New Jersey Flows

New Jersey Water Resources Research Institute

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NJ Water Resources Research Institute Completes Five-Year USGS Review

The New Jersey Water Resources Research Institute receives an annual Federal matching grant as authorized by section 104 of the Water Resources Research Act of 1984 (Public Law 98-242) as amended by Public Law 101-397, Public Law 104-147, and Public Law 106-374.

Every five years the Secretary of the Interior is required to "conduct a careful and detailed evaluation of each institute at least once every 5 years to determine that the quality and relevance of its water resources research and its effectiveness as an institution for planning, conducting, and arranging for research warrants its continued support under this section."

The New Jersey Water Resources Research Institute completed a comprehensive review of its U.S. Geological Survey (USGS) funded research from 1998 through 2002. The New Jersey Water Resources Research Institute (NJWRRI) is primarily funded by the Federal Section 104b funding, supplemented by funding from the NJ Agricultural Experiment Station and Rutgers University.

New Jersey is a microcosm of the water resource problems facing states throughout the nation; with no single type of problem dominating the subject, and strives to use its resources to provide as broad an array of solutions as possible given limited funding. From this perspective, the Institute uses its research funds to support exploratory research by new investigators, both junior faculty and graduate students early in their careers, in the hope of producing excellent researchers who will develop large research programs that continue to address important water resource issues.

Using the funding from the university, the NJWRRI developed a program of undergraduate internships. The goals of this program are 1) to entice undergraduates into water-related fields by giving them research experience, and 2) to ensure that the NJWRRI supports education and research at smaller institutions which are not able to compete for the faculty and graduate student awards.

Federal and university funds are used to support research, education and information transfer across the broad array of water resource problems. Consisting of a Director and a half-time Administrative Assistant, the NJWRRI administers a research program whose goal is to support the development of excellent researchers and conducts information transfer activities whose goal is to communicate both information about water resource problems and also to communicate the importance of research in solving problems.

Section 104 Objectives

The objectives of the NJWRRI Sec 104 program are:

1) To encourage the development of excellent researchers on water resource issues by providing support to new investigators

2) To support the training of excellent water resource professionals by providing funding for graduate students to develop innovative and original thesis research.

3) To communicate to the general public new knowledge concerning water resources, the scientific context of water resources education at all levels, and by so doing, encourage public support for water resources research and professional training.

The NJWRRI does not emphasize one particular subject area of water research, but rather seeks to develop a high-quality pool of researchers and students to address the broad array of issues

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The Director's Chair

by Joan G. Ehrenfeld, Ph.D., Director, New Jersey Water Resources Research Institute
Rutgers, The State University of New Jersey

This issue describes the range of research on water issues that is being conducted in New Jersey now, emphasizing the research supported by the NJ WRRI. As will be evident, this research covers an impressive range of issues in water resources. New Jersey's water resources are varied, and face a wide range of problems, and thus it is appropriate that our research ranges widely over the fields of water resource science. We are also pleased to announce the "grand opening" of the expanded NJWRRI website. For the latest in water research, funding announcements, events, and more visit us at *http://njwrri.rutgers.edu*. We invite you to share your comments and opinions by sending an e-mail to *derbedrosian@aesop.rutgers.edu*

Five-Year USGS Review *(Cont. from Page 1)*

facing the state's water resources.

The NJWRRI obtained significant additional funding from Rutgers University as a result of negotiations held during 2000, which became available for use in the latter part of FY 2000. The NJ Agricultural Experiment Station committed funds for a half-time Administrative Assistant to develop and manage an information transfer program, and the central administration of the university committed $80,000 ($40,000 each year for two years) to support both the research and the information transfer programs.

Water had not previously been a high-profile issue in New Jersey until the drought of 2002 forced water shortage issues into the news.

Allocations of combined federal grant and matching funds to the NJWRRI during the 5 year period included in the review went 58% to research, 7% to information transfer, 21% to education and 14%% toward administration.

The research that has been supported addresses the most prominent water resource problems in the state. The fate, transport and mechanisms of biotransformation of a wide variety of toxic substances is a major area of investigation (16 projects), and has been the subject of both research projects of junior faculty, graduate students, and undergraduate interns. Prominent within this group of projects is research on mercury methylation and MTBE. Another important area is wetland and stream ecology (20 projects). Because New Jersey has the most stringent freshwater wetlands law in the country, as well as high-profile coastal wetlands in heavily populated areas, there is an emphasis on wetland function and restoration both in regulatory agencies and the involved public.

Much of the research has been conducted at Rutgers University, simply because this is the only research university with appropriate faculty, aside from Princeton University, in the state. A small number of proposals from other institutions are received. Funding is also effectively distributed to other institutions through the undergraduate intern program; state colleges and universities that are undergraduate-oriented have been able to compete successfully for these awards. Funds have been distributed to at total of 7 college and universities in New Jersey, and the NJ Marine Sciences Consortium.

During the reported period, the NJWRRI had 45 seed grants awarded which resulted in 35 articles in refereed journals, 4 book chapters, 8 graduate theses and dissertations, 12 articles in Conference Proceedings, and 4 other publications.

Thirteen projects received follow-on funding from another source after completion as a section 104-funded project. Investigators supported by the NJWRRI funds generated $795,604 in extramural funding

Research categories of grants awarded included biological sciences (22), climate and hydrologic processes (3), engineering (2), groundwater flow and transport (3), and water quality (15).

During 1998 and 1999, the Institute was unable to maintain an Information Transfer program because of the lack of any support in either personnel or real dollars for such an effort from the host university. Following the commitment of matching funds for this purpose from Rutgers in 2000, our Information Transfer program was revitalized.

With the efforts of the half-time administrative assistant, our information transfer program has consisted of the production of a newsletter, organization as the lead agency in several regional or state-wide meetings, lead agency in hosting the visits of nationally-prominent speakers on topical issues in water resources, and co-sponsorships of other meetings and seminars. NJWRRI maintains a web site, and also disseminates a wide range of water resource information around the state about publications, meetings, conferences, regulatory developments, and other important water-related events.

The Institute also disseminates a wide range of water resource information around the state, including meeting and seminar announcements, training programs, publications, and useful websites. Separate lists are maintained so that mailings and messages can go to appropriate audiences (e.g., scientists, managers, citizens, people in selected portions of the state as appropriate).

