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GeoHealth Newsletter

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The U.S. Geological Survey's Environmental Health Newsletter

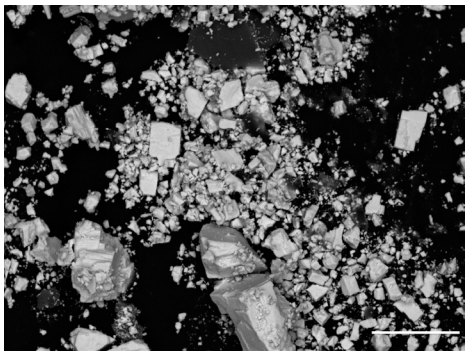
What's In This Issue

USGS Activities Related to Environmental Health Science

African Cosmetic Linked to Lead Poisoning

U.S. Geological Survey (USGS) scientists recently provided their expertise in geochemistry and mineralogy to the U.S. Centers for Disease Control and Prevention (CDC) and Boston Children's Hospital to help solve a mysterious lead poisoning case. A team of public health scientists were studying the source of lead poisoning in a 6-month-old Boston infant of Nigerian descent. The public health team ruled out environmental exposure sources of lead in the infant's residence. Their attention soon turned to an imported artisanal eye cosmetic (called tiro) that had been purchased from a street vendor in Nigeria and applied regularly, as per Nigerian customs, by the family to the infant's eyelids. Such folk cosmetics are commonly made from various ore minerals, and USGS analyses of the tiro confirmed that it was pure lead sulfide that had been ground into a fine powder. Although lead sulfide dissolves relatively slowly in stomach acids and other body fluids, there was apparently sufficient intake via hand-mouth transmission, the conjunctival surfaces of the eyes, and through ingestion of tears that the child developed lead poisoning. Fortunately, the child's blood lead levels dropped substantially when the parents stopped applying the cosmetic. This case illustrates that some immigrant populations may be at risk for lead poisoning via less well-known exposure pathways. Funds for the USGS's participation in this investigation came from the USGS Mineral Resources Program.

Galena (lead sulfide) is an ore mined for lead. Photo credit: USGS.



A scanning electron microscope image of the tiro eye cosmetic. The cubic structure of galena can be clearly seen. The white bar in the lower right hand corner is a 25-micrometer scale. Photo Credit: Geoffrey Plumlee, USGS.

Florida's Mangrove Swamps Boost Methylmercury Supply

A team of scientists from the U.S. Geological Survey (USGS), the Florida Gulf Coast University, and the State of Florida developed a new method to measure the amount of dissolved organic carbon, mercury, and methylmercury that flows from a southwest Florida mangrove swamp into coastal waters. The scientists started by measuring the amount of dissolved organic carbon flowing out of the mangrove swamp and then realized they could simultaneously measure mercury and methylmercury using the same technique. They discovered that a relatively large amount of mercury and

A large red mangrove near the Shark River in Everglades National Park. Until now, the amount of methylmercury coming from estuarine mangrove zones into the coastal areas was unknown because making accurate measurements of this type is extremely challenging. Photo credit: Paul Nelson, USGS.

methylmercury (the most toxic form of mercury and the form that accumulates in fish) flows from the mangrove swamp into the Gulf of Mexico.

The scientists showed that mangrove swamps could supply an amount of total mercury to the Gulf equivalent to that supplied by other sources (mostly atmospheric deposition) and an amount of methylmercury equivalent to ten times that supplied from other sources (mostly coastal sediments).

Where mercury in the Gulf of Mexico undergoes the conversion to methylmercury has not been understood. This new data suggests that mangrove swamps may act both to increase the atmospheric deposition and to increase the rate that mercury is converted to methylmercury. Mangrove swamps represent a unique combination of circumstances that result in surprisingly large amounts of mercury accumulation and methylmercury production, which can be transported into the coastal ocean. The mangrove trees increase atmospheric deposition by capturing gaseous mercury from the air through their leaves. When the leaves drop into the brackish swamp waters, the abundant organic carbon from the swamp and the presence of sulfate from seawater together facilitate the conversion of mercury to methylmercury by microbial activity. This study shows that mangrove swamps can account for much of the mercury and methylmercury found in the Gulf of Mexico near southwest Florida; this represents a significant contribution to the knowledge of mercury sources and fates in the region.

"Once we understand where the mercury is being methylated, and how much methylmercury is coming from various environments, resource managers, regulators, and decision makers will be better able to anticipate how the Gulf of Mexico will respond to reductions in mercury loads." said USGS scientist David Krabbenhoft.

Funding for this study was provided by the USGS Land Carbon Program (National Assessment of Ecosystem Carbon Sequestration and Greenhouse Gas Fluxes) and the USGS Priority Ecosystem Science Program.

USGS Publishes Its First Environmental Health Science Strategy

The new USGS Environmental Health Science Strategy describes the vision for, and priorities of, USGS environmental health science. Implementation of this strategy is intended to aid coordination of USGS environmental health activities with other Federal agencies and to provide a focal point for disseminating information to stakeholders. The Science Strategy will serve as a framework for USGS environmental health science goals, actions, and outcomes for the next decade.

The USGS defines environmental health science as the study of the interrelations among the quality of the physical environment, the health of the living environment, and human health.

Vision – The USGS is a premier source of the environmental health science needed to safeguard the health of the environment, fish and wildlife, domesticated animals, and people.

Mission – The mission of the USGS in environmental health science is to contribute scientific information to environmental, agricultural, natural resources, and public-health managers who use that information to support sound decision making. USGS will provide science to achieve the following societal goals:

Goal 1 – Identify, prioritize, and detect contaminants and pathogens of emerging environmental concern.

Goal 2 – Reduce the impact of contaminants on the environment, fish and wildlife, domesticated animals, and people.

Goal 3 – Reduce the impact of pathogens on the environment, fish and wildlife, domesticated animals, and people.

Goal 4 – Discover the complex interactions and combined effects of exposure to contaminants and pathogens.

Goal 5 – Prepare for and respond to the environmental impacts and related health threats of natural and anthropogenic disasters.

Arsenic and Other Natural Contaminants in New England Drinking Water Wells

USGS scientists have identified potentially harmful levels of naturally occurring arsenic, uranium, radium, radon, and manganese in groundwater that supplies drinking-water wells in New England. While public water supplies are treated to ensure that water reaching households meets Federal standards for contaminants, there are no such requirements for private water supplies, which serve more than 2.3 million people in the region. These results highlight the importance for testing and treating private water sources and for informing the public of potential contamination problems in their area.

Bedrock groundwater is a significant source of drinking water used by millions of people throughout New England. In the above photo, groundwater flows out of the open fractures and forms a frozen waterfall over the exposed bedrock. Photo credit: Sarah Flanagan, USGS.

Scientists examined water-quality data from more than 4,700 public-supply wells that were sampled for the U.S. Environmental Protection Agency Safe Drinking Water Program from 1997 to 2007 and 117 private wells sampled by the USGS from 1995 to 2007. These samples were from crystalline rock aquifers found in New England, northern New Jersey, and southern New York State. Arsenic, manganese, and radon exceeded existing and proposed Federal safety standards in 13, 7, and 33 percent in the untreated water samples in these three areas, respectively. Uranium was also found to be a significant indicator of the presence of other radionuclides, such as radon and radium. Elevated levels of these contaminants can cause various types of cancer, reproductive and developmental problems, kidney and blood diseases, diabetes, and reduced immune system functions.

