MA Water Resources Research Center

Annual Report FY 2005

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June 2006

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Cover photo by Jerry Schoen

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Introduction

This report covers the period March 1, 2005 to June 30, 2006*, the 40th year of the Massachusetts Water Resources Research Center (WRRC). The Center is under the direction of Dr. Sarah Dorner, who holds a joint appointment as Director of the WRRC and as Research Assistant Professor in the Department of Public Health at the University of Massachusetts Amherst.

In October 2005, the MA WRRC organized the Third Annual WRRC Conference – *Research to Practice: Science for Sustainable Water Resources*. The WRRC conference is now firmly established as a highly regarded meeting for scientists and water resources professionals in Massachusetts and New England.

Two innovative research projects were completed this year: *Potential Movement of Pesticides Related with Dissolved Organic Matter from Organic Fertilizer Application on Turf* by Dr. Baoshan Xing of the UMass Amherst Department of Plant and Soil Sciences, and *Copper Removal by Biofilms*, by Dr. Xiaoqi Zhang of the UMass Lowell Department of Civil and Environmental Engineering.

Dr. Stephen Mabee of the UMass Amherst Department of Geosciences continued work on a 104G USGS grant to look at *A Regional Approach to Conceptualizing Fractured-Rock Aquifer Systems for Groundwater Management*.

Dr. Sarah Dorner headed a one-year project in the Public Health Department on *Sources of E. coli during Wet-Weather Events*. At the University of Massachusetts Dartmouth, Dr. Yuegang Zuo of the Chemistry and Biochemistry Department began a two-year project on *Monitoring Estrogenic Hormones – Undesired Fish Contraceptives, and Investigating Their Sources, Transportation and Fate in Buzzards Bay, Massachusetts*. Finally, a graduate student grant was awarded to Brian Tavernia of Tufts University's Biology Department to study *Cryptic Marsh Birds as Bioindicators of Wetland Health*.

Other projects conducted at WRRC include the Massachusetts Water Watch Partnership, the Acid Rain Monitoring Project, and continued collaboration with UMass Extension on a stream continuity project. This was the second year of cooperation with the Mechanical Engineering Department at UMass Amherst on a Non-Point Source grant to develop a Clearinghouse for innovative stormwater Best Management Practices in Massachusetts. The History and the Computer Science Departments were WRRC's partners on two new projects looking at "Watershed Community" as a new way to teach environmental science to the public.

* The USGS reporting year covers March 1 to February 28, while the University of Massachusetts fiscal years runs from July 1 to June 30.

Research Program

Six research projects were conducted this fiscal year: two research projects funded through the USGS 104B program were completed after obtaining a one year no-cost extension; one project funded through the 104G Program completed the second of its three years of research; and three projects funded by the FY05 104B program were initiated this year. Final and progress reports for all six projects follow:

1. Potential Movement of Pesticides Related with Dissolved Organic Matter from Organic Fertilizer Application on Turf

Principal Investigator: Baoshan Xing, Professor, UMass Amherst Plant, Soil, and Insect Sciences
Start Date: March 1, 2003
End Date: February 28, 2006
Research Category: Water Quality
Focus Category: Nonpoint Pollution; Surface Water; Water Quality
Descriptors: Dissolved Organic Matter (DOM); Sorption; Organic Contaminants

Project Description: Incorporation of organic fertilizers/amendments including composts has been a popular strategy for golf course turfgrass management. Dissolved organic matter (DOM) derived from these organic materials may, however, facilitate organic chemical movement through soils. DOM was extracted from two commercial organic fertilizers and used for a column study. Chlorpyrifos and USGA (United States Golf Association) sand were used in this column study. It was observed that DOM reduced the retention of chlorpyrifos in the column as compared with the 0.01 M solution without DOM. Compost materials were also characterized using sequential alkaline extraction and spectroscopic techniques (e.g., FTIR and NMR). Significant structural variations among the extracted humic acid (HA) fractions and the original compost were observed. A decrease in the atomic C/H ratio and increase in the atomic C/O ratio among these HA fractions represented an increase in aliphaticity in conjunction with a decrease in polarity and aromaticity, confirmed by spectroscopic data.

Conclusions
The increasing interest of using organic fertilizers/amendments on turf is a critical part of integrated pest management programs. Results from this study indicate that addition of DOM extracted from organic fertilizers (Milorganite and NatureSafe) applied on turf may reduce sorption of chlorpyrifos, naphthalene and 2,4-D by soils. The higher concentration of extracted Dissolved Organic Carbon in solution, the more reduction of chlorpyrifos sorption. Breakthrough curves (BTC) results with or without DOM agree well with the batch equilibrium sorption data. These results support the idea that DOM can interact with pesticides and enhance their transport. Frequent fertilizer and pesticide applications and irrigation are a regular practice for high maintenance turfgrass, especially golf greens where a high percentage of sand is usually incorporated into the soil profile. The author recommends that organic fertilizers should not be applied on turf immediately after pesticide application, which would reduce the impact of organic fertilizer-derived DOM facilitated transport of applied pesticides.

Publications:

Li, K., B. Xing, and W.A. Torello, 2005. Effect of organic fertilizers derived dissolved organic matter on pesticide sorption and leaching. Environ. Pollut. (134) 187-194.

Heymann, K., H. Mashayekhi, and B. Xing, 2005. Spectroscopic analysis of sequentially extracted humic acid from compost. Spectroscopy Letters, 39(3) 293-302.

Li, K. 2004. Evaluation of organic turfgrass management and its environmental impact by dissolved organic matter. Ph.D. dissertation, Soil, Plant, and Insect Science Department, University of Massachusetts Amherst, 101 pp.

