Connecticut Institute of Water Resources Annual Technical Report FY 2014

Introduction

The Connecticut Institute of Water Resources (CTIWR) is located at the University of Connecticut (UConn) and reports to the head of the Department of Natural Resources and the Environment, in the College of Agriculture, Health and Natural Resources. The current Director is Dr. Glenn Warner and Associate Director is Mr. James Hurd.

Although located at UConn, the Institute serves the water resource community throughout the state at solicits proposals from all Connecticut universities and colleges. It works with all of Connecticut's water resource professionals, managers and academics to resolve state and regional water related problems and to provide a strong connection between water resource managers and the academic community.

The foundation for this connection is our Advisory Board, whose composition reflects the main water resource constituency groups in the state. Currently the Advisory Board is composed of 11 members. This past year, two members resigned their positions and were replaced by individuals from the same agencies. CTIWR staff also participates on statewide water-related committees whenever possible, enabling the CTIWR to establish good working relationships with agencies, environmental groups, the water industry and academics.

The USGS 104B program is the financial core of the CTIWR. The Institute does not receive discretionary funding from the state or the university, although the CTIWR does receive approximately two thirds of the Associate Director's salary per year from the Dean of the College of Agriculture, Health and Natural Resources as match for our program administration and other activities.

Research Program Introduction

The majority of our 104B funds are dispersed as grants initiated in response to our annual RFP, with the majority of those funds going to research projects. To solicit research proposals, the CTIWR sends an announcement to all Connecticut institutions of higher learning requesting the submission of pre-proposals. Pre-proposals received by the deadline date are reviewed by the CTIWR Director and Associate Director for appropriateness. Evaluation of pre-proposals are based on three main areas: 1. technical merit, 2. state needs and, 3. CTIWR priorities (use of students, new faculty, seed money for innovative ideas). Investigators meeting the initial requirements are invited to submit a full proposal. Each full proposal received is reviewed by two to four outside individuals with expertise in the topic described in the proposal. Proposals and reviewer comments are presented to the CTIWR Advisory Board, composed of individuals that reflect the main water resource constituency groups in the state, and a determination is made on which projects are to be funded.

For FY2014, four proposals were selected for funding. Two of the research projects funded were by investigators from the University of Connecticut, one by an investigator at Sacred heart University, and one by an investigator at the University of Hartford.

Evaluating and enhancing communities’ willingness to adopt N-Sink as a community based pollution mitigation decision tool

Basic Information

Title:	Evaluating and enhancing communities’ willingness to adopt N-Sink as a community based pollution mitigation decision tool
Project Number:	2014CT284B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	2nd
Research Category:	Social Sciences
Focus Category:	Management and Planning, Nutrients, Models
Descriptors:	None
Principal Investigators:	Christine Kirchhoff, Juliana Barrett

Publications

1. Rando, Caroline. 2015. Evaluating and Enhancing Communities' Willingness to Adopt N-sink as a Community Based Pollution Mitigation Decision Tool. Civil and Environmental Engineering Department. School of Engineering. The University of Connecticut. Storrs, CT. Undergraduate Thesis.
2. Kirchhoff C., J. Barrett, C. Arnold, Q. Kellogg, C. Chadwick, A. Gold. 2015. Can GIS-Based Tools Help Decision Makers Address the Non-point Source Pollution Challenge. [in preparation]

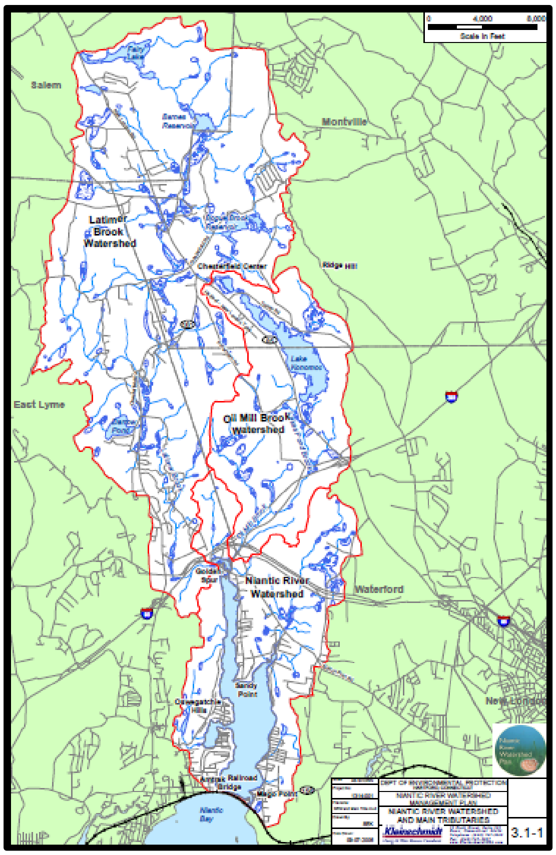

Fig. 1. Niantic River Watershed (DEEP 2006).

2014-2015 FINAL REPORT: EVALUATING AND ENHANCING COMMUNITIES' WILLINGNESS TO ADOPT N-SINK AS A COMMUNITY BASED POLLUTION MITIGATION DECISION TOOL

By: Christine Kirchhoff, Juliana Barrett, and Caroline Rando

1. Introduction

Nitrogen (N) is increasingly being recognized as a pollutant of concern in both coastal and inland waters. Excess nitrogen triggers algal blooms that in turn cause hypoxia in Long Island Sound. The Clean Water Act (CWA) was established in 1972 to regulate discharges of pollutants and quality standards for surface waters in United States. Connecticut enforces the CWA from point and non-point discharges into receiving waters. Polluted runoff accounts for about 50% of the nitrogen inputs into the Niantic River, a Long Island Sound watershed of concern (see Figure 1 on cover).

In recent years, Connecticut has worked with the EPA to implement a nitrogen pollution reduction plan to improve dissolved oxygen levels and to protect aquatic animals, along with public health. New York, Connecticut, local governments, and the EPA have built and upgraded sewage treatment plants to reduce the nitrogen that goes into Long Island Sound. Despite these improvements, it appears to be inadequate in reducing nitrogen and other pollutants in the Long Island Sound. Figure 2 shows the extent of hypoxia formation in the Sound between 1994 and 2014.

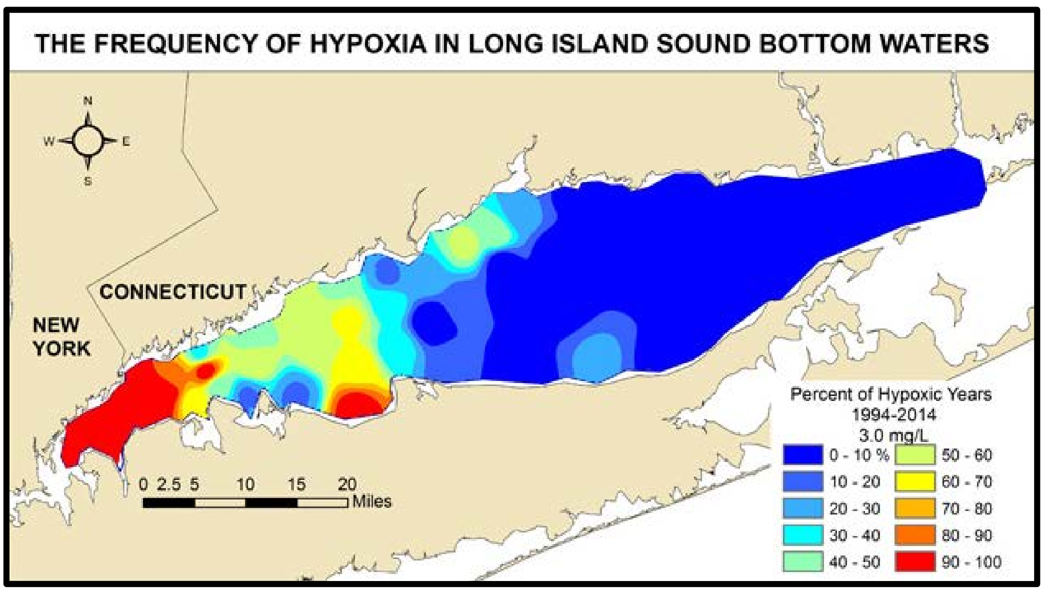

Figure 2. Percent of hypoxic area in Long Island Sound from 1991-2008 (LISS 2015).

Riparian wetlands, reservoirs, small-order streams, and impoundments have the capacity to function as "sinks" for nitrogen. Currently, local decision makers have limited knowledge about N sources and sinks, therefore they are not able to factor N pollution into land policies and decisions. In an effort to help decision makers understand nitrogen sources and sinks, researchers developed a GIS model called N-Sink. N-Sink uses the best available science on landscape-nitrogen interactions along with hydrography, soil, and land cover datasets to reveal major sources and sinks of nitrogen.

Model developers used the Niantic River watershed as a test watershed to develop potentially usable maps and data for identifying nitrogen sources and sinks for local decision makers. The challenge model developers' face is that often there is a gap between what model developers hope is useful and what is actually useful in practice. The purpose of this research was to help bridge the gap by better understanding nitrogen management and policy making in the watershed, decision maker's information needs and opportunities or barriers to integrating new decision support tools for nitrogen management. In addition, this research aimed to help N-Sink model developers test their tool to get feedback on the tool and its usability. The ultimate goal of the research was twofold: first, to understand the context of use of the tool, and second, to make the tool more user-friendly and effective for aiding decision-making. With these goals in place, the N-Sink model could be adopted into management systems including regional, state, and federal levels.

1.1 Research Objectives

This research seeks to help nutrient management decision and policy makers better respond to changing climatic conditions and their impacts on the Long Island Sound. The first goal of the study is to gain background knowledge for the use of the N-Sink tool. A secondary goal is to make the N-Sink tool more effective and user-friendly for assisting decision-making. In order to meet the objectives of this research, feedback was gathered on the N-sink tool. To make an effective and usable tool that can be widely used, it is important to consider criticism from the communities that will be using it.

2. Methods

Data were collected through semi-structured interviews and through observations and surveys of workshop participants. In total, ten semi-structured interviews were conducted in January 2015. Interviewees were selected purposefully to encompass a range of expertise and influence on nitrogen pollution management (see Table 1).

Table 1. Summary of interviewees by organization type or role.

Interviewees	Number
Federal agency	2
State agency	2
Town	3
NGO	1
Scientist	2

Interviewees were asked about the land use or conservation decisions that they make that could potentially have effect on nitrogen sources or sinks, what information they currently use to inform decisions or programs for nitrogen management, and what additional information is necessary to address nitrogen pollution. In addition, interviewees were asked about their perceptions about nitrogen pollution and what actions they or their organization can take to reduce nitrogen pollution. Interviews were transcribed and analyzed to identify patterns and themes around drivers and barriers to nitrogen pollution control, information needs, and strategies to address nitrogen pollution.

In addition to interviews, data were collected through a workshop focused on N-Sink (for more information and access to the tool see http://www.edc.uri.edu/nsinkv2/). Participants were invited to encompass a range of perspectives and potential uses of the tool (Table 2). In total twelve individuals participated in the workshop.

Table 2. Summary of workshop participants by organization type or role.

Workshop Participants	Number
Federal agency	1
State agency	4
Town	2
NGO	2
Scientist	3

The workshop followed an experimental set-up where by participants were first asked to rank a conservation and development scenario without using N-Sink only relying on maps and information distributed in the workshop. Then, workshops were trained on N-Sink and asked to rank conservation and development scenarios using the maps, information, and N-Sink. The decision making process of participants was observed. After each exercise, participants were asked to report how they made their decision and what information or criteria were used in their rankings. In addition to the experiment, participants were asked to provide feedback on the usability and usefulness of N-Sink. Responses were recorded and analyzed along with notes from the ranking experiment.