The water resources institute organized a large regional conference addressing the critical water shortages and social conflicts resulting from these shortages in southern New Jersey, bringing together many important stakeholders in these controversies. The Institute collaborated with the New Jersey District Office of the US Geological Survey in presenting an impartial overview of water resource availability and its connection to aquatic ecosystems in south Jersey, and followed these presentations with presentations from environmentalists, builders' groups, political representatives, and water resource managers from the NJ Dep. of Environmental Protection.

NJWRRI also contributed to a major conference on the role of the invasive plant, common reed (*Phragmites australis*) in wetland ecology. The proceedings of this conference were recently (2002) published as a special issue of the journal *Estuaries*. The role of this plant in wetland management, fisheries management, and wetland restoration; many tens of millions of dollars are spent in wetland projects related to removing this species and restoring native species; the results of the conference suggest that this may not be always necessary to maintain wetland functions.

Two nationally-recognized experts on Adaptive Restoration and TMDL's were brought by the Institute to New Jersey to give public lectures and meet with experts in the public and private sectors. Additionally the Institute has collaborated with other groups in sponsoring lectures from visiting scholars.

During the period reported to the USGS, the center also supported 32 undergraduate students, 3 Masters students, 26 Ph. D. candidates and 6 post-doctoral students. National Competitive Grants supported 4 undergraduate and 2 Ph. D. students.

Significant research programs funded at least in part by USGS funds through NJWRRI during the reporting period has resulted in a wide range of significant findings:

- Mercury contamination is widespread not only in New Jersey, but across the country. Paradoxically, there is often more methymercury present in otherwise protected and undisturbed waters than in highly developed, disturbed regions. Dr. Tamar Barkay has elucidated the molecular basis for this situation by identifying and characterizing the genes responsible for the microbial consumption of methylmercury. Her studies have improved the understanding of mercury cycling, and is leading to new strategies of managing this serious pollutant.

- Nonionic surfactants are widely used contaminants which are regulated in Europe but not in the United States. Dr. Kauser

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Rhizosphere Research Enhances PAH Degradation, Treats Contaminated Sediments *In Situ*

By Michael Fleming, Graduate Fellow[1], Jerome J. Kukor, Ph. D.[2], and Max M. Häggblom, Ph. D.[3], Rutgers University

The New Jersey wetlands provide a rich and complex habitat for many species of animals and plants. Unfortunately, decades of industrial activity along the northern New Jersey coastline have resulted in widespread environmental contamination in many areas of this ecosystem. Such disturbances can have a profound effect on the abundance and diversity of life in the wetlands.

Our work over the past few years has focused on cleanup of these contaminated areas of the New Jersey wetlands. More specifically, we are interested in lowering the levels of polycyclic aromatic hydrocarbons (PAHs) in wetlands soils and sediments. These compounds are of considerable concern to public health, as many of them are known carcinogens and/or teratogens. Additionally, they are highly stable, and can persist in soils for many years. A wide range of soil bacteria have been discovered that can utilize these contaminants as a sole source of carbon and energy, providing an effective and potentially low-cost solution to this problem.

Rather than attempting to isolate useful bacteria from bulk

soil, we opted to focus on the rhizosphere, the zone of soil immediately surrounding and influenced by plant roots, of the indigenous marsh grass *Spartina alterniflora*. Grass species like *S. alterniflora* and the invasive *Phragmites australis* have been recolonizing many contaminated areas of the wetlands in recent years. Our hypothesis was that the rhizospheres of these hearty grasses could provide a hospitable environment for bacteria capable of catabolizing PAHs and other pollutants in these regions.

We began collecting rhizospheric soil samples from polluted stands of *S. alterniflora* in mid-summer of 2000. Soil blocks containing intact plants were transported back to the lab for processing. Samples of these rhizospheric soils were used as inocula in batch bacterial enrichment protocols. Phenanthrene, a three-ring compound, and pyrene, a four-ring compound, were used as representative PAHs for the enrichment series.

The enrichment yielded 13 distinct isolates capable of utilizing the representative compounds as sole sources of carbon and

energy. These isolates were separated based on colony morphology and characterized through fatty acid profiling and DNA sequence analysis. Current experiments with the new isolates involve PAH degradation trials using the enrichment compounds and a range of additional PAH substrates. Future work will involve measuring the effects of aqueous root extract from *S. alterniflora* on PAH degradation by the bacterial isolates.

Environmental cleanup methods like bioaugmentation, biostimulation, and bioreactor-based treatment have already shown the vast potential of microbial degradation of environmental contaminants. Additionally, efforts to reintroduce indigenous plant species in disturbed areas have proven successful in the restoration of disturbed wetlands habitats. Demonstrating a positive link between microbial degradation of target pollutants and plant activities in the rhizosphere could lead to new frameworks for combined restoration and remediation strategies.

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Don't miss our all-new website at http://njwrri.rutgers.edu

Conference Calls

National Water Research Symposium, October 10-12, 2005, Blacksburg, Virginia. Theme: Balancing Water Law and Science. For more information see: http://www.conted.vt.edu/vwrs/

American Water Resources Association 2005 Annual Conference, November 7-10, 2005, Seattle, Washington. For more information see: http://www.awra.org/meetings/Seattle2005/

Potential Nitrogen Saturation in Urban Wetlands

By Emilie Stander, with Dr. Joan Ehrenfeld, Dept. Ecology, Evolution, and Natural Resources, Rutgers, The State University

Nitrogen (N) is one of the most widespread and pervasive pollutants present in surface waters throughout the United States and in the urban watersheds of New Jersey. Excess N in surface waters can have drastic negative consequences for ecosystems. The zones of hypoxia in the Chesapeake Bay and the Gulf of Mexico are dramatic examples of the extent to which excess N can cause eutrophication problems in receiving water bodies. Also, because N can be a drinking water pollutant, elevated N levels in surface waters pose a problem for human and wildlife health.

Wetlands are increasingly being used as a management tool to combat the problem of excess N in urban watersheds. This is based on the documented ability of treatment wetlands to remove N in sewage effluent and of riparian buffer strips to remove N from upland agricultural land use. N is removed through the process of denitrification, the microbially-mediated transformation of dissolved inorganic N to N_2 gas which is released to the atmosphere. This process requires anaerobic conditions which are typically found in the saturated soils of wetlands.