Xing, Baoshan, 2006. Potential Movement of Pesticides Related with Dissolved Organic Matter from Organic Fertilizer Application on Turf, MA Water Resources Research Center Publication No. 180, University of Massachusetts, Amherst, MA, 20pp. http://www.umass.edu/tei/wrrc/WRRC2004/WRRCrecentpubs.html.

Abstracts and Presentations:

Li, K., W.A. Torello, and B. Xing, 2003. Effect of dissolved organic matter on pesticide leaching in a USGA sand column experiment. Agronomy Abstracts, Denver, CO. Nov. 2-6. 2003.

Xing, B. and L. Kun, 2003. Pesticide movement and organic fertilizer application on turf. Water Resources in the Northeast Science and Policy Conference; Dec. 5, 2003; University of Massachusetts; p. 18 of the Final Program book.

Heymann, K., S. Ebdon, D. Reckhow and B. Xing, 2005. Characterization of dissolved organic matter and its effect on sorption of organic chemicals. Annual SSSA meetings, Nov. 6-10, Salt Lake City, USA. Abstract #: 119-13.

Students Supported:
One M.S. student
One Ph.D. student
Three undergraduate students.

2. Copper Removal by Biofilms

Principal Investigator: Xiaoqi Zhang, Assistant Professor, UMass Lowell Civil and Environmental Engineering
Start Date: March 1, 2003
End Date: February 28, 2006
Research Category: Water Quality
Focus Category: Treatment, Waste Water, Water Quality
Descriptors: Treatment, Toxic Substances, Water Quality, Wastewater

Biofilm systems have been widely used in wastewater treatment plants. However, little information is available on the impact of toxic chemicals on the performance of fixed film systems. This study was aimed at evaluating the impact of copper on a biofilm system by examining a variety of parameters, including reactor pH, DO, substrate concentrations, secretion of extracellular polymeric substances (EPS), and

copper removal and accumulation. The microbial communities in the biofilms were also examined using automated ribosomal intergenic spacer analysis (ARISA). Four rotating drum biofilm reactors were used to produce biofilms. One reactor was used to produce biofilms under copper free conditions, while the others were used to produce biofilms grown under three different copper contamination levels, namely 100 ppb, 200 ppb, and 500 ppb, for a prolonged period.

The following results were obtained:
(1) biofilm reactor performance was not significantly impacted as demonstrated by the pH, DO, substrate removal, and total solids in the effluent;
(2) however, copper contamination inhibited EPS production in the biofilms;
(3) copper removal efficiencies of 25-31% were obtained for the three copper contamination levels studied;
(4) fixed films functionalized as a reservoir to accumulate more copper over time;
(5) copper contamination selected for specific species that were able to tolerate this stress, and that may contribute to its remediation.

Publications

Zhang, X., Brussee, K., and J. Rooney-Varga, 2006. Impacts of Chemical Stress Induced by Copper: Examination of a Biofilm System, Water Science and Technology (Under review).

Zhang, X., 2006. Copper Removal by Biofilms, MA Water Resources Research Center Publication No. 179, 10 pp. http://www.umass.edu/tei/wrrc/WRRC2004/WRRCrecentpubs.html.

Brussee, K., X. Zhang, X., and J. Rooney-Varga, 2005. Examination of Cellular Response of Biofilms to Copper Contamination. 3rd Annual Water Resources Conference. Amherst, MA.

Presentations

Brussee, K. and X. Zhang, 2005. Copper Removal by Biofilms. Abstract for the University of Massachusetts Lowell 8th Annual Student Research Symposium.

Martinez, K., K. Brussee, and X. Zhang, 2005. Adaptability of Biofilm Exposed to Copper. Abstracts for the University of Massachusetts Lowell 8th Annual Student Research Symposium.

Brussee, K. and X. Zhang, 2004. Examination of Cellular Response of Biofilms to Copper Contamination. 2nd Annual Water Resources Conference. Amherst, MA.

Students Supported

One Master's student (Kevin Brussee)
One work study female undergraduate student (Kely Martinez).

Follow-through Funding

The PI is actively seeking funding from NSF to continue research on this topic.

3. A Regional Approach to Conceptualizing Fractured-Rock Aquifer Systems for Groundwater Management

Principal Investigators: Stephen B. Mabee, State Geologist, UMass Amherst and Michele Cooke, Professor, UMass Amherst Geosciences

Start Date: 9/30/2004
End Date: 9/29/2007
Research Category: Groundwater Flow
Focus Category: Water Supply, Groundwater, Water Quantity
Descriptors: Fracture Characterization, Domain Analysis, Well Yield, Fractured Rock Aquifers, Groundwater Availability, Groundwater Mapping, Borehole Geophysics

Problem Statement

The use of fractured-bedrock aquifers to meet private, public and commercial water supply needs is increasing in the New England region. Municipalities and water suppliers are finding it increasingly difficult to locate and develop water supplies in overburden aquifers because of contamination and a lack of suitable sites. In addition, recent droughts in the northeast have forced many communities and homeowners to drill new wells. As a result, water suppliers are going deeper into bedrock aquifers. Yet information on the factors that influence the availability and recharge characteristics of fractured bedrock aquifers in highly deformed crystalline metamorphic rocks is limited.

The availability of water in fractured rock aquifers is particularly critical in New England because growth and development along the coast, major transportation corridors, and in rural communities adjacent to large metropolitan areas are rampant. Municipalities and water suppliers are simply unprepared for the onslaught of development and need help in understanding the complex dynamics of the groundwater system.

