MA Water Resources Research Center

Annual Report

2018-2019

March 1, 2018 – June 30, 2019

Marie-Françoise Hatte

Interim Director

Massachusetts Water Resources Research Center
209 Ag Engineering Bldg
250 Natural Resources Rd
University of Massachusetts
Amherst MA, 01003

Tel: 413-545-5531
E-Mail: wrrc@umass.edu

Interim Director:
Marie-Françoise Hatte
mfhatte@umass.edu

Water Projects Coordinator/EAL Laboratory Manager:
Travis Drury/Cameron Richards
tdrury@umass.edu/cameronr@umass.edu

Cover photo: MF Hatte sampling Eagleville Pond, Orange MA
by Caleb Walk

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Introduction

This report covers the period March 1, 2018 to June 30, 2019, the 54th year of the Massachusetts Water Resources Research Center (WRRC). The Center was under the direction of Marie-Françoise Hatte as Interim Director. Research Fellow Travis Drury left the Center mid April 2019 and Cameron Richards was hired in the position in May 2019.

The goals of the Massachusetts Water Resources Research Center are to address water resource needs of the Commonwealth and New England through research, creative partnerships, and information transfer. Through the USGS 104B program, WRRC aims to encourage new faculty as well as students to study water resources issues.

In fiscal year 2019 (WRIP FY2018) one new research project was supported through the USGS 104b Program:

"**Forest land cover in water quality management: Developing a valuable addition to the Cape Cod Commission's 208 Technologies"** was led by Dr. Ivan Valiela and Dr. Javier Lloret at the Marine Biological Laboratory in Woods Hole, to quantify the potential of forested land cover management to reduce Nitrogen loads to fresh- and Nitrogen-sensitive coastal waters

The **Acid Rain Monitoring Project**, led by WRRC Associate Director Marie-Françoise Hatte, was continued for another year in order to document trends in surface water acidification. The **Blackstone River Water Quality Modeling** project also continued, as did the **MassDEP-UMass Data Sharing Collaborative**, started in early 2018 to assist the Massachusetts Department of Environmental Protection make use of water quality monitoring data collected by external groups.

The **North East Graduate Student Water Symposium 2018** was held in September 2018 to offer students an opportunity to present their water related research and meet other researchers.

Progress results for each project are summarized for the reporting year in the following sections.

Research Program

1. Forest land cover in water quality management: Developing a valuable addition to the Cape Cod Commission's 208 Technologies

Principal Investigators: Ivan Valiela
Start Date: March 1, 2018
End Date: February 28, 2019
Funding Source: 104B (2018MA469B)
Reporting Period: 3/1/2018 – 2/28/2019
Research Category: Hydrogeochemistry

Summary of completed program activities:
The goal of this project was to (1) quantify the potential of forested land cover management to reduce nitrogen loads to coastal waters and (2) develop a section of the Cape Cod Commission Technologies Matrix that conveys that assessment and its application to the Cape Cod region.

Over the course of the project duration we completed all the planned data compilations and modeling efforts to quantify the potential of forested land cover management to reduce nitrogen loads to estuaries in Cape Cod. We modeled nitrogen inputs to the watersheds and estuaries of the Waquoit Bay estuarine system, a series of Cape Cod watersheds with different degrees of forest cover and urbanization histories. We quantified decadal trajectories of forest cover and associated nitrogen retention. We also partitioned retention of N in forests and other land covers, and tested whether degree of urban development, and land cover configuration alter nitrogen retention within forests. Our main results emphasize the role of forest covers as effective areas for the reduction of nitrogen loads to estuaries, and clearly highlight the potential of forest cover preservation and recovery as effective tools for management of nitrogen in the watersheds of Cape Cod and elsewhere.

In support of the modelling efforts, the Cape Cod Commission GIS staff researched the best available satellite imagery currently available and that could be used for historical comparison. Forest cover reconstruction was reasonably accomplished using freely available satellite data from the USGS. Landsat (MSS/TM/ETM+/OLI) was one of the first-launched and continuously-maintained earth observing satellite series and has the necessary visible and near infrared bands from 1972 through present, which is essential to distinguish vegetation from other land cover types, as well as to differentiate broad-level tree families, such as conifer from deciduous.

CCC staff also compiled the best available land use data for the 15 towns of Cape Cod. This necessary step enabled classification of development density. The classification of land use and land cover required several meetings of the project partners. Using existing watersheds, we then applied the land use/land cover data and classified the forest cover accordingly (low, intermediate and high).

We prepared a technical report to complete our tasks under goal (2) of the proposal. This document has been written in the format of a scientific paper, and will be submitted for review and publication in a peer-reviewed journal. We will also work with the Cape Cod Commission to incorporate our results into their 208 Technologies Matrix, as planned. Together with the Cape Cod Commission, we are committed to completing this part of the project to inform the 208 Technologies Matrix and continue supporting Cape Cod communities watershed-management planning.

Student Support:
Claire Valva, BS University of Chicago
Paige Torres, BS Brown University
Ruby Rorty, BS University of Chicago
Nicole Vandal, BS Amherst College

Publications and Conference Presentations:

Lloret, J., Valiela, I., Reynolds, A., McElroy, H., Cormier, H. Nitrogen interception in coastal watersheds: Historical changes in the role of forest cover in the reduction of nitrogen loads to estuaries. (In prep.)

2. **Focus Group:**

While there are numerous faculty and extension staff at the University of Massachusetts interested in water resources issues, there is currently no established conduit for them to cooperate across departments and disciplines on collaborative research. The Water Resources Research Center (WRRC) created a listserv of all these researchers and hosted two social events to facilitate the water researchers to meet and exchange ideas and information. We also organized listening sessions around USDA NIFA calls to get a multi-disciplinary team to submit a proposal. Those events were well attended and appreciated, but to date no comprehensive project has materialized from these exchanges, mainly because of the uncompensated time required of faculty to lead proposal development.