3. Results

3.1 Interviews

To gain more information on the usability and effectiveness of the N-Sink tool, various employees across different governmental scales and authority over nitrogen were interviewed. While they do not all work at the same level, these interviewees all have ties to the Long Island Sound watershed. Working at a different level means access to different information, responsibilities, and power over regulations. Local or town employees' focus on the area they work for or in and mainly make recommendations pertaining to nitrogen and other contaminants. State level employees look at the bigger picture and make decisions and plans for the whole state or watershed spanning several towns. Out of the ten subjects that were interviewed, eight of them are only able to make recommendations regarding nitrogen pollution. Almost all of these employees work at the town or local level. An Environmental Planner for the town of Waterford, CT said in her interview when talking about the influence of local regulations on nitrogen reduction, there is "nothing directly about nitrogen, nitrogen loading, nitrogen control in either of the regulations, so this is all on a recommendation level." Employees working at the federal or state levels have more power and can make actual decisions and laws when it comes to nitrogen. For example, the EPA has more control over environmental issues with their numerous plans and access to funding. To restore the health of the Sound, the EPA, Connecticut, and New York formed the Long Island Sound Study (LISS). The EPA receives annual funding that contributes mostly to the Comprehensive Conservation Management Plan (CCMP), a plan created by the LISS. The CCMP is aimed at indirectly and directly reducing nutrients through education, public outreach, restoration or protection efforts and more.

A main focus of the interviews was to discover at what scale the subjects view the nitrogen issue, while also considering which level of government they work for. It was important to understand not only how they view the nitrogen issue, but also how they view solutions. In other words, how does their view of the issue shape their view of solutions? All of the subjects interviewed acknowledged that nitrogen pollution was indeed an issue, but at different scales. One interviewee believes it to be a town scale issue, two see it as a watershed scale issue, and one sees it as both a town and watershed scale issue. Most interviewees that work at the local or town level see nitrogen as a local or watershed issue, as that is the scale that they are able to make recommendations for. When asked if anything could be done for nitrogen at her scale, the Environmental Planner for Groton, CT said, "I mean no, I don't think so. I mean we can do it in bits and pieces here, but we're kind of at the bottom of a number of watersheds, so whatever happens to the north, generally it is to the north for us, impacts us." The scale of the problem is relevant when it comes to taking action to fix it.

The main barriers to nitrogen reduction in the LIS that the interviewees discussed were the lack of money, public education, and information regarding nitrogen. Although most local or town level employees that were interviewed are comfortable with the information we currently have on nitrogen, higher-level employees think we need to know more. They are not comfortable with the information we have on the sources and sinks of nitrogen and think more research needs to be done. Two of the ten that were interviewed believe that money constraints are the main problem when it comes to stopping nitrogen pollution. Four of the ten believe that the citizens are preventing them from making strides toward a cleaner environment. One interview stated, "I see that one main barrier is citizen awareness to get individuals that if they don't see the Sound or if they don't directly boat or swim on the sound, understanding that their activities impact water quality of the Sound." A Hydrologist with USGS commented that "it's a tricky situation to get people to do things too because there's a lot of people that don't like to be pushed to do things differently." Aside from these barriers, various interviewees think that storm water management implementations, more regulations, better support tool, green infrastructure, and overall action are required to facilitate change.

When it came to the potential use of the N-Sink tool, there were several different responses from the subjects. Multiple interviewees see the tool being powerful and potentially being very useful for watershed protection, land use planning, and restoration. It could be advantageous to researchers wanting to know where nitrogen is coming from. One interviewee said, "And maybe N-sink is the way, I don't know. It seemed to be it was a pretty cool thing when I seen an earlier version of a demo, it seemed like a very powerful tool, especially since I think a lot of these town officials are moving toward a lot, you know their sophistication is growing over time" (Latimer). There was an overall positive outlook on the tool when it came to the ten subjects that were interviewed.

3.2 Workshops

The experimental design deployed at the workshop enabled a comparison between how workshop participants made decisions about ranking conservation sites (to protect the Niantic Bay) and development sites (to least impact Niantic Bay) with and without the benefit of using NSink. When respondents were asked to rank conservation sites without NSink, using only the maps they were given, respondents proposed one of three combinations (see Table 3).

Table 3. Conservation Scenario – Old School Decision Making.

Priority Ranking	Combination 1	Combination 2	Combination 3
Highest Priority Site	C1	C3	C2
	C2	C1	C3
Lowest Priority Site	C3	C2	C1

The majority of respondents (five out of seven groups) proposed the first combination: C1, C2, C3. When asked to list the factors considered in ranking conservation sites from highest to lowest priority, respondents indicated they considered: presence of hydric soils at or adjacent to the site, proximity of the site to surface water, and the slope of the site as the most important features. Beyond physical features, workshop participants mentioned favoring sites that offer the "most bang for the buck" such as sites that have good public access, link to other open lands, or have the highest potential "developability." When respondents were given the same task for ranking conservation sites but with the option of using NSink, respondents chose four different rank order patterns (see Table 4).

Table 4. Conservation Scenario - N-Sink Test Drive.

Priority Ranking	Combination 1	Combination 2	Combination 3	Combination 4
Highest Priority Site	C1	C1	C3	C2
	C2	C3	C2	C1
Lowest Priority Site	C3	C2	C1	C3

Four out of seven respondents chose the same rank order as before: C1, C2, C3. When asked about the factors considered in ranking the conservation scenarios the second time, respondents indicated that the percent nitrogen removal was the most important overall. Although two groups did not record their factors, the other five groups listed nitrogen removal as their most important factor in ranking the conservation sites. One group stated that they, "looked at N removal and decided areas with greatest removal should be protected." Three of the seven groups made note of two different possibilities of nitrogen removal for C2 and C3. One of the four who ranked the sites as C1, C2, C3 wrote that the N-removal of C3 "depends on the location of the discharge point" which could account for the order variations across the groups.

When the respondents were asked to rank development scenarios without N-Sink, using only the maps they were given, respondents recommended six different development site priority rankings (see Table 5).

Table 5. Development Scenario – Old School Decision Making.

Priority Ranking	Combo 1	Combo 2	Combo 3	Combo 4	Combo 5	Combo 6
Highest Priority Site	D3	D3	D4	D4	D2	D4
	D4	D4	D1	D3	D3	D3
	D2	D1	D2	D1	D1	D2
Lowest Priority Site	D1	D2	D3	D2		D1

Most respondents (three out of seven) selected D4 as having worst impact followed by D3 followed by D1 and D2. The three respondents that chose D4 as the highest priority site all listed hydric soils, proximity to water or discharge, and existing development as factors. The two groups that chose D3 as the highest priority site specified the distance to the Niantic River as the most important factor. For the development scenario, distance from the Niantic River, topography, hydric soils, land cover, slope, land use, and existing development were the main factors considered in ranking site impact to Niantic Bay. When respondents were given the same task for ranking development sites but with the option of using N-Sink, respondents proposed fewer different rank order combinations—four compared with six in the first exercise (see Table 6).

Table 6. Development Scenario – N-Sink Test Drive.

Priority Ranking	Combo 1	Combo 2	Combo 3	Combo 4
Highest Priority Site	D3	D3	D3	D3
	D2	D1	D4	D4
	D4	D4	D1	D2
Lowest Priority Site	D1	D2	D2	D1

Differently from the morning session, once N-Sink was available to use in the afternoon session, participants relied almost exclusively on the tool for evaluating the development scenarios. With the N-Sink tool used to compute the nitrogen removal values for each site, rather than D4, every group chose site D3 as the highest priority development site. One of the seven groups noted that the higher the nitrogen value reported by N-Sink for a particular development site, the greater the potential impact of nitrogen pollution from that site. Still, the group noted, relying on N-Sink alone was insufficient for determining which development site should ultimately be the most important to site protect from development. While most groups relied completely on the nitrogen removal values computed by N-Sink in their evaluation of development sites, some groups accounted for other factors in their decisions. For example, in addition to using N-sink, one group considered the presence or absence of hydric soils when ranking their sites. The variation in use of information for site ranking helps to explain some of the variation observed in the different rankings and rank combinations.

3.3 N-Sink Feedback

The LIS workshop attendees were given the opportunity to use the N-Sink tool and share their thoughts about potential benefits and constraints to using the tool. Many workshop participants acknowledge the tool as being useful for educating the public and decision makers about nitrogen movement on the landscape as well as for assessing development impacts and site or conservation planning. For example, users thought that by integrating a lot of different information into one program, N-Sink helps users to understand connectedness of the land to Long Island Sound. One participant put it this way: the tool “combines graphics and teaches people about their land.” Other suggested that N-Sink allows users to easily consider nitrogen impacts by showing how much nitrogen is removed on the way to the Long Island Sound and by easily identifying sites that are “leaky.” Most of the nitrogen in a “leaky” site will get to the sound and not be removed, so these sites will need more protection. Another participant suggested that N-Sink would be “beneficial from a municipal standpoint for watersheds, parcels, and landscapes to track downstream effects.” Considering that the N-Sink tool was developed for use by decision-makers, it is also important to consider how it could impact their choices, whether the tool will help them make decisions or help them consider nitrogen in their decisions. From the workshop feedback, the participants feel that N-Sink will effect decisions made on development and conservation, permit processes, nitrogen management efforts, and potentially stormwater policies. There was also discussion about how N-Sink may help inform septic system policies and nitrogen management more generally. Because most programs for non-point source control of nitrogen pollution are voluntary, the tool could help decision makers consider nitrogen along with other factors in watershed management. That said, additional regulatory drivers for nitrogen reduction could increase motivation to use the tool.

The N-Sink workshop revealed many issues with the tool and provided suggestions for improvements. Multiple attendees mentioned difficulties with the actual set up of the program. Some technical issues they encountered were moving, expanding, and fitting different windows within the program. For example, users complained the land cover pie chart does not actually fit into the box (see Figure 3) and that it was difficult to use the heat map and land-use layers simultaneously.

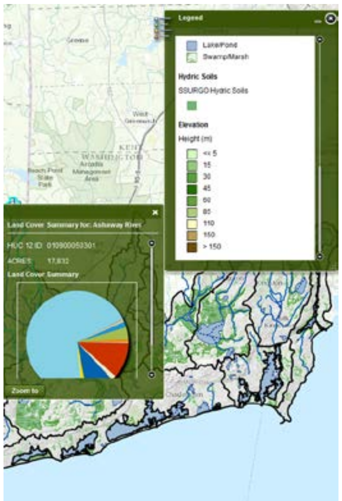

Figure 3. Illustration of mismatched legend and pie chart sizing.

In addition, users noted that the chart colors do not match the map legend, which adds unnecessary obfuscation and decreases ease of use. Several users reported that N-Sink ran very slowly, negatively impacting the speed of assessment. To speed assessment and increase productivity, several users suggested it would be helpful if N-Sink permitted assessment of multiple points (e.g., within a single site or single points across multiple sites) simultaneously (see Figure 4).

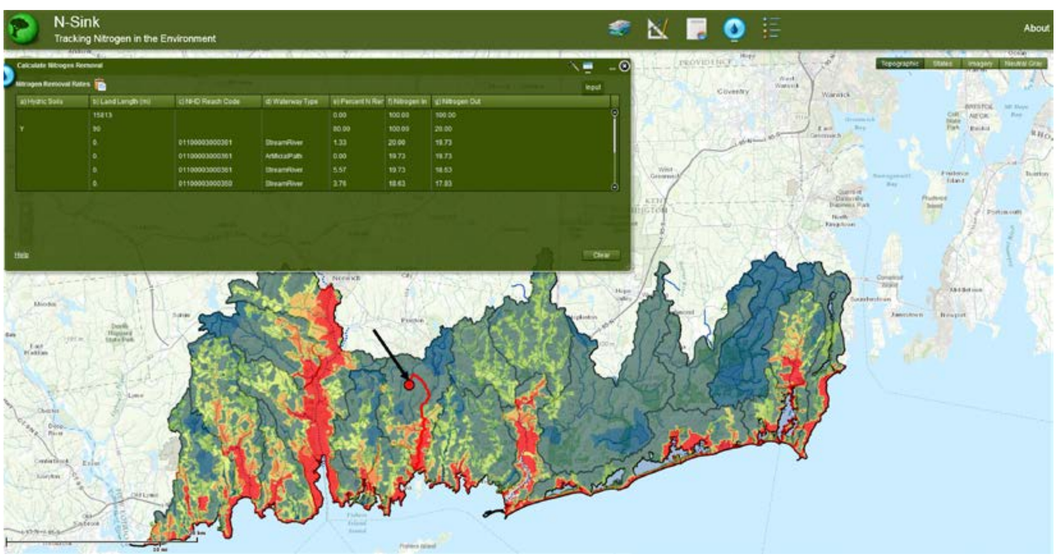

Figure 4. Showing the current single point approach with a black arrow indicating the single point.

If N-Sink had the capability to run multiples points and save the results, it would make it easier to compare different options. One person suggested usability would be increased if tool developers added the option to search by location and a second person suggested adding street names. This additional functionality would make it easier to find unnamed assessment sites that are near specific towns or features including streets. Other users' recommended that tool developers improve icon labeling and define terms to improve usability. For example, users were confused by the hammer icon which indicates "input" when a mouse hovers over it (see Figure 5) and by terms like "local" vs. "cumulative drainage area" making the tool more difficult to use.

