# Water Resources Research Center
# Annual Technical Report
# FY 2001

## Introduction

In completing its 36th year of operation, the Massachusetts Water Resources Research Center played a substantially larger role in the development of state water policy than in past years. The Center's long standing efforts to develop citizen water quality monitoring is rapidly becoming a mainstay of state agencies increasing reliance on volunteer monitoring data to meet state and federal needs. Supplementing the Centers 17 year contribution to high quality data collection by citizen volunteers, the Center has recently played a central role in the development of the state's lake management policy; development of joint projects between the Executive Office of Environmental Affairs and the University of Massachusetts system; development of a long-range plan for lake and pond management efforts by the state; and development of enhanced guidelines for volunteer monitoring Quality Assurance Project Plans. Future efforts under discussion involve establishing a natural phosphorus baseline for lakes and streams to aid the states TMDL response and a lake classification system to support the state, volunteer groups, and town conservation commissions in selecting appropriate management strategies for lakes. The Center also continued to provide the technical support to volunteer groups through its Massachusetts Water Watch Partnership, recognized as the principal coordinator of volunteer water quality monitoring in Massachusetts and as a principal player in a regional cooperative, the New England Regional Monitoring Cooperative, originally developed with Institute Program funding.

Not all the news was good, though. In the spring, Bernard Berger, the first Director of the Center (1965 to 1977) died. His successor, Dr. Paul Godfrey, has served from 1980 to present and is now the longest-tenured Director at a Water Resources Institute.

On the research front, the Centers program is quite diverse. Three years ago, the Center initiated support for the examination of improved treatment of airport deicer waste, a topic previously left to limited proprietary industry research even though the main impact is on municipal wastewater treatment systems. Another research area is the eutrophication of estuaries, usually from nitrate input. While many models have been developed, no comparisons had been made to assist estuary managers in selecting the most appropriate model. The Center funded such a comparison with a well documented watershed as the basis of comparison. The results seem destined for development as a web-based tool with follow-on funding. New projects starting this year include: 1) research aimed at developing an improved model of copper toxicity to ease the burden for many municipalities wastewater treatment facilities by better understanding the relationship between toxicity and copper complexation; and 2) research on developing cost-effective ways for small drinking water systems to comply with the new stage 2 Federal regulations for minimizing disinfection byproducts.

In a state with a concerned and involved citizenry, multiple state agencies, multiple regional Federal offices, and a plethora of top-notch research universities, communication is essential. Continuing its long-standing effort to improve communication with and between academic researchers, the Center has updated its directory of academic expertise. It is also beginning an effort to create a Massachusetts directory of state and federal agency expertise.

# Research Program

# Sources and Behavior of Copper-Binding Compounds in Rivers and Estuaries

## Basic Information

| | |
|---|---|
| **Title:** | Sources and Behavior of Copper-Binding Compounds in Rivers and Estuaries |
| **Project Number:** | 2001MA2301B |
| **Start Date:** | 4/1/2001 |
| **End Date:** | 3/1/2002 |
| **Research Category:** | Water Quality |
| **Focus Category:** | Toxic Substances, Water Quality, Surface Water |
| **Descriptors:** | humic substances, dissolved organic matter, complexation,copper |
| **Principal Investigators:** | Bettina Margrit Voelker |

## Publication

# Sources and Behavior of Copper-Binding Compounds in Rivers and Estuaries

## Problem and Research Objectives

Concentrations of copper in effluents from publicly-owned treatment works and other dischargers in Massachusetts regularly exceed permitted levels. It is generally agreed that current water quality criteria for copper, based on laboratory toxicity tests, are often stricter than intended by regulatory guidelines. The main reason for this is that complexation (binding) of copper by naturally present dissolved organic compounds decreases bioavailability of copper, resulting in lower toxicity in the natural waters than would be observed in the laboratory tests. Conducting toxicity tests in individual receiving waters to develop site-specific water quality criteria is possible, but prohibitively expensive. The U.S. Environmental Protection Agency (EPA) Office of Water has therefore supported the development of a chemical-biological model predicting copper toxicity in a given water as a function of easily measurable chemical parameters including pH, concentration of dissolved organic carbon, and concentrations of major ions such as calcium, magnesium, and sulfate. The EPA, the Massachusetts Department of Environmental Protection (MADEP) and other states' regulatory agencies, as well as the region's dischargers, are all interested in the speedy validation of this "Biotic Ligand Model" as a low-cost technique for developing site-specific water quality criteria for copper.

