Poster Session A

Pre-Function Lobbies (Concurrent Session Level)
9:30 am – 10:30 am

0415
New England – New York Pilot Climate Change Monitoring Network

Jen Stamp[1], Anna Hamilton[2], Britta Bierwagen[3], Lei Zheng[4], Benjamin Jessup[1] and Jeroen Gerritsen[4]

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Tetra Tech and the EPA's Global Change Impacts and Adaptation Group recently completed work on a project to facilitate the development of a pilot climate change monitoring network in New England and New York. This region was selected as a pilot largely because of the motivation and close interactions between regional state bioassessment scientists to incorporate climate change into revisions of their existing monitoring programs, and their desire to work interactively to increase efficiency of these additional efforts. In this presentation we discuss the process we followed while developing monitoring network design options. This included setting up a regional steering committee comprised of biologists from state biomonitoring programs, EPA, USGS and other agencies and organizations, from whom we solicited input on objectives and key elements of the network. We conducted a series of analyses to lay the analytical foundation for network design. These included exploration of stream classifications to define appropriate regional strata; analysis of variance structure in biological data and power analyses to inform sampling intensity (*e.g.*, number of sampling sites per stratum) and frequency; assessment of reference conditions and criteria for site selection; and a climate change vulnerability analysis to further focus site selection in concert with classification. Other aspects of the design - such as what parameters should be collected, what methods should be used, and what indicators should be tracked over time - were informed by analyses of long-term regional biomonitoring data, as well as practical considerations. Consideration also was given to structuring the network to allow for expansion beyond the current target population of freshwater medium-high gradient wadeable streams, for inclusion of data from other entities (*e.g.*, tribes, nonprofits, academia, volunteer groups), and for integration with other existing efforts regionally and nationally, such as the USGS Hydrologic Climate-Response Program in New England and EPA OWOW's National Aquatic Resource Surveys.

0146
P

Snap Shot Monitoring of the Niangua River Watershed – Part II, Results from a Large-Scale Monitoring Effort with Reflections on Data Presentation

Daniel Obrecht, Anthony Thorpe and John Jones

Univ. of Missouri, Columbia, Mo., USA

Citizen volunteers (with a little help from project staff) collected 85 water samples from 78 sites within the Niangua River watershed (2650 km^2) on a single day. Sites included springs, intermittent and permanent flowing streams, navigable rivers, and lentic sites in a tributary arm of a large reservoir. Water quality varied considerably among sites, with total nitrogen and total phosphorus ranging one and two orders of magnitude, respectively. Conductivity varied the least, yet still differed by a factor of four. This poster will review some of the results of the monitoring, with a focus on presenting the data in a public-friendly yet meaningful way. This poster is a follow-up to Snap Shot Monitoring of the Niangua River Watershed – Part I, which laid out the planning and organization of the sampling event.

0464
Innovations in Sharing Water Quality Data and Identifying Sources of Impairment

TK Conrad

Windsor Solutions, Inc., Portland, Oreg., USA

The EPA Exchange Network has been steadily expanding to enable a growing number of organizations to seamlessly exchange environmental data. Over the last few years, one innovative application of the Network has been used to support emergency responders by supplying important and timely environmental data into their hands.

The Homeland Emergency Response Exchange (HERE) has just completed a recent expansion to include water quality

monitoring data. The Exchange now provides end users with a PC application (the HERE Client) that collates data from many data providers. The client also includes advanced capabilities to support the analysis of monitoring data in conjunction with data identifying local potential sources of contamination, such as spill remediation sites, flooded chemical storage locations, and wastewater dischargers.

As a recent example of its use in action, in late 2011, HERE was employed to support the Gulf of Mexico Alliance (GOMA) to evaluate water quality data collected after the Deepwater Horizon oil spill within the Week's Bay estuary in Alabama, and the St. Louis Bay in Mississippi. GOMA's needs are prime examples where HERE provides a unique solution, as the necessary assessment requires data from multiple neighboring state agencies to be combined to support the evaluation, restoration, and promotion of the general health of the Gulf and other co- managed waterbodies.

This tool was funded by EPA and a growing number of State government agencies, and is publically owned and freely accessible. During this session the PC based tool will be demonstrated, along with an explanation of the infrastructure that is in place that allows water quality and point source data to be shared in an automated and highly-compatible way.

Please see http://www.herenetwork.org/ for more information.

0528
P

To Wade or Not to Wade? Inquiring Minds May Want to Know

David Peck[1] and Elizabeth Smith[2]

[1]US Environmental Protection Agency, ORD National Health and Environmental Effects Research Laboratory, Western Ecology Division, Corvallis, Oreg., USA, [2]Kansas Dept. of Health and Environment, Bureau of Environmental Field Services, Topeka, Kans., USA

The target population for the USEPA National Rivers and Streams Assessment (NRSA) includes features ranging from headwater streams to Great Rivers. A sample frame is the spatial representation of the target population. For various reasons, a portion of the frame is non-target because the channel at the sampling point is dry. Sites are sampled by wading ("wadeable" sites) or by boat or raft ("boatable" sites). Knowing whether a steam or river site is dry, and which mode of sampling is required before visiting it to sample has important logistical implications related to scheduling equipment and field crews. We looked at dry streams identified in NRSA either before or at the time of a sampling visit, and the mode of sampling (wadeable vs. boatable), as it related to Strahler order among nine aggregated Omernik ecoregions ("regions"). Nationally (n = 2,135), 10% of the sites were dry when visited. In six regions, > 20% of 1st order sites were dry when visited. In the northern plains aggregated ecoregion, > 20% of sites in orders 1-4 were dry when visited. For the sites sampled (n = 1,960), >95% of 1st through 3rd order sites were wadeable, There was more uncertainty in sampling larger order stream sites by boat, ranging from 56-100% for 5th through 8th order sites. In the northern plains region, ≥ 90% of 1st-6th order streams were wadeable. In three regions, ≥ 90% of 1st-4th order streams were wadeable. In four regions, ≥90% of the 1st-3rd order sites were wadeable. In the northern Appalachians region, ≥ 90% of sites 5th order or larger were boatable. In three regions, ≥ 90% of sites 6th order or larger were boatable. In three other regions, ≥ 90% of sites 7th order or larger were boatable. Results of these comparisons focus site evaluation efforts in future monitoring studies to reduce the number of dry streams that are visited, and help determine the mode of sampling required so field crews are more efficient with sampling equipment and scheduling. 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.

0271
P

Engaging Farmers in the McKenzie Watershed

Nancy Toth and Karl Morgenstern

Eugene Water & Electric Board, Eugene, Oreg., USA

The McKenzie River is the sole source of drinking water for over 200,000 people in Eugene, Oregon. The Eugene Water & Electric Board (EWEB) has developed a comprehensive source water protection program to protect the excellent water quality of the McKenzie as a valuable drinking water resource for current and future generations. EWEB has identified a number of threats to water quality, one of which is runoff from agricultural lands. At the same time, EWEB recognizes that agricultural land is a preferred land

use to increasing development and would like to help farmers increase their economic viability in order to protect farmland from development pressures. In order to address this issue, EWEB has created a Healthy Farms Clean Water Program to engage farmers in the watershed and to encourage sure

EWEB's Healthy Farms Clean Water Program is designed to encourage sustainable agricultural practices in the watershed and ultimately strengthen food supplies to local communities while protecting regional drinking water resources. In this project, EWEB will focus on engaging growers and providing financial incentives to: 1) reduce chemical storage on farms; 2) reduce chemical use and/or transition to certified organic crops; 3) provide access to local markets that tend to pay more for crops; and 4) encourage growers to participate in programs designed to increase energy efficiency, incorporate renewable energy, reduce water consumption and protect and/or restore riparian habitat.

Another related initiative is the Berggren Watershed Conservation Area (BWCA) Demonstration Farm. The BWCA was purchased with funds from the Bonneville Power Administration (BPA) and EWEB primarily to mitigate for hydropower impacts on the river and is owned by the McKenzie River Trust (MRT). This 92 acre property contains about 60 acres of riparian habitat which will be restored and maintained for fish and wildlife habitat. The remaining 30 acres will become a demonstration farm designed to demonstrate a variety of sustainable farming and land management practices to reduce chemical inputs and show how farming can coexist with riparian floodplain areas. Educational programs and workshops will be developed for both students and for local farmers.

0238
P

The Maryland Water Monitoring Council: Furthering the Cause of Water Monitoring in Maryland

Daniel Boward

Maryland Dept. of Natural Resources, Annapolis, Md., USA

Now in its 17th year, the Maryland Water Monitoring Council has effectively fostered communication, collaboration, and cooperation among agencies and organizations monitoring and managing water throughout the State. Other goals include facilitating collaborative watershed-based monitoring strategies, documenting and sharing information about monitoring activities, and promoting quality-assured procedures for collection, analysis, assessment and data management. Technology-based tools include the MWMC website, email lists, and social media. Several hands-on workshops and a very successful annual conference provide excellent forums for learning, networking and sharing ideas. Workshops include an annual Stream Monitoring Roundtable, Benthic Macroinvertebrate Identification, Vernal Pools, Innovative Monitoring Equipment, and Reference Conditions. Full of energy and good ideas, the 25-member all-volunteer Board of Directors guides the Council toward its goals. Committees include Monitoring and Assessment, Community Outreach and Citizen Stewardship, and Information Management and Communication. Challenges, successes and goals for the next 17 years will be discussed.

0388
P

New Jersey Water Monitoring Council: Strengthening Monitoring Collaboration and Partnerships Across a State Water Monitoring Community

Alena M. Baldwin-Brown1, Leslie J. McGeorge1 and Robert G. Reiser2

1New Jersey Dept. of Environmental Protection, Water Monitoring and Standards, Trenton, N.J., USA, 2US Geological Survey New Jersey Water Science Center, West Trenton, N.J., USA

The New Jersey Water Monitoring Council (NJ Council) was formed on World Water Monitoring Day in 2003, with a common interest among its members in integrating and strengthening the State's water monitoring community. The NJ Council's vision is to provide a water information foundation for the management and protection of the State's aquatic resources. The mission of this consensus-driven organization is to promote coordination, collaboration and communication of scientifically sound water data. Membership includes federal, state, regional and local government entities, interstate organizations, academia, water and wastewater utilities authorities, and the volunteer monitoring community. Goals are: facilitating monitoring technology transfer; enhancing data exchange and compatibility; promoting partnerships and efficient use of monitoring resources; developing support for monitoring and assessment; identifying water research needs; and learning from other national/state councils.

Throughout its nine years of operation, the NJ Council has sustained an ability to strengthen collaboration and partnerships through a number of mechanisms, including an active Steering Committee and core group of members, leadership from the state environmental agency and the USGS NJ Water Science Center, modest USEPA grant support, a focus on meeting members' technical information

needs, and bringing members useful monitoring information via the National Water Quality Monitoring Council (NWQMC). The NJ Council's meetings and its website (www.state.nj.us/dep/wms/wmcchome) facilitate access to members' data and information, and provide an online reference through both its repository of technical presentations and its inventory of continuous monitoring sites. The Council has played a key role in developing and populating NJ's water quality data management system, and has increased the use of data external to the State programs for NJ Integrated Water Quality Monitoring and Assessment Reports. Other Council products include three state water monitoring workshops and several trainings. NJ Council participation in NWQMC-sponsored webinars, and use of NWQMC's website help bring value-added national perspectives to the State. Partnerships facilitated via the NJ Council include: Delaware Basin Pilot for the National Monitoring Network: NJ Pilot for the National Groundwater Monitoring Network; and a new Barnegat Bay Comprehensive Ambient Water Monitoring Project, resulting from a Governor's priority initiative.

0252
P

Hydrologic Mixing of Geothermal and Alluvial Groundwater in Dixie Valley, Nevada

Michael R. Rosen, Jena Huntington and C. Amanda Garcia

US Geological Survey, Carson City, Nev., USA

Dixie Valley, located in north-central Nevada, is a hydrologically-closed groundwater flow system that terminates in the Humboldt Salt Marsh, a moist playa lakebed. The basin is a fault-bounded graben structure bordered with steep mountains to the east and west. Fresh groundwater occurs in the alluvial aquifer system around the margins of the basin and becomes hypersaline towards the playa center. Since 1988, a 62 megawatt double-flash geothermal power plant has operated northwest of the playa. Due to reduced pressure from pumping of the geothermal water, cold alluvial groundwater has been used to maintain pressure heads over the geothermal field. Currently, alluvial groundwater is being considered for drinking water export; however, several studies conducted in the 1990s indicated that there is some interaction between the geothermal and alluvial aquifer systems. Therefore, understanding the degree of mixing between geothermal and alluvial aquifer systems is necessary to evaluate the potential groundwater resource. Geothermal and alluvial aquifer similarities and chemical evolution were evaluated using chemical data from geothermal wells, alluvial wells, springs and streams. Geothermal indicators such as elevated temperature, lithium, boron, chloride, and silica indicate that mixing occurs in many wells tapping the alluvial aquifer particularly in the south and west sides of the basin. Geothermal waters have high lithium and boron concentrations and low magnesium, whereas alluvial aquifer water derived from volcanic rocks in the basin have high magnesium and low lithium concentrations. Silica concentrations in alluvial groundwater is typically greater than 30 mg/L, which is often indicative of a geothermal source; however, silica might also be derived from weathering of volcanic tuffs and diatomite that occur in the basin. Mixing ratios of end member geothermal and alluvial aquifer water indicate that approximately 15 percent of the elemental concentrations found in the alluvial groundwater might be derived from geothermal water.

0202
P

Water Availability and for the Future – Is Brackish Groundwater the Answer for Growth and Sustainability

Steven Sagstad[1] and Deborah Patton[2]

[1]*Civil & Environmental Consultants, Inc, Phoenix, Ariz., USA,* [2]*Rural Community Assistance Corporation, Phoenix Ariz., USA*

This paper presents a look at brackish groundwater in the US, describes the abundance and difficulties in extraction and treatment, and provides case studies that identify the challenges associated with economic development. Local groundwater resources have historically been the principal source of potable water supplies of many large and small cities. Tribes, towns and cities are feeling the pressures of population growth creating additional demands on already over drafted aquifers. As demand grows, pressure grows to bring water sources on-line that were not previously utilized due to less desirable qualities (TDS, Nitrate, Arsenic), such as brackish groundwater.

The roadblocks associated with developing brackish groundwater includes permitting (disposal of brine), well head treatment and larger scale pretreatment, concentrate management, and re-use of concentrate. After 10 years of a persistent drought, the accompanying reduction in recharge to groundwater, water levels in the potable aquifers have declined significantly. The drop in groundwater levels along with significant reduction in well production capacity and water quality throughout the western US, has caused local tribes, towns and cities to monitor and investigate the need to develop alternative supplies developing very different approaches to groundwater management.

Without having untapped potable groundwater resources available for supply, brackish groundwater availability evaluations are becoming common to obtain an estimate of sustainable use. Consequently, adaptive measures to meet long-term water demands have

been identified and implemented by water purveyors in several states, which includes developing these alternative water sources. The unique nature of the local hydrogeologic conditions throughout the West makes the case studies presented herein a prime example of the challenges that water providers in the semi-arid Southwestern US may face in the coming decades. Adaptation to loss of potable groundwater supplies and development, treatment and disposal of treatment concentrate of poor quality groundwater will determine how growth will play out. Therefore understanding available resources with planning for future needs is critical in developing sustainable water supplies.

0258

Wisconsin Intensification Study of Lake Michigan Basin Wetlands: Combining Quantity Trends and Condition Assessment

Thomas Bernthal

Wisconsin Dept. of Natural Resources, Madison, Wis., USA

The National Wetland Condition Assessment will provide a snapshot of baseline condition of the wetlands of the 48 conterminous states, using the USFWS Status and Trends plots as the sample frame. Condition will be reported by 7 broad wetland types across 9 ecoregions.

The Wisconsin Intensification Study focuses in on a portion of the Lake Michigan Basin in Wisconsin that lies primarily within the Glacial Till Plains ecoregion where agricultural and urban land uses predominate. The geographical boundaries of the study area were chosen to maximize homogeneity of land use and ecological context so that results of the probabilistic survey will be more representative of the sampled area, while still retaining watershed boundaries.

The wetland condition portion of the study employs the same methods as the NWCA, therefore the results can be added to the national dataset. The wetland quantity portion of the study uses the Status and Trends mapping and analytical methods to report on changes in wetland quantity by the 5 freshwater types. Aerial photography from 1980, 1991 and 2008 is used to determine wetland quantity changes between 1980 and 1991 and between 1991 and 2008.