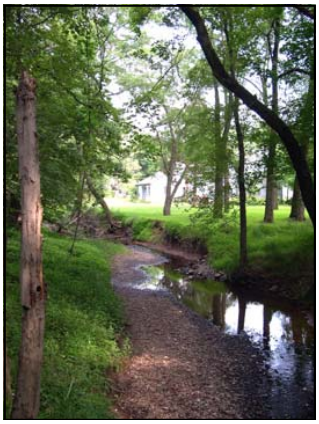
In a highly developed state such as New Jersey, many wetlands are located in urban and suburban watersheds. Very few studies have attempted to determine whether urban wetlands remain capable of removing N. It is not possible to extrapolate the results of the aforementioned agriculturally-oriented studies to urban wetlands due to the unique hydrological disturbances to which urban systems are subjected. In urban systems hydrological disturbance is a result of development and stormwater management practices. Reduced infiltration of stormwater due to impervious cover leads to reduced groundwater recharge and thus reduced stream water levels. Stormwater runoff is quickly channeled from impervious surfaces directly to receiving water bodies. The high volume of stormwater reaching receiving streams over a short period of time causes increased erosive force, which results in stream incision and downcutting.

These large-scale hydrological alterations can cause changes in wetlands soils. Stream incision can result in lowered water tables, resulting in drier soils. Some wetlands strongly impacted by urban hydrological disturbance display sudden and large fluctuations in water table levels, while less impacted wetlands display higher, more stable water table levels. This means that wetland soils are drier than they have been historically, and therefore the process of denitrification is inhibited. This means excess N might leach out of the soil, into groundwater, and eventually into streams and rivers.

I am studying groundwater and nitrogen levels in fourteen forested wetlands in northeastern New Jersey to determine whether these ecological characteristics are altered in the manner described above. Some of these wetlands I would predict to be altered because they are surrounded by a high amount and intensity of urban land use. These wetlands, which I will refer to as my "urban" sites, are located in places like Hillside, East Hanover, Edison, and Morris Township. Other wetlands I would expect to be less altered, because they are surrounded by municipalities with lower population densities and are larger and may therefore be buffered from some of the impacts of urbanization. These wetlands, which I will refer to as my "reference" sites, are located in places like Hillsborough, Griggstown, Basking Ridge, and Troy Hills.

In order to measure hydrology, we have installed one well to a depth of one meter at each site. These wells automatically measure water table levels every six hours and store the information in data loggers, which I later download in the field. We have also installed clusters of piezometers at each site. Piezometers allow us to determine whether water is moving up into the soil from the groundwater or whether it is moving in the opposite direction. I measure the piezometers manually every two to four weeks. To measure N levels and N cycling processes, I have collected numerous intact soil cores from each site. Some of these cores are brought back to the lab and analyzed immediately for N content; other cores are returned to the soil to incubate at field conditions. At the end of one month's time, I collect these incubating cores and analyze them in the same manner as the fresh cores. I can calculate rates of nitrogen cycling processes by measuring the amount of N which accumulates from the time the fresh cores are taken to the time the incubating cores are harvested.

So far I have found that many of these wetlands have the lower groundwater levels I predicted. These same wetlands also have higher levels of nitrogen. In fact they produce additional nitrogen on top of what comes in from urban land uses because the soils are so dry. This coming summer I will study whether these high levels of nitrogen in our urban wetlands are causing nitrogen to leak to nearby streams. In many cases it is the reference, or less urban sites, which show high levels of hydrological disturbance. Some of the urban sites do as well, but other urban sites have stable, high water table levels. I do not yet know what factors explain this pattern. Perhaps road density or specific types of land use (i.e., residential versus industrial) are driving these patterns. This question deserves additional research, and the results could be very useful for managers and members of the regulatory community.



There are solutions to this problem. There are ways to restore healthy hydrology to New Jersey's urban wetlands. One of the most popular methods is to restore eroded streambanks. Streambank restoration does not come cheap, and it requires long-term maintenance to be successful. Another way to help our wetlands is to reduce the amount of impervious surface in our current and future urban/suburban developments and to support smart growth initiatives.

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Development of Continuous Supported Liquid Membrane Extraction Followed by On-line HPLC-UV Detection for Halo-Acetic Acids (HAAs) Monitoring

By Xiaoyan Wang, Ph.D candidate and Somenath Mitra, Professor, Department of Chemistry and Environmental Science New Jersey Institute of Technology

Chlorination is the most common method for disinfecting drinking water. It is known to reduce waterborne diseases dramatically. However, chlorine also reacts with naturally occurring humic and fulvic acids [naturally occurring organic matter in water] to form halogenated organic compounds, which are referred as the disinfection byproducts (DBPs). Halo-acetic acids (HAAs) are the major nonvolatile DBPs. USEPA has regulated the total Maximum Concentration Limit (MCL) in drinking water of the five HAAs to be less than 60 mg/L. Current USEPA standard methods for HAAs analysis involve cumbersome liquid-liquid extraction and derivatization, followed by GC/ECD detection. Typical analysis time costs about four hours per sample. Methods that do not need derivatization have been developed recently, however there is no method for continuous, on-line monitoring of all the nine HAAs. Automated online measurements are less inexpensive, provide real-time information and have better accuracy and precision. Since there is less manual sample handing, these techniques are free from contamination. The goal of this study is to develop automated, online methods for the continuous monitoring of all the nine HAAs in water.

NJIT Ph.D Candidate, Xiaoyan Wang discusses the membrane extraction module with her advisor, Dr. Somenath Mitra (left)

Membrane extraction has recently emerged as a promising technique for sample enrichment and cleanup. It has several advantages, such as simple instrumentation, requires small solvent volumes and offers high enrichment factors. It allows a sample flow continuously on one side, while the extractant on the other. This leads to continuous, on-line extraction. It has been coupled to GC, HPLC, mass spectrometry (MS) and CE etc, for continuous monitoring. There are two major approached to membrane extraction, supported liquid membrane extraction (SLME) and liquid-liquid membrane extraction (LLME). SLME is a three-phase extraction system, where the analytes are extracted from an aqueous sample into anacceptor phase via an organic extractant held in the pores of the membrane. It works well for the extraction of highly polar and ionizable compounds, such as HAAs. In this study continuous SLME followed by on-line HPLC-UV detection was developed for HAAs monitoring. The effect of the flow rates of water sample and acceptor on enrichment factors and extraction efficiencies were studied. With continuous SLME, all the nine acids could be extracted and quantified. Enrichment factor as high as 500, and method detection limits low to sub-ppb level were achieved.