The Biotic Ligand Model's ability to produce accurate predictions of copper toxicity in an effluent-receiving water depends on its ability to predict the extent of copper complexation in that water. The model assumes that humic substances, the biologically refractory degradation products of higher plants, are both the copper-binding compounds (ligands) controlling complexation and the main constituents of the dissolved organic carbon present in surface waters. However, other compounds less abundant than humic substances have been shown to be more significant copper complexing agents in a variety of natural waters. In addition, other organic compounds may constitute a significant fraction of the dissolved organic carbon, especially in estuaries and sewage effluents. The assumptions of the Biotic Ligand Model may therefore lead to both overestimates or underestimates of the actual toxicity of copper in a given water. The goal of our study was to examine the behavior of copper-binding compounds in a sewage-effluent impacted river, in a relatively unimpacted estuary, and in highly impacted estuaries in order to determine whether the assumptions made by the Biotic Ligand Model will lead to reasonable predictions of copper toxicity in these systems or whether other factors need to be taken into account.

## Methodology

### a. Field Sites

**1.** ***Sewage-effluent impacted river.*** Field samples were collected from the Taunton River watershed in Massachusetts. This part of the project was conducted in close collaboration with an ongoing project by the environmental consulting firm ENSR, whose goal was to validate the Biotic Ligand Model in this watershed.

Grab samples of discharge of three POTW's (Bridgewater, Mansfield and Middleborough, MA), receiving waters upstream of the POTWs, and Taunton River samples were collected during ENSR sampling campaigns under both low-flow and high-flow conditions in acid-washed

Teflon bottles using “clean hands/dirty hands” trace-metal clean sampling techniques. A YSI Model 6920 multi-parameter water quality monitor was used to measure temperature, specific conductivity, pH, dissolved oxygen, and turbidity in the water before sampling. Additional ancillary measurements needed as input to the Biotic Ligand Model (DOC, calcium, magnesium, chloride, sodium, potassium, alkalinity, sulfate and sulfide) were performed by ENSR’s subcontractors and provided to us.

**2. *Unimpacted estuary.*** Water samples from the Saco River estuary across a salinity transect were collected in acid-washed Teflon bottles from a small aluminum boat or a polyethylene kayak. For copper speciation measurements, 1-2 liter samples of surface water were collected from upstream of the boat to minimize copper contamination of samples. Samples for DOC measurements were also collected upstream of the boat, syringe-filtered using pre-combusted glass syringes and pre-rinsed polysulfone cartridge filters, acidified, and stored in the refrigerator in pre-combusted glass vials. Temperature, chlorophyll, dissolved oxygen, turbidity and salinity were measured at each sampling site using a Hydrolab Datasonde.

**3. *Impacted estuaries.*** Samples were collected near the University of Rhode Island dock in Narragansett Bay, near docks of Waquoit Bay and Eel Pond on Cape Cod, and 100 meters offshore in Quincy Bay and Dorchester Bay (both in Boston Harbor), using the same techniques as for the Saco River.

### b. Sample Storage

Samples for copper were kept on ice during transport to the laboratory, where they were quick-frozen in liquid nitrogen for storage. We have found that this quick-freezing technique eliminates artifacts sometimes associated with freezing of samples, especially coagulation processes. After thawing, samples were either analyzed without filtering, or were syringe-filtered through 0.2 μm polycarbonate membrane filters (Nucleopore, 47 mm filter diameter) sandwiched in polycarbonate filter holders. For some of the samples from impacted estuaries, subsamples of this 0.2 μm filtrate (dissolved fraction) were filtered again through 0.02 μm pore size inorganic membrane cartridge filters (Anatop-25, 22 mm filter diameter). The filters were acid-cleaned and rinsed with DDW before use. Filter controls indicated that contamination of samples with copper and copper-binding compounds was negligible.

### c. Sample Analysis

The content of copper-binding compounds in our samples was analyzed using the competitive ligand exchange adsorptive cathodic stripping voltammetry titration techniques described in our previous works[1,2]. We have made two significant improvements over more commonly used approaches. First, we used *overload* titrations[1] for accurate calibration of the technique in each sample. Second, we quantified copper bound by *kinetically inert* compounds using very high quantities of competing ligand. Furthermore, we have calibrated the competing ligand, salicylaldoxime, for use in a range of salinity and pH values. Previous works have only used salicylaldoxime in seawater systems.

## Principal Findings and Significance

**1.** ***Sewage effluent impacted river.*** The ENSR study determined that copper toxicity was well predicted by the Biotic Ligand Model in these systems. However, the results of our part of this study were inconclusive. Both the sewage effluents and the receiving waters contained a high quantity of surfactants, which interfered with the voltammetric technique. Most of the interferences we observed were not reproducible, so even attempts to calibrate the technique for surfactant effects remained generally unsuccessful.