By combining analysis of wetland quantity and condition a more comprehensive report on wetland status can be produced. Wetland condition results will represent a baseline measurement to be used for comparison with any future surveys of the same area.

0441
P

Relations Between Hydrology, Water Quality, and Taste-and-Odor Causing Organisms and Compounds in Lake Houston, Texas, April 2006 – September 2008

Lee Bodkin, Jennifer Graham and Mike Lee

US Geological Survey, Houston, Tex., USA

Lake Houston is a surface-water-supply reservoir and an important recreational resource for the city of Houston, Texas. Growing concerns over water quality in Lake Houston prompted a detailed assessment of water quality in the reservoir by the US Geological Survey in cooperation with the City of Houston. The hydrologic and water-quality conditions influencing the occurrence of taste-and-odor causing organisms and compounds in Lake Houston were assessed using discrete and continuously monitored water-quality data collected during April 2006-September 2008. The hydrology of Lake Houston is characterized by rapidly changing conditions. Likewise, the reservoir can stratify and destratify over a period of several hours, even during non-summer and at relatively short water residence times, given extended periods with warm temperatures and little wind**.** The rapidly changing hydrology likely influences all other aspects of water quality in Lake Houston, including the occurrence of taste-and-odor causing organisms and compounds. The taste-and-odor causing organisms cyanobacteria and actinomycetes bacteria were always present in Lake Houston. Cyanobacterial biovolume was largest during summer (June-September) and when water residence time was greater than 100 days. Annual maxima in cyanobacterial biovolume occurred during July-September of each year, when temperatures were larger than 27 degrees Celsius and water residence times were longer than 400 days. In contrast, actinomycetes bacteria were most abundant during non-summer and when water residence times were less than 100 days, reflecting the close association between these organisms and transport of suspended sediments. Geosmin and 2-methylisoborneol are the taste-and-odor causing compounds most commonly produced by cyanobacteria and actinomycetes bacteria. Geosmin was detected more frequently (62 percent of samples) than 2-methylisoborneol (29 percent of samples) in Lake Houston. Geosmin exceeded the human detection threshold (10 nanograms per liter) only once during the study period and 2-methylisoborneol exceeded the human detection threshold twice. Reservoir inflow (water residence time) and turbidity, variables related to the abundance of potential taste-and-odor causing organisms, are currently (2011) continuously measured

in Lake Houston, and predictive models could be developed in the future when the hydrologic and water-quality conditions associated with taste-and-odor problems have been better quantified.

0561
P

Field Guides for Inventory and Monitoring of Groundwater Dependent Ecosystems on National Forests and Grasslands

Christopher Carlson[1], Joseph Gurrieri[2], Leslie Bach[3] and Allison Aldous[3]

[1]USDA Forest Service, Washington, D.C., USA,[2]USDA Forest Service, Golden, Colo., USA,[3]The Nature Conservancy, Portland, Oreg., USA

The Forest Service, in cooperation with The Nature Conservancy, has produced a set of Field Guides for inventory and monitoring of groundwater dependent ecosystems (GDEs). These Field Guides will provide the agency with a consistent and scientifically sound approach to characterizing and monitoring groundwater-dependent resources on agency-managed lands. With new demands on water resources within and adjacent to National Forests and Grasslands, predicted scarcity of water due to current uses, energy development, and climate change, GDE resources are increasingly threatened. Groundwater-dependent ecosystems (GDEs) include numerous regionally and nationally significant ecosystems such as springs, many wetlands and riparian areas, and cave/karst regions. Strongly groundwater dependent systems occupy only a small percentage (1% or 2%) of the land area. However, these groundwater-fed systems are highly significant from a conservation perspective because in water-limited areas or in thermally-stressed aquatic systems, these locations of focused groundwater discharge concentrate biodiversity, and serve as refugia for sensitive species. The Field Guides present options for different levels of intensity of data collection, depending on objectives and priorities, available resources, and spatial and temporal scales of interest. The Level I Field Guide, aimed toward informing land management planning and large scale assessments, primarily describes the GDE type, location, extent, current uses, physiographic and geologic setting, and general ecological conditions. The Level II Field Guide, designed for project-level design and monitoring, captures all Level I information and also includes field methods to inventory and monitor springs, fens and other wetlands, with focus on the measurement of hydrology, soil, geology, and vegetation-related parameters. Rigorous field testing at several locations across the US produced a user-friendly product and proved that the methodology is applicable in a wide range of different ecological and climatic locations. The Field Guides will be published in 2012 and available in hard copy and on the web for use by the wider monitoring community.

0088
P

Guidelines for Design and Sampling of Water, Sediment, and Biological Quality in Lakes and Reservoirs – A New Chapter in the US Geological Survey National Field Manual for the Collection of Water-Quality Data

Reed Green and Franceska Wilde

US Geological Survey, Arkansas Water Science Center, Little Rock, Ark., USA

The US Geological Survey (USGS) develops sampling procedures and collects data necessary for accurate assessment and management of our Nation's surface-water and groundwater resources. Federal and State agencies, water-resource regulators and managers, and many organizations and interested parties in the public and private sectors depend on the reliability, timeliness, and integrity of USGS data and the scientific soundness of USGS data assessments and analyses. The standard data-collection methods used by USGS water-quality personnel are peer reviewed, updated as needed, and published in the National Field Manual for the Collection of Water-Quality Data. A new chapter in this National Field Manual is being drafted to include guidelines for the design of sampling strategies for water, sediment, and biological quality of lakes and reservoirs. Included in this document will be a discussion of the differences between natural lakes and constructed reservoirs that may require different monitoring strategies for specific objectives. General data-collection considerations will include selection of sampling methods, field preparations, safety precautions, and documentation of quality-assurance procedures and onsite practices and observations.

0230
P

Testing Landscape Metrics as Indicators of Lake Ecological Condition

Lillian Herger, Peter Leinenbach and Gretchen Hayslip

US Environmental Protection Agency, Region 10, Office of Environmental Assessment, Seattle, Wash., USA

Landscape metrics generated by GIS may be useable for estimating lake ecological conditions as they can integrate conditions over

the broader watershed contributing area. Our goal was to identify and test landscape metrics as indicators of lake watershed condition with the following objectives: 1) evaluate a large group of available landscape metrics to identify a shorter list of those with the most potential for estimating lake watershed condition and 2) use the best metrics from the short list to describe lake watershed condition for the Western Mountains portion of the Pacific Northwest from the National Lakes Assessment and compare results to physical habitat indicators.

This analysis uses watersheds from 101 lakes sampled in the Pacific Northwest as part of the National Lakes Assessment. We evaluated 60 basin-scale landscape metrics at various buffer widths for each sample lake. Those with the strongest relationship to lake disturbance/response indicators were retained. The best landscape metrics were: forest cover, scrub-shrub cover, potential Unit Grazing, and RUSLE cover factor. These best landscape metrics were then converted to condition indicators by setting thresholds for each based on reference site data.

The thresholds calculated for the four landscape indicators were applied to the Western Mountains lakes data yielding the relative percents of sites within least disturbed, somewhat disturbed, and most disturbed categories. These results were compared to the physical habitat indicator used in the National Lakes Assessment for the same western mountain sites. The four landscape indicators yielded results similar to the physical habitat indicators. With further refinements, these landscape indicators may serve as a reasonable substitution for field data from lakes that are too large to efficiently collect physical habitat field data. Landscape metrics are generated uniformly for all sites, which is useful when lake size prohibits adequate field collection of physical habitat data from lake shoreline zones.

0359
P

Modeling of Phosphorus Dynamics in a Deep Reservoir in the Asian Monsoon Region (Lake Soyang, Korea)

Yoonhee Kim, Sungmin Jung, Jaesung Eum, Jai-ku Kim and Bomchul Kim

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The phosphorus cycle was studied in a deep stratified reservoir, Lake Soyang, Korea, in the summer monsoon region, by surveying phosphorus derived from the watershed and the movement of phosphorus within the reservoir. The spatial and temporal distribution of phosphorus within the reservoir was modeled with a 2-dimensional water quality model (CE-QUAL-W2, V.3.6). Phosphorus loading was calculated by measuring Total Phosphorus (TP) in the Soyang River, which is the primary input to the reservoir. Data was collected weekly during the dry season and daily during stormy weather, from 1999 to 2002. TP loading from the watersheds was calculated to be 252~920 $kgP \cdot yr^{-1}$. TP loading during the rainy season (July through September) accounted for 90~97% of annual TP loading of Lake Soyang. TP of the Soyang River showed a large daily variation that positively correlated with inflow rate. High phosphorus loading was derived from a few storm events that provided runoff laden with suspended sediment and phosphorus. Because storm runoff on rainy days had lower temperatures, it descended in the reservoir to a depth of the same temperature (usually below 20 m), forming an intermediate-depth turbid layer 20 ~ 30 m thick. Because thermal stratification is stable in summer, the intermediate turbid layer exhibiting high phosphorus content was selectively discharged from the reservoir through a mid-depth dam outlet without phosphorus diffusing into the epilimnion. The movement of runoff water within the reservoir and the subsequent distribution of phosphorus were well-simulated by the water model. The factor having the highest effect on the phosphorus cycle was the settling velocity of detritus which was calibrated to be 0.75 $m \cdot day^{-1}$. It is concluded that the model may be a good simulator of phosphorus dynamics for deep reservoirs in summer monsoon regions.

0432
P

Water Quality Evaluation of Isabella Lake in Preparation for Dam Remediation

Heather Jackson, John Baum and Alison Plant

US Army Corps of Engineers, Sacramento, Calif., USA

Isabella Lake is a reservoir formed by two earthen dams on the Kern River about 45 miles northeast of Bakersfield, California, that are operated and maintained by the US Army Corps of Engineers (USACE).The dams were constructed to prevent downstream flooding and provide water storage for agriculture.

In recent years, the auxiliary dam was found to have major seepage and seismic instability issues and has been classified as a Dam Safety Action Class Level I: urgent and compelling. Alternatives for dam remediation are currently under consideration by the USACE. An Environmental Impact Statement (EIS) is also being prepared for public review. With increasing California water

quality regulation and awareness, issues such as construction storm water discharge and wildlife impacts from in-water work will be considered during the design, construction, and post-construction phases.

The USACE is in the process of collecting baseline data such as temperature, pH, dissolved oxygen, and metal concentrations to assess impacts to water quality associated with implementing the proposed dam remediation alternative. The collection of data is accomplished through continuous monitoring near the main dam, monthly monitoring of inflows, outflows, and profiles of the lake, and quarterly water sample collection.

Data from monitoring activities suggests that there are some existing concerns regarding the water quality of Isabella Lake that may be exacerbated by remediation activities depending on the selected alternative. The main areas of concern include continued compliance with State and Federal water quality regulations during potential reservoir drawdown, the possible implications of construction activities around a lake that remains fully-mixed throughout the seasons, ecosystem impacts from a lowered pool level during construction, elevated arsenic levels, and hazardous algal blooms which are suspected to have caused fish and bird kills in the past.

Impacts to water quality are important to consider for dam remediation alternative selection and completion of the EIS, but also throughout all phases of potential construction. An expanding monitoring program allows further study and awareness of water quality issues. Major goals of the water quality evaluation are to ensure public safety, maintain and improve water quality, and protect ecosystems now and in the future.

0296
P

Zooplankton Community Structure, Body Size and Biomass in Western US Reservoirs Prior to Potential Invasion of Dreissenid Mussels

Teodoro Rosati[1], John Beaver[1], Thomas Renicker[1], G. Chris Holdren[2], Denise Hosler[2] and Claudia Tausz[1]

[1]BSA Environmental Services, Inc., Beachwood, Oh., USA, [2]US Bureau of Reclamation, Denver, Colo., USA

The US Bureau of Reclamation (BOR) implemented a survey of reservoirs maintained in the western United States to establish the baseline abiotic (inorganic nutrients, ions) and biotic (phytoplankton and zooplankton community) components of western reservoirs to evaluate potential impacts of invasive dreissenid mussels (quagga and zebra mussels). As part of this monitoring, 320 zooplankton vertical tow samples were collected from approximately 100 reservoirs located within 14 states in the western United States from August to October in 2010. Samples were collected from multiple locations from each water body once. Identification, enumeration and biomass (length/width measurements) of the zooplankton community were conducted using the Utermohl method.

Preliminary results showed a strong positive correlation of herbivorous pelagic cladoceran body size as well as biomass with latitude of sample site, irrespective of elevation. Calanoid copepod body size and biomass also showed a strong positive correlation with latitude of sample sites but only at reservoirs with elevations less than 1000 meters. Generally mean zooplankton biomass was primarily composed of *Daphnia* spp., a large-bodied cladoceran and a key taxa mediating energy transfer between primary producers and higher trophic levels. This trend was more pronounced with higher elevation and increased latitude. However, zooplankton biomass at some sample sites at lower latitude and/or lower elevation was dominated by copepods, possibly from seasonal temperature limitation on cladoceran body size and biomass at these locations. Generally rotifers contributed a relatively minor amount to the total zooplankton biomass regardless of latitude or elevation. The relationship between zooplankton community structure and the phytoplankton community as well as the abiotic components will be discussed. This study demonstrates the importance of thermal regimes and latitude on the size distribution of zooplankton populations in western US reservoirs. Although the sampling was limited to one sampling event for each water body, our results are consistent with literature describing crustacean zooplankton size distribution and latitude.

0418
P

Experiences with the National Wetland Condition Assessment and Implications for the Follow on Intensification Grant with North Carolina, South Carolina and Alabama

Rick Savage[1], Virginia Baker[1], James Graham[1], Anthony Scarbraugh[1], James Glover[2] and Tonya Mayberry[3]

[1]North Carolina Dept. of Environment and Natural Resources, Raleigh, N.C., USA, [2]South Carolina Dept. of Health and Environmental Control, Columbia, S.C., USA, [3]Alabama Dept. of Environmental Management, Montgomery, Ala., USA

For the National Wetlands Condition Assessment (NWCA), North Carolina (NC) had 47 wetland sites to survey, South Carolina had 42 wetland sites to survey, and Alabama had 20 wetland sites to survey the summer of 2011. Next summer (2012), the EPA funded Southeast Wetland Monitoring Intensification Grant; each state will have 20 sites to survey (10 in the piedmont ecoregion 45 and 10 in the inner coastal plain ecoregion 65). The purpose of this presentation is to summarize our experiences with the NWCA survey work and to understand the implications for the follow on Southeast Wetlands Monitoring Intensification Grant.

Observations were made during the NWCA surveys of the wetland sites which were noted to be potential short- comings or difficulties, and have implications for conducting the Southeast Wetland Monitoring. Some of the observations dealt with the difficulty of detecting certain disturbances such as salt intrusion and storm damage. It was also noted that small woody plants were not being measured in terms on DBH which is important for use in our past wetlands monitoring research for developing Indices of Biological Integrity. The determination of vegetation cover of very similar species growing together was also difficult as was the detection of certain unusual species such as lichens in trees. It was also noted that many times a team of five worked better than a team of four. These points and others have implications for how we conduct the Intensification grant next summer.

The methodology use for the NWCA was a very good and sound methodology and did good job to allow a one day survey of wetland sites and collected very good data. The Southeast Wetland Monitoring Intensification Grant will use the NWCA protocol with some modifications based on the above observations and with the goal of producing a regional wetland assessment for the southeast. Some additional monitoring methods will be added such as surveying amphibians and macroinvertebrates, and monitoring the wetland hydrology will be discussed. Finally, some discussion about how a regional wetland assessment will result from this effort.

0312
P

New Jersey Statewide Statistical Assessment of Lakes for Aquatic Life Use

Brian Taylor, Debra Hammond and Victor Porettie

New Jersey Dept. of Environmental Protection, Trenton, N.J., USA

The New Jersey Department of Environmental Protection Ambient Lake Monitoring Network is based on the USEPA-recommended GRTS Spatially-Balanced Survey Design. The design of this network involves the monitoring at approximately 200 lakes selected randomly from New Jersey named lakes over two hectares (5 acres) in surface area, and a minimum of one meter in depth, Water supply reservoirs are excluded because the water levels are closely managed by the water supply authorities and water drawdown activities do not represent a typical lake. Five panels of 40 lakes each are sampled once every five years. Each lake is sampled three times per year (Spring, Summer, and Fall) and, depending on the size and depth, additional in-lake stations and/or samples from multiple depths are collected. The results from the 200 monitored lakes serve to statistically represent all accessible lakes meeting the minimum criteria; a total of 635 lakes, or 29,519 lake acres, throughout New Jersey.