Sustaining and managing groundwater resources in fractured bedrock require an evaluation of 1) the availability of water, 2) the source and vulnerability of recharge to water supply wells and 3) the impact of water withdrawals from the bedrock on streams, wetlands and unconsolidated aquifer systems that overlie the bedrock. These evaluations all require basic information on the physical characteristics of the groundwater system.

Objectives

The objectives of this project are to gather regional bedrock characteristics that relate to the occurrence and movement of groundwater in bedrock and use this information to begin constructing regional conceptual models of the fractured-rock aquifers in the Nashoba terrane in Massachusetts. The approach utilizes existing information augmented by the collection of low-cost field data to develop regional conceptual models of the groundwater flow system. Water managers can then use these conceptual models as an initial framework for formulating an understanding of bedrock flow behavior and recharge characteristics.

Work Accomplished in Past Year

1. Conducted fracture characterization field work and visited 79 outcrops over a two and a half month period and collected over 4000 brittle fracture measurements.
2. Analyze and summarize fracture characterization data.
3. Analyze GWSI well data of terrane including performing variography.
4. Begin constructing hydro-structural domain map of the terrane from the field data.
5. Currently building discrete fracture network models of individual outcrops and assigning hydraulic conductivity values to several domains for testing against well-field scale pumping test and borehole geophysical data.

6. Working with the USGS to acquire additional borehole geophysical data.

The final year will be spent performing numerical modeling of the conceptual models developed from the hydro-structural domains and field fracture data. The models will be calibrated against well-field scale hydraulic data.

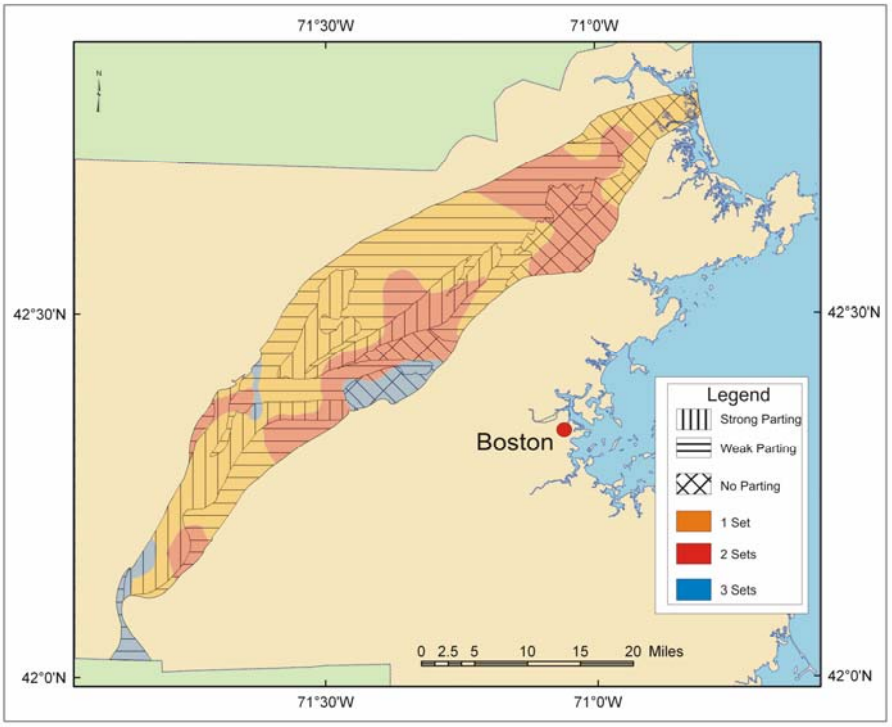
Presentations

Manda, A.K., 2005. Characterizing the fractured bedrock aquifer of the Nashoba Terrane, Massachusetts, Mass. Water Resources Research Center/UMass Extension 3rd Annual Conference, Research to Practice: Science for Sustainable Water Resources, Amherst (Poster).

Manda, A.K., S.M.B. Mabee, and S. Hubbs, 2005. Field Mapping and Fracture Characterization Techniques Predict Groundwater Preferential Flow Paths in Fractured Bedrock Aquifers, Nashoba Terrane, MA, American Geophysical Union Annual Meeting, San Francisco, Abstract H23E-1477 (Poster), published on CD.

Students Supported

1 PhD student in Geosciences Department at University of Massachusetts (Alex Manda)



Preliminary hydrostructural domain map of the Nashoba Terrane.

4. Sources of *E. coli* during Wet-Weather Events

Principal Investigator: Sarah M. Dorner, Research Assistant Professor, UMass Amherst Public Health
Start Date: 3/1/2005
End Date: 2/28/2006
Research Category: Water Quality

Focus Category: Sediments, Non Point Pollution, Models
Descriptors: Hydrologic Modeling, Pathogens, Indicators

Through the use of both monitoring and modeling, an overall goal of this study was to assess the temporal and spatial variability of *E. coli* in stream sediments and in the water column in the Blackstone River watershed in south central Massachusetts. The information gained from this study will assist in the identification of primary contributing potential sources of pathogens in such a watershed and will have the potential to positively influence the implementation of management practices with regard to their efficiency and effectiveness.

The specific objectives of this investigation were to:

- determine *E. coli* densities in water and sediment samples, with particular emphasis on storm water samples,
- estimate the absolute and relative numbers of *E. coli* from land based and sediment sources,
- identify the environmental conditions such as temperature, solar radiation, hydrologic conditions (i.e. antecedent moisture content, streamflow, precipitation) that contribute to peak occurrences of *E. coli*,
- increase our fundamental understanding of the mechanistic behavior of microbial fate and transport, and
- develop a set of recommendations for assessing source waters for pathogenic contamination.