Figure 5. Hammer icon shown in red circle.

Additional suggested improvements included adding a pop-up window that would display when users hover over different parts of the watershed to describe layer information, adding more detail on water flow paths and clarification of receiving waters, and adding known sinks not displayed currently. Finally, workshop participants noted that the heat map layer (Figure 6) was a useful part of the tool, but that to improve usability, more work should be done to better explain how to use the heat map to avoid misinterpretation.

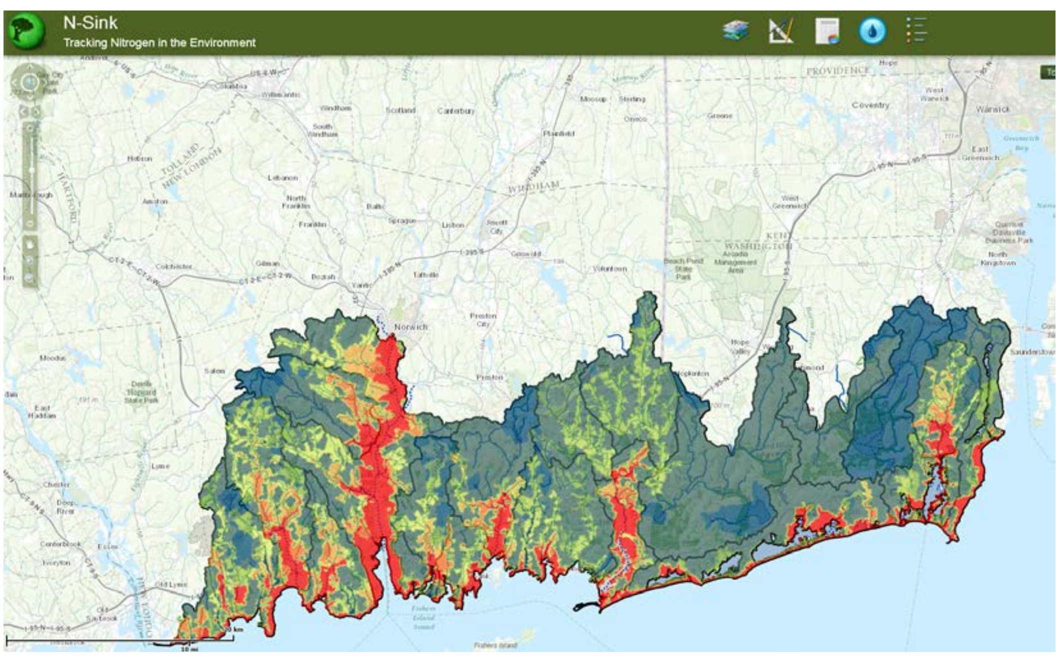

Figure 6. Heat map.

4. Discussion

The voluntary nature of non-point source nitrogen pollution management in the US complicates efforts to reduce nitrogen pollution. Both point (e.g., wastewater treatment plants and municipal separate storm sewer systems (MS4)) and non-point sources contribute to nitrogen pollution. While point sources are regulated, non-point sources are controlled through mostly voluntary programs. When discussing nitrogen pollution, most respondents referred to what is done to comply with the MS4 permits and the many sources of non-point source pollution from agriculture, fertilizer on lawns, atmospheric deposition, septic system leaks, and manure. Respondents who are local and town government employees make recommendations about how to address these diffuse sources of nitrogen pollution, but there is no regulated entity to target which results in little or no change. With little influence they possess, local and town employees seem to be comfortable with the information they currently have on nitrogen. On the other hand, state and federal employees seem to be more aware of the problems caused by non-point sources of nitrogen as they think we need more information on nitrogen. Overall, state and federal employees have a larger scope and more impact on nitrogen decisions and are open to learning more about nitrogen sources and sinks.

The N-Sink tool is based on the premise that local decision makers require environmental data that is highly localized, easily accessible and immediately understandable. Since nitrogen sources and sinks are closely linked to land use, land use decision-makers are a critical audience for a tool like N-Sink that can translate science into information that can be used for management. Respondents at the workshop found the N-Sink tool to be useful for various decisions on development, conservation, permit process, nitrogen management efforts, and stormwater policies. With this broad applicability, N-Sink has potential to aid in implementing decisions to reduce non-point source nitrogen pollution and in so doing help to improve implementation of the voluntary system. A key benefit of the N-Sink tool is that it helps to make it to easier to think about nitrogen and to make changes. For example, comparing the development scenario from exercises 1 and 3 from the workshop, you can see less variation in combinations when the N-Sink tool could be used. While some respondents still considered things such as hydric soils, the tool helped people directly consider nitrogen in their decision. Without the use of the tool it is much harder to think about nitrogen because a concrete number is not given.

There are advantages for decision-makers as well as the public with the creation of the N-Sink tool. The N-Sink tool was originally created "to provide a useful and accessible tool for local land use managers to explore the relationship of land use in their towns and counties to nitrogen pollution of their waters" (Tracking the fate of watershed nitrogen: The "N-Sink" Web Tool and Two Case Studies). Based on suggestions from the pre-workshop interviews, the tool could also be beneficial for public education on nitrogen issues. Whether it is because they live far from the sound or just do not have the background on nitrogen, many interviewees were concerned that the public does not understand why this is an issue and what they can do to help. One respondent included, "I think there's coastal communities where maybe many people are aware of these issues, especially people who use the water a lot and see the effects of what maybe is going and trying to figure out, or you know the fisherman who wants to know why there is no fish left." On the other hand, another respondent said, "I see that one main barrier is citizen awareness to get individuals that if they don't see the Sound or if they don't directly boat or swim on the sound, understanding that their activities impact water quality of the Sound." Whether or not they have direct access to the sound does not necessarily mean they know what to do to lessen the nitrogen impact. One interviewee added, "In the end, you're trying to change behaviors." There is potential for the N-Sink tool to act as a education tool for communities that affect the quality of Long Island Sound. If the public does not know they are hurting the environment with certain practices then they will have no motivation to change.

In order to use N-Sink as a tool for local decision-makers as well as the public, the workshop attendees agreed that modifications were necessary. N-Sink was created to make the process of tracking nitrogen easier and more efficient. If the tool can be updated to become faster and simpler to use, it seems that more decision-makers will consider it in their work. Hopefully the tool will promote more knowledge on nitrogen and how it makes its way to Long Island Sound.

5. Conclusion

The N-Sink interviews and workshop were conducted to gain background on current nitrogen management and decision makers, as well as to test the effectiveness and usability of the N-Sink tool. Based on the feedback collected in the interviews and workshop, there seems to be potential for the tool when it comes to improving the current voluntary nitrogen program, making nitrogen decisions easier and more efficient, and educating the public on nitrogen issues. If technical changes are made to the tool, there will be better usability and the N-Sink tool can be applied to real life nitrogen management scenarios.

6. References

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Investigating the effects of storm and wastewater treatment inputs on the biouptake and transfer of heavy metals in urban stream food webs

Basic Information

Title:	Investigating the effects of storm and wastewater treatment inputs on the biouptake and transfer of heavy metals in urban stream food webs
Project Number:	2014CT285B
Start Date:	3/1/2014
End Date:	2/15/2015
Funding Source:	104B
Congressional District:	CT-1 and CT-2
Research Category:	Water Quality
Focus Category:	Ecology, Water Quality, Non Point Pollution
Descriptors:	None
Principal Investigators:	Bin Zhu, Timothy Vadas

Publications

There are no publications.

CTIWR Project Progress Report

Investigating the effects of storm and wastewater treatment inputs on the biouptake and transfer of heavy metals in urban stream food webs

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Project objectives

In this project, our objectives are: 1) to study the biouptake and transfer of Cu and Zn in macroinvertebrates in urban streams exposed to two different conditions: one with impacts from increased water column concentrations during stormflow and the other with wastewater effluent release of metals; and 2) to investigate how Cu and Zn are transferred in the food webs, i.e. from stormflow and wastewater effluent impacted streamwater to periphyton (algae) and to benthic invertebrate grazers (e.g., mayflies) by setting up laboratory experiments.

Implementations

To achieve our first goal, we studied 20 selected streams in CT. These stream reaches were selected based on wadeable streams that are impacted directly by municipal wastewater effluent discharges or were listed as an impaired water body by CT DEEP. Below we will report some data. Other data such as heavy metal concentration in water, periphyton, and macroinvertebrates are still to be measured at Dr. Vadas' lab.

For our second goal, we will set up a factorial experiment in the summer and fall 2015 to investigate the transfer of heavy metals across the stream food web.

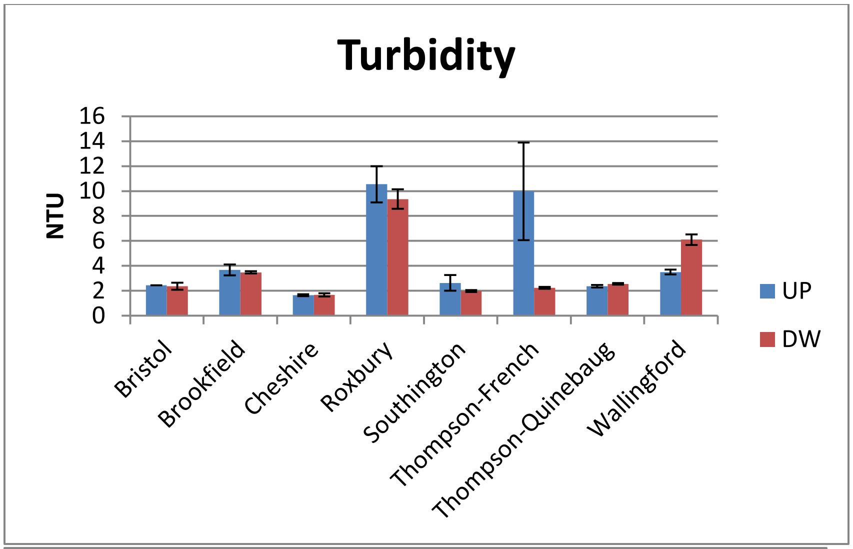
Preliminary results

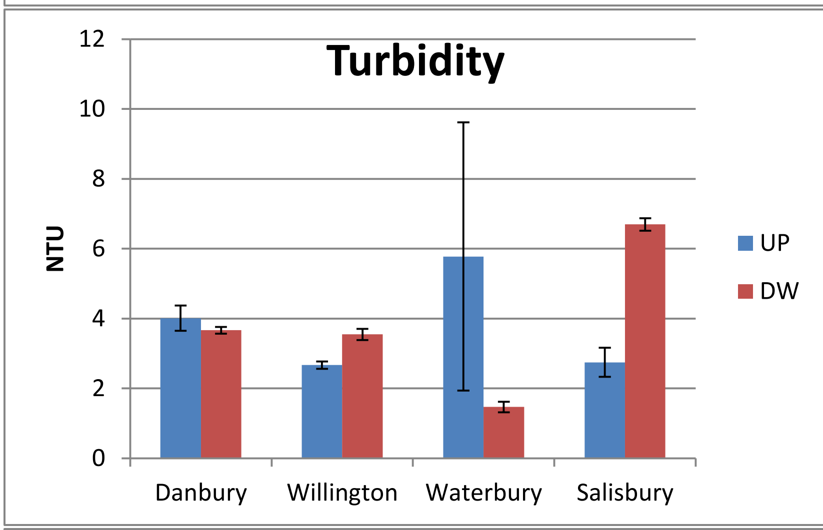
We divided the 20 streams into three groups:

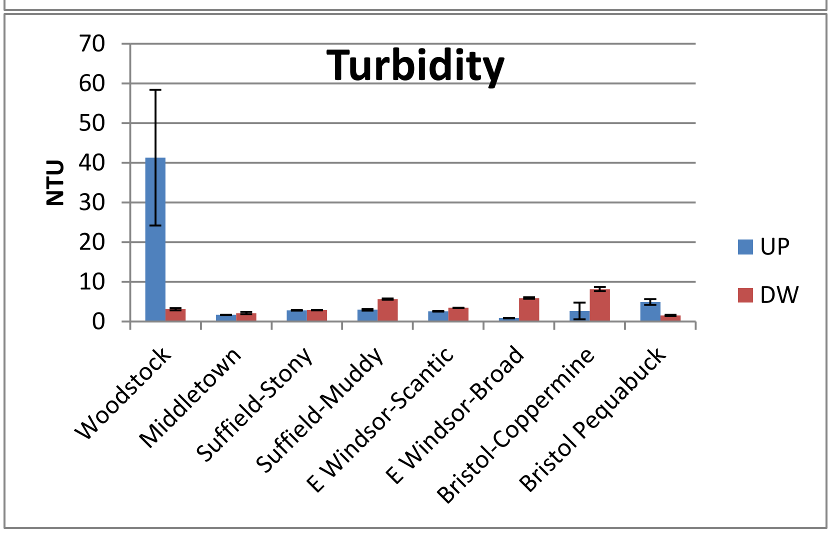
1. Wastewater sites (8 sites from DEEP algal sampling sites)
2. Sites with approved TDML (only four sites can be located and made a mistake in identifying one stream; so there are only three sites).
3. Sites with unidentified problems (8 sites selected from the page you sent to me)

I. Turbidity and nutrients in water

We measured turbidity and nutrients (total phosphate, soluble reactive phosphate [SRP], and nitrate) in upstream and downstream of these streams (labelled as UP and DW in the figures). There were no general trends.