New Jersey assessed compliance with three water quality criteria for aquatic life use: total phosphorus (TP), dissolved oxygen (DO), and pH. Of the 200 monitored lakes, 57 did not support aquatic life use. Non-support of the aquatic life use may be caused by more than one parameter within a single lake. For example, many lakes that exceed the DO criterion also exceed the TP criterion. Of the 57 lakes that did not support the aquatic life use, 30 exceeded the TP criterion, five exceeded the DO criterion, and 28 exceeded the pH criterion. Statewide lake conditions have been estimated using these parameters which show the percentage of NJ lakes predicted to fully support aquatic life use: 84.5%, or 26,511 acres, meet the TP criterion; 97.4%, or 28,286 acres, meet DO; and 86.0%, or 27,748 acres, meet pH. The first round of sampling indicated that overall 71% of lakes fully support aquatic life use based on TP, DO and pH. EPA has posted the results for 2010 in ATTAINS.

0127
P

Assessing Water Quality and Food Web Resources Supporting Juvenile Salmonids in Tidal Emergent Wetlands in the Lower Columbia River and Estuary

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Current natural production of salmonids in the Columbia River basin is estimated to be at 12 percent of historic levels, with 13

salmonid stocks listed as “threatened” or “endangered” under the U.S. Endangered Species Act since 1991. Restoration of estuarine habitats used by rearing salmonids is expected to be an important contributor to the effectiveness of recovery efforts for anadromous salmonids throughout the basin. The Ecosystem Monitoring Program (EMP) coordinated by the Lower Columbia River Estuary Partnership (LCREP) is the only comprehensive assessment of juvenile salmonid habitat in the Columbia River estuary. The EMP assesses the habitat capacity, opportunity, and realized function of estuarine habitats, addressing key gaps in information to support ecosystem restoration and salmonid recovery planning. The EMP involves coordinated monitoring of salmon, habitat, food web, and abiotic water conditions in relatively undisturbed emergent tidal wetlands in the lower Columbia River and estuary. Data from these sites can be used to inform restoration planning in the lower river and estuary. Currently, the U.S. Geological Survey (USGS) is monitoring continuous water-quality parameters and characterizing food web resources supporting juvenile salmonids in these important rearing habitats. Other partners measure hydrology, vegetation, plankton species composition, and fish presence, condition, and diet. Data are collected April through July–the period immediately before, when, and shortly after salmonids have been found at the sites. In 2010, USGS monitored water quality and tested methods to assess food web resources supporting juvenile salmonids at one site in order to refine protocols that were used at four fixed sites in 2011. The same four sites are being studied again in 2012. Measured water-quality parameters are temperature, dissolved oxygen, pH, specific conductance, water depth, light availability, and nutrient concentrations. The food web assessment involves measurements of algal biomass and productivity and the use of stable isotopes of carbon and nitrogen in the tissue of juvenile salmonids and in their potential food sources to evaluate the structure of their food web. Preliminary analyses of water-quality and food web data collected in 2010 and 2011 will be presented.

0574
P

Role of BMAA (Cyano-Neurotoxin) in Nebraska Freshwater Ecosystems

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Photosynthetic microorganisms play an important role in the functioning of aquatic ecosystems, in that they are often among the main primary producers that form the base of aquatic food webs. Several genera of photosynthetic microorganisms are capable of producing toxins that can impact aquatic ecosystems.

Cyanobacteria rank among the most important of these; several of its members produce a variety of toxins (termed cyanotoxins), including hepatotoxins and neurotoxins. Here, we focus on the potent neurodegenerative cyanotoxins BMAA (β-Methylamino-L-alanine), which has recently been shown to cause ALS, Alzheimer’s, and Parkinson’s disease in humans in several parts of the world (*e.g.*, China, the Middle East).

Biomagnification of BMAA via the food chain is a recently-studied process of potentially great relevance to both human and animal health. Because cyanobacteria are widespread in freshwater systems and BMAA release is widespread among numerous genera, BMAA could be found in many freshwater systems, resulting in an important human exposure risk. Thus, the overall objectives of our research are to: (1) develop the methodology necessary to detect this single amino acid, at very low levels, in open water, as well as in macrophyte and fish tissues, (2) better understand the ecological factors that may be involved in the production of BMAA, and (3) ascertain the routes of exposure of BMAA in humans. Here we present findings which address parts of all three objectives, including the first report of BMAA in open fresh water in the U.S.

0470
P

Genetic and Toxin Analysis of Single Colonies to Catalogue the Toxigenicity of Pacific Northwest Bloom-Forming Cyanobacteria in Water Bodies Used for Drinking Water Supplies

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Although many bloom-forming cyanobacterial genera have been reported to be capable of producing toxins, the toxigenicity of natural blooms and the toxins associated with them have not been well documented. It is well known that Aphanizomenon blooms in Upper Klamath Lake, Oregon, are non-toxic, although Aphanizomenon from other parts of the world have been associated with the production of toxins, including microcystin and anatoxin-a. It is not known whether this is an isolated case, or whether variations in toxigenicity are more widespread. To address this question, we are analyzing the toxins associated with Oregon cyanobacterial

blooms. Bloom samples are being analyzed by DNA sequencing to determine the genotypes present, and by LC/MS/MS to identify the presence of microcystins and anatoxin-a. These analyses are also being applied to individual colonies picked from mixed blooms in reservoirs that serve as drinking water sources for communities in the Willamette Valley, Oregon. By determining the association or lack thereof of toxins with particular cyanobacteria, this study should allow the development of evidence-based responses to blooms. Current guidance treats all blooms consisting of cyanobacteria that have at some point been reported to be toxic as equally toxic health risks.

0456
P

High Throughput Sequencing Analysis of Cyanobacterial Bloom Populations for Identifying Commonalities and Differences Across Time and Location

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Cyanobacterial blooms in lakes and reservoirs are of continually increasing concern for recreational contact and drinking water supplies. Despite their widespread occurrence and the impact of their toxicity, there is a general dearth of knowledge of the genetic identity of major blooms and of the relationships between different blooms. Genetic identifications of cyanobacterial taxa are more reliable than visual identification and are more comparable between investigators and across time. The very large capacity of 454 pyrosequencing allows DNA targets of many cells in each of several samples to be simultaneously sequenced. We have applied 454 sequencing to analyze the ITS and CPC loci of cyanobacteria present in blooms in the US Pacific Northwest. We discuss the applicability of this technique for the genetic cataloguing of blooms, and the potential for better understanding the ecology and origin of blooms.

0291
P

Citizen-Based Monitoring of Cyanobacteria in Littoral Regions of the Muskingum River Watershed, Ohio

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The Muskingum River Watershed is Ohio's largest wholly contained watershed, covering about 20 percent of the state, and is heavily utilized for outdoor recreation. Reservoirs in the Muskingum River Watershed are located in two Ohio ecoregions: the Western Allegheny Plateau and Erie Drift Plain. Both ecoregions are more forested and less productive agriculturally than the Eastern Corn Belt Plain of western Ohio. Phytoplankton grab samples and raw water samples were collected by citizens trained by the Ohio Lake Management Society from littoral regions of nine reservoirs and analyzed for algal composition, nutrients, and cyanotoxins. Samples were collected six times between July and October 2011 from areas of each reservoir most frequented by the public such as docks and beaches. Seven of the nine lakes were dominated by cyanobacteria between July and October, with an average biovolume of over 50%. Higher percentages of nitrogen-fixing cyanobacteria were found in more heavily forested sites based on GIS land use data. The most common cyanobacteria species in terms of biovolume was *Cylindrospermopsis raciborskii*, which often reached concentrations typical of algal blooms. However, when tested for cylindrospermopsin, only two of 41 samples produced quantifiable concentrations > 0.1 µg/L. Out of 62 samples tested for microcystin, seventeen samples from August and September produced concentrations greater than the quantifiable threshold of 0.15 µg/L. Our results suggest a relationship between land use patterns and nitrogen-fixing cyanobacteria taxa in Ohio reservoirs.

0306
P

Microcystin Toxin Migration, Bioaccumulation, and Treatment Fremont Lake #20 Dodge County, Nebraska

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Degradation of water quality in the over 800 sandpit lakes is a public health concern in Nebraska. Monitoring conducted on Fremont Lake #20, a popular lake for water contact recreation, indicated high concentrations (greater than the Nebraska lake health alert criteria of 20 ppb) of the microcystin blue-green algal toxin. From 2005 to 2007, 32 percent of the samples exhibited microcystin concentrations above the health criteria resulting in a significant loss of recreation opportunities for lake users. In 2008, Fremont

Lake #20 was placed on Nebraska's List of Impaired Waters (Section 303(d)) due to impacts to recreation and aquatic life. Many residents who live around these sandpit lakes also rely on their water source from adjacent wells.

Three separate monitoring studies were conducted at Fremont Lake #20. To address concerns about the persistence of the microcystin toxin, assessments were conducted of pre- and post lake treatment nutrient and biological conditions, microcystin accumulation in fish tissue, and microcystin migration out of the lake into the adjacent groundwater.

Maximum microcystin concentrations in the upgradient monitoring well was 0.88 µg/L while concentrations in down gradient wells were as high as 6.52 µg/L. Four of the six down gradient wells exhibited concentrations greater than 1.0 µg/L, which exceeds the maximum drinking water concentration of 1 µg/L recommended by the World Health Organization.

All four samples (2 tissue, 2 liver) analyzed from white crappie had concentrations greater than the detection limit (0.147 µg/g). White crappie microcystin concentrations ranged from 0.27 µg/g to 0.32 µg/g. Largemouth bass also had one liver and one tissue sample that exceed the detection limit. Concentrations ranged from 0.21 µg/g to 0.32 µg/g.

The alum treatment had a positive impact on several parameters including total and dissolved phosphorus, total nitrogen, chlorophyll *a*, dissolved oxygen, water transparency, and pH. The most drastic improvements were shown for the microcystin toxin which was reduced by 98 percent. Total phosphorus and total nitrogen was reduced by 85 and 70 percent respectively. Monitoring on this project allowed for the de-listing of total phosphorus, total nitrogen, chlorophyll *a*, and algal toxins on the 2010 Section 303(d) list.

0056
P

Why Cyanobacteria Dominate the World: Ecological Strategies

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Cyanobacteria, also commonly called blue-green algae, have numerous physiological and structural features that allow them to thrive and often out-compete other organisms. These advantages can lead to massive accumulations of cells, commonly called blooms, that impact aesthetics, water quality and the ecological health of the aquatic system. One advantage that promotes cyanobacterial blooms in planktonic species is the ability to regulate buoyancy. An internal structure, the gas vesicle, accumulates air which leads to upward migration, allowing the organisms to have greater to light for photosynthesis. Once cells accumulate photosynthate, they sink in the water column and take advantage of the nutrients release by sediments. Cyanobacteria have a full array of photosynthetic and auxiliary pigments that adjust to light quantity and quality as they migrate in the water column. As cells accumulate at the surface of water body, commonly called scums, they can cause dire consequences because many species produce cyanotoxins, compounds that are harmful to domesticated animals, wildlife and humans if ingested or inhaled. Several species of cyanobacteria have other advantages, such as the ability to fix atmospheric nitrogen. In water bodies that have limited supplies of nitrogen, traditionally in the form of nitrate, nitrite, and urea, the nitrogen-fixing cyanobacteria can dominate. Nitrogen fixation is performed by the nitrogenase enzyme complex, which is inhibited by oxygen. To overcome this problem, the cyanobacteria have this enzyme complex in a specialized cell, the heterocyst. The heterocyst has a special external cell wall that prevents oxygen from seeping into the cells. Another key nutrient for cyanobacteria is phosphorus and blooms are often an indicator of eutrophication as a consequence of phosphorus availability. Cyanobacteria have the ability to store phosphorus internally when it is abundant, luxuriant uptake, which can be used by cells when this nutrient is no longer available. A final example of a cyanobacterial ecological strategy is their thermal tolerance, commonly thriving at temperatures above 30°C where other organisms reach their thermal limits. Water bodies experiencing warm peak temperatures and for greater durations will likely see an increased frequency and intensity of cyanobacterial blooms.

0539
P

Cyanobacterial Management in Clear Lake, the Oldest Lake in the Nation

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Clear Lake is possibly 2.5 million years old with a 65 square mile surface area. Cyanobacteria (blue-green algae (BGA)) blooms are well known in Clear Lake and usually occur at a particular season in localized bays around the lake. They are temporary and do not disrupt tourism or residential use of the water. The cyanobacteria involved with these transient blooms are *Anabaena,*

Aphanizomenon, *Microcystis*, *Gleotrichia* and *Oscillatoria*. There are accounts of BGA blooms from 1873. The description of those blooms and others since, in a possible 20 year cycle, are similar to the blooms that have plagued the lake for the last three years, caused by *Lyngbya*. This BGA blooms from June through October and results in sewer gas release and four foot thick mats of unsightly, highly colorful, barriers to water enjoyment.

The effect on Lake County's economy has been devastating. The County allocated funds in 2011 to mitigate the effects of the *Lyngbya* bloom. This presentation will describe the various techniques used.

Mitigation efforts attempt to deal with surface matting looking like raw sewage or something out of a sci-fi movie, and sewer gas odor. The surface matting and odor can be prevented by water surface agitation. Techniques achieving this include circulating pumps, portable trash pumps, plumbed-in PVC spray system, airboat, Solar Bee, turbidity curtains or booms, submerged aeration system, cyanobactericide, and microbes.

The County's desire to turn this major negative into a positive has led me to investigate BGA harvesting, dewatering, and using the resulting biomass as a fertilizer or biofuel.

0106

Environmental Factors that Influence Cyanobacteria and Geosmin Occurrence in Two Southeastern United States Reservoirs

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Occurrence of dissolved geosmin was studied in two reservoirs in Spartanburg County, South Carolina. The reservoirs are relatively shallow, meso-eutrophic, warm monomictic, cascading impoundments. Overall, water- quality conditions and phytoplankton community assemblages were similar between the two reservoirs but differed seasonally. Median dissolved geosmin concentrations in the reservoirs ranged from 4 to 6 nanograms per liter. Annual maximum dissolved geosmin concentrations tended to occur between March and May. In this study, peak dissolved geosmin production occurred in April and May 2008, ranging from 50 to 100 nanograms per liter at the deeper reservoir sites. Peak dissolved geosmin concentrations were not concurrent with maximum cyanobacterial biovolumes, which tended to occur in the summer (June to August). Nonetheless, annual maximum cyanobacterial biovolumes rarely resulted in cyanobacteria dominance of the phytoplankton community.

In both reservoirs, elevated dissolved geosmin concentrations were correlated to environmental factors indicative of unstratified conditions, greater light penetration, and reduced algal biomass, but not to nutrient concentrations or ratios. Additionally, elevated geosmin concentrations were correlated to biovolumes of specific geosmin-producing cyanobacteria genera (*Oscillatoria* and *Synechococcus*) but not to actinomycetes concentrations. Conversely, environmental factors that correlated with elevated cyanobacterial biovolumes were indicative of stable water columns (stratified conditions), warm water temperatures, reduced nitrogen concentrations, greater residence times, and greater phosphorus concentrations in the hypolimnion. Related variables were selected as input into a multiple logistic regression model that would serve as a tool to evaluate the likelihood of geosmin concentrations exceeding the threshold level for human detection.

0104

P

Fluvial Transport of Mercury and Dissolved Organic Carbon in Contrasting Stream Basins in the Eastern United States

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Multi-scale assessment of mercury and dissolved organic carbon loads (fluxes) was conducted in the Edisto River basin (in the Coastal Plain of South Carolina) and the upper Hudson River Basin (in the Adirondack Mountains of New York). The assessment focused on the role of headwater basins in the transformation of mercury species and their transport to downstream larger river habitats where mercury concentrations in resident fishes have historically been elevated above wildlife and human dietary guidelines. Annual fluxes and yields (area-weighted flux) of dissolved and particulate mercury species (methylmercury and total mercury) were compared

between headwater (drainage areas less than 80 square kilometers) and main stem (drainage areas greater than 200 square kilometers) scales in both study areas. Dissolved organic carbon was included in the assessment because of the strong affinity of mercury for organic matter and its potential to control mercury fate and transport.

Fluxes and yields of dissolved and particulate mercury species (methylmercury and total mercury) and dissolved organic carbon were computed from stream discharge and concentrations data using the S-LOADEST software program based on the "rating curve" method. Consistent application of laboratory analytical methods and load estimation procedures were adopted to allow flux comparisons among basins while directly addressing the effect of basin scale on mercury supply. Results of the load estimation and comparison of annual methylmercury yields at different locations within river basins will be presented and discussed in relation to the impact of basin scale on methylmercury supply, the challenges inherent in comparisons between different sized basins, and the appropriate standardization procedures for inter-basin comparisons.