This primary study demonstrated the spatial and temporal patterns of fecal indicator concentrations in the surface water and sediments of the Blackstone River, and also gave an indication of the source and transport pathways of the pathogens. According to the results, wet weather clearly impacts *E. coli* concentrations. Following the variation of precipitation, the number of the *E. coli* was changed accordingly. However, for the Blackstone River it is not clear that the increase of *E. coli* in the surface water is originating from the sediments, as *E. coli* in the sediments followed the same general trends as for the surface water. Isolated and confirmed *E. coli* will be further analyzed by ribotyping methods.

This research will provide a greater mechanistic understanding of the fate and transport of *E. coli*, a primary microbial indicator of water quality. The expected results of this investigation include a better understanding of environmental factors with respect to the numbers of pathogenic microorganisms arriving at a water treatment plant, as well as more detailed information on sources of pathogens in a complex watershed. This study will provide water managers and regulators with reliable information to help them develop strategies for source water protection for drinking water and for other important uses of the watershed such as recreation.

Students supported

One MS student (Jianyong Wu) was supported by the project, and one additional MS student (Debalina Das) was trained to conduct field and lab measurements. Both students are in the Department of Public Health at UMass Amherst.

Publications

One abstract has been accepted for the upcoming AWWA Source Water Protection Conference. A manuscript has been written and will be submitted in summer 2006.

Follow-through Funding
A $28,000 Faculty Research Grant to Sarah Dorner from UMass Amherst will allow continuing this study for one more year.

5. Local and Landscape-level Effects on Marsh Bird Distributions in a Developing Landscape

Principal Investigators: Brian G. Tavernia, Graduate Student, Tufts Biology and J. Michael Reed, Associate Professor, Tufts Biology
Start Date: March 1, 2005
End Date: February 28, 2006
Research Category: Biological Sciences
Focus Category: Conservation, Ecology, Wetlands

Extensive wetland loss associated with agriculture and urban sprawl has placed many marsh-dependent birds at risk, including several species of conservation concern at state and federal levels. Assessing effects of habitat loss requires effective monitoring. Many marsh species, however, are poorly covered by common survey methods, and rails in particular are behaviorally cryptic. During 2005, visual surveys and call playback were used to do repeated surveys for breeding marsh birds in 44 wetlands in central and eastern Massachusetts. Wetlands were in habitat matrices ranging from urban to rural settings. The relationships between measured local and landscape features and species richness were analyzed, as well as occupancy by the most common rail species, the Virginia Rail (*Rallus limicola*). Local habitat variables included areas of wetland, open water, and cover of different types of emergent vegetation. Features thought to affect wetland occupancy by these species, including land use, road cover, and human census size at 8 spatial scales (50 m through 4 km)were quantified at the landscape level. Both local and landscape variables were found to be associated with species richness (r2 =0.84) and occupancy by Virginia Rails (r2 = 0.46). Important landscape-level variables associated with species richness included a variety of urban associations, including census size and road cover. These factors had effects at larger spatial scales (1-4 km); urban measures negatively associated with human census size (e.g., industrial land) were positively associated with species richness. Virginia Rail occupancy was driven by area of water smartweed (*Polygonum punctatum*), and wetland cover measures (at 50 m and 1 km levels). One insight from this analysis is that some urban measures (people, roads) are negatively associated with others (industrial, commercial), and should be distinguished when assessing effects of “urbanization.”

Students supported:
Travel for one undergraduate student from Tufts Biology department was provided by this grant.

Presentations:
Tavernia B., S. Melvin. and J.M. Reed, 2006. Local and Landscape-level Effects on Marsh Bird Distributions in a Developing Landscape. Conserving Birds in Human-Dominated Landscapes, symposium sponsored by American Museum of Natural History's Center for Biodiversity and Conservation (Poster).

6. Monitoring Estrogenic Hormones – Undesired Fish Contraceptives, and Investigating Their Sources, Transportation and Fate in Buzzards Bay, Massachusetts

Principal Investigator: Yuegang Zuo, Ph.D., Associate Professor, Department of Chemistry and Biochemistry, Graduate School of Marine Sciences and Technology University of Massachusetts Dartmouth
Start Date: February 1, 2005
End Date: February 28, 2007
Focus Categories: Water Quality, Toxic Substances, and Geochemical Processes
Keywords: Estrogenic Hormones, mestranol, 17α-ethinylestradiol, estrone, 17beta-estranol, Buzzards Bay, Natural Water, Microbial Degradation, Photodegradation

Project Activities:
Estrogenic hormones and related synthetic steroid compounds, such as those used in contraceptive pills, have been shown to be present in the aquatic environment, mainly as a result of inefficient removal in wastewater-treatment plants. The concentrations of the compounds, although very low (sub-ng to a few ng/L), are sufficient to induce estrogenic responses and alter the normal reproduction and development of wildlife organisms. Of estrogenic compounds, synthetic contraceptive steroids, such as 17α-ethinylestradiol (EE2), are found to be the most potent endocrine disruptor. It can cause feminization of male fish even at extremely low concentrations (e.g. 0.1 ng/L).

