New York State Water Resources Institute
Annual Technical Report
FY 2012

Introduction

The Mission of the New York State Water Resources Institute (WRI) is to improve the management of water resources in New York State and the nation. As a federally and state mandated institution located at Cornell University, WRI is uniquely situated to access scientific and technical resources that are relevant to New York State's and the nation's water management needs. WRI collaborates with regional, state, and national partners to increase awareness of emerging water resources issues and to develop and assess new water management technologies and policies. WRI connects the water research and water management communities. Collaboration with New York partners is undertaken in order to: 1) Build and maintain a broad, active network of water resources researchers and managers, 2) Bring together water researchers and water resources managers to address critical water resource problems, and 3) Identify, adopt, develop and make available resources to improve information transfer on water resources management and technologies to educators, managers, policy makers, and the public.

Research Program Introduction

The NYS WRI's FY2012 competitive grants research program was conducted in partnership with the NYS Department of Environmental Conservation (DEC) Hudson River Estuary Program (HREP). The overall objective of this program is to bring innovative science to watershed planning and management. In FY2012 research was sought that fit within the context of New York State's growing concerns about aging public infrastructure, economic constraints on public investment, and the recent requirement for State planning agencies to incorporate principals of "smart growth" as promulgated in the 2010 Smart Growth Public Infrastructure Policy Act (http://smartgrowthny.org/index.asp). The specific areas of interest for the FY2012 grants program solicitation were: 1) Water-related infrastructure including water supply and wastewater treatment facilities, distribution networks, decentralized treatment installations, dams, constructed wetlands, etc., and their current state and effectiveness at providing water services regionally at reasonable cost; 2) Regional economic vitality with respect to water infrastructure and its effect on private and public investment and industrial development; 3) Integration of scientific, economic, planning/governmental and/or social expertise to build comprehensive strategies for public asset and watershed management; 4) Smart growth and its implications for water related infrastructure development, regional water quality, and regional economy; 5) Novel outreach methods that enhance the communication and impact of science-based innovation to water resource managers, policy makers, and the public; 6) The economics and benefits of source watershed protection strategies and the use of ecological services to meet water supply and quality needs, as opposed to treatment at point of delivery. Projects were evaluated by a panel consisting of representatives of the US Geological Survey, the NYS DEC, and faculty from Cornell University. Two research projects were supported in FY12 through the 104(b)competitive grants program with a total funding level of $39,840. These projects included:

1. Relative abundance of blueback herring in relation to permanent and removable dams on the Mohawk River. PIs: Dr. Karin Limburg & Dr. Neil Ringler, SUNY Environmental Science & Forestry.

2. Pollution trade-offs associated with the use of riparian zones as best management practices. PI: Dr. Philippe Vidon, SUNY Environmental Science & Forestry.

We also report here on two projects that received no-cost extensions beyond FY2011. The two projects listed below were completed in February, 2013, and December, 2012, respectively:

3. N availability as a driver of methylmercury production in forested soils and stream sediment. PI: Dr. Philippe Vidon, SUNY Environmental Science & Forestry.

4. Two-dimensional river model for predicting bacterial contamination of bathing beaches in the St. Lawrence. PI: Dr. Michael Twiss, Clarkson University.

Lastly, we include information on a supplemental award:

USGS Award No. G11AP20223 Flood Frequency Research for California

and also on a 104(g) project that has just begun:

2012NY189G The Remote Monitoring of Surface Velocity, Bathymetry, and Discharge

NITROGEN (N) AVAILABILITY AS DRIVER OF METHYLMERCURY PRODUCTION IN FORESTED SOILS AND STREAM SEDIMENTS

Basic Information

Title:	NITROGEN (N) AVAILABILITY AS DRIVER OF METHYLMERCURY PRODUCTION IN FORESTED SOILS AND STREAM SEDIMENTS
Project Number:	2011NY161B
Start Date:	3/1/2011
End Date:	2/28/2013
Funding Source:	104B
Congressional District:	25
Research Category:	Water Quality
Focus Category:	Non Point Pollution, Toxic Substances, Nitrate Contamination
Descriptors:	
Principal Investigators:	Philippe Gilles Vidon

Publications

There are no publications.

FINAL Report for NYWRRI Award # 64038-9616

NITROGEN (N) AVAILABILITY AS DRIVER OF METHYLMERCURY PRODUCTION IN FORESTED SOILS AND STREAM SEDIMENTS

Start / End dates: 03/11-02/13
(a 1-year no-cost extension was granted to SUNY-ESF in May 2012)

Principal Invesigators: P. Vidon and M. Mitchell.

Objectives

Atmospheric deposition of nitrogen (N), sulfur (S) and mercury (Hg) is ubiquitous in the Northeastern United States and has a major impact on forested lands and the water quality of this region. However, although recent research suggests significant interactions exist between the N, S and Hg cycles in forested landscapes, the exact nature of the complex interactions between these cycles is still poorly understood. For this project, the objectives were to: 1) Determine what variable or combination of variables regulate S, Hg and MeHg export at the watershed scale across a range of seasonal and hydrological conditions (e.g., low flow versus high flow); and 2) Determine to what extent nitrate availability in forest soils and associated wetland sediments regulate S, Hg and methylmercury (MeHg) availability across a range of redox conditions, from headwater locations (oxic) to stream hyporheic zones, and lowland wetland soils (anoxic). Addressing these objectives is critical to the management of our forests as climate and rates of N, S and Hg atmospheric deposition are constantly changing. Understanding what variables affect S and Hg cycling in these watersheds in relation to changes in hydrological and redox conditions in soils and streams will help **1)** better predict how future changes in climate and atmospheric deposition might affect N, S, and Hg dynamics, and **2)** identify areas of the landscape that are especially sensitive to N, S or Hg contamination and where management should be focused.

Activity Report

Because FY2011 funds did not become available to the PIs before the middle of August 2011, it was decided that the project would be delayed one year in order to capture N, S and Hg dynamics in spring, a critical time of year for Hg export. A one-year no-cost extension was granted by the NYWRRI to SUNY-ESF in May 2012 until 02/2013.

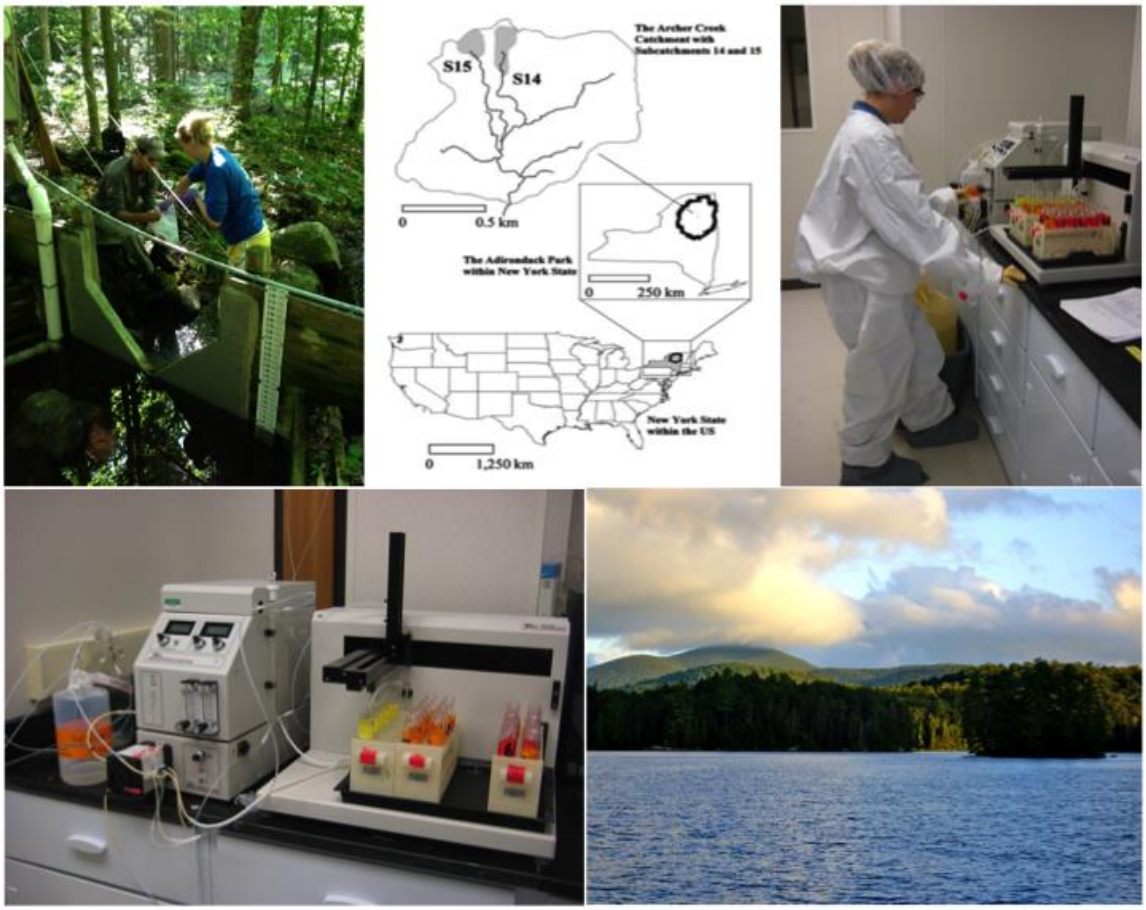
To date, all fieldwork has been completed, and total mercury (THg), methylmercury (MeHg), nitrate (NO_3^-), dissolved organic carbon (DOC) concentrations, and sulfate / sulfide ratios were determined for a total of 12 dates between April and October 2012 (growing season).

THg concentrations in the study streams typically varied between 1 ng/L and 5 ng/L, and were significantly positively correlated to DOC ($p<0.05$). Similarly, THg was positively correlated to a variety of fluorescence indices (FI, HIX, Humic A) suggesting, that together with DOC, the fluorescence properties of organic matter may be good indicators of Hg concentrations in the stream.

Nitrate was only poorly correlated to THg suggesting that differences in nitrate levels in the watershed were not tied to clear differences in THg export at the watershed scale. However, THg was strongly negatively correlated to Sulfide. Although the methylmercury data are still being analyzed at this report is being written, these results are consistent with our understanding of Hg chemistry. Indeed, as sulfate reduction occurs in the summer, and therefore as more sulfide is

produced, a large fraction of THg is converted into MeHg, therefore leading to a drop on THg concentration.

Water quality analysis also revealed a large increase in DOC concentration in the lower section of the watershed where a wetland is present. As MeHg data become available, we will explore in more details the relationship between nitrate level, DOC, and MeHg. Specifically, we will investigate the spatial and the temporal variability of MeHg production, in relation to nitrate dynamics in particular.



Graduate and Undergraduate Student Training (1 Graduate Student, 3 Undergraduate Students)

This research project forms the basis of the MS Thesis for Whitney Carleton, graduate student in the Department of Forest and Natural Resources Management at SUNY-ESF under the supervision of PI Vidon. Whitney started her MS project in Fall 2011, and is expected to graduate from SUNY-ESF after completion of this research project in Summer 2013.

