and managers can understand, use, and amend. Under the oversight and guidance of the California Water Quality Monitoring Council, the California Estuary Monitoring Workgroup (CEMW) is beginning to answer stakeholder questions with a collaborative toolset that brings together peer-reviewed datasets with useful tools to help practitioners tell their stories. This process has resulted in the development of the California Estuaries Portal, an interactive website that strives to present information for decision makers and the public on water quality and quantity, living resources, habitat, ecosystem processes, and stewardship for California's estuaries. The initial launch of this portal mainly focuses on the largest estuary in western North America, the San Francisco Bay-Delta Estuary.

After the initial portal launch in fall 2013, the Estuary Monitoring Workgroup will continue efforts to develop the public portal, improve web-based collaboration tools, enhance access to environmental monitoring data, and identify performance measures – ecosystem health indicators with target goals. This collaborative effort involves multiple state and federal government agencies and non-governmental organizations, working toward improved estuarine science, restoration, and protection of beneficial uses of California's water resources. The California Water Quality Monitoring Council was mandated by statute to improve the efficiency and effectiveness of California's water quality and associated ecosystem monitoring, assessment, and reporting through increasing collaboration between the numerous governmental agencies and non-governmental organizations that monitor California's waters. The Estuary Monitoring Workgroup is just one of seven collaborative workgroups established by the Monitoring Council.

Landowner Outreach: "Know Your Steam" Handouts

Jason Ramming and Stacey Day
Oklahoma Conservation Commission, Oklahoma City, Okla.

Abstract
The Oklahoma Conservation Commission (OCC) has an extensive monitoring program which focuses primarily on determining the extent, nature, and probable sources of nonpoint source pollution. A statewide Rotating Basin Program was initiated in 2001 so that a total of 245 fixed sites representing most HUC 11 watersheds in the state are monitored on a staggered, rotational schedule by basin every five years. Sites are sampled every five weeks for two consecutive years, with approximately 100 sites assessed each year for water quality parameters, aquatic habitat condition, and biological community health.

A copious amount of data has resulted from the Rotating Basin Program. OCC data is used for many purposes, including use support assessments in fulfillment of Clean Water Act requirements, watershed implementation project assessment and reporting, watershed targeting, TMDL development, and public education. In addition, the OCC has established single page summary sheets for each site so that landowners don't have to wade through lengthy reports to access meaningful information on streams that are on their property. These site summaries condense the 19 water quality parameters collected on each stream over two years into a single score and a rating of "good," "moderate," or "poor" to indicate overall stream health. Monitoring staff often encounter landowners who ask about the health of the stream that runs through their property. While this information exists in the agency database, it is not currently in a format that can be easily communicated to the landowners or other interested public. The site summaries have enabled monitoring staff to effectively engage with landowners that they encounter while in the field by communicating information simply, concisely, and immediately. This then accomplishes another purpose: to inform landowners whose property abuts a monitored stream about the quality of the water running through their property.

This poster will address the usefulness of condensing data into site summary sheets that are intelligible to the general public.

Building Public Awareness of Wisconsin's Streams through Signage at Long-term Volunteer Stream Monitoring Sites

Heather Smith[1,2], Kris Stepenuck[1,2], Jeff Strobel[1] and Sarah Congdon[1]
[1]University of Wisconsin – Extension, Madison, Wis., [2]Wisconsin Dept. of Natural Resources, Madison, Wis.

Abstract
The "Building Public Awareness of Wisconsin's Streams through Signage at Long-term Volunteer Stream Monitoring Sites" project is led by the Wisconsin Department of Natural Resources and UW-Extension's Water Action Volunteers' Stream Monitoring Program, a state-wide volunteer monitoring program established in 1996. The project is intended to increase Wisconsin citizens' environmental science literacy by providing them with a unique opportunity to learn about local stream monitoring efforts and how land use affects stream health. The project includes designing and posting educational road signs at long-term volunteer monitoring sites across Wisconsin. Road signs will contain a QR code that will direct Smartphone or other mobile device users to a special section of the WAV website that contains information on monitoring parameters, how land use affects each stream health parameter, and links to site-specific data. The webpage will also link to self-guided tour maps to encourage citizens to compare stream health at nearby stream monitoring sites. The self-guided tours will be publicized broadly using social media to encourage family and school group participation.

Source Water Protection for Drinking Water Production: An International River Memorandum

Peter Stoks[1] and Ina Brüning[2]
[1]Association of Rhine Water Works RIWA, Nieuwegein, The Netherlands, [2]International Association of Water Works in the Rhine Basin IAWR, Düsseldorf, Germany

Abstract
From the seventies of last century the waterworks along the Rhine River in Europe (International Association of Waterworks in the Rhine basin, IAWR) have been active in the improvement of the Rhine water quality. The ultimate

goal has always been a source water quality allowing the production of perfect drinking water using simple treatment only. This view has also been adopted by the International Rhine Commission ICPR.

Already in 1973 IAWR published a Rhine Memorandum stating quality demands that would help reach that goal. Interestingly, those very demands were subsequently used by the European Union as the basis of a Directive on the abstraction of surface water for drinking water production (75/440/EC). Several updates of this memorandum were published over the years. In 2008 other associations of water works, along the Danube and the Meuse, also endorsed the underlying philosophy and the memorandum was broadened to the Danube-, Meuse- and Rhine Memorandum.

The Commissioner of DG Environment in the EU, when confronted with this memorandum suggested to include more European rivers used for drinking water production and in 2013 the International River Memorandum was published, representing over 170 utilities in 17 European countries, with well over 115 million consumers.

The most important aspects of this memorandum are quality objectives for not otherwise regulated variables as groups, and demands and suggestions to (political) decision makers on the achievement of the desired water quality based on the precautionary approach. A distinction is made between pollutants that show biological activity (such as, *e.g.*, pharmaceuticals or biocides) as well as pollutants for which such information is not currently available (such as many metabolites and degradation products) and other pollutants. The former type of pollutants should not exceed 0.1 µg/L in the source waters; the latter group should not exceed 1 µg/L. A motivation based on scientific criteria for these demands and objectives is also given.

The ICPR has recently reconfirmed its former statement that the Rhine should, ultimately, allow drinking water production using simple treatment and in the Netherlands some of the approaches stated in this memorandum have already been incorporated into legislation.

Water-body Check-up: Monitoring and Ecological Modeling to Evaluate Risk of Preventable Health Problems

Harry Stone
Battelle, Cincinnati, Oh.

Abstract
Freshwater harmful algal blooms represent a growing class of problems in North American waters: non-linear disruptions of ecosystems that result in profound economic impacts and/or health risks. Ecosystem services from water bodies may be significantly damaged or lost as a non-linear response to linear trends in stressors. Further, complex interactions among stressors may influence the tipping point at which the ecosystem transforms from the "normal" state, *e.g.*, a clear lake, to a new stable ecological condition, *e.g.*, a lake dominated by cyanobacteria. Once a tipping point is reached, a new, stable, undesirable ecosystem may prevail, unless costly interventions are instituted. This new ecological condition may be reflected in changed fish communities, loss of species, decrease in property values, lake closures, unsafe drinking water, damage to politicians, costly (and often ineffective) treatments, costly regulations, and many other impacts. Avoiding the tipping point is far preferable to the loss of valued ecosystem services and the high costs that may result after the tipping point is reached.