**2.** ***Unimpacted estuary.*** The content of ligands we found in the highest salinity sample (salinity 27.6) of a winter transect of the Saco river corresponded to what would be expected if the ligands from lower salinity samples (salinities 0.5 and 20.4) were diluted with ligand-free seawater. The copper-binding ability of these ligands per mg DOC corresponded closely to the copper-binding ability of standard humic substances isolated from the Suwannee River in Georgia. This finding indicates conservative dilution of riverine humic ligands with no significant contribution of the seawater endmember. DOC and color measurements (absorbance at 300 nm) indicated a mid-estuary source of both. This means that although the assumption that humic substances dominate metal binding behavior seems to be correct for our samples, DOC or color measurements are not good predictors of humic content.

We also observed large salinity and pH effects on the strength of copper binding by the riverine ligands. We plan to determine whether the Biotic Ligand Model makes accurate predictions of copper binding by humic substances under these conditions. The data analysis will be completed after further calibration of our competing ligand technique, using the ligand salicylaldoxime, as a function of pH and salinity.

**3.** ***Impacted estuaries.*** In these samples, we observed the presence of both weak ligands similar to those found in the Saco River estuary, as well as copper bound in kinetically inert compounds which were not present in significant quantities in the Saco. The content of weak ligands in our samples was reasonably consistent with quantities expected from riverine inputs, but other sources of these ligands could not be ruled out. No relationship between content of weak ligands and DOC or salinity was observed. The finding of metal bound in kinetically inert forms is new for any field system, since previous methods would not have been able to distinguish between kinetically inert and strong but reversible binding. This important finding constrains the possibilities for the identity of the copper binding compounds in this system, and maybe relevant for binding of copper and other metals in other systems as well.

In summary, our results show that the Biotic Ligand Model's basic assumptions are flawed in estuarine waters. We are continuing work in Boston Harbor, to collect extensive data sets of spatial and temporal variability in the content of both kinetically inert copper and weaker ligands. These data sets will help us to determine whether an alternative approach to predicting copper complexation in estuarine waters will be feasible.

**References Cited**

1. Kogut, M. B. & Voelker, B. M. Strong copper binding behavior of terrestrial humic substances in seawater. *Environ. Sci. Technol.* **35**, 1149-1156 (2001).
2. Voelker, B. M. & Kogut, M. B. Interpretation of metal speciation data in coastal waters: the effects of humic substances on copper binding as a test case. *Mar. Chem.* **74**, 303-318 (2001).

**Publications Resulting from this Research**

Kogut, M.B. and Voelker, B.M. Kinetically inert Cu in coastal waters. *Environ Sci. Technol*., accepted pending minor revisions.

We anticipate at least one more publication from the results of the Saco River study. However, further calibration of our competing ligand technique is needed before the data analysis can be completed.

**Students Supported**

Megan Brook Kogut, who completed her Ph.D. in Environmental Chemistry in MIT's Department of Civil and Environmental Engineering in June 2002, was the only student supported from this grant. Her thesis is entitled "Copper Speciation in Estuaries and Coastal Waters."

# Monitoring Disinfection Byproducts in Drinking Water: Strategies for Small Utilities

## Basic Information

| | |
|---|---|
| **Title:** | Monitoring Disinfection Byproducts in Drinking Water: Strategies for Small Utilities |
| **Project Number:** | 2001MA3341B |
| **Start Date:** | 4/1/2001 |
| **End Date:** | 3/30/2003 |
| **Research Category:** | Water Quality |
| **Focus Category:** | Water Quality, Methods, Toxic Substances |
| **Descriptors:** | Trihalomethanes, monitoring, modeling, disinfection byproducts, Haloacetic Acids |
| **Principal Investigators:** | David Alan Reckhow |

## Publication

# Monitoring Disinfection Byproducts in Drinking Water: Strategies for Small Utilities

## Problem and Research Objectives

***To develop and test several strategies for non-compliance monitoring of THMs and HAAs in small to medium sized drinking water systems using free chlorine as a residual disinfectant.*** Over the next decade, small drinking water systems will have to comply with the new stage 2 federal regulations for minimizing disinfection byproducts (DBPs). These contaminants are costly to measure and their concentrations are highly dependent on source water quality, physical conditions, and engineering parameters. Reliable and cost-effective control of DBPs requires good knowledge of the relationship between system operation and DBP concentrations throughout the system. Currently only large water systems have the resources to measure their own DBP concentrations. This leaves small systems at the mercy of commercial laboratories, with almost no chance of managing their system in ' real time'. The combination of staffing limitations and the forementioned disengagement between utility and data analysis leaves small systems with little opportunity to develop their own in-house expertise at controlling DBPs. The end result of this project will be new set of tools that can empower small utilities to better manage their THM monitoring and control.