The Buzzards Bay receives stormwater runoff and effluent from wastewater treatment facilities of New Bedford, Fairhaven, Fall River and other surrounding towns. This leads to direct input of many different classes of pollutants, including endocrine-disrupting estrogenic hormones, through the sewage effluents and industrial wastewater. The combination of these estrogenic compounds and other pollutants can adversely affect plankton and fish, and could be related to the decline in lobster abundance in Buzzards Bay. The objectives of this research project are (1) to develop an SPE-GC-MS analytical method for the separation and quantitation of estrogenic hormones: estrone, 17β-estradiol, 17α-ethinylestradiol and mestranol; (2) to employ the analytical methods developed in this project to monitor estrogenic hormones: estrone, 17β-estradiol, 17α-ethinylestradiol and mestranol in New Bedford Harbor and Buzzards Bay Water; (3) to assess the microbial and photochemical fate of estrogenic hormones in the Buzzards Bay; (4) to train graduate and undergraduate students to use the techniques developed in this project to monitor and protect our aquatic environment.

In the first year of this project, research has been focused on developing a Solid-Phase Extraction (SPE) GC-MS analytical method for the separation and quantitation of estrogenic hormones and other endocrine disrupting compounds. These included developing a new silylation solution to prevent the formation of undesired multiple derivatization products and conversion of trimethylsilyl derivatives of EE2 formed to their respective E1 derivatives reported in previous studies, and integrating an SPE method into GC-MS analysis, as well as the effects of solvent, temperature, and reaction time on the derivatization of EE2.

The estrogenic hormones in seawater around Acushnet river estuary in Buzzards Bay were determined with the newly developed analytical method. Some preliminary studies on the photochemical degradation of estrogenic steroid hormones in Buzzards Bay seawater were also carried out.

Research results obtained in this project were presented in professional conferences, three papers were published in peer-reviewed international scientific journals, and two more manuscripts are being prepared for publication soon.

Project Findings:

1. The determination of estrogenic steroids, particularly in natural water systems, has been an analytic challenge for chemists due to the extremely low concentration of estrogenic steroids and interference from the sample matrices. Many immunoassay, gas chromatography (GC), gas chromatography-mass spectrometry (GC-MS), liquid chromatography (LC), and liquid chromatography-mass spectrometry (LC-MS) techniques have been developed for the determination of estrogenic steroid hormones in aquatic environments. GC-MS has been a preferred approach for simultaneous analysis of both synthetic and natural estrogenic steroids because of its superior separation and identification capabilities. In order to employ high-resolution GC for the analysis of estrogenic steroids, derivatization is required to increase analyte volatility and thermal stability and thus improve chromatographic separation. Many reagents are available for this purpose. Trimethylsilyl (TMS) derivatives are probably the most widely employed. The combination of *N,O*-bis(trimethylsilyl)trifluoroacetamide (BSTFA) + trimethylchlorosilane (TMCS) is among the most popular silylating reagents used for the identification and quantification of estrogenic steroid hormones in water samples. However, several research groups reported on the formation of different derivatization products of EE2 with this silylating reagent, and thus suggested that derivatization with BSTFA + TMCS might not be suitable for the determination of EE2 by GC-MS under the previously reported conditions. This project's researchers developed a new silylation mixture (BSTFA :TMCS:pyridine = 49.5:05:50 (v/v/v)), overcame these pitfalls and generated a single product of di-TMS derivative of EE2 (Zuo and Zhang, 2005; Zhang and Zuo, 2005).

2. Project leaders have successfully applied their developed analytical procedure in the simultaneous determination of both natural and synthetic estrogenic steroids (estrone and 17α-ethynylestrodiol) in Acushnet River estuarine seawater (Zuo et al., 2004). Results show that the concentration of three common estrogenic hormones, 17α-ethinylestradiol, estrone and 17beta-estradiol, could be over 4.7, 1.2 and 0.83 ng/L, respectively, during the summer, which can certainly cause fish feminization in the Bay and may be responsible for the significant decline in lobster population in Buzzards Bay (see photo next page of an "intersex" lobster caught on the Massachusetts coast).

3. This preliminary study has shown that EE2 can undergo a rapid photodegradation in estuarine seawater under natural sunlight irradiation, with a half-life of less than 1.5 days in spring sunny days. Previous studies have shown that natural estrogenic compound E2 can be oxidized to E1 by microorganisms in natural river water with half-lives of 0.2-9 days at 20^{o}C, and E1 is then further degraded at similar rates. Compared to E2, synthetic EE2 is much more resistant to biodegradation in natural water. Although EE2 is relatively resistant to microbial degradation, EE2 -like other estrogenic steroids- contains a phenolic functional group, which is susceptible to photodegradation. To study the photochemical degradation of EE2 in seawater, EE2 was dissolved into seawater collected from Buzzards Bay and Acushnet River Estuary and irradiated under natural sunlight or simulated solar source in cylindrical quartz tubes (20 cm long x 1.4 cm i.d.). The results obtained indicate that the photochemical transformation represents a major fate of estrogenic steroids in natural surface water.

"Intersex" lobster caught on the Massachusetts coast

Student Support:

Three graduate students have been trained in this project to use the techniques developed to monitor and protect our aquatic environment from estrogenic pollutants. Jingping Wu has just completed his M.S. degree thesis defense. Another, Kai Zhang, is scheduled to have his research proposal defense on June 16, 2006 and Ph.D. thesis defense late this summer.

Publications:

Zuo, Yuegang, Kai Zhang and Yiwei Deng, 2006. Occurrence and photochemical degradation of 17α-ethinylestradiol in Acushnet river estuary. Chemosphere (63), 1583-1590.

Zuo, Yuegang and Kai Zhang, 2005. Discussion: Suitability of *N,O*-bis(trimethylsilyl)trifluoroacetamide as derivatization reagent for the determination of the estrogens estrone and 17 α-ethinylestradiol by gas chromatography-mass spectrometry. J. of Chromatogr. (A 1095), 201-202.