0542
P

Rapid Site Characterization at a Former Mercury Mine Site Using Lumex

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The OhioLumex mercury analyzer is an effective tool for characterization of mercury in soil and sediments that supports the TRIAD approach for dynamic field decisions and green remediation goals to reduce resource usage. Characterization of the soil and sediment at the watershed below the Klau and Buena Vista Mines, Paso Robles, CA required the ability to provide high quality of data along with rapid decisions on the nature and extent of mercury contamination. The OhioLumex mercury analyzer was selected, reviewed and approved by EPA for screening mercury concentrations in soil and sediment at this site with supporting information provided from fixed laboratory confirmation samples. Personnel from EPA's Office of Superfund Remediation and Technology Innovation provided verification reviews of this technology and additional quality control checks. Results of the real-time soil and sediment mercury concentrations using the OhioLumex mercury analyzer produced a high correlation to co- located soil and sediment samples sent for offsite total mercury analysis. This session presents how to assure high quality usage of this green technology that will save time and costs by minimizing the need to wait for offsite fixed laboratory analysis, and provides the opportunity to collect a significantly greater number of samples for expanded characterization within a given fixed budget. Practical approaches were developed and applied at this EPA Superfund project to establish tight quality controls and increase the ability to provide dynamic field decisions and optimize investigation of an extensive watershed study area.

0483
P

***In situ* Measurements of Porewater Hg and MeHg via DGT**

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The diffusive gradient in thin film (DGT) technique is applied to determine porewater mercury and methyl mercury concentrations in both laboratory and field studies. DGT devices have been a useful indicator of dissolved metals in aqueous systems, although the technique is not as well developed for measuring mercury or for measuring concentrations in sediments. DGT devices were fabricated with Spheron-Thiol Resin (STR) or 3 Mercaptopropyl Functionalized Silica Gel (3MP) as a resin layer covered by an agarose diffusive gel and 0.45 µm polysulfone membrane filter. Laboratory experiments showed that both resins strongly associated with dissolved Hg^{2+} and that the 3MP could be used to measure methyl Hg as well. Further the 3MP is readily available while STR is no longer commercially produced. Laboratory testing was used to evaluate mercury DGT probe uptake parameters from the sediment and to develop procedures for analysis and interpretation of the probe. Laboratory experiments were also conducted to evaluate the fate and behavior of mercury due to biogeochemical changes in sediments, for example, after placement of a sediment cap or as a result of benthic activity. DGT probes were then deployed in the field at South River (Va., USA). Multiple disk probes and sediment probes were deployed in the South River *in situ* to determine overlying water Hg concentrations and sediment porewater Hg and methyl mercury and concentration profiles. Substantial variations in mercury and methylmercury were observed in different locations and as a function of depth below the sediment-water interface. The initial deployment showed that the DGT could be a useful tool for exploring available and mobile mercury and methyl mercury in the South River and further field testing has been commenced.

0162
P

Simulation of Streamflow in the McTier Creek Watershed, South Carolina, Using TOPMODEL and GBMM

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The McTier Creek watershed is located in the Sand Hills ecoregion of South Carolina and is a small catchment within the Edisto River basin. Two watershed hydrology models were applied to the McTier Creek watershed as part of a larger scientific investigation to expand the understanding of relations among hydrologic, geochemical, and ecological processes that affect fish-tissue mercury concentrations within the Edisto River basin. The two models are the topography-based hydrological model (TOPMODEL) and the grid-based mercury model (GBMM). TOPMODEL uses the variable-source area concept for simulating streamflow, and GBMM uses a spatially explicit modified curve-number approach for simulating streamflow. The hydrologic output from TOPMODEL can be used explicitly to simulate the transport of mercury in separate applications, whereas the hydrology output from GBMM is used implicitly in the simulation of mercury fate and transport in GBMM. The modeling efforts were collaboration between the US Geological Survey and the US Environmental Protection Agency, National Exposure Research Laboratory.

0205
P

Development of a Mercury Load Model for McTier Creek, South Carolina using TOPMODEL

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McTier Creek is a small watershed located in Aiken County, South Carolina and forms part of the headwaters for the Edisto River basin. The Edisto River basin is noted for having some of the highest measured fish-tissue mercury concentrations in the United States. In an attempt to improve the understanding of the factors causing these high mercury levels, the National Water-Quality Assessment Program of the US Geological Survey conducted an extensive field investigation of mercury in the McTier Creek ecosystem. This investigation included the collection of hydrologic, biologic, and water-quality data as well as the development of a number of hydrologic and water- quality models. One modeling effort involved the development of a simple water-quality load model that utilized a mass-balance equation in conjunction with hydrologic simulations from the topography-based hydrological model (TOPMODEL). Several variants of this load model were developed including one, called TOPLOAD, which utilized the simulated surface and subsurface flow components taken directly from TOPMODEL. A second variant, TOPLOAD-H, added a groundwater partitioning algorithm (Hornberger and others, 1994) to TOPMODEL, thereby providing for multiple groundwater flow components. A brief description of the development of these simple mercury load models and results of the simulation in the McTier Creek basin will be presented.

Reference:
Hornberger, G.M., Bencala, K.E., and McKnight, D.M., 1994, Hydrological controls on dissolved organic carbon during snowmelt in the Snake River near Montezuma, Colorado: Biogeochemistry, v. 25, p. 147-165.

0535
P

More than Generalist Predators: Are Behavioral Guilds Useful for Monitoring Mercury Concentration in Larval Dragonflies?

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Mercury concentration among dragonfly species can vary across genera within a single water body. Although dragonfly larvae are classified as generalist, benthic predators, species can be placed into distinct guilds based on differences in behavior, morphology, and microhabitat occupancy. Consequently, dragonflies from different guilds are likely to encounter and consume different prey species at distinct rates. These behavioral differences may help explain the variability in methylmercury (MeHg) bioaccumulation among species within and across water bodies. Behavioral guilds include: burrowers (body concealed beneath fine, loose substrates); claspers (body exposed among macrophytes and other structures); and sprawlers (body openly exposed, active in well-

illuminated areas near the surface of the water). We analyzed total (THg) and methylmercury concentrations in late-instar dragonfly larvae collected from 22 water bodies across 6 National Park units in the Great Lakes Inventory and Monitoring Network (2008-2009). The majority of dragonfly species collected in this region spend between 2 and 4 years as larvae underwater before emerging as terrestrial adults. Therefore, differences in MeHg concentrations among guilds are not the result of somatic growth dilution, but likely reflect differences in foraging habits. Methylmercury concentrations were positively correlated to filtered aqueous THg concentrations across water bodies only for the burrowers. Mean (± SD) MeHg concentration among the water bodies was greatest in the claspers (140.4 ± 102.7 ng/g dry wt.) followed by the sprawlers (87.5 ± 61.0 ng/g dry wt.), and burrowers (76.5 ± 45.6 ng/g dry wt.), respectively. Methylmercury concentrations in the burrowers were better correlated with concentrations in sprawlers than for claspers. Comparing guilds with water bodies, clasper MeHg concentrations were, on average, 685% and 178% above those for burrowers and sprawlers, respectively. Mean (± SD) bioaccumulation factors (log10) across the water bodies were 4.9 ± 0.3 L/kg for burrowers, 5.1 ± 0.4 L/kg for claspers, and 4.9 ± 0.4 L/kg for sprawlers. Claspers and sprawlers include species that are active hunters feeding on prey located at or above the benthic zone, while burrowers are sit-and-wait predators feeding primarily on benthic prey. Recognizing differences in larval behavior among dragonflies will improve their utility as sentinel organisms.

0136
P

Variability in Selenium:Mercury Molar Ratios in Fish in Freshwater Ecosystems

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Over the last several decades considerable attention has been devoted to measuring mercury (and methylmercury) levels in freshwater fish, evaluating potential risk to consumers (including humans), and managing that risk. Risk can be managed by source reduction, interdiction of pathways, erection of barriers to exposure (for eco-receptors and humans), or by behavioral modification (for people). Recently, the potential protective effects of selenium on mercury toxicity have been proposed, and examined in some animal laboratory studies, and with limited epidemiological studies. Transport and uptake clearly influences mercury levels in individuals and species. Yet, the interspecific and intraspecific variability in selenium:mercury molar ratios have not been examined in detail. Here we compare these molar ratios in several species of freshwater fish from streams in Tennessee with those from the Savannah River. We found considerable variation in selenium:mercury ratios among and within fish species. The ratios were more strongly influenced by Hg than by Se, and were negatively correlated with fish length for some species. Some species with high mean ratios had some individuals with ratios below 1. Given the uncertainty in the protectiveness of a given ratio, the uncertainty in whether the same ratio is protective for brain, kidney, or other organs, and the uncertainty in variability in ratios for a given species, it seems impractical at the present to use these selenium:mercury ratios in either risk assessment or risk management.

0135
P

Parameters for a Biomonitoring Plan for Mercury in Freshwater Ecosystems

Joanna Burger[1,2] and Michael Gochfeld[2]

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Biomonitoring for contaminants of concern to eco-receptors and humans is an important part of protecting human and ecological health. Usually a biomonitoring plan is developed to fit several objectives, several stressors, and several contaminants, making it difficult to manage the variability involved. We propose that a tiered approach is necessary for biomonitoring in freshwater ecosystems whereby an initial assessment examines a wide range of contaminants and radionuclides, followed by a periodic sampling plan that addresses specific contaminants of concern, with a smaller set of bioindicators. We suggest that for mercury, the following steps are required 1) Identification of lead agency (or organization), 2) involvement of stakeholders 3) definition and agreement of objectives, 4) clarification of temporal and spatial scales, 5) definition of scope, 6) selection of bioindicators, 7) development of monitoring methodology (and agents to conduct the sampling and analysis), 8) development of remediation or actions with specific results, 9) cost, time, and expertise evaluations (can the plan be easily conducted and evaluated), and 10) iterative evaluation of all previous steps. For monitoring of mercury levels in freshwater organisms, the following must be considered: 1) interspecific and intraspecific variation, 2) age, sex, and condition variables of indicator species, 3) seasonal differences, 4) mobility and migration effects, 5) trophic status (and food items), 6) foraging location (water column, bottom), 7) habitat usage (eggs and tadpoles are aquatic, adult frogs may be semi-terrestrial), 8) current or water movement patterns, and 9) life span and growth rates. Further attention needs to be devoted to co-contaminants or co-elements that might amplify effects (*e.g.,*

PCB levels that might enhance toxicity) or ameliorate effects (*e.g.*, selenium that can partly protect against mercury toxicity).

0445

Mercury Bioavailability and Transport in Deer Creek Over Lake Wildwood Dam Justin Wood, Joanne Hild,

Michael O'Connor, John van der Veen and Jane Sellen *Sierra Streams Institute, Nevada City, Calif., USA*

Beginning in 2008, an effort has been underway to determine the amount of mercury that remains in the Deer Creek watershed, a Sierra Nevada foothill tributary system, from a century of gold mining beginning with the California Gold Rush; to determine the extent to which mercury is being transported over Lake Wildwood Reservoir dam on Deer Creek during storm and other high flow events; and to determine the extent to which mercury has become available for uptake by stream organisms. Deer Creek flows into the San Francisco Bay/Delta via the Yuba, Feather and Sacramento rivers, and the findings have broad implications for the health of downstream waterways.

Water samples were collected during the peak of storms in the winters of 2008-9 and 2009-10, as well as during a single reservoir dewatering event in the fall of 2008, and in monthly reservoir sampling from the surface, at depth, and from the bottom. The samples were analyzed to determine the quantity of algae-sediment complex in each sample as well as the quantity of mercury within the algae-sediment complex. These measurements were combined with flow data to calculate both the amount of algae-sediment and the load of mercury that are flowing over the spillway during each storm and dewatering event. Biological sampling of riparian vegetation, fish, and benthic macroinvertebrates was conducted within, upstream and downstream of Lake Wildwood in September 2011.

Initial results indicate that mercury concentrations in the algae-sediment complex are in the range of 0.1-0.5 ng/g. During a specific storm in January 2010 it is calculated that 82,000 kg of algae/sediment was transported over Lake Wildwood dam, containing 36 g of mercury. Biological samples are currently being analyzed for mercury content and the results will be available by October 2011.

0397
P

Stability and Behaviour of Low Level Spiked Inorganic Mercury in Natural Water Samples

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In recent years tracer experiments using stable and radioactive mercury isotopes have been extensively used to understand Hg transformation processes in soils, sediments and water. Tracer experiments have also been used in method evaluations. Isotope dilution mass spectrometry (IDMS) is based on the use of enriched stable Hg isotopes, where a known mass of a spike of an enriched isotope is added to an aliquot of the sample prior to the pre-treatment procedures and the ratio of the added to the naturally occurring isotope is then measured. Although initially it was believed that this is the most powerful tool for the optimization and validation of analytical procedures, several reviews have outlined the advantages and limitations of IDMS approaches, among which contamination cannot fully be avoided, which is not the case with the use of radiolabelled Hg. An important obstacle in many of these experiments is that the quantity of labelled Hg used for spiking significantly exceeds the natural concentrations leading to significant perturbation of the system. The information obtained, therefore, poorly represents the "natural" response. In recent years the method sensitivity for the use of both, stable and radioactive isotopes has improved and the validity of laboratory experiments in Hg research gained in credibility.

The present study is focused on the use of $^{197}Hg^{2+}$ radiotracer (prepared from enriched ^{196}Hg) in natural water samples. Different samples were tested in the experiments including marine, lagoon, lake, river and rain waters. The purpose of these experiments was to test the stability and partitioning of labelled Hg^{2+} between dissolved and particulate-bound fractions under different storage conditions, namely temperature, preservation by acidification and container material (Teflon, borosilicate glass and polyethylene). Reduction of spiked Hg was also measured and was found to be responsible for a few % losses.

The practical implications of these experiments is that studies using tracer experiments in natural water need to be done with great care, taking into account the particular characteristics of the water under study. The use of $^{197}Hg^{2+}$ provides accurate results, enabling fast testing of different parameters and conditions.

0319

P

Mercury Monitoring from the Tundra to the Tropics: Using Songbirds as Indicators of Ecological Risk

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Monitoring globally distributed contaminants is challenging but crucial to understanding their effects on ecosystem health. Mercury (Hg) is particularly difficult to monitor on a broad scale because quantifying the amount deposited into a given habitat does not allow inference into biological exposure. Because of this, mercury contamination is generally assessed by using biological indicator species, such as fish and fish-eating species, as a measure of ecological risk. Although these aquatic-dependent species are useful for many monitoring programs, we now understand that Hg biomagnifies in terrestrial ecosystems as well. Thus, in order to understand the true distribution of Hg exposure and risk, it is important to monitor the amount of methylated Hg in species, such as songbirds, that can be sampled across a wide range of habitat types and locations. Toward this end, the Biodiversity Research Institute (BRI) has begun the Terrestrial Ecosystem Research and Assessment (TERRA) program, designed to monitor mercury exposure in songbird species from the North Slope of Alaska to Central and South America. In order to quantify the practicality of using songbirds of indicators of mercury risk, we ran a mixed effect model on a large dataset of songbird blood mercury concentrations collected across the east coast of the United States. We found no difference between the different ecoregions, but did find significant effects of habitat and foraging guild. Our results indicate that birds in wetland ecosystems are at highest risk to mercury exposure, but those living near river, creek, pond and lake edges also exhibited elevated mercury concentrations compared to those living in upland, dry forest habitat. Using knowledge learned from this analysis, we can put in context the limited data we have in the central and western United States. In the future, we hope to incorporate songbird blood mercury data into the regional mercury synthesis, which is already underway across the western United States.

0044
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Biogeochemical Cycling of Mercury Coupled with a Nitrogen and Carbon Watershed Hydrology Model (VELMA)

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Watershed scale mercury modeling is just beginning to emerge and help further understand the mercury cycle and how it moves and transforms within a watershed. The principle processes and equations governing mercury transport and transformation were incorporated into VELMA (Visualizing Ecosystems for Land Management Assessment) to predict daily fluxes and concentrations of total mercury (THg) and methylmercury (MeHg) for a specified catchment. VELMA is a spatially-distributed eco-hydrological model that simulates soil water infiltration and redistribution, evapo-transpiration, surface and subsurface runoff, carbon (C) and nitrogen (N) cycling in plants and soils, and the transport of dissolved organic carbon (DOC), dissolved inorganic nitrogen (DIN), and dissolved organic nitrogen (DON) from the terrestrial landscape to streams. VELMA uses a distributed soil column framework to simulate the vertical movement of water, heat, and nutrients within the soil, between the soil and vegetation, and between the soil surface and vegetation to the atmosphere. The transport of mercury species down the hill slope is accomplished through aqueous phase and DOC complexation. Each soil column within the watershed accounts for mercury accumulation through governing deposition, decomposition, inflows, outflows, and reactions. Site and species-specific rate constants, along with complexation constants, have a significant role in mercury transport. The mercury incorporated VELMA model has been calibrated and simulated for both WS10 of the H.J. Andrews experimental forest and McTier Creek of the Edisto River Basin. The seasonality of in-stream mercury concentration was low during dry summers, while mercury concentration typically peaked during the first fall storm and remained notable throughout the rainy winter season. A large flux in mercury through storm events did not always correspond to an increase of in-stream mercury concentration. At both sites simulated total mercury concentration are within range and help to predict and understand mercury species at the watershed level.

