Water Resources Research Center Annual Technical Report FY 2014

Introduction

This report covers the period March 1, 2014 to February 28, 2015, the 49th year of the Massachusetts Water Resources Research Center (WRRC). The Center is under the direction of Dr. Paula Rees, who holds joint appointments as Director of the WRRC and Director of Diversity Programs for the College of Engineering at the University of Massachusetts Amherst (UMass).

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 2014, five research projects were supported through the USGS 104B Program:

• UMass Amherst Geosciences Associate Professor David Boutt finished a 2013 project entitled “Linking groundwater heatflow to fish habitat in stream catchments with till-mantled bedrock” • Natural Resources Conservation Research Assistant Professor and Massachusetts Cooperative Fish and Wildlife Research Assistant Unit Leader Allison Roy led “Investigating effects of annual winter lake drawdowns on fish and macroinvertebrate assemblages and diet” at UMass Amherst • Harvard University Environmental Engineering Associate Professor Chad Vecitis researched the “Fate, transport, and remediation of PFOS, PFOA, perchlorate, and 1,4-dioxane at the Eastham MA landfill” • Assistant Professor Anita Milman of UMass Amherst Natural Resources Conservation started a study called “Going With or Against the Flow: Choices for Flood Mitigation Response in Massachusetts” • Worcester Polytechnic Institute Civil and Environmental Engineering Associate Professor Paul Mathisen worked on “Assessing the effectiveness of a biofiltration facility and associated groundwater flow in protecting water quality of a water supply reservoir.”

The 104B Program also supported two Information Transfer projects: • “Continuous Stream Temperature and Flow Monitoring,” a workshop on the topic of continuous stream temperature and flow monitoring, led by Dr. Allison Roy of UMass Amherst with help from other UMass Amherst faculty, USEPA, Mass. Department of Fish and Game, and Tetra Tech’s Center for Ecological Sciences • “New England Graduate Student Water Symposium,” a three-day conference tailored to graduate and undergraduate students in the water resources field, organized by a group of UMass Amherst students under the supervision of Dr. David Reckhow in Civil and Environmental Engineering.

The USGS Supplemental Program supported another year for the research project “Developing Tools for Climate eRisk Assessment and Adaptation in Water Resources Systems” led by Casey Brown of UMass Amherst Civil and Environmental Engineering. The IWR – funded project “RiverSmart Communities and Federal Collaborators: Attuning Federal Agencies and Programs with the State, Regional, and local Efforts to Support Ecologically Restorative Flood Prevention and Remediation in New England” continued under PI Eve Vogel of UMass Amherst Geosciences.

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

Research Program Introduction

None.

Linking groundwater heatflow to fish habitat in stream catchments with till-mantled bedrock

Basic Information

Title:	Linking groundwater heatflow to fish habitat in stream catchments with till-mantled bedrock
Project Number:	2013MA409B
Start Date:	4/1/2013
End Date:	3/31/2014
Funding Source:	104B
Congressional District:	MA-02
Research Category:	Climate and Hydrologic Processes
Focus Category:	Hydrology, Groundwater, Water Quality
Descriptors:	
Principal Investigators:	David Boutt

Publications

1. Mitchell R. Isaacson; David F. Boutt (2013), How do hydrodynamics in the critical zone relate to stream temperature distribution?, Abstract H23F-1350 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.
2. Mitchell R. Isaacson; David F. Boutt (2013), How do hydrodynamics in the critical zone relate to stream temperature distribution?, Abstract H23F-1350 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.
3. Mitchell R. Isaacson; David F. Boutt (2014), Investigating the role of critical zone hydrodynamics on stream temperature distributions, 2014 GSA Annual Meeting in Vancouver, British Columbia.

Problem and Research Objectives:

Stream temperature models based on air temperature alone cannot be uniformly applied to regions of differing geologic stratigraphy without accompanying physical models to incorporate subsurface heat flow. By coupling stream temperature distributions with subsurface heat flow dynamics we can better understand the resilience of thermal microhabitats in streams in the Northeast to climate changes. Our study focuses on a critical gap in our understanding of how temperature dynamics within subsurface flow paths relate to stream temperature distributions and the prevalence of thermal refugia for fish habitat.

Methodology:

We used fiber-optic distributed temperature sensing (DTS) to characterize stream temperature distributions with high spatial and temporal resolution. In conjunction with physical groundwater heat flow models, we use detailed stream temperature distribution profiles to provide new insight into the temperature variability and thermal buffering capacity of streams in till-mantled fracture bedrock catchments.

Principal Findings and Significance:

Our findings show that mean annual groundwater temperatures range consistently between 9-10 deg C in fractured bedrock at depths greater than 40' below ground surface. Till aquifer temperatures show greater seasonal variation, ranging from 6 – 13 deg C which fall along a damped phase lag of 3.5 months from air temperature. Shallow soil aquifer temperatures at depths of 1 m below ground surface surprisingly show a similar phase lag of 1-3 months ranging from 0 -15 deg C. Main channel stream temperature ranged between 1 – 20 deg C with a phase lag of <1 month. Most interestingly, localized groundwater input in the stream channel provided temperature offsets of up to 3 deg C, where 2 deg C temperature difference where common, despite a relatively well mixed channel area. The timing and magnitude of these localized groundwater inputs supports the hypothesis that groundwater is responsible for providing relatively cooler microhabitats during the cold or frozen winter months and warm summer months where stream temperatures can reach the extreme tolerance for salmonid survival. We observed that in-stream temperature variability was less present in stream reaches with extensive sand and gravel, rather the highest concentration of localized groundwater inputs coincided with bedrock outcrops and high near-stream hydraulic heads. Ongoing work will investigate the temperature variability of the streambed sediments and their relationship to site selection for egg-laying female brook char during the autumn redd.

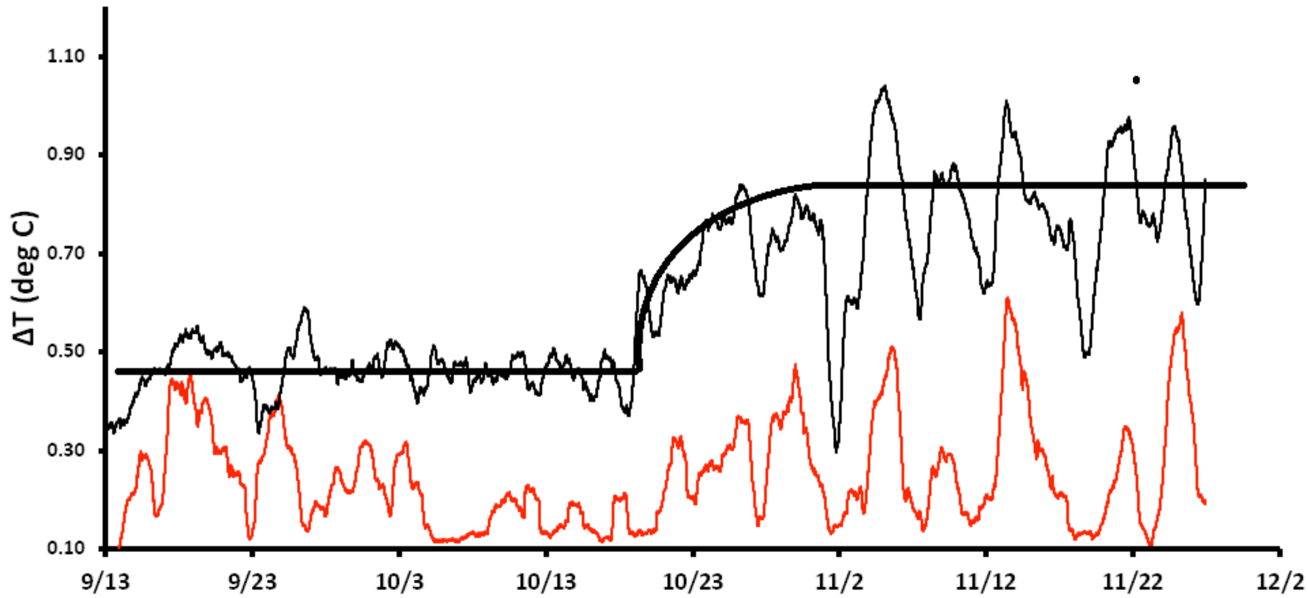


Figure 1: Red and black lines indicate the temperature differences between localized in-stream groundwater seeps and the main stream channel. Notice a step increase in dT around October 20th, 2013.

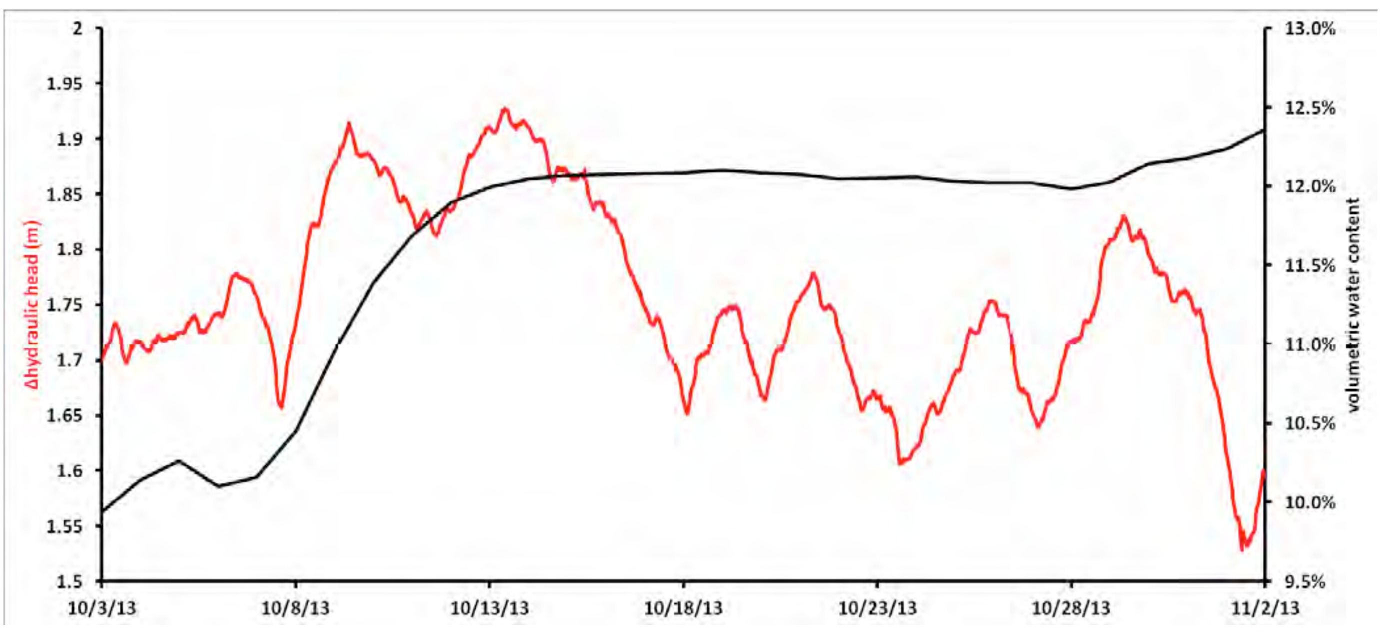


Figure 2: Hydraulic head changes in the surficial till (red) and saturation state of overlying soils (1m depth). A similar response to increased saturation can be seen as hillslope aquifers discharge to localized seeps in upstream reaches of Jimmy Nolan Brook

The following presentation, Mitchell R. Isaacson; David F. Boutt (2014), Investigating the role of critical zone hydrodynamics on stream temperature distributions, at the 2014 GSA Annual Meeting in Vancouver, British Columbia, is attached here.

GSA Topical Session:
Dynamics of Groundwater Temperature: From Recharge to Discharge Zones

Investigating the role of critical zone hydrodynamics on stream temperature distributions

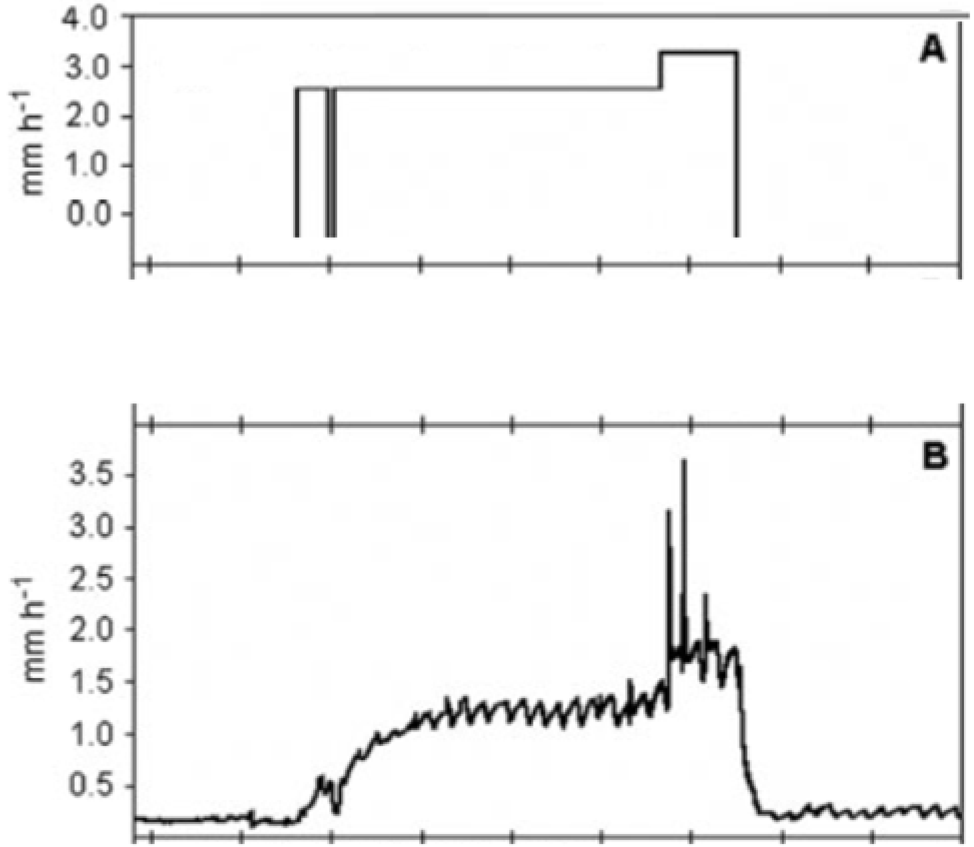
Mitchell Isaacson
MS student
University of Massachusetts Amherst

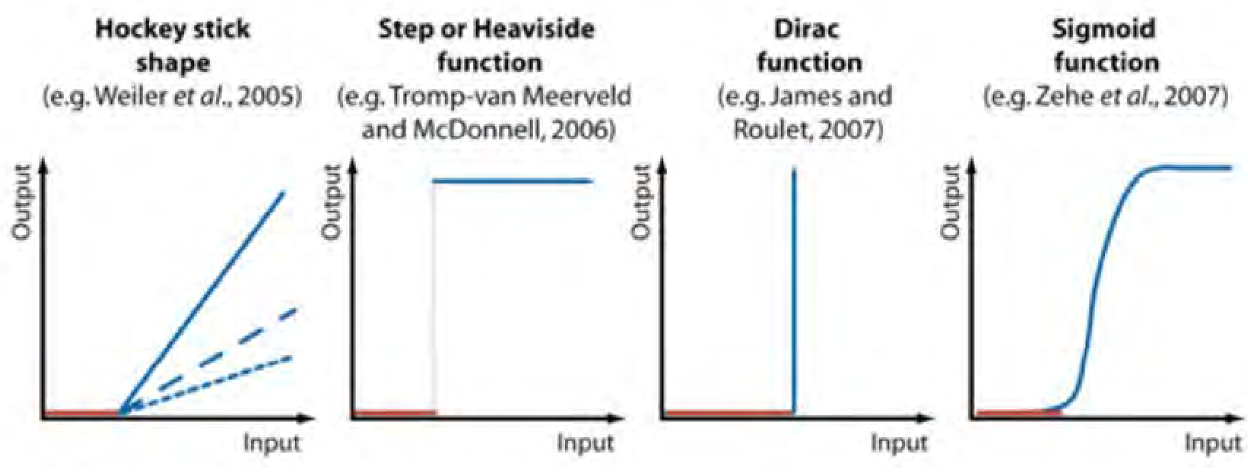
Why is stream temperature important at a <1k reach scale?