In addition to Whitney, three undergraduate students (Joshua Enck, Mario Alciati, and Angela Marcoccia) were directly involved in this project.

Conference Presentations

Carleton, W., P. Vidon, M. Mitchell, 2012. Total mercury and methylmercury dynamics: Stream export in an upland-forested watershed in the Adirondack region of New York State. **SUNY-ESF Spotlight on Research 2012 Conference**, Syracuse, NY, April, 2012.

Carleton, W., P. **Vidon**, M. Mitchell, 2013. Total mercury and methylmercury dynamics: Stream export in an upland forested watershed in the Adirondack region of New York State. **2013 CNY Earth Science Student Symposium**. Syracuse, NY, April 2013.

Carleton, W., P. **Vidon**, M. Mitchell, 2013. Total mercury and methylmercury dynamics: Stream export in an upland forested watershed in the Adirondack region of New York State. **SUNY-ESF Spotlight on Research 2013 Conference**, Syracuse, NY, April, 2013.

Carleton, W., P. **Vidon**, M. Mitchell, 2012. Total mercury and methylmercury dynamics: Stream export in an upland-forested watershed in the Adirondack region of New York State. **SUNY-ESF Spotlight on Research 2012 Conference**, Syracuse, NY, April, 2012.

Carleton, W., P. **Vidon**, M. Mitchell, 2012. Total mercury and methylmercury dynamics: Stream export in an upland forested watershed in the Adirondack region of New York State. Abstract # B31C-0432. **American Geophysical Union Annual Meeting**. San Francisco, California, December 2012.

In addition, **two manuscripts** are currently in preparation for submission to peer-reviewed journals in fall 2013.

Two-Dimensional River Model for Predicting Bacterial Contamination of Bathing Beaches in the St. Lawrence River

Basic Information

Title:	Two-Dimensional River Model for Predicting Bacterial Contamination of Bathing Beaches in the St. Lawrence River
Project Number:	2011NY165B
Start Date:	3/1/2011
End Date:	8/31/2012
Funding Source:	104B
Congressional District:	23
Research Category:	Water Quality
Focus Category:	Surface Water, Non Point Pollution, Models
Descriptors:	
Principal Investigators:	Michael Twiss

Publications

There are no publications.

Final Report: Use of Two-Dimensional River Modeling for Predicting Bacterial Contamination of Bathing Beaches in the St. Lawrence River

Michael Twiss, Department of Biology

Clarkson University, Potsdam NY

Introduction

Human health concerns stemming from recreational bathing are an important issue in the St. Lawrence River (over 100 miles in length) and throughout New York State. Despite high water quality in the main channel of this major river, bathing beaches are affected by tributary inputs that carry agricultural and urban effluents and have profound impacts on near shore water quality for considerable distance downstream; this is a concern for municipalities (e.g., Clayton, Alexandria Bay, Massena) and the NYS Office of Parks, Recreation & Historic Preservation who are responsible for beaches in this area, as well as those in Canada. At present there are no viable protocols in place to forecast beach closures in this region. Decisions on bathing risk are made >24 h after sampling due to the time required for water sampling and processing (incubation) to measure fecal indicator bacteria, typically *E. coli*..

Objectives

We conducted a combination of computer modeling, field sampling during the summer bathing season, and field experimentation to develop the basis for a predictive model of beach health assessment. The investigation focused on the International Section of the St. Lawrence River (the section of the St. Lawrence shared by Canada and the United States from its headwaters in Lake Ontario downstream to the Moses-Saunders Power dam at Massena NY/Cornwall, ON. The scope was refined to examine two beaches of interest: one in New York at Coles Creek State Park and one in Ontario at Crysler Beach.

Personnel involved

Dr. Michael R. Twiss, Professor of Biology/Director of Great Rivers Center at Clarkson University, Potsdam, NY, 13699, email: mtwiss@clarkson.edu; tel. 315-268-2359

Dr. Joseph Skufca, Associate Professor of Mathematics & Computer Science, Clarkson University, email: jskufca@clarkson.edu; tel. 315-268-2399

Dr. Jeffrey J. Ridal, St. Lawrence River Institute of Environmental Sciences, 2 Belmont Street, Cornwall, ON, Canada K6H 4Z1, email: jridal@riverinstitute.ca; tel. 613-936-6620

Students:

1. Anthony Harvey, Master of Science candidate, Environmental Science and Engineering, Clarkson University
2. Nicholas Marshall (2011), Bachelor of Science candidate, Applied Mathematics, Clarkson University

Completed Work Overview

Our work was conducted over two field seasons (2011, 2012). In 2011, fecal coliform in nearshore waters was determined at specific locations along the NY side of the St. Lawrence River with the objective of developing a predictive model for fecal contamination at Coles Creek State Park Beach. In 2012, we were not able to continue with this sampling design since the New York State Department of

Transportation began work in June on a culvert under Route 37. This culvert was the fecal coliform contaminated tributary ("Red Mills Tributary") that we identified, through hind casting of water flow using a 2D hydrodynamic model, as being 24 hours upstream. The construction created a dam upstream of the tributary and a pumped diversion. Due to the high impact we decided to invest our remaining efforts on the project to obtain rate constants on fecal coliform growth and loss rates in river water and further observations of fecal coliform distribution in the St. Lawrence River. These will be used to develop a mechanistic model of fecal bacteria transport in the St. Lawrence River.

Summary of Results from Work Completed

● 2011 ●

Experiment 1A: Monitoring Coles Creek State Park Beach

Description: A 10 week study (16 June 2011to 18 August 2011; day of year 167-230) was performed in order to gain information about water quality and fecal coliform presence at specific locations along the St. Lawrence River. These locations were selected based on a 2D river flow model of the St. Lawrence River that showed how water interacted with the near shore of the U.S. side of the river from Red Mills Tributary to Coles Creek State Park Beach. Petri-Film (3M Corp.) plates were used to enumerate *E. coli* and fecal coliform bacteria.

Result-Expt.1A: Rainfall does not appear to have a significant effect on total coliforms or *E. coli* at Coles Creek State Park Beach (Fig. 1). However, rainfall may affect other parameters that affect *E. coli* levels or the rainfall may not have an immediate effect due to lag time in runoff.

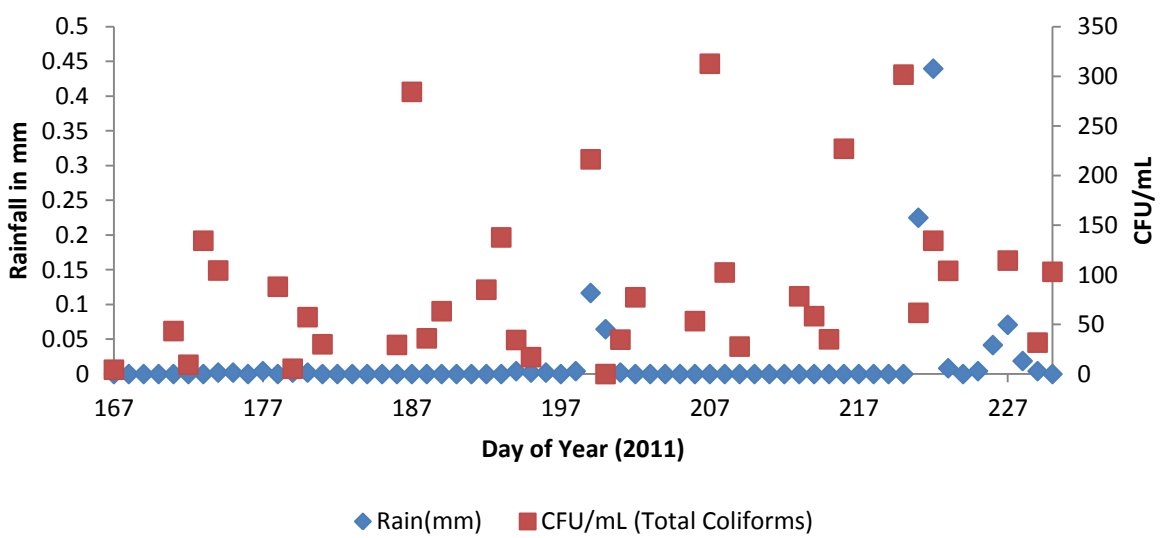


Figure 1. Total coliform detected at Coles Creek State Park Beach over a 60 day period in 2012 that encompassed the peak bathing period. Statistical predictive modeling showed no ability to predict total coliform or *E. coli* contamination in the water based on any ancillary measured parameters, including rainfall.

Samples collected during this project at Coles Creek State Park Beach were notably greater in *E. coli* than samples taken by the State Park personnel, which were analyzed by a separate lab (Fig. 2). This will be communicated to the NYSDOH in order to notify them of what is considered to be an important discrepancy. One possible explanation of this is that samples collected (independently) in our study wer placed in a darkened cooler at ambient river water temperature and processed within an hour at the laboratory. In contrast samples collected by the State contractor were kept cool and processed up to 24 hours after collection; we suspect t that that protocol adversely affected *E. coli* survivorship in the sampled river water.

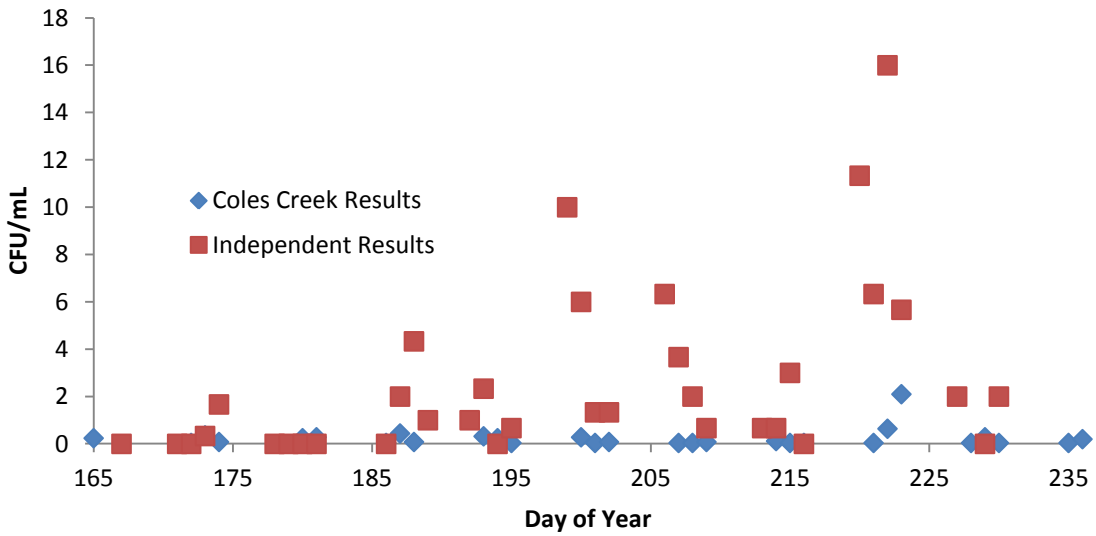


Figure 2. A comparison of *E. coli* detected in samples collected in this study (independent) versus those collected by contractors sampling water for the State at Coles Creek State Park Beach.