0342
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Influence of Fire on Mercury Cycling in Boreal Forests

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We have been studying the impacts of fire on mercury cycles in the Boundary Waters Canoe Wilderness Area of the Superior National Forest in northeast Minnesota. In 1999 severe winds damaged 200,000 ha of the Superior National Forest. Over the past decade, the US Forest Service used prescribed fire to reduce fire risk. In addition to prescribed fire, two wildfires also occurred. In 2005 we set up an experiment to measure mercury in soil, lake water, atmospheric deposition, and fish before and after fire in five pairs of watersheds, (five burned and five unburned controls). As of fall 2011, four of our five treatment watersheds have been burned. In addition to the watershed study, we have assessed forest floor and mineral soil mercury pools in nearby areas burned by wildfire. Over the
course of these studies we have discovered that fire leads to increased deposition shortly after fire and that deposition adds about 40% to annual deposition in the year of the fire. Our soil studies indicate that fire decreases mercury stored in the forest floor and there are strong relationships between watershed soil mercury and fish mercury. We also found relationships between lake water chemistry and fish mercury. Presumably as fire influences both soil and lake water chemistry, it will also influence fish mercury.

0014
P

Fishery Assessments on the Duck Valley Reservation, Idaho and Nevada, 2007-09

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Since 2007, the US Geological Survey and the Shoshone-Paiute Tribes of the Duck Valley Reservation have cooperated to assess aquatic biological resources in reservation reservoirs and in the Owyhee River. Decades of mining activity near the reservation in northcentral Nevada and recent mercury advisories on consumption of sportfish from southern Idaho waters prompted these assessments. The objectives were to evaluate mercury concentrations in fish tissue found in reservoir and riverine habitats on the reservation and to evaluate the biological integrity of the fish communities and associated summer water temperatures along the East Fork Owyhee River. In 2007 and 2009, fish tissue filet samples composed of multiple age classes of rainbow trout were collected from Mountain View, Billy Shaw, and Sheep Creek Reservoirs and were analyzed for total mercury. In 2008, fish community data and continuous water temperatures were collected at four East Fork Owyhee River sites and selected sportfish tissue was analyzed for total mercury. Total mercury wet weight concentrations in rainbow trout from the reservoirs were found to be above background concentrations (0.02-0.29 ppm, n=90 versus background of 0.01-0.05 ppm, n=10) but they were below concentrations that would warrant a fish consumption advisory. Fish community data summarized by the Index of Biotic Integrity (IBI) developed to evaluate northwest rivers indicated impairment at lower river sites, with scores ranging from 34 to 57 out of 100. The absence of coldwater native fish species (*i.e.*trout and sculpins) appears to be the primary reason for community impairment at the sites as indicated by the IBI scores. Measurements of continuous summer water temperatures may provide the best explanation for this absence of coldwater fish species. Lower river sites regularly had summer water temperatures exceeding coldwater temperature criterion of 22 C.

0067
P

Role of Particles in Mercury Transport in a Coastal Plain Subsurface Environment

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Mercury concentrations exceeding 2 µg/L (the New Jersey State drinking-water maximum contaminant level) occur in water from about 700 domestic wells completed in the principal unconfined aquifer system of the New Jersey Coastal Plain. This highly permeable quartzose system is vulnerable to contamination from the land surface, with a water table commonly less than 20 feet from the land surface. Past use of mercurial pesticides in agriculture and atmospheric deposition are two likely sources of the mercury. US Geological Survey cooperative studies with the New Jersey Department of Environmental Protection indicate that particulate mercury trapped by a 0.45 µm filter is commonly found in domestic-well water where little flushing of the well bore takes place.

An hypothesis that mercury in soils is mobilized by disturbance during residential development was tested in column experiments in which sodium chloride and fertilizer solutions and de-ionized water were passed (simulating rapid stormflow) through well-mixed B-horizon soils bearing atmospherically deposited mercury. In the leachates, most of the mercury and iron released was particulate (0.28-0.45 and 11,870-30,230 µg/L, respectively), indicating likely mercury sorption to iron hydroxide particles, and suggesting a mechanism for moving Hg from land surface to the water table. Under reducing conditions, such as in septic-system leach fields,

mercury-bearing iron oxides are dissolved and mercury is mobilized and likely is reduced to the elemental form. The mercury may be oxidized and re-adsorbed as the aquifer flowpath becomes more oxidizing. The nature of the particles in domestic-well water is yet to be determined. The column experiments indicate that mercury can begin its path from soils to aquifer in particulate form, and can end its path at the household tap as a particle, as well.

0079
P

Spatial Patterns of Mercury in Macroinvertebrates and Fishes from Streams of Two Contrasting Forested Landscapes in the Eastern United States

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Controls on mercury bioaccumulation in lotic ecosystems are not well understood. During 2007-2009, we studied mercury and stable isotope spatial patterns of macroinvertebrates and fishes from two medium-sized (<80 km^2) forested basins in contrasting settings. Samples were collected seasonally from multiple sites across the Fishing Brook basin (FB_{NY}), in New York's Adirondack Mountains, and the McTier Creek basin (MC_{SC}), in South Carolina's Coastal Plain. Mean methylmercury (MeHg) concentrations within macroinvertebrate feeding groups, and mean total mercury (THg) concentrations within most fish feeding groups were similar between the two regions. However, mean THg concentrations in game fish and forage fish, overall, were much lower in FB_{NY} (1300 and 590 ng/g dw, respectively) than in MC_{SC} (2300 and 780 ng/g dw, respectively), due to lower trophic positions of these groups from FB_{NY} (means 3.3. and 2.7, respectively) than MC_{SC} (means 3.7 and 3.3, respectively). Much larger spatial variation in topography and water chemistry across FB_{NY} controbuted to greater spatial variation in biotic Hg and positive correlations with dissolved MeHg and organic carbon in streamwater. Hydrologic transport distance (HTD) was negatively correlated with biotic Hg across FB_{NY} , and was a better predictor than wetland density. The small range of landscape conditions across MC_{SC} resulted in no consistent spatial patterns, and no discernable correspondence with local-scale environmental factors. This study demonstrates the importance of local-scale environmental factors to mercury bioaccumulation in topographically heterogeneous landscapes, and provides evidence that food-chain length can be an important predictor of broad-scale differences in Hg bioaccumulation among streams.

0529
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The Song Sparrow as a Biosentinel for Methylmercury in Riparian Food Webs of the San Francisco Bay Area

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High levels of mercury in San Francisco Estuary ecosystem are arguably the region's most intractable water quality challenge. Regional water quality monitoring programs in the Estuary and its associated watersheds are moving toward measuring mercury in biota rather than only in sediment and water. The advantage of using a monitoring tool that is directly tied to a beneficial use target is that results reflect more direct monitoring and are, therefore, more easily interpreted in terms of effects on individuals and populations. This new emphasis, however, requires new monitoring tools and methods for monitoring biota. Recent studies have documented unexpectedly high concentrations of methylmercury in terrestrial invertebrate-eaters indicating possible risk from exposure via the food web. Such discoveries, coupled with the known mercury problem in local watersheds, prompted interest in developing a biosentinel for methylmercury in stream riparian food webs of the Bay Area. The Song Sparrow (Melospiza melodia) was determined to be the best riparian biosentinel candidate on the basis of its natural history, sampling feasibility, and sensitivity to mercury. The ability of Song Sparrows to reflect a wide a range of mercury concentration in their blood, and to thereby distinguish methylmercury risk between conditions, was assessed by sampling individuals from riparian sites across the Bay Area. Sampling sites were chosen according to a conceptual model that identified total mercury in sediment and net methylation environment as the primary drivers of methylmercury exposure. The study demonstrated that Song Sparrow abundance, and the species' ability to reflect mercury exposure risk between sites, confirms their appropriateness as a biosentinel species. Observed differences in mercury between conceptual model categories -despite the rough measures used to classify sites into categories-supports the idea that net methylation environment and total mercury are critical factors in determining methylmercury exposure in riparian food webs. The riparian biosentinel tool developed here can be used to understand and monitor spatial and temporal patterns in mercury condition, long-term trends, and the impact of events such as management actions.

0348

P

Methylmercury in Lower Food Web Components of Six National Park Units in the Western Great Lakes Region

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A growing body of evidence indicates that factors supplying methylmercury (MeHg) to the lowest portions of the aquatic food web are controlling its trophic transfer, and ultimately, its exposure to top predators and humans. As part of a larger study examining mercury contamination within six US National Parks of the western Great Lakes region, we quantified the total and methylmercury content in water, surficial sediment, seston, and bulk zooplankton in 24 lakes, streams, and wetlands. Our results from May 2010-11 collections indicate that aqueous fractions of MeHg (range, 0.02-2.3 ng/L) correlated significantly with dissolved organic carbon and pH, but not with measures of sulfate ion. Aqueous MeHg averaged 13% that of total mercury across all sites, with elevated values in lakes and streams with wetland-dominated watersheds. Sediment, seston, and zooplankton MeHg averaged 1.4±0.6 (SE) ng/g dry weight, 10.2±1.9, and 99±16 ng/g (comprising 42±3 % of total Hg), respectively. Lakes that exhibited elevated mercury in fish tended to have high MeHg concentrations in lower food web components as well. Corresponding lake seston:water bioaccumulation factors (mean log BAF = 4.7±0.1 L/kg) and zooplankton:seston biomagnification factors (mean log BMF = 1.0±0.1) were similar across widely disparate sites, supporting the contention that environmental factors supplying aqueous MeHg to food webs are of primary importance.

0281

Bioaccumulation and Ecological Risk of Methylmercury to Fish in National Parks of the Western Great Lakes Region

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Fish populations in the Laurentian Great Lakes region are contaminated with methylmercury as a result of atmospheric deposition, subsequent methylation of inorganic mercury, and bioaccumulation in food webs. In conjunction with a project monitoring contaminants in fish populations within national parks of the western Great Lakes region, we conducted a screening-level risk assessment of mercury to lacustrine populations of northern pike (*Esox lucius*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*Micropterus salmoides*), and walleye (*Sander vitreus*) in Voyageurs National Park, Isle Royale National Park, Sleeping Bear Dunes National Lakeshore, and Pictured Rocks National Lakeshore. Not all species were obtained at all locations in all parks. Adult fish were sampled by angling and with gill nets in spring 2008, 2009, and 2010.

Total mercury in axial muscle of the fish was measured by direct combustion analysis. Concentrations of mercury in standard-size fish (size at sexual maturity) were estimated from the relation between mercury concentration and total length of individual fish at each location. Concentrations of mercury in standard-size fish and maximum measured concentrations were compared to toxicity reference values for mercury from the literature. Mean mercury concentrations in standard-size largemouth and smallmouth bass did not exceed toxicity reference values at any location. However, maximum measured concentrations in three lakes exceeded threshold values, indicating that some portion of each population was at risk due to methylmercury. Mean mercury concentrations in standard-size northern pike and maximum measured concentrations exceeded toxicity reference values in four and ten lakes, respectively. A sufficient number of walleye for analysis were obtained from only one lake and maximum measured concentrations, but not mean concentrations of mercury in standard-size walleye, exceeded threshold values. Results indicate that fish populations at a substantive number of locations within these Parks are at risk from methylmercury exposure and would benefit from reduction in mercury concentrations.

0264

Geochemical Controls on Mercury Methylation in the Water Column of Backwaters of a Gulf Coastal Plain River System, Lower Ouachita River, Arkansas

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The abundance and distribution of mercury and methylmercury were investigated at three sites in the lower Ouachita River, Arkansas, in the summer of 2010 to provide the first characterization of mercury contamination in this river system and to investigate the potential for mercury methylation in the water-column of backwaters off of the main channel. Results showed that filtered

methylmercury was positively correlated to dissolved organic carbon ($r^2 = 0.76$) for water samples taken from the bottom 1 ft of the water column at three sites, suggesting the importance of dissolved organic carbon in mercury methylation. Concentrations of filtered methylmercury and filtered total mercury in the bottom-water were significantly different (P = 0.039 and P = 0.022 respectively) between two sample sites located approximately 14 river miles apart. Sulfide concentrations of 65-143 micrograms/liter indicate that sulfate reduction was occurring in the bottom water or the sediment-water interface, yet filtered and particulate methylmercury concentrations were not significantly correlated to sulfide concentrations. The occurrence of sulfide in the bottom water, or lack thereof, is important as sulfate-reducing bacteria are commonly associated with mercury methylation. Water chemistry results for one site, including total iron in whole water (39.8 milligrams/liter), high dissolved organic carbon (13.5 milligrams/liter), filtered methylmercury concentration (the highest observed for the study at1.90 nanograms/liter), and no detectable sulfate, suggests the predominance of iron reduction at this site. Microbial iron reduction is also a known mercury methylation pathway. Total mercury concentrations for two of seven samples exceeded the Arkansas numeric water quality standard for total recoverable mercury in water (12 nanograms/liter), at concentrations of 13.8 and 14.0 nanograms/liter. These data provide evidence that availability of dissolved organic carbon affects mercury methylation at all three of the sites, and that iron reduction may contribute to mercury methylation at one of the sites. No correlation between sulfide and dissolved methylmercury was observed, suggesting that sulfate reduction may not be the driving process of mercury methylation at all our study sites, and that there may be multiple controls on mercury methylation in this river system.

0559

Linking Local-Scale Monitoring to Form an Integrated Regional Seafood Safety Assessment for Southern California

Kenneth Schiff

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Southern California has an active marine fishing community yet no regional assessment of seafood safety exists. An estimated 8.4 million fish were landed by recreational anglers in 2009 and nearly $3 million was spent monitoring seafood tissues by local agencies. Yet there was no coordination among monitoring agencies with each measuring different species, different tissue types, different chemical parameters, and using different quality assurance requirements. No data was routinely shared among the monitoring agencies or with the State who evaluates the information for seafood risk. The goal of this study was to create a southern California regionwide monitoring program for seafood safety by integrating and redirecting existing monitoring efforts. More than 1,700 fish were collected during the summer of 2009, including the top five most landed recreational sportfish species. Samples of edible tissues were analyzed for the chemicals with the greatest risk to consumers; mercury, PCBs and DDTs. Results indicated that moderate tissue contamination was widespread, with no site exhibiting levels below advisory guidelines for all species, but only a handful of sites exceeding no consumption advisory thresholds. Mercury and PCBs were the most widespread contaminants. Despite known hot spots of DDT, DDT tissue concentrations were uniformly below advisory guidelines. Embayments had greater mercury and PCB concentrations, and exceeded advisory guidelines more frequently than open coastal sites. The greater embayment concentrations compounds health risk since angler surveys illustrate these habitats are where the greatest frequency of fishing occurs.

0272
P

EPA's Assessment of Mercury in Fish from US Rivers

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Elevated mercury concentrations in fish are the leading cause of fish advisories. In a continuing effort to characterize the extent of mercury contamination in the Nation's waters, EPA's Office of Water and Office of Research and Development are collaborating to conduct the first statistically-based survey of mercury in fish from US rivers. This national fish survey is being conducted under the framework of EPA's National Rivers and Streams Assessment (NRSA), a probability-based survey designed to assess the condition of the Nation's streams and rivers. In 2008 and 2009, field teams applied consistent methods nationwide to collect samples of fish commonly consumed by humans at about 570 river locations in the lower 48 states during June through October. They collected one fish composite sample at every sampling location, and each composite sample consisted of five similarly-sized adult fish of the same species. Largemouth and smallmouth bass were the primary species collected for the study, accounting for 34% and 24% of all fish composites, respectively. Fillets from the fish composite samples were analyzed for total mercury. Mercury was detected at quantifiable levels in every fish sample collected for the study. Based on results from this study, the median concentration of mercury

in fish from US rivers is 0.2 ppm, and the maximum mercury concentration measured for the fillet samples is 1.4 ppm.

