Vermont Water Resources and Lake Studies Center
Annual Technical Report
FY 2002

Introduction

Attached is the Fiscal Year 2002 Annual Report for the Vermont Water Resources and Lake Studies Center. The grant, awarded under the State Water Resources Research Institute Program, is numbered 1434-HG-96-GR-02702.

Research Program

The 2003 Vermont Water Resources and Lake Studies program has featured three new research projects. "Water quantity and quality dynamics in high-elevation watersheds: developing a scientific approach to understanding ski area impacts in Vermont" by Wemple et al. is using a paired watershed approach on the eastern slopes of Mt. Mansfield. Scientists have detected a distinct difference in runoff volume and water quality between developed and undeveloped watersheds. Research results will be useful to state regulators charged with maintaining the quality of Vermont's high elevation streams. In "Detection of cyanobacterial blooms using remote sensing," Levine et al. are experimenting with the use of satellite imagery to detect the presence and extent of blooms of blue-green algae in Lake Champlain and other Vermont lakes. Already, researchers have clearly demonstrated the potential of Landsat imagery to detect and characterize algal blooms from space. Finally, "Substrate- and size-dependent measurement of particle-phase mercury in the atmosphere by aerosol mass spectrometry" by Petrucci has been attempting to perfect a method for measuring a critical environmental pollutant in real time and with high sensitivity. Such a capability would dramatically enhance our ability to understand how mercury moves through ecosystems.

Water quantity and quality dynamics in high-elevation watersheds: Developing a scientific approach to understanding ski area impacts in Vermont

Basic Information

Title:	Water quantity and quality dynamics in high-elevation watersheds: Developing a scientific approach to understanding ski area impacts in Vermont
Project Number:	2002VT1B
Start Date:	3/1/2002
End Date:	2/28/2004
Funding Source:	104B
Congressional District:	First
Research Category:	Water Quality
Focus Category:	Hydrology, Water Quality, Models
Descriptors:	
Principal Investigators:	Beverley Wemple, Donald Ross, James Shanley

Publication

1. Shanley, J.B. and B. Wemple, 2002. Water Quality and Quantity in the Mountain Environment. Vermont Law Review (Special issue - Mountain Resorts: Ecology and the Law), 26(3):717-751.
2. Wemple, B., J. Shanley, and J. Denner. "Effects of an Alpine Ski Resort on Hydrology and Water Quality in the Northeastern U.S.: Preliminary Findings from a Field Study," American Geophysical Union Fall Meeting, San Francisco, CA. December 2002.
3. Mussleman, K. Analysis of Spatial Variability of Precipitation on Mt. Mansfield, Stowe, VT. Vermont Geological Society Spring Meeting, Middlebury, VT. April 2002.
4. Denner, J., J. Shanley, and B. Wemple, 2001. Comparison of Runoff from a Ski Resort and Adjacent Undeveloped Watershed in Northern Vermont. Eastern Snow Conference, Stowe, VT. June 2001.
5. Mussleman, K. 2002. Analysis of Spatial Variability of Precipitation and Snow Accumulation on Mount Mansfield, Stowe, Vermont. Unpublished senior research project, Dept. of Geology, University of Vermont.
6. Muth, M. and L. Pascale. 2001. Runoff from Paved and Unpaved Parking Lots at the Spruce Peak Parking Area, Stowe Mountain Resort, Stowe, Vermont. Unpublished student research paper.
7. White, M. 2002. Total Suspended Solids and Runoff Analysis for the Big Spruce and Mansfield

Tributaries in the West Branch Watershed, Stowe, Vermont. Unpublished student research paper.

Water quantity and quality dynamics in high-elevation watersheds: Developing a scientific approach to understanding ski area impacts in Vermont

Annual Progress Report for the period

March 2002 – March 2003

Submitted to:
Vermont Water Resources and Lake Studies Institute
University of Vermont
Burlington, VT 05405

by:
Beverley C. Wemple, Principal Investigator
Dept. of Geography
University of Vermont
Burlington,VT 05405

Introduction and Project Objectives

Activities associated with the development and operation of alpine ski areas, including forest clearing, development of impervious surfaces, and snowmaking, represent distinct impacts in the mountain environment. Cleared and impervious surfaces alter the quantity and quality of runoff reaching stream channels. Snowmaking operations reduce instream flows and alter the dynamics of snow accumulation and melt. The nature of land development activities associated with alpine resort operations and the temporal persistence of their effects may differ from those imposed by traditional forest harvesting operations, which have been the subject of substantial scientific research. Despite the rather widespread persistence of this land use activity -- roughly 326 U. S. alpine ski resorts belong to the National Ski Areas Association (NSAA, 2003) -- few scientific studies have examined the effects of alpine ski area development and operations on water quality and quantity. This project seeks to combine the approaches of paired-watershed studies and simulation modeling to assess the impacts of ski area operations on watershed processes in two high-elevation watersheds in Vermont. The objectives of the research include:

1. To collect baseline data on streamflow, sediment transport and water quality, using a paired-watershed approach, to examine current and potential future effects of ski area development and operations.

2. To use simulation modeling to assess the impacts of existing operations and proposed future development on the magnitude and timing of runoff from the study watersheds.

Approach

Our approach combines the use of empirical data analysis of a paired-watershed study with simulation modeling to evaluate the effects of ski area operations. Our study area includes the West Branch (11.7 km^2) and Ranch Brook (9.6 km^2) watersheds, tributaries to the Little River in northwestern Vermont. The watersheds drain the eastern slopes of Mt. Mansfield, Vermont's highest peak, and have similar characteristics with respect to geology, soils, vegetation and relief. The West Branch watershed encompasses an entire alpine ski resort, which occupies roughly 15% of the basin area. The Ranch Brook watershed is undisturbed except for a network of cross-country ski trails. A paired-watershed study, initiated in the fall of 2000 and funded jointly by the U.S. Geological Survey and the Vermont Monitoring Cooperative, established stream gaging stations on both watersheds. Automated ISCO water samplers allow collection of water samples. Funding provided through this grant supports the analysis of total suspended solids, common cations (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, Fe^{3+}, and Mn^{2+}), inorganic anions (Cl^{-}, NO_3^{-} and SO_4^{2-}), total nitrogen and total phosphorus.