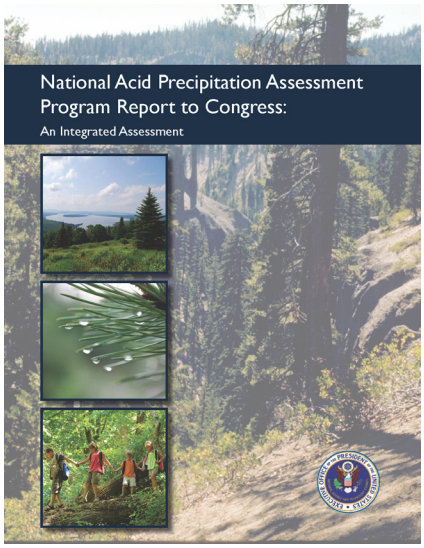
While the presence of arsenic was documented earlier, the scientists identified previously unknown contaminants and provided information on the type of bedrock geologic formations where high concentrations of these elements are most likely to be found. The study, part of an ongoing national effort by the USGS to systematically assess the quality of the Nation's most important aquifers, is the most comprehensive study of the quality of New England's bedrock groundwater to date.

This work was funded by the USGS National Water-Quality Assessment (NAWQA) Program.

Acid Rain Study Shows Substantial Decreases

The National Acid Precipitation Assessment Program (NAPAP) reported measurable improvements in air quality and visibility, human health, and water quality in many acid-sensitive lakes and streams. These improvements were achieved through decreases in acid rain as a result of reduced emissions from electric generating power plants. NAPAP is a cooperative Federal program that includes USGS scientists; the program was authorized in 1980 to coordinate acid rain research and report the findings to Congress.

Acid rain occurs when emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) react in the atmosphere with water, oxygen, and oxidants to form acidic compounds. Emissions may be transported hundreds of miles away from their emitting sources. These acidic compounds can damage human health, and in addition to degrading air quality and visibility, can cause further environmental damage, including acidification of lakes and streams, harm to sensitive forests and coastal ecosystems, and acceleration of the decay of building materials.



Cover of the NAPAP report to Congress.

The recent NAPAP report shows that, since the establishment of the Acid Rain Program under Title IV of the 1990 Clean Air Act Amendments, there have been substantial reductions of SO_2 and NO_x emissions from power plants that use fossil fuels like coal, gas, and oil, which are known to be the primary causes of acid rain. As of 2009, emissions of SO_2 and NO_x declined by about two-thirds relative to levels in the 1990s. These emission levels declined even further in 2010. Despite these emission reductions, the report also indicates that full recovery from the effects of acid rain is likely to be prolonged and influenced by other ecosystem stressors such as climate change.

Member agencies of the NAPAP include the National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, U.S. Department of Energy, U.S. Department of the Interior, U.S. Department of Agriculture, and National Aeronautics and Space Administration. Funding for the report was provided by the USGS Atmospheric Deposition Program, U.S. Environmental Protection Agency, National Park Service, and National Oceanic and Atmospheric Administration.

Reduced Tree Swallow Hatching Success Associated with PFCs

USGS scientists and their collaborators studying the effects of exposure of tree swallows to perfluorinated compounds (PFCs) found that the exposed swallows had reduced hatching success. The tree swallows in the study nested on Lake Johanna, a lake contaminated with perfluorinated carboxylic and sulfonic acids in central Minnesota. PFCs are worldwide contaminants because of their widespread industrial usage. These compounds are used in fire-fighting foams; as a surface treatment on textiles, leather, and carpet (stain repellent); and in paper products used for food preparation and storage.

Tree swallows have been used extensively for monitoring the exposure and effects of environmental contaminants because they feed on aquatic insects; concentrations of contaminants in eggs reflect sediment contamination. Photo credit: Tom Custer, USGS.

The researchers found that concentrations of nearly all PFCs were elevated in the tissues of tree swallows nesting around the contaminated Lake Johanna compared to tree

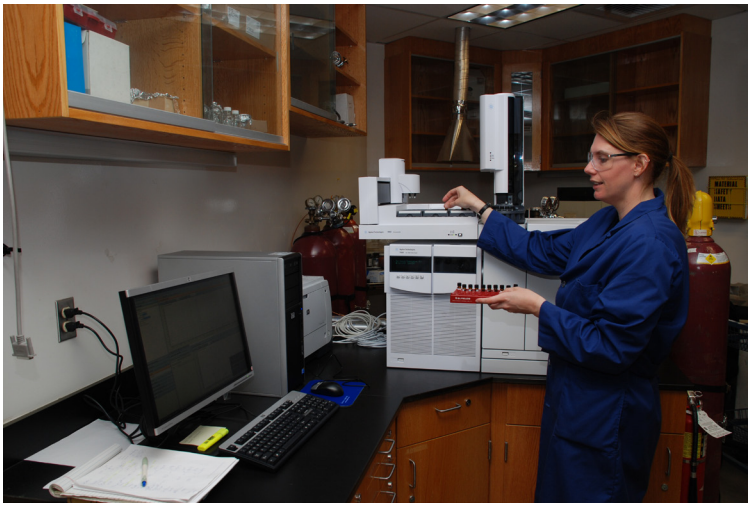
swallows nesting on the nearby reference lake. Reduced hatching success was associated with higher concentrations of perfluoroocatane sulfonate in tree swallow eggs.

This research was conducted in collaboration with the Minnesota Pollution Control Agency and the Aquatic Toxicology Laboratory, Department of Biological Sciences at St. Cloud State University, St. Cloud, Minnesota. Funding was provided by the USGS Contaminant Biology Program and Minnesota Pollution Control Agency.

Pyrethroid Insecticide Contamination Increases with Urbanization

Contamination and toxicity in streambed sediments caused by pyrethroid insecticides generally increased with the degree of urbanization in seven metropolitan areas across the Nation, according to a USGS study. Pyrethroids are a group of synthetic insecticides similar to the natural pesticide pyrethrum—produced by chrysanthemum flowers—that are used to control insect pests. USGS scientists tested sediment and water from 98 streams for 14 commonly used pyrethroid insecticides. The streams are in the following metropolitan areas: Atlanta, Boston, Dallas, Denver, Milwaukee-Green Bay, Salt Lake City, and Seattle. The scientists also conducted laboratory toxicity tests on streambed sediments from the streams, which showed that pyrethroid insecticides in these urban streams reached levels that were toxic to aquatic organisms. The U.S. Environmental Protection Agency (EPA) is working with the California Department of Pesticide Regulation to reevaluate certain pesticide products containing pyrethroids. This study will provide additional information to the EPA and to water-resource and wildlife managers about the occurrence and environmental impacts of pyrethroids in urban streams across the Nation.

Funding for this study was provided by the USGS Toxic Substances Hydrology Program, National Water-Quality Assessment (NAWQA) Program, and Contaminant Biology Program.



USGS scientist uses a sensitive laboratory instrument to measure concentrations of pyrethroid insecticides in sediments.

Genetic Variations Help Explain Spread of Chronic Wasting Disease

USGS scientists have linked genetic variation in white-tailed deer with varying levels of resistance to chronic wasting disease (CWD). This study provides valuable insights into the factors involved in the transmission and spread of CWD and supports the role of infectious diseases in driving natural selection in wildlife. Currently there are no methods for eradicating the disease or preventing its spread. CWD is transmitted by direct contact between animals or from environmental contamination. Understanding how different genetic traits in wildlife increase or decrease their susceptibility to disease can also improve how we manage CWD-affected wildlife populations.