WRRC therefore proposed to take a more proactive step with the goal of preparing research project proposals from multidisciplinary teams within our University system. Multidisciplinary projects are more complex and can address water issues more completely, and are therefore more successful to secure funding from agency programs such as USDA or NSF.

A Master's Student in Geosciences (GIST Program) compiled a list of grants with applicability to our water resources project to restore a salt marsh. For each opportunity, he researched the due dates, application requirements, specific requests for proposals and likelihood of success. These, along with a proposal template, will be extremely useful to our multidisciplinary team as we continue to seek support for this important wetland research. In addition, the MS student assisted with processing and analysis of several soil samples from the site to assess the hydrologic properties of each to determine whether or not they are suitable for wetland development.

3. Acid Rain Monitoring Project

Principal Investigators: Marie-Françoise Hatte
Start Date: January 1, 2019
End Date: June 30, 2019
Funding Source: Massachusetts Department of Environmental Protection and Bureau of Waste Prevention
Reporting Period: 1/1/2019 – 6/30/2019
Research Category: Water quality

Introduction
This report covers the period January 1, 2019 to June 30, 2019, the eighteenth year of Phase IV of the Acid Rain Monitoring Project. Phase I began in 1983 when about one thousand citizen volunteers were recruited to collect and help analyze samples from nearly half the state's surface waters. In 1985, Phase II aimed to do the same for the rest of the streams and ponds[1] in Massachusetts. The third phase

[1] Note: The term stream in this report refers to lotic waters (from creeks to rivers) and the term ponds refers to lentic waters (lakes and ponds, but not marshes)

spanned the years 1986-1993 and concentrated on a subsample of streams and ponds to document the effects of acid deposition to surface waters in the state. Over 800 sites were monitored in Phase III, with 300 citizen volunteers collecting samples and doing pH and ANC analyses. In 2001, the project was resumed on a smaller scale: about 60 volunteers are now involved to collect samples from approximately 150 sites, 26 of which are long-term sites with ion and color data dating back to Phase I. In the first years of Phase IV (2001-2003), 161 ponds were monitored for 3 years. Between Fall 2003 and Spring 2010, the project monitored 151 sites twice a year, mostly streams, except for the 26 long-terms sites that are predominantly ponds. Since 2011, reduced funding eliminated our October sampling and monitoring now occurs in April only. In 2011, we also stopped monitoring some of the streams in order to add and revisit ponds that were monitored in 2001-2003. This year is the eighth year of monitoring for those added ponds.

Goals

The goals of this project are to determine the overall trend of sensitivity to acidification in Massachusetts surface waters and whether the 1990 Clean Air Act Amendment has resulted in improved water quality.

Methods

The sampling design was changed in 2011 to monitor both streams and ponds, and that design continues to date. In 2001-2003 mostly ponds were monitored. In Fall 2003 the sampling scheme switched to streams to evaluate their response to air pollution reductions. In 2011 the site list was modified to include both ponds and streams. Half of the streams monitored since 2003 were kept, and half of the ponds monitored in 2001-2003 were added back. The streams that were removed were chosen randomly within each county. Ponds that were reinstated on the sampling list were chosen at random within those counties and by ease of accessibility to replace the removed streams. Because those sites were chosen without a preconceived plan, they can be considered picked at random.

One collection took place this year, on **April 7, 2019**.

Methods were unchanged from previous years: Volunteer collectors were contacted six weeks before the collection to confirm participation. Clean sample bottles were sent to them in the mail, along with sampling directions, a field sheet/chain of custody form, and directions including latitude and longitude coordinates along with maps to the sampling sites. Volunteers collected a surface water sample at their sampling sites either from the bank or wading a short distance into the water body. They collected water one foot below the surface, upstream of their body, after rinsing their sample bottle three times with pond or stream water. If collecting by a bridge, they collected upstream of the bridge unless safety and access did not allow it. They filled in their field data sheet with date, time, and site code information, placed their samples on ice in a cooler and delivered the samples to their local laboratory right away. They were instructed to collect their samples as close to the lab analysis time as possible. In a few cases, samples were collected the day prior to analysis because the lab is not open on traditional "ARM Sunday." Previous studies by our research team have established that pH does not change significantly in 24 hours when the samples are refrigerated and stored in the dark.

One change was that Statewide Coordinator Travis Drury left UMass service, but not before sampling, and UMass analyses were completed in mid-April. He is succeeded by Cameron Richards, who took over the Statewide Coordinator position in early May.

Volunteer labs were sent any needed supplies (sulfuric acid titrating cartridge, electrode, buffers), two quality control (QC) samples, aliquot containers for long-term site samples, and a lab sheet one week to ten days before the collection. They analyzed the first QC sample (an unknown) in the week prior to the collection and called in their results to the Statewide Coordinator. If QC results were not acceptable, the volunteer analyst discussed possible reasons with the Statewide Coordinator and made modifications until the QC sample analysis gave acceptable results. On collection day or the day after, volunteer labs analyzed the second QC sample before and after the regular samples, and reported the results on their lab sheet along with the regular samples. Analyses were done on their pH-meters with KCl-filled combination pH electrodes. Acid neutralizing capacity (ANC) was measured with a double end-point titration to pH 4.5 and 4.2. Most labs used a Hach digital titrator for the ANC determination, but some used traditional pipette titration equipment. Aliquots were taken from 24 long-term sites to fill two 50mL bottles and one 50mL tube per site for later analysis of ions and color. These aliquots were kept refrigerated until retrieved by UMass staff.

This year all 26 long-term sites were sampled, and Great Pond in Barnstable County was reinstated to the long-term sites list and analyzed for the full suite of parameters. Aliquots, empty bottles, and results were collected by the ARM Statewide Coordinator between one and three days after the collection.