"...regional models of stream temperature would not fully capture thermal variation at the local scale and may misrepresent thermal resilience of stream networks. Groundwater appeared to play a major role in creating the fine-scale spatial thermal variation, and characterizing this thermal variation is needed for assessing climate change impacts on headwater species accurately. "

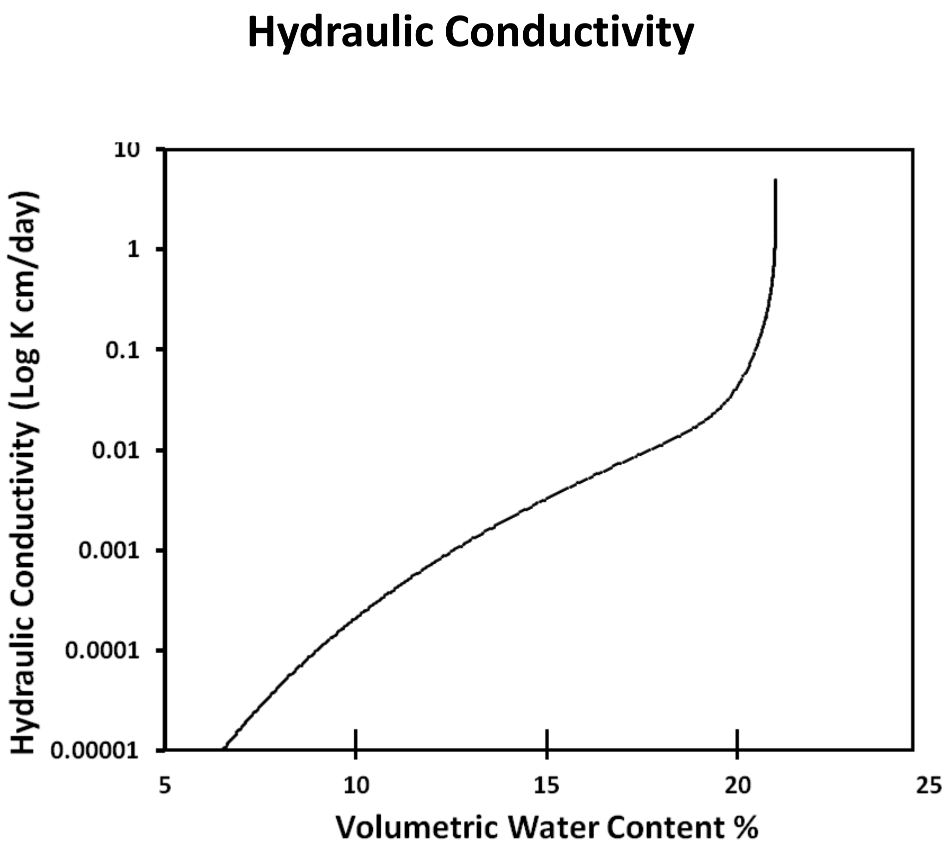
Kanno, Y., Vokoun, J. C. and Letcher, B. H. (2014), PAIRED STREAM–AIR TEMPERATURE MEASUREMENTS REVEAL FINE-SCALE THERMAL HETEROGENEITY WITHIN HEADWATER BROOK TROUT STREAM NETWORKS. River Res. Applic., 30: 745–755.

Hydrodynamics in the Critical Zone: thresholds





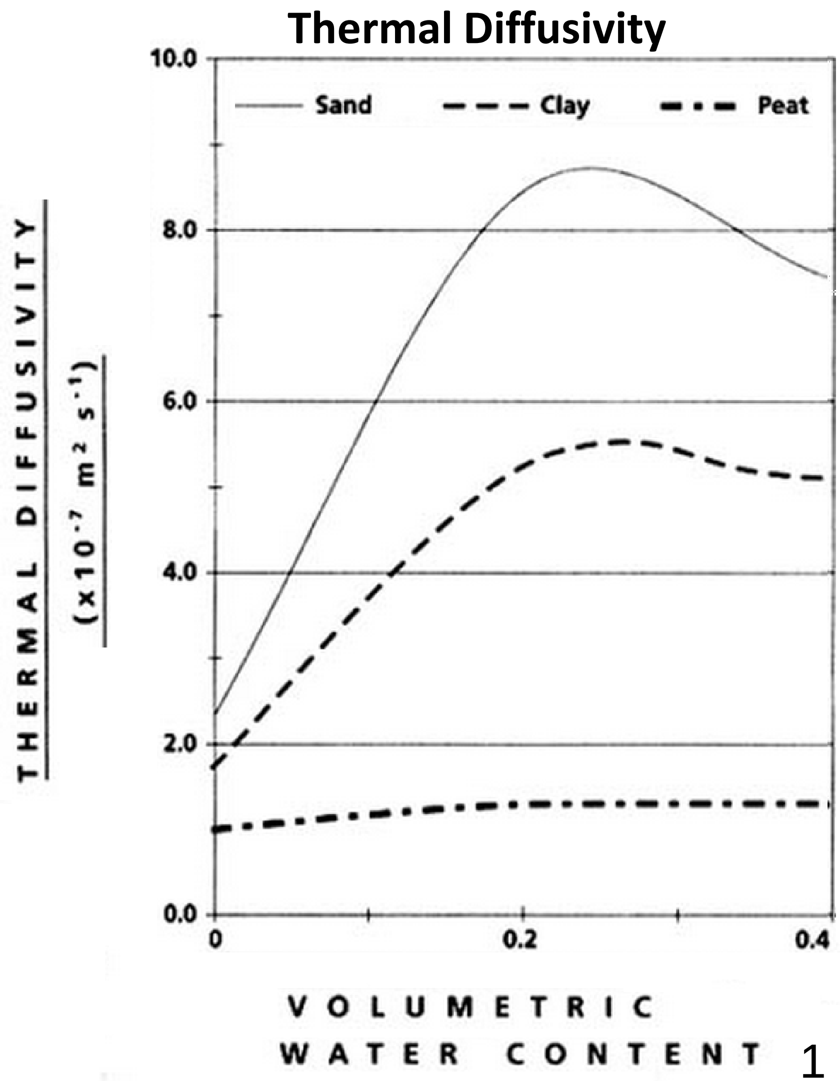
Soil response to threshold conditions



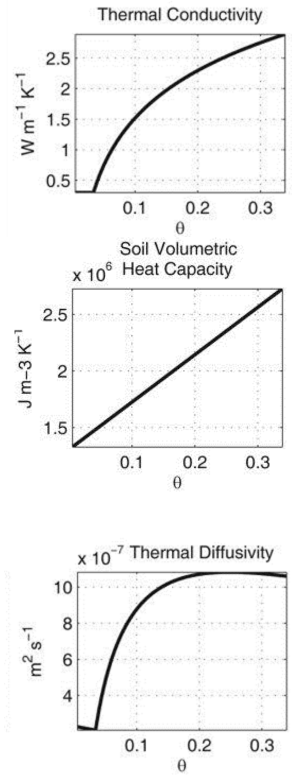
Higher saturation values lead to exponential increases in hydraulic conductivity

Field measurements using a Hyprop

Soil response to threshold conditions



1



2

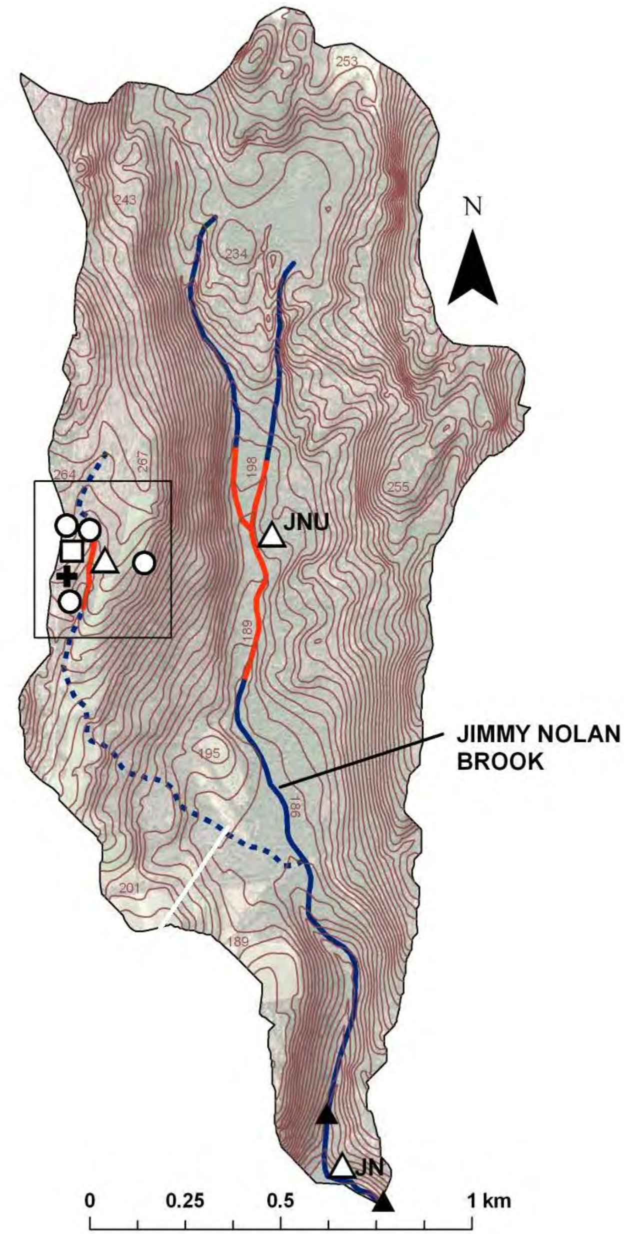
Soil Conductivity (W/m/K, n=15)	
Saturated	Dry
0.63	0.166

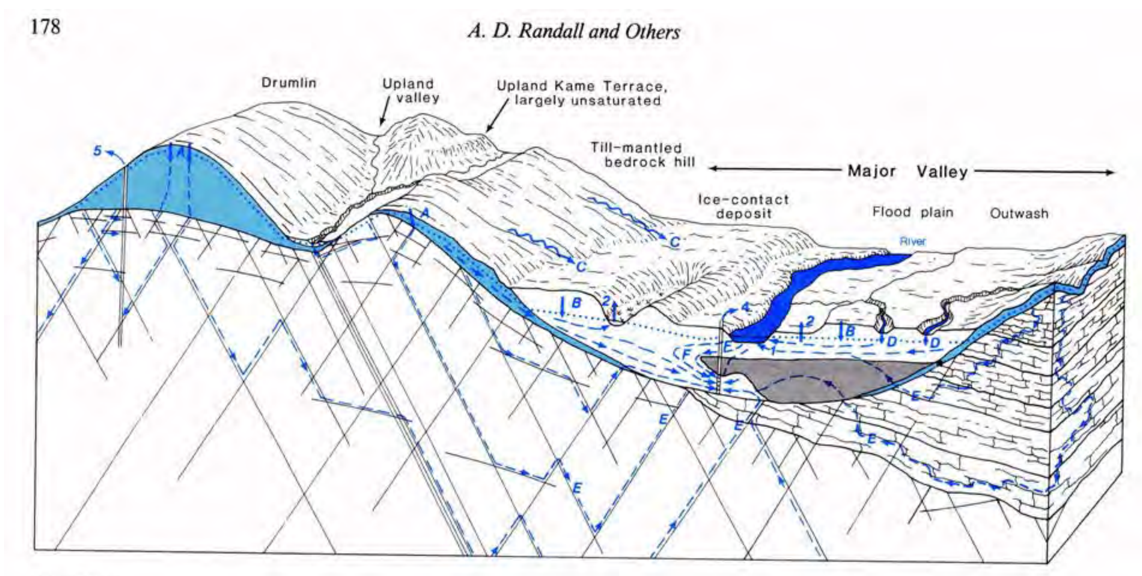
1 - fao.org modified from Montieth and Unsworth, 1990

2 - Rutten et al. 2010.