Experiment 1B: Mathematical Modeling Techniques for predicting fecal Coliform Contamination at Coles Creek State Park Beach

Description: As our foundational mathematical goal, we wanted to develop a *methodology* that could be used to predict *E. coli* levels at a beach, where we specifically intend for this methodology to allow for either now casting (based on immediately available factors) or forecast (based on previous days values). As such, we take as explanatory variables a number of measured quantities deemed to be biologically relevant, measured at the beach site. Additionally, we used river flow models to estimate "day-ahead" sources of water at the beach, and made water quality measurements at these specified upstream locations. As a third source of available explanatory measurements, we consider weather information (wind, rainfall, temperature). Mathematically, our goal was to determine a prediction function

$$y = f(x_1, x_2, \dots, x_n)$$

that could predict beach e-coli level y as a function of the explanatory variables.
Our general approach was to consider both regression models (linear and nonlinear), which could predict a *bacteria level*, logistic regression models, predicting a *likelihood of exceeding a safe level*, and classifiers – predicting whether we are *above or below* some threshold. For each models explored, we had to make a selection of which predictor variables to include in the model. Although it might seem that better models could be achieved through inclusion of all the variables, it is reasonably easy to

imagine that if a predictor variable was not very important, it could add "noise" to prediction without adding much power to the predictive performance. As such, we desired to determine which predictor variables are most important to the modeling process. Our algorithm in evaluating these models is outlined as follows:

1. Assume a basic model structure
2. Choose a subset of explanatory variables
3. Choose model parameters (regression coefficients, for example) that minimize model error and measure performance
4. Evaluate performance of that subset of variables by using a cross-validation procedure.
5. Repeat steps 2-4 to exhaustively search all subsets of explanatory variables to determine the most robust set of variables for that model structure
6. Repeat steps 1-6 for other model structures.

Result-Expt.1B: From our preliminary modeling effort, we draw the following main conclusions:

- Linear Regression performed very poorly, indicating likely non-linear dependence on explanatory variables.
- K-Nearest Neighbor classifier (a simple, non-linear approach) appears to be the most robust of the models studied.
- For the beaches under study, upstream tributaries are the likely source of the bacterial contamination.
- Key variables in predicting next day beach levels are conductivity and bacteria level at the upstream tributary, along with current and previous day rainfall.

Our initial analysis was based on data measured within this funded study. Additionally, we applied a similar result on collaborator data collected at Canadian beaches during a previous summer (2010). The approach to identify a good model seems to have worked well on these datasets. However, the approach must be viewed as "exploratory data analysis" in that we are considering all possible models before evaluating performance.

● 2012 ●

Experiment 2: The Effects of Tributary Inputs on Water Quality on Crysler Beach, St. Lawrence River.

Description: Crsyler Beach is located 7 km northeast from Coles Creek State Park. Owing to the issue with road work affecting the tributary sampling related to our initial study site, Coles Creek, we applied the same type of hind casting to determine that water impinging on Crysler Beach was in the vicinity of Hoasic Creek , 24 hours previously. Since we could not conduct the same type of thrice-weekly sampling as done at Coles Creek State Park Beach in 2011, we coordinated with personnel from the St. Lawrence River Institute of Environmental Science (SLRIES) to conduct an intensive survey, on 22 June 2012 of the river from Crysler Beach to 8 km upstream. Water was sampled for *E. coli* and fecal coliform bacteria, temperature, specific conductivity, turbidity, and chromophoric dissolved organic matter (CDOM). Sampling was conducted from a depth of 0.3 m to 2 m using a zodiac boat of the SLRIES and from 2 m to the mid-channel using

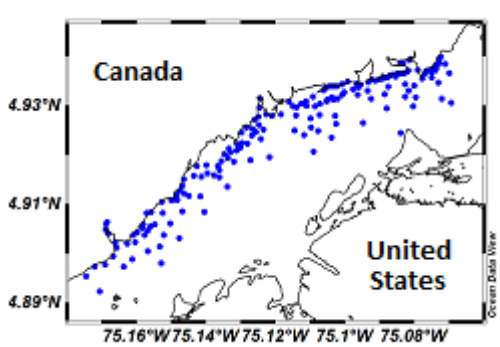


Figure 3. Sampling stations (Experiment 2).

the coastal research vessel of the Great Rivers Center at Clarkson University. The investigative survey was performed to gain information regarding tributary outputs and if they cause a significant amount of *E. coli* to enter the near shore and main channel of the river.

Result-Expt.2:
The results of the investigative survey show that there are major water quality differences in the tributaries and low flow areas of the river compared to the main channel area (Fig. 4A-D). These trends can be seen with all water quality parameters that were measured. However, there did not appear to be elevated bacteria at the mouth of the tributary or in low flow areas as indicted by water quality. Instead, the near shore water more closely resembles the main channel water (Fig. 4E-F). This may be due to the low flow from the tributaries into the St. Lawrence River, which causes gradual mixing. One possible reason for the the lack of abundant coliform bacteria from the tributaries may be the lack of precipitation in the days prior to the day of sampling, as reported by the City of Cornwall water filtration plant's climatological station report which stated that there was a total of 0.5 mm of rainfall in the 10 days prior to the survey date.

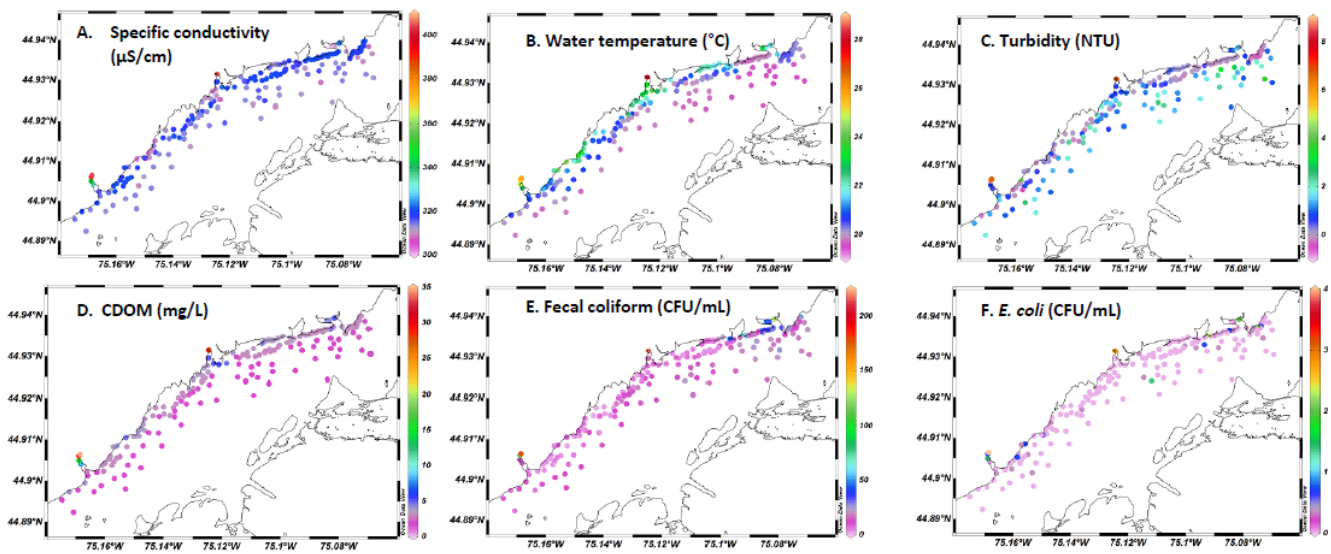


Figure 4. Water quality and bacterial content in water samples collected on 22 June 2012. Sampling locations furthest east (*right*) are immediately downstream of Crysler Beach; samples furthest west (*left*) are immediately upstream of Hoasic Creek.

Experiments 3, 4 & 5: Experiments to assess the die-off of *E. coli* in river water.

Water of "Red Mills Tributary" upstream of the construction area was collected and from it *E. coli* was cultured and isolated. This culture of *E. coli* was maintained at laboratory temperatures (21°C) in sterile culture media prepared using St. Lawrence River water. Several experiments were conducted to determine the fate of bacteria entering the river from tributaries. A measurement of the UVR extinction in the nearshore water of the St. Lawrence River revealed a UVR extinction coefficient of $2.24 \cdot m^{-1}$; this indicates that 1% of UVR incident at the surface will found at a depth of 2.1 m.

Three day-length long experiments (from sunrise [approx. 06h:00 to sunset [approx. 20h:30]), were conducted on 30 July, 7 August, and 10 August to determine the effect of ambient ultraviolet (UVR) on *E. coli*. These experiments used both polycarbonate and Teflon bottles, each set being exposed to direct light and covered by foil to block light as a control. The experiment were deployed at a depth of 10 cm in the river water fro in situ incubations. These experiments used filtered (0.4-µm) and unfiltered river

water collected from the nearshore zone and inoculated with cultured *E. coli* to achieve an estimated 100 CFU/mL.

Result-Expt. 3, 4 & 5: Based on the day long exposures, it appears that die-off of *E. coli* is greatest when the sun is directly overhead and is less inhibitory to growth at sunrise and sunset.

Experiments 6, 7, 8, 9 & 10: Dilution assays to measure *E. coli* growth and grazing rates as affected by light exposure.

The daylong exposures (Expts. 3-5) proved the impact of light exposure and revealed that there was additional losses of *E. coli* in unfiltered river water. The loss of bacteria in the unfiltered river water in the dark was due to microzooplankton grazing, wherein small metazoans and unicellular flagellates (generally < 200 µm) consume bacteria as prey items. Microzooplankton grazing is an active trophic activity amongst the plankton in the Upper St. Lawrence River (Twiss and Smith, 2012).

One technique to determine loss rates due to grazing is to conduct dilution assays (Landry and Hassett, 1982) using light and dark exposures. A 4 hour long experiment, from 10h:00 to 14h:00, to determine the effect of UV radiation and grazing on E. coli. This experiment used both polycarbonate and Teflon bottles, each set being exposed to direct light and covered by foil to block light as a comparison and a dilution series assess the effects of grazing versus light inhibition. Six dilutions were conducted for each experimental treatment. *E. coli* concentration was determined at the beginning of the experiment and in each replicate after the 4 hour exposure time. The intrinsic specific growth rate was determined as the intercept with the ordinate of a linear least squares regression of specific growth rate in each dilution versus the respective dilution factor; specific grazing rate was determined as the slope of this regression (Landry and Hassett, 1982). Here we consider any grazing rate to be the sum of *E. coli a* specific loss due to microzooplankton grazing, viral lysis, or other cell death. The following rules were applied to accepting estimated rates. In cases where there was a statistically non-significant ($P > 0.10$) regression, the growth rates in all dilutions was averaged rather than using the intercept to predict the specific growth rate (per Chen et al., 2009) and no grazing rate was determined (i.e., not applicable [NA]). In addition, grazing rates were considered to be undeterminable (NA) in assays that resulted in a positive slope (theoretically impossible), in which case growth rates in all dilutions were averaged.