## Methodology

Our first activities were to test out some of the simple analytical tools that were proposed for this work: UV absorbance measurement, chlorine residual titration, and the Fujiwara-based colorimetric THM test (Hach's THM Plus). The students were trained in the use of these tests in the laboratory, and they developed strategies for field use.

Early in the summer of 2001 we identified Northampton as the test site for the medium-sized utility. Several meetings with the Northampton Department of Public Works staff followed, and we were given access to key information on their system (e.g., pipe network, past water quality data, operational practices). Tighe & Bond also assisted in providing us a nearly-working hydraulic distribution system input file.

With the assistance of Boston Water and Sewer Authority, we were able to secure a 1000-pipe version of Haested Methods's WaterCAD program, just sufficient to accommodate Northampton's 926-pipe system. Following several months of discussions between Northampton, UMass and Tighe & Bond, we were able to formulate a reasonable water demand file and run the full program. Since then we have modeled chlorine residuals throughout the system and have graphical and tabular outputs that were generated to compare with field data.

In addition to the laboratory activities and computer modeling, there were four major field sampling events. These occurred on October 2, 2001, October 16, 2001, February 5, 2002 and June 28, 2002. In each case, samples were collected from the raw water sources, and up to 20 separate locations in the distribution system. At the time of collection, field measurements for chlorine residual, temperature, and pH were made. The samples were brought back to the UMass laboratory for analysis of TOC, DOC, UV absorbance, haloacetic acids, trihalomethanes and other neutral extractable byproducts. In addition, several bulk raw waters samples were collected on the second, third and fourth field sampling dates. These have been subject to an extensive set of kinetic experiments that involve chlorination under varying conditions with analysis of byproducts by gas chromatography.

Extensive data analysis followed each of the field sampling events. Laboratory kinetic experiments provided data for use in calibration of a kinetic model. These types of models constitute one of the major strategies proposed in this work for assessing and managing disinfection byproduct (DBP) concentrations. When combined with the hydraulic model (which estimates water age), the kinetic model is used to predict concentrations at specific locations. These are then tested against the field data to determine predictive accuracy.

The next major field effort will involve one of several resin extraction protocols. These are currently being developed in the laboratory. Options being investigated include use of hydrophobic (reverse phase) resins, hydrophilic (normal phase) resins and anion exchange resins. Each will be tested for retained (following elution) and unretained TOC and UV absorbance. Problem and Research Objectives

## Principal Findings and Significance

- The concept of using a hydraulic model with a chemical water quality model has shown itself to be viable in the Northampton system. Predicted chlorine residuals based on laboratory data and modeled hydraulic retention time matched well the actual measured concentrations in the system. This leads one to conclude that both models (hydraulic and chemical) are effective at describing the data, and that there are no overwhelming "pipe effects" in the Northampton distribution system. Since, we have not even had to adjusted the node demands to reflect the real heterogeneous use pattern that exists in Northampton, this also suggests that demand allocations need not be highly spatially resolved. Nevertheless, there was at least one sampling campaign (Febuary 2002) where model predictions could have benefited from a pipe wall demand term. Future testing will better clarify the need for this model add-on.
- During warm weather, HAA biodegradation occurs at locations where the chlorine residual drops below 0.2 mg/L. During the cold weather, biodegradation cannot be detected even under conditions of no detectable chlorine residual. HAA biodegradation is one process that cannot be accurately studied in laboratory systems. Information of this type could form the basis of an empirical approach to modeling this process.
- At certain times of the year, there is a substantial drop in TOC at long residence times. This was not expected, and may reflect excessive levels of biodegradation or possibly chemical degradation in the "dead ends". This may be another key in understanding the HAA degradation puzzle.
- In several locations, pH was seen to drift upward with increasing residence time. This seemed to be associated with the presence of asbestos cement piping. Increasing pH will result in higher levels of THMs and lower levels of trihaloacetic acids. For this reason, pH modeling and/or monitoring is quite important.
- Delta-$UV_{272}$ (change in absorbance at 272 nm) showed a weak positive correlation with TTHM level, but not with the HAAs. Additional refinements in the methodology may show this correlation to be stronger in future tests. The Delta-$UV_{272}$ correlation has been proposed as a useful surrogate for the formation of a wide range of disinfection byproducts.