Watershed modeling is accomplished using the Distributed Hydrology Soil Vegetation Model (DHSVM), a process-based, distributed parameter rainfall-runoff simulation model. Specification of vegetation and soil types occurs at the resolution of the digital elevation model (DEM). Elevation data of the DEM are used to simulate topographic controls on absorbed shortwave radiation, precipitation, air temperature and downslope water movement. The model simulates evaporation, transpiration, snow accumulation and melt, and runoff through vertical

unsaturated flow, lateral saturated groundwater flow, and overland flow over surfaces or in channels (Wigmosta, 1994; Waichler et al, in review). Input to DHSVM includes grids of surface elevation, soil type and thickness, and vegetation; tables of soil and vegetation biophysical parameters; and time series of meteorological variables. The model is validated against existing streamflow data. We have obtained 30-meter DEM data for the study area from the Vermont Mapping Program. Vegetation and land cover data have been interpreted from high resolution remotely-sensed imagery. Soils data have been taken from GIS coverages and tables provided by the Natural Resource Conservation Service and distributed by the Vermont Center for Geographic Information (www.vcgi.org). Meteorological data have been provided by the Vermont Monitoring Cooperative and the U.S. Geological Survey (USGS). Stream flow data for the West Branch and Ranch Brook basins have been provided by the USGS.

Progress to Date

Activities during Year 1 of the project have focused on data collection and analysis of water quality and quantity from the study watersheds. We have collected and processed over 300 samples for total suspended solids (TSS), common cations and inorganic anions. In addition, we have processed 35 samples from spring snowmelt and summer storms for total nitrogen (TN) and total phosphorus (TP). Our analysis involves establishing correlations between streamflow and water quality constituents (TSS, cations, anions, TN, TP) in order to estimate basin yields. We have also conducted empirical analyses of hydrograph data to compare water yields, peak flows and low flows between the two watersheds.

Modeling activities during Year 1 have focused on land cover analysis and data compilation for model parameterization. We have used a combination of manual interpretation of 1:5000 digital orthophotos and an unsupervised classification of satellite imagery to interpret land cover conditions for the watersheds (Table 1). We have also compiled and formatted GIS datalayers to represent elevation, soils, and vegetation for model input. Model parameterization is underway, with initial modeling results expected by September 2003.

Table 1: Characteristics of the study watersheds

	West Branch	Ranch Brook
Watershed Area (km^2)	11.7	9.6
Watershed area in		
• ski trails (%)	11.60	0.38
• impervious surfaces* (%)	2.17	0.01
• exposed bedrock (%)	3.16	0.63
Land use	Alpine skiing	State forest, Nordic skiing

* includes buildings and paved or gravel roads and parking lots

Results

Runoff analysis for the two basins indicates that flow is synchronized in time but distinctly different in peak magnitude and water yield (Figure 1). In WY 2001 and 2002, 80% of all paired peak flow events occurred within 1 hour of each other at the two basins. Unit area peak discharge at West Branch is higher than at Ranch Brook for summer and fall storms, but lower for winter and spring storms (Figure 2), suggesting that development increases peak runoff during rain events but reduces snowmelt peaks by storing and slowly releasing water from ski trails. This seasonal difference was statistically significant ($p = 0.04$) in WY 2001, when prodigious natural snow was available, but not in WY 2002 ($p = 0.16$), a drought year with little natural snowpack. Annual water yield for WY 2001 at West Branch was over 40% higher than at Ranch Brook, and exceeded water yield at other mountainous basins in the region (Figure 3). Differences in water yield between West Branch and Ranch Brook are larger than can be reasonably explained by land cover differences or basin hypsometry (Table 1, Figure 4) and appear to be due to large differences in measured streamflow during low and moderate flow periods (Figure 5). We are currently investigating whether a high precipitation anomaly exists in West Branch basin (Mussleman, 2003).

Our preliminary data analysis indicates that development in the West Branch basin affects key water quality parameters. Concentrations of TSS are higher, and they are flushed earlier in West Branch than the Ranch Brook basin (Figure 1). TSS concentrations are related to discharge, but concentrations peak in advance of the runoff peak (Figure 1b), leading to considerable scatter in the TSS vs. discharge rating curve (Figure 6). Yield of TSS also varies seasonally, with higher concentrations in both basins during spring/summer storms, presumably due to the lack of snowcover protection. Deicing salts applied to ski area parking lots cause a sharp chloride spike in streamwater at the onset of snowmelt (Figure 3a). The chloride concentration falls off rapidly but the signal persists year round, remaining several times higher than at Ranch Brook in late summer storms (Figure 1b)

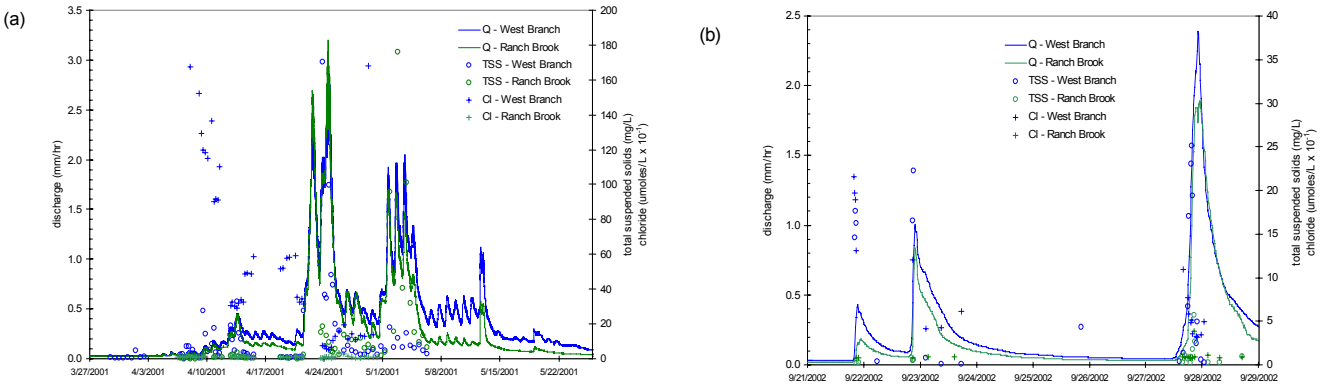

Figure 1: Hydrographs and concentrations of total suspended solids and chloride for (a) spring snowmelt 2001 and (b) a summer storm in 2002.