The Statewide Coordinator reviewed the QC results for all labs and flagged data for any lab results that did not pass Data Quality Objectives (within 0.3 units for pH and within 3mg/L for ANC). pH and ANC data were entered by one ARM staff and proofread by another. Data were entered in a MS excel spreadsheet and uploaded into the web-based database at http://63.135.115.71/acidrainmonitoring/.

Data were also posted on the ARM web page at http://wrrc.umass.edu/research/acid-rain-monitoring-project.

Water Resources Research Center's Travis Drury, with the help of sophomore student Haena Jung, managed the Environmental Analysis Lab (EAL) and provided the QC samples for pH and ANC to all of the volunteer labs. EAL also provided analysis for color analysis for the long-term site samples. The UMass Extension Soils Laboratory analyzed the samples from the long-term sites for cations, and University of New Hampshire's Water Quality Analysis Laboratory, under the direction of Jody Potter, analyzed the samples from the long-term sites for anions.

Aliquots for 26 long-term sites were analyzed for color on a spectrophotometer within one day; anions within two months on an Ion Chromatograph; and cations within one month on an ICP at the UMass Extension Soils Laboratory on the UMass Amherst campus. The available data was sent via MS Excel spreadsheet to the Statewide Coordinator who uploaded it into the web-based database.

The Project Principal Investigator plotted the data to check for data inconsistencies and gaps. She then analyzed the available April data from 1983 through 2019, using the statistical software JMP (http://www.jmp.com/software/) to run bivariate analyses of pH, ANC, and ions against date. This yielded trends analyses with a fitted X Y line, using a 95% confidence interval.

Results

1. There were 149 sites to be monitored, 76 ponds and 73 streams. All sites were sampled this year. Of those, 19 ponds and 7 streams are "long-term" sites that are sampled every year and analyzed for color and a suite of ions in addition to pH and ANC.

2. Sampling was completed for all 149 sites (76 ponds and 73 streams) including all 26 of our long-term sites.

3. There was only one quality control problem this year, with one lab failing pH data quality objectives, affecting five sites in the northeastern part of the state.

4. For the ion analyses, both UNH and UMass analyzed the 26 long term site samples for Mg, Ca, Na, and K. This provided a comparison opportunity between the two labs, which agreed fairly well. UMass ran duplicate analyses for one site, and only one of the duplicates matched well with the UNH data, so the UMass analysis for that sample was used in the data analysis.

5. The network of volunteers was maintained and kept well informed on the condition of Massachusetts surface waters so that they would be able to participate effectively in the public debate. This was accomplished by e-mail and telephone communications, as well as through updates via an internet listserv. 56 volunteers participated in this year's collection. Several new volunteer collectors were recruited to replace ill or retiring volunteers via Volunteermatch.org, a press release which was picked up by at least two Massachusetts newspapers, several internet listservs, and by word of mouth. There were 10 volunteer labs across the state, in addition to the EAL at UMass Amherst, in charge of pH and ANC analyses (Table 1). As the Pepperell Waste Water Treatment lab was not available this year, their samples were analyzed by the Cushing Academy lab. The Westfield State University was short of staff, so they analyzed only half of their usual samples, and the Springfield Water and Sewer Commission analyzed the other half.

Table 1: Volunteer Laboratories

Analyst Name	Affiliation	Town
Joseph Ciccotelli	Ipswich Water Treatment Department	Ipswich
Amy Johnston	UMass Boston	Boston
Mark Putnam	MDC Quabbin Lab	Belchertown
Dave Bennett	Cushing Academy	Ashburnham
Kimberly Newton and Mary Rapien	Bristol Community College	Fall River
Bob Bentley	Analytical Balance Laboratory	Middleborough
Dave Christensen	Westfield State University	Westfield
Devon Avery	Upper Blackstone Water Pollution Abatement District	Millbury
Sue Tower	Springfield Water and Sewer Commission	Westfield
Cathy Wilkins	Greenfield High School	Greenfield
Travis Drury	UMass Amherst Environmental Analysis Lab	Amherst

6. The ARM web site and searchable database were maintained and updated. 2019 pH, ANC, color, and ion data that met data quality objectives were added to the web database via the uploading tool created in previous years. Our database consultant added components to the database to greatly improve the database download function, which resulted in a much simplified effort for our statistical analysis.

7. The data collected was analyzed for trends in pH and ANC in April months (149 sites) and for color and ions (26 sites), using the JMP® Statistical Discovery Software (http://www.jmp.com/software/). Trend analyses (scatter plots, regression, and correlation) were run on pH, ANC, color, and each ion separately for each site, predicting concentration vs. time. Note that the flagged pH data were inadvertently left in the statistical analyses for pH, but as the difference was small and didn't affect the summary calculations, the analysis was not run again without the five affected sites.

Data Analysis Results

pH and ANC

Table 2 displays the number of sites that show a significant change over time for pH or ANC. If the difference was not statistically significant (p>0.05), the sites are tabulated in the 'No Change' category.

Table 2: Trend analysis results for pH and ANC, April 1983 – April 2019 (Number of sites)

	All sites		Ponds		Streams	
	pH	**ANC**	**pH**	**ANC**	**pH**	**ANC**
Increased	47	56	24	37	23	19
Decreased	8	1	2	0	6	1
No Change	94	92	50	39	44	53
Total	149	149	76	76	73	73

Those results are graphed as percentages of all sites in Figure 1.