Zhang, Kai and Yuegang Zuo, 2005. Pitfalls and solution for simultaneous determination of estrone and 17α-ethinylestradiol by gas chromatography – mass spectrometry after derivatization with N,O-bis(trimethylsilyl)trifluoroacetamide. Anal. Chim. Acta (554), 190-196.

7. Acid Rain Monitoring Project

Principal Investigator: Sarah Dorner, Director, MA Water Resources Research Center, UMass Amherst
Start Date: July 1, 2005
End Date: June 30, 2006
Keywords: Acid Deposition, Surface Water Quality, Volunteer Monitoring

The Acid Rain Monitoring project continued for the 6th consecutive year after an 8 year hiatus preceded by 10 years of consecutive sampling. About 150 sites (mostly streams) were sampled by volunteer collectors and tested for pH and alkalinity by volunteer labs. Of those, 26 long-term sites were analyzed for the full suite of major cations and anions. The data from 1983 to 1993 were previously analyzed for trends relevant to acid rain control. With sufficient new data on lakes and streams collected over the past 4 years, changes resulting from passage of state and federal clean air act revisions can be evaluated. These analyses are in process and should provide important evidence in the ongoing debate about clean air standards.

The more than 43,000 records of water chemistry for Massachusetts' lakes and streams, now covering 1983-2006, were moved to a new server and web site in a searchable and downloadable form so that additional data analyses specific to the user may be conducted (http://umatei.resuo.ads.umass.edu/armproject1/).

The 1986 WRRC, *Acid Rain in Massachusetts*, is being updated to include the past two decades, as well as the results of the trend analysis and their relevance to the current national debate on clean air act standards. Publication of the revised edition is planned for summer 2006.

Presentations:

Godfrey, Paul Joseph, 2005. Long-term monitoring of water quality in Massachusetts: Assessment of acid deposition impact changes, New York State Energy Research and Development Authority's Environmental Monitoring, Evaluation, and Protection conference, October 25-26, Albany, New York (Poster).

Information Transfer Program

1. Massachusetts Water Watch Partnership: Monitoring Assistance for Volunteer Water Quality Monitoring

Principal Investigators: Jerry Schoen, Marie-Françoise Walk, MA Water Resources Research Center
Start Date: 3/1/2005
End Date: 2/28/2006
Descriptors: Citizen Monitoring, Non-point Pollution, Monitoring, Volunteer, Quality Control

The Massachusetts Water Watch Partnership (MassWWP) was formed in 1990 to empower citizens to collect, evaluate, and act on scientifically credible water quality information for the Commonwealth's surface waters. The program relies on building

a partnership with government, industry, educators, conservation organizations and the general public, who lend their respective talents to this effort to achieve practical solutions to water quality problems.

MassWWP funding was this year again limited to support received via a memorandum of understanding with UMass Extension, which allowed to provide basic assistance to volunteer monitoring groups throughout the state. Five training sessions or courses were offered, including four on river benthic macroinvertebrate sampling and identification.

MassWWP managed a listserv of about 135 members to facilitate communications in the Massachusetts watershed monitoring community. The website www.masswwp.org was also updated with the latest news and technical information.

2. Generic Quality Assurance Project Plan Project

Principal Investigators: Jerry Schoen, MA Water Resources Research Center
Start Date: 11/1/2005
End Date: 6/30/2006
Descriptors: Citizen Monitoring, Quality Assurance Project Plans, Coastal and Estuarine Water Quality

MassWWP collaborated with the Salem Sound Coastwatch on the production of a generic guide to Quality Assurance Project Plans, a template for associated Sampling and Analysis Plans, and a guide to writing these documents for a target audience of volunteer and community water monitoring groups. This was conducted under contract with the Coastal Zone Monitoring Program of the Executive Office of Environmental Affairs.

Publications:
CZM will publish the QAPP guide in summer of 2006.

3. Water Resources Conference 2005

Principal Investigator: Sarah Dorner, Director, and Marie-Françoise Walk, MA Water Resources Research Center, UMass Amherst
Start Date: 3/1/2005
End Date: 2/28/2006
Descriptors: Conference, Water Resources, New England

The Water Resources Research Center held its third annual Water Resources Research Conference*, Research to Practice: Science for Sustainable Water Resources*, October 21, 2005 at UMass in Amherst. New to this year's conference was the collaboration of the Cooperative State Research, Education, and Extension Service New England Regional Program who helped with conference planning and fundraising. Five co-sponsors helped underwrite the cost of the conference. Over two hundred people attended the conference (188 pre-registered, and close to 50 walk-ins, including many local university and college students). The 188 pre-registered participants can be categorized as follows:

Category	Number of participants
Academic	106
Agency	30
Commercial/Consultants	20
Government	1
Individuals (unaffiliated)	2
Municipal	2
Non-profit	27

Thirty-five posters were presented and there were 36 paper presentations in three concurrent sessions. The presentations were grouped into four tracks subdivided into three sessions each:

Biological Response and Ecological Impacts
- Climate Change
- Integrative Modeling for Sustainable Waters
- Habitat Alteration

Critical Contaminants
- Endocrine Disruptors
- Perchlorate
- Metals

Water Resources Monitoring, Modeling, and Assessment
- Groundwater
- Pathogens
- Cyber Infrastructure and Sensor Networks

Protecting and Restoring Water Resources
- Protecting Water Quality
- Creating a Watershed Community
- Stormwater Management

The Keynote Address was given by Sandra Postel, Director of the Global Water Policy Project, and Brian Richter, Director of The Nature Conservancy's Sustainable Waters Program, on the topic of the book they co-wrote, *Rivers for Life: Managing Water for People and Nature*. Postel and Richter were given the 2005 MA Water Resources Research Center John W. Olver Leadership Award. This award is presented to individuals who have made exceptional contributions and shown great leadership in environmental research and in protecting our natural resources.