Results- Expts. 6-10

A summary of the experiments in Table 1 proves the detrimental impact of light on survivorship of *E. coli* in river water. One experiment (Expt. 6) provided valid estimates of both growth and loss rates of *E. coli*. Loss rates were similar ($0.15 \pm 0.02 \cdot h^{-1}$) despite light regime or the type of container used. However, the experiments show a strong adverse effect of light on *E. coli* survivability. For example, in all 5 experiments, growth rates of *E. coli* in the dark was far greater than exposed to ambient sunlight, which would have both visible and UVR components, since Teflon is nearly UVR transparent. A reduction of UVR by using a Mylar-D coating reduced the adverse impact of light exposure on *E. coli* growth in 2 of 3 instances (Expts. 8 & 9, Expt. 10 shows no difference compared to full light exposure).

Table 1. Dilution assay results for experiments on *E. coli* fate in St. Lawrence River water using various light exposures due to various containers (Teflon or polycarbonate [PC]) or coatings, none (light), reduced (Mylar) or dark (aluminum foil). Values are specific rates of growth (μ) or loss (g) in each treatment.

Treatment				
EXPT6				
Material:	**Teflon**	**Teflon**	**PC**	**PC**
Illum.:	**Light**	**Dark**	**Light**	**Dark**
μ (h^{-1})	-0.65	0.16	-0.31	0.15
g (h^{-1})	0.16	0.17	NA	0.13
EXPT7				
Material:	**Teflon**	**Teflon**	**PC**	**PC**
Illum.:	**Light**	**Dark**	**Light**	**Dark**
μ (h^{-1})	-0.75	0.02	-0.70	-0.06
g (h^{-1})	NA	NA	NA	NA
EXPT8				
TEFLON:	**Light**	**Dark**	**Mylar**	
μ (h^{-1})	-0.83	0.08	-0.18	
g (h^{-1})	NA	NA	NA	
EXPT9				
TEFLON:	**Light**	**Dark**	**Mylar**	
μ (h^{-1})	-0.93	-0.06	-0.22	
g (h^{-1})	NA	NA	NA	
EXPT10				
TEFLON:	**Light**	**Dark**	**Mylar**	
μ (h^{-1})	-0.90	-0.10	-0.09	
g (h^{-1})	NA	NA	NA	

Anticipated Impact and Outcomes

Despite the setback with the loss of our primary sampling site ("Red Mills Tributary") in 2012, we have been able to design and carry out meaningful experiments in 2012 that provide us with rate constants so that we can derive a mechanistic model. The mechanistic model requires identification of polluted inputs, in this case tributaries. Based on two-dimensional hydraulic modeling, we can predict, with a high degree of reliability, where water will be transported.

The basic equation governing transport of water parcels is given by

$$\frac{\partial c}{\partial t} = D\nabla^2 c - \vec{v} \cdot \nabla c + q(t),$$

where c represents the concentration of *E. coli* bacteria. On the right hand side, the first term gives the effect of diffusion, the section is the advection (caused by the velocity of the fluid), and q is a source or sink term. Since the velocity field in the Upper St. Lawrence is known, this equation can be used to determine concentrations as a distribution in both space and time. As first approximation, we may ignore the source term and assume diffusion to be small, such that spatial changes in concentration are governed by the velocity field. For determining the fate of *E. coli* in the river water we can, assume a given concentration at one location and evoke growth and loss terms, such as those measured in our field experiments. This approach may be suitable for assessing risk of contaminated tributaries, with respect to the anticipated impact they might have downstream.

Conference Presentations

1. Twiss, M. R., Smith, D. E., Ulrich, C., Kramer, S. J., Skufca, J. D., Bollt, E., "*Do Nearshore Water Quality Transitions Reflect Functional Process Zones Along the International Section of the St. Lawrence River? How 2-D Hydraulic Models Can Be Used to Describe Plankton Dynamics in this Major River Reach*", 18th Annual Conference on the Great Lakes/St. Lawrence River Ecosystem, St. Lawrence River Institute of Environmental Sciences, Cornwall, ON (May 2011).
2. Harvey, A. M., Marshall, N. F., Skufca, J. D., Twiss, M. R., "*Monitoring fecal coliforms to protect public health: Using 2D river modeling to help predict fecal coliform presence at Coles Creek State Park Beach*", Great Lakes Research Consortium Annual Student/Faculty Conference, Great Lakes Research Consortium, Oswego, NY (March 2012).

Student training

Three students were involved with this project. The project comprises the primary thesis work of Anthony Harvey, a Master of Science candidate (anticipated completion date May 2013). Nicholas Marshall (Bachelor of Science candidate), was involved with developing statistical mathematical models. Heather Sprague (Biosystems Engineering, B.S. candidate, Clemson University) assisted with field work during summer 2012.

References cited

Chen, B., Liu, H., Landry, M.R., Dai, M., Huang, B., Sun, J., 2009. Close coupling between phytoplankton growth and microzooplankton grazing in the western South China Sea. *Limnol. Oceanogr*. 54: 1084–1097.

Landry, M.R. and Hassett, R.P. 1982. Estimating the grazing impact of micro-zooplankton. *Mar. Biol.* 67: 283-288.

Twiss, M.R., Smith, D.E., 2011. Size-fractionated phytoplankton growth and microzooplankton grazing rates in the upper St. Lawrence River. *River Res. Appl.* 27: 1047-1053.

USGS Award No. G11AP20223 Flood Frequency Research for California

Basic Information

Title:	USGS Award No. G11AP20223 Flood Frequency Research for California
Project Number:	2011NY177S
Start Date:	9/1/2011
End Date:	8/31/2012
Funding Source:	Supplemental
Congressional District:	
Research Category:	Climate and Hydrologic Processes
Focus Category:	Climatological Processes, Floods, Surface Water
Descriptors:	
Principal Investigators:	Jery Stedinger

Publications

1. Lamontagne, Jonathan R., Jery R. Stedinger, Charles Berenbrock, Andrea G. Veilleux, Donna L. Knifong, and Justin C. Ferris, 2012, Development of Regional Skews for Selected Flood Durations for the Central Valley Region, California, Based on Data Through Water Years 2008–9, U.S. Geological Survey Scientific Investigations Report in cooperation with U.S. Army Corps of Engineers, Under Review.
2. Lamontagne, Jonathan R., Jery R. Stedinger, Charles Berenbrock, Andrea G. Veilleux, Donna L. Knifong, and Justin C. Ferris, 2012, Development of Regional Skews for Selected Flood Durations for the Central Valley Region, California, Based on Data Through Water Years 2008–9, U.S. Geological Survey Scientific Investigations Report 2012-5130 in cooperation with U.S. Army Corps of Engineers, 60 pages.

Development of Regional Skews for Selected Flood Durations for the Central Valley Region, California, Based on Data Through Water Years 2008–9

By Jonathan R. Lamontagne[1], Jery R. Stedinger[1], Charles Berenbrock[2], Andrea G. Veilleux[3], Donna L. Knifong[2], and Justin C. Ferris[2]

Abstract

Flood-frequency information is important in the Central Valley Region of California because of the high risk of catastrophic flooding. Most traditional flood-frequency studies focus on peak flows, but for the assessment of the adequacy of reservoirs, levees, other flood control structures, sustained flood flow (flood duration) frequency data are needed. This study focuses on rainfall or rain-on-snow floods, rather than the annual maximum, because rain events produce the largest floods in the region. A key to estimating flood-duration frequency is determining the regional skew for such data. Of the 50 sites used in this study to determine regional skew, 28 sites were considered to have little to no significant regulated flows, and for the 22 sites considered significantly regulated, unregulated daily flow data were synthesized by using reservoir storage changes and diversion records. The unregulated, annual maximum rainfall flood flows for selected durations (1-day, 3-day, 7-day, 15-day, and 30-day) for all 50

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[3]U.S. Geological Survey, Office of Surface Water, 12201 Sunrise Valley Drive, Reston, Virginia

sites were furnished by the U.S. Army Corp of Engineers. Station skew was determined by using the expected moments algorithm program for fitting the Pearson Type 3 flood-frequency distribution to the logarithms of annual flood-duration data.

Bayesian generalized least squares regression procedures used in earlier studies were modified to address problems caused by large cross correlations among concurrent rainfall floods in California and to address the extensive censoring of low outliers at some sites by using the new expected moments algorithm for fitting the LP3 distribution to flood-duration data. To properly account for these problems and to develop suitable regional-skew regression models and regression diagnostics, a combination of ordinary least squares, weighted least squares, and Bayesian generalized least squares regression was adopted. This new methodology determined that a nonlinear model relating regional skew to mean basin elevation was the best model for each flood duration. The regional-skew values ranged from -0.74 for a flood duration of 1-day and a mean basin elevation less than 2,500 feet to values near 0 for a flood duration of 7-days and a mean basin elevation greater than 4,500 feet. This relation between skew and elevation reflects the interaction of snow and rain, which increases with increased elevation. The regional skews are more accurate and the mean squared errors are less than in the National skew map of Bulletin 17B.

Relative Abundance of Blueback Herring (Alosa aestivalis) in Relation to Permanent and Removable Dams on the Mohawk River

Basic Information

Title:	Relative Abundance of Blueback Herring (Alosa aestivalis) in Relation to Permanent and Removable Dams on the Mohawk River
Project Number:	2012NY178B
Start Date:	3/1/2012
End Date:	2/28/2013
Funding Source:	104B
Congressional District:	25
Research Category:	Biological Sciences
Focus Category:	Ecology, Management and Planning, Economics
Descriptors:	
Principal Investigators:	Neil H. Ringler, Karin Limburg

Publication

1. Limburg, Karin, 2013, River Herring: Past, Present, Future (?), in Proceedings of the 2013 Mohawk Watershed Symposium, Union College, Schenectady, NY, page 34.

Final Report to Cornell Water Resources Institute

"Relative Abundance of Blueback Herring (*Alosa aestivalis*) in Relation to Permanent and Removable Dams on the Mohawk River"

To: Water Resources Institute, Cornell University

From: Dr. Karin Limburg and Dr. Neil Ringler, SUNY – ESF

Date: April 15, 2012

Subject: Final report for blueback herring research on the Mohawk River

This report summarizes field and lab procedures as well as our findings.