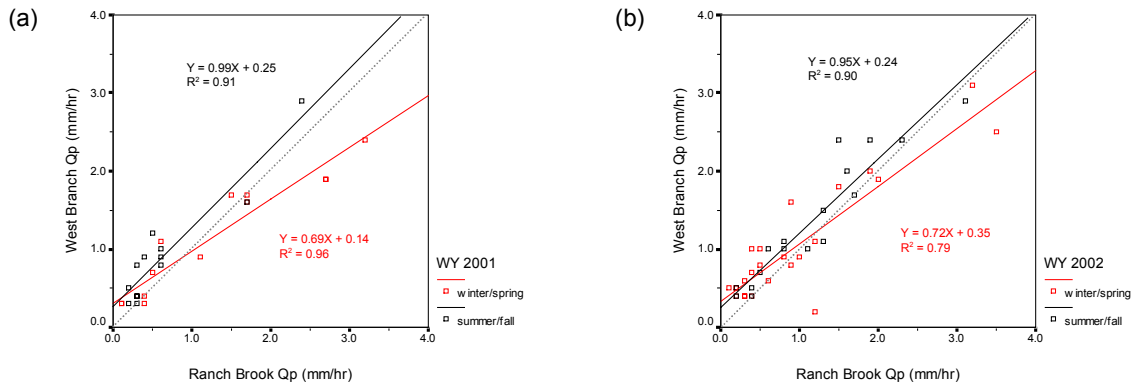

Figure 2: Scatterplots of peak discharge at West Branch vs. Ranch Brook basin for (a) WY 2001 and (b) WY 2002. Regression lines for seasonal effects are statistically different for WY 2001 but not for WY 2002. Dotted line is 1:1.

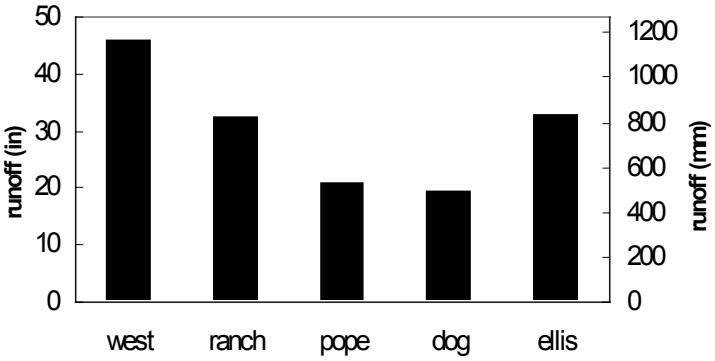

Figure 3: Annual water yield for WY 2001 at West Branch, Ranch Brook and three other basins in the region. Comparative basins are Ellis River (USGS Station #01064300), Pope Brook (USGS Station #01135150), and Dog River (USGS Station #04287000)..

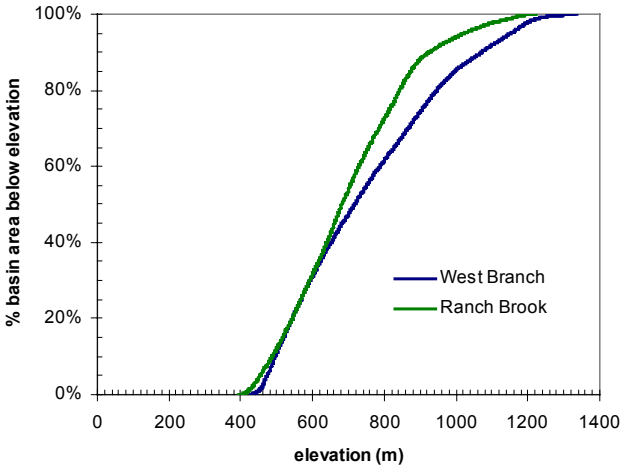

Figure 4: Basin hypsometry.

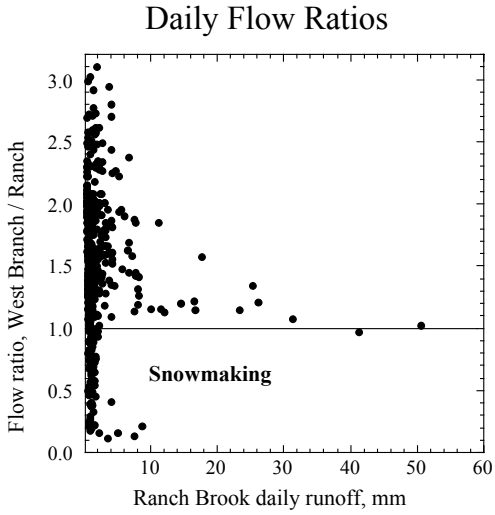

Figure 5: Ratio of West Branch to Ranch Brook average daily flow vs. Ranch Brook average daily flow (WY 2001).

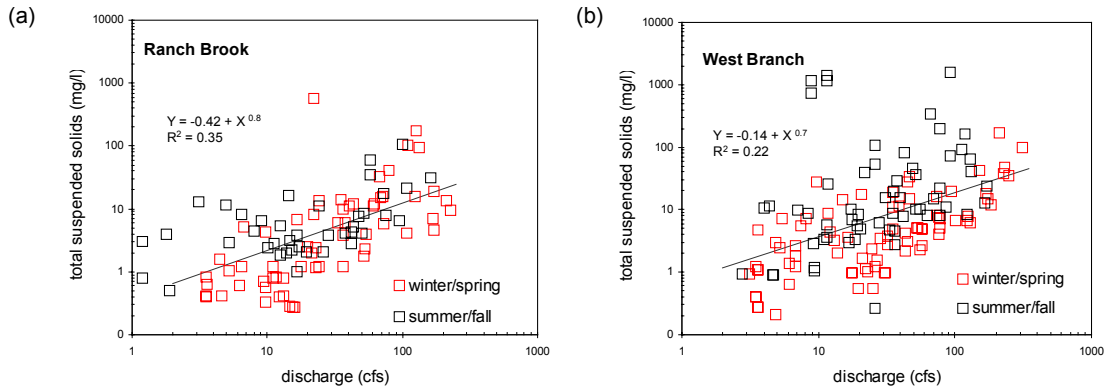

Figure 6: Scatterplots of total suspended solids vs. discharge at (a) Ranch Brook and (b) West Branch for WY 2001. Regression line is for all points (samples from winter/spring and summer/fall flows). The regression intercept is greater for West Branch than for Ranch Brook, suggesting slightly higher sediment yields in the managed basin; however, regression lines for the two basins are not statistically different. Seasonal effects are statistically significant in both basins, indicating that total suspended sediment concentrations are lower for winter/spring flows than for summer/fall flows.