Wisconsin white-tailed deer infected with chronic wasting disease. Photo credit: Dohald Savo.

CWD is a fatal neurodegenerative disease caused by proteins called prions that infect North American deer and elk. While it is always fatal in deer, CWD is not known to affect livestock or humans. However, the long-term disease trends and risks to deer and elk, other wildlife species, livestock, and human health are unknown. Understanding the ecology and transmission of CWD in free-ranging wildlife is challenging, but is critical for wildlife management decisions and for predicting future disease impacts. The scientists used a population model to evaluate whether CWD could be managed through natural selection for disease resistance in wild deer. Although all deer genotypes are susceptible to CWD, their findings indicated that significant changes in the natural resistance of deer populations to CWD would take more than 100 years, which is rapid in evolutionary time, but too slow for disease management.

Diseases can impact biological diversity by limiting the abundance and distribution of a species or by causing the extinction of animals with small populations. This study illustrates the potential for disease to influence the evolution of wildlife populations, shape biodiversity at the genetic level, and emphasize the importance of genetic variation in maintaining the ability of species to adapt to ecological changes. Funding for this study was provided by grants from the U.S. Department of Agriculture (Hatch Act Grants), the USGS Wildlife: Terrestrial and Endangered Resources Program, and the Wisconsin Department of Natural Resources.

Tackling Devastating Human Parasite — Schistosomiasis

The USGS in collaboration with the University of California, Santa Barbara, Projet-Crevette, and the non-profit organization 20|20 Initiative, are studying how a species of freshwater prawn, commonly known as crayfish, might help combat a devastating disease in Africa called schistosomiasis. The disease is caused by a parasite in the genus *Schistosoma* (trematodes, also known as flukes) that can penetrate internal organs causing illness and

Villagers filling containers with water from the Sénégal River, Sénégal, Africa, for use in their homes. Daily activities like gathering water, bathing, washing dishes, and swimming carry the risk of exposure to the parasite that causes schistosomiasis. Photo credit: Kevin Lafferty, USGS.

death. Although the parasite that causes this disease is not found in the United States, more than 200 million people are infected worldwide according to the Centers for Disease Control and Prevention.

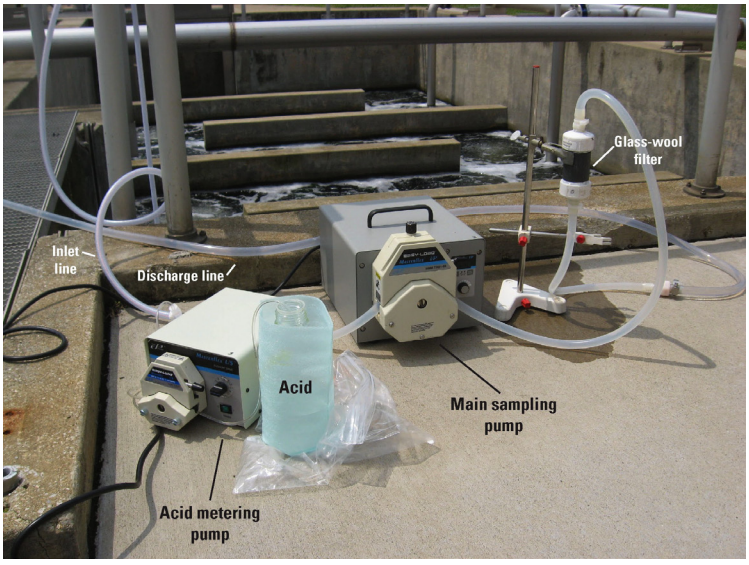
In the West African country of Sénégal, the native snail-eating prawn *Macrobrachium vollenhovenii* is a potential biocontrol agent for the parasite's intermediate host—snails. The life cycle of *Schistosoma sp.* occurs in freshwater. Snails provide the environment for the trematode to produce the infective life stage, known as "cercariae," which are tiny free-swimming larvae. When humans or animals come in contact with infested water, the cercariae larvae can penetrate skin and move through the bloodstream, move into tissues, and eventually cause organ failure.

Scientists are designing experiments to determine if the native snail-eating prawns can effectively suppress snail populations. In some regions of Sénégal, this native snail-eating prawn was decimated due to a river dam project that altered the native ecosystem, allowing the host snails to thrive. Since *Schistosoma sp.* rely on snails to complete their life cycle, prawns could keep the snail population low, and the prevalence of schistosomiasis in local waters and the risk of human infection might be reduced.

This study is funded in part by the USGS Terrestrial, Freshwater, and Marine Environments Program and the University of California, Santa Barbara.

Microorganism Removal in Different Wastewater-Treatment Systems

Disease causing microorganisms are removed more efficiently from wastewaters by a new breed of advanced sewage treatment plants than by conventional plants. Such are the findings of USGS scientists and their colleagues comparing the removal efficiency of indicator microorganisms and viruses at wastewater treatment plants employing a new technology—membrane bioreactors (MBRs)—compared with conventional technology.



Equipment setup for filtering wastewater samples for enteric viruses. Photo Credit: Donna Francy, USGS.

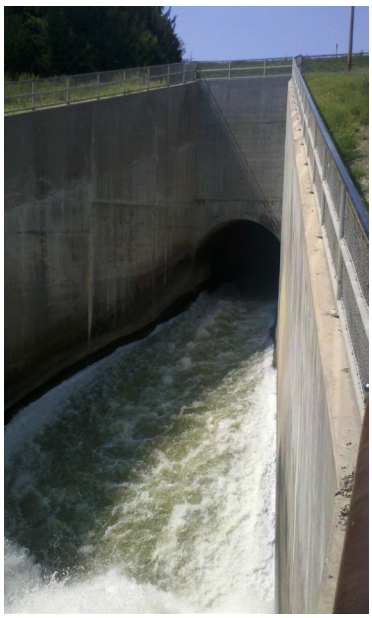
MBRs are a relatively new wastewater-treatment technology in which conventional secondary treatment is replaced by a membrane separation process. Secondary wastewater treatment focuses on removing biological content, such as human waste, food waste, and soap. Information is lacking on the effectiveness of MBRs in removing human enteric viruses (viruses associated with feces) from wastewaters, particularly as compared to removal by conventional plants before and after ultraviolet or chlorine disinfection. Removal of bacterial indicators, coliphage (indicator viruses), and human enteric viruses were studied throughout the treatment processes in three MBRs and two conventional secondary activated-sludge municipal wastewater treatment plants. For human enteric viruses, molecular methods that detect infective and non-infective viruses and culture methods that detect only infective viruses were used. The study was conducted during three recreational seasons (May–October) when disinfection of wastewater effluents is required in Ohio. The scientists found that:

- Wastewater treatment plants that used MBRs were more effective at removing bacterial indicators, coliphage, and viruses (by molecular methods) through secondary treatment than were conventional plants.
- Although culturable viruses were found in 63 percent of samples collected after primary treatment, they were not detected in any post-secondary, post-MBR, post-ultraviolet, or post-chlorine samples. MBR and conventional plants, therefore, were equally effective in removing infective viruses.
- Ultraviolet disinfection after MBR secondary treatment provided little additional removal of any organism except for one type of viral indicator (coliphage).