- A colorimetric THM test method used in the field failed to produce data exhibiting the same strong correlation with water age, as noted for the GC-based THM data. Some exceptionally low values were recorded for the colorimetric method, which were largely responsible for the poor correlation. This test may require more operator experience; so future testing will likely prove decisive.
- Raw water samples chlorinated in the laboratory showed slightly lower DBP levels than those chlorinated by the full-scale plant and held in the laboratory. The latter samples matched the distribution system samples better (based on the modeled retention times). The reasons for this are not clear.

**Publications Resulting from this Research**

None yet, but at least one is planned for the *Journal of the American Water Works Association.*

**Students Supported**

Three students in Civil & Environmental Engineering: Bree Carlson (MS student), Shem Kellogg (BS student), and Narayan Venkatesan (MS student).

# Acid Rain Monitoring Project

## Basic Information

| | |
|---|---|
| **Title:** | Acid Rain Monitoring Project |
| **Project Number:** | 2001MA14O |
| **Start Date:** | 4/1/2001 |
| **End Date:** | 3/30/2002 |
| **Research Category:** | Water Quality |
| **Focus Category:** | Water Quality, Non Point Pollution, Surface Water |
| **Descriptors:** | acid rain monitoring |
| **Principal Investigators:** | , Paul J. Godfrey |

## Publication

## Acid Rain Monitoring Project

### Problem and Research Objectives

On Earth Day, April 22, 2001, and quarterly after that, 70 volunteers sampled 192 water bodies (mostly lakes) in Massachusetts as part of the **Acid Rain Monitoring Project**. Volunteers brought their water samples to 15 volunteer labs for the first part of the water quality analysis with additional analyses to be completed at UMass Amherst. The water samples were the first collected for the project since 1993, when the project had culminated in a ten-year database of lake and stream acid sensitivity covering the period 1983-1993. Since the early 1990s, both the State and Federal versions of the revised Clean Air Act have been implemented. However, recently the scientific community has expressed concern that acid rain impacts were not lessening and might even be worsening, primarily because of increased nitrogen oxide emissions from automobiles and trucks. For this reason, the internationally recognized Acid Rain Monitoring Project was reactivated by the Water Resources Research Center at UMass Amherst with support from the Department of Environmental Protection, Division of Air Quality. Dr. Paul Godfrey, Director of the Massachusetts Water Resources Research Center, has spearheaded the effort since its beginning.

### Methodology

The key question is how the status of lakes has changed since the 1983-1993 period. In the earlier phases of the Acid Rain Monitoring Project, six categories of sensitivity to acid deposition were established. These mostly mimicked similar categories used by the U.S. EPA and state agencies, basically applying names to specific ranges of pH and acid neutralizing capacity (ANC) or alkalinity. Acid neutralizing capacity is a natural characteristic of lakes and streams that results from the types of geology and thickness of soils. Calcareous rocks and soil have more ANC, while granites and sand have little to none. If ANC is abundant, as it is in the lower elevations of Berkshire County, additions of acid will be neutralized; but if ANC is nearly non-existent, as it is in many other areas of the state, even small additions of acid will drastically change the acidity of the water body. It is the water bodies that are lowest in ANC that are of greatest concern because a change in acidity, measured by pH, will have severe effects on the flora and fauna of lakes and streams. PH ranges from extremely acid at pH 1 to extremely basic at pH 14, but most of life is content in a narrower range around neutral, pH 7.0. In the northeast, water bodies are naturally somewhat acidic with a pH around 6.0-6.5. It is generally agreed that when the pH drops below 5.0, serious effects on the biota are in progress including the disappearance of species, reproductive failures, and heavy metals accumulation. The Acid Rain Monitoring Project sensitivity categories, used since 1983, attempt to capture these features.

| Sensitivity Categories | Alkalinity (mg/l) |
|---|---|
| Acidified | <0 and pH < 5.0 |
| Critical | 0-2 or 0 and pH < 5.0 |
| Endangered | >2-5 |
| Highly Sensitive | >5-10 |
| Sensitive | >10-20 |
| Not Sensitive | >20 |

## Principal Findings and Significance

Current results for each water body are posted on the Center's web site at www.umass.edu/tei/wrrc. In a comprehensive survey of nearly all named lakes and streams in Massachusetts, the Acid Rain Monitoring Project found the following:

| | |
|---|---|
| Acidified | 5.5% |
| Critical | 16.7% |
| Endangered | 19.5% |
| Highly Sensitive | 21.2% |
| Sensitive | 20.4% |
| Not Sensitive | 16.7% |