0117
P

Estimation of Particulate Mercury Washout Using National Atmospheric Deposition Program Samples and Instrumental Neutron Activation Analysis

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Speciation of atmospheric mercury (Hg) deposition (flux) is important to quantifying and modeling Hg fate in watersheds. The National Atmospheric Deposition Program / Mercury Deposition Network (NADP/MDN) measures weekly wet-only deposition of all Hg species combined in acidified whole-water precipitation samples. The NADP National Trends Network (NTN) measures concentrations of weekly wet-only deposition of major ions, reactive nitrogen species, and hydrogen-ion in filtered (<0.45 micron pore size), unpreserved precipitation samples. Wet- deposition (flux) is calculated by multiplying aqueous concentrations by precipitation depth measured by onsite rain gages and dividing by the collector surface area. Particulate flux is calculated by dividing total mass on the filters by the collector surface area.

In order to estimate particulate Hg flux, filters from seven NTN sites were composited by site and month from December 2010 through May 2011 for Instrumental Neutron Activation Analysis (INAA) by USGS TRIGA Reactor Group, Denver. After blank correction, particulate Hg was quantified in 25 of 42 monthly samples. Calculated fluxes ranged from 0.04 to 7.5 micrograms Hg per square meter per month. Two of the sites: IN34, Indiana Dunes and CO96, Molas Pass have co-located NTN and MDN monitoring. IN34 is downwind of industrialized areas (Chicago, IL). CO96 is a remote alpine site (Colorado) and had the highest particulate Hg flux. The 10 highest particulate Hg flux values were from high-altitude sites.

Calculated NTN particulate Hg flux ranged from 0.05 to 0.5 percent of MDN total Hg flux. Non-quantitative transfer of Hg from NTN buckets to the filters might account for this large difference. NTN particulate Hg flux is positively and linearly correlated with MDN total mercury flux for IN34 (R^2~0.85), but not for CO96 (R^2~0.35). MDN total Hg flux values are not correlated with NTN particulate bromine flux values (R^2<<0.15). A known atmospheric Hg oxidizer, Br should increase Hg solubility in precipitation; reducing particulate Hg flux (Seigneur and Lohman, 2008)[1]. NTN particulate Hg flux is positively and linearly correlated with precipitation depth for IN34 (R^2~0.96), but not for CO96 (R^2~0.45); which indicates site-specific factors influence the phase distribution of wet-deposited Hg.[1] Journal Geophysical Res., 2008, vol 113.

0192
P

Occurrence and Distribution of Fecal Indicator Bacteria and Gene Markers of Pathogenic Bacteria in Great Lakes Tributaries, March – September 2011

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From March through September 2011, the US Geological Survey (USGS) Michigan Water Science Center (MI- WSC), in conjunction with USGS Water Science Centers in Indiana, Minnesota, Ohio, New York, and Wisconsin, conducted studies to determine the frequency of occurrence of genetic markers of bacterial pathogens and densities of fecal indicator bacteria in tributaries to the Great Lakes. This project was funded as part of the Great Lakes Restoration Initiative, and included analysis of 21 sampling locations throughout six states that border the Great Lakes. From March through September 2011, 160 samples were collected at USGS streamgaging locations during storm events, as well as during routine baseflow conditions, and analyzed by the Michigan Bacteriological Research Laboratory located at the MI-WSC. The majority of samples were collected using the equal width interval method (EWI) in order to obtain the most representative sample at each site. Water samples were analyzed for *Escherichia coli* (*E. coli*) and enterococci fecal indicator bacteria concentrations, 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). The fecal indicator bacteria concentrations and bacterial pathogen results are being analyzed with respect to land use, seasonality, hydrologic conditions, and water chemistry. The results of this study will be used to improve the understanding of microbiological water quality in Great Lakes

tributaries with the goal of determining the relationship between the occurrence of bacterial pathogens/fecal indicator bacteria and the parameters stated above. The results of the study may be useful to Great Lakes resource managers in determining the risks to human health through recreational activities in water, as well as developing future monitoring plans for pathogens.

0181
P

Validation and Application of Large Volume MPN Techniques Using a Modification of US EPA Method 1601: Detecting Low Concentrations of MS2 Coliphage to Demonstrate the Efficacy of Soil- Aquifer Treatment of Secondary Effluent

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The State of California Department of Public Health (CA DPH) is requiring wastewater utilities utilizing groundwater recharge and extraction operations through soil-aquifer treatment (SAT) to demonstrate a 99.999 percent (5-log) reduction of the plaque-forming units (pfu)of male-specific (MS) bacteriophage (phage). The secondary effluent of many treatment plants discharge phage concentrations below the sensitivity level of standard protocols. Analysis of large volumes of extracted water are necessary to show that the 5-log reduction is being met. In this study, a modification of the presence-absence format of EPA Method 1601 was validated for use in demonstrating MS phage concentration, in a most probable number (MPN) format, for volumes from 30 L to 300 L. For the larger volumes (300 L), three electro-positive filters processing 100 L each were used. A 3-portion, one dilution MPN calculation was made to demonstrate a detection limit of 0.0004 MPN/100 mL. This method was applied to two sites where utilities were attempting to demonstrate 5-log reduction by SAT. One utility consistently demonstrated >5-log reduction by SAT, while the other was sporadically in compliance with the 5-log reduction goal. Approval of this analytical method by CA DPH that illustrates tertiary filtration and virus compliance of percolated groundwater can save utilities millions of dollars by avoiding unnecessary construction associated with advanced water treatment for reclaimed water production.

0350
P

Quantitative Microbial Risk Assessment for Recreational Exposure in Northern California Receiving Waters

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This one year assessment is being conducted for the City of Vacaville (CA) Easterly Wastewater Treatment Plant (EWWTP). EWWTP discharges disinfected secondary wastewater with seasonal filtration into the watershed of the Sacramento-San Joaquin Delta. The assessment is being conducted to support NPDES permit renewal and further clarify and inform stakeholder concerns regarding potential human health risks from pathogenic organisms in receiving waters for recreational exposures. Both plant effluent and receiving waters are being monitored for various indicator and pathogenic microorganisms. Indicator organisms are sampled twice per month and include the coliform group; *E. coli*; *Enterococcus*; male-specific bacteriophage; and, the Bacteroidales. Pathogens are sampled seasonally and include, *Giardia* and *Cryptosporidium*; infectious *Cryptosporidium*; and Noroviruses GI and GII. In addition, positive findings of *Cryptosporidium* are being genotyped. The data are being used to update a previous 2001 quantitative microbial risk assessment of potential recreational exposure to the microbial constituents from EWWTP final effluent in local receiving waters. In addition, preliminary source tracking results indicate that runoff from agricultural areas are the primary contributor to microbial contamination.

0232
P

Genetic Sequencing Methodologies to Assess Human Contributions of Fecal Coliforms to aFreshwater Receiving Stream

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The State of South Carolina, Department of Health and Environmental Control (SCDHEC) is charged through the SC Pollution Control Act and the Federal Clean Water Act with the responsibility to ensure that classified uses of State waters are maintained and that waters are free from pollutants in excess of State standards. Water bodies that fail to meet water quality standards, or support classified uses, are reported to the Environmental Protection Agency (EPA) on a biennial basis through the Section 305(b) report and the Section 303(d) list of impaired water bodies. Total Maximum Daily Loads (TMDLs) are required in all 303(d) listed water bodies. Crucial to any plan to achieve compliance with fecal coliform standards is an understanding of the probable sources of fecal coliform bacteria (e.g., human, domesticated animals, wild animals). Once identified, sources of NPS fecal coliform may be adequately mitigated through appropriate corrective action. However, conventional use of fecal coliform as an indicator of fecal contamination does not provide an indication of the source of contamination.

Metagenomics (sequencing and analysis of DNA from environmental samples), polymerase chain reaction (PCR) and quantitative PCR (qPCR) are genetic methodologies that can be used for the identification of microbial organisms specific to potential sources of fecal coliform pollution. Metagenomic methods were used first to sequence DNA present in municipal wastewater and receiving stream water samples. These DNA sequences were then compared to available databases to identify known sequences. A literature search was conducted to determine if any known sequence is a likely genetic marker from a known microbial species. Once identified, qPCR methodology will then be used to quantify the presence of known genetic markers to further substantiate and confirm the presence of potential fecal coliform pollution sources.

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. Three rounds of sampling were conducted during the months of June – August.

0365
P

Stormy Weather: Event-Based Pathogen Monitoring in the Bull Run Watershed

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As part of a study to characterize the concentration of pathogens in the Bull Run source water, the Portland Water Bureau (PWB) conducted scheduled and event-based monitoring at several locations in the protected Bull Run watershed-Portland’s unfiltered surface water supply. Wildlife is the only potentially significant source of *Cryptosporidium* and *Giardia* in the watershed. Storm monitoring was undertaken to test the hypothesis that pathogens increase during rainfall events after a dry period or during significant peak stream flows.

PWB selected locations upstream of the intake where wildlife fecal deposits may accumulate. Four sites are major tributaries to the two Bull Run reservoirs. Event sampling was triggered when the mean daily stream discharge exceeded a threshold based on historical data. PWB staff intensively sampled during heavy storms, especially after a dry period, to capture the rising limb, peak, and falling limb of the stream hydrograph.

PWB also sampled the deepest part of each reservoir and two upper reservoir sites adjacent to potential wildlife grazing areas. Event sampling was triggered by high turbidity or by significant rainfall following several dry days during summer drawdown.

In response to the triggers, staff traveled to the remote locations and collected samples for *Cryptosporidium* and *Giardia* (using EPA Method 1623) and *E. coli*. At the tributaries, solar powered auto-samplers inside USGS gaging stations were used to fill sample containers.

Event sampling presented many logistical challenges, particularly on weekends and during storms selected for intensive monitoring. PWB implemented a successful program to manage staff training and availability, ongoing equipment needs, meteorological monitoring, communications, decision making, and safety considerations. Lessons learned from this program may be helpful for others who plan to conduct similar event-based monitoring.

During the first year of pathogen monitoring, 315 samples (3,383 liters) were collected and analyzed. Of these, 38% were collected during the weather events, when there would be the highest potential for pathogens to enter the water. Results indicate that the concentration of some pathogens is higher for event samples than non-event (scheduled) samples. Sampling will continue through 2011 and results will be presented in April 2012.

0049
P

E. coli in the Urban South Platte River Watershed

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The Urban South Platte River, which originates in the Rocky Mountains, runs through the center of metropolitan Denver, Colorado and north through agricultural plains. Since 1998, the watershed has been extensively monitored by the South Platte Coalition for Urban River Evaluation (SPCURE). In 2008 at the NWQMC it was reported that there was little if any impact on E. coli levels in the South Platte as it moved through the Denver metropolitan area. New research using a more sensitive data trend modeling and corrections for differences between analytical methodologies can now distinguish an impact in the metropolitan area despite very noisy data.

The data collected from this ongoing study still demonstrates that the now implemented stream standard of 126 cpu/100ml will be difficult, if not impossible, to attain in the urban South Platte River watershed because of natural biological conditions. It also demonstrates the degree to which large sets of data, temporal and spatial, are necessary to understand complex relationships in a watershed.

0324
P

Volunteer Stream Monitoring: Assessing Aesthetics along Urban River Corridors

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The Wisconsin Department of Natural Resources (WDNR) and University of Wisconsin - Extension's (UWEX) Volunteer Stream Monitoring Program (VSM) coordinates participants state-wide to conduct water quality monitoring, contributing data to the WDNR database. Many hours of hard work go into collecting water quality data that drives implementation of regulations in hopes of improving water quality, however, no information is collected on aesthetic parameters including floating or submerged debris, oil, scum or materials producing color, odor, taste, or unsightliness.

In the fall of 2011, a program designed to monitor aesthetics was developed as an extension of the VSM program coordinating volunteers to assess stations along urban river corridors listed in the Great Lakes Area of Concern (AOC) in Green Bay, Wisconsin. Participants from the area evaluate the aesthetic quality of a station allowing for assessment of public perception and correlation between aesthetics and water quality improvements.

Decisions about the aesthetic quality of water are highly subjective in nature and involve personal interpretation of what is an "unacceptable level" or an "objectionable" amount that would interfere with public rights or impair use. In order to normalize data, a unique monitoring rotation plan and datasheet were developed. Through the questions on the datasheet, volunteers describe an overall experience they have when visiting the stations. Information about the methods and analyzed data from the pilot project will be described in the presentation.

0137
P

Assessment of Water Quality and Ecological Condition of Urban Streams in Independence, Missouri Using Multiple Lines of Investigation and Continuous Water-Quality Monitors

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The US Geological Survey in cooperation with the City of Independence Water Pollution Control Department initiated an ongoing (2012) study in June 2005 to characterize water quality and evaluate the ecological condition of streams within Independence, Missouri. Multiple lines of investigation are being used including base-flow and stormflow water-quality sampling, point source identification, macroinvertebrate surveys, and microbial source tracking. Continuous water-quality monitors (CWQMs) deployed at five sites measure temperature, specific conductance, pH, dissolved oxygen, and turbidity. At a sixth site a CWQM measures specific

conductance and temperature. Daily values calculated from the CWQM data are considered as variables in regression models to estimate continuous and annual flow-weighted concentrations, loadings, and yields for chloride, total nitrogen, total phosphorus, suspended sediment, and *Escherichia coli* bacteria densities. Models using only streamflow as a variable tend to overestimate loads and yields. Specific conductance and turbidity have proved useful as regression variables to decrease unaccounted-for variability of the estimates for chloride, nutrients, and bacteria. From 2005 through 2008, the estimated average daily sediment yield for the Little Blue River increased downstream. Although total drainage area increased only about 20 percent, estimated annual suspended loads were two to three times larger.

Base-flow and stormflow samples are being used to characterize the physical, chemical, and biologic effects of storm runoff on water quality. Streamflow, physical properties, dissolved oxygen, chloride, metals, nutrients, chlorophyll, common organic micro-constituents, fecal indicator bacteria, and microbial source tracking data are being collected. Dry-weather screenings during base flow of all major streams draining Independence help identify point-source discharges and other sources of potential contamination. Benthic macroinvertebrate community surveys and habitat assessments are being used to evaluate the ecological condition and health of streams.

Data collected June 2005 through December 2008 have been presented and interpreted in the Scientific Investigations Report 2010-5074. Regression models, including those using CWQM variables, indicate that the potential exists for decreasing concentrations, and consequently loads, of nutrients and bacteria to streams associated with suspended sediment in stormflow by the continuing implementation of stormwater Best Management Practices such as detention basins and public education by the City of Independence.

0563
P

Analysis of the Patrick Henry School Stormwater Retrofit Demonstration Project

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The Patrick Henry School of Science and Arts (PHSSA) is a new charter school located in the Reedy Creek watershed (City of Richmond, VA). The historical building the school occupies was built in 1921. Like many buildings and developments of it's time, no stormwater measures were installed. Additionally, the school site contributes to the City of Richmond's combined sewer overflow (CSO) system, which discharges raw sewage and stormwater into the James River during heavy rain events.

PHSSA has a total of 5000 m^2 impermeable surface as well as highly compacted soils other areas of the property. A variety of Low Impact Development (LID) conservation practices to mitigate stormwater are planned for installation in phases. These include a rain garden, conservation landscaping, vegetated swales, an educational forest garden, a green roof, and downspout disconnects.

Baseline data has been collected for bacteria, nutrients, rain fall, and flows in 2011 and are compared with samples collected after phase one conservation practices have been installed. This paper will provide a project overview, discuss the monitoring design, and summarize the initial results of the data collected to date.

Partners with Patrick Henry School of Science and Arts include Virginia Commonwealth University (VCU), the Alliance for the Chesapeake Bay, Richmond Department of Public Utilities, Waterstreet Studio, and the Reedy Creek Coalition (RCC).

0273
P

Stormwater Sampling: A Look at the City of Portland's UIC Monitoring Program

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In the fall of 2012, the City of Portland enters into the eighth year of its ten year Water Pollution Control Facilities (WPCF) Permit for Class V Stormwater Underground Injection Control (UIC) Systems. This UIC WPCF Permit is the first regional permit of its kind in the United States and results in the City's Bureau of Environmental Services Field Operations group collecting about 250 samples from UIC systems each stormwater year. We will look at how Field Operations prepares for and collects samples and how stormwater sampling efficiency has improved.