Three "streams" must merge to reverse risky trends before a catastrophic change occurs. The first stream is ecological knowledge. Monitoring of appropriate data and ecological modeling of outcomes of concern is critical to provide credible assessment of the risk associated with trends in stressors. A second "stream" is a policy process that can respond in a timely and adequate manner to indicators of risk, rather than just requiring a catastrophic event to inspire action. The third "stream" represents affordable and feasible actions that can reverse stressor trends sufficiently to avoid the tipping point.

Harmful algal blooms will serve as a vehicle for introduction of an approach and challenges associated with proactive application of monitoring and ecological modeling to generate knowledge necessary to anticipate and prevent non-linear changes.

Demonstrating the Value of Monitoring in Measuring Environmental Change

Determining the Timing and Cause of Water Quality Changes from Increased Nutrient Loading to an Urban Kettle Lake near Toronto (Ontario, Canada): Using Paleolimnological Techniques to Set Lake Management Objectives

Melissa Moos and Brian Ginn
Lake Simcoe Region Conservation Authority, Newmarket, Ont., Canada

Abstract
Musselman Lake is a small (~46 ha, maximum depth = 8.5 m) kettle lake located on the Oak Ridges Moraine of the Greater Toronto Area in south-central Ontario. Since the mid-1990s, shoreline residents and lake users have expressed concerns over water quality issues that are indicative of increased phosphorus (P) loading and eutrophication: (a) relatively high water column P concentrations (TP = 27 µg/L) in comparison to other Moraine lakes; (b) increased prevalence of algal blooms; (c) a high biomass of aquatic plants; and (c) a toxic cyanobacterial bloom in 2007. Due to sporadic monitoring of water chemistry, two potential sources of phosphorus inputs (septic systems vs urban run-off), and a lack of pre-disturbance water quality data, a paleolimnological approach was used to reconstruct environmental changes in this lake. Using diatoms (Bacillariophyta) as biological indicators from a sediment core, we tracked historic trends in water quality, determined the source of P inputs, and placed current ecological conditions into a long-term context. This information can now be used to develop lake management targets based on pre-disturbance conditions. Prior to ~1840, Musselman Lake was typical of undisturbed systems in this area with a forested catchment and waters made slightly acidic from DOC inputs. With increased land clearance and agricultural activities, the lake slowly became more mesotrophic (1840 – 1920) with further increases in productivity associated with the establishment of seasonal cottages and a hotel along the shoreline (~1920) and the conversion of these dwellings into year-round homes (1960 – 1990). As wastewater treatment in this community has relied on small, individual, septic systems, the greatest decline in water quality has occurred since the 1990s when individual groundwater wells were replaced by servicing homes with the municipal water supply. The results of this study serve as an example of how rapid urbanization of a watershed, coupled with inadequate wastewater treatment, can lead to decreases to water quality. By identifying the major source of nutrient inputs and reconstruction pre-disturbance environmental conditions, suitable restoration targets can be developed for remediation and management of this lake.

Economic Valuation of Monitoring Based on the Uncertainty Factor in Nutrient Trading Ratios

Richard Smith[1], Jhih-Shyang Shih[2], Gregory Schwarz[1] and Molly Macauley[2]
[1]US Geological Survey, Reston, Va., [2]Resources for the Future, Washington, D.C.

Abstract
One of the potential economic benefits of water quality monitoring is a reduction in pollution control costs achieved through greater accuracy in predicting the effects of pollution controls in improving water quality. Increased monitoring leads to measurably smaller errors in water quality model predictions which, in turn, reduces the "margin-of-safety" required of pollution

control programs to meet water quality goals with a desired level of reliability. Nutrient trading programs account for uncertainty in the effects of controls through a trading ratio, which imposes an additional charge on purchases of pollution credits to cover the risk of not meeting water quality goals. Currently, uncertainty ratios in nutrient trading range from 2:1 to 5:1 , implying low confidence in the ability of models to predict the effects of reducing nutrient sources in watersheds. In this study, we attempt to quantify the potential value of increased monitoring by estimating its effects on the marginal cost of a control program designed to reduce the export of reactive nitrogen (N_R) from a watershed with a specified reliability level. We conducted repeated calibrations of SPARROW models of watershed total nitrogen (TN) export using data from varying numbers of monitoring stations randomly chosen from a 425-station database. The results show a strong positive relation between number of stations used in the calibration and model accuracy. Based on the standard error of the "nitrogen fertilizer" coefficient, we estimated the minimum (90 percent confident) amount of reduction in watershed N_R export that would result from a unit reduction in nitrogen input from cropland sources. Assuming a marginal cost of $4.00 per kg for reducing cropland nitrogen runoff at the source, the total estimated value of an additional monitoring station in four example US watersheds ranged from about $50K per year to more than $700K per year.

The Circumarctic Lakes Observation Network (CALON): Hierarchical Sampling of a Lake-Rich Region of Northern Alaska

Kenneth Hinkel[1], Amy Townsend-Small[1], Richard Beck[1], Christopher Arp[2], John Lenters[3] and Hongxing Liu[1]
[1]University of Cincinnati, Cincinnati, Oh., [2]University of Alaska, Fairbanks, Alas., [3]University of Nebraska, Lincoln, Nebr.

Abstract
Over 55 lakes in arctic Alaska were instrumented in 2012 as the initial phase of CALON, a project designed to document landscape-scale variability in physical and biogeochemical processes of Arctic lakes developed on permafrost. The current network has two latitudinal transects extending from the Arctic Ocean south 200 km to the Brooks Range foothills. Representative lakes of differing area and depth are instrumented at different intensity levels, and a suite of instruments deployed to collect field measurements on lake physiochemistry, lake-surface and terrestrial climatology, and lake bed and permafrost temperature. Loggers record time series of water temperature and water depth, and water samples are collected in winter and summer. In general, lake ice thickness increases with latitude, with ice-off occurring 2–4 weeks later on lakes near the coast although there is significant inter-lake variability related to lake depth. Following ice-off in late June or early July, rapid warming occurs and water temperature varies synchronously in response to synoptic weather variations. Average mid-summer (July) lake temperatures spanned a relatively wide range in 2012 from 7 °C to 18 °C, with higher temperatures in small shallow lakes and more southern latitudes. Most lakes are well-mixed and isothermal, with thermal stratification occurring for short durations in deeper lakes during sunny and calm periods. Over the ice-free season, the majority of the available energy from net radiation is expended on evaporation, followed by sensible heat flux and warming of bottom sediments. Thermal bands of MODIS and Landsat imagery were fused using a spatio-temporal cokriging method to generate daily surface temperature estimates at Landsat spatial resolution, and the close agreement between satellite-derived and *in situ* measured near-surface lake temperature suggests that this approach yields viable results. Biogeochemical and inorganic geochemical constituents were also measured. The greatest difference in the dissolved CH_4:CO_2 ratio in summer was longitudinal, with several lakes in western Alaskan Arctic exhibiting CH_4 concentrations hundreds of times more supersaturated than air. Stable isotope analyses of CH_4 ($\delta^{13}C$ and $\delta^{2}H$) indicates that several lakes have natural gas methane sources. Methane concentrations under ice (April) were several thousand times higher than in open-water conditions (August).