The recent samplings consisted of a small random sub sample of this larger effort. While the results can be translated into similar percentages for the entire state, this has not yet been done. Similarly, it is desirable to remove the effect of unusual prior weather conditions, such as the heavy snow packs of 2001 and 1993 which store acids until the spring melt. This also has not yet been done. Because the present sub sample of lakes is not the same as the comprehensive survey nor has it been adjusted to represent those statewide percentages, the only fair comparison is between the earlier conditions of these specific lakes and their present condition. The results do allow a preliminary comparison of acid sensitivity in 1983-1985, 1992-1993 and present during the month of April. If conditions have improved, there should be relatively fewer lakes in the acidified through endangered categories and relatively more that are in the highly sensitive to not sensitive categories.

Overall, there is relatively little change from 1983-1985 data to present except that conditions appeared to be worsening by 1992-1993 and have been "turned around" since then. These raw data do not suggest that conditions have improved much since the early 1980s but that we may have avoided worsening conditions. A fairer sense of the degree of change over the past 18 years will occur when weather factors are included. In short, these preliminary results appear to suggest that we have not gained any ground on the acid rain problem but, at least, we have not lost ground either. For nearly a decade, many assumed the acid rain problem was solved. It now appears that it was only put on hold. Recent state actions to continue emission reductions and reduce acid rain seem completely justified but more will be needed nationally if we hope to make actual progress.

The project has also collected data on total phosphorus levels in these randomly selected lakes. This will provide information to the state's TMDL program and provide a better sense of a representative range of nutrients in Massachusetts lakes to complement work done recently by the New England Interstate Water Pollution Control Commission, EPA, and ENSR.

# Springfield Surface Water Action Monitoring Partnership

## Basic Information

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|---|---|
| **Title:** | Springfield Surface Water Action Monitoring Partnership |
| **Project Number:** | 2001MA15O |
| **Start Date:** | 12/11/2000 |
| **End Date:** | 12/10/2002 |
| **Research Category:** | Water Quality |
| **Focus Category:** | Water Quality, Toxic Substances, Water Use |
| **Descriptors:** | watersheds, sediments, exposure and risk, ecological effects, human health, PCBs, metals, organics, aquatic, monitoring |
| **Principal Investigators:** | , Paul Joseph Godfrey |

## Publication

## Springfield Surface Water Action Monitoring Partnership - Other Federal

Environmental Monitoring for Public Access and Community Tracking (EMPACT)
U.S. EPA Grant

### Problem and Research Objectives

The City of Springfield Planning Department and the University of Massachusetts Water Resources Research Center are conducting a study, the **Springfield Surface Water Action Monitoring Partnership (SSWAMP)** to determine the health of Springfield's water bodies. The two-year study consists of water quality monitoring, fish tissue analysis, sediment analysis, and storm water monitoring. In addition to establishing a water quality baseline, the study will make recommendations on health warnings for the consumption of fish and educate residents on Best Management Practices (BMP's). Residents will be trained to collect samples and coordinate lake associations for their water body of interest. Long-term goals for the project include the posting of water quality information in several languages on signs and websites so that residents may make informed decisions regarding the recreational use of local water bodies.

The SSWAMP project has four primary objectives, each of which meet the overarching goal of protecting human health and water quality through collection and dissemination of environmental information:

- To determine the baseline chemical and biological characteristics of thirteen water bodies in Springfield and to determine the baseline levels of nutrients, metals, and organic contaminants in the sediments. Given that much of the pollution in area lakes comes from storm water drainage, another objective is to determine the extent of nutrient, sediment, and toxic contaminants provided to the water bodies by storm drainage.
- To determine the current level of mercury, other heavy metals, PCBs, and chlorinated pesticides in frequently consumed fish species within the City of Springfield. This has been done so that recreational users of the water bodies and sustenance fishermen, especially those who are non-English speaking, can be informed as to which water bodies' fish populations present an elevated health hazard when consumed.
- To disseminate the research findings to the public. The fish tissue information will be presented through information outlets most frequented by those effected - fishermen and their families. Water quality information will also be disseminated to the public with educational messages explaining the pollution levels and how water quality can be improved or protected.
- To actively enlist the participation of residents in surface water monitoring as partners in order to ensure the project's long-term sustainability.