This study was funded by the USGS Cooperative Water Program and the Ohio Water Development Authority. The City of Delphos, Ohio, and CT Consultants participated as co-principal investigators. Many others provided in-kind services or financial support for this study.

Algal Toxins in the Kansas River

USGS scientists found that within a week after reservoir releases in September and October 2011, cyanobacteria, associated toxins, and taste-and-odor compounds were detected throughout a 173-mile reach of the Kansas River and remained detectable for several months. Despite toxin levels in one upstream reservoir being extremely high, toxin levels in the river did not exceed State public health warning thresholds and were not detected in finished drinking water from Kansas River sources. The Kansas River is a primary drinking water source for about 800,000 people in northeastern Kansas.



Releases from Milford Reservoir, Kansas, during a cyanobacterial bloom resulted in downstream transport of algal toxins and taste-and-odor compounds. Photo by Eric Looper, USGS.

The water release from upstream reservoirs prompted concerns about the potential transport of cyanobacteria and associated compounds to downstream drinking-water supplies. While taste-and-odor compounds are not harmful, elevated levels of algal toxins can be harmful to people, aquatic life, pets, and livestock. This study is one of the first to document and measure the transport of

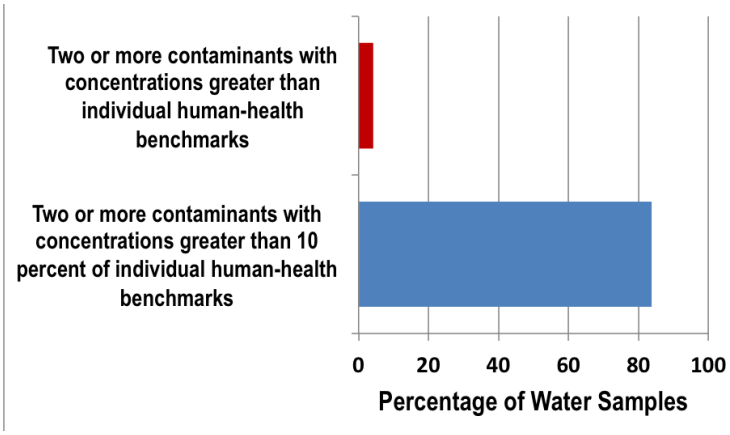
cyanobacteria and associated compounds during reservoir releases; the study improves understanding of the fate and transport of cyanotoxins and taste-and-odor compounds downstream from reservoirs. The study results indicate that cyanobacterial toxins and taste-and-odor compounds may persist in the environment long enough to be transported over hundreds of miles.

On July 1, 2012, the USGS, in cooperation with the cities of Topeka, Lawrence, and Olathe; WaterOne; and the State of Kansas started a 5-year monitoring program for algal toxins (cyanobacterial toxins) and taste-and-odor compounds in the Kansas River. These efforts will help water-resource managers understand the triggers for these harmful algal blooms and also how to reduce their occurrence, thereby protecting water supplies. This work was funded by the USGS Water Resources Cooperative Water Program, the City of Lawrence, Kansas, the City of Topeka, Kansas, Johnson County WaterOne, the Kansas Water Office, and the Kansas Department of Health and Environment.

Chemical Mixtures Common in Public Water Supply

USGS scientists found that contaminants detected in water samples from public supply wells usually co-occurred with other contaminants as mixtures. However, little is known about the potential health effects of chemical mixtures. The study included more chemical contaminants than in previous studies of public-supply wells. The scientists:

- Assessed the occurrence of chemical mixtures in untreated source-water samples from public-supply wells,
- Determined the composition of the most frequently occurring mixtures, and
- Characterized the potential toxicity of mixtures.



About 4 percent of source-water samples contained mixtures of two or more contaminants with concentrations greater than individual human-health benchmarks. (From Toccalino and others, 2012, Science of The Total Environment)

Human-health benchmarks have not been established for most chemical mixtures, but concentrations of contaminants in mixtures were compared to individual benchmarks. The human-health benchmarks used in the study were Environmental Protection Agency Maximum Contaminant Levels or USGS Health-Based Screening Levels.

About 4 percent of the 383 source-water samples in this study contained mixtures of two or more contaminants with concentrations greater than individual human-health benchmarks. By contrast, most (84 percent) samples contained mixtures of two or more contaminants with concentrations greater than 10 percent of individual human-health benchmarks.

The chemical mixtures that most frequently occurred and had the greatest potential toxicity primarily were composed of trace elements (including arsenic, strontium, or uranium), radon, or nitrate. Herbicides, disinfection by-products, and solvents were the most common organic contaminants in mixtures.

The findings can be used to help set priorities for groundwater monitoring and suggest future directions for drinking-water treatment studies, and for toxicity assessments of chemical mixtures in water resources.

This work was funded by the USGS National Water-Quality Assessment (NAWQA) Program.

Monitoring Avian Botulism at Great Lakes Beaches

USGS scientists are monitoring the spread of avian botulism on the shores of Lake Michigan to document and understand the spread of the disease. Photo credit: Taaja Tucker, USGS.

USGS scientists have been monitoring the avian botulism on the shores of Lake Michigan in partnership with the Great Lakes Restoration Initiative and the private sector. Since the 1960s, avian botulism has caused large-scale bird deaths in the Great Lakes. In recent years, health professionals have become increasingly concerned about the effects of botulism on wildlife and public health. Avian botulism is caused by a toxin produced by the bacteria *Clostridium botulinum*, which is widespread in soil, but can grow in aquatic environments during warm temperatures where there is decomposing vegetation, the remains of small animals (such as insects and invertebrates), and a lack of oxygen. The toxin the bacteria produces causes paralysis in the birds' muscles, and the birds eventually die due to respiratory failure, water deprivation, drowning, or predation. Botulism is one of the most significant causes of wild bird mortality worldwide, and outbreaks may indicate environmental conditions that are detrimental to overall wildlife and ecosystem health. Human illness has not been associated with typical avian botulism (see text box) but caution when handling carcasses is strongly advised.

In the Great Lakes, mats of Cladophora algae contain high concentrations of bacteria and pathogens, including *Clostridium botulinum*. USGS scientists are collecting environmental data on the

Can Avian Botulism Affect Humans?

There are seven types of botulinum toxins, which are all destroyed by heat. Although human cases of type E botulism occasionally result from consumption of improperly smoked or cured fish or other marine products, the risk of botulism from properly cooked food is minimal. Avian botulism is most often caused by Type C botulism and has not been associated with disease in humans. Cases of human botulism result from eating improperly home-canned foods and are most often caused by types A or B botulinum toxins. (Avian Botulism (Chapter 38), in Field Manual of Wildlife Diseases: USGS ITR 1999-001)

occurrence of Cladophora algal mats and tracking Type E botulism related wildlife deaths. This information will help wildlife managers to understand the environmental conditions and disease pathways that result in the deaths of birds and other wildlife. The long-term goal is to develop wildlife and habitat management practices that will lead to the restoration and protection of Great Lakes wildlife and beaches. This study is funded by the Great Lakes Restoration Initiative.