Turbidity
NTU
16
14
12
10
8
6
4
2
0
Bristol
Brookfield
Cheshire
Roxbury
Southington
Thompson-French
Thompson-Quinebaug
Wallingford
UP
DW


Turbidity
NTU
12
10
8
6
4
2
0
Danbury
Willington
Waterbury
Salisbury
UP
DW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50
40
30
20
10
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Middletown
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Suffield-Muddy
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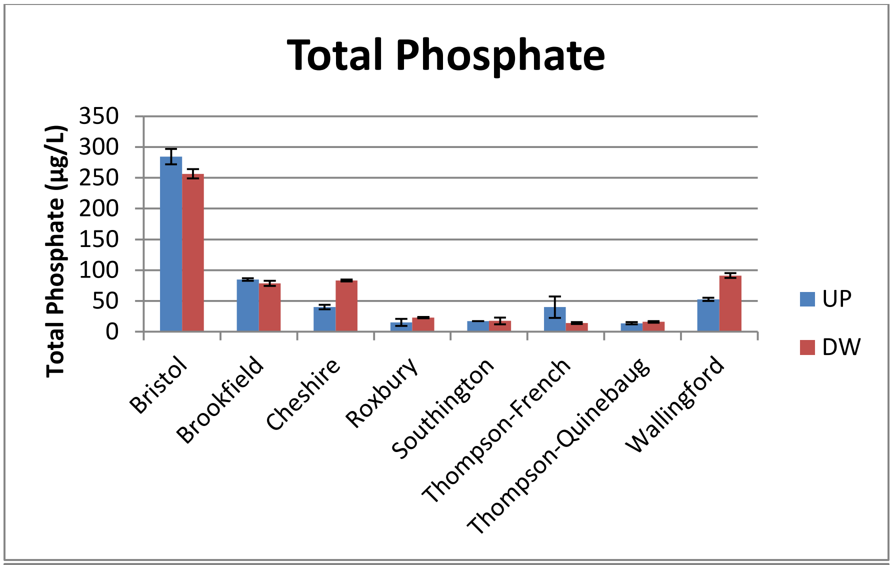
E Windsor-Broad
Bristol-Coppermine
Bristol Pequabuck
UP
DW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Total Phosphate (µg/L)
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300
250
200
150
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50
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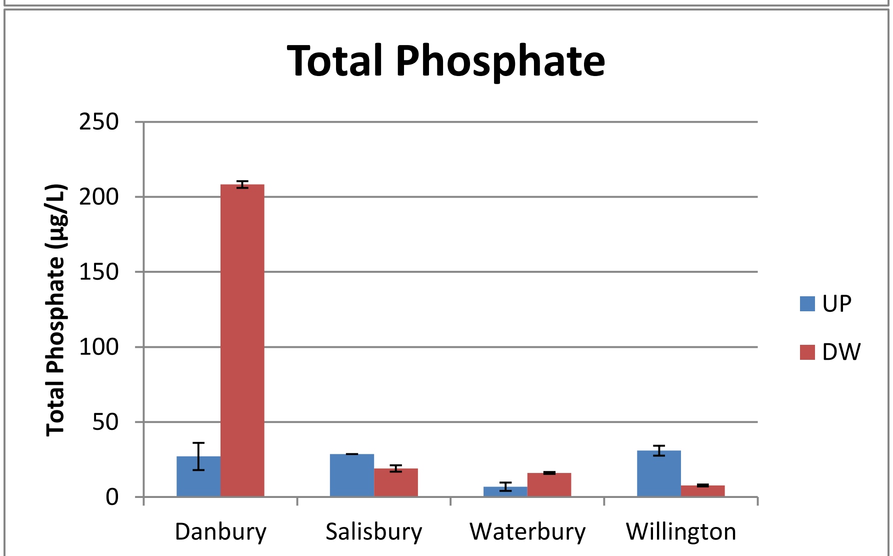
Brookfield
Cheshire
Roxbury
Southington
Thompson-French
Thompson-Quinebaug
Wallingford
UP
DW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Total Phosphate (µg/L)
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100
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Danbury
Salisbury
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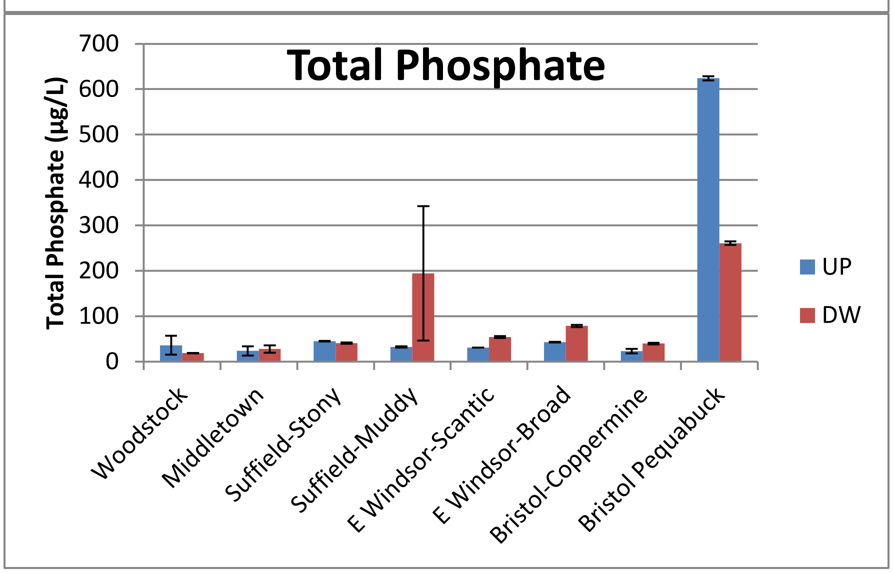
Willington
UP
DW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Total Phosphate (µg/L)
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600
500
400
300
200
100
0
Woodstock
Middletown
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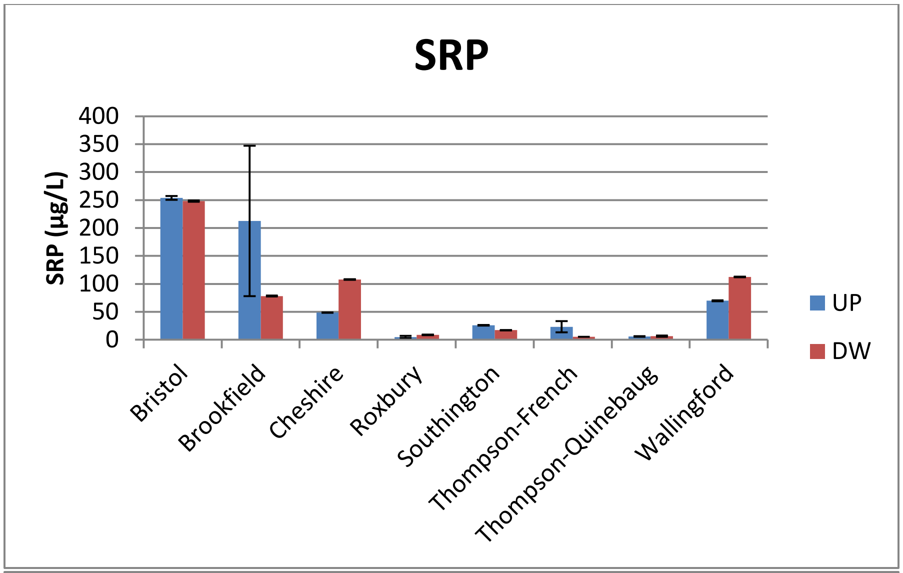
Suffield-Muddy
E Windsor-Scantic
E Windsor-Broad
Bristol-Coppermine
Bristol Pequabuck
UP
DW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SRP (µg/L)
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300
250
200
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50
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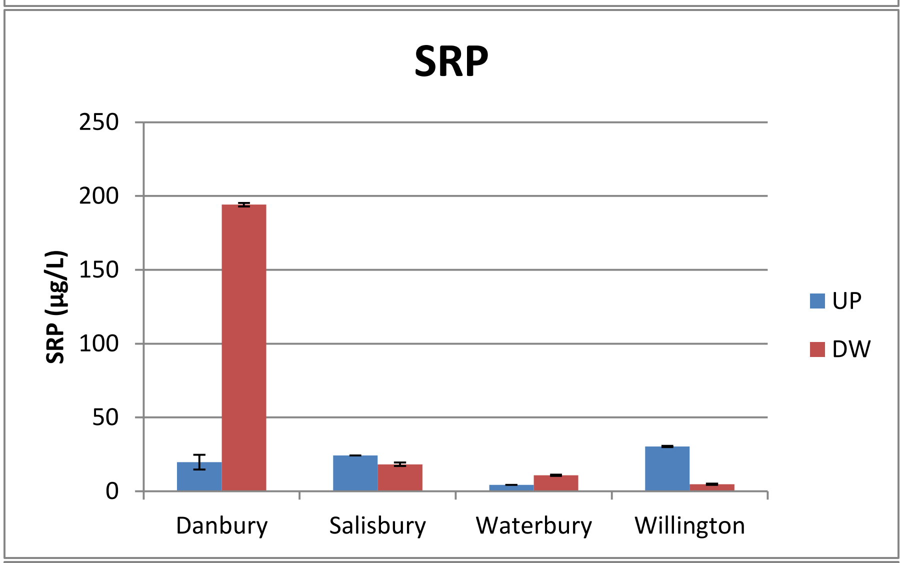
Wallingford
UP
DW


SRP
SRP (µg/L)
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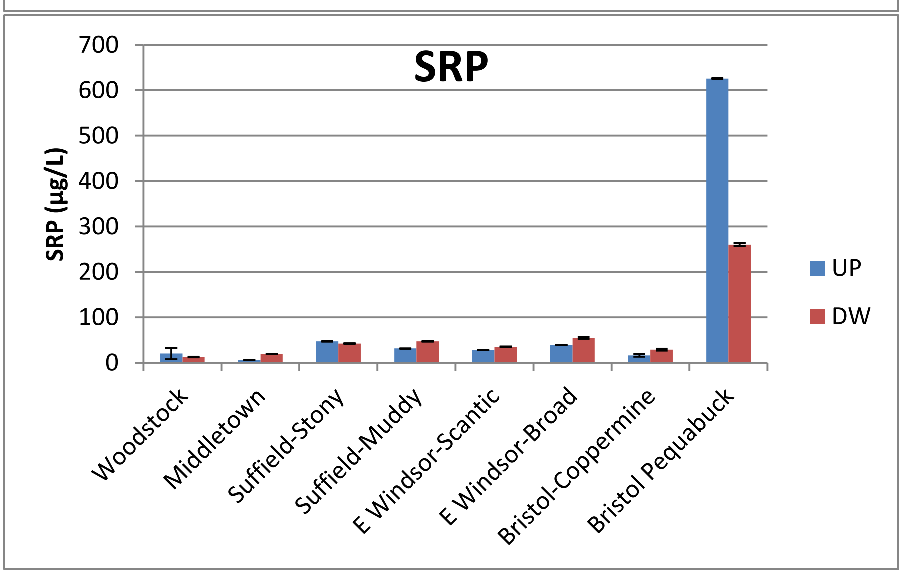
200
150
100
50
0
Danbury
Salisbury
Waterbury
Willington
UP
DW