Field sampling:

We conducted field sampling on the Mohawk River from May to July. The purpose of our field sampling was to determine the timing and distribution of the blueback herring spawning run. We used boat electrofishing gear to sample adult blueback herring at five sites on the Mohawk River. The sample locations were Locks 7, 9, 11, 15 and Little Falls, NY. All field sampling was done with assistance from the New York State Department of Environmental Conservation (NYSDEC). The sample dates, locations and personnel involved are summarized in the table below. No fish were collected on the final date (July 2) and so the sampling was terminated then.

Date	Location	Personnel
May 22	Little Falls, NY	Christopher Legard (SUNY-ESF graduate student) Dave Erway (NYDEC region 6)
May 23 - 24	Locks 7, 8, 9, 11 and 15	Christopher Legard Tiffany Evanchoff (SUNY-ESF Undergraduate) Scott Wells (NYDEC region 4)
June 12 - 13	Locks 7, 8, 9, 11 and 15	Christopher Legard Tiffany Evanchof Scott Wells
June 14th	Little Falls, NY	Christopher Legard Dave Erway
June 26th	Locks 7, 8, 9, 11 and 15	Karin Limburg (SUNY-ESF) Christopher Legard Scott Wells

Date	Location	Personnel
July 2nd	Little Falls, NY	Christopher Legard Dave Erway

Sample Processing:

A sub-sample of 230 fish was retained for laboratory analysis at SUNY-ESF. The sub-sample will be used to determine demographic information about the population (length, weight, age, sex ratio, gonadosomatic index, diet, migration history, number of repeat spawners, genetic make-up, and stable isotope data). All fish were weighed, measured, and samples were taken of scales, otoliths, gonads, stomach contents, gill rakers, and muscle tissue. Within the scope of this project, length, weight, age, sex ratio, gonadosomatic index, diet, and degree of repeat spawning were quantified.

Results:

Size, sex ratios, and GSI.

Table 1 shows mean size, weights, gonadal weights, and gonado-somatic (GSI) indices in May and June 2012. Males ranged in size (total length, TL) from 205 to 262, and females from 220 to 280 mm.

Table 1. Summary statistics for adult blueback herring in Mohawk river, spring 2012.

Date	N	Sex ratio (M:F)	Mean Total Length, mm	Mean Fork Length, mm	Mean wet weight, g	Mean Gonad weight, g	Mean GSI
May 23-24	124	79-45	239	212	119	9.6	0.086
June 12-13	98	75-23	235	209	100.1	4.9	0.049
June 26	7	5 to 2	246	218	111.9	5.4	0.050
Total	229	159-70	238	211	110.6	7.5	0.069

GSI was highest in May and stabilized in June, indicating that most spawning went on in May. This is consistent with previous observations.

Compared to an earlier study of Mohawk River blueback herring conducted by KL and Ian Blackburn in 1999-2001, adult spawners have declined in size significantly (Figure 1) and sex ratios have skewed toward males (Figure 2). This may reflect selective fishing at sea. Note that there are no directed marine fisheries on blueback herring, but bycatch is a well-known problem (ASMFC 2012).

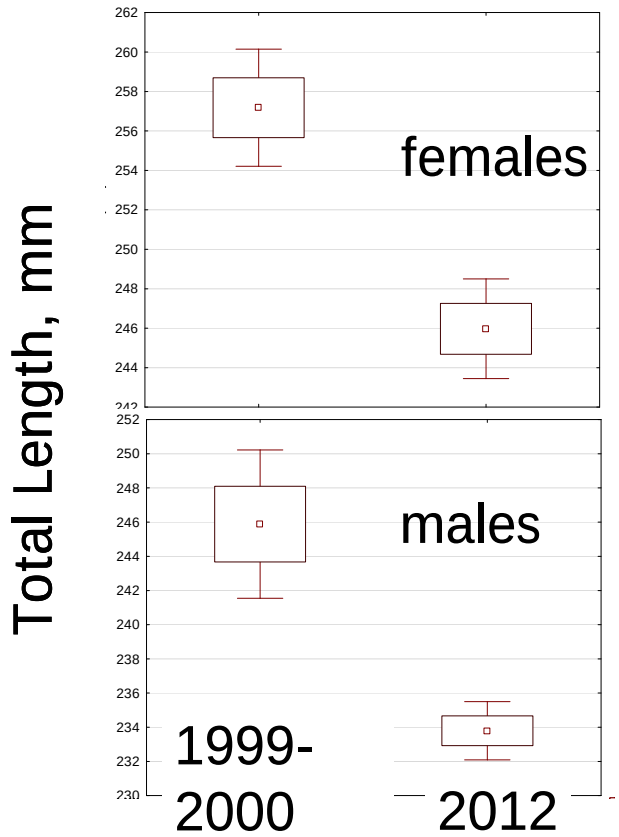


Figure 1. Lengths of blueback herring adults collected in spring spawning runs in the Mohawk and Hudson rivers in two time periods. Fish were collected with non-selective gear in both periods.

Diet.

Blueback herring were also observed to be feeding on benthic macroinvertebrates during the 2012 spawning run. This is consistent with earlier observations by Simonin et al. (2007), who reported feeding by blueback herring in the Hudson/Mohawk watershed, but only when fish were captured in uni-directional flow. Fish captured in the tidal Hudson River estuary were not observed to feed. Simonin et al. (2007) concluded that feeding occurs in unidirectional flow to subsidize the energy required to reach spawning grounds in the Mohawk and other tributaries.

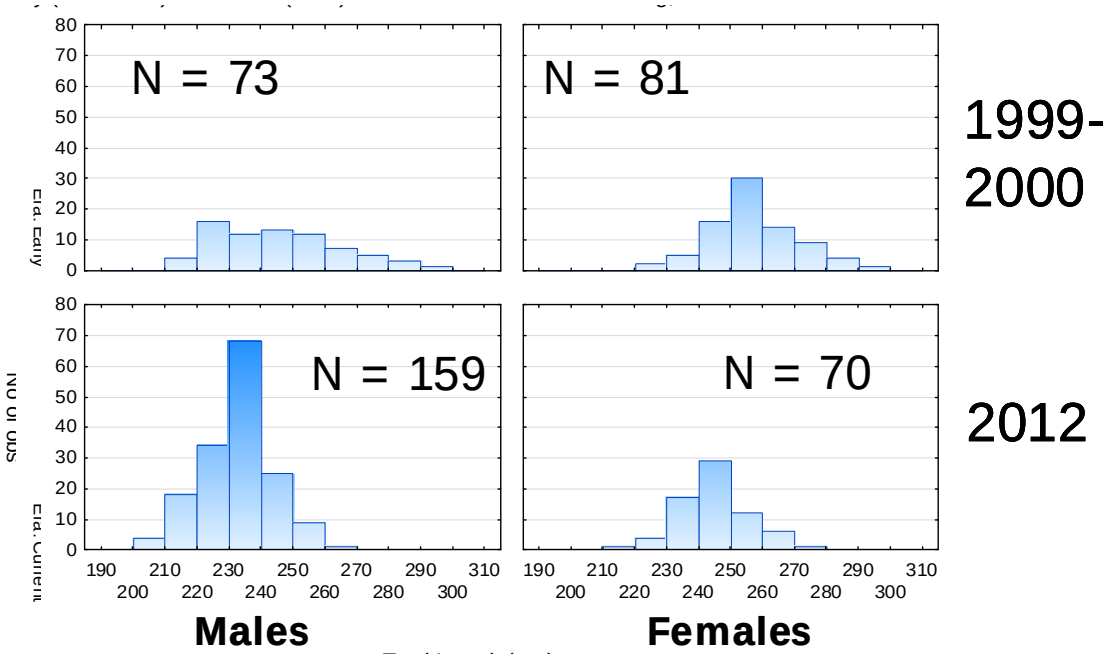


Figure 2. Size distributions of male and female blueback herring collected in the Hudson and Mohawk rivers in two time periods. Note the marked difference in sex ratios as well as changes in sizes.

Possible effects of dams.

No effects of dams was detected on size of spawning blueback herring in 2012, irrespective of sex or sampling date ($p > 0.2$). However, female GSI was significantly lower ($p < 0.05$) at Lock 15, the farthest upstream location at Little Falls, NY, suggesting that most spawning took place downstream of that location. Again, this is in agreement with earlier studies.

Anticipated products of this research: A manuscript will be developed over the summer. Also, the results will be disseminated to the Mohawk River and Hudson River Estuary Programs of the NYS DEC.

Conclusions.

Although this was a preliminary study, the findings thus far do indicate some substantial changes in the Mohawk River component of the Hudson River watershed's blueback herring stock; in particular, size of fish has declined over the past decade and the sex ratio is skewed toward males. If more funding can be found, then more demographic analysis (age, growth, and provenance via isotopic and trace elemental chemistry) could be performed on otoliths and tissues archived from these samples. This could help identify not only the origin of these fish (Mohawk, Hudson, or elsewhere), but also could shed light on marine habitat use. Given the parlous state of river herring (blueback herring and alewife), such information could be very useful for conservation management.

Literature cited.

Atlantic States Marine Fisheries Commission (ASMFC). 2012. River Herring Benchmark Stock Assessment. Stock Assessment Report No. 12-02. Atlantic States Marine Fisheries Commission, Arlington, VA.

Simonin, P.W., K.E. Limburg, and L.S. Machut. 2007. Bridging the energy gap: anadromous blueback herring feeding in the Hudson and Mohawk Rivers, New York. Transactions of the American Fisheries Society 136: 1614-1621.

POLLUTION TRADE-OFFS ASSOCIATED WITH THE USE OF RIPARIAN ZONES AS BEST MANAGEMENT PRACTICES

Basic Information

Title:	POLLUTION TRADE-OFFS ASSOCIATED WITH THE USE OF RIPARIAN ZONES AS BEST MANAGEMENT PRACTICES
Project Number:	2012NY181B
Start Date:	3/1/2012
End Date:	2/28/2013
Funding Source:	104B
Congressional District:	25
Research Category:	Water Quality
Focus Category:	Water Quality, Management and Planning, Nitrate Contamination
Descriptors:	
Principal Investigators:	Philippe Gilles Vidon

Publications

1. Rook, S.P., 2012, Riparian zone hydrology and biogeochemistry as a function of stream evolution stage in glaciated landscapes of the US Northeast, Master Thesis. SUNY College of Environmental Science and Forestry, Syracuse, New York, 107 pages.
2. Marcoccia, A., 2012, Greenhouse gas flux in a Fall Creek riparian zone in Freeville, NY, Undergraduate Thesis, SUNY College of Environmental Science and Forestry, Syracuse, New York, 20 pages.

FINAL Report for NYWRRI Award # 64038-9840

POLLUTION TRADE-OFFS ASSOCIATED WITH THE USE OF RIPARIAN ZONES AS BEST MANAGEMENT PRACTICES

Start / End dates: 03/12-02/13

Principal Invesigators: P. Vidon.