Database Template Now Available for Tracking Pathogens of Aquatic Animals

USGS scientists, in cooperation with the Northwest Alliance for Computational Science and Engineering based at Oregon State University, have designed a database, AquaPathogen X, that can be used as a template for creating databases for recording information about aquatic pathogens. The database template is freely available for download. The template can accommodate the many biological, chemical, and physical traits associated with samples of various pathogens (such as viruses, parasites, and bacteria) from multiple aquatic animal host species (such as fish, shellfish, shrimp, and others), as well as the genetic data generated from these samples in molecular epidemiological studies. The simultaneous cataloging of samples from different aquatic pathogens is a unique and useful feature of the AquaPathogen X database. The database can be used for the surveillance of emerging aquatic animal diseases, which will then allow scientists to determine the key risk factors associated with pathogen introductions into aquatic systems.

AquaPathogen X was used as a template to create a separate database called Fish ViroTrak, which stores epidemiological profiles of over 1,600 samples of fish viruses. Web-accessible Fish ViroTrak databases are available for two aquatic viruses, Infectious hematopoietic necrosis virus (IHNV) and Viral hemorrhagic septicemia virus (VHSV). IHNV causes significant mortality in both wild and cultured salmon and trout in North America, Asia, and Europe, while VHSV affects over 25 freshwater and marine fish species in the Northern Hemisphere and has caused massive fish die-offs in the Great Lakes. The high mortality rate associated with these viral infections is a major concern of both wildlife scientists and fisheries managers, and this database will help to manage these diseases.

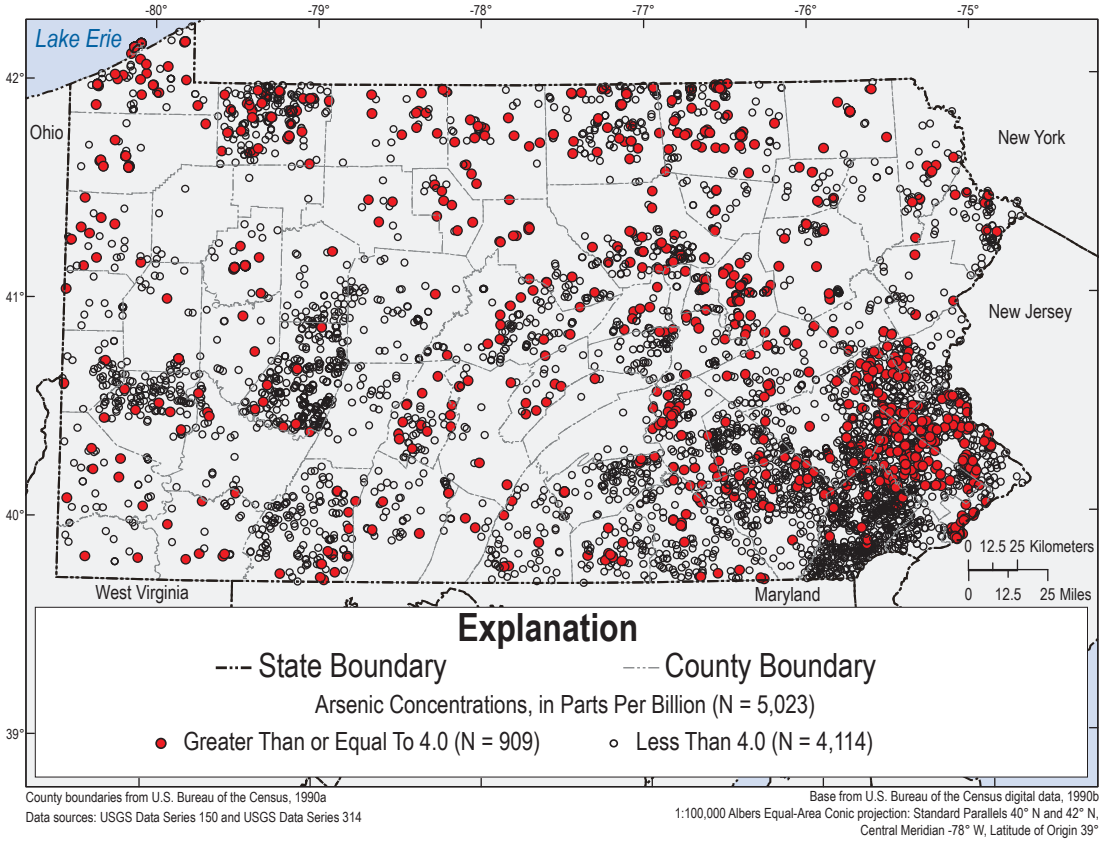
Koi (*Cyprinus carpio koi*) infected with an exotic fish virus (spring viremia carp virus) emerging in North America. This fish is exhibiting typical clinical signs of disease, hemorrhaging in all fins and pop-eye. Scale at the bottom is in centimeters. A centimeter ruler is shown at the bottom for scale. Photo credit: Evi Emmenegger, USGS.

Development of the database was funded by the USGS Fisheries: Aquatic and Endangered Resources Program and National Biological Information and Infra-structure (NBII) Programs, U.S. Department of Agriculture Critical Issues Program, and Great Lakes Fisheries Trust. The database logo was designed by Shauna R. Brennan, USGS, and graphically enhanced by Barry Egenes, USGS.

Predicting the Probability of Elevated Arsenic in Pennsylvania Groundwater

USGS scientists are identifying the predicted probability of elevated arsenic concentrations in Pennsylvania groundwater. The resulting maps will identify geographic areas with relatively high potential for elevated arsenic concentrations (defined in this study as greater than or equal to 4 parts per billion (ppb)) and will help health officials direct resources for additional sampling and education programs in areas of potential concern. The new study will:

- document arsenic concentrations in 5,023 groundwater samples in Pennsylvania (see map),
- describe the relation between arsenic concentrations and geochemical groundwater conditions and other groundwater-quality variables, and
- utilize available arsenic concentration and explanatory data to define areas of Pennsylvania with the highest predicted probability of elevated arsenic concentrations.



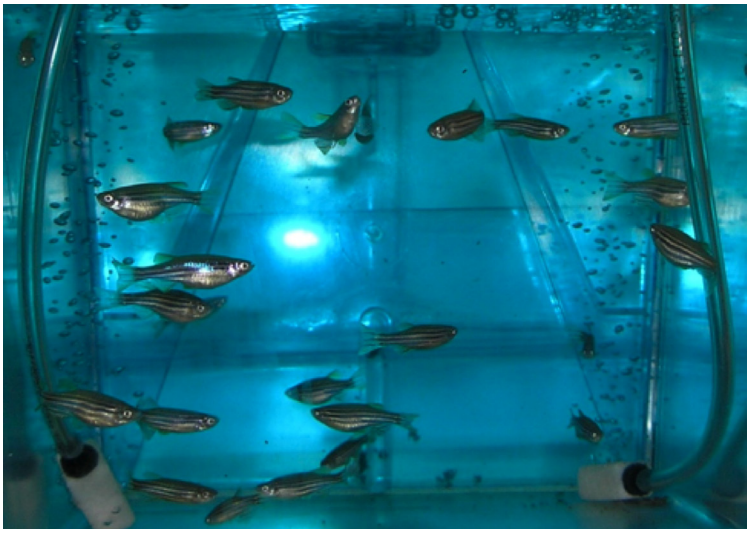
Location of selected wells in Pennsylvania that have been tested for arsenic. The solid red dots are wells with arsenic concentrations greater than or equal to 4 parts per billion. (Data sources: USGS Data Series 150 and USGS Data Series 314).