SRP
SRP (µg/L)
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600
500
400
300
200
100
0
Woodstock
Middletown
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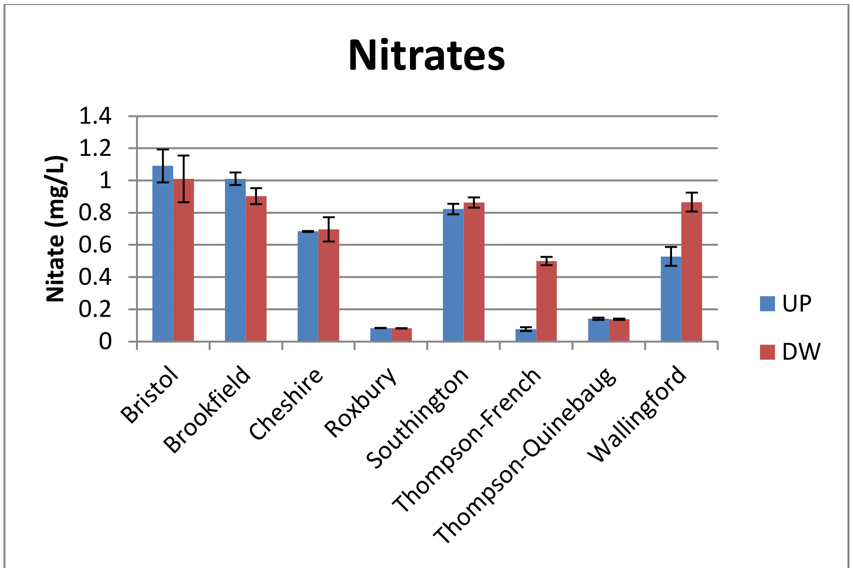
E Windsor-Scantic
E Windsor-Broad
Bristol-Coppermine
Bristol Pequabuck
UP
DW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Nitate (mg/L)
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0.4
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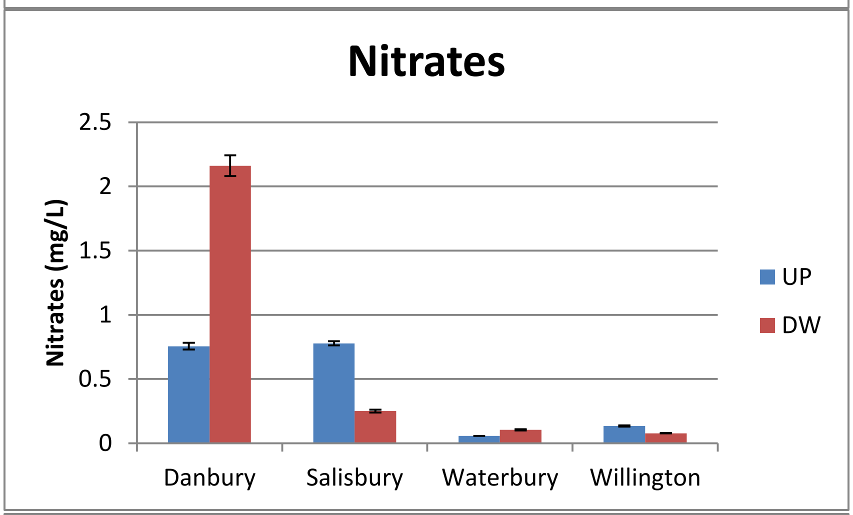
Roxbury
Southington
Thompson-French
Thompson-Quinebaug
Wallingford
UP
DW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Waterbury
Willington
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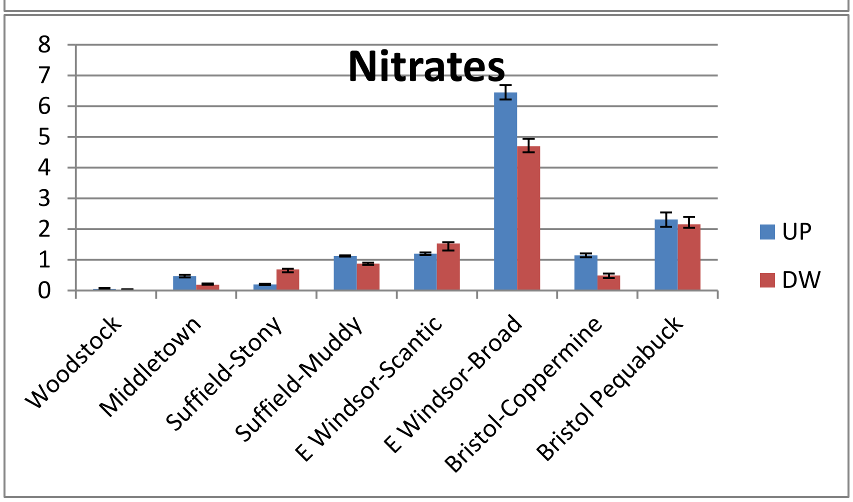
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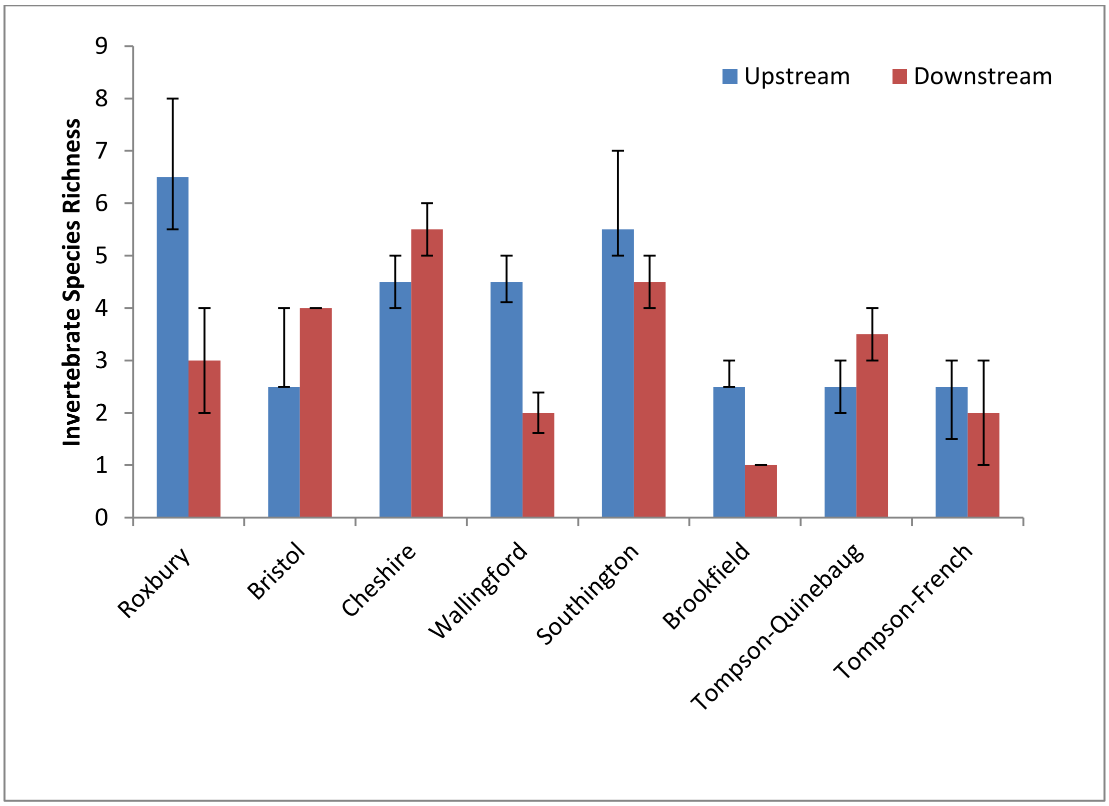
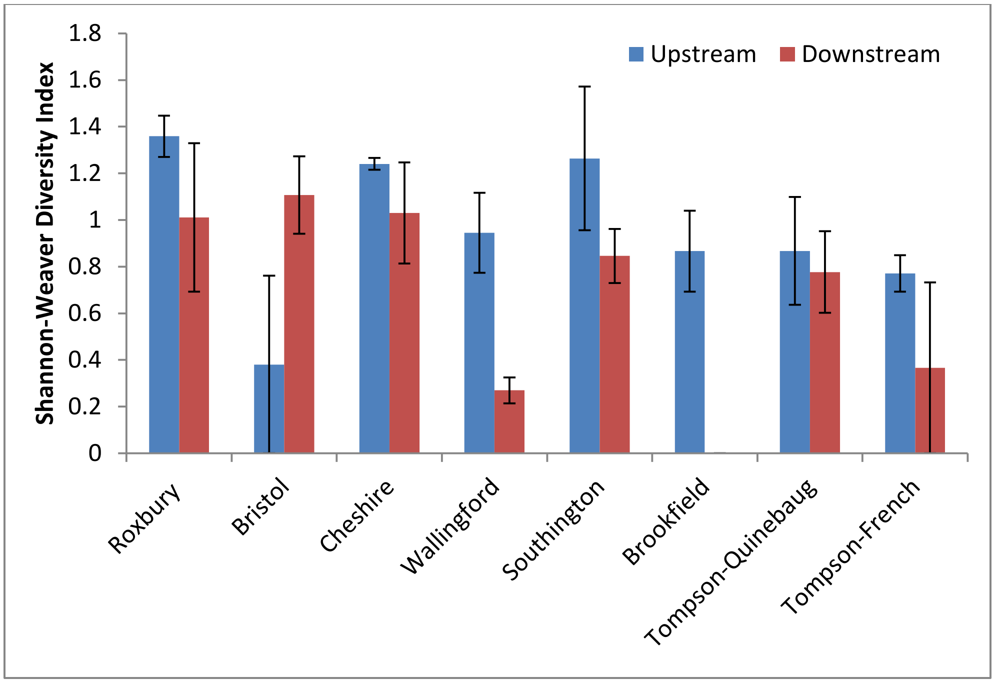
Woodstock
Middletown
Suffield-Stony
Suffield-Muddy
E Windsor-Scantic
E Windsor-Broad
Bristol-Coppermine
Bristol Pequabuck
UP
DW

II. Benthic macroinvertebrate comparisons

Three indices were measured: species richness- how many species at each site; Shannon-Weaver Diversity Index – a standard diversity measure; and evenness – how much abundance difference between species. ANOVA analysis showed upstream and downstream differed in diversity and evenness at wastewater sites and sites with unidentified problems but not at the sites with approved TDMLs. This suggests wastewater negatively affect benthic macroinvetebrates downstream of the discharging locations.