Objectives:

Riparian zones (near stream zones) are widely recommended best management practices (BMP) to mitigate the impact of agriculture on the quality of our waters owing to their inherent ability to remove nitrate from subsurface flow. However, recent research suggests that the strong biogeochemical gradient often observed in riparian zones as water moves from the upland environment to streams also influences the fate and transport of many other redox sensitive elements such as phosphorus, sulfate and iron, as well as the production and/or consumption of greenhouse gases (GHG) (N_2O, CO_2, CH_4)[3,4,5]. These elements affect the quality of our water and air, and it is critical to **determine to what extent the promotion of riparian zones as BMPs for nitrate removal is done at the expense of air quality (greenhouse gas production), or at the expense of water quality vis-à-vis phosphorus, sulfate and/or iron, and associated contaminants?**

Addressing these questions in the context of stream/riparian zone restoration is extremely important both nationally and regionally. Every year, millions of dollars are spent to restore streams and adjacent riparian zones (including in the Hudson River Watershed), primarily to restore fish habitat, reduce sediment load in streams and prevent stream erosion. However, stream restoration often fails to recognize the importance of stream channel geomorphology and evolution on riparian zone hydrological and biogeochemical functioning. As a result of this, many stream restoration projects use homogenous stream restoration designs that are in fact far remote from the complexity of natural systems (*Figure 1*). Stream geomorphology (including meander curvature) nevertheless impacts surface water – groundwater interactions in the near stream zone, and in turn, regulates riparian zone hydrology (e.g. water table level, water table gradient) and biogeochemistry (e.g. dissolved oxygen availability, organic carbon availability, oxidation-reduction potential). **There is therefore a critical need to quantify potential**

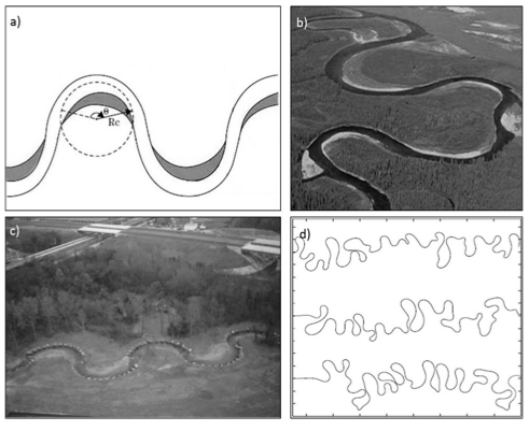


Figure 1 Meander planimetry a) simplified in design books [NRCS, 2007], grey is point bar, b) complexity observed in natural setting Charley R., AK, c) redundancy observed in restoration Deep Run, MD [Smith and Prestergaard, 2005], d) complexity simulated to represent natural systems (Camporeale *et al.*, 2005).

pollution trade-offs associated with the use of riparian zones as BMPs within the context of stream restoration.

The **three primary objectives** for this project include:

1) Determine the concentration of soluble reactive phosphorous (SRP), the Sulfate/Sulfide and FeII/FeIII ratios in groundwater, and fluxes of N_2O, CO_2, CH_4 gases at the soil-atmosphere interface in relation to nitrate (NO_3^-) concentrations and fluxes in a series of three riparian zones located along a stream reach with contrasting stream curvatures in Central NY.

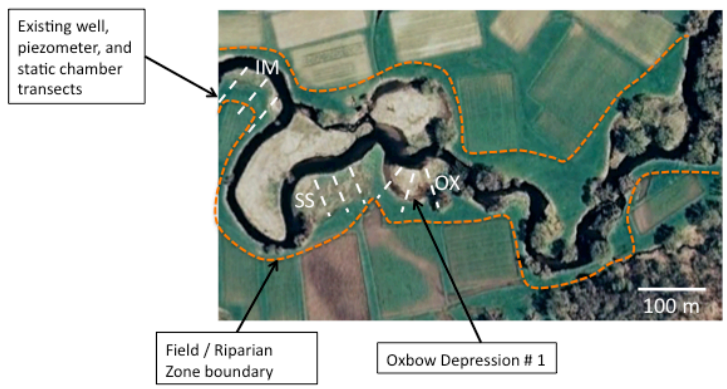
2) Determine the impact of stream curvature (outer bend and oxbow, inner bend, straight section) on riparian zone functioning with respect to N, P, S, Fe, and GHG fluxes.

3) Quantify potential water and air quality trade-offs associated with the use of riparian zones as BMPs for N removal.

Activity Report

As of today, all fieldwork has been completed, and most of water and air samples collected for this project have been analyzed. Although data analysis is underway, some preliminary conclusions have been reached:

Figure 2: Description of the studied stream reach and of its main features.



Water quality and hydrological measurements have primarily focussed along a series of 3 riparian sections (inner meander (**IM**), straight section (**SS**), outer meander with oxbow depression (**OX**)) on the banks of a 600 m long agricultural floodplain section of Fall Creek, near Freeville, NY (*Figure 2*).

Hydrological data indicate overall contrasting groundwater flow directions and water table depth depending on location and stream meander curvature (*Figure 3,* next page).

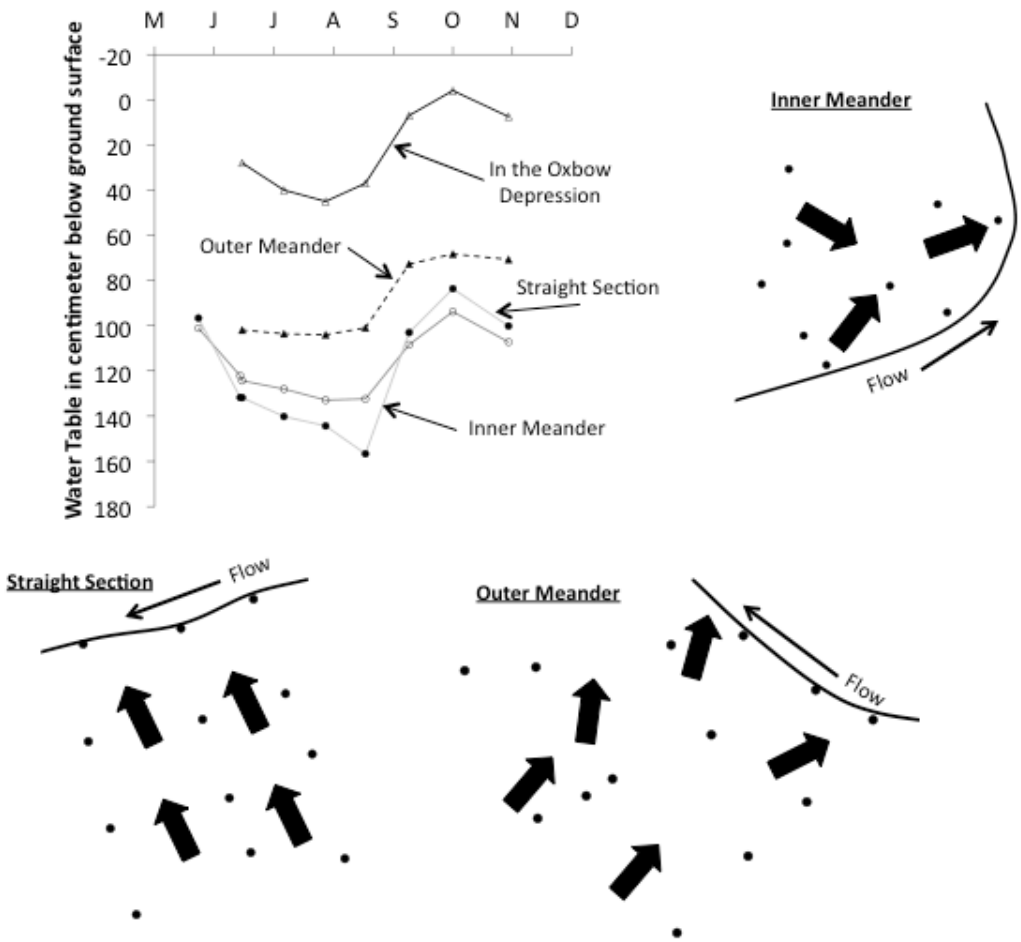
Biogeochemical data indicate significantly (α=0.05, $p<0.05$) greater NO_3^- concentrations (1.45 mg N/L) at the IM site than at the OX site (0.2 mg N/L). In the oxbow depression at site OX, mean N_2O and CH_4 fluxes in the oxbow (N_2O: 1.26 mg N / m^2 / day (+/- 1.94); CH_4: 24.50 mg C / m^2 / day (+/- 130.36)) were significantly (α=0.05, $p<0.05$) higher than at locations on higher ground at the field edge (N_2O: 0.18 mg N / m^2 / day (+/- 0.38); CH_4: -0.67 mg C / m^2 / day (+/- 0.48).

Together, these data indicate clear differences in hydrological conditions, N dynamics, and GHG production/consumption between the various landscape elements found in the

floodplain. Ultimately, sites exhibited different biogeochemical conditions, with elevated NO_3^- loss, N_2O and CH_4 emissions within the oxbow formation, suggesting the geomorphology and the meander setting significantly influenced subsurface biogeochemistry and associated pollution trade-offs.

Additional analyses are underway to fully address all the questions posed in the objectives. As indicated below, several manuscripts are in preparation for submission to peer-reviewed journals as this report is written.

Figure 3: Riparian water table level and typical groundwater flow direction at key locations throughout the floodplain.



Graduate and Undergraduate Student Training (1 Graduate Student, 3 Undergraduate Students)

One graduate student (Sara Marchese) was supported by this award in Summer 2012. This award also partially supported additional data collection for Pat Rook (MS2012). Three undergraduate students participated in fieldwork, and one of them, Angela

Marcoccia, used some of the data collected as part of this project to complete her undergraduate thesis (see details below).

Conference Presentations

Marchese, S., P. **Vidon**, S. Rook, 2013. Stream meander curvature as a control of riparian water table dynamics, groundwater flow and nitrogen dynamics. **2013 CNY Earth Science Student Symposium**. Syracuse, NY, April 2013.

Thesis partially supported by work conducted under this award

Rook, S.P. 2012. Riparian zone hydrology and biogeochemistry as a function of stream evolution stage in glaciated landscapes of the US Northeast. *Master Thesis*. SUNY College of Environmental Science and Forestry, Syracuse, New York, 107 pages.

Marcoccia, A., 2012. Greenhouse gas flux in a Fall Creek riparian zone in Freeville, NY. *Undergraduate Thesis*. SUNY College of Environmental Science and Forestry, Syracuse, New York, 20 pages.

Peer Reviewed Publications

One MS Thesis (Sara Marchese) and three (3) manuscripts are currently in preparation. The manuscripts will be submitted to peer reviewed journals in summer or fall 2013.

PI Vidon will present results from this work at the American Geophysical Union conference in December 2013, while graduate student Sara Marchese will present results from this work at the Soil Science Society of American meeting in November 2013.