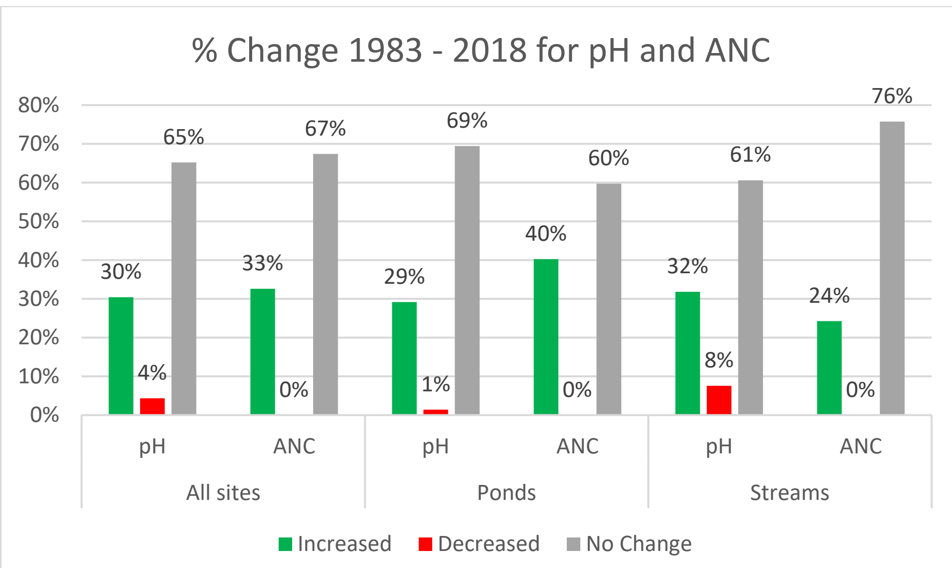

Figure 1. Percent change in number of sites for pH and ANC, from trend analysis, April 1983-2018

This trend analysis indicates that for most sites, neither pH nor ANC changed significantly over time. However, for those sites that show a significant change, many more show an increase than a decrease in value: 32% of the sites saw an increase in pH (30% last year) and 38% had an increase in ANC (33% last year). It can be noted that a larger percentage of sites have seen an increase in pH and ANC this year than last year.

Again this year we see a much higher percentage of ponds exhibiting an increase in ANC compared to streams (49% vs. 26%), but unlike last year when more streams had a higher pH than in the past than ponds (32% vs. 29%), this year both streams and ponds have 32% of water bodies showing an increase in pH. As far as decreases in pH are concerned, the situation is the same as last year: more streams saw a drop in pH (8%) than ponds (3%), while only 1% of streams and no ponds saw a decrease in ANC.

The 2018-2019 winter saw less snowfall than in the past couple of years. We purposely sample in early April to catch any large snowmelt events, but this year there was no snow left on the ground by April 7, and our results indeed do not indicate an acid pulse due to snowmelt.

Ions and color

Trend analyses were run for 26 long-term sites that were analyzed for eleven ions and for color. Results are shown in Table 3 and Figure 2. Note that the trends period is 1985-2019.

Table 3: Trends for number of sites with increases or decreases in ion concentration and color April 1985 – April 2019

	Increased	Decreased	No Change
Color	22	1	3
Cl	17	0	9
NO3	10	1	15
SO4	0	24	2
Mg	6	0	20
Mn	0	9	17
Fe	0	6	20
Cu	1	0	25
Al	1	4	21
Ca	4	1	21
Na	14	0	12
K	8	0	18

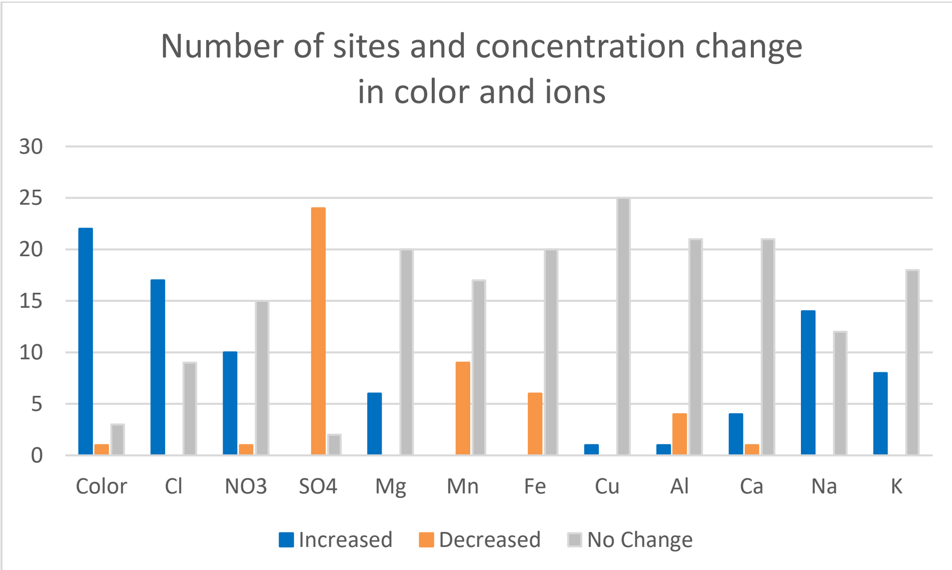

Figure 2: Results of trend analysis for ions and color at 26 long-term sites, April 1985-2019
Shown is how many sites showed an increase (blue), decrease (orange), or no significant change (yellow) over the period 1985 – 2019

Results are similar to previous years. While there are still more sites that show no significant change either up or down, more cations display an increase than a decrease over the years. Sodium continues to be the ion with the most increases, with manganese showing the most decreases.

For anions, we continue to see a very significant downward trend in Sulfate (24 sites). Nitrates, on the other hand, continue to show more increases than decreases, and it is unknown at this time whether it is due to increasing vehicular emissions, or a result of climate change – smaller and less persistent snowpacks result in fine root damage and reduced microbial activity. This can result in losses of nutrient elements, most notably Nitrogen in the form of NO_3^-.

Color is still increasing in most of our sites, which is consistent with a recovery of natural alkalinity.