Research Products

Peer-reviewed publications

Shanley, J. B. and B Wemple, 2002. Water Quality and Quantity in the Mountain Environment. Vermont Law Review (Special issue – Mountain Resorts: Ecology and the Law), 26(3): 717-751.

Presentations at Scientific Meetings

Wemple, B., J. Shanley, and J. Denner. "Effects of an Alpine Ski Resort on Hydrology and Water Quality in the Northeastern U.S.: Preliminary Findings from a Field Study," American Geophysical Union Fall Meeting, San Francisco, CA. December 2002.

Mussleman, K. Analysis of Spatial Variability of Precipitation on Mt. Mansfield, Stowe, VT. Vermont Geological Society Spring Meeting, Middlebury, VT. April 2002.

Denner, J., J. Shanley, and B. Wemple, 2001. Comparison of Runoff from a Ski Resort and Adjacent Undeveloped Watershed in Northern Vermont. Eastern Snow Conference, Stowe, VT. June 2001.

Student research papers

Mussleman, K. 2002. Analysis of Spatial Variability of Precipitation and Snow Accumulation on Mount Mansfield, Stowe, Vermont. Unpublished senior research project, Dept. of Geology, University of Vermont.

Muth, M. and L. Pascale. 2001. Runoff from Paved and Unpaved Parking Lots at the Spruce Peak Parking Area, Stowe Mountain Resort, Stowe, Vermont. Unpublished student research

paper, prepared for Geol 151, available at http://geology.uvm.edu/morphwww/classes/morph/2001/projects/PROJ2001.html, accessed June 17, 2003.

White, M. 2002. Total Suspended Solids and Runoff Analysis for the Big Spruce and Mansfield Tributaries in the West Branch Watershed, Stowe, Vermont. Unpublished student research paper, prepared for Geol 198.

Students supported by the grant (* funded research assistant, ** unfunded student collaborators)

Michael Eller, graduate student, Dept. of Geography *
Ashley Feerer, undergraduate student, Dept. of Geography *
Keith Mussleman, undergraduate student, Dept. of Geology **
Marianne Muth, undergraduate student, Dept. of Geology **
Lelia Pasale, undergraduate student, Dept. of Geology **
Matthew White, undergraduate student, Dept. of Geology **

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Mussleman, K. 2002. Analysis of Spatial Variability of Precipitation and Snow Accumulation on Mount Mansfield, Stowe, Vermont. Unpublished senior research project, Dept. of Geology, University of Vermont.

National Ski Areas Association (NSAA), 2003. About NSAA – Working together for the future of skiing and snowboarding. Available at http://www.nsaa.org/nsaa2002/_home.asp, accessed June 17, 2003.

Waichler, S. R., M. S. Wigmosta, and B. C. Wemple (in review). Simulation of water balance and forest treatment effects at the H. J. Andrews Experimental Forest, submitted to *Hydrological Processes.*

Wigmosta, M. S., L. W. Vail, and D. P. Lettenmeier, 1994. A distributed hydrology- vegetation model for complex terrain, Water Resources Research, 30, 1665-1679.

Detection of cyanobacterial blooms using remote sensing

Basic Information

Title:	Detection of cyanobacterial blooms using remote sensing
Project Number:	2002VT5B
Start Date:	3/1/2002
End Date:	2/28/2003
Funding Source:	104B
Congressional District:	First
Research Category:	Water Quality
Focus Category:	Water Quality, Methods, Toxic Substances
Descriptors:	
Principal Investigators:	Suzanne Levine, Gerald Livingston, Leslie A. Morrissey

Publication

1. None

Detection of cyanobacterial blooms using remote sensing

Suzanne N. Levine, Gerald P. Livingston, and Leslie A. Morrissey
School of Natural Resources, University of Vermont, Burlington, VT 05405

Progress To Date:

This was a small ($6K) pilot study to investigate the feasibility of tracking and quantifying cyanobacterial blooms in Lake Champlain and small Vermont lakes using remote sensing. Methods were developed for accurately describing bloom intensity across grids representing the pixels detected by satellite detectors, as well as the light spectra reflected from such regions. Flow-through fluorometry was used for chlorophyll *a* and phycocyanin measurement along transects (the latter pigment is specific to cyanobacteria), while examination of reflected light spectra and cyanobacterial cell densities occurred at 10 point-sites along the transects. Two bays within Lake Champlain and two small eutrophic lakes were studied. The results suggested that algal biomass is best detected by near-infrared reflection, a conclusion also reached by other researchers investigating near-surface reflection through spectroradiometry (Arenz et al. 1996, Gitelson et al. 2000). One LandSat image of Lake Champlain was purchased to investigate whether image analysis at these wavelengths would detect blooms. Figure 1 shows three bloom areas on the image obtained, two of which were verified through ground observations. The high spatial heterogeneity of the blooms confirms the desirability of aerial or satellite monitoring rather than the single station sampling now carried out by the State of Vermont in these regions.

This project has been funded at a higher level ($30K) during 2003. The additional money will allow us to rent a boat large enough to reach more open regions of Lake Champlain, purchase of probes that allow simultaneous measurement of biomass indicators (in 2002, transects were traversed twice as pigments were measured with the same instrument set up with different lamps and filters), and purchase several satellite images. The impacts of suspended particles and dissolved organics, waves, and algal distribution in the water column, on light reflectance also will receive more attention, as these factors may influence the algorithms developed to predict algal biomass from satellite imagery. Because this project was strictly preliminary in 2002, its results have not been published or presented at conferences.