1. **Wastewater Site.**




Shannon-Weaver Diversity Index
Upstream
Downstream
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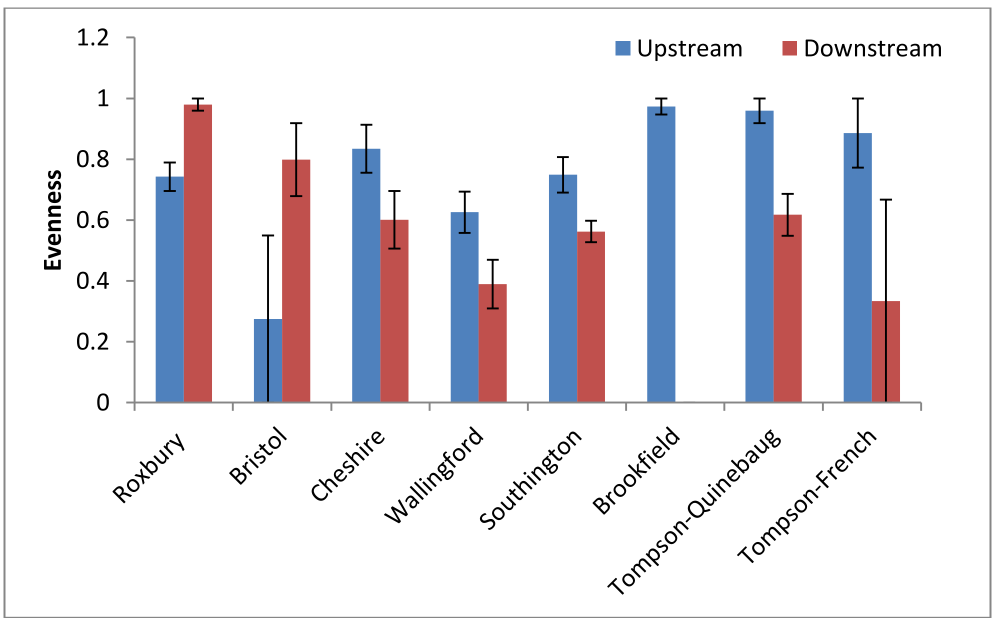
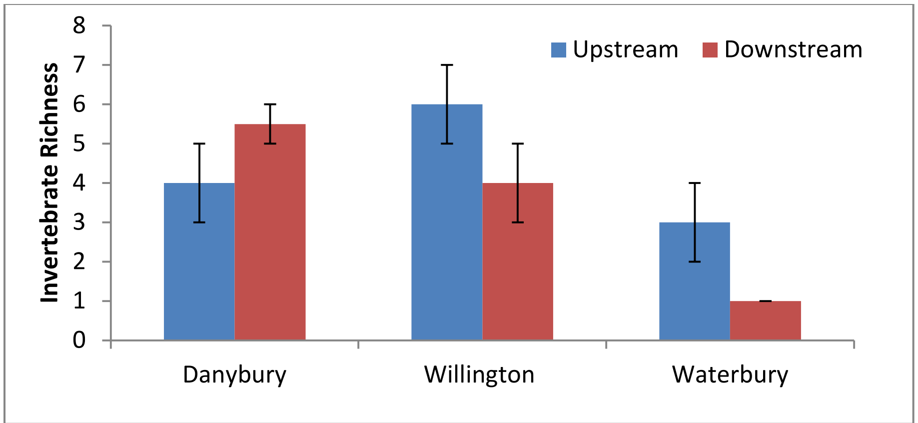
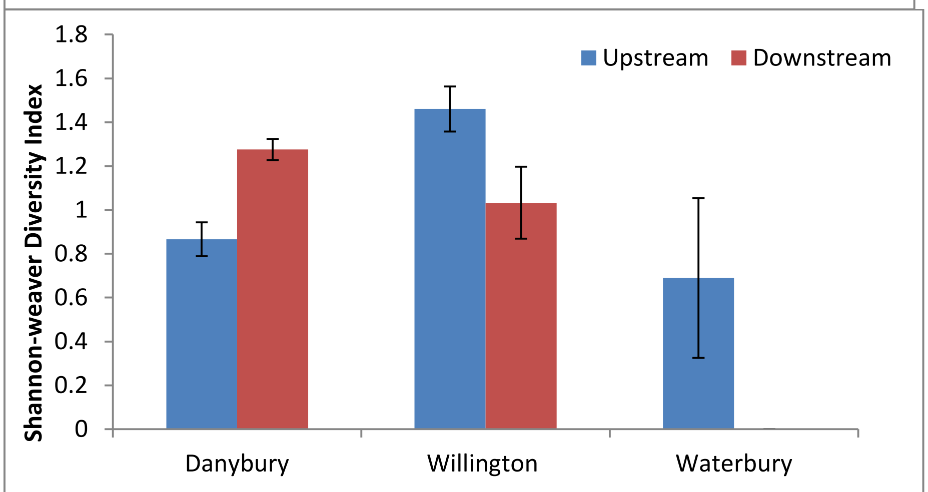
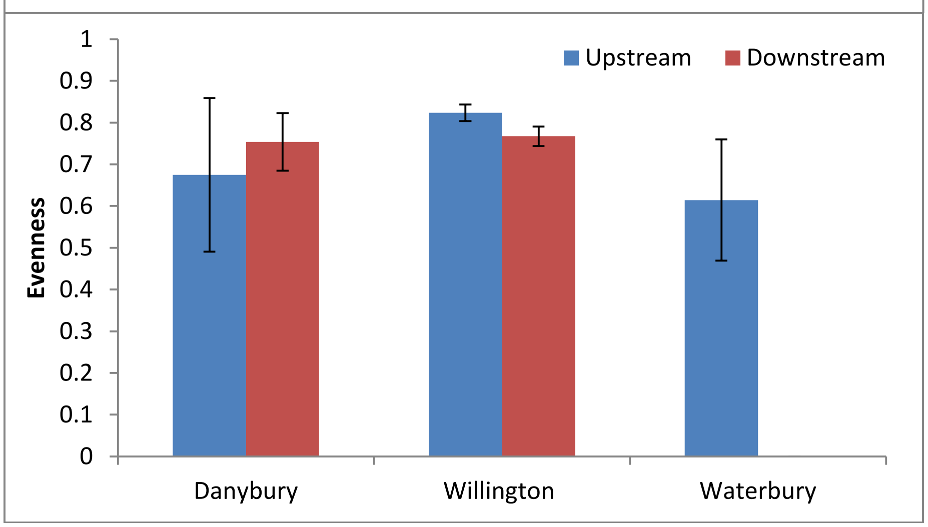
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Roxbury
Bristol
Cheshire
Wallingford
Southington
Brookfield
Tompson-Quinebaug
Tompson-French


Evenness
Upstream
Downstream
1.2
1
0.8
0.6
0.4
0.2
0
Roxbury
Bristol
Cheshire
Wallingford
Southington
Brookfield
Tompson-Quinebaug
Tompson-French

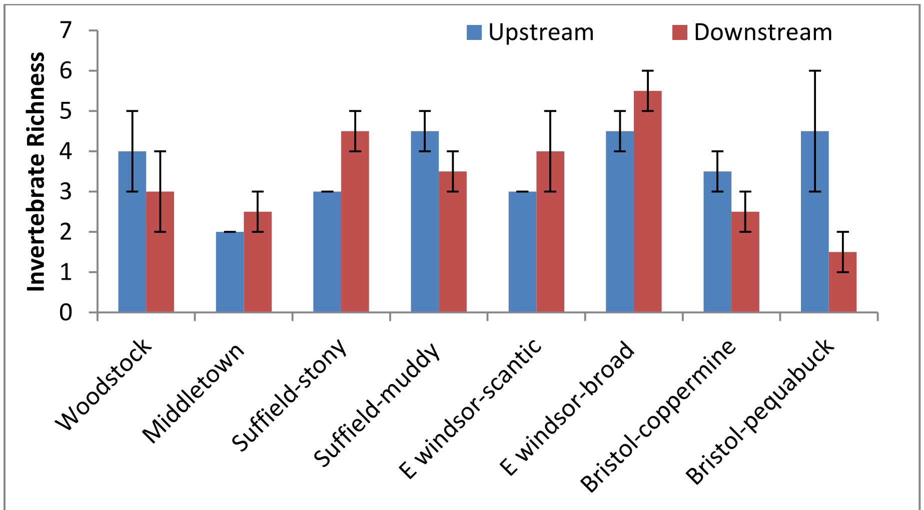
2. Sites with TDMLs

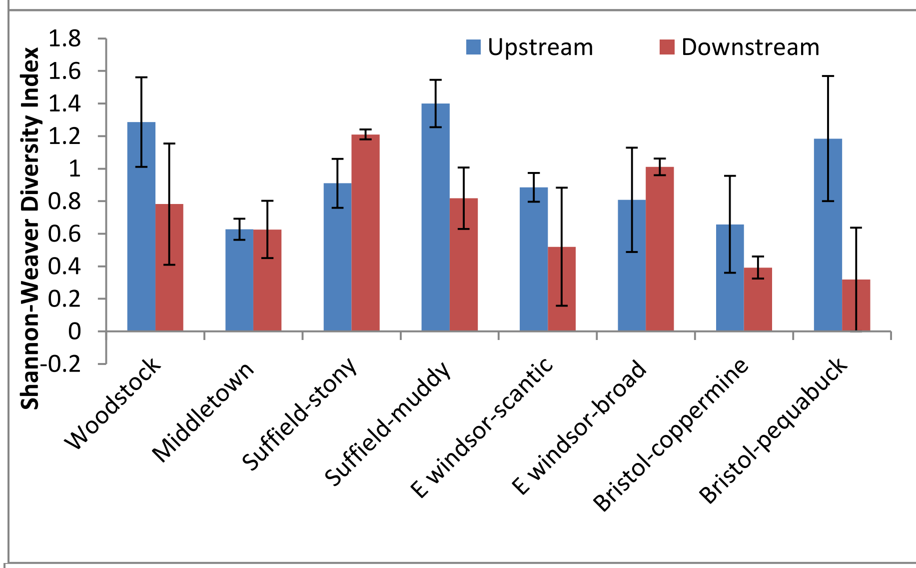


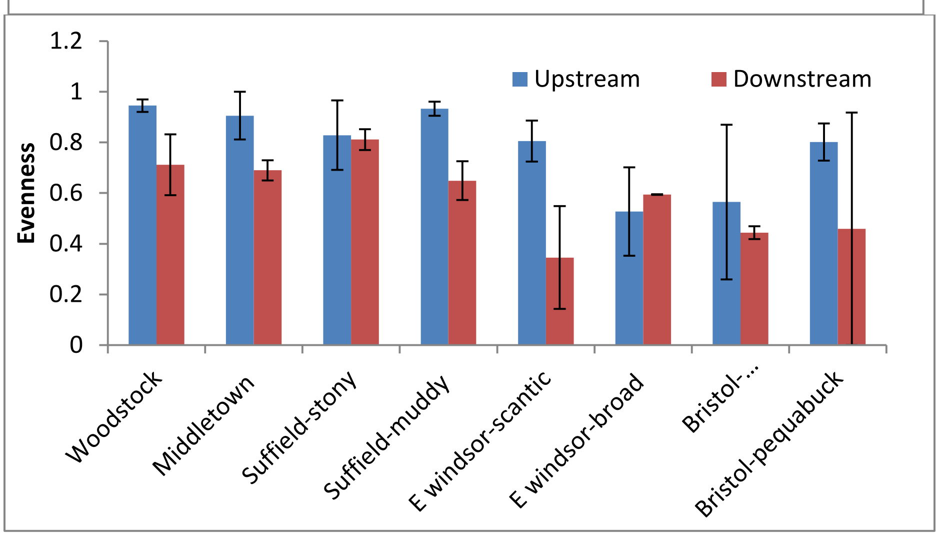




3. Sites with unidentified problems







Mitigating Eurasian watermilfoil invasion success and ecosystem impact using native herbivores

Basic Information

Title:	Mitigating Eurasian watermilfoil invasion success and ecosystem impact using native herbivores
Project Number:	2014CT286B
Start Date:	3/1/2014
End Date:	2/28/2016
Funding Source:	104B
Congressional District:	CT-4
Research Category:	Biological Sciences
Focus Category:	Invasive Species, Ecology, Water Quality
Descriptors:	None
Principal Investigators:	LaTina Steele, Michele Guidone

Publications

1. Steele LaTina, Michelle Guidone. 2015. Using Native Herbivores to Mitigate Eurasian Watermilfoil Invasion in New England. Benthic Ecology Meeting 2015. Quebec City, Canada. Oral Presentation.
2. *Ray, Courtney; Jessica Michaud; LaTina Steele; Michelle Guidone. 2015. The Use of Native Herbivores as a Mitigation Strategy for Eurasian Watermilfoil (Myriophyllum spicatum) in Connecticut Lakes. Connecticut Association of Wetland Scientists Annual Meeting. Southbury, CT. Poster Presentation.
3. Ray, Courtney; LaTina Steele; Michelle Guidone. [in preparation]. Use of Native Aquatic Herbivores as Biocontrol Agents for Eurasian Watermilfoil (Myriophyllum spicatum) in New England. Oecologia.

Proposal Title: *Mitigating Eurasian Watermilfoil Invasion Success and Ecosystem Impact Using Native Herbivores*

Final Report, FY 2014-2015
LaTina Steele, Sacred Heart University, 5151 Park Ave., Fairfield, CT 06825

Introduction & Research Objectives

Eurasian watermilfoil has invaded lakes across the state of Connecticut, often becoming dominant within these submerged aquatic vegetation communities. Factors contributing to milfoil's invasion success are poorly understood and are limited mainly to nutrient conditions and the broad assertion that invasion is less likely in lakes with an established submerged macrophyte community (Smith and Barko 1990, Madsen 1998). However, evidence suggests that allelopathic interactions between milfoil and epiphytic algae may contribute to milfoil's establishment (Gross et al. 1996). These allelopathic phenolic compounds produced by *M. spicatum* are also well-known feeding deterrents in terrestrial, aquatic, and marine plants (Constabel 1999). Thus, it seems reasonable that chemical interactions may reduce milfoil herbivory and play a role in its invasion success. Increased understanding of factors leading to successful milfoil invasions is critical for effective management and prevention of milfoil invasion, highlighting the importance of studies like the one proposed here. Managers, policy-makers, and those who use our state's lakes for recreational purposes will all benefit from this study.