The Remote Monitoring of Surface Velocity, Bathymetry, and Discharge

Basic Information

Title:	The Remote Monitoring of Surface Velocity, Bathymetry, and Discharge
Project Number:	2012NY189G
Start Date:	9/1/2012
End Date:	8/21/2014
Funding Source:	104G
Congressional District:	22
Research Category:	Engineering
Focus Category:	Methods, Water Quantity, Hydrology
Descriptors:	None
Principal Investigators:	Edwin A. Cowen

Publications

There are no publications.

The Remote Monitoring of Flow Rate Based on the Surface Velocity Field and Bathymetry Inferred from Surface Turbulence Metrics

Traditional methods of measuring river flow rates are relatively expensive and often require field technicians to work in hazardous conditions. Under high flow conditions, during which the bathymetry changes widely, the use of extrapolated rating curves can result in errors of up to 70%. In an effort to develop a reliable, continuous and efficient method of remotely monitoring volumetric flow rate, an initial series of surface particle image velocimetry (SPIV) experiments were conducted in a wide open channel flow facility to measure the surface velocity field and study the physics connecting the surface turbulence metrics to bathymetry. The experiments were carried out in fully developed flows at a range of non-dimensional flow depths (B/H = 8 – 20, where B is the channel width and H is the flow depth), Reynolds numbers (Re_H = 8,000 – 59,000, based on the mean velocity and flow depth) and Froude numbers (Fr = 0.1 – 0.5). Both mean and turbulent velocities and integral length scales were calculated from the surface PIV data. It was found that the mean surface velocity is linearly related to the depth-averaged velocity. This result, which has been noted by several other researchers, is a consequence of the self-similarity of wall-bounded flows. The slope of the best-fit line was found to be 0.94, which is consistent with the 0.90 value indicated by Rantz (1982) for concrete-lined channels.

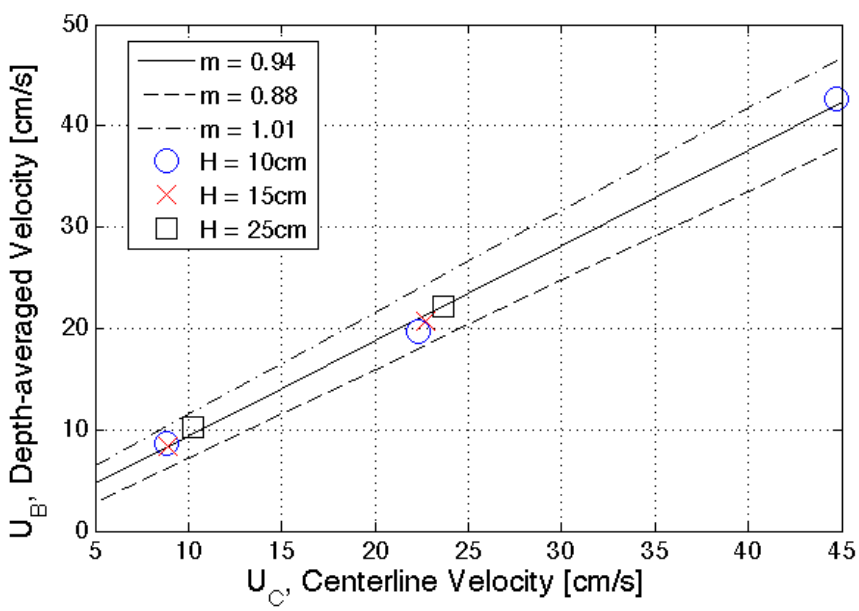


Figure 1. Mean Centerline Velocity vs. Depth-Averaged Velocity

The integral length scale, calculated from the surface turbulent velocity field, varies predictably with the flow depth as seen is figure 2a and clearly demonstrates a Reynolds # dependence (figure 2b).

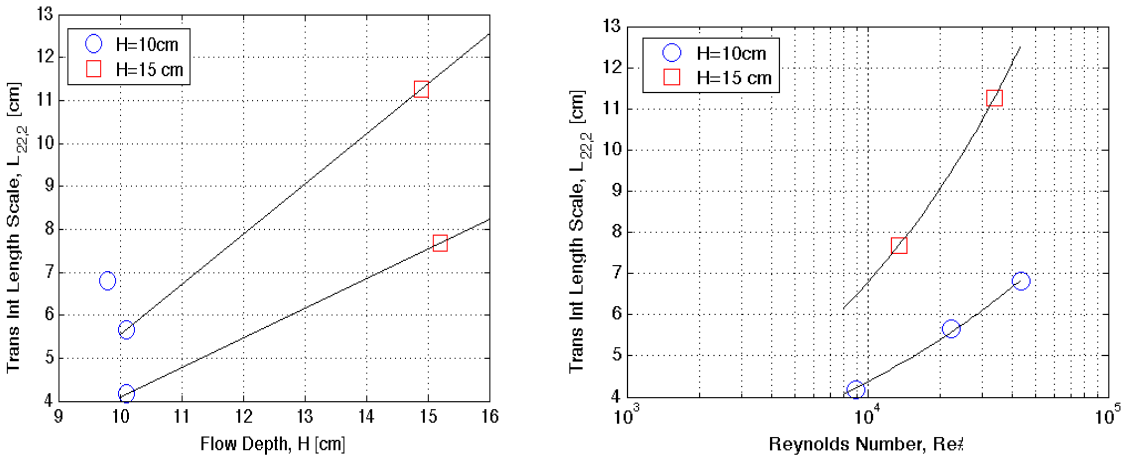


Figure 2. (a) Transverse integral length scale, $L_{22,2}$ vs. flow depth, H. (b) Transverse integral length scale, $L_{22,2}$ vs. Reynolds number, Re #.

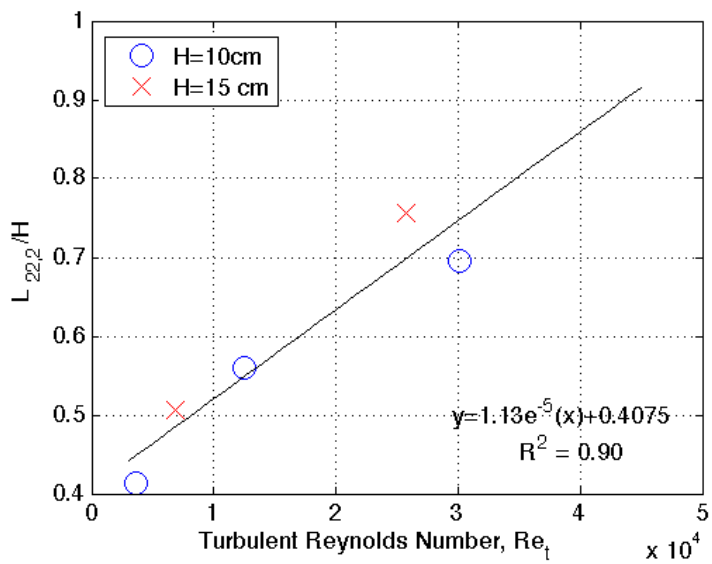


Figure 3. Integral length scale ($L_{22,2}$) normalized by the flow depth, H vs. the turbulent Reynolds number, Re #.

The results are fully characterized when the integral length scale is normalized by the flow depth and plotted versus the turbulent Reynolds number, $\mathrm{Re}_t\# = u_{rms}L_{22,2}/\nu$ as seen in figure 3. This relation thus enables direct calculation of the flow rate from the measurement of only the surface

velocity field. Initial estimates of volumetric flow rate as compared to an independent measure prove quite promising (Table 1).

H, Flow Depth [cm]	Uc, Centerline Velocity [cm/s]	Q, SPIV Results [m^3/s]	Q, Submerged Weir Theory [m^3/s]
10.1	8.8	0.0075	0.0087
10.1	22.2	0.0158	0.0183
9.8	44.5	0.0341	0.0374
15.2	8.9	0.0137	0.0123
15.5	23	0.0311	0.0332

Table 1. Measured and estimated values of volumetric discharge.

In the upcoming year we intend to carry out additional experiments where the channel cross-section will be modified to a trapezoidal shape and where the bed roughness will be increased with the addition of gravel. The gravel experiments have already been initiated. Our goal in the upcoming year is to carry out field measurements at prototype scale at one or more of the local USGS gaging sites. To this end we have made multiple field site visits in coordination with the Ithaca USGS to begin to design these prototype experiments.

Information Transfer Program Introduction

The Director and staff of the NYS Water Resources Institute undertake public service and partnership activities. Most are conducted through multidisciplinary projects funded outside the Water Resources Research Act (WRRA) context. In order to couple WRRA activities to other NYS WRI activities, a portion of WRRA resources are devoted to information transfer through a partnership program with the Hudson River Estuary Program, dissemination of information related to emerging issues, and student training.

NY Water Resources Institute Information Transfer

Basic Information

Title:	NY Water Resources Institute Information Transfer
Project Number:	2012NY207O
Start Date:	3/1/2012
End Date:	2/28/2013
Funding Source:	Other
Congressional District:	
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	
Principal Investigators:	Susan Riha, Brian Gramlich Rahm

Publications

1. Vedachalam, S; Riha S.J. 2012. Desalination in northeastern U.S.: Lessons from four case studies. Desalination, 297:104-110.
2. Shaw, S.B.; Riha, S.J. 2012. Examining individual recession events instead of a data cloud: Using a modified interpretation of dQ/dt-Qstreamflow recession in glaciated watersheds to better inform models of low flow. Journal of Hydrology, 434-435:46-54
3. Rahm, B.G.; Riha, S.J. 2012. Toward strategic management of shale gas development: Regional, collective impacts on water resources.Environmental Science and Policy, 17:12-23

NEW YORK STATE WATER RESOURCES INSTITUTE

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New York State Water Resources Institute FY2012

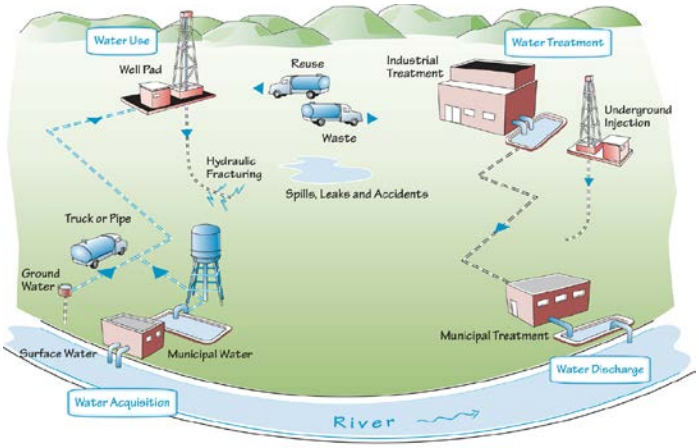
The mission of the New York State Water Resources Institute (WRI) is to increase awareness of emerging water resources issues and to identify creative ways to improve the management of water resources in New York State and beyond. Additionally, WRI acts as bridge to foster communication and knowledge exchange between the various stakeholder groups, government agencies, and research institutions that are engaged with water resources management in New York State.