### Methodology

Fifty-two citizens were trained as water quality monitoring volunteers. The volunteers were trained to collect in-lake samples, collect storm water samples, complete analysis for dissolved oxygen, and carry out chlorophyll prep for further chlorophyll analysis. Volunteers also learned how to interpret the results of the tests in terms of good or poor water quality. Each monitoring group has taken this information and worked with a water quality scientist from UMass Amherst to determine the best course of action for water quality restoration and continued monitoring. Analyses include the following:

- **Water Quality Monitoring -** From April to September water samples are taken monthly from a mid-lake location. Samples are analyzed for pH, alkalinity, dissolved oxygen, phosphorus, and nitrates. Observations are made regarding temperature, clarity, and algae.
- **Fish Tissue Analysis** - During summer months, several species of fish are collected and analyzed from each water body. Analyses include mercury and PCB's.
- **Storm Water Monitoring** - During rain events, water samples are taken from storm drain culverts that flow into a lake or pond. The storm water is then analyzed for phosphorus, nitrates, solids, mercury, and other heavy metals.
- **Sediment Analysis** - Sediments are collected from lake bottom locations using a dredge. The sediments are then analyzed for phosphorus, mercury, and other heavy metals

## Principal Findings and Significance

The analyses are still underway - current efforts include designing the best format for public presentation of the water quality information. The average citizen does not want to know the details of the sampling results; they want to know is the water safe for drinking, swimming, fishing, and or boating. The team has also developed a website (still under construction), working with citizen monitors so that the site is useful to them for sharing and posting water monitoring data. The design of information kiosks is also underway and a "SSWAMP Things" newsletter has been published, including technical information, poetry, and a recipe for dealing with mosquitoes. The 1983 report on the "State of our Lakes" has also been updated, with citizen input and the general reader in mind. The previous version of the report compiled a large amount of data and modeling results but was difficult for the general reader to understand.

The next steps are to complete the analysis of the two year sampling cycle and distribute results to the citizen monitors, the media, and community groups; complete the website and post all of the collected data and related analyses; and complete the design and begin construction of the sign kiosks that will display collected data and best housekeeping practices at each water body. The team will also continue to work with each of the thirteen citizen monitoring pond associations that have been established as a result of this program. Each pond will finalize their monitoring plan for the future and a plan for restoration work.

**Publications and Presentations**:

**Publication:** SSWAMP Things Newsletter.
**Presentations to**: Massachusetts Association of Public Health Professionals Annual Conference, U.S. EPA Engaging Communities Conference - Poster Presentation, Elms College Public Health Program (3 semesters), various neighborhood councils, Project Based Environmental Instruction, University of Massachusetts teacher education training.

# Information Transfer Program

## Basic Information

| | |
|---|---|
| **Title:** | The Massachusetts Water Watch Partnership |
| **Start Date:** | 7/1/1997 |
| **End Date:** | 6/31/2002 |
| **Descriptors:** | Citizen Monitoring, Non-point Pollution, Rivers, Lakes, Monitoring, Volunteer, Quality Control |
| **Principal Investigators:** | Paul Joseph Godfrey |

## Publication

## Massachusetts Water Watch Partnership:
## Monitoring Assistance for Volunteer Water Quality Monitoring

**Investigators:** Jerry Schoen, Marie-Françoise Walk, and Paul J. Godfrey
**Descriptors:** Citizen Monitoring, Non-point Pollution, Monitoring, Volunteer, Quality Control

### Problem and Research Objectives

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. The program has grown from working with 15 groups in 1990 to over 80 today.

### Methodology

MassWWP services fall into a number of broad categories:

- *Workshops and Conferences* - to train volunteers and promote information sharing on the major aspects of planning and running a monitoring program, from program planning to field and laboratory methods to data management and presentation. MassWWP also regularly presents papers and workshops and helps plan water monitoring related conferences around New England and the nation.
- *Partnership and Network Building* - to foster productive relationships among volunteer groups and between volunteer programs and governments, business, and other interests.
- *Special projects* - on specific issues, such as satellite imagery and a nationwide Secchi disk survey.
- *Research* - on topics that have the potential to enhance the utility of volunteer monitoring programs.
- *Consultation and Advice* - including the loaning of sampling equipment, and other direct services.
- *Publications* - development and/or distribution of documents of use to volunteer monitors.
- *Statewide Coordinator and Western Massachusetts Service Provider* - as one of the four designated regional service providers and responsible for western Massachusetts.