Common techniques for eradicating nuisance milfoil involve costly and harmful chemical application and physical removal of milfoil. Such measures often need to be repeated in order to be effective and inherently affect other members of the lake community (e.g., Delong and Mundahl 1996). Furthermore, physical removal of milfoil could increase its spread to other areas, since it is propagated via fragmentation (Maezo et al. 2010). Mitigation of *M. spicatum* using native herbivores is a much more palatable alternative to many common eradication measures.

Many studies have investigated the potential of a North American weevil to mitigate Eurasian watermilfoil impacts (e.g., Sheldon and Creed 1995). However, few have considered additional herbivores native to particular regions or the impacts of community composition (i.e., the identity and abundance of herbivores, predators, and algal species) that can also influence invasion success. For example, herbivorous snails may either directly or indirectly affect milfoil populations, as some gastropods feed on *M. spicatum* (Boland et al. 2008), while others positively impact milfoil growth by limiting the growth of algal competitors (Chase and Knight 2006). Predator identity and abundance is also vital to our understanding of milfoil success. In lakes where predators are abundant, herbivore populations may be suppressed to levels that inhibit their control of milfoil growth (Ward and Newman 2006). This last point is particularly important for making informed mitigation choices, as there are a number of predatory fish species that are commonly stocked for recreational fishing.

Most studies proposing herbivory as a milfoil control measure have been conducted in the Midwest or the southeast United States. Few have been conducted in New England, and none of those have considered the use of multiple native herbivores to mitigate milfoil impacts. Nor have those studies considered the role of chemical deterrents in determining when and where milfoil will invade, despite evidence that *M. spicatum* produces many allelopathic chemicals

(Gross et al. 1996, Spencer and Ksander 1999), which commonly contribute to plant invasion success (Callaway and Ridenour 2004). Connecticut lakes are home to many potential herbivores, including crustaceans (amphipods and crayfish), insect larvae, gastropods, and herbivorous fishes. Previous studies in other regions suggest that crayfish (Parker and Hay 2005, Maezo et al. 2010) and insect larvae (Johnson et al. 1998) are milfoil consumers, with some insects leading to shifts in community structure from milfoil-dominated systems to dominance by *Elodea canadensis* (Gross et al. 2001).

The objectives of the project were to 1) investigate the role of chemical interactions between plants and herbivores in determining milfoil invasion success, 2) identify native consumers with the potential to successfully mitigate milfoil invasions, and 3) measure the effects of milfoil invasion on community structure by comparing community composition and diversity between Eurasian watermilfoil and native aquatic plants.

Methods & Progress

Field Sampling

During summer 2014, five throw trap samples were collected in milfoil-dominated areas of Osbourndale Pond in Derby, Connecticut and another five throw trap samples were collected from *Elodea*-dominated areas of the same pond. All animals within each trap sample were identified to the lowest possible taxon and enumerated. Primer-E software was used to conduct Analysis of Similarity (ANOSIM) on a Bray-Curtis similarity matrix constructed using abundance of all taxa per m^2 to determine if community composition differed in milfoil and *Elodea* dominated areas. Results were considered significant at $p<0.05$.

Upon identifying an appropriate reference pond without Eurasian watermilfoil (Colony Pond, Ansonia, CT), an additional five throw trap samples were collected from each of three areas: 1) milfoil-dominated areas of Osbourndale Pond, 2) *Elodea*-dominated areas of Osbourndale Pond, and 3) Colony Pond, where milfoil is not present. All plants within these traps were identified and the wet weight was recorded. Animals from these trap samples were preserved in 10% formalin for two weeks, then rinsed and stored in 70% isopropyl alcohol. Processing of these preserved samples is currently underway. Rose Bengal stain is being added to each sample prior to identifying and counting all animals within the sample.

Samples of Eurasian watermilfoil and three native aquatic plant species (*Elodea canadensis*, *Ceratophyllum demersum*, and *Potamogeton berchtoldii*) were collected during the summer in order to compare the chemical deterrent content of invasive milfoil and the native plant species. These samples were rinsed, placed in sample vials, flash frozen in liquid nitrogen, and stored at -80°C prior to freeze drying. Samples were ground to a fine powder in liquid nitrogen in their tubes and returned to the -80°C freezer until chemical analysis was performed.

Eurasian watermilfoil was sampled in the early morning hours (before sunrise) and in the late afternoon (just before sunset) to assess diurnal differences in chemical deterrent production; chemical analyses on these samples have not yet been conducted. The vacuum pump on the freeze dryer at Sacred Heart University is currently being replaced. When the pump has been replaced, samples will be dried, and chemical analyses will be performed.

Field Experiments

Diurnal differences in milfoil and *Elodea* consumption in the field were examined using tethering experiments. Five tether lines consisting of two feet of sisal rope with six pre-weighed milfoil fragments each and another five tether lines with six pre-weighed *Elodea* fragments each were deployed at approximately 08:00. Tethers were collected after 36 hours. The first 24 hours allowed time for animals to colonize the tethered fragments, and the following 12 hours allowed time for herbivores to feed on the plants during the day. These tethering methods were then repeated, deploying the tethers at approximately 19:00, with 24 hours to allow animals to colonize the tethered plants and another 12 hours to allow for additional feeding during the night. All plants were weighed a second time after tethers were collected from the field, and the change in weight (taking into account both consumption and growth) was calculated. Because the change in weight data were not normally distributed and did not meet the assumption of equal variance, a two-way ANOVA could not be used to determine if there were differences in consumption between the two plant species during the day and at night. Instead, two Mann-Whitney U tests were performed to determine if there were differences in consumption during the day and at night, with one test run on the milfoil data and a second test run on the *Elodea* data. Results were considered significant at $p<0.025$ to account for multiple tests.

Laboratory Experiments

A series of four separate laboratory experiments were conducted to quantify milfoil consumption by the following native herbivores: amphipods (*Hyalella azteca*), snails (*Physella* sp.), mayfly larvae (*Caenis* sp.), and milfoil weevils (*Euhrychiopsis lecontei*). Choice feeding experiments were used to test the palatability of invasive milfoil and native *E. canadensis* to *H. azteca*, *E. lecontei* and *Physella* sp. T-tests and Mann-Whitney U tests were used, as appropriate, to determine if there were differences between control treatments (milfoil only) and herbivore treatments (milfoil + one herbivore species). Paired t-tests were used to determine if amphipods, weevils, and snails consumed different quantities of milfoil and *Elodea* in choice feeding experiments, since the data from all choice experiments were normally distributed and had homogenous variances. Results were considered significant at $p<0.05$ in all cases.

Chemical Analyses

A simple colorimetric assay, the Folin-Denis assay (cf. Steele et al. 2005), was used to quantify total reactive phenolics in freeze-dried and ground samples of milfoil, *E. canadensis*, and two additional native plant species, *Potamogeton berchtoldii* and *Ceratophyllum demersum*. A one-way ANOVA was used to determine if there were differences in phenolic concentrations among plant species, since the phenolic data were normally distributed and variances among groups were equal. A post-hoc Tukey test was used to identify which plants had significantly different phenolic concentrations from each other. Results were considered significant at $p<0.05$.

Results and Discussion

Results from the throw trap sampling suggest that in Osbourndale Pond, invasive milfoil has not had a detrimental impact on the lake community (Figure 1). A similar suite of animals seems to take up shelter in both milfoil and the native *Elodea*, which are the two dominant aquatic plants in Osbourndale Pond. In areas such as this where milfoil has not caused a noticeable effect on the consumer community, costly and ecologically harmful removal methods for the invasive plant may not be necessary. Likewise, the particular herbivore community found at this site may be acting to prevent milfoil from overgrowing the area. Additional experiments will be performed during summer 2015 (Year 2 of the project) to help address this question. However, the information gained at this one site may still be useful in determining lake characteristics that, when absent, may lead to greater effects of milfoil invasion (e.g., lack of plant competitors, lack of amphipods and snails).

The field tethering experiment suggests that herbivores may be more active during the night than during the day, though the difference in biomass reduction at night compared to during the day was only significant in *Elodea* and not milfoil (Figure 2). Plant samples were collected to determine if chemical deterrent production in milfoil and *Elodea* changes during the night and during the day to match times of greatest herbivore activity. These samples have not yet been analyzed.

Data obtained from the feeding experiments suggest that locally abundant native herbivores like the amphipod *Hyalella azteca* and the snail *Physella* sp. may be effective in controlling milfoil biomass and in mitigating its effects (Figure 3). Data from feeding preference tests are consistent with those results, since they showed that amphipods will still consume milfoil, even in the presence of other, less chemically defended plant species (Figures 4 & 5). Likewise, snails also consumed milfoil in the presence of alternative plant prey, showing no preference for either milfoil or native *Elodea canadensis* (paired t-test, $t = 0.29$, $p = 0.78$, $n=10$).

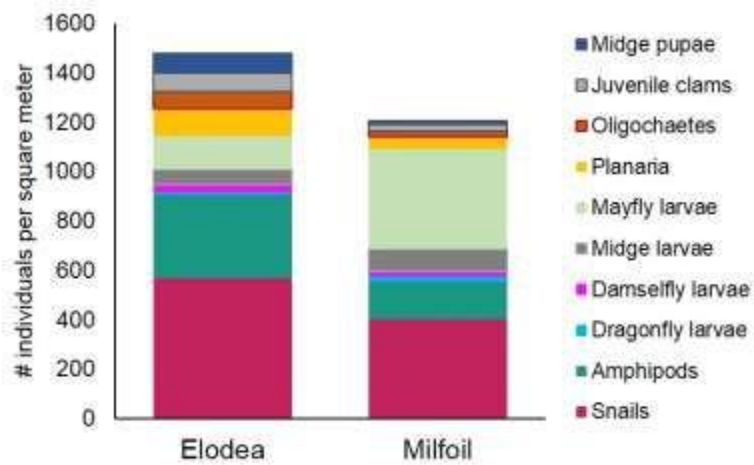


Figure 1. Most abundant taxa in throw trap samples (# individuals/m^2) collected in *Elodea*- and milfoil-dominated areas of Osbourndale Pond (Derby, CT). Analysis of similarity (ANOSIM) detected no significant differences in community composition between habitats (Global R = 0.036, p = 0.333).

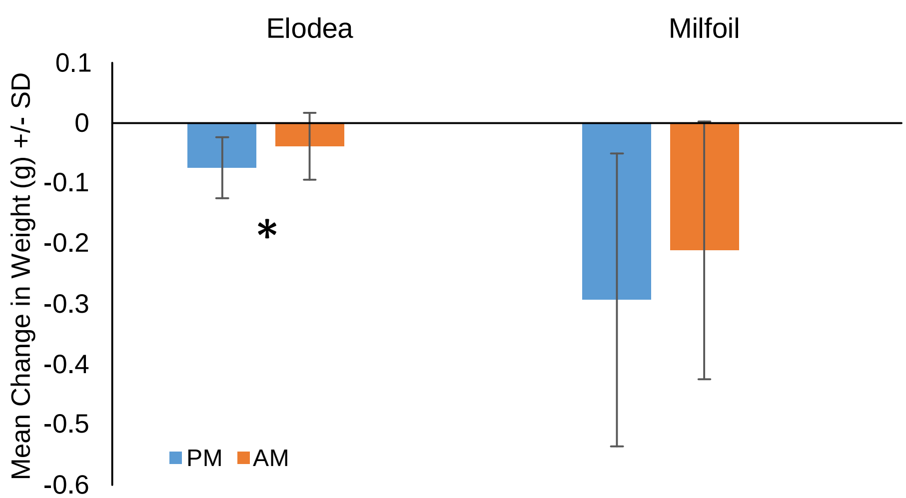


Figure 2. Mean change in weight of *Elodea canadensis* and Eurasian watermilfoil (*Myriophyllum spicatum*) after being deployed in the field in the morning (AM) or evening (PM) and remaining in the field for 36 hours. Mann-Whitney U tests indicated that significantly more *E. canadensis* was lost during the night than during the day (U = 159, p = 0.001), while there was not a significant difference in milfoil loss during the night and day (U = 315, p = 0.146). Asterisk indicates a significant difference in weight change between AM and PM.