Almost 2.2 million people in Pennsylvania drink groundwater from privately owned wells not regularly tested for arsenic, which is a known carcinogen. The health-based maximum contaminant level for arsenic is 10 ppb. The maps can be used as part of the Pennsylvania Environmental Public Health Tracking Program, which is designed to serve citizens of Pennsylvania by interactively informing them of their environment in relation to their health.

Funding for this study was provided by the collaborative sub-grant 5U38EH000191-4 from the Pennsylvania Environmental Public Health Tracking Program of the Pennsylvania Department of Health, Bureau of Epidemiology; the Pennsylvania Department of Environmental Protection; and the USGS Cooperative Water Program.

Zebrafish Immune Response Sheds Light on Human Response

USGS scientists have shown that a bacterial infection in zebrafish results in an immune response that is similar to that seen in humans. These results demonstrate that infection in zebrafish can be used as a model for studying the immune systems of both fish and humans, particularly in response to bacterial infections.



Zebrafish (*Danio rerio*) are used in studies of the effects of contaminants, endocrine disruptors, and infectious diseases on key elements of the fish immune response. Photo Credit: Jim Winton, USGS.

The scientists infected zebrafish with a rod-shaped bacteria (*Francisella noatunensis*), an emerging fish-specific pathogen that causes high levels of disease and death in fish reared in fish farms including tilapia, Atlantic cod, Atlantic salmon, and hybrid striped bass. This bacteria is similar to *Francisella tularensis*, which causes the disease tularemia (rabbit fever) in both rabbits and humans. The CDC has classified *Francisella tularensis* as a "select agent"—one that can be easily used as a biological weapon—so understanding the innate (natural) immune response to this bacteria is an important part of prevention.

The scientists demonstrated that the proteins involved in the immune response of zebrafish to this bacteria behave similarly to the behavior of the proteins involved in the mammalian immune response to *Francisell a.* infections. These results not only increase our understanding of the immune system of fish, but also that of humans.

This study was funded by the USGS Contaminant Biology Program and the University of Washington.

Novel Method for Detecting Domoic Acid Exposure

Marine life, such as these sea lions, can suffer from chronic toxic effects of domoic acid by eating contaminated fish. Photo credit: John Hansen, USGS.

USGS scientists and collaborators from other Federal and State laboratories have developed a new method for measuring chronic domoic acid exposure in sea lions. Domoic acid is a potent neurotoxin released by diatoms (genus *Pseudo-nitzschia*) during harmful algal blooms. Diatoms are microscopic one-celled algae with cell walls made of silica. Exposure to the toxin can result in serious neurological damage including temporary or permanent memory loss, seizures, and potentially death. Fish and shellfish can consume and accumulate significant quantities of domoic acid without any noticeable effects. However, the toxin can cause serious health problems in mammals such as sea lions, otters, or humans that regularly consume fish or shellfish laden with the toxin.

Acute domoic acid exposure in humans is typically preventable because local health authorities can directly measure domoic acid levels in shellfish and thus can regulate harvesting of affected shellfish. There have been no laboratory tests available for identifying exposure of marine animals to domoic acid previous to the development of this new method. The method was first discovered by exposing zebrafish (a major biomedical model organism) to low levels of domoic acid. The results of the scientist's investigations are:

- An immunoassay method (similar technology to home pregnancy tests) to detect the specific antibodies produced in response to chronic domoic acid exposure in sea lions. The new method is sensitive enough to potentially allow veterinarians and other health professionals to test for chronic domoic acid exposure when symptoms are not yet present.
- The discovery of domoic-specific antibodies that could serve as a potential biomarker for chronic domoic acid exposure. The biomarker could potentially be useful for studying domoic acid exposure in humans and other animals.
- The finding that repetitive exposure of zebrafish to domoic acid, even below the threshold for acute toxicity, has underlying neurotoxic consequences.

The development was a collaborative effort by scientists from the USGS, National Oceanic and Atmospheric Administration—Northwest Fisheries Science Center, the University of Washington—Departments of Environmental and Occupational Health Sciences, Radiology, and Bioengineering, the University of Santa Cruz—Department of Microbiology and Environmental Toxicology and Marine Mammal Center.

The study was funded in part by the National Oceanic and Atmospheric Administration's Ecology and Oceanography of Harmful Algal Blooms Program and the USGS Contaminant Biology Program.

Emerging Contaminants in the Columbia River Basin

USGS scientists measured a wide range of emerging contaminants in wastewater-treatment-plant (WWTP) effluent and stormwater-runoff in the Columbia River Basin.

One hundred and twelve of 210 compounds analyzed were detected in samples of WWTP effluents in nine cities along the Columbia River, including pharmaceuticals, PCBs, flame-retardants, pesticides, and mercury. Despite the differences in location, size of human populations, the method used for water treatment, and plant size, detection frequencies were similar for many of the compounds detected. By contrast, the occurrence of polycyclic aromatic hydrocarbons (PAHs) was sporadic, and PCBs were detected at only 3 of the 9 WWTPs.

Stormwater pipe draining to the Willamette River in downtown Portland, one of the nine cities sampled in Oregon and Washington to characterize contaminants flowing to the Columbia River from wastewater-treatment plant effluent and stormwater runoff. Photo credit: Jennifer Morace, USGS.

One hundred and fourteen of 195 compounds analyzed were detected in stormwater-runoff samples from the 9 cities studied with many expected to be related to road and land runoff, including PCBs, PBDEs, PAHs, pesticides, trace elements, mercury, and oil and grease. The detection patterns and concentrations measured in the stormwater-runoff were more heterogeneous than in the WWTP effluents, reflecting differences in factors like suspended-sediment concentrations and known contamination sources.

This study was conducted to help water managers and policy decision makers design future sampling efforts and toxic-reduction activities. Future work can focus on developing studies to characterize the effects of these contaminants on aquatic life and to prioritize toxic-reduction efforts for the Columbia River Basin.

This study was funded by the Columbia River Inter-Tribal Fish Commission, Lower Columbia River Estuary Partnership, and USGS Cooperative Water Program.

Groundwater Contamination Under Brooklyn and Queens

USGS scientists find that the extent of groundwater contamination is greater in the New York City (NYC) area in comparison to other urban regions of the Northern Atlantic Coastal Plain aquifer system that extends from Long Island to coastal North Carolina. Such contamination is not unexpected considering the long time frame and intensity

USGS scientist monitors an observation well being purged in preparation for groundwater sample collection in New York City. Photo credit: Irene Fisher, USGS.

of urban development in the NYC area. These data come from (1) a regional assessment of groundwater quality in the Northern Atlantic Coastal Plain aquifer system and (2) an ongoing effort to monitor the quality of groundwater beneath Brooklyn and Queens, New York, with the goal of providing data to assess the possibility of an alternative public water supply for the NYC area.

Median concentrations of select constituents in raw groundwater samples collected by the USGS in Brooklyn and Queens were computed for two time frames, 1999-2006 and 2008-2011. Nitrate, chloride, dieldrin, tetrachloroethene (PCE), trichloroethene (TCE), methyl tert-butyl ether (MTBE), and total trihalomethanes (TTHMs) were chosen for this evaluation because they are typically associated with urban land use. Reported concentrations were compared to a human-health benchmark established by the U.S. Environmental Protection Agency (EPA), the New York State Department of Health, or a USGS health-based screening level (HBSL).

A greater percentage of sampled wells in Brooklyn and Queens exceeded human-health benchmarks for chloride, PCE, and TCE than sampled wells from urban areas throughout the wider Northern Atlantic Coastal Plain. In addition, the extent of groundwater contamination has increased through time in the NYC study area. However, none of the sampled wells exceeded the 80 micrograms per liter Maximum Contaminant Level for TTHMs during the time frames evaluated.