STUDY DESIGN

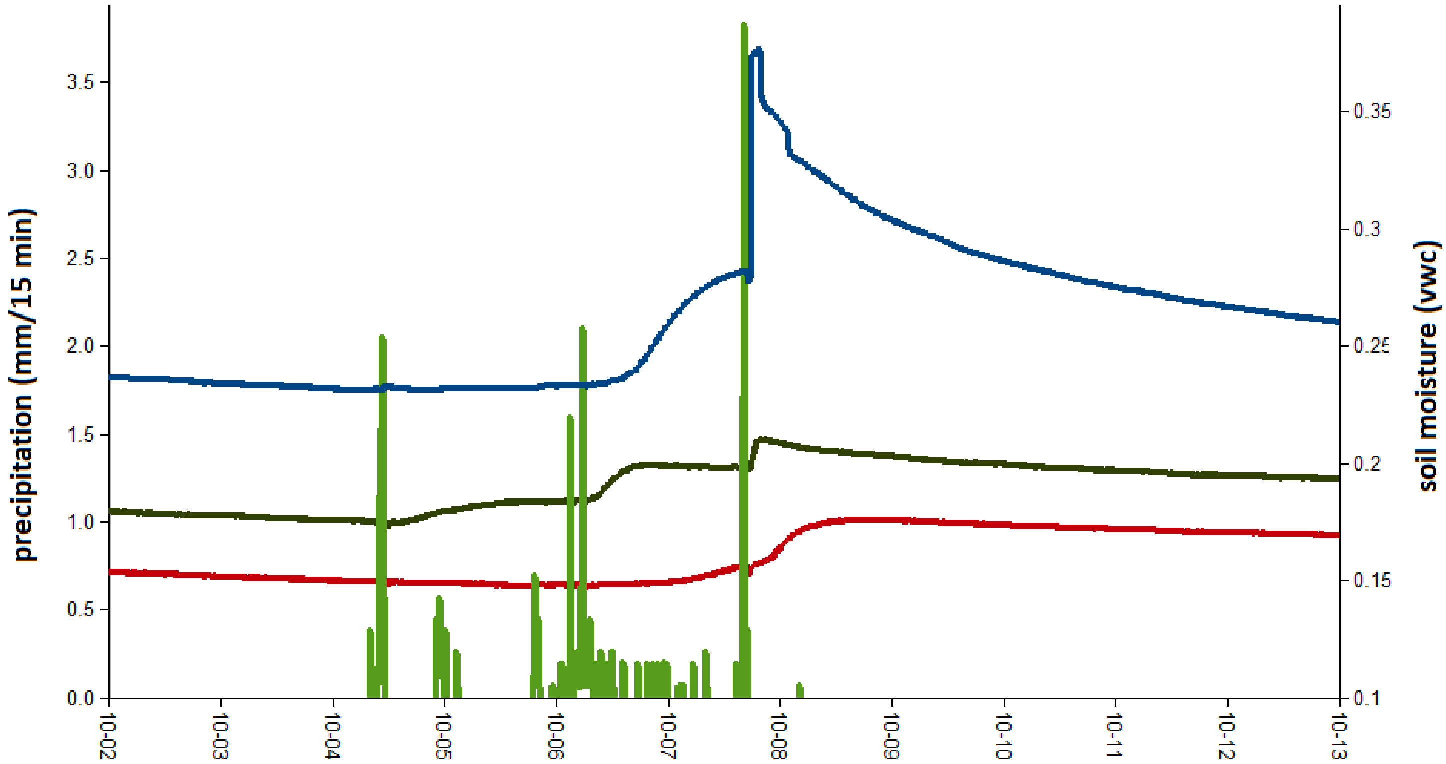
- Soil
- Stream
- Groundwater





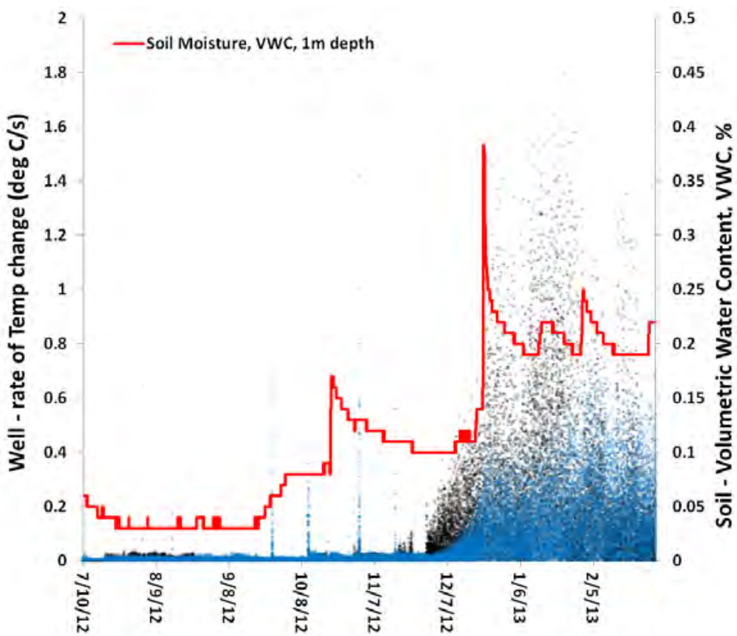
Soil saturation thresholds:

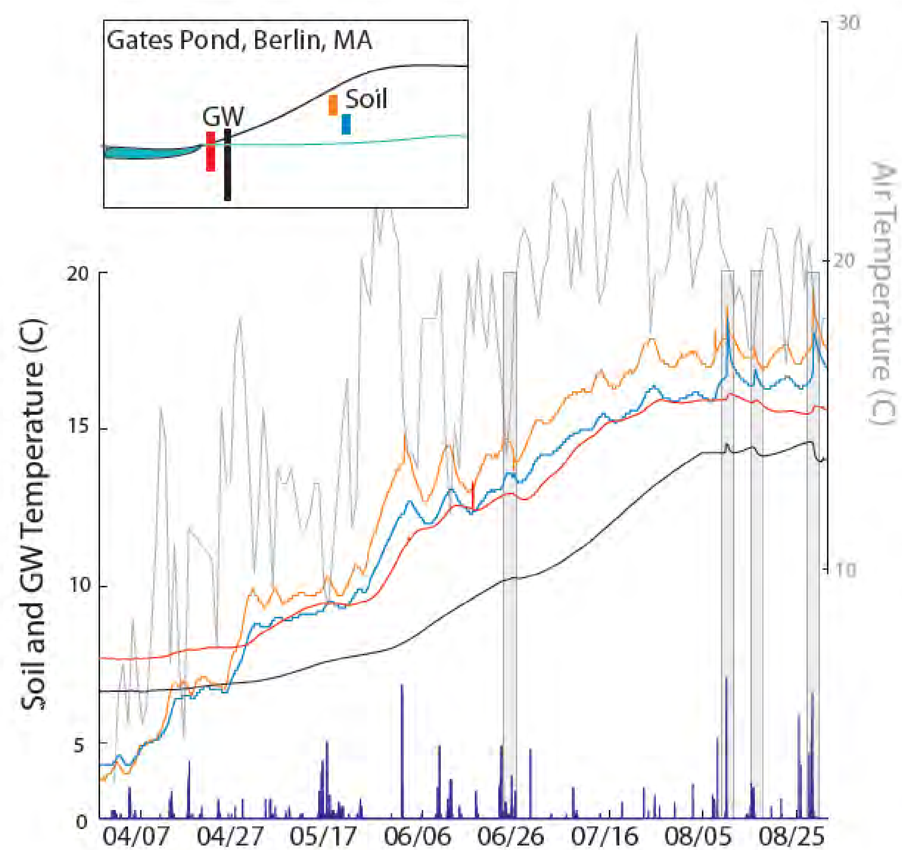
lateral and downward water movement



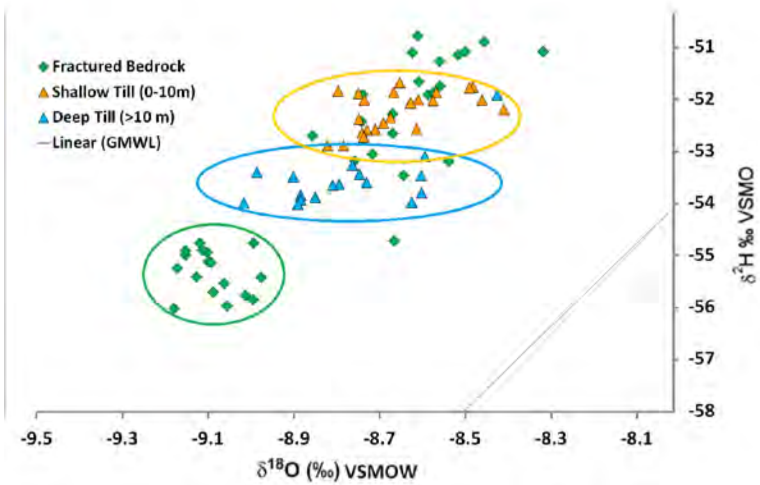
Green - precipitation
Black – soil, hilltop 50 cm depth
Red - soil, hilltop 100cm depth
Blue – hillslope gully, 30 cm depth

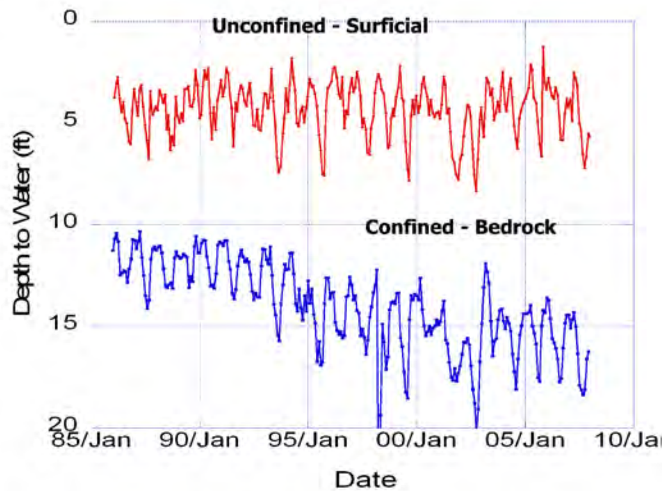
Fractured bedrock response

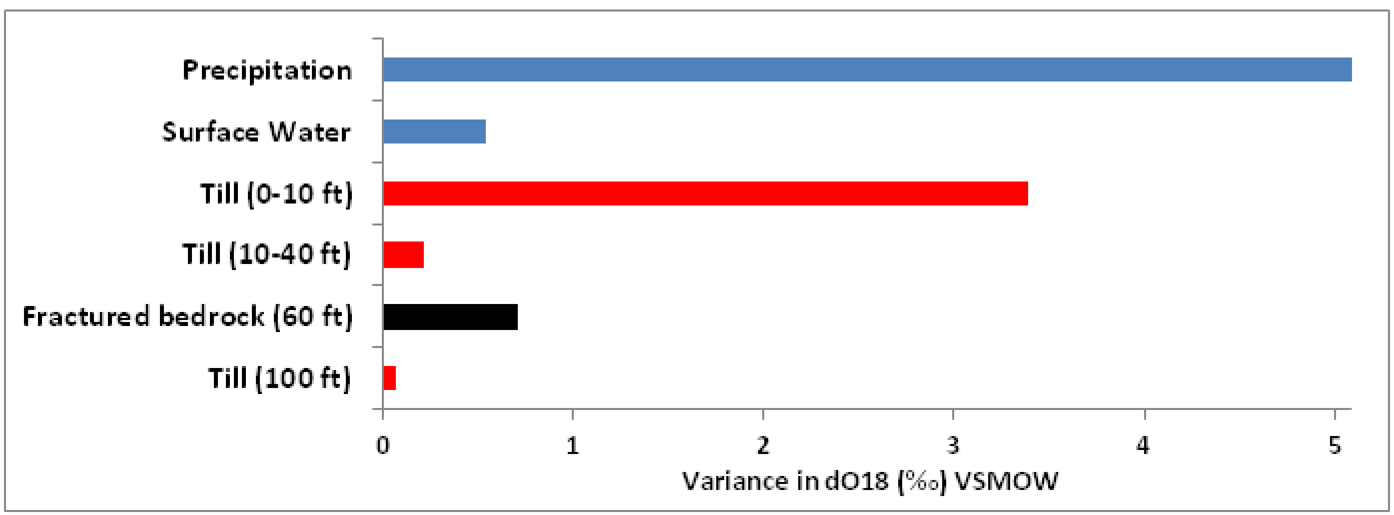


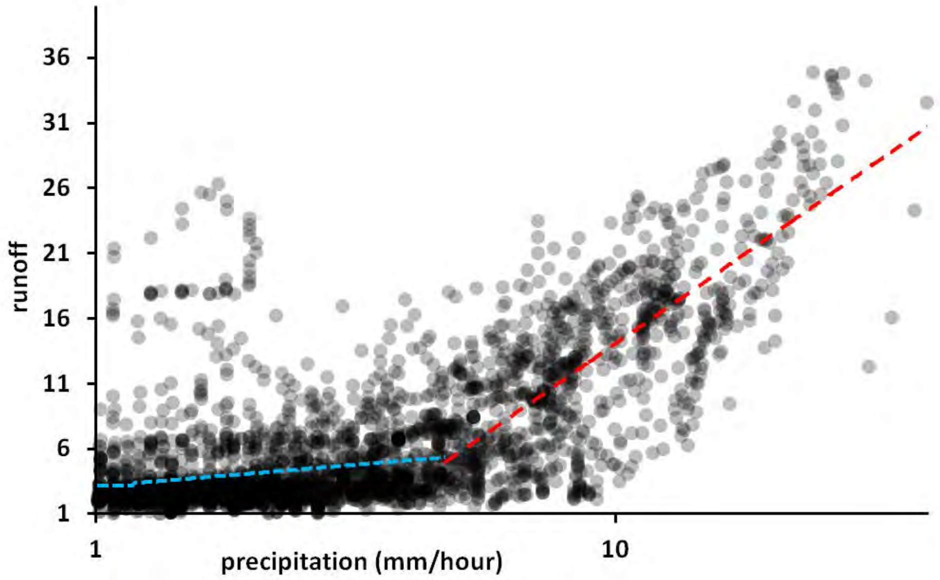


ABOVE: Soil Moisture and temperature change in fractured bedrock (blue) and glacial till (black) wells.

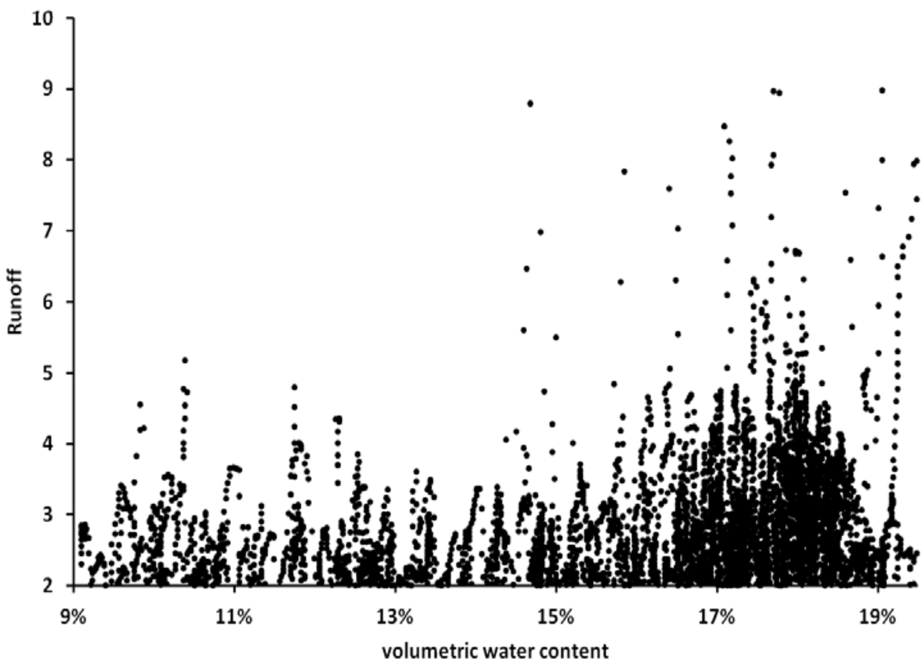

Fractured Bedrock
Shallow Till (0-10m)
Deep Till (>10 m)
Linear (GMWL)
δ18O (‰) VSMOW
δ2H ‰ VSMO
-9.5
-9.3
-9.1
-8.9
-8.7
-8.5
-8.3
-8.1
-51
-52
-53
-54
-55
-56
-57
-58


Unconfined - Surficial
Confined - Bedrock
Depth to Water (ft)
Date
0
5
10
15
20
85/Jan
90/Jan
95/Jan
00/Jan
05/Jan
10/Jan