Determining the Holistic Value of Water - How Science, Public Opinion, Economic and Social Information are Used for Better Water Management and Decision Making

The Impact of High Yield Irrigation Wells on Groundwater Supplies in Western Kentucky: Involving Stakeholders in the Process of Gathering More Information and Managing this Resource

Caroline Chan, Chip Zimmer, Bill Caldwell and Jessica Moore
Kentucky Division of Water, Frankfort, Ky.

Abstract
The drought of 2012 prompted several complaints in Western Kentucky regarding private drinking wells drying up and questioning whether nearby irrigation wells could be playing responsible. Over the past 15 years, numerous droughts and record high prices for corn and soybean have led farmers to begin investing in these wells at increasing rates. With over 9,000 documented domestic wells located in Western Kentucky, the Kentucky Division of Water (KDOW) has committed to study the effects of high capacity irrigation wells on local groundwater supplies and to work with stakeholders on managing groundwater supplies. KDOW's role is to provide information on the quantity and quality of water resources available to those who intend to use the water. An understanding of the impact of high capacity wells on groundwater supplies was sought.

KDOW certifies well drillers to ensure the proper protection of groundwater and public health. The well construction log submitted by drillers does not identify the type of irrigation system installed, making identification of center pivot or lateral irrigation systems difficult. GIS was used to visually identify center pivot wells. Only 37 of 264 visually identified center pivot wells had been reported to KDOW (14%). Installation forms importantly inform the state about yield, depth of well and other information needed to understand the impact of high capacity irrigation on groundwater supplies.

Two physiographic regions were examined. In the Jackson Purchase, wells may pull from one of several aquifers, depending on the depth of the well. In the Western Pennyroyal, groundwater flows through secondary porosity features that are not continuous resulting in unpredictable withdrawal rates. The differences between the two regions require unique management plans, however inadequate data makes this difficult to accomplish.

Without more information, KDOW cannot inform stakeholders about the quantity and quality of groundwater. Recommendations to gain this information are: modification of well installation forms, educating drillers on the importance of compliance, issuing notices of violation for those that fail to comply, educating domestic well users on the effects of drought on aquifers, and encouraging deeper domestic wells.

San Diego Regional MS4 Permit: Adoption Process and Outcome

Matt Rich[1], Drew Kleis[2], Chris Minton[3] and Rachel Davenport[1]
[1]AMEC Environment & Infrastructure, Inc., San Diego, Calif., [2]City of San Diego, San Diego, Calif., [3]Larry Walker & Associates, Seattle, Wash.

Abstract
In April, 2012, the San Diego Regional Water Quality Control Board released an Administrative Draft of a new regional MS4 Permit. A series of focused meetings, workshops, and informal meetings with Board staff took place over the following year, culminating in the adoption of Order R9-2013-0001 after a three-day hearing conducted in April and May, 2013. Multiple stakeholders

participated in the process, and substantial revisions were made to the draft permit. For the first time, the San Diego permit is watershed-based, and places all NPDES permittees within the Board's jurisdiction under a single MS4 Permit.

The presentation will describe the process that took place during the time between release of the Administrative Draft and final Permit adoption. It will also objectively present the major issues raised by the stakeholders, including alternative compliance strategies, and describe the ultimate outcome in the adopted Permit. The authors of the presentation worked closely with the San Diego Copermittees during the year-long process to identify the issues and develop and coordinate approaches to resolve the issues, and prepare formal comments.

Evaluating and Managing Water Protection and Restoration Activities

Characterization of Dissolved Solids in the Ohio River and Selected Tributaries

Samuel Dinkins, Lila Ziolkowski, Travis Luncan and Stacey Cochran
Ohio River Valley Water Sanitation Commission, Cincinnati, Oh.

Abstract
The Ohio River Valley Water Sanitation Commission (ORSANCO) adopted a 500 mg/L ambient water quality standard for total dissolved solids (TDS) in 2011 to protect drinking water utilities. This action was in response to episodic occurrences of elevated TDS on the Monongahela River, a tributary to the Ohio River, which limited the ability of some treatment plants to provide adequate treatment. At the time of the standard's adoption, however, very little data existed to define ambient background levels of TDS and its individual ion constituents. To fill this data void, the Commission initiated a study to characterize dissolved solids concentrations in the Ohio River.

The yearlong study involved collecting weekly samples at 11 Ohio River and 5 tributary ambient monitoring locations. Samples were analyzed for TDS and 14 individual ion constituents. Specific conductance was also measured for each sample to evaluate the appropriateness of using conductivity as a surrogate to estimate TDS concentrations.

TDS levels in the Ohio River ranged from 104 mg/L to 368 mg/L, with a median concentration of 215 mg/L. These results indicate that all Ohio River samples collected during the one-year study period, including those at low flow conditions, had concentrations well below ORSANCO's 500 mg/L standard for TDS.

Five ions accounted for nearly 93 percent of the TDS concentration measured in Ohio River samples. Sulfate routinely had the highest concentrations, typically comprising 31% of the total ions present. Bicarbonate was the second most abundant ion making up 25 percent of the total concentration. Calcium, chloride, and sodium accounted for 15 %, 12%, and 10%, respectively. The other nine ions included in the study collectively made up the remaining seven percent.

Site specific conversion factors to translate specific conductance to TDS all fell within a narrow range between 0.55 and 0.58, with an overall factor of 0.566 for the Ohio River. Commonly used conversion factors were found to be up to 20 percent greater than the site specific factors determined from this study. Use of such default conversion factors would overestimate TDS concentrations, and thus may not be appropriate for use on the Ohio River.

Monitoring the Banklick Creek Regional Wetland for Water Quality Improvement: Challenges, Results and Lessons Learned

Craig Frye[1], James Gibson[1] and Scott Bell[2]
[1]Sanitation District No. 1 of Northern Kentucky, Ft. Wright, Ky., [2]LimnoTech, Ann Arbor, Mich.

Abstract
Sanitation District No. 1 of Northern Kentucky (SD1) is a sanitary and storm water utility managing a service area covering more than 200 square miles in Northern Kentucky. In 2007, SD1 entered into a Consent Decree to address combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) in its service area. This agreement endorses an innovative watershed-based approach for improving water quality, including the development of watershed plans for sixteen watersheds and the provision that if nonpoint sources are contributing to water quality impairment, control measures to offset CSO controls or SSO elimination would be considered.