References

Arenz, R.F. Jr, W.M. Lewis, Jr and J.F. Saunders, III. 1996. Determination of chlorophyll and dissolved organic carbon from reflectance data for Colorado reservoirs. Int. J. Remote Sensing 17: 1547-1566.

Gitelson, A.A., Y.Z. Yacobi, J.F. Schalles, D.C. Rundquist, L. Han, R. Stark and D. Ettzion. 2000. Remote estimation of phytoplankton density in productive waters. Arch. Hydrobiol. Spec. Issues Advanc. Limnol. 55: 121-136.

Substrate- and size-dependent measurement of particle-phase mercury in the atmosphere by aerosol mass spectrometry

Basic Information

Title:	Substrate- and size-dependent measurement of particle-phase mercury in the atmosphere by aerosol mass spectrometry
Project Number:	2002VT6B
Start Date:	3/1/2002
End Date:	2/28/2003
Funding Source:	104B
Congressional District:	First
Research Category:	Climate and Hydrologic Processes
Focus Category:	Methods, Toxic Substances, Solute Transport
Descriptors:	
Principal Investigators:	Giuseppe Petrucci

Publication

1. Holmes, B. and G.A. Petrucci, 2002. Measurement of atmospheric particle-phase mercury by laser aerosol mass spectrometry. Federation of Analytical Chemistry and Spectroscopy Societies, FACSS, Providence, RI, USA, October 13-17.

Substrate- and Size-dependent Measurement of Particle-phase Mercury in the Atmosphere by Aerosol Mass Spectrometry

Annual Progress Report for the Period March, 2002 – February, 2003

Giuseppe Petrucci, Principal Investigator
Chemistry Department, The University of Vermont

Project Overview: The primary objective of this work is to optimize an aerosol mass spectrometer (AMS) to sample, size and analyze single mercury particles. Targeted photoionization of Hg in single particles was proposed to improve ionization efficiencies, thereby decreasing minimum detectable limits. To date, we have been able to measure Hg from single particles of $HgSO_4$ or Hg_2Cl_2 from particles as small as 0.11 μm. A typical mass spectrum (positive ion only) obtained from such a test particle generated in our laboratory is shown in Figure 1. From the Hg signal-to-noise shown, we estimate a limit of detection of ~10^{-16} g of Hg. Our estimated detection limit corresponds to 1 ppm Hg in a 10 mm particle or 100 ppm in a 1 μm particle. On average, the atmospheric particulate Hg burden is estimated to be 10 pg per 10 μg of atmospheric particulate, or 1 ppm in single particles (assuming a homogeneous distribution of Hg in all particles). Therefore, our present capabilities fall short of the needed sensitivity to measure Hg in single atmospheric particles at normal ambient levels. Having developed a better understanding of the laser-particle interaction and possible ionization dynamics, we now wish to pursue several different avenues to improve the sensitivity of the method. We wish to be clear, however, that we cannot guarantee that we will be able to achieve the necessary detection capabilities to measure atmospherically relevant levels of particle phase mercury.

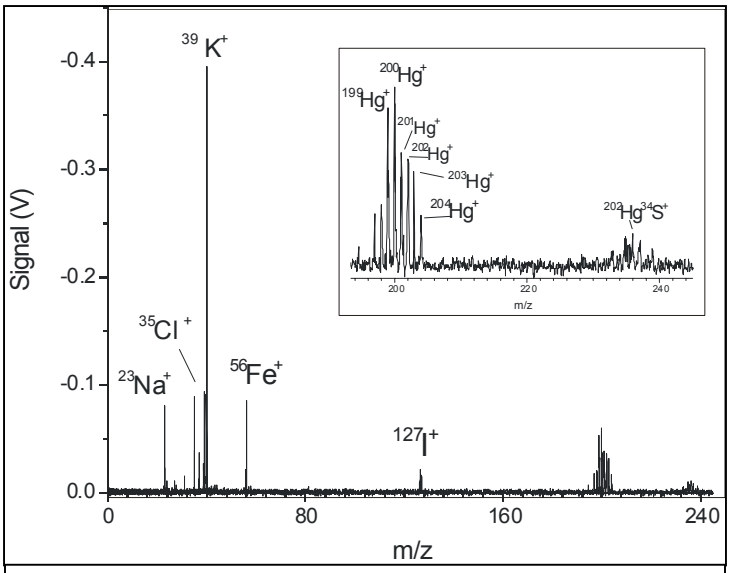


Figure 1. Positive ion mass spectrum of a single, 0.11 μm diameter $HgSO_4$ particle.

Progress to date:

Results from this project were recently presented at the Federation of Analytical Chemistry and Spectroscopy Societies (FACSS) conference in Providence, RI, in mid-October 2002. (A copy of the presentation is available upon request.) FACSS is considered the premier international conference for analytical chemistry and applied and fundamental spectroscopy.

We have adapted our aerosol mass spectrometer to Hg analysis. In accordance with risk management, we've set-up a system to safely handle ultrafine mercury aerosols in our

laboratory. We've also developed the expertise needed to generate ultrafine mercury particles with different chemical compositions and oxidation states of mercury.

The proposed plan involved using a tunable laser to vaporize and photoionize Hg particles. However, energy densities available with our tunable laser and optical system were not sufficient to overcome the lattice energies of the study particles. A modification has been made to the optical setup to increase the energy density in the relevant (laser) wavelength range by about a factor of 50, which should be sufficient for particle vaporization. In anticipation of this modification, the AMS was evaluated for Hg particle analysis with a laser operating at a fixed wavelength of 266 nm. Note that this wavelength is not sufficient to ionize neutral Hg by the simultaneous absorption of only two photons. Therefore, ionization efficiencies were expected to be low at this fixed wavelength, with a correspondingly poor sensitivity.