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New Bacteria From a Spoonful of Mud!!!!

By Priya Narasingarao, Ph. D candidate in Environmental Sciences, and Dr. Max Häggblom, Department of Biochemistry and Microbiology. Rutgers, The State University

Anaerobic respiration using compounds such as nitrate, sulfate, or carbonate instead of oxygen has been known for decades and is well characterized. Some lesser-known bacteria can respire with toxic compounds, such as selenium, arsenic, chromium and chlorate! These bacteria are mostly beneficial in that they use these toxic compounds and convert them into substances harmless to the environment, for example, resulting in the precipitation of elemental selenium. These reactions are in themselves highly interesting and useful because they are carried out by these wondrous microscopic living creatures, which have been performing the most important role of recycling nutrients back to the soil in nature for millions of years.

We have in our laboratory used sediments from many sites in New Jersey, such as the Arthur Kill estuary and The Hackensack Meadowlands, to study the respiration of selenium and arsenic by microorganisms. We have found that selenium respiration is a highly ubiquitous process. Microorganisms abundant in these sediments readily convert selenate to selenium even though the sediments have had no known history of selenium contamination. We have thus far isolated several novel bacteria from these sites. We are currently characterizing these novel bacteria, which represent new species and genera. We propose to name one of our isolates from the Arthur Kill, as *"Terracola selenatireducens"* meaning selenate-reducing bacterium of the earth!

Our work has shown that the selenate reducing bacteria are diverse and possess a unique way of living in nature. One of our isolates, *Pseudomonas stutzeri* has the extraordinary capability to switch between aerobic and anaerobic selenate respiration. This ubiquity and diversity has given rise to some very interesting questions such as: What is the role of these bacteria in the cycling of selenium in soils? How could these organisms be used in the bioremediation of polluted sites? One of the strategies that has been previously demonstrated is to use these selenate-respiring bacteria in selenium contaminated waters and thus convert this toxic, water-soluble selenate into highly insoluble selenium. Once selenium precipitates, it can very effectively be filtered out. The bacteria isolated from our laboratory are ideal candidates for use in bioremediation. Our work will aid in devising effective strategies to manage selenium-contaminated aquifers and increase water quality. This will prevent further ecological damage caused by these selenium-contaminated systems.

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A Sometimes Deceptive Average

NJ precipitation from 2004 through Spring 2005

By Dr. David A. Robinson, Professor, Dept. of Geography, Rutgers, The State University, New Jersey State Climatologist

The late 1990s and early 2000s were years of extreme variability across the Garden State. Extended periods of drought occurred between summer 1998 and summer 2002. Beginning in fall 2002, hydrometeors began to fall in earnest, with conditions remaining quite wet through the end of 2003. Since then, New Jersey has gone through an extended period with monthly and seasonal precipitation most often quite near long-term averages (1971-2000).

In 2004, annual precipitation across the Garden State averaged 47.94". This is only 0.75" above the 1971-2000 norm of 47.19". NJ residents witnessed 7 months of below average precipitation and 5 above. July, with 7.30", was the wettest, at 2.81" above average, and January, with 2.11" of rain and melted snow, was the driest, at 1.83" below average. Precipitation in 6 of the 12 months was within an inch of normal. Temperatures were slightly above average over the course of the year (+0.6 degrees).

2004 was not without some very wet events. On July 11-12, as much as a foot of rain fell in the headwaters region of the Rancocas Creek in Burlington County. This localized event resulted in several dam failures and significant flooding. On September 18-19, the remnants of Hurricane Ivan dumped 4-8" of rain over the middle and upper Delaware River basin. The intense nature of the event and the "wall to wall" coverage of heavy precipitation within the basin led to the third largest Delaware flood on record. Just a little more than a week later, the remnants of Hurricane Jeanne poured 3-6" of rain on a larger portion of the Garden State than found with Ivan. Fortunately, the amounts were on the low end of this range within the Delaware basin, preventing the recurrence of significant flooding.

The early portion of 2005 has continued the "average" theme of last year. Precipitation was within a half inch of the long-term average from January through March, while April's preliminary total was slightly less than an inch above average. A series of three storms in late March and the first several days of April brought 6" or more of rain and melted snowfall to a broad portion of NJ. Augmented by melting remnant snow pack at higher elevations, this precipitation resulted in serious flooding in the Passaic basin. The disastrous flood crest on the Delaware River eclipsed September 2004 levels. Only the floods of 1903 and 1955 exceeded the magnitudes of these latest two events.

Since the late March-early April wet spell, NJ has experienced below average precipitation (through the third week of May). Some areas of the state have recorded less than 2" of rain in this recent 6 week period, about one third of average. The result has been several minor episodes of forest and brush fires and some early season browning of lawns. However May temperatures have been a very cool 5 degrees below average, keeping evaporation levels down, reservoirs are full, and ground water is ample. Thus we enter the 2005 summer in good shape water wise (*http://www.njdrought.org/*).

To sum up, notice that the word "normal" has been avoided in this note. That's because the precipitation totals that at times have run well above, well below and close to the long term average over recent years all contribute to or represent normal conditions! The National Weather Service avoids this word in their long-range outlooks. For instance, their outlook for this coming June through August is "equal chances" for NJ precipitation and for temperature to fall either in the lower, middle, or upper thirds of historic distributions of these variables (*http://www.cpc.ncep.noaa.gov/products/predictions/90day/lead01/index.html*). This should not be misinterpreted as a forecast for a "normal" summer, with totals and means close to long-term averages.

You are invited to monitor the latest weather conditions by visiting the Office of the NJ State Climatologist web site *http://climate.rutgers.edu/stateclim*. Or link directly to the NJ Weather and Climate Network at: *http://climate.rutgers.edu/njwxnet*. (Monthly and annual totals and averages back to 1893 are found at *http://climate.rutgers.edu/stateclim_v1/data/index.html*.