In developing its overall watershed plan for water quality improvement, SD1 considered a wide range of control measures, including regional-scale control measures, which lead to the concept of the Banklick Creek Regional Wetland. This project, which received Federal stimulus funding, is a pilot project consisting of six acres of constructed wetland to treat water diverted from adjacent Banklick Creek. The 58.2-square mile Banklick Creek watershed located in Kenton and Boone Counties is one of 16 watersheds in Northern Kentucky. Potential pollutant sources in this watershed include CSOs, SSOs, septic systems, KPDES-permitted discharge, livestock, storm water and streambank erosion. The primary pollutant of concern in the SD1 service area is bacteria. Instream monitoring conducted by SD1 shows that Banklick Creek has elevated bacteria counts even in dry weather and only attains recreational season standards 40% of the time.

Wetland operation and monitoring began in 2012 and has continued through the second operating season, which runs from April through November. This paper will describe the monitoring program that has been implemented for this innovative project over the past two years, the results that have been obtained the lessons learned in the process of monitoring and the adjustments made to the monitoring program. The monitoring and data assessment approach used for the Banklick Creek Regional Wetland may provide a valuable example for others designing and implementing similar water quality improvement projects.

Effectiveness of Buffers Installed at Targeted Critical Drainage Areas in Minnesota

John Hanzas[1] and Ron Struss[2]
[1]Stone Environmental, Montpelier, Vt., [2]Minnesota Dept. of Agriculture, St. Paul, Minn.

Abstract
A paired watershed study is being conducted in Minnesota to assess the effectiveness of semi-circular 30-foot grass buffers, installed around critical drainage points from corn and soybean fields, in reducing herbicide residues, sediment and nutrients in runoff water. These buffers are a voluntary Best Management Practice (BMP) recommended by the Minnesota Department of Agriculture (MDA). Previous research conducted by the University of Minnesota for the MDA using digital terrain analysis and SWAT modeling indicated that critical surface drainage points could be identified and pollution reduction per land area placed in BMPs can be maximized. The study includes a single, yearly pre-emergent application of herbicide at a reduced rate (another Minnesota BMP) and measurement of rainfall, runoff flow, herbicide residue, sediment and nutrients. Runoff events in 2010 yielded a strong statistical calibration between study watersheds. Minimal runoff data was collected during the 2011, 2012, and 2013 field seasons, however, encouraging preliminary conclusions can be drawn as to the effectiveness of this BMP.

Improving Waters – How Can You Tell?

Diane Wilson
Pennsylvania Dept. of Environmental Protection, Harrisburg, Pa.

Abstract
Pennsylvania has a wealth of surface water resources with over 86,000 miles of streams and rivers along with more than 160, 455 acres of lakes. These water resources are protected by a vast array of laws, regulations, policies and on-the-ground best management practices (BMPs). There have also been enormous efforts and resources invested by government at all levels and public groups across the state to restore and protect water resources.

It is estimated that since 2000, over $600,000,000 has been invested in BMPs to restore and protect water resources in the state. This effort has been primarily focused on non-point source (NPS) related restoration.

Despite these efforts, there are still a number of rivers, streams and lakes that are considered "impaired". According to the 2012 *Pennsylvania Integrated Water Quality Monitoring and Assessment Report*, DEP has found 16,343 miles to be impaired. The two largest sources of pollutants are agriculture and abandoned mine drainage. Urban runoff and storm sewers are also a major source of pollutants in metropolitan areas.

Similarly 37,015 lake acres were found to be impaired. The largest pollutant source is agriculture.

Since 2000 there have been 3295 miles of rivers and stream miles along with 5545 acres of lakes pond and reservoirs removed from the impaired waters list. In view of the large investments in water resource restoration and protection in PA, this may seem like slow progress. Some reasons for this may include: The significant lag time between removal or reduction of a pollutant source and the corresponding response in the water body; the lack of regulatory authority over NPS; and a delisting process that does not recognize incremental improvement. To address this PA Department of Environmental Protection has developed a process to define and document significant improvements in water quality in impaired streams, rivers and lakes due to regulatory compliance, grant driven and voluntary actions that result in progress towards delisting. The process will help in prioritizing watershed protection and restoration efforts.

Evaluating the Impact of Extreme Events – Natural and Man-made

Space-time Evaluation of Surface Water Quality of Alegria Stream Micro-basin (Uberaba, Brazil) using Environmental and Anthropic Variables

Maurício Guimarães and Eduardo von Sperling
Universidade Federal de Minas Gerais, Belo Horizonte, Brazil

Abstract
On June 10, 2003, a train crash occurred in Uberaba, Brazil, involving the derailment of eighteen wagons and the spilling of hazardous chemicals (methanol, octanol, isobutanol and potassium chloride) directly on the ground, affecting the water quality of Alegria Stream, an important tributary of the major Uberaba River. This paper describes the implementation of an intensive monitoring program and the results from a space-time evaluation of surface water quality in Alegria stream's micro-basin, using environmental and anthropic variables.

The study was based on the evaluation of analytical results from 292 monitoring campaigns in 9 sampling stations with a fortnightly average frequency during two periods: June 16 to August 8, 2003; and April 10, 2005 to July 4, 2012. The main parameters analyzed were: electrical conductivity, pH, chloride, soluble potassium and soluble iron. Concentrations of chloride, total iron and total potassium were also obtained from the analyses of 153 samples in 51 points distributed over the area of the accident in three distinct horizons (surface – 0.5 m; Intermediate – 1.0 to 2.5 m, and deep – 2.0 to 8.5 m) plus 10 samples (surface).

Variations of Chloride and Soluble Potassium in surface water presented a strong correspondence with rainfall periods, with concentration peaks often associated with the first rains and input of sediments to the river bed. During dry seasons the median concentrations of chloride and soluble potassium ranged from 0.500 to 1.730 mg/L and 0.681 to 1.405 mg/L, respectively. In rainy seasons these variations tended to be higher, with medians between 0.760 and 1.675 mg/L for chloride and between 1.221 mg/L and 1.660 mg/L for soluble potassium. These changes in chloride concentrations are associated with the use of fertilizers. The lithology composition seems to affect the availability of soluble potassium in surface water and, in a lesser extent, it is also related to the use of potash fertilizers in the drainage basins. Comparisons between chloride and soluble potassium concentrations from water samples collected downstream and upstream the point of the accident suggest that this event did not affect, in a long term, the water quality of Alegria stream.

Managing and Sharing Water Quality Monitoring Data

The AL-MS-KY Multi-State Configurable System for State Water Quality Data: Mississippi enSPIRE'd to Give a DAM About Enhancing ALAWADR

Valerie Alley[1], Natalie Segrest[1], Jeff Thomas[2], Russ Gibson[1] and Kosalram Gopalsamy[3]
[1]Mississippi Dept. of Environmental Quality, Jackson, Miss., [2]Ray Montgomery Associates, Inc., Jackson, Miss., [3]The GeoSpatial Group, Jackson, Miss.