0085

Assessing Progress towards Reducing E. coli Levels in Dry Weather Discharges from Denver's MS4

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An E. coli TMDL was finalized for the segment of the South Platte River that passes through Denver, Colorado in October of 2007. The TMDL identified dry weather discharges of E. coli from Denver's storm sewers as a major source of E. coli in the South Platte River and assigned a wasteload allocation of 126 CFU / 100 mL E. coli to that source. The wasteload allocation was implemented in Denver's storm water discharge permit in March of 2009. That permit includes a special section on E. coli that establishes a ten-year compliance schedule to meet the wasteload allocation and describes best management practices (BMPs) that must be implemented. Required BMPs are largely focused on infrastructure maintenance – cleaning storm sewers, eliminating illicit connections to the storm sewers, and identifying and eliminating cross connections between the storm and sanitary sewers. The permit also requires Denver to conduct an annual analysis to demonstrate the effectiveness of the BMPs.

Efforts to implement BMPs are focused on several priority storm drainage basins, basins which have been identified as significant contributors of E. coli during dry weather. The 2012 Annual Analysis consisted of a preliminary evaluation of the effectiveness of the E. coli BMPs in the priority basins using data collected from 2006 through 2011. Data were analyzed using simple plots and standard non-parametric statistical techniques such as the Wilcoxon Rank Sum Test and the Mann-Kendall trend test. The results of the analysis suggest that BMP implementation has successfully reduced E. coli levels in and E. coli loading from dry weather discharges, especially in those basins where the first round of implementation is complete. Ongoing implementation of BMPs and implementation of multiple BMPs within a storm sewer drainage basin make it difficult to determine if any one of the BMPs is more effective than the others.

0412
P

Development of Urban Steam Water Quality Indices in the Kansas City Urban Streams Network

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Water column and sediment samples from 36 urban network monitoring sites in the Kansas City metropolitan area revealed the presence of chemical contaminants. Some contaminants were above published thresholds and criteria, but most were either below criteria levels or, as with the case of most sediment contaminants, have no published criteria. In recognition of the fact that co-occurrence of toxicants occurs in aquatic ecosystems and can lead to joint toxicity as a result of exposures to combinations of contaminants, an indicator concept was developed to express the potential exposure to multiple toxicants. An index related to the occurrence of anthropogenic related compounds (ARC) was proposed. This richness index is based on the summed occurrence of toxicants that are anthropogenic in origin. Chemical species such as metals and salts, which could be present at normal (i.e.</i>, background) levels, were not included in the ARC indices. ARC indices were developed for water-only, sediment and water, and sediment-only contaminants. ARC scores regressed with land use and land cover data were statistically significant when regressed with land cover data and biotic indices.

To assess the combined physical, biological and chemical effects on overall stream health, an urban stream index has been proposed. The Urban Stream Index (USI) is an index that scores streams from zero (highly degraded) to 100 (pristine conditions). The USI is composed of ten factors: urban land use, habitat (QHEI score), invertebrate richness, fish richness, ARC water & sediment, algae biomass (chlorophyll a), nutrients (total nitrogen), bacteria (total coliforms) and sediment (total dissolved solids). USI results revealed a gradient of stream health conditions from highly degraded stream conditions on streams in the urban core to moderately degraded conditions on streams on the urban fringe.

0034
P

Water-Quality Assessments of Principal Aquifers

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In the second decade (2002-2012) of the US Geological Survey's National Water-Quality Assessment (NAWQA) Program, a major focus is on regional assessments of ground-water quality conditions and trends. The assessments evaluate conditions and trends in 19 of the 62 PAs (Principal Aquifers) of the United States. These 19 PAs account for about 75% of the estimated withdrawals of groundwater for drinking-water supply.

The regional assessments build on NAWQA Cycle 1 (1991 to 2001) findings by complementing and extending those findings to fill gaps in our understanding of ground-water quality and flow over broad regions, and by studying trends in groundwater quality. The assessments have increased our understanding of how natural features and human activities affect ground-water quality. For example, regional differences in climate, geology, land use, and other factors can lead to regional differences in water quality among PAs.

Four broad issues are addressed by each regional assessment: contaminants in aquifers; water quality in domestic and public-supply wells; processes affecting both water quality and contaminant transport; and the effects of land use on water quality. Each of the regional assessments also addresses water-quality issues of concern within that particular PA - for example, the occurrence of arsenic, radon and deicing chemicals in the glacial deposits aquifers; radium in the Northern Atlantic Coastal Plain aquifer system; salinity in aquifers underlying the Basin and Range and California Coastal Basins; and fumigants in volcanic aquifers of the western U.S.

Resource managers and scientists can use the results of these studies in assessing the vulnerability of ground water to contamination across different regions. By identifying natural and human factors and processes affecting the occurrence and transport of contaminants, the assessments will allow managers and scientists to apply findings to broader classes of contaminants and to newly identified contaminants. Tools, such as regional-scale models that integrate aquifer characteristics, land use, and water-quality monitoring data, will help water managers to assess conditions in unmonitored areas and the sustainability of water resources for future supply.

0277
P

Water Quality of the Denver Basin Aquifer System

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The Denver Basin aquifer system is a critical water resource for municipal, industrial, and domestic uses along the semi-arid Front Range urban corridor of Colorado. The aquifer system consists of confined sandstone bedrock aquifers interbedded with shale confining units and is overlain at the land surface by unconfined sand and gravel alluvial aquifers that occur along present-day stream channels. The occurrence and distribution of anthropogenic and natural contaminants in the aquifer system largely is controlled by human activities at the land surface and variations in chemical composition of aquifer solids, groundwater hydrology, and geochemistry.

The most common anthropogenic compounds in samples collected from the Denver Basin aquifers in 2003 to 2005 were nitrate, volatile organic compounds (VOCs), and pesticide compounds. Concentrations of nitrate were highest in samples from the shallow aquifer system underlying agricultural and urban areas; one-fifth of these concentrations exceeded the US Environmental Protection Agency (USEPA) drinking-water standard of 10 milligrams per liter. Use of nitrogen-containing chemicals at the land surface and infiltration of oxic recharge water promote nitrate mobility and transport in the subsurface and shallow groundwater. VOCs and pesticide compounds were detected at low concentrations in samples from wells at shallow and intermediate depths. Pumping from bedrock aquifers has enhanced the downward movement of water containing these chemicals from the land surface deeper into the aquifer system.

The most common naturally occurring compounds in samples from Denver Basin aquifers with concentrations that exceeded USEPA drinking-water standards or guidelines were dissolved solids, uranium, selenium, and manganese. Elevated concentrations of dissolved solids, uranium, and selenium were detected more frequently in samples from the shallow system and were related to chemical composition of subsurface and aquifer solids, mineral dissolution and evaporative concentration in the unsaturated zone, recharge from human activities, and groundwater residence time. Concentrations of manganese typically were highest in anoxic samples from deep parts of aquifers. Radon was detected in all drinking-water samples in which it was measured. Most values were greater than the lower proposed drinking-water standard of 300 picocuries per liter (pCi/L); exceedances of the higher proposed standard of 4,000 pCi/L were rare.

0298
P

Water Quality of the Floridan Aquifer System – Anthropogenic and Naturally Derived Contaminants

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The Floridan aquifer system underlies approximately 100,000 square miles in the southeastern US and provides drinking water to about 10 million people. Nearly 400 samples were collected from domestic, public supply and monitoring wells in the Floridan aquifer system from 1993 to 2010 as part of the National Water-Quality Assessment program. The distribution of contaminants in this aquifer system is largely controlled by variations in hydrogeology, aquifer materials, and groundwater geochemistry, as well as anthropogenic inputs from agricultural and urban sources. Some localized areas of contamination are related to the large groundwater withdrawals from public supply wells which can cause changes in groundwater geochemistry. The most common water-quality issues from anthropogenic sources are related to nitrate and pesticides occurrences from agricultural and urban areas. Concentrations of nitrate in the Floridan aquifer system were among the lowest in the nation and most concentrations were less than 1 mg/L as N. Pesticide concentrations were also low in the Floridan aquifer system but pesticides were detected in about 38 percent of samples collected from this aquifer system. Concentrations of nitrate greater than 1 milligram per liter and detections frequencies of *pesticides were more common in groundwater beneath agricultural areas* where numerous sinkholes and other karst features were present. The most common water-quality contaminants from natural sources in the Floridan aquifer system are radon, and arsenic. Concentrations of radon commonly exceeded the lower proposed human health benchmark (300 picoCuries per liter) but only rarely exceeded a higher proposed human health benchmark (4,000 picoCuries per liter). Exceedances varied by region for radon with the highest concentrations located in some areas in central Florida, which are related to the high uranium content in the overlying clay materials. Concentrations of arsenic were greatest where groundwater is anoxic or where geochemical conditions have been altered by pumping of public supply wells which enhance the release of arsenic from aquifer materials.

0111
P

Water Quality of the Surficial Aquifer System of the Northern Atlantic Coastal Plain

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The surficial aquifer system of the Northern Atlantic Coastal Plain (NACP) extends from New Jersey through North Carolina and includes unconfined aquifers of varying thickness that occur throughout most of the area. The system is an important, renewable source of drinking water and the source of most base flow to local streams. The relatively coarse and permeable sediments that comprise the surficial aquifer system, however, make it susceptible to contamination from chemicals applied to the land surface and transported into groundwater with infiltrating rainfall. These chemicals affect the suitability of the aquifer as a source of drinking water and the quality of receiving surface waters.

Chemicals from anthropogenic sources are widespread in groundwater of the NACP with nitrate and dieldrin most commonly detected above human-health benchmarks. Nitrate occurrence in groundwater reflects the distribution of nitrogen sources as well as hydrogeologic and geochemical conditions in the aquifer system. In parts of the NACP with intensive agricultural land use and oxic aquifer conditions, concentrations of nitrate are among the highest in the Nation. Dieldrin, an insecticide that was widely used in urban areas for termite control until its use was banned in 1987, is still widely detected in drinking water because of the slow movement of groundwater through the surficial aquifer system. Other pesticide and volatile organic compounds also are common in groundwater in areas of use, and concentrations occasionally exceed human-health benchmarks.

Natural chemical contaminants also are detected in NACP groundwater. Radium and manganese are the most frequently detected at concentrations exceeding human-health benchmarks. Radium, a product of the radioactive decay of naturally-occurring uranium and thorium, in drinking water is known to increase cancer risk. Elevated concentrations of radium are most common in acidic, oxic groundwater. Radon gas, another radioactive decay product, is also frequently detected. Manganese is present at higher concentrations in groundwater under anoxic aquifer conditions and also in water with high concentrations of radium. Concentrations of dissolved iron, which does not affect human health but does affect the taste of drinking water and stain plumbing fixtures, is often associated with elevated concentrations of manganese and anoxic conditions.

0176
P

Water Quality of the Mississippi Embayment-Texas Coastal Uplands Aquifer System and Mississippi River Valley Alluvial Aquifer – Anthropogenic and Naturally Derived Contaminants

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About 250 wells throughout the Mississippi embayment-Texas coastal uplands aquifer system and Mississippi River Valley alluvial (MRVA) aquifer were sampled from 1994 through 2009 as part of the US Geological Survey's National Water-Quality Assessment Program. Many parts of these aquifers are confined and the occurrence of contaminants related to activities at land surface was most common where groundwater residence times were relatively short such as in shallow groundwater and in outcrop areas. Although agriculture accounts for about 40 percent of the land use in the study area, elevated concentrations of nitrate were not a widespread issue because of reducing conditions throughout much of these aquifers. Nitrate that moves into the aquifers with recharge likely is transformed to nitrogen gas as a result of denitrification. The median concentration of nitrate in all samples was < 0.06 milligrams per liter (mg/L as N), and only one sample had a concentration greater than the Maximum Contaminant Level (MCL) of 10 mg/L. Similarly, pesticides were detected relatively infrequently. Atrazine and simazine were the most commonly detected pesticides and both were detected in about 10 percent of samples. Concentrations of detected pesticides were low, with maximum concentrations nearly an order of magnitude lower than their respective MCLs. Dieldrin was detected five times and was the only pesticide detected at a concentration greater than its human-health benchmark. No volatile organic compounds were detected at concentrations greater than a human-health benchmark. Constituents derived from natural sources that were detected at concentrations greater than human-health benchmarks included radon, arsenic, manganese, boron, lead, strontium, and zinc. For most of these constituents, concentrations exceeded the benchmark in less than 5 percent of samples. However, radon exceeded the proposed MCL of 300 picocuries per liter in about 30 percent of samples. Elevated concentrations of arsenic were primarily measured in the MRVA aquifer and were associated with high dissolved iron concentrations and reducing conditions. Although phosphorus in groundwater is not a drinking-water concern, elevated concentrations (median 0.22 mg/L; maximum 1.3 mg/L) in the MRVA aquifer could adversely affect the quality of streams receiving groundwater discharge.

0436
P

Water Quality in the Piedmont and Blue Ridge Crystalline- and Carbonate-Rock Aquifers, Early Mesozoic Basin Aquifers, and the Valley and Ridge Carbonate- and Siliclastic-Rock Aquifers, Eastern United States, 1993-2009

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The Piedmont and Blue Ridge crystalline- and carbonate-rock aquifers, Early Mesozoic basin (siliciclastic-rock) aquifers, and the Valley and Ridge carbonate- and siliciclastic-rock aquifers are five principal aquifers which are used as a source of drinking water in the Eastern United States. The distribution of groundwater contaminants varies widely in these aquifers, depending on whether the contaminant is naturally occurring or anthropogenic. There are two very different sets of conditions that define the occurrence of these two groups of contaminants, and thus results of water-quality sampling in siliciclastic- and crystalline-rock aquifers differs greatly from results of water-quality sampling in carbonate-rock aquifers.

The naturally occurring contaminants that most commonly exceeded human health benchmarks come from minerals in aquifer materials, but generally require specific geochemical conditions to mobilize the contaminants in the groundwater. The Piedmont and Blue Ridge crystalline-rock aquifers have minerals in the rocks that resulted in water samples with the highest concentrations of radon of all five aquifers. The two siliciclastic-rock aquifers had source minerals and geochemical conditions that resulted in water samples with the highest concentrations of arsenic, manganese, and uranium. Groundwater samples from the crystalline- and the two siliciclastic- rock aquifers were much more likely to contain naturally occurring contaminants at levels of potential concern for human health than groundwater samples from carbonate-rock aquifers.

The anthropogenic contaminants that were the most commonly detected or exceeded human-health benchmarks were related to the amount of the contaminant source present and the conditions in the aquifer with respect to transport of that contaminant. The carbonate-rock aquifers are highly vulnerable to surficial contamination and are overlain by a large percentage of agricultural and

urban land use. Thus, groundwater samples from the carbonate- rock aquifers generally had higher concentrations of many anthropogenic contaminants when compared to the crystalline- or siliciclastic-rock aquifers, which tend to be overlain by less agricultural land, are generally less susceptible to surface contamination. In the carbonate-rock aquifers, anthropogenic contaminants such as nitrate, the insecticide dieldrin, and the microbial contaminant E. coli were present at levels of potential concern for human health more frequently than in the other two types of aquifers.

0197
P

Water Quality of the High Plains Aquifer System

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The High Plains aquifer is a nationally important water resource that underlies about 174,000 square miles in parts of eight states. The aquifer serves as the primary source of drinking water for most residents of the region, and it also sustains more than one-fourth of the Nation's agricultural production. The distribution of contaminants in this aquifer system is largely controlled by anthropogenic inputs from agriculture, and variations in aquifer and groundwater geochemistry.

Irrigated cropland was a direct or indirect source of chloride, nitrate, and pesticides to the High Plains aquifer. Urban land was also a source of those constituents, as well as volatile organic compounds, although urban development is much less widespread than agriculture in the High Plains. Processes that promote recharge in this semiarid area, such as irrigation, increase the potential for groundwater contamination by increasing chemical fluxes and decreasing chemical transit times to the deep water table. Furthermore, conversion of rangeland to irrigated cropland has the potential to mobilize large natural salt deposits in the unsaturated zone that could eventually reach the water table. The median nitrate concentration in water from sampled domestic wells was 2.2 milligrams per liter as nitrogen (mg/L as N), which is the third highest median concentration among principal aquifers studied by the US Geological Survey's National Water-Quality Assessment (NAWQA) Program, but only 5.4 percent of the samples exceeded the federal drinking-water standard for nitrate (10 mg/L as N). Thirty-two percent of the samples from domestic wells had at least one detection of a pesticide compound, but none of the concentrations exceeded a federal drinking-water standard.

Water from domestic wells had concentrations of several constituents from natural sources that exceeded federal drinking-water standards. These constituents included arsenic (9.3 percent of the samples), fluoride (3.4 percent), and uranium (2.2 percent). Radon activities exceeded the proposed drinking-water standard of 300 picocuries per liter in 58 percent of the samples. Concentrations that exceeded standards were not evenly distributed across the aquifer. Most exceedances for arsenic, fluoride, and radon occurred in the southern High Plains and most exceedances for uranium occurred in the northern High Plains.