Precipitation
Surface Water
Till (0-10 ft)
Till (10-40 ft)
Fractured bedrock (60 ft)
Till (100 ft)
0
1
2
3
4
5
Variance in dO18 (‰) VSMOW



Precipitation
And
Stream runoff



Soil saturation
And
Stream runoff

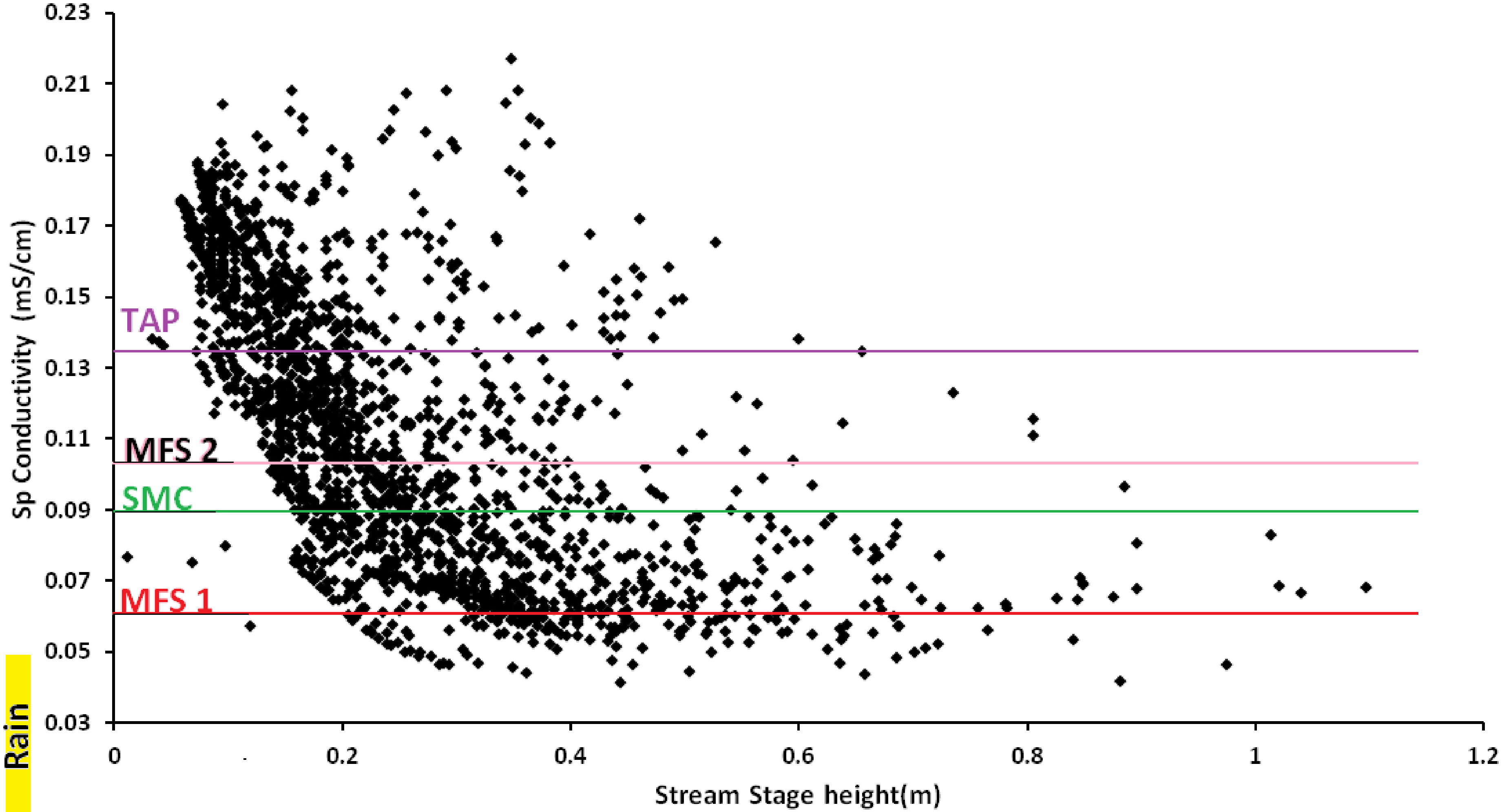
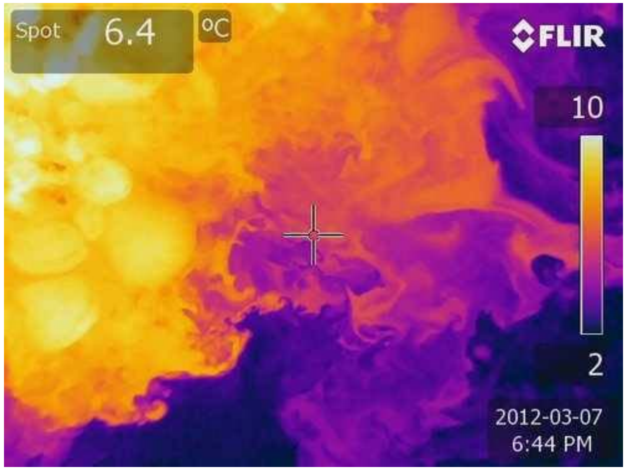
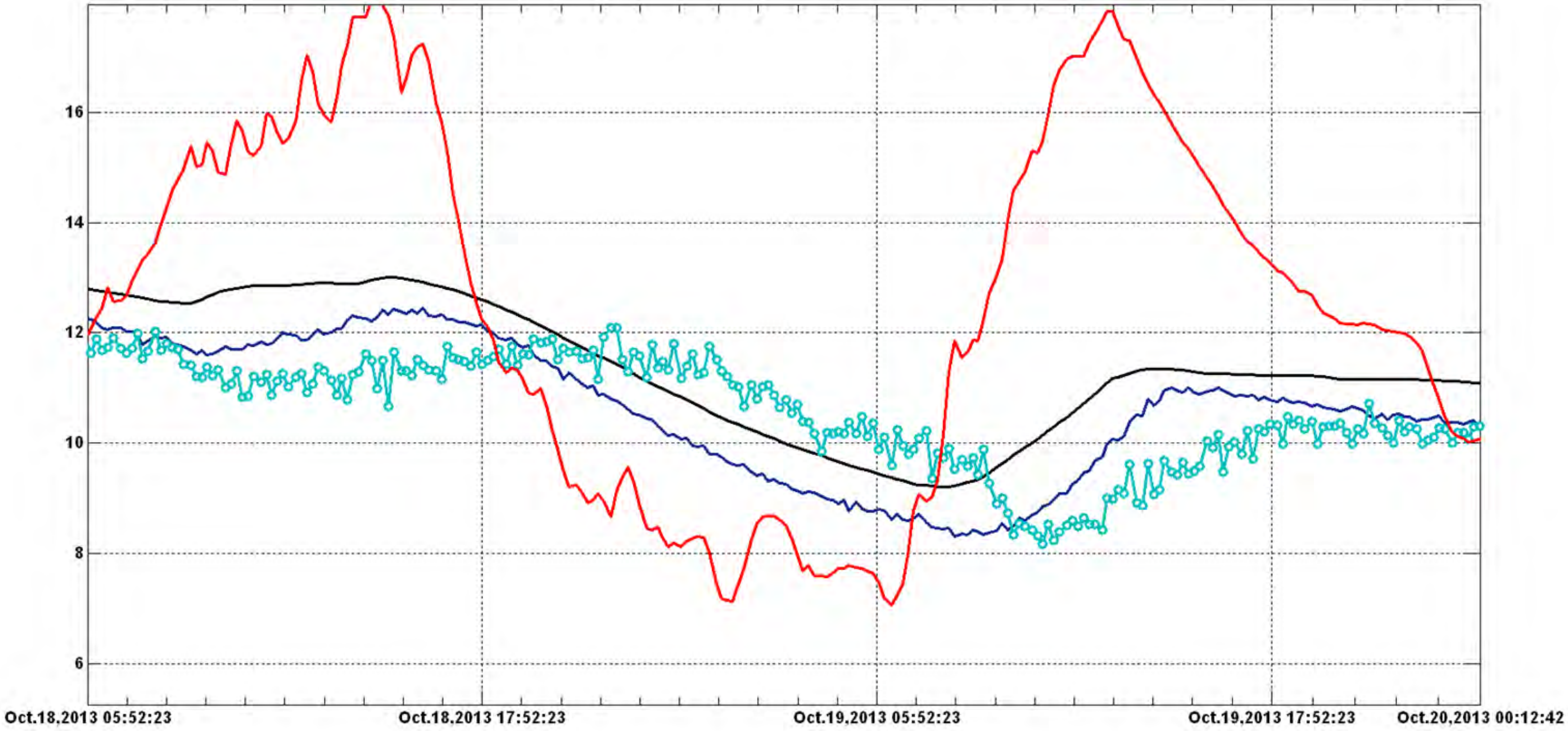
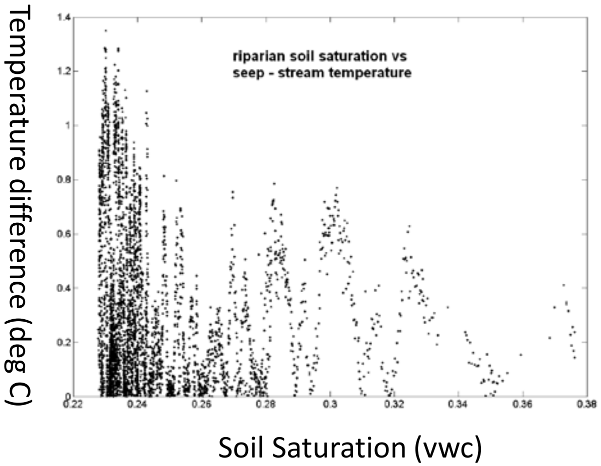


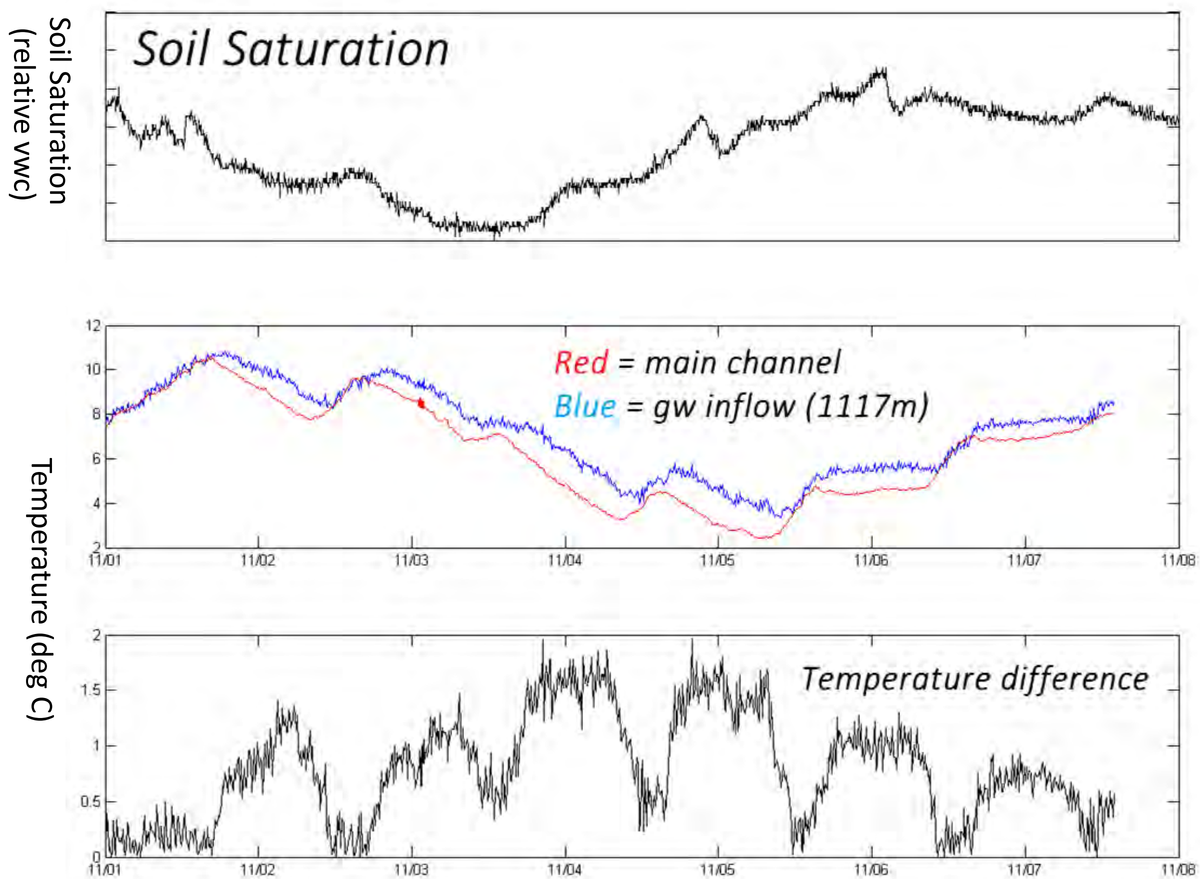
Figure: Average daily specific conductivity and stream stage on the Westbrook River (1999 - 05)


Spot
6.4
°C
FLIR
10
2
2012-03-07
6:44 PM

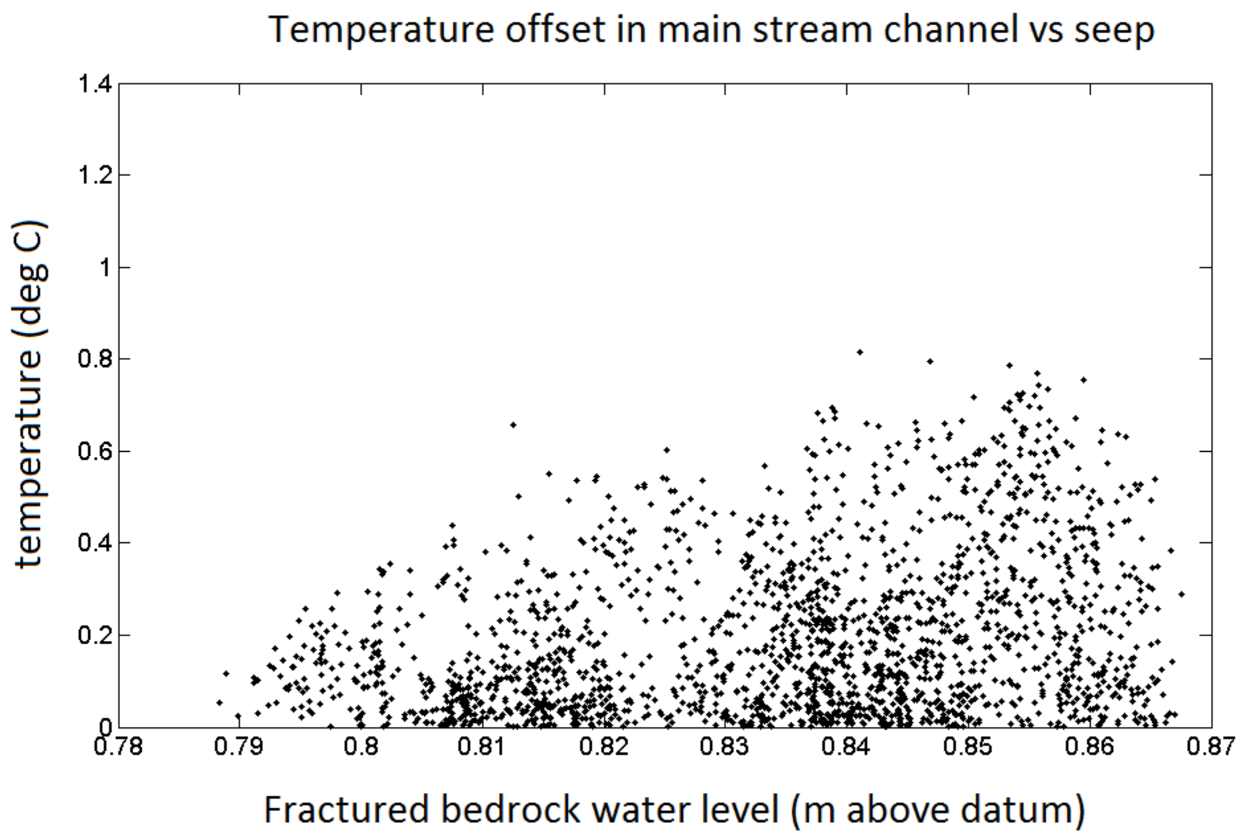

16
14
12
10
8
6
Oct.18,2013 05:52:23
Oct.18,2013 17:52:23
Oct.19,2013 05:52:23
Oct.19,2013 17:52:23
Oct.20,2013 00:12:42