Abstract
Alabama Department of Environmental Management (ADEM), Mississippi Department of Environmental Quality (MDEQ), and Kentucky Division of Water (KDOW) have joined in a collaborative effort to share a data management system customized to meet state-specific requirements, while retaining elements that allow for sharing new features and planning for system expansions. An oral presentation and two other posters at this conference describe the history and overview and details of the respective agencies' systems. ADEM developed the base system the Alabama Water Quality Assessment and Monitoring Data Repository (ALAWADR) and shared it with MDEQ and KDOW. MDEQ made minor enhancements to address gaps in business processes, and rebranded as enSPIRE. MDEQ was able to enhance the system to automate transfer of validated laboratory data from our laboratory system, and develop the Data Assessment Module (DAM). Modifications made to existing tables in ALAWADR to facilitate DAM include adding Designated Use Classification and freshwater or saline designation to the stations table. MDEQ developed the ability to house water quality criteria or thresholds for each applicable parameter and designated use combination. DAM applies logic for the appropriate parameter and designated use combination from data at each station, processing information behind the scenes. DAM then returns scorecards for each station that meet minimum data quantity and quality objectives. This scorecard provides an interpretation of data, highlights criteria violations, provides basic statistics and assigns a water quality impairment decision rating automatically for each parameter with results at the station. The scorecard is editable. Staff reviews the compiled information and assigns an attainment decision for the station. Edited scorecards are saved in the database, retrievable, and locked as read only at the end of the 305(b) cycle. Implementing DAM in the 2012 305(b) cycle saved MDEQ ~300 man hours in water quality data review, increasing efficiency of the water quality assessment

team as well as reducing errors in attainment decisions. MDEQ, ADEM and KDOW continue working together to share needed enhancements to the database and user interface with each other as part of the MSCS.

"Safe to Swim" Water Quality Webportal Development Survey to Support Freshwater Recreation

Erickson Burres[1] and Sonia Djordevic[1,2]
[1]SWRCB – CWQM Council – Safe to Swim Workgroup, Los Angeles, Calif., [2]University of California Los Angeles, Los Angeles, Calif.

Abstract
The "Is It Safe to Swim In Our Waters?" (aka "Safe to Swim") My Water Quality Portal (www.mywaterquality.ca.gov/safe_to_swim) run by the California Water Quality Monitoring Council (www.mywaterquality.ca.gov/monitoring_council) aims to inform and protect swimmers and waders (REC-1) from waterborne diseases. The monitoring of "beach" water quality is done by city and county health agencies, sewage treatment plants, environmental groups, citizen monitoring groups and others. While data is available for marine beach water quality, data for freshwater beaches and swimming areas are not as readily available. Help is needed in all 58 counties of California with collecting, interpreting, transforming, and sharing freshwater safe to swim water quality data.

In 2013 a project was conducted to investigate how to enhance the usability of an existing website to inform the public about safe to swim water quality for freshwater recreation. The project also investigated how the web-portal could promote collaboration, data sharing and otherwise assist agencies to provide better protection for swimmers/bathers within their jurisdictions and provide usable information for the recreating public.

Information was collected using an online survey from organizations that conducted water quality monitoring which included "safe to swim" water quality parameters, informed the recreating public about water quality or were otherwise involved with protecting freshwater swimmers and waders. Recommendations based on the survey results were prepared for the Safe to Swim Workgroup so that they can provide guidance to initiate web-portal improvements, promote data sharing via CEDEN and establish new collaborations.

Winter Stormwater Sampling – Data Management Challenges and Solutions

Amy Franz, Adam Wong, Cristina Grosso and Jennifer Hunt
San Francisco Estuary Institute, Richmond, Calif.

Abstract
There is great interest within the San Francisco Bay region in monitoring pollutants of concern migrating from our watersheds into our storm drain system and the Bay. San Francisco Estuary Institute (SFEI) has been leading a multi-year stormwater monitoring project within the San Francisco Bay area, fulfilling monitoring requirements under the Municipal Regional Stormwater Permit. Results are validated, uploaded to a centralized database, and made available online for project funders and the public. The project monitors six sites of various sizes and land use. The resulting data set includes more than 17,500 records including results for Mercury, PCBs, SSC, TOC, and nutrients. The scope of monitoring poses a particular data management challenge of coordinating communication and the exchange of data between internal staff, external partners, and analytical laboratories.

To address this challenge we instituted a detailed data management plan that included a document describing how to handle all of the project's components. We coordinated delivery of collection information by requiring the submission of a standard field datasheet. Staff coordinated with each sampling entity to determine standard codes for the equipment, locations and other collection information. A database was created using SQL Server, with procedures written for uploading field datasheets and electronic data deliverables, generating reporting templates, and retrieving data for processing. Tables were used to track incoming and outgoing transactions. A web-based review tool was developed to allow project funders to evaluate preliminary results as they were submitted by the laboratories.

Formal data processing began 30 days after the final storm event. All data were formatted using standard business rules and controlled vocabulary approved by the California Environmental Data Exchange Network (CEDEN). Results were internally reviewed according to the project's QA/QC protocol to evaluate if the data quality objectives were met. Project funders review the finalized dataset prior to uploading the data to CEDEN. Using CEDEN's web query tool (http://www.ceden.us/AdvancedQueryTool), these data can then be combined with other regional datasets to help address management questions on the contaminant loads entering the Bay.

Biological Monitoring for California's Diverse Aquatic Ecosystems

Dustin Harrison
California Dept. of Fish and Wildlife, Sacramento, Calif.

Abstract
California contains open ecosystems which are home to many diverse aquatic habitats, plants and organisms. With the highest population in the United States and increasing pressure from traffic and commerce, water quality monitoring has become a major topic of interest both to preserve Threatened and Endangered species and prevent the spread of Aquatic Invasive Species (AIS). The California Environmental Data Exchange Network (CEDEN) provides a central location to find and share information about California's water bodies, including streams, lakes, rivers, and the coastal ocean. Many groups in California monitor water quality, aquatic habitat, and wildlife health to ensure good stewardship of our ecological resources. Two programs practiced by the state which contribute to management of aquatic resources are the California Department of Fish and Wildlife's (CDFW) Scientific Collecting Permit (SCP) program and the State Water Resources Control Board's (SWRCB) Surface Water Ambient Monitoring Program (SWAMP). These two programs provide a platform to increase the opportunity of citizen monitoring and provide applicants with resources to gain knowledge and hands-on experience sampling California's biological indicators of water quality.

Managing Water Information for the National Wildlife Refuge System with the Water Resource Inventory and Assessment (WRIA) Application

Michael Higgins
US Fish and Wildlife Service, Fort Collins, Colo.

Abstract
The National Wildlife Refuge System (NWRS) is unique among federal land management agencies with a mission dedicated to the conservation, management, and restoration of fish, wildlife, plants, and their habitats. The success of this mission depends on reliable supplies of clean, fresh water; water is the lifeblood of the NWRS. As critical as water is to the 565 National Wildlife Refuges (NWRs) across the country, there has been no centralized system in place for managing water resource information. As such, it has been difficult to assess and prioritize needs and threats to refuge water supplies. In addition, the lack of a holistic view of existing monitoring efforts across the NWRS has hampered the ability to develop a nationally consistent, integrated effort to monitor refuge water quality and quantity. To address these limitations, the NWRS has developed a centralized, geo-referenced web-based database application to gather, store, and retrieve refuge water resource data. The Water Resource Inventory and Assessment (WRIA) application contains information

on water features, monitoring, water rights, water quality, water-related infrastructure, and hydroclimate for each NWR. The WRIA application also contains an assessment of water-related threats and needs for each refuge. This information can be queried and presented in a report for use at the refuge, regional, or national level. Although currently available only internally to FWS users, the plan is to eventually offer non-sensitive refuge water data on a public facing website.