0075
P

Water Quality in the Columbia Plateau, Snake River Plain, and Hawaiian Basaltic-Rock and Basin- fill Aquifers, Washington, Idaho, Hawaii, 1992–2005

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The Western Volcanics Aquifer Systems include three areas with similar aquifer materials: the Columbia Plateau in Washington, the Snake River Plain in Idaho, and the island of Oahu, Hawaii. The primary focus of this study is to compare and contrast the groundwater quality of the regional basaltic-rock aquifers in the three areas, although important sedimentary aquifers (basin-fill aquifers) that overlie basalts of the Columbia Plateau and Snake River Plain are also included. Groundwater-quality samples were collected from 1992-2005.

This study has identified some interesting similarities and differences in groundwater quality between the three areas. Elevated nitrate concentrations are common to all three areas, with concentrations in water from 20 percent of the Columbia Plateau wells and 3 percent of the Snake River Plain wells above the US Environmental Protection Agency drinking-water standard of 10 milligrams per liter. Pesticides were detected frequently in groundwater of the three study areas, but generally at concentrations below human-health benchmarks for drinking water. Different pesticides detected in groundwater of the three study areas reflect different crops and pesticides favored in those areas. For example, simazine, metribuzin, and metolachlor were detected in groundwater of the Columbia Plateau and the Snake River Plain but not in Oahu groundwater. Simazine, metribuzin, and metolachlor are used on the row crops

grown in the Columbia Plateau and Snake River Plain (such as potatoes, barley, and alfalfa), but not on any major crops grown on Oahu (pineapple and sugarcane). Groundwater from Oahu and the Columbia Plateau had some of the highest percentages of soil fumigant detections in the United States. Soil fumigants are pesticides that are applied to soils to reduce populations of plant parasitic nematodes (harmful rootworms) in crops such as potatoes and pineapple. DDT and dieldrin are still detected at low concentrations in groundwater from all three areas even though they have been banned for over 30 years. The naturally occurring constituents-arsenic, fluoride, and uranium-were commonly detected in groundwater from the Columbia Plateau and the Snake River Plain, but not Oahu.

0243
P

Water Quality of the Southwest Basin-fill Aquifers

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Basin-fill aquifers in the Southwestern United States include four of the principal aquifers of the United States: the Coastal Basin aquifers and the Central Valley aquifer system in California; the Basin and Range basin-fill aquifers in California, Nevada, Utah, and Arizona; and the Rio Grande aquifer system in New Mexico and Colorado. These aquifers are the primary source of water for many cities and agricultural communities in this arid to semiarid region, and demand on the limited high-quality water resources will increase with population growth.

Parts of basin-fill aquifers are naturally susceptible to contamination because of aquifer properties, and well pumping and artificial recharge have increased the likelihood of contamination in some areas. Water from 26 percent of the public-supply wells and 42 percent of the domestic wells sampled by the National Water-Quality Assessment (NAWQA) Program in the Southwest contained at least one constituent with a concentration that exceeded its human-health benchmark. Of the exceedances, 66 percent were for a naturally occurring constituent (mostly arsenic and uranium) and 24 percent were for nitrate.

Natural sources and geochemical processes can result in high concentrations of constituents in Southwest basin-fill aquifers. For example, evapotranspiration increases concentrations of dissolved solids, arsenic, uranium, and nitrate in groundwater. Concentrations of dissolved solids were greater than the secondary drinking-water standard of 500 milligrams per liter (mg/L) in more than 25 percent of samples from drinking-water wells (both public-supply and domestic wells) and concentrations of arsenic were greater than the human-health benchmark of 10 micrograms per liter in 16 percent of samples.

Potential groundwater contaminants are intentionally applied (nitrogen fertilizers, manure, and pesticides) or accidentally released (volatile organic compounds) at the land surface. Irrigation and pumping can result in the downward movement of anthropogenic contaminants to deeper parts of aquifers used for drinking-water supply. Concentrations of nitrate exceeded the human-health benchmark of 10 mg/L as nitrogen in about 11 percent of the samples from drinking-water wells. Although at least one pesticide compound or volatile organic compound was detected in water from about half of all wells sampled in Southwest basin-fill aquifers, concentrations generally were low.

0155
P

Water Quality of the Glacial Aquifer System – Anthropogenic and Natural Contaminants

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Approximately one-sixth (41 million people) of the United States population relied on the glacial aquifer system for drinking water in 2005. However, untreated water from one in five drinking water wells in this aquifer, sampled as part of the US Geological Survey National Water Quality Assessment Program, exceeded a human health benchmark for at least one contaminant. The distribution of contaminants is largely controlled by anthropogenic and natural sources and variations in groundwater geochemistry.

The most common anthropogenic contaminants were nitrate, pesticides, and chloride. Nitrate and pesticides have anthropogenic sources in agricultural areas; whereas, chloride was associated with urban areas. Concentrations of nitrate in groundwater in the glacial aquifer system were among the highest in the nation and 10 percent of all samples, including monitoring wells, exceeded the human health benchmark (10 mg/L). The percentage of drinking water samples with nitrate concentration above 10 mg/L was 4

percent. Further, nitrate in groundwater contributed to the annual total nitrate load from streams. Pesticide concentrations were low but frequently detected (25 percent of wells). Chloride increases greater than 20 mg/L over 10 years of sampling were observed in four areas and the highest concentrations in groundwater and streams occurred in urban areas where halite is used for roadway deicing. Chloride is also common in sewage and animal waste.

The most common water-quality contaminants had natural sources and included arsenic, uranium, and manganese. Concentrations of arsenic were greatest where groundwater is old, anoxic, and alkaline-generally, these factors increase from east to west in the glacial aquifer system and with depth. Uranium was elevated where uranium was common in glacial deposits and where groundwater had high alkalinity. High manganese concentrations were widespread but were highest in the west-central region where the benchmark was exceeded in 46 percent of 174 public wells and 25 percent of 502 domestic wells. Concentrations of radon commonly exceeded the lower proposed human health benchmark (300 pCi/L), but only rarely exceeded the higher proposed human health benchmark (4,000 pCi/L).

0389
P

New Mexico's Hydrology Protocol – An Expedited Field Methodology for Classifying Ephemeral, Intermittent and Perennial Waters and Documenting the Supported Uses

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The New Mexico Environment Department has recently developed a *Hydrology Protocol* that outlines a field methodology to quantitatively distinguish between ephemeral, intermittent and perennial streams and rivers. The ability to make such determinations is often crucial to assuring that the appropriate water quality standards are applied to a waterbody. The Protocol identifies the aquatic life and recreation uses supported by the particular flow regime of a water body, and generates the necessary documentation for an expedited Use Attainability Analysis.

The objective of the Protocol is to produce a scientifically sound and practical methodology that evaluates a variety of stream features to determine if a stream or river is ephemeral, intermittent, or perennial. The process stresses using many different indicators to provide a robust weight-of-evidence approach enabling proper classification of the wide diversity of streams found in New Mexico. To develop the Protocol, 17 field indicators were evaluated at 57 sites across New Mexico during the 2008 and 2009 field seasons, including hydrological (*e.g.*, water in channel), geomorphic (*e.g.*, sinuosity and particle sorting), and biological (*e.g.*, macro-invertebrates and riparian vegetation) features related to the persistence of water. Evaluation of each indicator was based on a strong, moderate, weak, and absent scoring system. Each indicator was evaluated to determine its ability to distinguish a stream's hydrologic condition - those with the strongest relationship (*e.g.*, water in channel) were weighted highest in the final scoring for the protocol whereas those with a weaker, but still significant, relationship were weighted less (*e.g.*, presence of seeps and iron-oxidizing bacteria). Those indicators with no ability to distinguish between hydrologic classes in New Mexico, such as the accumulation of leaf or stick debris, the presence of a continuous bed and bank, and the occurrence of a braided channel were removed from the final protocol.

The Hydrology Protocol went through two rounds of public comment and was approved as an appendix to the State's Water Quality Management Plan by the New Mexico Water Quality Control Commission on May 10, 2011. It has been submitted to the Environmental Protection Agency for review and approval.

0222

Application of a Water Quality Index for the New River Estuary, NC

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The water quality index used in the Environmental Protection Agency's National Coastal Assessment was applied to the of water quality monitoring data collected by the Strategic Environmental Research and Development Program's Defense Coastal/Estuarine Research program (DCERP) for the New River Estuary in North Carolina. The DCERP collects monthly water column data at 8 fixed stations throughout the estuary, operates continuous autonomous vertical profiles (AVPs), and conducts monthly longitudinal surveys of the estuary. The results from this highly- resolved spatial and temporal monitoring program are evaluated by the DCERP using a variety of sophisticated water quality models. The objective of this analysis was to compare the results obtained by the modeling

efforts with results obtained by applying the EPA's water quality index that utilizes only five water quality indicator (chlorophyll a, water clarity, bottom dissolved oxygen concentration, dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP). Our goal was determine if application of the more simplified EPA water quality index would accurately depict water quality condition on an annual basis as compared to results obtained using the more sophisticated analysis and could more clearly communicate water quality conditions to state and local stakeholders. We also examine historic data (1998-2006) collected prior to the start of DCERP to determine whether the same WQI values can be applied to assess water quality improvement after a regional wastewater treatment plant was upgraded. The WQI was evaluated for its sensitivity to assess temporal changes in water quality associated with major climatic changes - periods of drought vs. periods of extensive rainfall from severe storm events.While the WQI may not identify the precise cause of water quality degradation, it can signal when additional research is needed to determine the specific cause of the impairment so that management actions can be taken.

0199
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Utilization of an Agricultural Water Quality Index to Augment Water Quality Monitoring

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Water quality monitoring is a complex and expensive endeavor. USDA has recently developed an index to gauge aggregate water quality in agricultural settings. This index is a user friendly tool that qualitatively ascertains A) agricultural inputs, B) the physical setting and C) vegetative and climatic contexts. It is designed to be used as a standalone product that will elucidate the water quality condition of a field or small catchment. Temporally, it can be used not only throughout the year but also used to establish multi-year trends.

Additionally, the water quality index can be coupled with established, rigorous monitoring efforts to augment our understanding of nutrients and sediment loading. The index can be correlated with in stream monitoring to establish relationships between the agricultural settings and long term monitoring efforts. The water quality index plays a pivotal role in a multi-scale monitoring framework. At the largest scales, modeling is used, water quality monitoring is used at the stream reach and watershed scales, and the water quality index will be used at the finest scale, over large agricultural areas.

The index is specifically designed to not only ascertain an aggregate water quality rating but to provide useful input back to the landowner for timely inclusion in their land management practices. In this way the index tool is a critical piece of adaptive management leading to improvements in water quality.

0482
P

Salinity in the Lower Middle Rio Grande, Socorro County, New Mexico

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Found approximately in the geographic middle region of New Mexico, Socorro County is an agricultural community that relies on the Rio Grande as the major source of water for irrigation. The Rio Grande is used throughout the region for agricultural, industrial, domestic-municipal consumption, recreation and riparian vegetation, as well as for the protection of endangered species found in the environment. Salinity, a concern for all users, has been studied throughout the Rio Grande reach from Colorado to the Mexico border. Previous research suggests that salinity may increase by irrigation practices, municipal and industrial uses, evapotranspiration, climatic changes, and also through natural geologic processes and weathering through dissolution of minerals. This study examines salinity variability in river and irrigation water through the Socorro region, from March to November, at the time irrigation water is diverted by the Middle Rio Grande Conservancy District, and delivered to agricultural lands through a series of canals and diversions. The study region extends from the San Acacia Diversion Dam, located north of Socorro, where irrigation for agriculture is supplied by the surface and groundwater return flows from the Unit 7 Drain and runs south for approximately 27 miles to San Antonio, NM, near the Bosque Del Apache National Wildlife Refuge. The Low Flow Conveyance Channel (LFCC) is found directly west of the river and is hydrologically connected to the river, drain and irrigation systems. The drain canal is found west of the river, between the irrigation canals and LFCC, drawing off excess water from agricultural fields and from areas where the river bed is higher than the valley floor. Salinity of the Rio Grande, LFCC, drains, and the irrigation canal flows were measured semi-monthly, both preseason and throughout the irrigation season from March 1st to November 10, 2011. Regional flows of the Rio Grande hydrograph, within the Socorro region between San Acacia and San Antonio, NM, are compared to associated salinity levels within this time frame. Seasonality accounted

for the greatest salinity variations. EC, as well as increases in alkalinity, in general, rose over time along the study reach. For example, the EC at any given point in early spring (April 18) was between 590 and 861 µs/cm, while by the later part of the irrigation season ranged from 812 and 967 µs/cm (October 28). During the same time period, the alkalinity of samples (as $CaCO_3$) ranged from 105-156 mg/L (April 18) to 176-209 mg/L (October 28). As expected, in most cases, salinity increased further south down river, such as the salinity of the Rio Grande at San Acacia on April 7 which was 537 µs/cm compared to San Antonio at 605 µs/cm on the same day. In addition, irrigation water, in general, had higher EC than the Rio Grande. For instance San Antonio irrigation was higher over the course of the season (average 868 µs/cm), than the river water EC average (715 µs/cm) at San Antonio. The Rio Grande, except for periods in late in summer when the river was at its lowest stream flow or had no flow at all, tended to have lower EC and alkalinity.

0112

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Clark County Stream Health Report: Sharing Stream Health Information with Citizens in Clark County, Washington

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Clark County's streams and rivers play an important role in the lives of our citizens. Like many municipalities, Clark County faces significant stream health challenges, and takes seriously the responsibility to promote stewardship and public awareness. Without awareness and understanding, there can be little hope of maintaining the public support that leads ultimately to stream improvement. The success of this effort hinges on presenting scientific information in ways that make sense to the general public. The Clark County Stream Health Report is an important tool to help people learn about conditions in their own watershed, overall trends in stream system health, and ways we can work together to make a difference.

Stream systems are variable and complex, constantly changing in response to many factors. In such a complex system, scientists use selected indicators to describe stream conditions, identify and predict problems, and provide clues about how things might be improved. Good indicators provide a reliable picture of conditions. They respond consistently and predictably to changes. They must be able to represent very complicated processes, and yet be easily understood.

Clark County stream health is rated based on calculated metrics for three widely used indicators: water quality, biological health, and stream flow. The 2010 report compiles results from nearly 900 water quality samples, 125 macroinvertebrate samples and 19 stream flow datasets collected from over 80 locations county-wide. Most data is collected by Clark County, but the report also includes data from citizen volunteers, the City of Vancouver, Washington Department of Ecology, Clark Public Utilities, and the United Stated Geological Survey.

Stream health is presented graphically in color-coded score cards and maps, allowing readers to easily find information by subwatershed, by indicator, or for an entire watershed. Since activities on land have profound effects on streams, additional tables and maps describe the significance and location of forest, pasture, and hard surfaces.

The report concludes with descriptions of Clark County programs and activities aimed at protecting and enhancing our natural environment. Readers are provided ideas and contacts designed to encourage stream improvement through activities in the home, volunteer opportunities, and lifelong learning.

http://www.clark.wa.gov/water-resources/stream.html

0007
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Evaluating Seasonal Effects on Langelier Saturation Index Ability to Predict Corrosion Potential of Water

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Source water quality varies regionally in the United States and fluctuates seasonally. These variations can create serious challenges to water utility operators in maintaining a desired finished water quality. Highly corrosive source water can challenge a utility in meeting the required regulations ensuring water that is fit for human consumption. In addition, finished corrosive water leads to premature pipe failure and very costly distribution pipe repair.

This research will attempt to determine if one of the most widely used corrosion indexes is applicable for raw water sources used by the Birmingham Water Works Board (BWWB) and can be used for finished water. BWWB supplies water for 600,000 customers in central Alabama. Finished water samples were collected and the analyzed parameters used to calculate the Langelier Saturation Index. Other parameters, specifically free and dissolved metals, total dissolved solids, conductivity, free and total chlorine were all evaluated for seasonal variation for a 12- month period. Also, the research will look to see if there is a seasonal effect on the ability of the Langelier Saturation Index (LSI) to produce reliable corrosion potential results for finished water if it is reliable for this particular raw water resource.

Because of seasonal fluctuations in water characteristics, sampling was performed twice weekly over a 12-month period. LSI was calculated and 6-week preliminary results confirmed that the BWWB finished water was within acceptable corrosion limits. Additional result for the entire 12-month assessment will be evaluated and reported.

This research is particularly relevant to water distribution maintenance cost containment, potable water quality, and using LSI index to help with federal regulatory compliance of the Safe Drinking Water Act.