For more information contact: Dr.David A. Robinson at: 732-445-4741or Email: drobins@rci.rutgers.edu

Volunteer Monitoring News

The New Jersey Department of Environmental Protection, in cooperation with the Watershed Watch Network Advisory Council, will host the ***3rd Annual Volunteer Monitoring Summit*** on November 4 & 5th at the Clarion Hotel and Towers in Edison NJ. This year's theme will be "Using your Data for Local Community Efforts", as well as hands-on demonstrations of monitoring equipment.

Two NJDEP-sponsored Fall workshops include **RAPID BIOASSESSMENT PROTOCOL 3 (RBP3): Rocky Bottom Training - October 11, 2005 and Muddy Bottom Training - October 12, 2005.**

For additional information on these events, please call the NJDEP, Division of Watershed Management, Bureau of Watersheds Estuaries, and Monitoring at 609-292-2113 or see *http://www.nj.gov/dep/watershedmgt/volunteer_monitoring_events.htm*.

The Office of Outreach and Education in the NJDEP Division of Watershed Management is responsible for the coordination of the **Volunteer Monitoring Program and the Watershed Watch Network**. Watershed Watch Network is a program acting as an umbrella for all of the volunteer monitoring programs within New Jersey. Information at the Watershed Watch website includes a PowerPoint presentation on the network, the four-tiered approach to Volunteer Monitoring, the NJ Visual Assessment Protocol, and other downloadable files. The Watershed Watch website can be found at: *http://www.nj.gov/dep/watershedmgt/volunteer_monitoring.htm*

Proceedings for the 2004 National Water Quality Monitoring Conference are now available online. This link includes materials from the conference notebooks, plus an interactive Conference Agenda with links to workshop materials, PowerPoint presentations, and title pages or accompanying papers. See: *http://water.usgs.gov/wicp/acwi/monitoring/* (click on 2004 Conference).

Field Trip To Sonargaon, Narayangonj, Bangladesh To Observe the BRAC Arsenic Mitigation Project

Images indicate how personal shallow water tube wells have been abandoned and a water tank has been constructed to deliver water pumped from deeper aquifers which are arsenic free. Some water sampling was also conducted from wells installed for water quality monitoring with help from BUET staff.

Microbial Transformation of Arsenic in Bangladesh

By Dr. Kauser Jahan, P.E., Associate Professor of Civil & Environmental Engineering, Rowan University

A team of four Rowan University students from the Colleges of Engineering and Liberal Arts and Sciences were led by Professor Kauser Jahan of the Civil and Environmental Engineering Department. Dr. Jahan has recently taken initiative in arsenic research as Bangladesh has one of the world's worst cases of arsenic contaminated groundwater. The arsenic is naturally occurring and has impacted millions of Bangladeshis. Dr. Jahan received funding from the American Institute of Bangladesh Studies to lead a team of students to Bangladesh. Three engineering students and one Biology student accompanied her on the trip. The major objectives of the trip were to present their research findings to the Bangladeshi researchers at the Bangladesh University of Engineering and Technology (BUET) and the International University of Bangladesh (IUB) and to observe arsenic mitigation projects. It was also anticipated that the trip would be a valuable exposure for the students to see first hand the social problems of Bangladesh and efforts at eliminating such problems. Finally the trip was also expected to help students have a better scholarly understanding of the Bangladeshi culture and history.

A ten day trip to Dhaka, the capital of Bangladesh was planned. The trip included seminars, presentations, sightseeing tours and observation of poverty elimination and arsenic mitigation programs. Seminars included presentations and exchange of research ideas on arsenic remediation. Discussions with BUET and IUB faculty indicated that the country was poised for abandoning all shallow tube wells and tapping into deeper aquifers for arsenic free water withdrawal. Research currently is focused more on the fate and transport of arsenic in the soil and edible crops and plants.

An all day trip was arranged by BRAC (Bangladesh Rural Advancement Cooperation) to their regional headquarters at Sonargaon. This all day trip allowed students to be exposed to initiatives led by BRAC to empower women and children via micro finance and educational programs. The team also visited a BRAC arsenic mitigation project that currently helps a community to pump water from a deep groundwater well for distribution. Poor people have access to this water through community taps available at public schools.

Dr. Jahan was also invited by the BRAC University to present a three day workshop on teaching effectiveness. Twenty five faculty from various institutions attended this workshop. The workshop offered insight to student learning styles, tips on lecture organization, lecture delivery, questioning techniques and the use of audio-visual aids in the classroom. Course and instructor evaluations and course assessment techniques were also discussed. Dr. Jahan has been invited by BUET to offer such a workshop for their faculty later this summer.

Finally time was set aside for learning the culture and history of the country. The team took a one day Dhaka city sightseeing trip that included the famous parliament building designed by American architect Louis Kahn, who studied architecture at the University of Pennsylvania and found many similarities of Dhaka with the city of Philadelphia. The visit to the Liberation Museum exposed students to the horrors of the Liberation War of Bangladesh, the mass massacre of intellectuals and innocent people and the role of the USA during this war. Students witnessed the role of famous Beatles singer George Harrison and his fundraising concert for Bangladesh. A visit to the Folklore Museum at Sonargaon, the old capitol of Bangladesh helped students with an understanding of the professions, tribes and products that are common to the countrymen.

Students also experienced the Bangaldeshi cuisine by dining at local restaurants and dinners hosted by the BRAC University Vice Chancellor, the AIBS personnel in Dhaka and the BUET faculty.

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FY 2004 Senior Level Research Projects Completed

High resolution geophysical imaging as a novel method for noninvasive characterization of contaminated wetlands: application to Kearny Marsh, Dr. Lee D. Slater, Rutgers University-Newark

ABSTRACT

Wetland sediments and pore waters are often cumbersome to sample directly. Geophysical technologies are increasingly used on land for rapid, non-invasive, environmental contamination assessment. State-of-the-art electrical geophysical imaging surveys permit non-invasive time-lapse "imaging" of dynamic subsurface processes (such as contaminant movement) that is analogous to medical imaging. Despite the extensive development and utilization of these novel methods of contaminant detection, they are essentially unused in the study of wetlands.