The USGS, in a cooperative agreement with New York City Environmental Protection (NYCEP), has monitored the quality of groundwater in Brooklyn and Queens since the early 1980s. The NYC study was funded by the USGS Cooperative Water Program and NYCEP. The regional assessment of groundwater quality in the Northern Atlantic Coastal Plain aquifer system is part of the USGS National Water-Quality Assessment (NAWQA) Program.

Sodium Bicarbonate Can Be Toxic to Fish

Water from coalbed natural gas production may contain sodium bicarbonate at concentrations that can harm aquatic life, according to a new study by the USGS, the Montana Fish, Wildlife and Parks, the Bureau of Land Management, and the U.S. Environmental Protection Agency. Aquatic life criteria have been available for sodium chloride, but until this study, data have not been available to develop aquatic life criteria for sodium bicarbonate.

Precipitation of salts on the streambank and suspended sediment in the water, downstream from a produced water discharge on Beaver Creek, a tributary to the Powder River, Montana. Photo credit: Aïda Farag, USGS.

Over the past few years, an increase in the production of coalbed natural gas has occurred throughout the Nation. Salts such as sodium bicarbonate, which are found naturally in the water of the coalbed natural gas seams, are brought to the surface with the water (called produced water) during natural gas production. The produced water is sometimes discharged into freshwater streams and rivers.

To determine the ability of aquatic life to survive exposure to the range of concentrations of sodium bicarbonate found in produced waters from coalbed natural gas production in the Tongue and Powder River Watersheds in Montana and Wyoming, a team of scientists conducted several types of laboratory and field experiments on 13 aquatic species, including several native to the Tongue and Powder Rivers.

The results of the experiments showed that the aquatic species had difficulty surviving in waters with sodium bicarbonate concentrations typically found in some tributaries of the Tongue and Powder Rivers (greater than 1,120 milligrams per liter). The results varied across species and depended upon the age of the organism. The data from this study can be used to develop water-quality criteria for aquatic life exposed to sodium bicarbonate. In addition, the results may have applications beyond coalbed natural gas production. Other energy production practices, such as conventional and unconventional (including hydraulic fracturing) oil and gas extraction, and mountaintop removal mining, also provide potential pathways for sodium bicarbonate to enter surface water.

Funding for this study was provided by the USGS Contaminant Biology Program; Montana Fish, Wildlife and Parks; the Bureau of Land Management; and the U.S. Environmental Protection Agency.

Upcoming Meetings

American Public Health Association 140th Annual Meeting and Exposition, San Francisco, California, October 27-31, 2012

The goal of the American Public Health Association (APHA) annual meeting is to provide health professionals and practitioners the opportunity to enhance their knowledge and exchange information on best practices, latest research, and new trends in public health. The meeting's program addresses current and emerging health science, policy, and practice issues in an effort to prevent disease and promote health.

http://www.apha.org/meetings/AnnualMeeting/

USGS

Come visit our booth on USGS Environmental Health Science at the Public Health Exposition during the APHA Annual Meeting – Booth number 2727 – Moscone Convention Center South. USGS staff will be on hand to answer questions, and fact sheets on a variety of environmental health topics will be available.

2012 GSA Annual Meeting and Exposition—Geosciences: Investing in the Future, Charlotte, North Carolina, November 4-7, 2012

The Geological Society of America (GSA) 124th Annual Meeting and Exhibition theme is "Geosciences: Investing in the Future." The meeting features a broad array of special technical sessions, field trips, short courses, and special lectures. USGS scientists are presenting a wide variety of information on USGS science, including environmental health science. The following session presentations by USGS scientists are related to environmental health:

During the GSA Annual Meeting please feel free to stop by the USGS's booth (number 603) in the Charlotte Convention Center's exhibit hall on the lower level. Information will be available on USGS science activities.

Sources, Transport, Fate, and Toxicology of Trace Elements and Organics in the Environment (no. 136) Session

Presentation: Water Chemistry in Areas with Surface Mining of Coal, West Virginia, USA, by William H. Orem

Presentation: Biogeochemical Controls on Degradation of Chlorobenzenes in a Wetland, by Michelle M. Lorah

Recent Advances in Geology and Health (no. 188) Session

Presentation: Geology and Health Insights Into Lead Poisoning From Artisanal Gold Mining, NW Nigeria: Sources, Exposure Pathways, Additional Health Concerns, and Global Implications, Geoffrey S. Plumlee

Presentation: The Connection Between the Quality of Water and Potential Cost to the Consumer for Water Supplies from the Glacial Aquifer System, by Kelly Warner

Frontiers in Coal Science: From Basic Research to Applied Technology (no. 194) Session

Presentation: Geochemistry of Atmospheric Particulates in the Vicinity of Mountaintop Coal Mines, West Virginia, USA, by Allan Kolker

Geochemistry of Urban Environments (no. 261) Session

Presentation: The Environmental and Medical Geochemistry of Urban Disasters, by Geoffrey S. Plumlee

http://www.geosociety.org/meetings/2012/

SETAC North America 33rd Annual Meeting—Advancing Science Though Innovation and Collaboration, Long Beach, California, November 11-15, 2012

The Society of Environmental Toxicology and Chemistry (SETAC) annual North America meeting will feature several special sessions on various aspects of environmental health science. Some session titles are:

- Flame Retardants: Sources, Fate, Wildlife/Human Exposure, and Health Implications
- Concepts Critical to the Next Generation of Human Health and Ecological Risk Assessment
- What Have Marine Mammals Really Been Telling Us About Contaminants? Lessons Learned from Aquatic Food Webs
- Pesticides in Urban Aquatic Environments: Occurrence, Effects, and Mitigation Options
- Impacts of Resource Mining on Inland Environments: Oil and Gas Extraction and Coal Mining
- Methods and Tools for Effective Human Health and Ecological Risk Communication
- Environmental Impacts of Oil Pipeline Spills

- Radionuclides in the Environment: Fate, Effects, and Risks
- Prioritizing Contaminants of Emerging Concern (CECs) for Monitoring in California
- Harmful Algal Bloom Toxins in Inland Waters: Environmental Contaminants of Emerging Concern
- Assessing the Risks of Nanosilver in the Environment
- Endocrine Disrupting Compounds (EDCs) and Pharmaceuticals in the Environment

USGS scientists will be giving a wide variety of presentations at the meeting.

http://longbeach.setac.org/

AGU 2012 Fall Meeting, San Francisco, California, December 3-7, 2012

Stop by the USGS's booth (number 417) in the Moscone Center North Hall during the AGU Fall Meeting. Information will be available on USGS science activities.

The American Geophysical Union (AGU) 45th annual Fall Meeting on geophysical sciences is attended by earth and space scientists, educators, students, and others from universities, government agencies, and industry. Several special sessions at the meeting are related to environmental health science. The following are a few of the sessions related to environmental health issues.