4. Watershed Community

Principal Investigators: Jerry Schoen, MA Water Resources Research Center
Start Date: 7/1/2005
End Date: 12/30/2006
Descriptors: Natural History, Watershed Education, Community Journaling

Jerry Schoen collaborated with the Community Service Learning Program, Professor David Glassberg of the UMass Amherst History Department, the Millers River Environmental Center and the Athol Historical Society to organize the course History 397S: Public History Workshop: Athol and The Millers River. The course was taught in spring of 2006.

WRRC staff also collaborated with Christopher Pal of the UMass Amherst Computer Science Department on a Community Journaling project proposal to Microsoft Corporation. The project is funded for $50,000 to develop information technology tools and deploy them in a community journaling program in the Miller River watershed. The project began January 2006,and is expected to run through December 2006.

Further collaboration with several outside organizations resulted in the submission of proposals for continued work on this project. Proposals are pending on collaborations with the Otis Parks and Recreation Commission, the City of Pittsfield, and the Housatonic River Museum.

Presentations

Jerry Schoen organized and chaired one session of the 2005 WRRC conference on "Creating a Watershed Community", UMass Amherst, October 21, 2005.

5. Other Information Transfer/Outreach

Sarah Dorner gave two presentations to high school teachers and students on climate change, water, and health as part of the Massachusetts Envirothon program. More than 100 participants attended the presentations.

Other Activities

External Advisory Board Meets

The External Advisory Board (EAB) met October 21, 2005 at UMass Amherst for an update on WRRC activities and discussion of resources research priorities in Massachusetts.

Working Groups

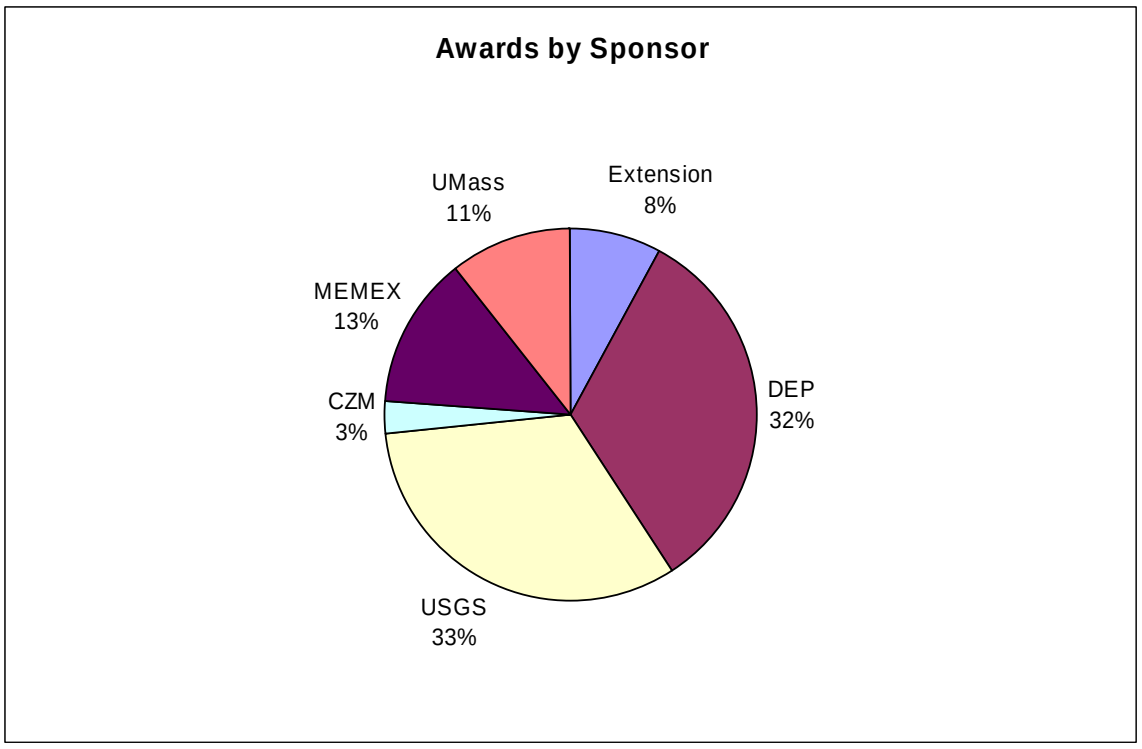
The WRRC has been participating in the coordination of interdisciplinary working groups on themes such as Climate Change and Environmental Contaminants. The working groups coordinate seminars, and have written proposals to fund interdisciplinary research. An NSF IGERT pre-proposal was submitted to develop an interdisciplinary graduate research and education program on climate change, land cover change and water resources.