Both Hg(I) and Hg(II) salt aerosols were generated to test the capabilities of the AMS. We wanted to test whether the oxidation of state of the Hg in the particle could be maintained during the vaporization process (thereby permitting some degree of speciation). Much to our disappointment, however, we saw no evidence of Hg(II) in our particle mass spectra when analyzing ultrafine $HgSO_4$ particles. We believe that upon particle vaporization and ionization, the large local electron density results in a high degree of electron attachment to the Hg ions, resulting directly in the measured Hg(I) ions. Another possibility is full reduction of the Hg(II) to the neutral atom that is then photoionized by multiphoton absorption from the laser. If the latter is prevalent, then we can anticipate a significant increase in photoionization efficiency, and hence sensitivity, by tuning the laser to about 237.5 nm. At this wavelength, photoionization to Hg(I) can occur by absorption of only two photons. As stated above, we have the new optical setup in place that will allow us to use the tunable laser to determine the extent of electron attachment and evaluate the possibility of improving the sensitivity of the aerosol mass spectrometer to Hg.

Dissemination of information and educational objectives – Due to equipment problems and the complexity of the filtration setup to meet risk management guidelines, our first results were obtained late in 2002. This being the case, we have not yet deemed it appropriate to conduct the planned formal meetings with our colleagues at the Vermont Agency of Natural Resources of the School of Natural Resources at the University of Vermont. A half-day workshop is now being planned for either mid-December (immediately after Final Exams) or in the beginning of the new year (2003) before the beginning of the spring semester. Finally, we also feel it important to note that the development of the AMS for mercury analysis has been an important learning tool for the graduate students in the group as well as one undergraduate student, who has been working in the group since the beginning of the Fall 2002 semester.

Information Transfer Program

The Water Center continues to publish its newsletter in collaboration with the university's Extension System distributing approximately 620 copies during FY02. It also continues to play a leadership role in evolving strategies for managing watersheds and storm water runoff in Vermont. The Director is currently working on plans for an October 2003 session focused on engaging communities in storm water issues and will be administering a USEPA-funded project on storm water runoff in a local watershed.

Information Transfer Program

Basic Information

Title:	Information Transfer Program
Project Number:	2002VT7B
Start Date:	3/1/2002
End Date:	3/28/2003
Funding Source:	104B
Congressional District:	First
Research Category:	Water Quality
Focus Category:	Education, Water Quality, Water Use
Descriptors:	newsletter
Principal Investigators:	Linda Marek Howe, Alan W. McIntosh

Publication

1. Howe, L.M., A.W. McIntosh, and J. Homziak. 2002. Reflections on Water Newsletter. 24(1):6. Approximately 620 were distributed.

Reflections on Water

Vermont Water Resources & Lake Studies Center

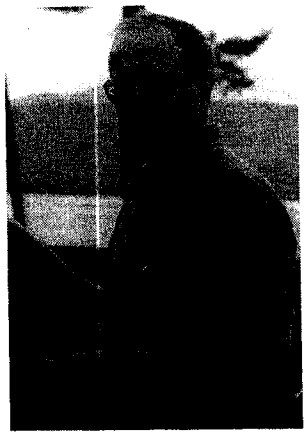
University of Vermont Extension

VOL. 24

January 2002

NO. 1

MESSAGE FROM THE DIRECTOR



Odds and Ends

In our last Newsletter in June, I noted the dry conditions. Not much has changed, with dry month following dry month. It's amazing to see the lake at such a low level this time of the year. Hopefully, we'll see a return to wetter conditions soon.

Water Center update: we recently submitted our latest set of research proposals to the USGS for funding consideration. Once we receive approval, hopefully by the end of February, we'll post abstracts describing the new projects. I think you'll find them fascinating! Current projects by Professor Leslie Morrissey (UVM) on Vermont's agricultural riparian zones and Professor Tom Manley (Middlebury College) on Lake Champlain's flow patterns are ending, and we'll be posting results on our web site soon. (http://snr.uvm.edu/vtwater)

What's new with storm water?

If you've been following the water scene in Vermont, you know that storm water has been a red-hot issue of late. Rulings, lawsuits, and proposed legislation have been flying like snowflakes. Essentially, the issue revolves around proposals for new development in watersheds where surface waters have been declared impaired by the state. To try to help shed some light on the controversy, the Water Center and the Vermont Law School held an all-day workshop on storm water Saturday, January 19. A group of about 45 folks, including Vermont legislators, city officials, representatives of NGOs, private citizens and scientists and engineers gathered to discuss the science and engineering of storm water in the morning and legal and policy aspects in the afternoon. Two national experts, Dr. Ed Herrick of the University of Illinois and Dr. Bob Pitt of the University of Alabama, joined Cully Hession and Al McIntosh of UVM via videoconference to share their knowledge of storm water. In the afternoon, Pat Parenteau of the Vermont Law School led a discussion of the legal and policy aspects of stormwater, along with Ann Williams of USEPA-Region I and Lajuana Wilcher of LeBoeuf, Lamb, Greene, and MacRae. Chris Recchia, Commissioner of the Vermont ANR's Department of Environmental Conservation spoke with attendees about the state's storm water initiative. Attendees agreed that the workshop was a useful start.

If you'd like to view a taped version of the afternoon portion of the workshop, check out our web site. We are hoping to organize a follow-up session later this spring or summer focused on a particular watershed in the local area. Stay tuned!

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Nutrient Management Plans Implemented on Vermont Farms

Sid Boswoth, Extension Agronomist, along with Extension Field Crop Specialists Jeff Carter and Willie Gibson, received funding from the U.S. Department of Agriculture to implement effective comprehensive nutrient management plans on Vermont livestock farms. This project will be a highly coordinated effort of university extension, research, and educational faculty partnering with consultants and will focus on the high priority, multi-state and international watersheds of the Lake Champlain Basin, the Connecticut River, and Lake Memphramagog.

In order to develop and implement effective nutrient management plans, farmers will need decision-making tools, support systems and an understanding of whole farm nutrient management. Farmers will need a complete and comprehensive set of field records describing properties, ownership, resources and allocations and costs of production inputs. Farmers and consultants are presently using Vermont CropMD© software. Farm advocacy teams, comprised of representatives of different agricultural industries and agencies, have been shown to be effective in helping farmers to improve their management skills and adopt improved production practices.