During FY2012, staff research and information transfer focused on the following major areas:

1. **Responding to potential shale gas development and associated hydraulic fracturing**
2. **Assessment and funding of public water resource infrastructure**
3. **Long-term resilience to extreme weather events and climate change**

Additional research and information activities on various topics were conducted as appropriate and needed.

Shale Gas & Hydraulic Fracturing



Above: A cartoon from WRI publication "Water's journey through the shale drilling and production processes in the Mid-Atlantic region," released in cooperation with Penn State Extension, West Virginia and Ohio State Universities

What we do

Activities associated with the recovery of natural gas from shale, such as the Marcellus Shale in NY, can have significant impacts on water resources. There remains a robust and at times contentious public discussion of the type and severity of these risks. WRI has supported and added to this discussion by providing objective and timely analyses. In the past year WRI has:

- Published a peer-reviewed study "Toward strategic management of shale gas development: Regional, collective impacts on water resources," in *Environmental Science & Policy*, January 2012 (most downloaded ES&P article on the internet from June to November, 2012)
- Submitted commentary on USEPA's "Draft investigation of ground water contamination near Pavillion, Wyoming," February 2012
- Participation on expert panel for "Municipal law & planning: A local perspective on hydrofracking," organized by the Albany Law School, September 2012

Public Water Infrastructure

What we do

Replacing and upgrading aging water infrastructure throughout the State will require investment of billions of dollars from both public and private entities over the coming decades. This infrastructure is critical to maintaining and improving environmental and public health. The Smart Growth Public Infrastructure Policy Act of 2010 prioritizes the funding of public infrastructure projects that promote *smart growth*.

Above: New York watersheds in the Hudson and Mohawk basins, the location of WRI analyses of infrastructure function, efficiency, and funding

Using data from state and federal agencies, as well as local municipalities and utilities, WRI is investigating the state of public infrastructure and exploring strategies for investing in capital projects. The goal of these analyses is to aid planners and public decision makers at various levels of government, and to generate insight with respect to strategic management of state funds and the maintenance and improvement of public health and New York's environmental assets. In the past year WRI has:

- Submitted a manuscript entitled "A watershed-scale goals approach to assessing and funding wastewater infrastructure," to the *Journal of Environmental Management*
- Initiated multidisciplinary research with experts in city and regional planning, business management, natural resources, environmental engineering, and policy analysis
- Conducted a national survey (via Cornell) investigating issues related to public perception of water and wastewater infrastructure
- Published a study, "Desalination in northeastern U.S.: Lessons from four case studies" in *Desalination*

Extreme Weather & Climate Change

Above: in New York, streams impact or run through agricultural, forest, and urban landscapes

What we do

New York State has been impacted by many major floods in the last decade and will continue to experience high precipitation events and sea level rise in the coming decades. Research projects are underway at WRI and our project partners to analyze the causes and spatial patterns of past floods, to identify watershed planning and infrastructure management options, and to develop information and tools for decision-makers to use to increase future flood resilience. Current projects and partnerships include:

- Assessing flood risk in a changing climate in the Mohawk and Hudson River Basins (SUNY ESF)
- Determining peak flow under different scenarios and identifying undersized culverts (Cornell University and county Soil and Water Conservation Districts)
- Documenting impacts of storms Irene, Lee, and Sandy on water and wastewater infrastructure and shoreline communities in the Hudson Valley (NYS WRI)
- Watershed resilience education in the Hudson River Estuary: Needs assessment and program evaluation (Cornell University)
- Integrating Climate Change Messages into K-12 Estuary Lesson Plan Offerings (NY Sea Grant)

A more complete list of NYSWRI activities follows. For more information please email Director Susan J Riha at nyswri@cornell.edu, or call (607) 255-3034, Website: wri.eas.cornell.edu

New York State Water Resources Institute FY2012 Activity

Peer Reviewed Publications

1. Vedachalam, S; Riha S.J. 2012. Desalination in northeastern U.S.: Lessons from four case studies. *Desalination*, 297:104-110 [link, preprint].

2. Shaw, S.B.; Riha, S.J. 2012. Examining individual recession events instead of a data cloud: Using a modified interpretation of d*Q*/dt-*Q*streamflow recession in glaciated watersheds to better inform models of low flow. *Journal of Hydrology*, 434-435:46-54 [link].

3. Rahm, B.G.; Riha, S.J. 2012. Toward strategic management of shale gas development: Regional, collective impacts on water resources.*Environmental Science and Policy*, 17:12-23 [link].

Outreach and non-Refereed Publications

1. NYSDEC/NYSWRI. 2012. Water Resource Summary: Town of Chatham. Report submitted to the Town of Chatham, NY [link].

2. Abdalla, C.; Drohan, J.; Rahm, B.G.; Jacquet, J.; Becker, J.; Collins, A.; Klaiber, A.; Poe, G.; Grantham, D. 2012. Water's journey through the shale gas drilling and production processes in the Mid-Atlantic region. Penn State Cooperative Extension [link].

3. Rahm, B.G., Riha, S.J.; Yoxtheimer, D.; Boyer, E.; Carder, D.; Davis, K.; Belmecheri, S. 2012. Environmental water and air quality issues associated with shale gas development in the Northeast. Marcellus Shale Multi-State Academic Research Conference Position Paper, 12p [link].

4. Stanne, S. 2012. The ecological and environmental effects of Huricane Irene and Tropical Storm Lee. *New York State Conservationist*, 67(1): 8-13 [link].

5. Bowser, C. 2012. Out of the classroom, into the estuary. *New York State Conservationist*, 67(1): 20-24 [link].

6. Vedachalam, S. 2012. Water supply in Chennai: Desalination and missed opportunities. *Economic and Political Weekly*, 47(23):16-19 [link,preprint].

7. Vail, E.; Meyer, A. 2012. Barriers to Green Infrastructure in the Hudson Valley: An Electronic Survey of Implementers [link].

Policy Related Outreach

1. NY Assemblywoman Ellen Jaffee cites NYSWRI article "Desalination in northeastern U.S.: Lessons from four case studies" in a letter to the New York State Public Service Commission. August 5 [link].

Conference Presentations & Invited Talks

1. Meyer, A.; Vail, E. 2013. Keeping it Green as it Flows Downstream. Tivoli Bays Talks. Tivoli, NY. February 7 [link].

2. Meyer, A.; Roessler, B.; Strong, K.; Vail, E. 2012. Natural Resources of Chatham: Presentation made to the Town of Chatham. Chatham, NY. December 6 [link].

3. Cuppett, S. 2012. Developing Leadership in Water Resources. Rockland Environmental Leadership Day. Ramapo, NY. October 25 [link].

4. Rahm, B.G.; Bertoia, L.R.; Bates, J.T.; Riha, S.J.; Galford, A.; Yoxtheimer, D.; Pieretti, P. 2012. Shale Gas Development in Pennsylvania: Management and Spatial Trends in Waste Water Management. Universities Council on Water Resources (UCOWR) Annual Conference. Santa Fe, NM. July 17-19.

5. Rahm, B.G.; Vedachalam, S.; Shen, J.X.; McConnell, R.D.; Riha, S.J. 2012. A New Assessment of Wastewater Infrastructure in the Hudson and Mohawk Basins. Universities Council on Water Resources (UCOWR) Annual Conference. Santa Fe, NM. July 17-19.

6. Vedachalam, S.; Riha S.J. 2012. Desalination in northeastern U.S.: Lessons from four case studies. Universities Council on Water Resources (UCOWR) Annual Conference. Santa Fe, NM. July 17-19 [link].

7. Vedachalam, S.; Rahm, B.G.; Riha, S.J. 2012. A New Assessment of Water Infrastructure: Water Quality, Economics, and Smart Growth at the Watershed Scale. Hudson River Estuary Management and Advisory Committee. Norrie Point, NY. June 6 [link].

8. Vail, E.; Meyer, A. 2012. Barriers to Green Infrastructure in the Hudson Valley: An Electronic Survey of Implementers (*poster*). Clean Water Act at 40: Facing the Future. Poughkeepsie, NY. May 7 [link].

9. Vedachalam, S.; Rahm, B.G.; Riha, S.J. 2012. Using a Regional Assessment of Wastewater Infrastructure: The Case of the Hudson River Watershed (*poster*). Clean Water Act at 40: Facing the Future. Poughkeepsie, NY. May 7 [link].

10. Cuppett, S. 2012. What Are Your Watershed Neighbors Up To? 17th Annual Ramapo River Watershed Conference. Mahwah, NJ. April 25 [link].

11. Vail, E. 2012. Using Green Infrastructure to Manage Combined Sewer Overflows and Flooding. Revitalizing Hudson Riverfronts. Kingston, NY and Hudson, NY. January 12 and April 13 [link].

12. Rahm, B.G. 2012. Shale Gas Development & Water Resources: Technology, Trends, Policy, and Planning. Thirtieth Annual Greater Buffalo Environmental Conference, New York Water Environment Association – Western Chapter. Buffalo, NY.

Press

1. NYSP2I announces recepients of 2012-2013 Community Grants Program, *NYSP2I Press Release*, February 22 [link].

2. As India grows, water supply shrinks, *Asia Pacific Defense Forum*, December 6 [link].

3. DEC, Cornell and local stakeholders to work together on improving the Cayuga Lake water quality, *NYSDEC Press Release*, October 19 [link].

4. 'A Day in the Life of the Hudson River' event to celebrate ten years of exploring the estuary, NYSDEC press release, October 2 [link].

5. Simple and cheap solution to India's grave water crisis: Waste water recycling, *The Economic Times* (India), September 23 [link].

6. Where are the herring? Day out seeks answers, *The Daily Gazette*, June 27 [pdf].

7. Studing impact of Irene, Lee can lessen future storm damage, *Poughkeepsie Journal*, June 24 [link].

8. Another wastewater treatment facility proposed, *Morning Times* (Sayre, PA), June 6 [link].

9. Sparkill Creek Watershed Alliance readies annual 'Trees for Tribs' planting, *The Journal News*, May 19 [link].

10. Eagle Scout plants Trees for Tribs, *Your News Now*, May 20 [link].

11. Symposium's message: Save water, save money, *Poughkeepsie Journal*, April 25 [link].

12. DEC again hosts 'Trees for Tribs' potting, *Poughkeepsie Journal*, April 24 [link].

13. Green smartphone apps leverage power of citizen scientists, *The Californian,* April 20 [link].

14. NYSWRI-supported American Eel Research Project counts record number of eels this year [Press release]. Media coverage: The New York Times, Poughkeepsie Journal, Staten Island Real-Time News, NY1 News, Times Herald-Record.

15. As New York state ponders hydrofracking, Auburn overturns ban on gas drilling waste water at municipal treatment plant, *The Post-Standard*, March 11 [link]

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	2	0	0	0	2
Masters	4	0	0	0	4
Ph.D.	0	1	0	1	2
Post-Doc.	1	0	0	0	1
Total	7	1	0	1	9

Notable Awards and Achievements

Publications from Prior Years