Discussion

The continued trend in decreasing sulfate confirms that the Clean Air Amendment of 1990 is having a positive effect in the quality of the Commonwealth's surface water quality. Road salting in the winter continues to affect the concentration of sodium and calcium in the water bodies. Continued monitoring will help tease out whether nitrate pollution is countering the beneficial effect of decreased sulfates.

4. Blackstone River Water Quality Monitoring Study

Principal Investigators: Marie-Françoise Hatte
Start Date: 7/1/2012
End Date: Ongoing
Funding Source: Upper Blackstone Water Pollution Abatement District
Reporting Period: 7/1/2018 – 6/30/2019
Research Category: Water quality

The Upper Blackstone river water quality monitoring program was initiated in 2012 to monitor and assess the impact of WWTF upgrades. Since the 2008 upgrades were completed and brought online in 2009, Upper Blackstone has continued to refine its treatment process to minimize nutrients, particularly in the summer months. Compared to 2018, the WWTF performed at about the same level in 2019, the effluent TP load has been reduced by 92% and the effluent TN load has been reduced by 53% compared to the average pre-upgrade nutrient loads between 2006 and 2008.

Water quality monitoring data collected by Upper Blackstone in 2019 continued to show water quality improvements relative to conditions prior to the WWTF upgrade. Reduced nutrient loads from the WWTF's effluent correlate with reduced river nutrient and chlorophyll-a levels, increasingly meeting MassDEP river water quality guidelines for the Blackstone River.

In 2019, river TP concentrations were average to low at all sampling sites, with 80 percent of the samples collected below the 100 ppb MassDEP guidance value. River TN concentrations were slightly higher than in the past few years, especially just below the UB effluent confluence with the Blackstone River, but are still lower than the pre-upgrade condition, contributing to observed water quality improvements in downstream marine waters such as Narragansett Bay.

The 2019 river TP loads were in general average to lower, though TP loads increased at the Rhode Island sites. TN yearly loads were higher at all sites, but lower than in the past three years when averaged over summer months. The increase in river loads can be explained by high streamflows in the spring and fall, and low streamflows in the summer. However, when compared to before the Upper Blackstone plant upgrade, overall nutrient loads have been greatly reduced.

The 2019 sampling season was preceded by a lower than average snowy winter and in general the year can be characterized by normal temperatures though a warmer summer, and somewhat higher than average precipitation and streamflow until July. A combination of factors, including temperature, exposure to sunlight, streamflow, nutrient availability on the days preceding routine sampling, and along-stream transport dynamics likely contribute to the observed year-to-year differences in water column nutrient and chlorophyll-a levels. Though river nutrient loads were higher than average in 2019, and despite summer temperatures being higher than average, chlorophyll-a measurements met MassDEP's guidance values nearly all of the time.
Field measurements of water temperature, pH, and dissolved oxygen, in addition to conductivity measured in the laboratory, documented that the Blackstone River meets state water quality standards on the dates and times visited by this project's crews.

Continuous Dissolved Oxygen levels followed a consistent pattern in the stretch of the Blackstone River that was monitored in 2019. DO levels above the Upper Blackstone treated effluent discharge (W0680) indicate the river supports aquatic life uses based on guidance in MassDEP’s 2018 CALM. At the middle two stations in the program, aquatic life uses are not supported due to occasional drops in DO below 5 mg/L and DO diurnal variations that exceed 3 mg/L. But farther downstream aquatic life uses are again supported based on DO data. Exceedances of water quality guidance and standards occurred most frequently during a very low flow period in September and October.

Finally, one benefit of a long-term data collection efforts like Upper Blackstone’s is that a more robust statistical analysis of data trends can be completed. Trends in water quality were evaluated on streamflow-weighted TP and TN data collected since 2012. Statistically significant, decreasing TP trends were noted at all sites except for W0680 and UBWPAD2, and decreasing TN trends were noted at all sites except for W0680, UBWPAD2, and W0767. The chlorophyll-a trend analysis suggests that overall chlorophyll-a levels are increasing slightly, especially at the upper mid-river sites (W1258 and W1242); however, the overall chlorophyll-a concentrations are generally low.

The Upper Blackstone water quality monitoring program has documented significant improvements relative to nutrient and chlorophyll-a concentrations in the Blackstone River since the WWTF upgrade was completed. Subsequent optimization efforts have resulted in continued reductions in nutrients and chlorophyll-a concentrations. These trends are promising, and water quality is expected to improve even more as Upper Blackstone continues its work to improve its effluent water quality in accordance with its NPDES permit and Administrative Order on Consent.

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5. MassDEP-WRRC Data Sharing Collaborative

Principal Investigator: Marie-Françoise Hatte
Start Date: July 1, 2018
End Date: June 30, 2019
Funding Source: Massachusetts Department of Environmental Protection
Reporting Period: 7/1/2018 -6/30/2019

Background

The Massachusetts Department of Environmental Protection (MassDEP)'s Watershed Planning Program (WPP) is responsible for protecting, enhancing, and restoring the quality of the waters of the Commonwealth, and is required by the Federal Clean Water Act (CWA) to report to the US Environmental Protection Agency (EPA) every two years on the health of both fresh and marine waters with respect to the level of attainment or impairment of designated uses such as recreation (e.g., swimming, boating), shellfishing, fish consumption, drinking water, and the integrity of aquatic ecosystems. The cornerstone of WPP's decision-making related to designated use assessments is reliable scientific data and technical information from its monitoring program, as well as that from other parties. To meet specific data needs, the WPP collects physical, chemical and biological data for surface waters throughout the Commonwealth. This monitoring activity requires a comprehensive array of plans, procedures and activities that culminate in producing sufficient data of known and documented quality. In addition to these data, WPP also solicits data from outside groups and reviews them for potential use in decision-making.