Documentation Methods for Water Quality and Hydrologic Data Review

Jennifer Hill[1,2] and Amy Russell[1,2]
[1]University of Illinois at Urbana-Champaign, Champaign, Ill., [2]Illinois State Water Survey, Champaign, Ill.

Abstract
With the explosion of the amount and size of data generated in the sciences, the effort needed to process and review these data has likewise increased. Furthermore, raw environmental data often require interpretation by knowledgeable staff before the data are used in analyses.

Although there are many guidelines available for how to review and correct environmental data, there is little discussion on documenting the review process itself. This type of documentation can have many benefits, such as preserving a history of data transformations immune to staff turnover or the fallibility of human memory. In addition, standardizing methods for data review increases confidence in data quality and allows delegation of review responsibilities.

In this presentation we discuss our method for documenting water quality and hydrologic data review with the goal of preserving not only what was corrected, but why. Our method is intentionally flexible to accommodate the diverse nature of water quality data and requires minimal technological resources. Working examples of the recommended documentation from our own monitoring projects will be presented.

Susquehanna River Basin Commission Water Quality Portals

Dawn Hintz, Charles Frank and Thomas Clark
Susquehanna River Basin Commission, Harrisburg, Pa.

Abstract
As the general public becomes more aware of environmental concerns (climate change, alternative energy sources, etc.), the demand for access to environmental data has increased. The Susquehanna River Basin Commission (SRBC) is meeting the demand for water quality data by creating several water quality online applications.

In 2010, SRBC began collecting continuous water chemistry data in select watersheds in the shale producing region of the Susquehanna River Basin. These provisional data are transmitted on a two- to four-hour interval to an in-house SQL database and published to a Remote Water Quality Monitoring web site (http://mdw.srbc.net/remotewaterquality/data_viewer.aspx). Real-time data are not only available for viewing, but can be queried in various ways including mapping, graphing, basic statistical analysis, and downloading. The provisional data are corrected annually for instrument and fouling drift using Aquarius software, which creates a data processing log to document all changes. The corrected data are also available to the public.

In addition to the continuous water chemistry data web site, SRBC recently created two data portals, Water Quality and Mine Drainage, to provide an efficient method to disseminate sampling data to other agencies and the public. The Water Quality Portal (http://mdw.srbc.net/waterqualityportal) provides the public with discrete water chemistry, biological, and habitat data collected by SRBC; the Mine Drainage Portal (http://mdw.srbc.net/minedrainageviewer) is a compilation of chemical data associated with mine drainage in the Susquehanna River basin. The portals, a merging of databases, GIS, and web development allow the user to select, view, and download data immediately.

Through user-friendly web tools, SRBC now effectively and efficiently disseminates water quality data to other agencies and the public. This increased access to data provides a better understanding of human activities and their effect on water quality, and fosters better management approaches to mitigate those effects.

The AL-MS-KY Multi-State Configurable System for State Water Quality Data: Alabama Says, "WADR a Few Databases among Friends?"

Lisa Huff, Vickie Hulcher and Gina Curvin
Alabama Dept. of Environmental Management, Montgomery, Ala.

Abstract
Alabama Department of Environmental Management (ADEM), Mississippi Department of Environmental Quality (MDEQ), and Kentucky Division of Water (KDOW) have joined to form the Multi-State Configurable System Workgroup (MSCS). This is a collaborative effort to share a data management system customized to meet state-specific requirements, while retaining elements that allow for sharing new features and planning for system expansions. An oral presentation and two other posters at this conference describe the history and overview and details of the respective agencies' systems. ADEM developed the base system the Alabama Water Quality Assessment and Monitoring Data Repository (ALAWADR) and shared it with MDEQ and KDOW. ALAWADR is an open architecture, centralized ORACLE database that manages and stores all station information, water quality data, and observational data collected by the Department. The database is designed to support the basic STORET/WQX framework. It facilitates data entry for projects, sampling trips, station visits, and multiple types of field activities, including macroinvertebrate and fish bioassessments. It incorporates quality assurance procedures and import of laboratory results from the Department's Laboratory Information System, as well as electronic in situ field measurements. By starting with a functioning data management system, MDEQ and KDOW were able to leverage their limited resources to enhance ALAWADR with new modules and functionality. Through the collaborative MSCS effort, the three states are working together to share current and future enhancements.

Managing Monitoring Equipment: A Sensor Extension for the CUAHSI Observations Data Model

Amber Jones, Jeffery Horsburgh, Maurier Ramirez and Juan Caraballo
Utah State University, Logan, Ut.

Abstract
Research sites conducting long term monitoring using *in situ* sensors need the functionality to track equipment, deployments, calibrations, and other events related to site maintenance and to link this information to the observational data that they are collecting. The Observations Data Model (ODM) was designed to capture consistent descriptions of environmental observations and is implemented in a relational database system for storage and management. ODM 1.1 was intended for publication of point-based hydrologic observations using the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Hydrologic Information System (HIS). Because of its focus on data publication, ODM 1.1 does not provide all of the functionality needed to fully describe the data collection and management process for sensor and sample-based observations. Efforts are underway to develop a new version of ODM (ODM2) that better supports both management and publication of sensor and sample-based observations. ODM2 consists of a core set of entities common to all types of observational data that describe the location,

observed variable, and time of each observation. Additional metadata can be provided via extensions to the core to support particular types of observations. In this presentation, we describe a Sensors Extension to the ODM2 core and a set of tools that have been developed to enable research groups to better manage their sensor infrastructure. The Sensors Extension includes tables that store attributes of sensors and other pieces of field equipment, sensor output variables, information on sensor deployments, and details on field activities and factory service events. The Sensors Extension permits information about individual sensors and deployments to be recorded and managed, and the connection between the Sensors Extension and the ODM2 core will provide linkages between observations and the equipment associated with the observation. We will also present a case study where we are implementing and testing these tools for the iUTAH (innovative Urban Transitions and Aridregion Hydrosustainability) network of aquatic and terrestrial sensors. The Sensors Extension and associated tools will be useful for similar large scale and long term monitoring networks.

Release of the USGS Suspended-Sediment Data Portal for the United States

Casey Lee
US Geological Survey, Lawrence, Kans.

Abstract
The natural sedimentation cycle of erosion, transport, and deposition sustains habitats necessary for diverse aquatic ecosystems. However, accelerated or artificially decreased transport of sediments to streams and rivers can harm infrastructure and aquatic life through flooding, bridge scour, loss of wetlands, decreased primary productivity, decreased abundance of secondary consumers, and impaired feeding success of visual predators. Human-induced changes to sediment transport also can have substantial effects on water-quality, as sediment transport is a primary mechanism by which many of the chemical and biological agents that degrade water quality move through (or are deposited within) streams and rivers.