The objectives of this project include:1) expand and revise the CropMD© database software by adding decision-making modules for farmers and consultants for environmental assessment and nutrient management planning and to use the software to evaluate the impact of nutrient management plans on whole farm nutrient balances and economics on cooperating farms; 2) demonstrate on case-study farms the use of Farm Advisory Teams in developing and implementing comprehensive nutrient management plans, and 3) develop and carry out a statewide curriculum-based extension education program for farmers and agricultural professionals involved in comprehensive nutrient management planning.

More details of this project can be found at pss.uvm.edu/cnmp. Expected outcomes will include an increased understanding and usage of comprehensive nutrient management planning by farmers and nutrient management planners.

PUBLICATIONS

A Dynamic Approach to Groundwater Remediation Design. Papadopoulou, M.P., G.F. Pinder, and G.P. Karatzas. 1999. pp. 8. Project was funded, in part, by a grant from the Vermont Water Resources and Lake Studies Center. $4. To obtain a copy contact: Murphy MacLean at (802) 656-4057 or mmaclean@zoo.uvm.edu.

Emergency Planning for Water Utility Management, Fourth Edition, catalog #30019, $55/manual (for AWWA members) and $85 (for nonmembers). Covers hazards, vulnerability assessment, mitigation actions, preparedness plan, and emergency, response, recovery, and training. Order from Customer Service, American Water Works Association, 6666 W. Quincy Ave, Denver, CO 80235. Or phone 800-926-7337.

WEB SITES

Visit the Vermont Water Resources and Lake Studies Center website at: **http://snr.uvm.edu/vtwater** for information about the Water Center and the School of Natural Resources at The University of Vermont.

EPA's River Corridor and Wetland Restoration - Biweekly Restoration Information Updates can be found online at the following address: http://www.epa.gov/owow/wetlands/restore/update/ . The Biweekly Updates provide current information on wetland and river corridor restoration projects, recognizes outstanding restoration projects, and provides a forum for information sharing.

The ***U.S. Geological Survey recently launched its new, online National Water Information System.*** The new website, located at http://water.usgs.gov/nwis/ allows users to access several hundred million pieces of archival and real-time data. The information can help water managers, engineers, scientists, emergency managers, recreational water users, utilities, and others to: evaluate current water supplies and plan for future supplies, forecast floods and droughts, operate reservoirs for hydropower, flood control, or water supplies, evaluate and control water quality, navigate rivers and streams, safely recreate. For information on other USGS data types, visit the home page at http://www.usga.gov.

The ***National Environmental Services Center*** has redesigned their web site. Located at www.nesc.wvu.edu, the site features information about treatment technologies, management and financial strategies, current and changing environmental regulations, environmental training, and other issues related to running a small community water or wastewater system.

VIDEO

Stormwater Conference: Level and Policy Aspects of Stormwater. Available at the Vermont Water Resources and Lake Studies Center website: **http://snr.uvm.edu/vtwater**

WORKSHOPS

March 11-13, 2002 Watershed Management to Meet Emerging TMDL Environmental Regulations Conference and Exhibition, Radisson Plaza Hotel, Fort Worth, Texas. Sponsored by the Society for engineering in agriculture, food, and biological systems. For information contact ASAE by phone at 1-800-371-2723 or internet at http://www.asae.org/

April 11, 2002 Vermont GIS Expo 2002, a Road Map to Geographic Information Systems in Vermont, Capital Plaza Hotel, Montpelier, VT. For information contact Leslie Pelch, Outreach Coordinator, Vermont Center for Geographic Information, Inc., 590 Main St., University of Vermont, Burlington, VT 05404, phone 802-656-4277, or internet at http://www.vcgi.org (Look for the EXPO link).

May 7-9, 2002 Hardrock Mining 2002 Issues Shaping the Industry, Westminster, CO (Denver/Boulder area). Visit the U.S. Environmental Protection Agency's web page at www.epa.gov/ttbnrmrl.

August 12-15, 2002 StormCon, The North American Surface Water Quality Conference and Exposition, Marco Island, FL. The conference will address the impacts of urbanization on aquatic systems, evaluate new surface water-quality technology, tests and techniques, look at effective local storm water management ordinances, and look at effective storm water planning and protection methods. For information on the internet at http://www.StormCon.com.

SEA GRANT WORKSHOPS

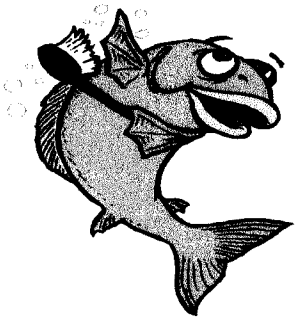
Leadership Workshops for Watershed Management **Benchmarking: Financial Management & Organizational Assessment**. $25 registration fee.

Presenters: Sharon Behar & Margaret McCoy. February 11, 2002, The University of Vermont campus, Burlington, VT 05405. Phone (802) 656-0682, e-mail at: jhomziak@snr.uvm.edu; website: http://snr.uvm.edu/lcseagrant

Fundraising: The Nuts and Bots. $25 registration fee. Presenter: Andy Robinson. March 15, 2002. Plattsburgh State University. Phone (802) 656-0682, e-mail at: jhomziak@snr.uvm.edu; website: http://snr.uvm.edu/lcseagrant

Leadership Development: Skills for Watershed Stewardship. $25 registration fee. Presenters: Sharon Behar & Steve Dickens. April 26, 2002. The University of Vermont campus, Burlington, VT 05405. Phone (802) 656-0682, e-mail at: jhomziak@snr.uvm.edu; website: http://snr.uvm.edu/lcseagrant

Register for all 3 workshops at a cost of $60



AQUACULTURE CORNER

In the last issue, Aquaculture Corner described the basics of raising trout in ponds. This and following issues will provide landowners and others more details on how to manage ponds for warm-water and cold-water fish in Vermont. The information in this series is taken from UNH and Cornell Extension fish farming fact sheets.

POND HABITAT ASSESSMENT

Planning to stock and raise fish requires an assessment of what your pond has to offer. The key items to check are temperature, depth and water quality.

Temperature

Cold-water ponds have a summer maximum of less than 74° F, while warm-water ponds reach temperatures above 74° F during the summer months. Cold-water ponds can sustain various trout species. Ideally, trout ponds should not exceed 70° F in the summer. Ponds that get warmer are good for sunfish and bass.