This study applies these geophysical technologies to the study of shallow water as a means to significantly improve understanding of shallow-water wetland environments. The study site, the Kearny Marsh, is an approximately 1.5 km^2 freshwater wetland situated within the Hackensack Meadowlands of Northern New Jersey (NJ); a complex wetland system connected to the New York Harbor and estuary system

It is thought that as the water depth is so shallow (typically a few feet), with the aid of a paddle boat, electrical current penetration into the sediments can be maximized and high resolution electrical imaging is possible.which will provide spatially extensive, non-invasive information on sediment and subsurface water quality hitherto unavailable to ecologists, geochemists and hydrologists involved in wetlands research.

Fate of Brominated Flame Retardants in New Jersey Wastewater Treatment Facilities, Dr. Donna E. Fennell, Dr. Lisa A. Totten and Dr. Uta Krogmann, Rutgers University

ABSTRACT

Wastewater treatment facilities (WWTF) are called upon to prevent macropollutants such as biochemical oxygen demand, nitrogen and phosphorous from entering aquatic systems. Increasingly they are also expected to remove trace persistent, bioaccumulative and toxic chemicals (PBTs). This class of chemicals includes emerging pollutants such as the brominated flame retardants, polybrominated diphenyl ethers (PBDEs). This research documents the presence and level of PBDEs in New Jersey sewage, sludges and biosolids from selected wastewater treatment facilities (WWTF), and explores whether environmentally relevant congeners of PBDEs are transformed or detoxified during one sludge treatment process—anaerobic digestion. Understanding the fate of such compounds is essential to future planning for wastewater treatment and biosolids management in an ecologically sound manner that is protective of human health and water resources.

NJWRRI FY 2005 Research Awards

New Jersey Water Resources Research Institute is proud to announce that funding for the FY 2005 State Water Resources Research Program (104B) has been awarded to support the following research:

Graduate Research Grants Awarded

"Examining Effects of Soil Compaction on Pollutant Removal Efficiency and Lifespan of a NJ Approved Stormwater Best Management Practice", Michael Mak, Rutger University, Dr. Chris Obropta, Advisor.

"The Influence of Urbanization on Watershed Nitrogen Cycling Watersheds", Bernice Rosenzweig, Princeton University, Dr. Peter Jaffe, Advisor.

"Microbial Degradation of MTBE in Anaerobic Environments", Laura K. G. Youngster, Rutgers University, Max Haggblom, Advisor.

"Lab-on-a-chip Device for Monitoring Trace Level Arsenic", Kamilah Hylton, New Jersey Institute of Technology, Somenath Mitra, Advisor.

"Resistance of Fractured Rock Dechlorinating Bacteria to Pressure from Heavy Metals", Eun Kyeu Son, Rutgers University, Donna K. Fennell, Advisor.

Senior Research Grants Awarded

"A Study to Link Atmospheric N Deposition with Surface and Ground Water N and Denitrification Capabilities in an Urban New Jersey Wetland", Barbara Turpin, Sybil Seitzinger and B.W.Ravit, Rutgers University.

"Impacts of Organic Matter Heterogeneity on Desorption and Availability of Sediment-bound PCBs", Weilin Huang, and Lisa Totten, Rutgers University.

WEFTEC 05 Features Hurricane Katrina Technical Session
WEFTEC.05 - The Water Quality Event
78th Annual Conference and Exhibition
October 29 - November 2, 2005, Washington, DC USA

WEF is currently developing a new technical session on Hurricane Katrina for WEFTEC®.05. The session is expected to feature a panel of experts who will discuss the storm's impacts to local water quality, public health, and the environment, as well as the status of recovery efforts in the devastated areas of Louisiana, Mississippi and Alabama. For more information on this year's conference, see http://www.weftec.org/

EIGHTH ANNUAL WETLANDS & WATERSHEDS WORKSHOP

Aquatic Systems and Water Quality, Holiday Inn-Boardwalk, Atlantic City , New Jersey, October 24-27, 2005

Sponsored by the **Wetlands & Watersheds Work Group**, this workshop will further investigate contemporary wetland issues that have been addressed in previous workshops using a watershed-based approach to environmental decision making and community based involvement. This year's theme is watershed-based decision-making in the protection and management of aquatic ecosystems. The workshop is co-sponsored by the *Water Resources Association of the Delaware River Basin*. In addition, *the Mid-Atlantic Chapter of the Society of Wetland Scientists* will be meeting with the group. For more information, see: *http://www.wetlandsworkgroup.org/wetlands workshops.htm* or call **(540) 286-0072.**

Research Activities at the USGS New Jersey Water Science Center in 2004

By By Anthony S. Navoy, Ph.D., Assistant Director, USGS New Jersey Water Science Center (formerly known as USGS New Jersey District Office)

The U.S. Geological Survey (USGS), a Bureau of the Department of the Interior, has an extensive program of hydrologic data collection and research in New Jersey that is focused on providing information pertaining to hydrologic hazards, watershed and water-supply management, vulnerability of source waters for drinking water, and hazardous-waste-site characterization. These data-collection and research activities are done in cooperation with the N.J. Department of Environmental Protection (NJDEP) , N.J. Department of Transportation, N.J. Pinelands Commission, N.J. Water Supply Authority, Rutgers University, National Oceanic and Atmospheric Administration, U.S. Army Corps of Engineers, U.S. Department of Defense, U.S. Environmental Protection Agency (USEPA), and many county and municipal agencies.

USGS Hydrologist Tim Reed making a discharge measurement on West Brook near Wanaque, N.J. (photo by John Trainor)

Hydrologic Hazards: The USGS operates streamflow-gaging and ground-water-level networks to monitor conditions relating to flood and drought hazards, and to provide hydrologic data for research, regulatory, and management purposes. The streamflow-gaging network in New Jersey in 2004 included 99 flow gages, of which 84 were equipped with data-collection platforms (DCP's) for automatic telemetry; 5 additional stations record only stream stage. The network also included 106 crest-stage gaging stations and 95 stations where low-flow measurements were periodically made. Three flood-warning systems were operated to provide emergency management personnel with critical real-time hydrologic data. These systems included a Coastal Tide Network, composed of 28 tide gages, 30 crest-stage gaging stations, and 5 weather stations; a network in Somerset County composed of 5 streamflow, 13 stage-only, 7 crest-stage, and 9 rain gages; and a network in Passaic County composed of 21 streamflow gaging stations and 35 rain gages. These networks were instrumental in monitoring two significant flood events in 2004 -- the July 12-14, 2004, flooding in parts of Burlington, Camden, and Ocean Counties and the September 17-23, 2004, flooding of the Delaware River and its tributaries.