Since the first samples on the Rio Grande in 1889, the U.S. Geological Survey has been the primary entity collecting sediment data in small streams and large rivers across the United States. While the USGS maintains an extensive database of suspended-sediment and sediment-related data, these data have been difficult to interpret because (1) it is unclear where and when suspended-sediment data have been collected, (2) suspended-sediment and associated constituents are prone to bias when collected through non-representative sampling methods, and (3) there has been little aggregation of information which can help interpret sediment data, such as information on sediment grain size, streamflow, and landscape conditions.

The U.S. Geological Survey National Water Quality Assessment Program (NAWQA) summarized existing suspended-sediment and related data at more than 4,000 gaged sites in the United States to (1) identify biases and outliers using available information on sampling methods, streamflow conditions, and sediment grain size, (2) characterize data availability and sediment concentrations with respect to space, time, streamflow, and landscape conditions, and (3) allow users of this database to easily locate and download sediment and sediment-related data.

The data compilation and aggregation process culminated in the production of a USGS sediment data portal, which can be accessed at cida.usgs.gov/sediment. This presentation will describe the rationale for producing the portal and will show attendees how to use the portal to view, interpret, and access USGS sediment and related data.

Three Rivers QUEST – Managing and Displaying Water Quality Data throughout the Upper Ohio River Basin

Melissa O'Neal, Paul Ziemkiewicz, Glenn Waldron and Joshua Ash
West Virginia Water Research Institute, Morgantown, W.Va.

Abstract
The West Virginia Water Research Institute (WVWRI), a program of the National Research Center for Coal and Energy at West Virginia University, has been actively researching water related issues since 1967. When municipal water authorities were puzzled by the sudden increase of total dissolved solids (TDS) in late 2008, it was in the interest of WVWRI to find out what might be causing the changes in the water chemistry of the Monongahela River.

While numerous programs exist that monitor water quality, the data collected was either too sporadic or the studies reported on the total metals rather than the dissolved fraction of the samples. Seeing a need for thorough water quality monitoring on the Monongahela River, WVWRI began a project in 2009 known as the Mon River QUEST. The project, funded by the United States Geological Survey and WVWRI, has since won a Regional IMPACT Award by the National Institutes for Water Resources. In 2011, thanks to funding by the Colcom Foundation, the program expanded to include areas surrounding the Monongahela River, Allegheny River, and Ohio River – now called the Three Rivers QUEST.

Collectively, with the data input from grass-roots water monitoring organizations, the Three Rivers QUEST project, or 3RQ, manages data collected throughout the Upper Ohio River Basin. Analytical data resultant from the bi-weekly sampling of the research teams, field readings from volunteer efforts, and data from continuous loggers are all managed through the 3RQ Data Management Tools. Utilizing a secure log in, users are able to enter data independently and the tools assist key persons with managing data sets using various reporting features.

An interactive mapping platform on the project's website, www.3RiversQUEST.org, serves to display and disseminate resultant data to be used by federal and state agencies, researchers, industries, and the general public.

The AL-MS-KY Multi-State Configurable System (MSCS) for State Water Quality Data: Kentucky WADE-ing in Deeper with a Little Help from Our Friends

Lara Panayotoff, Melissa Miracle, C.J. Watts, Jo Blanset, Susan Cohn, Lisa Hicks and Jessica Schuster
Kentucky Division of Water, Frankfort, Ky.

Abstract
Alabama Department of Environmental Management (ADEM), Mississippi Department of Environmental Quality (MDEQ) and Kentucky Division of Water (KDOW) have joined in a collaborative effort to share a common data management system that is customized to meet state-specific requirements, but retains common elements that allow for sharing new features and planning for common system expansions. An oral presentation and two other posters at this conference describe the history and overview of this effort and details of the respective agencies' systems. ADEM developed the base system (called the Alabama Water Quality Assessment and Monitoring Data Repository, ALAWADR) and shared it with MDEQ and KDOW. KDOW is in the late stages of development of its modification of the system, called Kentucky Water Quality Assessment Data for Environmental Monitoring (K-WADE). KDOW's primary enhancements to the system have been to expand the biological data handling components and to make modifications to the system that will allow their current data partners to enter, manage and store similar projects and data. The enhanced system accommodates sampling information and results for fish, macroinvertebrates, algae, and mussel monitoring activities. Taxonomy reference tables incorporate flexible handling of species trait information to

facilitate addition of new traits in the future. Partners who submit biological community data to KDOW for assessment purposes (Kentucky Department for Fish and Wildlife Resources, Kentucky Nature Preserves Commission, and US Forest Service) will be able to access and use the system using a secure web login. Kentucky expects their system to be in routine use by summer 2014 for managing all of the agency's surface water monitoring projects and data, and flowing the data to STORET through WQX. Participation in the MSCS collaborative effort has allowed KDOW to make small modifications to match business processes, while focusing most time and resources on adding new features, significantly reducing costs and maximizing the scope of data and project types that can be accommodated. Components added by KDOW will be shared back with the group through future virtual and in-person meetings of the MSCS.

U.S. Geological Survey Surface-Water-Quality Data in Ohio

Kimberly Shaffer
US Geological Survey, Columbus, Oh.

Abstract
The U.S. Geological Survey's Ohio Water Science Center (OHWSC), in cooperation with local, State, and Federal partners, operates real-time surface-water-quality monitoring stations in Ohio. These stations provide hourly (or more frequent) data on one or more of the following parameters: temperature, specific conductance, pH, dissolved oxygen, and (or) turbidity throughout the State. These data are used for decision making regarding water supply, wastewater treatment, regulatory programs, recreation, ecosystem health, and public safety. Data are stored in the National Water Information System (NWIS) and can be accessed at http://waterdata.usgs.gov/oh/nwis/current/?type=quality&group_key=NONE. Streamflow data are available for many of these same sites, making it easy for NWIS users to explore the relationship between streamflow and water quality. The OHWSC uses outreach products such as quick-response codes, business cards, and factsheets to better share the availability of this data.

Strengthening Monitoring Collaboration and Partnerships

The Kentucky Agriculture Science and Monitoring Committee (KASMC)

Peter Cinotto[1], Kimberly Richardson[2] and Angela Crain[1]
[1]US Geological Survey, Louisville, Ky., [2]Kentucky Division of Conservation, Frankfort, Ky.

Abstract
The Kentucky Agriculture Science and Monitoring Committee (KASMC) was created in 2009 and now includes over 20 members representing a wide range of state, federal, and local agencies as well as academic institutions and the agricultural industry. Membership continues to expand along with KASMC activities - new members are continually being added. KASMC members work collectively to coordinate resources and expertise in order to address the agricultural science and monitoring needs of the citizens of Kentucky; to date KASMC members have collaborated on numerous proposals, projects, and outreach efforts. KASMC meetings are generally held quarterly at locations across Kentucky along with field trips to agricultural facilities. Subsequent to its formation, KASMC now also serves as a subcommittee under Kentucky's Agriculture Water Quality Authority (AWQA) and provides information to help resource managers steer Kentucky's agricultural policies in that role.