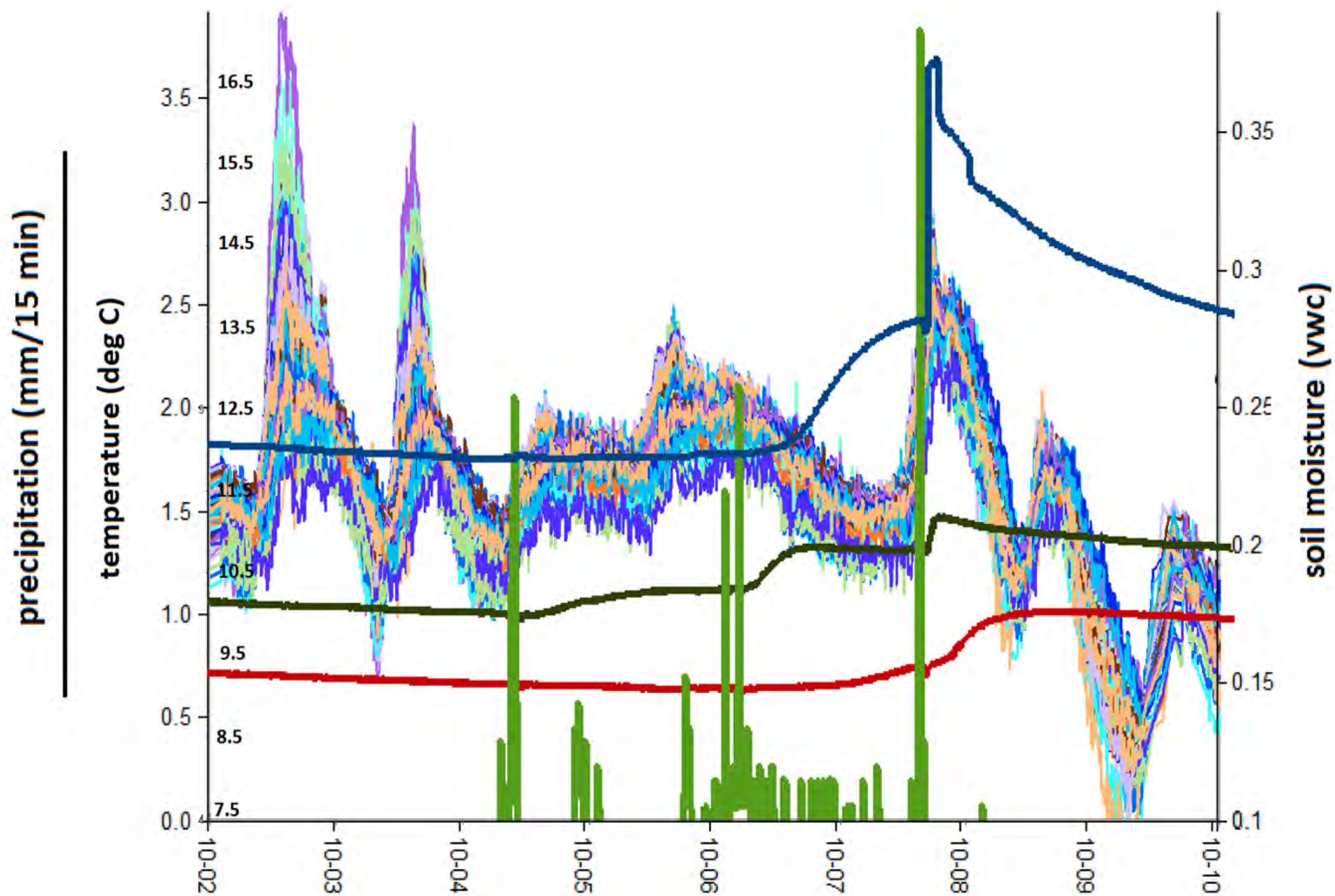
soil saturation and stream temperature: negative feedback





Fractured bedrock groundwater and higher head gradient in uplands





precipitation (mm/15 min)
temperature (deg C)
soil moisture (vwc)
16.5
15.5
14.5
13.5
12.5
11.5
10.5
9.5
8.5
7.5
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.35
0.3
0.25
0.2
0.15
0.1
10-02
10-03
10-04
10-05
10-06
10-07
10-08
10-09
10-10

Groundwater seeps show stronger temperature offset when fractured bedrock water tables are highest.

Riparian/hillslope saturation may act as a heat sink, allowing greater penetration of air temperature into the ground near stream discharge

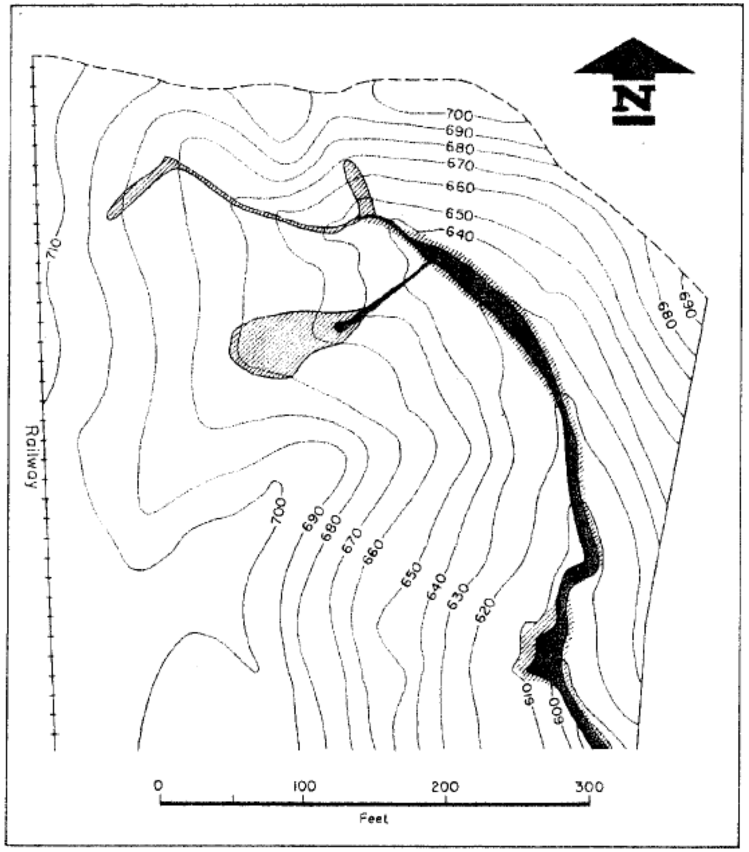


Fig. 11. Areas contributing storm flow: variation between short intense summer storms, and extreme autumn storms on wet conditions.

Dunne and Black, 1970

Investigating effects of annual winter lake drawdowns on fish and macroinvertebrate assemblages and diet

Basic Information

Title:	Investigating effects of annual winter lake drawdowns on fish and macroinvertebrate assemblages and diet
Project Number:	2014MA421B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	2nd
Research Category:	Biological Sciences
Focus Category:	Ecology, Surface Water, Hydrology
Descriptors:	None
Principal Investigators:	Allison Hunt Roy, Stephen DeStefano

Publications

1. Carmignani J.R. and A.H. Roy, 2015, Do Annual Winter Drawdowns Alter the Physical Habitat Structure and Complexity of the Littoral Zone?, New England Association of Environmental Biologists Conference, Bartlett NH, March 2015.
2. Carmignani J.R. and A.H. Roy, 2015, Do Annual Winter Lake Drawdowns Alter the Physical Habitat Structure and Complexity of Shallow Littoral Zones?, Society for Freshwater Science Meeting, Milwaukee WI, May 2015.

Problem and Research Objectives:

Annual wintertime water level drawdowns are a common management practice in lakes, ponds, and reservoirs in the Northeastern US. In Massachusetts, at least 100 waterbodies undergo or have used annual winter drawdowns for a variety of purposes, including: control of nuisance aquatic vegetation, maintenance and protection of structures (e.g., docks, retaining walls, impoundments), hydroelectric power, and spring flood storage. Despite the widespread use of annual winter drawdowns, waterbody water levels are rarely monitored. Furthermore, our understanding of the effects of winter drawdowns on littoral and benthic zone ecology is limited especially in Massachusetts where drawdown amplitudes are relatively mild (<3m) compared to other locations (e.g., Canada, Scandinavia) where amplitudes can exceed 10m and have attracted more scientific investigation. Our objectives are to: (1) quantify the intra-annual water level fluctuations of winter drawdown and non-drawdown waterbodies along a gradient of historical drawdown amplitude, (2) quantify littoral zone habitat structure, (3) determine the benthic invertebrate assemblage composition in multiple habitats in these waterbodies, (4) and quantify diet niche breadth of common fish species using stable isotopes and gut content analysis.

Methodology:

In July and August of 2014 we sampled physical habitat (objective 2) in 16 waterbodies that encompassed a gradient of drawdown amplitude (0–2.5 m). Of these 16 waterbodies, three served as reference conditions with no history of annual winter drawdowns. Within each waterbody, we established two, 20-m sites with 50-m buffers of similar land cover representing a developed and forested shoreline condition. At each site we sampled large wood (density, branching complexity, diameter), macrophytes (e.g., cover, biovolume, complexity, stem abundance, biomass), and substrate texture (substrate heterogeneity, leaf litter cover) using a quadrat-transect method at three fixed depths (0.5m, 1m, 2m).

In September and October of 2014 we installed Onset HOBO water level data loggers in the 16 waterbodies. The data logger and staff gauge were installed adjacent to the waterbody impoundment either by either attaching it directly to an abutting structure or by fixing it to a galvanized metal pole driven into the lakebed. Each submerged water level logger was coupled with an identical logger on land to account for atmospheric pressure and calculate water level. Data loggers were set to continuously record pressure every two hours. Additional water level loggers will be installed in summer 2015 in waterbodies with no annual winter drawdown history to bolster our design and analysis.

Sampling will be conducted for objectives 3 and 4 in the summer of 2015 in a subset of 10 waterbodies sampled in 2014. We will collect macroinvertebrates in July to determine the taxonomic and functional diversity in three habitats: stony bottom, macrophyte bed, and soft bottom (i.e., predominantly silt and detritus). Littoral zone food web sampling will be conducted in August 2015. At least four species of fish representing different levels of the food chain will be collected for stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$) and gut content analysis. Additionally we will collect macroinvertebrates from habitats sampled in the prior month and sort them based on functional feeding groups for stable isotope analysis. We will also collect long-lived primary consumers (e.g., mussels and snails) to serve as the algal baselines in each lake.

Principal Findings and Significance:

Winter drawdowns and localized shoreline development significantly alter littoral zone habitat particularly at 0.5m and 1m depths, which are closer to shore and exposed during winter drawdowns.

Our preliminary results indicate that macrophyte biomass and biovolume decreased and substrate heterogeneity increased with drawdown amplitude, with an additive negative effect of localized shoreline development. However, macrophyte structural complexity, small and large wood density, and leaf litter cover showed no discernible trend with drawdowns. Generally, waterbodies with drawdowns less than 1.5 m varied widely in habitat structure and complexity, suggesting that low-amplitude drawdowns may not consistently alter littoral habitat. These results will allow future waterbody management to make more informed decisions concerning changes in winter drawdown regimes.

Currently, we are conducting bathymetry surveys for each waterbody sampled in 2014. By coupling this depth data with the water level data, we will be able to determine the extent and duration of lakebed exposure during the winter drawdown. This will allow us to develop more accurate representation of winter drawdown stress and disturbance exerted on elements of physical habitat (e.g., macrophytes, sediment) and biotic assemblages, particularly benthic invertebrates.

Fate, transport, and remediation of PFOS, PFOA, perchlorate, and 1,4-dioxane at the Eastham MA landfill

Basic Information

Title:	Fate, transport, and remediation of PFOS, PFOA, perchlorate, and 1,4-dioxane at the Eastham MA landfill
Project Number:	2014MA422B
Start Date:	3/1/2014
End Date:	2/29/2016
Funding Source:	104B
Congressional District:	5
Research Category:	Water Quality
Focus Category:	Toxic Substances, None, Toxic Substances
Descriptors:	None
Principal Investigators:	Chad David Vecitis

Publication

1. Weber A. K., Vecitis C. D., Barber L. B., LeBlanc D. R., 2015, Poly- and Perfluoroalkyl Substances: Fate and Transport at the Joint Base Cape Cod. Fluoros 2015.

Problem and Research Objectives:

The Cape Cod groundwater aquifer is the peninsula's residents' sole source of drinking water. Thus it is vitally important to preserve the groundwater quality. Located just a few miles north of East Falmouth, MA, the Joint Base Cape Cod (JBCC) is the location of the well-documented Ashumet Valley Plume, which has groundwater contamination from both wastewater effluent disposal and fire training area activities. In addition to the known contaminants on the site, including trichloroethylene and tetrachloroethylene, we also suspected there would be a widespread contaminant plume of poly- and perfluoroalkyl compounds (PFASs) as a result of the aqueous film-forming foams (AFFFs) used in the fire training area. AFFFs were used to fight hydro- and chloro- carbon fires during regular training exercises from 1958 – 1985 and are a complex mixture of chemicals including large quantities of PFASs. PFASs are thermally stable synthetic organic contaminants, are likely carcinogenic, and have been shown to correlate with thyroid disease and immune deficiencies. PFASs also have high water solubility (mobility) and low biodegradation (persistence), indicating there is concern for the region surrounding the Joint Base Cape Cod. Our research objectives were to determine the extent of PFAS contamination at the JBCC, investigate the transport properties of PFASs and develop an effective remediation technology. The results from this study will be widely applicable to air force bases, airport hangars, and other municipal point sources across the country with similar AFFF contamination issues. The funding from WRRC allowed us to start this project and obtain follow-up funding from the 2015 Milton Fund at Harvard. This progress report outlines the current state of the project, and the remaining funds will be used for field sampling this summer and to send the primary PhD student working on the project to a conference in July 2015 focused on fluorinated compounds.