The ground-water network consisted of 185 wells (50 in shallow aquifers) where water levels were monitored to assess the effects of withdrawals and climatological changes; 111 wells had continuous recording equipment, including 16 that were equipped with DCP's. Sixteen wells had maximum/minimum water-level recorders; and 58 wells were measured manually about four times per year.

The streamflow and ground-water level networks have stations that are well suited for monitoring conditions during droughts. These included 43 streamflow gaging stations equipped with DCP's, 35 low-flow measurement sites, 16 shallow wells equipped with DCP's, and 14 shallow wells equipped with continuous monitors.

Watershed and Water Supply Management: USGS research projects pertaining to watershed and water-supply management relied on the networks described above. The projects addressed the development of flow models and characterization of aquifers and watersheds. Projects that included the development of ground-water flow models for Ocean County, Salem and Gloucester Counties, and Cape May County were underway. These efforts focused on the collection of detailed hydrologic data for model development and calibration, such as hydrogeologic framework information from borehole and driller's logs; results of aquifer tests; and water-level, streamflow, and water-use data. The results of these ground-water investigations can be used in water planning, regulation, and management tasks. Analysis continued on the synoptic water-level measurements that were made in the Coastal Plain confined aquifers in late 2003. This important data-collection campaign has been undertaken every 5 years since 1978 to obtain water-level measurements from 750 to 1000 wells in the 10 major confined aquifers of the New Jersey Coastal Plain. These measurements provide data on ground-water conditions for many purposes, including model calibration and regulatory decision-making.

The development of a surface-water flow model of the Passaic River basin was undertaken by USGS as part of a consortium, to facilitate the establishment of total maximum daily loads (TMDLs) for the river basin. The ecological flow goals project was underway with efforts aimed to define the minimum streamflow needed to protect aquatic ecosystem integrity using hydrologic indices developed from existing streamflow data. USGS, part of a research team with the New Jersey Pinelands Commission, Rutgers University, the U.S. Fish and Wildlife Service, and NJDEP, continued work on a multiyear investigation to define the relation between the hydrology of southern New Jersey and the Pinelands ecosystem.

Vulnerability of Source Waters For Drinking Water: USGS undertook studies to monitor the water quality of streams and ground water in order to assess environmental effects and vulnerabilities of drinking-water supplies. Sampling was accomplished at 116 sites in a statewide surface-water-quality network. These sites included 6 background sites, 42 statewide status sites, 22 watershed integrator sites, 42 land use indicator sites (undeveloped, agriculture, urban, mixed), and 4 sites on the Delaware River. The sites were sampled seasonally (4 times per year). Continuous monitoring to assess the short-term variability of water quality was conducted at 3 sites for the entire year and at 16 sites for a period of 3 to 7 days. The focus for the statewide ground-water-quality network is to assess nonpoint source contamination. The network is composed of 150 randomly selected shallow wells in urban, agricultural, and undeveloped land-use areas. Each year, 30 wells are sampled in a 5-year cycle. USGS

(Continued on page 11)

Spotlight on New Jersey Watersheds

Pequannock River Coalition Active in Highlands Watershed

By Ross Kushner, Executive Director, Pequannock River Coalition

Traversing the Highlands region of northeastern New Jersey and a mere 30-minute drive from downtown Manhattan, the Pequannock River is a unique and significant waterway. In its upper reaches, thousands of acres of undeveloped land provide a stronghold for sensitive, endangered and threatened wildlife including wild brook trout, river otter, osprey and bald eagles. This region offers vast recreational opportunities and supplies potable water directly or indirectly to more than two million New Jersey citizens. Although the lower Pequannock River is far more developed and was once a victim of industrial abuse, it has enjoyed a renaissance in recent years due to the closing of riverside mills and tougher pollution standards. Water quality there has improved to the point where wild trout now inhabit this river section too. However, a number of hurdles have prevented the Pequannock River from reaching its full potential.

In response to environmental threats across the area, the Pequannock River Coalition was founded in 1995 as a grassroots watershed association. Today the Coalition enjoys the support of its 400+ members and member groups and provides a critical rallying point for anglers, hikers, boaters, birders and other citizens with a shared passion for environmental activism. With their help the Coalition is successfully facing a number of issues.

Reservoir construction in the Pequannock headwaters occurred more than 75 years ago, when environmental regulations were few and the impacts of these projects on downstream resources were ignored or misunderstood. Consequently no provisions were made for continued minimum passing flows. A result was the controversy erupting in 1994-95 when reduced flows from a Newark-owned reservoir caused high water temperatures creating a major fish kill.

Working with the aid of watershed residents and local officials the Coalition's earliest achievements included a minimum-flow/maximum temperature agreement for the river segment where the fish kill occurred in 1995 – the first agreement of its kind in New Jersey. In addition, they have been successful in raising public awareness and support on a variety of watershed land-use and land preservation issues. Through community activism the Coalition defeated a controversial waste transfer station destined for the Pequannock riverbank, a cell tower aimed at a scenic ridgeline, and an ill-sited golf course proposed for the river headwaters. This success in influencing public policy has been dependent on their ability to build grassroots support and to relay key watershed conditions and concepts to local residents and decision makers. To this end they lead seasonal watershed tours and hikes where citizens and officials can gain first-hand information on significant sites. They also host annual river clean-ups, restoration projects, and offer environmental presentations in local schools through their recently created "River in the Classroom" educational program.

A Greenway project, initiated in 2001 began the important work of identifying and preserving riverside lands as a proactive water protection measure and to offer increased recreational access. To-date more than $700,000 has been raised in a cooperative effort with the Passaic River Coalition.

Perhaps their most important achievement is a water temperature monitoring program launched in 1997. Temperature is a critical water quality element in coldwater ecosystems like the Pequannock, and trout spawning waterways across the State have a mandated 68F temperature limit. Their program, utilizing electronic "data loggers", was stringent enough to earn the group a state license as a laboratory, placing several river segments and tributaries on the federal 303(d) list of impaired waterways. Currently the State is negotiating new water releases from Newark-owned reservoirs to address the bulk of these temperature problems. The Coalition's findings have also allowed them to successfully challenged stormwater discharge permits throughout the Pequannock watershed, forcing tighter requirements on new development projects statewide.