In light of declining Federal and state CWA program resources, MassDEP is looking to include in its assessment data collected by watershed groups and municipalities. Toward this goal, MassDEP entered into a collaborative partnership with the Water Resources Research Center at the University of Massachusetts Amherst (WRRC) to communicate with monitoring groups and assist in the technical review of Quality Assurance Project Plans (QAPP) and data submissions from those groups.

Project Outline

The project in FY2019 included the following tasks:

1) Provide Training to Watershed Groups
   Work with MassDEP and Mass Rivers Alliance to design and implement a curriculum for training in data planning, collection, management, transmittal, review and analysis.
   a) Design, develop and host at least 2, ¾ day workshops to be hosted in the MassDEP Worcester office
   b) Develop a list of invited groups
   c) The first workshop will focus on what data MassDEP needs (especially from volunteer groups), QAPP development, and data management
   d) The second workshop will be focused on methods for data review and interpreting quality control data, and data transmittal.
2) Outreach and Assistance to Monitoring Groups
   WRRC will continue building relationships with existing/potential monitoring groups in western Massachusetts and encourage/assist them to develop a QAPP and submit it for review, plan collections, execute surveys with attention to QA/QC and manage data, and submit data to MassDEP.
   a) In coordination with MassDEP, create a system for effective outreach and communication with water quality monitoring groups (e.g. listserv, website, quarterly newsletter or email to inform groups of opportunities and remind them of deadlines)
   b) Correspond with groups regarding QAPP and data reviews
   c) Document communications and outcomes
   d) Coordinate with the Connecticut River Conservancy (CRC) to provide support to the Connecticut River Strategic Monitoring Plan project design and the development of a QAPP for this initiative.
3) External QAPP and Technical Data Reviews
   In coordination with MassDEP:
   a) Coordinate directly with outside monitoring groups throughout the process regarding all aspects of QAPP development, submittal, and review (acting on MassDEP's behalf)
   b) Review draft QAPPs consistent with MassDEP expectations and standard review criteria (primary and secondary reviews)
   c) Review submitted data sets for usability by MassDEP, including comparison to project-/program-specific <u>AND</u> MassDEP data quality objectives. Utilize Excel worksheet to perform and document reviews
   d) Document primary and subsequent reviews back to MassDEP in a standard report format for QAPP and Data reviews

e) Make recommendations to MassDEP related to QAPP approval and data use suitability
f) Provide critical review of MassDEP's External Database (EDB), an internal warehouse of water quality data submitted to MassDEP from outside groups.

Results

Task 1: Provide Training to Watershed Groups

- Participated in 9 phone meetings with DEP and Mass. Rivers Alliance to discuss the development and logistics of the workshops
- Created detailed agendas for both workshops
- Created web pages for both events
- Developed presentations with slides and handouts for both workshops
- Added and updated resources for QAPP development and data submission on WRRC web pages (http://www.umass.edu/mwwp/resources/qapp.html & https://wrrc.umass.edu/water-quality-monitoring-data-quality-review-resources)
- Led Water Quality Monitoring Quality Assurance Workshop on 5/2/2019 at DEP facility in Worcester
  Agenda available at http://wrrc.umass.edu/events/water-quality-monitoring-quality-assurance-workshop.
  Presenters were Barbara Kickham, Sue Flint, Jerry Schoen and Marie-Françoise Hatte.
  14 participants from 2 lake associations, 7 river watershed associations, & Mass Rivers Alliance
  Slide presentations available at http://www.umass.edu/mwwp/pdf/DEP-update-UMassQAPP-workshop.pdf and http://www.umass.edu/mwwp/pdf/QAPP_Workshop_Presentation_5-2-19_WRRC.pdf
- Led Water Quality Monitoring Data Quality Review Workshop on 5/15/2019 at DEP facility in Worcester
  Agenda available at http://wrrc.umass.edu/events/water-quality-monitoring-quality-assurance-workshop
  Presenters were Barbara Kickham, Sue Flint, Jerry Schoen and Marie-Françoise Hatte.
  16 participants from 2 lake associations, 12 river watershed associations and Mass Rivers Alliance
  Slide presentations available at https://wrrc.umass.edu/water-quality-monitoring-data-quality-review-resources
- Created online evaluation forms for both workshops.
  2 responses for QAPP workshop
  0 responses for Data Decisions workshop
- Followed 2 EPA webinars on Study Design and WQX to gain knowledge necessary for workshop contents.

Task 2: Outreach and Assistance to Monitoring Groups

- Obtained credentials to edit and update the MWWP website, added resources for volunteer monitoring, particularly for QAPPs and Data Submission to DEP and EPA
- Updated MWWP listserv, adding members as requested
- Sent messages to listserv re DEP grants and workshops
- Met with Ryan O'Donnell three times in Greenfield (once with Andrea Donlon) and spoke with him via telephone several time regarding CRC's needs for assistance with volunteer monitoring

programs. As CRC no longer needed sub-groups to monitor nutrients in the watershed, decided to help with the DRWA monitoring program. Reviewed the QAPP and made suggestions to re-write QAPP for DEP

- Prepared a QAPP for the DRWA bacteria monitoring program
- Discussed helping Friends of Lake Warner and the Mill River with Jason Johnson re QAPP and SAP
- Communicated with Mike Liberty of lake Quinsigamond Watershed Association re starting a bacteria monitoring program, writing a QAPP, and hiring student intern help
- Worked on UMass Environmental Analysis Lab QAPP so volunteer groups can reference it in their own QAPPs
- Assisted Ryan O'Donnell with QAPP reviewed by Sue Flint, offered corrections and advice.