### Principal Findings and Significance

- Conducted nine classes as part of the Quality Assurance Project Plans (QAPP) workshop series and conducted a macro invertebrate workshop. Provided follow up assistance to participants, along with maintaining the volunteer monitoring web site.
- Completed the Watershed Monitoring Collaborative Project funded by the Massachusetts Environmental Trust. Work included producing over 20 workshops and offering follow up assistance to participating organizations; helping groups establish technical advisory committees; and producing or upgrading handbooks and manuals on data interpretation, working with state agencies, and field sampling procedures.

- Participated in the development of a Watershed Assessment Strategy and related work for the New England Regional Monitoring Collaborative (NERMC). NERMC grew out of a 1994 USGS grant to the WRRC; it secured a contract with U.S. Environmental Protection Agency to develop the strategy, to provide training materials and related workshops on several watershed monitoring tools, and to develop a "training the trainers" network for New England volunteer monitors. Other NERMC partners include the River Network, Cooperative Extension units of the Universities of Rhode Island and New Hampshire, and the University of Maine Public Affairs division.
- Led three workshops to train Springfield volunteers in shoreline surveys, lake sampling, and lab analyses for the Springfield Surface Waters Action Monitoring Program.
- Led three workshops for middle and high school teachers on river chemistry, shoreline surveys, lab analysis, and streamside survey of benthic macroinvertebrates.
- Participated in data interpretation workshops and completely revised data interpretation manual, with the addition of a lake case study.
- Assisted in writing and review of Quality Assurance Project Plan (QAPP) guidance book for volunteer monitors.
- Researched and created river ecology and recreation web pages for the Deerfield River Water Association's web page.
- Conducted workshop "Introduction to Lake Monitoring" at Congress of Lakes and Ponds conference.
- Held lake sampling and lab analysis workshop at the New England Chapter of the North American Lake Management Society (NEC-NALMS) conference in Springfield.
- Held stream ecology workshop for high school students in two-week summer course at Smith College.
- Revised all field and lab protocols.
- Served on the editorial board of *The Volunteer Monitor* newsletter.
- Developed a package of tips and templates for web designers. This can be found on the MassWWP web site (http://www.umass.edu/tei/mwwp/). A new feature is a web "slide show" that portrays water quality data within the context of an informational presentation about the Deerfield River Watershed Association's monitoring program, recent results, and conclusions drawn by the Association. Also completed a test version of an Excel utility that allows groups to enter macro invertebrate data on a standardized data entry form and then generate a variety of graphs of the data with little extra effort. We are in the process of distributing this to groups to test, and preparing a web version of some of the graphs.
- Two graduate students were supported through this work to assist at the macro invertebrate workshops

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# Student Support

| Student Support | | | | | |
|---|---|---|---|---|---|
| **Category** | **Section 104 Base Grant** | **Section 104 RCGP Award** | **NIWR-USGS Internship** | **Supplemental Awards** | **Total** |
| **Undergraduate** | 1 | 0 | 0 | 0 | 1 |
| **Masters** | 4 | 0 | 0 | 0 | 4 |
| **Ph.D.** | 1 | 0 | 0 | 0 | 1 |
| **Post-Doc.** | 0 | 0 | 0 | 0 | 0 |
| **Total** | 6 | 0 | 0 | 0 | 6 |

# Notable Awards and Achievements

The Acid Rain Monitoring Project provided data on the current status of Massachusetts’ lakes affected by acid deposition to the New England Governors/Eastern Canadian Premiers for assessment of the 1990 Clean Air Act revisions. The project also provided nutrient data to the Massachusetts Department of Environmental Protection for use in developing TMDL assessments.

In cooperation with the City of Springfield on an EPA EMPACT grant, the Center helped establish neighborhood lake monitoring groups to encourage active stewardship of the 16 ponds and lakes in greater Springfield and to make subsistence fisherman from several cultural groups aware of fish consumption health concerns.

The Center Director was principal author of The Massachusetts Volunteer Monitors Guidebook to Quality Assurance Project Plans", the principal guidance for state and federally supported volunteer monitoring efforts in Massachusetts.

The Center Director served as a member of the Lakes and Ponds Implementation Committee that provides policy guidance to the Massachusetts Executive Office of Environmental Affairs on implementation of the statewide lake and pond management strategy.

The Center Director served as a member of the Citizens Advisory Committee on the development of a generic environmental impact review (GEIR) for lake management and coauthor of the GEIR.

The Center Director served as a member of the Executive Office of Environmental Affairs/University of Massachusetts Joint Committee on Watersheds.

The Center Director served as the Executive Secretary for the National Institutes of Water Resources.

The Center Director was awarded the Chancellors Citation in recognition of exemplary and outstanding performance in service of the University of Massachusetts Amherst.

# Publications from Prior Projects