Methodology:

In the summer of 2014 we conducted an initial field sampling effort at the JBCC in collaboration with the USGS. Based on prior knowledge of the field site, a selection of 9 wells was sampled with HDPE bottles both at and downgradient the fire training area where large quantities of AFFF may have been spilled. A vertical profile was also sampled in December 2014 at one well downgradient of the fire training area in what is known as the wastewater infiltration beds. This allowed us to obtain a more detailed subsurface understanding of PFAS concentrations. After groundwater sampling, samples were kept at 4 ˚C until analysis, at which point they were shaken and sub-sampled between 5-10 cm below the surface to ensure a representative sample. 750 μL of water sample was added to 720 μL of methanol and 30 μL of internal standard in polypropylene centrifuge vials and centrifuged at 13,000 rpm for 20 minutes. After centrifugation, 0.5 ml of supernatant was extracted and transferred to polypropylene autosampler vials and analyzed within 24 hours with an Agilent 6460 LC-MS/MS with online SPE.

In addition to groundwater analysis, initial sorption experiments were designed to understand PFAS transport at the site. A core from the JBCC was obtained through our USGS collaboration and dried and sieved to 2 mm. 40 ml of groundwater from a background well with no detectable PFAS concentrations was added to 15 g of the homogenized core section and spiked with PFAS concentrations between 0.5 and 5 µg/L. These batch reactors were then placed on a shaker table for an equilibration period of 10 days after which both the aqueous and solid phases of these batch reactors were sampled. The resulting data was fitted with a Freundlich isotherm. Future work will use the above outlined methodology to conduct more detailed experiments to understand specific sorption mechanisms. Additional cores will be drilled specifically for this study in the summer of 2015 in addition to an extensive field sampling effort to collect more than 200 groundwater samples.

Principal Findings and Significance:

Initial results indicate that groundwater PFAS concentrations exceed 10 ppb in the fire training area and that significant PFAS contamination is also located in the wastewater infiltration beds directly downgradient of the fire training area. Low levels of PFAS (above the detection limit) were found up to approximately 8 km downstream. The vertical profile taken within the wastewater infiltration bed area displayed a large increase in PFASs in a zone that also had low dissolved oxygen (DO). In this low DO zone, we found that generally PFASs that are cited in the literature to have higher sediment organic carbon – water partition coefficient (k_{oc}) values had the highest concentrations, and PFASs with lower literature-cited k_{oc} values had lower concentrations. This may indicate that PFASs were sorbed onto solid surfaces and were subsequently desorbed under redox conditions. The initial isotherm experiments conducted indicated that sediment-water distribution coefficient (K_d) values are significantly lower, while K_{oc} estimates are significantly higher, than reported literature values. Further work is needed to determine the source of this discrepancy.

An additional complication to PFAS transport is the degradation of AFFF into perfluoroalkyl acids. In order to investigate how perfluoroalkyl acid concentrations could change over time, we implemented a precursor oxidation method that degraded any precursors within the groundwater to determine the oxidation products in contaminated samples. Results indicate that there is an increase in short-chained perfluoroalkyl acids, including perfluorobutanoate (PFBA), perfluoropentanoate (PFPeA) and perfluorohexanoate (PFHxA), after oxidation. An increase in these short-chained perfluoroalkyl acids just below the water table beneath the infiltration beds may indicate that precursors in the vadose zone are acting as a slow-release source of PFBA, PFPeA and PFHxA to the aquifer.

Future work is needed to gain a thorough understanding of PFAS transport. Specifically, it is not well understood which aquifer constituents increase sorption or whether hydrophobic or electrostatic interactions control PFAS sorption. We plan to investigate these questions by testing PFAS sorption to specific iron oxides (goethite, hematite), organics, and AFFF itself. While it is necessary to understand PFAS transport in aquifers, it is also essential to design more effective remediation methods. As PFASs are resistant to degradation due to the strong electronegativity of fluorine, treatment is difficult. We propose to improve upon an existing electrochemical carbon nanotube (CNT) filter by coating the CNTs with tin oxide doped with antimony and bismuth for stability. Initial experiments without this coating were unsuccessful. This coating has been shown to be effective at degrading certain PFASs using a titanium plate in a batch set-up. The CNT filter should be far more effective due to the high surface area, which will enhance PFAS sorption to the surface. PFASs will then potentially be degraded through direct electron transfer followed by decarboxylation and defluorination. In summary, a better understanding of both the hydrological transport of PFASs and remediation methods may help improve the quality of groundwater and allow for sustainable future use. The remaining funding available from the WRRC will be used for field sampling, housing and transportation for the summer of 2015 and for Andrea Weber, the PhD student working on this project, to attend a conference in Golden, Colorado focusing on fluorinated organic compounds in July 2015 (Fluoros 2015).

Going With or Against the Flow: Choices for Flood Mitigation Response in Massachusetts

Basic Information

Title:	Going With or Against the Flow: Choices for Flood Mitigation Response in Massachusetts
Project Number:	2014MA426B
Start Date:	3/1/2014
End Date:	2/29/2016
Funding Source:	104B
Congressional District:	MA-002
Research Category:	Social Sciences
Focus Category:	Floods, Management and Planning, Law, Institutions, and Policy
Descriptors:	None
Principal Investigators:	Anita Milman

Publications

There are no publications.

Problem and Research Objectives:

While research has highlighted the importance of motivation (Blennow and Persson 2009) and identified barriers to flood management (Burch, Sheppard et al. 2010),we still lack basic understandings of how adaptation decisions are made. Yet these decisions will be a key determinant of future impacts. Better understandings of the criteria used by decision-makers and the situational factors influencing those priorities are important for informing scientific analyses of projected impacts, for developing decision support tools, and for estimating future action. Thus this research project aims to delineate processes by which flood management decisions are made at the local level. It includes three objectives:

> ***Objective #1:*** Develop a catalog of flood protection measures undertaken at the town and regional level in the Connecticut and Deerfield River Basins.
> ***Objective #2:*** Identify the criteria used by decision-makers in selection of the flood mitigation measures to implement.
> ***Objective #3:*** Assess situational factors influencing the choice of decision-criteria

Methodology:

To delineate the processes for flood management at the local level, we interviewed representatives from 32 municipalities across western Massachusetts including 6 town administrators, 10 select board members, 9 conservation or planning directors, 3 public works officials and 5 emergency management officials. Interviews included both a structured and a semi-structured methodology. Semi-structured approaches were used to collect information on the institutional features of town government as it relates to flood mitigation and comparisons on local perspectives and approaches to structural and non-structural flood mitigation measures, including opinions on what would work best in their communities. Structured card sorting and talk-out loud methods were used to elicit a ranking of criteria used in decision-making. Interviews have been transcribed and we are in the process of using Nvivo to code and analyze the data.

Principal Findings and Significance:

Research on this project is on-going (we have requested a no-cost extension) and thus we are unable to report principal findings at this moment.

Assessing the effectiveness of a biofiltration facility and associated groundwater flow in protecting water quality of a water supply reservoir

Basic Information

Title:	Assessing the effectiveness of a biofiltration facility and associated groundwater flow in protecting water quality of a water supply reservoir
Project Number:	2014MA427B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	MA-001
Research Category:	Water Quality
Focus Category:	Water Quality, Hydrogeochemistry, Hydrology
Descriptors:	None
Principal Investigators:	Paul Mathisen

Publications

There are no publications.

Problem and Research Objectives:

Problem: Stormwater runoff contributes significant loads of nutrients, bacteria, metals and other contaminants to surface water supplies throughout the US. A wide variety of Best Management Practices (BMPs) have been developed to control the volume and quality of the runoff discharging to these surface water bodies. Biofiltration basins have commonly implemented as an effective approach for controlling nutrients, bacteria, and other constituents. Common designs make use of a forebay for sediment control, a larger biofiltration basin with vegetation and a sand layer to provide treatment, and a subdrain that discharges to surface water. Basins may be lined or unlined. For lined basins, the effluent from the sand layer flows into a drain that discharges directly to the surface water body. For unlined basins, a portion of the discharge will seep into groundwater which may provide additional treatment. For all of these cases, the transformations that govern the effluent quality are complex and not well-characterized. The extent of additional treatment provided by the passage through groundwater depends on site conditions and is not well characterized.

Overall goal and research objectives: The overall goal of this research is to determine the contribution of infiltration and subsurface transport in mitigating the impacts of stormwater discharges on groundwater and surface water supplies. The specific objectives are to:

(1) determine the effectiveness of biofiltration basin design in reducing contaminant discharges to surface water bodies,
(2) develop an understanding of the effects of groundwater flow and transport on discharges from these basins, and
(3) develop recommendations for improved design procedures for these basins.

Specific considerations include the impacts of recharge and infiltration on groundwater quality, and the associated role of subsurface transport and transformation in reducing contaminant loadings to surface water bodies.

Methodology:

This research involved an investigation of the processes associated with a biofiltration Best Management Practice (BMP) located in West Boylston, MA, adjacent to the Wachusett Reservoir. The basin treats runoff from an 8-acre watershed with two roadways (Routes 12 and 110) and surrounding residential and commercial land uses. Water exits the basin by either seepage directly to groundwater or by seepage through a two-foot filtration bed to an outfall pipe on one side of the basin. The methodology has included a combination of site preparation, field monitoring, analysis and modeling. Jackie Tupper, a graduate student at WPI, is working on the project. The field site selected for this project is located adjacent to the Wachusett Reservoir in West Boylston, MA. Specific requirements for these components of the research are included the following paragraphs.

Site preparation (installation of monitoring wells) – A set of monitoring wells was installed to provide information on groundwater flow and quality. The well locations are shown in Figure 1. At Location 1, a well is included to provide geochemical background information. At locations 2, 3, and 4, well nests were installed, each with 2 monitoring wells (one shallow and one deep). The well nests at Locations 2 and 3 provide information on water quality downstream of the basins, and Location 4 provided information further downstream, adjacent to the reservoir.

Figure 1 – Monitoring well locations

Field monitoring and sampling: Field monitoring has included monitoring for flow and water quality parameters. Monitoring included quantification of the flow and water quality in the basin inflow, the ponded area within the basin, the discharge drain, and groundwater leaving the basin. Monitoring of water level and water quality in the installed groundwater wells provided information on the quality and response time associated with the transport to groundwater. By quantifying the water budget (relating change in storage to the difference between inflow and outflow), we have been able to estimate the basin outflow to groundwater.

Monitoring has included the installation of boxes with v-notch weirs, the hydrolab units, ISCO samplers, and an In Situ temperature, specific conductance, depth probe. The pressure sensors provided real-time information on depth (which is related to flowrate). The hydrolab units provide real-time estimates of dissolved oxygen, conductivity, pH, turbidity, and temperature. Samples were collected periodically in the inflow, outflow, and ponds of the basin (including the biofiltration pond). The samples were analyzed for dissolved oxygen, suspended solids, pH, alkalinity, DOC, DO, anions (PO^{4-}, NO^{3-}, SO^{4-}, Cl^{-}) and cations (Fe^{2+}, Mg^{2+}, Ca^{2+}, Na^{2+}) , bacteria (total coliform and e-coli), and selected heavy metals.

Monitoring in 2014 and 2015 included 5 storms. The dates of the storms were on May 16th -17th, July 15th- 16th, August 13th, October 16th, and October 22nd -24th. Partial data sets were obtained for the May and July storms. More detailed data sets for the inflows and outflows were obtained for the August and October storms. As such, the latter two storms were analyzed in more detail.

Preliminary Findings and Significance:

The field program has provided quantitative data on the flows and transformations that occur within and in the groundwater downstream of the biofiltration basin. The results demonstrated that stormwater infiltration to groundwater is an important component to consider for BMP design. The flow path through the outfall was effective in removing sediments, but was found to have limited capacity for water quality treatment, since only small changes in stormwater quality occurred between the culvert inflow, basin, and outfall samples. However, analysis of the flow data showed that infiltration to groundwater was comparable to discharge through the outfall. Furthermore, the signatures of stormwater infiltration could still be seen in the wells, indicating that the infiltration from the stormwater basin can impact groundwater quality. The groundwater pathway was found to impact the chemistry of the constituents, and was particularly effective in removing bacteria and phosphorus. The analysis is of the geochemistry data is still being completed. However, the results to date demonstrate the value of groundwater recharge as a component of BMP design, and provide a basis for a number of specific design recommendations related to biofiltration basins.

Figure 2 – Surface water sample locations: (a) inflow, (b) outflow, (c) basin, and (d) Wachusett Reservoir

Figure 3 – Graduate student working at the Gate 27 field site: (a) preparing to monitor the inflow (b) groundwater sampling

Developing Tools for Climate eRisk Assessment and Adaptation in Water Resources Systems

Basic Information

Title:	Developing Tools for Climate eRisk Assessment and Adaptation in Water Resources Systems
Project Number:	2014MA432S
USGS Grant Number:	G14AP00003
Sponsoring Agency:	COD_UMass
Start Date:	11/25/2013
End Date:	11/24/2014
Funding Source:	104S
Congressional District:	
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	None
Principal Investigators:	

Publications

There are no publications.

No report received as of submission time (PI on sabbatical).

RiverSmart Communities and Federal Collaborators: Attuning Federal Agencies and Programs with the State, Regional, and local Efforts to Support Ecologically Restorative Flood Prevention and Remediation in New England

Basic Information

Title:	RiverSmart Communities and Federal Collaborators: Attuning Federal Agencies and Programs with the State, Regional, and local Efforts to Support Ecologically Restorative Flood Prevention and Remediation in New England
Project Number:	2014MA433S
USGS Grant Number:	G14AP00029
Sponsoring Agency:	COE_Mass
Start Date:	1/27/2014
End Date:	8/7/2015
Funding Source:	104S
Congressional District:	MA-002
Research Category:	Social Sciences
Focus Category:	Floods, Law, Institutions, and Policy, None
Descriptors:	None
Principal Investigators:	Eve Vogel

Publications

1. Gillette, Nicole, 2014, RiverSmart Communities: Deerfield River Watershed Case Study, Poster at New England Graduate Student Water Symposium, September 13th 2014, Amherst, MA.
2. Vogel, Eve, 2015, Politically creative applications of fluvial geomorphology in the evolution of the Vermont Rivers Program. In: (Politically) Possible Physical Geographies: Toward a Proliferation of Creative, Progressive and Sustainable Environmental Policy and Management (session organized and chaired by Eve Vogel). Paper presented at the New England-St. Lawrence Valley Geographical Society (NESTVAL) Annual Conference, Oct 24, 2015, Durham, NH

Problem and Research Objectives:

The Problem: Damaging River Floods, and Three Fundamental Challenges.
New England residents, landowners, infrastructure and businesses located along the region's often-narrow river valleys are frequently impacted by damaging floods that accompany heavy rains. Tropical Storm Irene was but one recent, drastic event; in 2011 in Vermont alone it affected 500 miles of state highways, 200 bridges, 960 culverts, and caused more than $175 million of damage. Damaging floods are likely to become more common and costly, as climate scientists predict more intense storms and increased annual precipitation in the Northeast.