Task 3: External QAPP and Technical Data Reviews

- 9 QAPPs were reviewed, 8 to completion and submitted to DEP with recommendation to approve. One QAPP (French River) was reviewed and sent back to the organization with comments. No response from French River by report writing time.
- 1 Data Submittal was reviewed.
- See details in table below.
- Acted as liaison between consultant Robert English of Daystar Consulting and MassDEP re review of the EDB and possible improvements. More details about accomplishments on this task below.
-

Technical Reviews Performed by WRRC

Organization	Document	Year(s)	Assigned on	Responsible Staff	Checked by	Date sent to DEP
Lake Cochituate	QAPP	2019-2020	12/19/18	Drury	Hatte	1/9/2019
OARS	QAPP	2019-2021	12/19/18	Schoen	Hatte	1/9/2019
NepRWA	Updated QAPP	2019-2021	3/5/2019	Schoen	Hatte	3/15/2019
Chicopee	QAPP	2019-2024	4/5/2019	Schoen	Hatte	5/29/2019
Orleans (Lonnie's Pond)	QAPP	2018-2020	4/5/2019	Schoen	Hatte	5/28/2019
French	QAPP	2019?	4/9/2019	Hatte		
CRC	QAPP	2019?	5/23/2019	Schoen	Hatte	6/14/2019
OARS	QAPP	2019-2021	6/12/2019	Hatte	Flint	6/13/2019
CRWA	Data submittal	2014-2016	6/18/2019	Schoen	Hatte	6/25/2019
NSRWA	QAPP	2019?	6/20/2019	Schoen	Hatte	6/26/2019

EDB Critical Review

Bob English of Daystar Computing and Research Services reviewed MassDEP's External Database for errors and potential improvements. He became familiar with the forms, database and Visual Basic code as well as the details of and complex problems with the review process. He added columns to the Analysis View and corrected the ID field on the "Follow Up" form, and made some changes that move towards solutions to the more complex problems.

The two complex problems that he could not solve under the time and budget constraints are:

1) the lack of data entry validation, which causes EDRID mismatches, and

2) some programming that looks like it was never finished having to do with copying reviews to other years and other labs.

There were two tasks that he did not have time to work on - the Federal WQX database task and the "Flagging" problematic records task, although he spent some time getting familiar with the requirements for both.

He created password protection for the database and the Visual Basic code, which he tested but warns that due to the rush of the end of fiscal year, there could be some issues or problems arising from one or two of the more complicated fixes.

Three files were shared in a Box account:
- FixesandChangesMasterEDB_061719.doc
- Questions and issues on database for UMASS2019_BECComments060419_JMS_RFC-BE0062119.doc.

- EDB_Apr_22_2019.mdb (no change but now password protected)

Conclusions/Recommendations

WRRC is pleased to provide QAPP and Data Submittal review assistance to MassDEP, and to assist volunteer monitoring groups establish programs that result in useable data for WPP. We offer the following suggestions for potential continuation of our collaboration on a Data Sharing project:

- Accelerate the administrative set-up of the project in order to start work before December.
- Encourage monitoring groups to submit QAPPs much sooner than April in order to have approved QAPPs by the time their programs begin in the spring.
- WRRC could take on the role, or assist MassDEP, in communicating with groups to explain the monitoring calendar year, drafting a study design, offering QAPP development assistance, and general monitoring advice to groups, in order to facilitate the timely organization of new monitoring projects.
- Our staff is less busy in the winter than in the spring, therefore any data submission reviews would be best assigned in the fall.
- EDB streamlining, downloading data from EPA STORET is not finished, could be continued by Bob English now that he is familiar with the database. Bob suggests that Richard Chase and Jennifer Shephard test the database that he sent, before replacing their current working

database. After they have become familiar with the changes, a web conference could be arranged to discuss potential future work.

Information Transfer

One of the Massachusetts Water Resources Research Center's goals is the transfer of information on water resources. In FY2019 we proposed to assist in planning and holding the **New England Graduate Student Water Symposium.**

6. North East Graduate Student Water Symposium 2018

Principal Investigators: Marie-Françoise Hatte
Start Date: March 1, 2018
End Date: February 28, 2019
Funding Source: 104B
Reporting Period: 3/1/2018 – 2/28/2019

National conferences provide valuable presentation experience and networking opportunities. Unfortunately, the cost of travel, lodging, and registration presents substantial obstacles for most graduate students. To address this problem, the New England Graduate Student Water Symposium (NEGSWS) was created in 2014 and ran for its fifth consecutive year in 2018. In 2017, the conference maintained the NEGSWS acronym, but the full name was changed to "North East Graduate Student Water Symposium" to more accurately reflect the expanding geographic representation of the attendees.

The conference was organized by a team of University of Massachusetts graduate students with help from the Massachusetts Water Resources Research Center and University of Massachusetts College of Engineering Professor Dr. David Reckhow. Thanks to the support of conference sponsors, registration was free for students and two nights of hotel accommodations were provided to presenters and student coauthors for a small $45 fee. Due to the unique draw of a student-only conference and low costs, 137 students registered for the conference from 33 institutions and organization from the North East region of North America (Table 1). In addition, as a free and open conference, students were welcome to attend one or more days on a walk-in basis and those attendees are not accounted for in this list. Registered attendees came to the NEGSWS conference from eight U.S. states—Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, and Rhode Island—and two Canadian provinces—Nova Scotia and Quebec.

Table 1: Institutions and organizations represented at the symposium

Belchertown High School	Pioneer Valley Coral and Natural Science Institute
Brown and Caldwell	Smith College
Clarkson University	Temple University
Cornell University	Tighe & Bond
Dalhousie University	Tufts University
Emmanuel College	Université Laval
Fuss & O'Neill, Inc.	University at Buffalo
Hampshire College	University of Connecticut
Harvard University	University of Maine
JPMorgan	University of Massachusetts Amherst
Lafayette College	University of Massachusetts Boston
Learning Lab for Resiliency	University of Massachusetts Lowell
MA Water Resources Research Center	University of New Hampshire
Middlesex Community College	University of Rhode Island
Montclair State University	Worcester Polytechnic Institute
New York University	Yale University
Northeastern University	

The conference opened Friday, September 7, 2018 with an informal dinner which allowed attendees to check in at registration and network with faculty, sponsors, and other students (Figure 1).