Water temperature is determined both by the water source and location of the pond. Potential water sources for a pond include surface runoff, streams, springs and wells. Cold-water temperatures in Vermont ponds are usually maintained by groundwater inputs from springs or wells. Groundwater usually maintains much colder temperatures during the summer than surface water sources - such as runoff and streams - which are heated by the sun's radiation and warm summer air. Warm-water ponds are usually fed by surface water and are found throughout the state. Only at higher elevations are surface waters cool enough during the summer to maintain cold pond water temperatures without groundwater inputs. Ponds fed entirely by runoff are often too warm for trout survival during summer, unless the pond is quite deep.

Water Quality

Nutrients are important to maintain production within ponds. However, too many nutrients are not a good thing.

Phosphorus and nitrogen are familiar nutrients that we use to fertilize lawns, gardens and houseplants. These nutrients also promote the growth of aquatic vegetation such as floating algae and rooted pond plants, controlling pond productivity. Ponds fed by groundwater or wells may be short of nutrients. Most Vermont ponds have enough available nutrients to support fish production. A much more common problem is excessive nutrient levels. Watershed land uses influence nutrient levels and water quality.

Runoff from cropland can increase the amount of sediment reaching the pond and may cause excessive turbidity. Runoff may also contain potentially toxic agricultural chemicals, and runoff from pastures and livestock holding areas is rich in nutrients from animal wastes. Residential, urban, and industrial runoff may contain substances (such as chemicals, oils, and sediment from construction activities) that can adversely affect a pond's water quality.

Oxygen levels are another important aspect of pond water quality. Oxygen levels can limit fish survival and production. High nutrient levels that produce algae blooms eventually result in decaying vegetation that uses up available dissolved oxygen. Fish kills often result from a lack of oxygen or, under extreme circumstances, the presence of toxic algae. During hot weather most ponds have a layer of water near the bottom that contains little or no dissolved oxygen. When high winds or cold rain cause this water to mix with the upper pond water, oxygen levels often drop to levels that can kill fish.

Depth

Ponds are usually constructed with depths between 6 and 8 feet, and with a maximum depth not greater than 10 to 12 feet. Natural ponds can be found with a wide variety of depths. An average depth of less than 6 feet favors the establishment of aquatic vegetation in the pond, and depths greater than 12 feet are not necessary for good fish production. Steep pond slopes help prevent the growth of nuisance aquatic vegetation, which can also become an important feature of the pond habitat.

ACTIVITIES TO ASSESS YOUR POND

Temperature

Use a thermometer to measure the surface water temperature of the pond. The water temperature at the deepest part of the pond can be measured using a thermometer attached to a weighted rope. Lower the device until it is just off the bottom and leave it suspended there for approximately 5 minutes. Raise the device quickly through the water column, remove the thermometer and check the temperature immediately. Thermometers can be purchased from local hardware stores, aquarium shops, or various equipment supply companies.

Depth

Water depth is best measured from a boat, along 2 perpendicular transects in the pond. Use a weighted line to measure depth at 5 points along one transect and at 5 points along the other transect. Add these depth measurements and divide by the total number of measurements to calculate the average depth. To obtain the best depth estimate, the larger the pond, the more measurements you should take. You can also effectively measure pond depth during the winter by boring holes in the ice with an auger along transects at regular intervals.

Water Quality

Water clarity can be influenced by many variables such as turbidity caused by suspended sediments and the density of microscopic algal in your pond. Monitoring the water clarity in your pond can be very interesting over the course of the year. It can give you important information about the amount of algae in your pond, which indicates how many nutrients are coming in. It can also tell you if sediments are coming as well. The standard method for measuring water transparency is to use a secchi disk. Secchi disks are available for purchase from various equipment supply companies. Instructions for making a secchi disk are available at http://dipin.kent.edu/makedisk.htm

To obtain a secchi reading, lower the disk into the water slowly and stop just when it disappears from sight. Record this depth. Slowly raise the disk back up until it comes into view, and then stop. Record this depth. The secchi disk reading, as a measure of transparency, is an average of these two measurements.

Keep a record of your measurements, especially temperature and turbidity. Take samples on a

regular basis to find out how your pond behaves at different times, and under different circumstances. A spike in turbidity immediately after a rain suggests that sediment is entering the pond. A gradual increase after a rainfall or peaks in turbidity during hot, dry periods suggest that algal growth is responsible, and lots of algae suggest that excess nutrients may be getting into your pond. The better you know your pond, the better you will be able to grow fish.

VEGETATION MANAGEMENT

This column cannot provide comprehensive information regarding vegetation management in ponds. However, since pond owners are frequently concerned about managing vegetation, a few links to sources of information for identifying aquatic vegetation may be useful.

Plant identification can be found at the following two commercial sites:
http://www.killlakeweeds.com/weeds.cfm
http://www.aquaticsystems.net/weedid.html

These are commercial sites. Mention of them here does not constitute an endorsement by Sea Grant or UVM extension in any way of the site, company, products or control methods discussed in them. Nevertheless, we have discovered that commercial aquatic vegetation control firms offer the best available web-based descriptions of aquatic vegetation.

MEETINGS AND CONFERENCES

Annual NHAA Meeting, March 2nd, 2002. Pot Luck Lunch. Volunteers needs. Contact: Klee Dugan (603) 464-3799.

World Aquaculture 2002. Annual Meetings of the World Aquaculture Society & the China Society of Fisheries. April 23-27, 2002 (Tradeshow: April 24-27, 2002). Beijing Convention Center, Beijing, China.

For more information, contact:
WORLD AQUACULTURE 2002
Conference Manager, 2423 Fallbrook Place
Escondido, CA 92027 USA
(760) 432-4270 / Fax: (760) 432-4275
Email: worldaqua@aol.com
Or visit the website: www.was.org

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Linda M. Howe Linda M. Howe
Extension Water Resources Specialist

USGS Summer Intern Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	0	0	0	6	6
Masters	3	0	0	0	3
Ph.D.	0	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	3	0	0	6	9

Notable Awards and Achievements

Publications from Prior Projects

None