Based on these achievements their Executive Director, Ross Kushner, was recognized as the "Outstanding Grassroots Activist" by the Highlands Coalition in 2002, and they received both a U.S. EPA Environmental Achievement Award and a NJDEP Environmental Excellence Award in 2003.

An important new "tool" in their watershed arsenal is the Highlands Act, signed into law in August of 2004. Although the Act promised a host of new protections, the Coalition remains concerned with substantial flaws identified in the latest NJDEP regulations. Waivers for "linear development", as one example, will allow roads and driveways to breach new safeguards for steep slopes, forests and waterway buffers. Loosely defined "brownfields" can also override these defenses. And the regulation's failure to properly limit the filling of floodplains may be detrimental to all Highlands watersheds. With these concerns in mind the Coalition is advocating for amendment of the regulations through a cooperative effort with the Highlands Coalition.

Despite these concerns the Coalition remains hopeful for the future of the Pequannock River Watershed. Growing public awareness of the need for water quality protection, and the residents of New Jersey's densely populated cities, hungry for the peace of the great outdoors, produce countless vocal allies and advocates. Increasingly local and state officials are also on board with sensible planning. This bodes well for their goals of restoring and maintaining good wildlife habitat, clean water, healthy ecosystems and expanded recreational use.

For more information, contact: Ross Kushner, Executive Director Pequannock River Coalition, P.O. Box 392, Newfoundland, NJ 07435 or www.pequannockriver.org or call 973-492-3212.

Research Activities at the USGS *(Cont. from Page 9)*

and NJDEP cooperatively collect the samples from streams and wells in these networks.

Several studies were conducted to investigate the vulnerability of drinking water to contamination, particularly by trace elements, organic compounds and radionuclides. An investigation was conducted to determine the movement of radium in septic systems and the potential for radium to migrate to domestic wells. The USGS has an ongoing effort to characterize the concentrations of pharmaceutical compounds and "emerging" contaminants in streams and ground water. Work during 2004 included sampling and analysis to determine the presence of these contaminants in New Jersey streams and the persistence of these contaminants through drinking-water treatment processes. A study was begun to define the natural and anthropogenic sources and concentrations of arsenic in waters of the Wallkill River basin in New Jersey. This information will facilitate development of TMDL's in that river basin. The USGS National Water Quality Assessment Program has two study units that encompass all of New Jersey and parts of surrounding states, the Long Island-New Jersey Coastal Drainages and Delaware River Basin. These study units are in a low intensity phase; some surface-water samples were collected at stations for water-quality analysis. USGS continued an effort in cooperation with USEPA Region 2, NJDEP, and water purveyors to devise procedures to provide for an early warning system to detect contaminants in surface-water sources of drinking water supplies.

USGS scientists assembling a sampling device for insertion into a well to enable long-term sampling from fractured zones at the NAWC site in West Trenton, N.J.

Hazardous-Waste-Site Characterization: USGS, in cooperation with USEPA continued the characterization of hazardous waste sites in Fair Lawn, Pohatcong Valley, and in the vicinity of the Puchack wellfield in Pennsauken. These activities involved defining the hydrogeology as it pertains to the potential source and movement of contaminants. The USGS Toxic Substances Hydrology Program, in conjunction with the U.S. Navy, continued an investigation of the occurrence and movement of trichloroethylene in fractured rock at the former Naval Air Warfare Center in West Trenton.

Much of the hydrologic data collected by USGS in New Jersey in 2004 can be accessed on the New Jersey Water Science Center web page at http://nj.usgs.gov/. USGS publications, for New Jersey (and elsewhere) can be ordered and in some cases downloaded from the Publications Warehouse web page at *http://infotrek.er.usgs.gov/pubs*.

Contact: 609-771-3930 or Email: anavoy@usgs.gov

Five-Year USGS Review *(Cont. from Page 2)*

Jahan has documented their presence and biodegradation kinetics in wastewater treatment plants, and shown that they resist complete degradation under treatment plant conditions. She has also shown these compounds sorb to soil solids, and has characterized the binding characteristics to a range of soil materials.

- Coastal wetlands throughout the region have been invaded by non-native variants of common reed, *Phragmites australis*; these invasions are thought to have major negative impacts on many components of wetland and estuarine food webs. We have supported a variety of research projects addressing this problem. Steven Litvin has used stable isotopes to show that only certain species of fish, and only in the upper reaches of estuaries, are using the Phragmites as a food source. Dr. Judy Weis has demonstrated that invertebrates and fish can utilize Phragmites for growth as well as native species. Together, these studies are helping to change the paradigm used for managing and restoring coastal wetlands.

- Wetlands in urbanized regions are assumed to be heavily degraded. However, research by Heather Bowman Cutway has demonstrated that forested wetlands surrounded by industrial land uses are surprisingly free of invasion by exotic plant species, unlike wetlands surrounded by residential land-use. Further research into the reasons for this difference will help in the development of restoration and conservation strategies for this important resource.

- The movement of pollutants such as pesticides and excess nutrients from agricultural land into ground water depends on the ability of the soil to transmit water, which in turns depends on the pore structure of the soil. Dr. Daniel Gimenez has developed novel methods to characterize and model the pore distribution, using multi-fractal methods, and relate these models to estimates of the saturated hydraulic conductivity. The results may help explain the spatial distribution of pollutant movement to groundwater in agricultural regions.

Conference Calls

October 11-12, 2005, **2005 Pennsylvania Stormwater Management Conference**, Villanova University, Villanova, PA. For more information see *http://www3.villanova.edu/VUSP/* or call **(610) 519-4358.**

Oct 21, 2005, Habitat Strategies for NJ: the Path to Sustainability ANJEC's 32 Environmental Congress, The Conference Center at Mercer, Mercer County College, West Windsor, NJ. **Registration**: http://www.anjec.org/html/workshops.htm or call 973-539-7547

March 25, 2006, 10th Annual Land Conservation Rally,New Brunswick, NJ. Call for Presenters deadline is October 14, 2005. Call for Exhibitors deadline is December 1, 2005. For more information see http://www.njconservation.org/html/conservationrally.htm or call 908/234-1225

Features

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