Figure 1: Friday evening NEGSWS dinner

Technical presentations began the next morning and continued through Sunday afternoon (Figure 2). All presentations were given by undergraduate and graduate students, but post docs, alumni, faculty, and industry representatives were invited to attend. Forty two oral presentations were given in eleven sessions, which were grouped into the following topics: data science applications, drinking water treatment, environmental modeling, environmental monitoring and sensors, hydrology, wastewater treatment, water quality, water quality monitoring for policy and governance tools, and water treatment.

Figure 2: Student presenting at NEGSWS 2018

Saturday's events also included a poster session (Figure 3) featuring 46 posters on research in a variety of water resources topics. Saturday evening's events concluded with a complimentary dinner for all attendees.

Figure 3: Poster presentations

On Sunday, one more session of technical presentations was held before the keynote speaker, Dr. Paul Anastas of Yale University, wrapped up the conference (Figure 4).

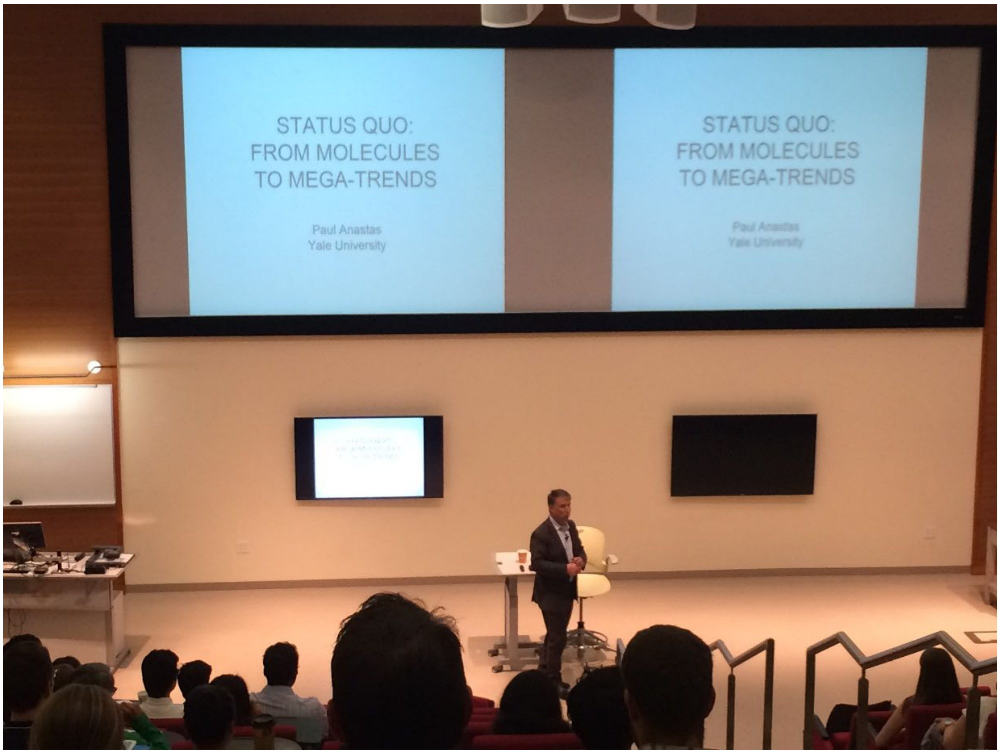

Figure 4: Keynote speech by Dr. Paul Anastas

Immediately after the conferences, attendees were sent a digital survey to assess the conference and determine ways in which it can be improved in future years. Out of 44 responses, 39 rated the overall quality of NESWS as either excellent or good. In all, 36 (82%) said they plan to attend next year, with graduation being the most common reason for not planning to attend in 2019. For NEGSWS 2019, responses indicated overall the students wish the conference to remain the same, but with slightly more networking events and speakers from government, industry, and academia.

Figure 5: Group Photo of NEGSWS 2018 Attendees

NEGSWS

North East Graduate Student Water Symposium

Friday, September 7th

6:00pm – 6:30pm	**Registration** – *Engineering Quad*
6:00pm – 8:00pm	**Dinner** – *Engineering Quad*

Saturday, September 8th

8:00am – 9:00am	**Registration** – *Integrative Learning Center (ILC) Lobby*
9:00am – 9:30am	**Group Photo** – *Meet in ILC Lobby*
9:30am – 11:00am	**Keynote Lecture – Paul Anastas** – *ILC Room 151*
11:00am – 12:30 pm	**Technical Session 1** – *See Technical Program for Room Locations*
12:30pm – 1:30pm	**Lunch** – *UMass Dining Commons*
1:30pm – 3:00pm	**Technical Session 2** – *See Technical Program for Room Locations*
3:00pm – 3:30pm	**Break** – *ILC Lobby*
3:30pm – 4:30pm	**Career Fair & Industry Presentations** – *ILC Room 151*
4:30pm – 6:30pm	**Poster Session** – *ILC Room N400 (Fourth Floor)*
7:30pm – 9:30pm	**Dinner** – *Ginger Garden, 351 Northampton Rd., Amherst, MA*

Sunday, September 9th

8:30am – 9:00am	**Registration** – *ILC Lobby*
9:00am – 10:30am	**Technical Session 3** – *See Technical Program for Room Locations*
10:30am – 11:00am	**Break** – *ILC Lobby*
11:00am – 12:00pm	**Tour of UMass Laboratories** – *Meet in ILC Lobby*
12:00pm – 1:00pm	**Small Reception & Closing Ceremony** – *ILC Lobby*

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Figure 6: NEGSWS 2018 schedule