- Mineral Dust Aerosols: From Small-Scale to Large-Scale Understanding
- Nanoparticles in the Earth's Atmosphere
- Microorganisms, Colloids, Engineered Nanoparticles, and Emerging Contaminants in the Environment
- Water Contamination and Water Quality in River Systems
- Remote Sensing and Modeling Resources for Airborne Dust Research over the Pan-American Region

http://fallmeeting.agu.org/2012/

32nd Annual Meeting of the Society for Risk Analysis, San Francisco, California, December 9-12, 2012

Risk analysis, including risk perception, risk assessment, risk management, and risk communication represents an interdisciplinary field that is the foundation of decision making across many disciplines. The annual meeting of the Society for Risk Analysis brings together scientists and practitioners from a wide range of disciplines that share an interest in risk analysis.

http://www.sra.org/events_2012_meeting.php

Fourth Conference on Environment and Health at the 93rd AMS Annual Meeting, Austin, Texas, January 6-10, 2013

One of the many sub conferences at the American Meteorological Society (AMS) annual meeting is the Fourth Conference on Environment and Health. The goal of the conference is to go in-depth into Earth's influence on human health and well-being. Information on the following selected topics will be presented at the conference:

- Vectorborne and Zoonotic Diseases
- Waterborne Illnesses
- Ocean And Coastal–Related Human Health Risks
- Dust Transport, Transformation, and Consequence

The overarching theme for the 2013 AMS Annual Meeting is "Taking Predictions to the Next Level: Expanding Beyond Today's Weather, Water, and Climate Forecasting and Projections."

http://annual.ametsoc.org/2013/

Environmental Health 2013—Science and Policy to Protect Future Generations, Boston, Massachusetts, March 3-6, 2013

This conference aims to provide a place for translating scientific evidence into strategies to direct future research and policy action. The conference will cover a wide variety of major environment-related health concerns. Topics include, but are not limited to:

- Emerging Substances and Mixtures
- Environment, Epigenetics, and Early Programming
- Environmental Inequalities and Justice
- Epidemiological Studies
- Hot Spot Contamination and Health Outcomes
- Integrating Health and Safety – Sustainable Product Design
- Nanoparticles and Health
- Nature-Human Health Interactions
- Omics and Health Outcomes - Bridging the Gap
- Directing Research Strategies to Protect Future Generations
- Translating Science into Political Action
- Urban Environments and Health

http://www.environmentalhealthconference.com/

2nd International Conference on Environmental Pollution, Restoration and Management—Enhancing Environmental Research and Education in Developing Countries, Hanoi, Vietnam, March 4-8, 2013

The conference is co-hosted by Hanoi University of Science, Loyola University of Chicago, and Society of Environmental Toxicology and Chemistry (SETAC) Asia/Pacific. The conference will feature information on topics such as:

- Environmental Health/Public Health: Implications of Compromised Ecosystems
- Environmental Toxicology/Ecotoxicology
- Ecological and Human Health Risk Assessments
- Development of Environmental Quality Criteria
- Environmental Remediation and Restoration
- Emerging Contaminants: Fate and Effects (Pharmaceutical and Personal Care Products, Nanoparticles)

https://vniceporm.com/

AWRA Spring Specialty Conference — Agricultural Hydrology and Water Quality II, St. Louis, Missouri, March 25-27, 2013

The American Water Resources Association (AWRA) is hosting its Spring Specialty Conference — Agricultural Hydrology and Water Quality II. The conference plans to address and discuss the impacts of agricultural production on nutrient loading to streams and rivers and the resultant problems with freshwater and coastal eutrophication.

http://www.awra.org/meetings/Spring2013/

Environmental Health Risk 2013—7th International Conference on the Impact of Environmental Factors on Health, Budapest, Hungary, April 23-25, 2013

The aim of the Environmental Health Risk 2013 conference is to provide a "forum for the dissemination and exchange of information on

the diverse aspects of the impact of environmental factors on health across different disciplines."

http://www.wessex.ac.uk/13-conferences/environmental-health-risk-2013.html

Biohydrology Conference 2013: Bio Meets Hydrology, Landau/Pfalz, Germany, May 21-24, 2013

The conference will focus on the interaction between biological and hydrological systems, including positive impacts such as water harnessing and flood mitigation, and negative aspects including threats to food production, water repellency, and environmental degradation through land use practices. The conference will cover the following topics:

- Biohydrological Processes at Various Scales
- Food and Water Security, Biodiversity and Climate Change
- Coupled Land-Water Ecosystems
- Role of Biogeochemical Interfaces in Hydrology

http://www.biohydrology2013.de/

2013 AWRA Summer Specialty Conference — Environmental Flows, Hartford, Connecticut, June 24-26, 2013

The American Water Resources Association (AWRA) is hosting a technical specialty conference on environmental flows. The meeting organizers are defining environmental flows as "the quantity, quality, and timing of water flows required to sustain freshwater ecosystems, human livelihoods, and the well-being of those who depend on them."

http://www.awra.org/meetings/EnvironmentalFlows2013/

NEHA 77th Annual Educational Conference and Exhibition, Washington, D.C., July 9-11, 2013

The National Environmental Health Association (NEHA) is hosting its annual Educational Conference. The goal of the conference is to "train, educate, and advance people who have an interest or career in environmental health and protection, as well as to bring people together to build a professional network of environmental health colleagues, exchange information, and discover new and practical solutions to environmental health issues."

http://www.neha2013aec.org/home.html

Environment and Health – Bridging South, North, East and West, A Joint Conference of ISEE, ISES and ISIAQ, Basel, Switzerland, August 19-23, 2013

The International Society of Environmental Epidemiology (ISEE), International Society of Exposure Science (ISES), and International Society of Indoor Air Quality (ISIAQ) are conducting a joint conference on environmental health. The conference goal is to present recent achievements in the field of exposure science and environmental health from a broad range of relevant scientific disciplines. The conference's theme—Bridging South, North, East and West—reflects a focus of bridging research from different geographic regions, scientific disciplines, and the three societies sponsoring the conference. Environmental health topics, such as the linkages between agriculture, the environment and diseases of poverty, the effect of climate change and climate variability on environment and health, and the health impacts of natural resources development and management will be featured at the conference.

http://www.ehbasel13.org/index.php

New Publications

Coming Soon!

Cloern, J.E., and Jassby, A.D., 2012, Drivers of change in estuarine-coastal ecosystems--Discoveries from four decades of study in San Francisco Bay: Reviews of Geophysics, doi:10.1029/2012RG000397.

Gammons, C.H., Nimick, D.A., and Parker, S.R., 2012, Diel cycling of trace elements in streams draining mineralized areas, in Environmental Geochemistry for Modern Mining, in Reviews in Economic Geology: Littleton, Colo., Society of Economic Geologists.

Riva-Murray, K., Bradley, P.M., Chasar, L.C., Button, D.T., Brigham, M.E., Eikenberry, B.C.S., Journey, C.A., and Lutz, M.A., 2012, Dietary carbon source influences mercury bioaccumulation in small streams of the Adirondack Mountains of New York and the Coastal Plain of South Carolina, US: Ecotoxicology.

Sihota, N.J., and Mayer, K.U., 2012, Characterizing vadose zone hydrocarbon biodegradation using CO_2-effluxes, isotopes, and reactive transport modeling: Vadose Zone Journal.

Published Recently!

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Barlow, J.R.B., Kingsbury, J.A., and Coupe, R.H., 2012, Changes in shallow groundwater quality beneath recently urbanized areas in the Memphis, Tennessee area: JAWRA Journal of the American Water Resources Association, v. 48, no. 2, p. 336-354, doi:10.1111/j.1752-1688.2011.00616.x. http://dx.doi.org/10.1111/j.1752-1688.2011.00616.x

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