Partnerships in Studying the Efficiency of a Stormwater Wetland

Kristine Hopfensperger and James Brown
Northern Kentucky University, Highland Heights, Ky.

Abstract
Unique collaborations were created to study the function and efficiency of a recently restored stormwater wetland located at an elementary school in Burlington, KY. The US EPA through a private company reached out to a local university to begin this effort. A biology faculty from the university worked with representatives from the EPA and the private company to create the study plan. Input from the company that restored the habitat was integral. With undergraduate research students, the professor set-up the field site in spring of 2012 and collected data for two years. We collected storm event data using automated samplers and measured samples in the laboratory for nitrate, ammonium, phosphorus, and total dissolved and suspended solids for both study years. In year two of the project, we expanded the study so that we could calculate complete nutrient flux in the wetland. To do this we partnered with a geology class at the university who completed a bathymetric survey of the wetland. We also had an undergraduate environmental science intern delineate the wetland using geographic information systems, and then calculate the percent of different land covers within the wetland's watershed. Undergraduate students also deployed water level loggers into the field, so we could calculate volume changes in the wetland during storm events. Through this study we have learned about the successful restoration of the stormwater wetland. The wetland is functioning well by holding water for longer than was originally predicted and by removing nutrients before discharging the water downstream. In addition, this project has been most successful in bringing together the US EPA with a restoration company and a local university including faculty from multiple departments and providing seven undergraduate students invaluable real-world experience.

Cooperative Science and Monitoring Initiative – Attempting Adaptive Management on Large Ecosystems

Paul Horvatin and Glenn Warren
US Environmental Protection Agency, Chicago, Ill.

Abstract
The Cooperative Science and Monitoring Initiative is a joint U.S./Canada effort to provide data and scientific synthesis to environmental managers of the Great Lakes. The five Great Lakes are visited in a five-year rotation: planning based on preceding scientific synthesis and addressing stated management data needs drives the intensive field year on each lake. As normally viewed, adaptive management requires experimentation to address areas of uncertainty in managing resources. In systems as large as the Great Lakes, in situ experimentation is difficult and costly. Intensive monitoring, modeling and scientific consensus are substituted for experimentation for most Great Lakes problems. Long-term monitoring serves to assess the results of previous management decisions. We will discuss our attempts to develop this approach to providing the science necessary for resource management decisions.

The Ohio River STEM Institute: A University-Community Partnership Bridging STEM Disciplines, Student Monitoring and Environmental Stewardship

Heather Mayfield[1] and Miriam Kannan[2]
[1]Northern Kentucky University, Highland Heights, Ky., [2]Foundation for Ohio River Education, Cincinnati, Oh.

Abstract
The Ohio River STEM Institute began as a partnership between the Foundation for Ohio River Education and Northern Kentucky University's (NKU's) Department of Biological Sciences. The goal of the partnership is to bring the STEM disciplines to life through innovative, inquiry-based activities that foster a strong a sense of connection and stewardship of the Ohio River.

Through this partnership, NKU and FORE have collaborated on a variety of programs that have focused on water quality monitoring, Ohio River Ecology, and current pollution issues, for a diverse collection of audiences including students in grades 4-12, science teachers, watershed volunteers, environmental educators, NKU students, English Language Learners, and communities. In 2013, the Ohio River STEM institute focused strongly on immersing underserved and minority audiences and delivered five exceptional programs that exposed students to water quality monitoring on the Ohio River as well as careers in source water protection and water quality treatment.

Another outcome of the Ohio River STEM Institute was the development of WaterQuality 1.1, a new mobile application developed by FORE and NKU that enables citizen monitors, teachers and students to easily log and interpret water quality data from rivers, lakes and streams.

This poster presentation will highlight Ohio River STEM Institute monitoring programs for underserved audiences as well as the WaterQuality 1.1 app.

Building Partnerships to Monitor the Condition of Streams and Rivers on Public Lands

Scott Miller[1], Sarah Judson[1], Jennifer Courtwright[1], Ellen Tarquinio[2], Steve Paulsen[3] and Tony Olsen[3]
[1]Bureau of Land Management / Utah State University, Logan, Ut., [2]US Environmental Protection Agency, Washington D.C., [3]US Environmental Protection Agency, Corvallis, Oreg.

Abstract
The Bureau of Land Management (BLM), in collaboration with the U.S. Environmental Protection Agency (EPA), will conduct its first Western Rivers and Streams Assessment (WRSA), a survey of the condition of BLM streams and rivers throughout the contiguous western U.S. The objective of this effort is to generate unbiased, quantitative baseline conditions from which regional and national aquatic priorities can be established and future conditions can be compared. The BLM is partnering with the EPA's National Rivers and Streams Assessment (NRSA) to intensify the NRSA design on BLM lands, and implement sampling of perennial streams and rivers to accomplish this task. The WRSA will provide the first-ever statistically valid estimates of the chemical, physical and biological condition of streams and rivers managed by the BLM. In this partnership, BLM is using a comparable survey design and the same field methods and indicators as the EPA and State effort. This level of partnership maximizes the use of the generated data and makes best use of the taxpayers' resources available for monitoring.

The WRSA is a component of the BLM's Assessment, Inventory and Monitoring (AIM) strategy designed to standardize aquatic data collection and facilitate science-based decision making on public lands. Similar to the EPA's NRSA, the WRSA will answer three central questions: 1. What percentage of BLM's streams and rivers are in good, fair or poor biological condition; 2. What is the linear extent of streams and rivers experiencing stressors such as excessive nutrients, high salinity, excess fine sediments and invasive invertebrates; and 3. What is the risk posed by the observed stressors to biological condition?

To answer these questions, the BLM will sample approximately 300 sites (both wadeable and non-wadeable) between 2013 and 2015, in collaboration with the EPA and western states. Statistically representative sites will be selected to derive condition estimates for at least three different spatial scales: 1. West-wide; 2. Three EPA western climatic regions and 3. Six hybrid Level III Ecoregions that encompass 95% of the linear extent of BLM's rivers and streams in the contiguous western U.S.

Citizen Volunteers versus Trained Field Technicians: Pros and Cons of Each in the Collection of Lake Samples

Daniel Obrecht, Anthony Thorpe and John Jones
University of Missouri, Columbia, Mo.

Abstract
The University of Missouri Limnology Laboratory oversees two long-term, statewide lake monitoring efforts. The Statewide Lake Assessment Program (SLAP) employs students as field technicians to collect water samples while the Lakes of Missouri Volunteer Program (LMVP) relies on citizen volunteers. Water quality data from the two projects have been shown to be quite comparable, a finding that is not surprising given analyses for both projects are conducted in the same laboratory using the same analytical methods. Besides differences in who is doing the sample collection, the programs differ in terms of monitoring protocol. These differences include the length of the monitoring season, number of samples collected within a season, and the number of sites on individual water bodies. This presentation will highlight the differences between the two programs, with a focus on the pros and cons of utilizing citizen volunteers in the collection of lake water quality data.