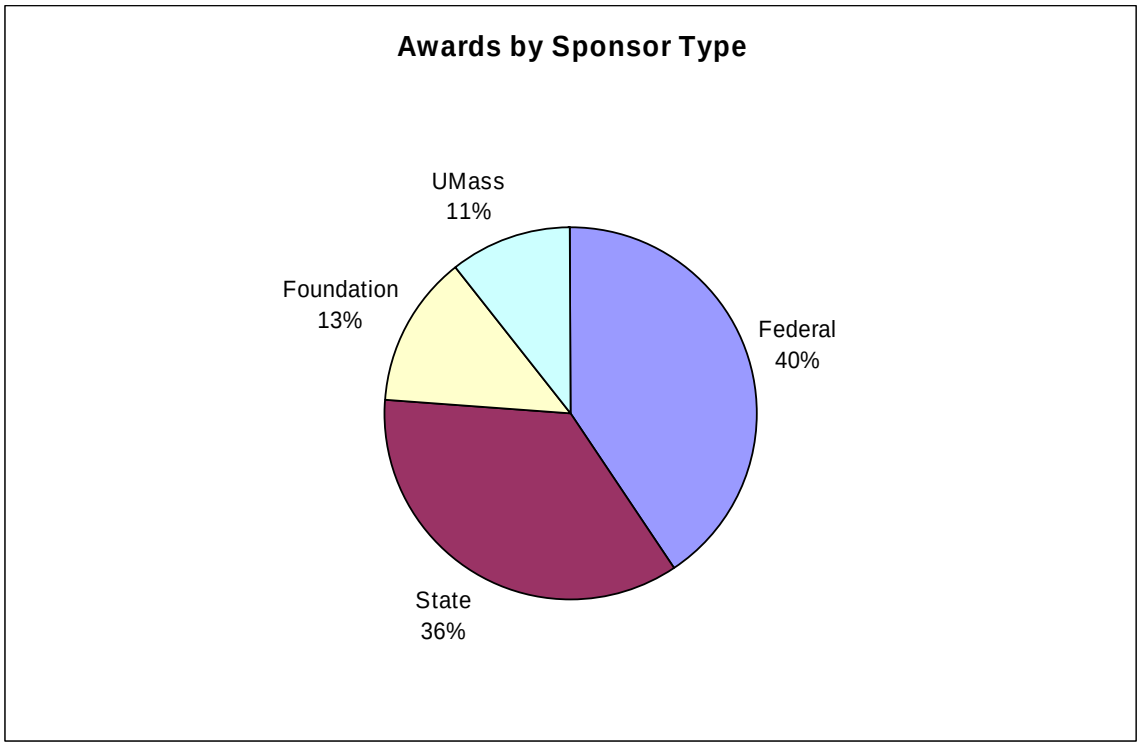
Financial Overview

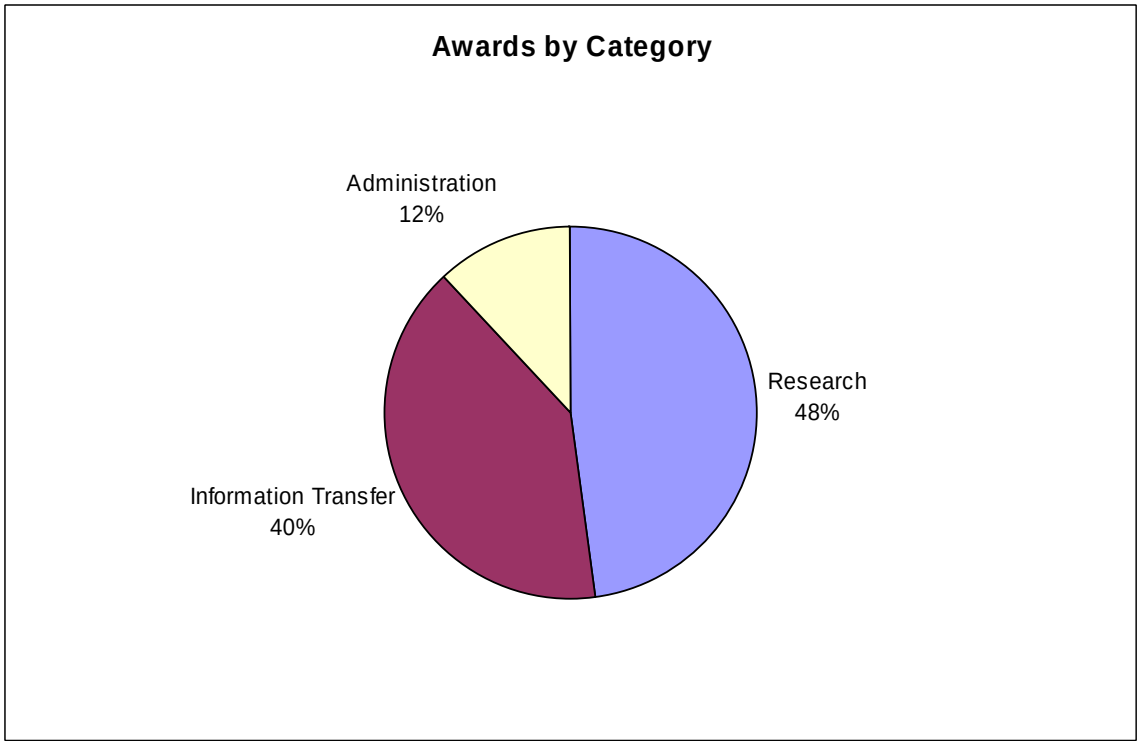
Center revenues come strictly from grants and contracts. The University of Massachusetts supports the half-time Director's salary and also provides physical facilities.

Total revenues amounted to $377,461:

USGS 104B:	$92,412 broken down as follows: $25,000 Zuo research project $25,000 Dorner research project $5,000 Tavernia research project $24,941 Administration $12,471 Information Transfer
USGS 104G	$30,667 (second of three year project)
Extension (MassWWP)	$30,000 Extension-WRRC MOU
DEP (Stormwater Project)	$74,051
DEP (Acid Rain Project)	$49,984
CZM (QAPP project)	$10,000
UMass (Director)	$40,347
Microsoft (MEMEX)	$50,000




Awards by Sponsor Type
UMass
11%
Foundation
13%
Federal
40%
State
36%


Awards by Category
Administration
12%
Research
48%
Information Transfer
40%