Unfortunately, three fundamental challenges make managing floods and addressing flood damage particularly challenging in New England. First, common structural approaches to flood mitigation and post-flood restoration in the region can increase flood hazards downstream, and re-create infrastructure vulnerable to future flood events. These approaches also often are environmentally damaging and require increased expenditures for environmental mitigation and restoration.

Second, jurisdictional authority is particularly fragmented in New England, because of the history of early small town settlement and incorporation, and the "home rule" traditions of several of the states. There are over 1500 towns and cities in the six New England states, each of which has at least some independent authorities over land and water use and regulation. Many of these have only a few hundred residents, and operate with volunteer governing bodies and only skeletal staff. Jurisdictional fragmentation is also more challenging because the federal government, which often plays a unifying role in river management in other parts of the country, has historically played a relatively small and distant role here, partly because the region was developed before the rise of many major federal land and water agencies, and partly because of frequent political insistence on state and local independence.

The third fundamental challenge is that governmental agencies at all levels as well as nonprofit agencies are facing a funding squeeze from reduced federal and state government budgets.

Objective: Ecologically restorative flood prevention and remediation, based on fluvial geomorphological science, met through collaborations that stretch from local municipalities to federal agencies and programs

The following are three strategies, which address each of the challenges listed above:

a. Advance ecologically restorative flood prevention and remediation by orienting policy and practice to work with natural dynamic river processes;
Flood mitigation and protection can work *with*, rather than against, natural fluvial and geomorphological processes. The approach is to allow much-increased water and sediment sufficient room to flow, by building large-enough culverts and bridge spans; and to allow rivers to spread out and move laterally during major flood events wherever possible, by protecting river "corridors" or "meander belts." This approach is founded on the science of fluvial geomorphology. It can provide longer-term flood protection and concurrently support environmental, fish, and wildlife goals.

b. Collaborate with and across a wide array of jurisdictions and agencies in ways that are effective and accessible, from small remote New England municipalities to federal agencies.

In New England, in order to achieve ecologically restorative flood hazard management, collaborations must be accessible even to small remote and rural municipalities, which often bear the worst flood damage. Though these communities have both the need and the jurisdictional authority to manage land and water resources, they often lack needed institutional capacity, and technical and financial resources. Federal agencies, in contrast, often have capacity and some resources, but may not be able to provide individualized support and response for every community. Systems of nested and interconnected inter-agency relationships are needed to link these.

c. Build institutions and approaches that can achieve better ecologically restorative and flood prevention results with limited budgets.
Both of the above strategies must be accomplished with limited budgets, and fortunately, can also be resource-efficient. Inter-agency collaborations can use resources in complementary rather than repetitive ways, and target resources where they can provide the greatest benefit. Flood risk assessment, remediation and prevention that are shaped to predict and adapt to natural dynamic river processes can last long-term without the need for costly structural repairs or the risk of amplified downstream damage.

The importance of federal agencies and programs – including FEMA, USACE, NRCS, USFWS and others – is clear. However, research has suggested that several of these agencies and programs are perceived or experienced by people working in small, often remote New England towns as cumbersome, ineffective and difficult to access.

A project objective is to advance improved coordination and mutual assistance between federal agencies and federal programs, on the one hand, and local, state and regional ones on the other. Federal programs have a great deal to offer; with multi-level coordination, education and attention to the needs of specific localities, these resources can be made accessible to and effective for small communities.

Methodology:

A. RiverSmart Communities and Federal Collaborators: Model Case Studies.
Researchers have completed the study of three case studies analyzing collaborations in which federal agencies and programs have worked successfully with state, regional, local and/or nonprofit efforts in New England to promote ecologically restorative flood prevention and remediation. In each of the case studies, federal agencies and programs met one or more of the three fundamental challenges listed at the start of this section. Our research was oriented toward understanding specifically how they achieve these results – with what institutional structures, programs, funding mechanisms, etc. specifically, they:

a) Advance ecologically restorative flood prevention and remediation by orienting policy and practice to work with natural dynamic river processes;
b) Collaborate with and across a wide array of jurisdictions and agencies in ways that are effective and accessible, from small remote New England municipalities to federal agencies;
c) Employ approaches that can achieve better results with limited budgets.

Case Study 1. US Army Corps of Engineers New England District / The Nature Conservancy (TNC-USACE) Connecticut River Partnership – barrier-crossing collaborations with demonstrated analytical and policy success
Project summary: Under two partnerships, the USACE New England District and TNC have worked together to provide more natural river flows, functions, connectivity and habitat. We focused on one key

effort: the revision of road-stream crossings standards for USACE permits across New England. The road-stream crossings standards are now in use by USACE permitting in all six New England states.

Our investigations: We investigated how and with what institutional, programmatic and on-the-ground effects TNC and USACE have been able to work with each other as well as across an array of stakeholders and jurisdictions, and specifically how the culvert standards in the six New England states were changed – that is, in what ways and with what policy process.

Case Study 2. USACE Silver Jackets Program: Federal collaborators helping to manage flood hazard risk.
Project summary: The USACE's Silver Jackets (SJ) program brings together federal agencies, including USACE and FEMA, with state and sometimes regional and local agencies, into a unified forum to address a state's flood hazard risk management priorities. Teams are state-based and led. SJ provides a formal and consistent structure and support for interagency collaboration. Significantly for our purposes, the Silver Jackets approach emphasizes addressing "life-cycle flood risk."

Our investigations: We investigated possible benefits and approaches for SJ in New England. Among New England's six states, New Hampshire has the most active team, which uses the name Post Incident Response and Recovery Team, or PIRRT. We examined the process by which PIRRT was established, its early activities, and results thus far.

Case Study 3. NRCS: Providing communities with Easy-to-Access Technical and Financial Support
Project summary: The Natural Resource Conservation Service (NRCS) works directly with towns, conservation districts or other political subdivisions, when neither the state nor the local community is able to repair a damaged watershed by itself. Our interviews in the Deerfield River suggest that among federal agencies, the NRCS is perceived as particularly accessible, responsive, efficient and cost-effective by community leaders.

Our investigations: We investigated the factors contributing to NRCS success in serving local communities and how replicable these factors might be. What institutional structures and relationships, policies and programs make the NRCS so readily accessible and responsive to community leaders in the Deerfield watershed, and so efficient and low-cost? Do NRCS projects also meet the goal of making post-flood recovery attuned to natural river processes?

B. RiverSmart Communities and Federal Collaborators: Applied Flood Prevention, Mitigation and Remediation Conversations with Communities.
Researchers have participated in a series of community meetings and interviews. Additionally we have combed after-action reports and interviewed a range of scholars and community leaders who have worked in flood-affected communities. From these we distilled community needs and ideas related to flood prevention, mitigation and remediation in an applied setting, the Deerfield River watershed (VT and MA). We built from this an initial set of policy recommendations for federal agencies and programs, and for their partners. At present, we are obtaining feedback and investigating further into the federal and state agency and legislative opportunities, constraints, and possible solutions to put these recommendations into practice.

Community Conversations about Irene: voices from the watershed.
Researchers have conducted interviews with and/or attended meetings of town select boards, regional agencies, and state and federal agencies and NGOs already working closely within the Deerfield river watershed, particularly those who have been involved with Tropical Storm Irene issues. Discussions have focused on local experiences, perspectives and lessons learned on the three fundamental challenges and solutions to advancing ecologically restorative flood prevention and remediation. Community representatives have discussed their assessments and experience, emphasizing data and assessments of on-the-ground needs, their technical and funding needs, experience with federal agency assistance, and their thoughts about how federal agencies could more readily meet the three fundamental challenges identified by this project. Using examples from the Deerfield River, community members have distilled initial recommendations for federal agencies to meet the three challenges to ecologically restorative flood prevention and remediation.

C. RiverSmart Communities & Federal Collaborators: Recommendations.
Researchers are developing a series of white papers and a glossy report based on the model case studies, community meetings, and workshop discussions. These papers and report will describe specific ways federal agencies, personnel and programs should and can be structured and targeted to work more effectively, economically and sustainably with state, regional and local agencies and programs in New England to effect ecologically restorative flood prevention and remediation. Recommendations will include specific measures for policy or regulatory change, as well as improved implementation of existing policies and programs.

D. RiverSmart Communities & Federal Collaborators: Information Tools.
Researchers have or will produce six to ten conference and one-on-one presentations, a website, a social media site, and several easy-to-understand factsheets which will disseminate analyses and recommendations to target audiences, including federal and state agencies and legislators, and municipal leaders and employees in New England communities.

Principal Findings and Significance:

Findings are in progress. Many states and federal agencies are considering how to deal better with flooding. Our recommendations and case studies planned for completion and release in summer 2015 will provide positive guidance and models for practical, feasible improvements.

Information Transfer Program Introduction

None.

Water Resources Workshops and Symposia

Basic Information

Title:	Water Resources Workshops and Symposia
Project Number:	2014MA428B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	MA -02
Research Category:	Not Applicable
Focus Category:	Education, Climatological Processes, Water Quality
Descriptors:	None
Principal Investigators:	Paula Sturdevant Rees

Publications

There are no publications.

As part of the WRRC Outreach and Education program, we worked with several faculty on the UMass Amherst campus as well as off campus experts to organize two training/educational gatherings. One was a training workshop on monitoring temperature and flow in wadeable streams, and the other was a student-oriented symposium on water resources research.

Continuous Stream Temperature and Flow Monitoring

Description:

Dr. Allison Roy of the University of Massachusetts Amherst Environmental Conservation, with the help of seven lead organizers (see below), organized a one and a half day invitation-only workshop in Amherst on November 5 and 6, 2014, on the topic of continuous stream temperature and flow monitoring in wadeable streams.

Climate change is altering temperatures and flows in stream ecosystems, which can affect the distribution, diversity, and abundance of biotic communities that are used as a basis for resource management. The lack of continuous temperature and flow data for minimally disturbed, unregulated freshwater wadeable streams is an impediment to analyses of long-term trends in biological, thermal, and hydrologic data. USEPA has been collaborating with east coast states to develop regional reference/climate change monitoring networks that can detect small, progressive changes in stream communities. States in the northeast (CT, ME, MA, NH, NY, RI, and VT) have begun monitoring macroinvertebrates and water temperature at 20-30 references sites, with air and flow data collected at a limited number of sites.

To help facilitate more uniform and effective collection of continuous temperature and water depth data, the USEPA and collaborators (many of whom are leads in this workshop) have developed a guidance document for sampling ungaged sites in wadeable streams (Available at: http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=280013). This document addresses equipment needs, installation, maintenance, stream discharge measurements, data retrieval, and data processing. The workshop used the EPA document as a basis for describing temperature and hydrology monitoring.

The first day included brief presentations describing the reference monitoring network, importance of continuous monitoring, monitoring protocols, and data management. These presentations were shared in real time via webinar with some participants. In the afternoon, participants visited streams in the Amherst area with existing gages to describe installation procedures and demonstrate sampling techniques. The second day was restricted to state participants in the reference network, and they discussed data management and analysis, logistics of field effort, and efforts to seek additional funding to support the network.

Lead Organizers:

Allison Roy, US Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst
Paul Barten, University of Massachusetts Amherst, Department of Environmental Conservation
Britta Bierwagen, US Environmental Protection Agency, Office of Research and Development
Michelle Craddock, MA Department of Fish and Game, Division of Ecological Restoration
Christine Hatch, University of Massachusetts Amherst, Geosciences Department
Marie-Francoise Hatte, University of Massachusetts Amherst, Water Resources Research Center
Laila Parker, MA Department of Fish and Game, Division of Ecological Restoration
Jen Stamp, Center for Ecological Sciences, Tetra Tech, Inc.

Contributors:
David Armstrong, US Geological Survey, New England Water Science Center
Anna Hamilton, Center for Ecological Sciences, Tetra Tech, Inc.
Zachary Holden, US Forest Service
Daniel Isaak, US Forest Service
Jana Stewart, US Geological Survey, Wisconsin Water Science Center
Yin Phan Tsang, Michigan State University
Roy Socolow, US Geological Survey, New England Water Science Center

Agenda:

Wednesday, Nov 5th (all invitees)

10 am-11:30 am: Presentations (Gunness Student Center, Marcus Hall, UMass-Amherst)
10:00 am Welcome & Logistics (A. Roy)
10:10 am Background about reference network (J. Stamp)
10:25 am Overview of hydrology protocols (M. Craddock)
10:55 am Overview of temperature protocols (J. Stamp, A. Moore, Z. Holden)
11:25 am Logistics for the afternoon (A. Roy)

11:30 am-1 pm: Lunch (on own; UMass Campus Center; convene on 10th floor lobby)

1 pm-5 pm: Field Demonstrations -- Divide into smaller groups and rotate among stations (45 min each):

Dean Brook & Nurse Brook, Shutesbury (2 stations, 1.5 hours total)

- Temperature logger installation & maintenance (C. Hatch & J. Stamp)
- Elevation surveys (L. Parker & T. Richards)

(walking break 15 min, 0.5-mile)

Adams Brook (2 stations, 1.5 hours total)

- Pressure transducer installation & maintenance (M. Craddock & D. Armstrong)
- Discharge measurements (P. Barten & A. Roy & R. Socolow)

Thursday, Nov 6th (State RMN folks and Partners only)

8:30-12pm: Meeting with state RMN folks (ISB 145, UMass-Amherst)
8:30 am State RMN updates on monitoring and issues/concerns (J. Stamp)
9:00 am QA/QC procedures for temperature and stage data (will include working through a sample
dataset together in MS Excel) (J. Stamp)
10:00 am Break
10:15 am NorEast portal temperature data uploading (J. Stewart)
Calculating temperature summary statistics (Yin Phan Tsang)
11:00 am State RMN needs assessment & next steps (J. Stamp & A. Roy)

12:00 Adjourn

Attendees:

Name	Affiliation
In Person	
Allison Roy	USGS, MA Coop Unit
Jen Stamp	Tetra Tech, Inc
Michelle Craddock	MA Division of Ecological Restoration
Laila Parker	MA Division of Ecological Restoration
David Armstrong	USGS New England WSC
Roy Socolow	USGS New England WSC
Paul Barten	UMass-Amherst
Christine Hatch	UMass-Amherst
Marie-Francoise Hatte	UMass-Amherst WRRC
Christopher Bellucci	CT Department of Environmental Protection
Neal Hagstrom	CT Department of Environmental Protection
Katie DeGoosh	RI Department of Environmental Management
Jeff Lojpersberger	NY Department of Environmental Conservation
Steve Fiske	VT Department of Environmental Conservation
Aaron Moore	VT Department of Environmental Conservation
Blaine Hastings	VT Department of Environmental Conservation
David Neils	NH Department of Environmental Services
Kirsten Nelson	NH Department of Environmental Services
Scott Wixsom	USFS, Green Mountain National Forest
Sue Staats	US Forest Service
Ashley Hyde	Plymouth State University
Jennifer Fulton	USEPA Region 3
Kelly Krock	USEPA Region 3
Greg Hellyer	USEPA Region 1
Diane Switzer	USEPA Region 1
Ralph Abele	USEPA Region 1
Toby Stover	USEPA Region 1
Mary Ratnaswamy	USGS NE CSC
Michelle Staudinger	USGS NE CSC
Ben Letcher	USGS Conte
Dan Hocking	USGS Conte
Keith Davies	Millers River Watershed Association
Sue Flint	OAR
Elisabeth Cianciola	Charles River Watershed Association
William Longfellow	Passamaquoddy Tribe - Pleasant Point
Katie Chang	VT EPSCoR
Kate Bentsen	UMass-Amherst
Paul Damkot	UMass-Amherst

Chris Smith	UMass-Amherst
Webinar	
Britta Bierwagen	USEPA
Zachary Holden	US Forest Service
Dona Horan	US Forest Service
Jana Stewart	USGS Wisconsin WSC
Yin Phan Tsang	Michigan State University
Kimberly Roth	NEIWPCC
Sarah Bounty	Neponset River Watershed Association
Dana Infante	Michigan State University

New England Graduate Student Water Symposium

Lead organizers: David Reckhow, UMass Amherst Civil & Environmental Engineering, Marie-Françoise Hatte, MA WRRC

Description: A committee of four Civil and Environmental Engineering students at UMass Amherst (Sarah Whately, Leslie Decristofaro, Camilla Kuo-Dahab, Joe Goodwill), advised by Dr. David Reckhow and helped by Marie-Françoise Hatte, organized a symposium September 12, 13, and 14, 2014 on the campus of the University of Massachusetts Amherst. The symposium's theme was "all areas of water engineering and science" and was targeted to graduate students in New England and nearby. All technical presentations and posters were given by students. This provided theses young water researchers an opportunity to present their research and network with each other, faculty, and other water specialists. The event, the first of its kind in our region, was extremely well attended, and gave all students more experience in presenting their work as well as more community-building, awareness of other areas of research, and networking. It also gave the four UMass Student Conference Chairs valuable experience in organizing and running a conference. These four students were in charge of the Call for Abstracts, abstracts review and acceptance, program development, fundraising, logistics, and all-around organization.

Certainly a big draw for this event was the low cost. Students were responsible only for their travel to UMass. We provided lodging, sponsors covered refreshments, and we made use of free classrooms and an auditorium during the weekend, thus allowing us to not charge a registration fee.

Participants

140 people registered for the event, and 128 checked in on the first day of presentations. Twenty-six universities were represented, as well as 8 companies and one Federal agency. Participants came from six US states and two Canadian Provinces.

Table 1: Universities and their state/province, and companies/agency represented at the Symposium

University	State	Company
Boston University	MA	Arcadis
Clarkson University	NY	Carollo Engineers
Columbia University	NY	Clean Membranes, Inc.
Cornell University	NY	Environmental Partners Group, Inc.
Dalhousie University	NS	FloDesign Sonics
Drexel University	PA	Hazen and Sawyer
Ecole Polytechnique de Montréal	QC	NEWIN
Hampshire College	MA	Strategic Water Resources
Harvard College	MA	US EPA
Harvard University	MA	
Lafayette College	PA	
Lehigh University	PA	
Manhattan College	NY	
McGill University	QC	
Montclair State University	NJ	
Northeastern University	MA	
Rensselaer Polytechnic Institute	NY	
Rutgers University	NJ	
Smith College	MA	
Syracuse University	NY	
Tufts University	MA	
UMass Amherst	MA	
University at Buffalo	NY	
University of Connecticut	CT	
University of New Hampshire	NH	
Worcester Polytechnic Institute	MA	
Yale University	CT	

<u>Program:</u>

52 oral presentations in ten sessions and 59 posters were presented over one and a half days.

See schedule in Table 2 and the list of presentation titles in Table 3.

Table 2: Symposium Schedule

FRIDAY	
5:00 –9:00	Social Dinner Lawn between Engineering Lab 1 and Engineering Lab 2
SATURDAY	
7:30–8:30	Breakfast and Registration Engineering Lab 2,118 and lobby
8:30–9:15	Welcome and Keynote Keynote featuring Earl Jones, NEWIN Engineering Lab 2, 119
9:30–11:00	Technical Session 1 Water Resources and International WQ Issues, 131 Marcus Hall Trace Organic Compounds and Advanced Oxidation Processes, Marcus Hall Student Center
11:15–1:00	Technical Session 2 Water Resources, Climate Change, and Hydrology,131 Marcus Hall Nanotechnology, Marcus Hall Student Center
1:00–2:00	Lunch
2:00–3:30	Technical Session 3 Natural Organic Matter and DBPs, 131 Marcus Hall Bioelectric Systems, Marcus Hall Student Center
3:30–4:00	Networking and Poster Session Engineering Lab 2, lobby and halls
4:00–5:00	"Business and Industry Experience in Environmental and Water Resource Engineering" Panel discussion with Horacio Caperan, Fusionview LLC; Chris Leidel, FloDesign Sonics; Per Suneby, Vangard Renewables LLC; and James Theroux, Isenberg School of Management, Engineering Lab 2, 119
5:00–9:00	Social Dinner Amherst Brewing Company, 10 University Drive, Amherst, MA 01002
SUNDAY	
8:00–9:00	Breakfast
9:00–12:00	Technical Sessions 4 & 5 CoDigestion, 131 Marcus Hall Water Quality in Natural and Contaminated Sources, 131 Marcus Hall

Ferrate and Water Treatment, Marcus Hall Student Center
Nutrient Control, Marcus Hall Student Center

12:00–1:00 "How'd We Do? Next Steps in Oral Technical Presentations" and Closing Remarks

Presentation featuring Jim Jensen, University at Buffalo

Table 3: Oral Presentations

Technical Session 1

<u>Water Resources and International WQ Issues</u>

Confronting decision cliffs: Diagnostic assessment of multi-objective evolutionary algorithms' performance for addressing uncertain environmental thresholds
Victoria Ward, Cornell University

Identifying and managing impacts of non-point source pollution on surface water quality
Patrick Malone, Worcester Polytechnic Institute

Assessing water quality and public perception in Eleuthera, the Bahamas
Emily Kraemer, Harvard University

Analyzing the Integrated Precipitation and Hydrology Experiment (IPHEx)
Lauren Weston, Smith College

Characterizing hydrodynamic conditions in the Upper Niagara River using field measurements
Shaurya Sood, University at Buffalo

Development of A REILP approach for long-term planning of WRM system in Saudi Arabia
Badir Alsaeed, Dalhousie University

<u>Trace Organic Compounds and Advanced Oxidation Processes</u>

Impact of AOPs on the composition and biodegradability of soluble organic nutrients in wastewater effluents
Nick Tooker, Northeastern University

Occurrence and removal of pharmaceuticals and personal care products in drip disposal onsite septic system
Soonmi Kim, University of Massachusetts Amherst

Plasma-based water treatment: investigating the effect of reactor design on degradation of Rhodamine B
Gunnar Stratton, Clarkson University

Heterogeneous photocatalysis for the degradation of contaminants of emerging concern in Water
Jose R. Alvarez Corena, Worcester Polytechnic Institute

The effects of Fenton reaction on the degradation of bisphenol A in a high voltage plasma reactor with
discharge through a turbulent liquid jet
Fei Dai, Clarkson University

The application of advanced oxidation processes for the removal of common pharmaceutical compounds
Sean MacIsaac, Dalhousie University

Technical Session 2
Water Resources, Climate Change, and Hydrology
The prediction of annual discharge due to oceanic indices variations in the northeastern United States
Rouzbeh Berton, Syracuse University

Optimizing long-term flood control management in an estuarine community facing uncertain climate change
Jory Hecht, Tufts University

Macro-economic analysis supporting a water security index
Hassaan Khan, University of Massachusetts Amherst

A decision-oriented approach for detecting and modeling nonstationary flood frequency
Jory Hecht, Tufts University
Hydrodynamic modelling and fecal indicator dispersion in current and future climates
Isabelle Jalliffier-Verne, École Polytechnique de Montréal

Potential impacts of changes in climate on turbidity in New York City's Ashokan reservoir
Leslie DeCristofaro, University of Massachusetts Amherst

Nanotechnology
Metallic nanoparticles characterization Using ICPMS
Pooya Paydary, Northeastern University

The impact of source material in nano-hematite synthesis on surface area and selenium adsorption
Amanda Lounsbury, Yale University

Reducing the production of brine from inland desalination plants using a Hybrid Ion Exchange-Reverse
Osmosis (HIX-RO) process
Ryan Smith, Lehigh University

Technical Session 3

<u>Natural Organic Matter and DBPs</u>

Influence of dissolved organic matters on acid-base status and aluminum speciation of surface waters in
the Northeastern USA
Habibollah Fakhraei, Syracuse University

Characterization of NOM to distinguish the impact of municipal wastewater effluent in a source water
Michael Brophy, Dalhousie University

Natural organic matter hydrophobicity and its relationship to DBP formation
Ran Zhao, University of Massachusetts Amherst

Removing trihalomethanes from pressurized water mains using horizontal diffused aeration systems
Meagan McCowan, University of New Hampshire

Halogen-specific analysis of disinfection by-products in drinking water by adsorption, pyrolysis and off-line ICP/MS.
Rassil El Sayess, University of Massachusetts Amherst

A study on 2,6-dichloro 1,4-benzoquinone: Determining potential natural precursors and its fate in the
distribution system
Aarthi Mohan, University of Massachusetts Amherst

<u>Bioelectric Systems</u>

Distributed benthic microbial fuel cells (DBMFCs) for durable, efficient, and reliable power generation
Bingchuan Liu, University of Connecticut

Treating metals with single-chamber microbial fuel cells (SCMFCs)
Yan Li, University of Connecticut

Competition for electron donors in anode-respiring biofilms
Varun Srinivasan, University of Massachusetts Amherst
Modeling microbial fuel cells for power generation from wastewater treatment
Secil Tutar, University of Connecticut

A paper shaped microbial fuel cell for instant energy harvesting
Kuichang Zuo, Tsinguha University and Harvard University

All-in-one microelectrode (AIO MECs) for real-time profiling at water/sediment interface for aftermath impacts of environmental shocks
Zhiheng Xu, University of Connecticut

Technical Session 4

Co-Digestion

Co-digestion of food waste and sewage sludge or algae-sludge granules
Camilla Kuo-Dahab, University of Massachusetts Amherst

Anaerobic co-digestion of New York City food waste
Allen Fok, Manhattan College

Ferrate and Water Treatment

Effect of different solutes and natural organic matter on ferrate decomposition rate in aqueous solutions
Yanjun Jiang, University of Massachusetts Amherst

Ferrate(VI) for treatment of municipal secondary effluent for water reuse
Nanzhu Li, Montclair State University

Use of ferrate in drinking water treatment
Joe Goodwill, University of Massachusetts Amherst

Integrating ozone into a direct filtration plant: Developing bench scale protocols
Dallys Serracin-Pitti, Dalhousie University

Development of the stacked rapid sand filter
William Pennock, Cornell University

Networking:

Eight companies, several being sponsors of the event, attended and exhibited at the Symposium. Students were able to converse one-on-one with company representatives to explain their research and discuss potential future employment opportunities.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	3	0	0	2	5
Masters	1	0	0	1	2
Ph.D.	3	0	0	0	3
Post-Doc.	0	0	0	0	0
Total	7	0	0	3	10

Notable Awards and Achievements

Publications from Prior Years

1. 2010MA237B ("Surface water-groundwater interactions on the Deerfield River") - Articles in Refereed Scientific Journals - Yellen, Brian and D. Boutt, 2015, Hydropeaking induces losses from a river reach: observations at multiple spatial scales, Hydrological Processes, Vol. 9, Issue 7. Published online in Wiley Online Library (http://onlinelibrary.wiley.com/doi/10.1002/hyp.10438/epdf)
2. 2010MA237B ("Surface water-groundwater interactions on the Deerfield River") - Other Publications - Lathrop, Janet, 2015, Daily Dam Releases on Massachusetts' Deerfield River Reduce Downstream Flows, Umass Amherst New & Media Relations, http://www.umass.edu/newsoffice/article/daily-dam-releases-massachusetts%E2%80%99
3. 2011MA286B ("A Remote Sensing Algal Production Model to Monitor Water Quality and Nonpoint Pollution in New England Lakes") - Articles in Refereed Scientific Journals - Isenstein, Elizabeth, Adam Trescott, and Mi-Hyun Park, 2014, Multispectral Remote Sensing of Harmful Algal Blooms in Lake Champlain, USA, Water Environment Research, 86(11), 2233-2241
4. 2011MA286B ("A Remote Sensing Algal Production Model to Monitor Water Quality and Nonpoint Pollution in New England Lakes") - Articles in Refereed Scientific Journals - Trescott,Adam, Elizabeth Isenstein, and Mi-Hyun Park, 2013, Remote sensing of cyanobacterial blooms in Lake Champlain, USA, Water Science and Technology: Water Supply, 13(5), 1402-1409
5. 2011MA291B ("Elucidation of the Rates and Extents of Pharmaceutical Biotransformation during Nitrification") - Articles in Refereed Scientific Journals - Sathyamoorthy, S., Chandran, K. and C.A. Ramsburg, 2013, Biodegradation and Cometabolic Modeling of Selected Beta Blockers durin Ammonia Oxidation, dx.doi.org/10.1021/es402878e | Environ. Sci. Technol. 2013, 47, 12835−12843
6. 2011MA291B ("Elucidation of the Rates and Extents of Pharmaceutical Biotransformation during Nitrification") - Articles in Refereed Scientific Journals - Sathyamoorthy, S., Vogel, R., Chapra, S., and Ramsburg C.A., 2014, Uncertainty and sensitivity analyses using GLUE when modeling inhibition and parmaceutrical cometabolism during nitrification, Environmental Modelling & Software 60 (2014) 219e227
7. 2011MA306B ("Authentic Research Projects for Undergraduates based on Groundwater Contamination Issues Related to Arsenic") - Articles in Refereed Scientific Journals - Tyson, J. , R. Kronquist, A. Begum and S. Begum, 2015, Integrating Arsenic-Related Environmental Topics into the Education of the Next Generation of Citizens for Arsenic-Hit Commmunities: Awareness and Mobilization, Int. J. Env. Monitor. Anal., 2015, 3, 50-55. Doi 10.11648/j.ijema.s.2015030301.16
8. 2012MA346B ("Biopolymer Sorbents for Tungsten Removal") - Articles in Refereed Scientific Journals - Birch, N. P. and Schiffman, J. D., 2014,"Characterization of Self-Assembled Polyelectrolyte Complex Nanoparticles Formed from Chitosan and Pectin" Langmuir, 2014, 30 (12), pp 3441–3447. DOI: 10.1021/la500491c