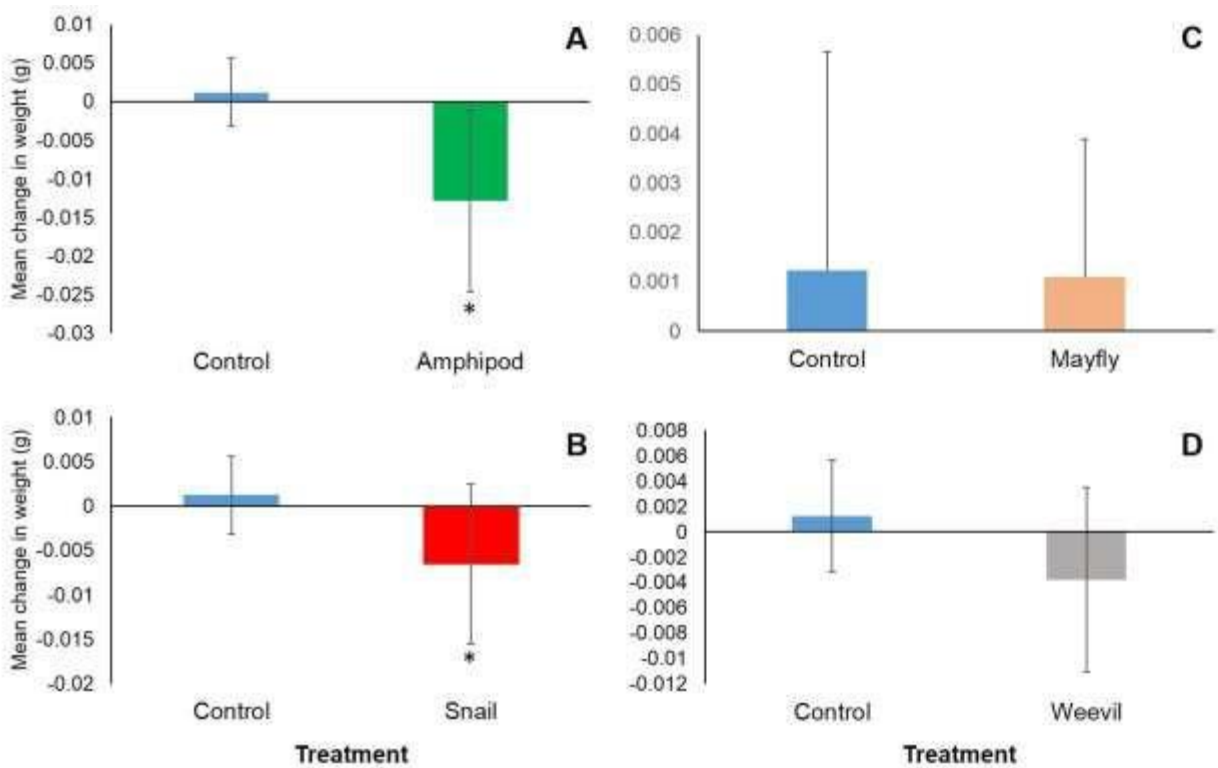


Figure 3. Change in *Myriophyllum spicatum* weight (g) after one week alone (controls) and following feeding by A) 10 individuals of the amphipod *Hyalella azteca* (Mann-Whitney test W = 61.0, df = 13, p = 0.0010, n = 10), B) 4 Physidae snail individuals (t-test t = 2.45, df = 13, p = 0.029, n = 10), C) 4 mayfly larvae (t-test t = 0.08, df = 15, p = 0.938, n = 10), and D) one milfoil weevil individual (t-test t = 1.72, df = 11, p = 0.114, n = 8). Each panel represents one experiment. Asterisk next to the error bar indicates a significant difference from the control.

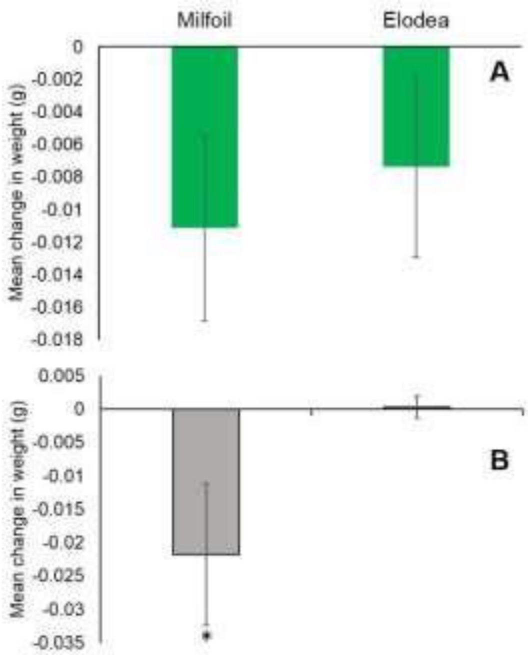


Figure 4. Mean change in weight of *Myriophyllum spicatum* and *Elodea canadensis* following one week of feeding by A) the amphipod *Hyalella azteca* (paired t-test t = -1.93, p = 0.086, n = 10) and B) the weevil *Euhyrchiopsis lecontei* (paired t-test t = -6.485, p < 0.001, n = 10) in choice experiments. Asterisk next to error bar indicates a significant difference between treatments.

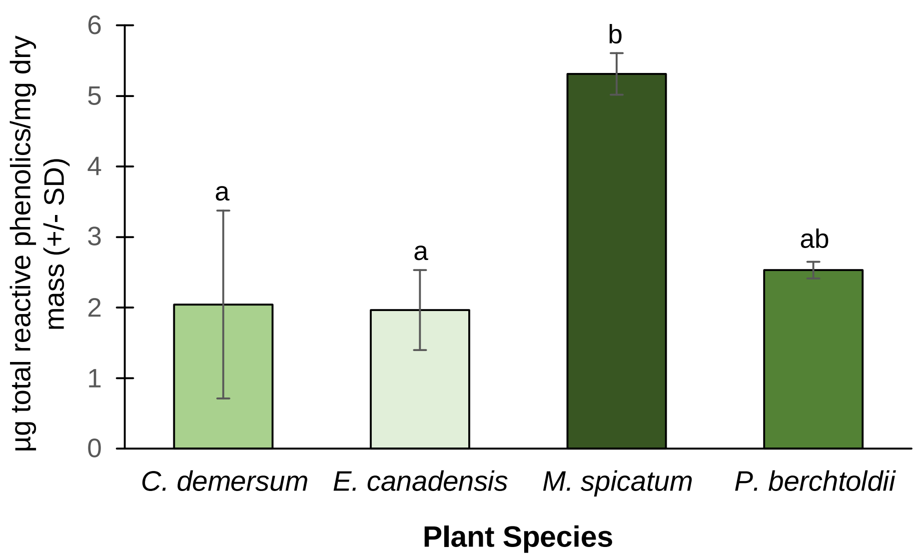


Figure 5. Total reactive phenolic content (µg phenolics/mg dry mass ± standard deviation) of four aquatic plant species: *Ceratophyllum demersum*, *Elodea canadensis*, *Myriophyllum spicatum*, and *Potamogeton berchtoldii*. Different letters over the error bars indicate significant differences among species (ANOVA $F_{1, 17} = 4.953$, $p = 0.012$).

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Interactions between catchment land cover, storm events, and nitrogen export from Connecticut streams

Basic Information

Title:	Interactions between catchment land cover, storm events, and nitrogen export from Connecticut streams
Project Number:	2014CT287B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	CT-002
Research Category:	Water Quality
Focus Category:	Non Point Pollution, Nutrients, Solute Transport
Descriptors:	None
Principal Investigators:	Ashley M Helton

Publications

There are no publications.

<u>Proposal Title</u>: "Interactions between catchment land cover, storm events, and nitrogen export from Connecticut streams"

Introduction/Research Objective

Humans have more than doubled the natural rate of nitrogen (N) fixation, dramatically increasing N loading to streams and rivers.[1] Streams and rivers transport N to coastal waters, where the environmental consequences of excess N loading, such as hypoxic "dead zones", are well documented.[2] Indeed, according to the EPA, excess nutrients (predominantly nitrogen and phosphorous) are number 3 on the list of the 100 leading causes of water quality impairment in the United States.[3]

Nitrogen loading to the Long Island Sound (LIS) has been identified as the primary cause of seasonal hypoxia.[4] The LIS is an estuary of the Atlantic Ocean, located between Connecticut to the north and Long Island, New York to the south. Its coastal areas are highly developed, and nearly 9 million people live within its 16,820 square mile watershed. In 2002 the Connecticut Department of Energy and Environmental Protection (DEEP) implemented a nitrogen trading program (Nitrogen Credit Exchange - NCE) among 79 sewage treatment plants located throughout the state. The NCE has substantially reduced N loads from point sources within Connecticut, and currently, the NCE is on track to reduce N loads by nearly 65% in 2014.[5]

Although the Connecticut NCE has substantially reduced N loading, the LIS still experiences hypoxia from excessive N loads, particularly via nonpoint catchment sources during storm flows. The NCE does not include nonpoint sources in its N trading program, but does allow for future consideration. However, including nonpoint sources from storm flows in N trading programs is problematic because predicting where and when N loading occurs from landscapes is difficult. Indeed, the Connecticut DEEP Nonpoint Source (NPS) Management Program's annual report states: "Identifying the causes of nonpoint source pollution and the relationship to human activities to the health of Long Island Sound is a priority area of concern for CT DEEP and the Long Island Sound Study estuary partnership."[6]

The Connecticut DEEP NPS Management Program works to abate and prevent water quality impairments from nonpoint source pollution using a mix of statewide programs and geographically targeted watershed projects to meet the required 10% reduction in nonpoint source N loads by 2015.[7] However, increases in surface water runoff and associated issues have already been experienced in our region and are not projected to improve.[8] Thus, current best management practices (BMPs) may alleviate some nonpoint source N loads from storm waters, but future increases in runoff intensity may require development of BMPs that better correspond with the locations and timing of large N fluxes from the landscape. Continued development of efficient BMPs for storm water treatment *<u>requires understanding how the distribution of N flux over the course of a storm event and the overall magnitude of N flux varies among storm events and different catchment land uses.</u>*

Thus, although non-point source N loading from Connecticut streams has been identified as an important contributor to environmental degradation in the LIS, and BMPs are currently implemented in many areas to treat storm water runoff, we understand little about how nonpoint source N loading varies within and among storm events and across catchment land use conditions. In this project we are asking: **How do storm magnitude, intensity, and**

frequency affect the magnitude and distribution of N export? And, how do those relationships change with land use conditions, specifically with urban development? To answer these questions, we are measuring detailed N dynamics across storm pulses for headwater streams to quantify how large scale N transport events vary 1) over time within and among storm events and 2) among catchments that range in their percent and distribution of developed land cover.

Methods/Procedures/Progress

Our overall approach is to collect high resolution measurements of N concentrations (total and dissolved N, nitrate, and ammonium) during storm flows and biweekly grab samples during the remainder of the study period. We are also measuring continuous stream discharge during the study period. Measurements are being collected across a wide range of storm events for five catchments that vary in their land covers (i.e., impervious covers).

Study sites and infrastructure: Our study sites, located in the Farmington River Watershed, include five headwater catchments that vary in their percent development, have similar watershed areas, and have no minimal wetland or agricultural land covers (Table 1). For each of the five sites, we installed flow meters to continuously record stream discharge and ISCO stations for automated water sample collection during storm events in July 2014. Equipment was removed in November 2014 to prevent freezing damage, and re-installed April 2015.

Table 1. Description of study site, including location, percent developed land cover in the watershed, and catchment area

ID	Site Name	Latitude	Longitude	% Developed	Area (sq. km)
1	Hop	41°51'44.10"N	72°48'31.29"W	40.29	3.5
2	Wins	41°55'30.96"N	73° 3'35.53"W	69.08	2.62
3	Tunx	42° 0'57.03"N	72°55'12.79"W	4.15	3.37
4	Bris	41°55'30.97"N	73°3'35.55"W	59.08	3.03
5	Tain	41°46'3.34"N	72°55'23.61"W	18.56	3.61

Stream sampling and analyses: From July to November 2014 and from April 2015 to present (and until November 2015) stream discharge has been continuously recorded at 15 min intervals, ISCOs have collected water samples during storms, and we have collected biweekly surface water samples for all five sites. We have samples for four storms thus far; and biweekly samples since June 2014. For each water sample we have/will measure all forms of N: nitrate, ammonium, total dissolved N, and total particulate N.

Data analysis: For each discrete storm event, we will quantify the total magnitude and the temporal distribution of N flux (for total N and each form of N - ammonium, nitrate, dissolved, particulate) at each of the five sites. We will calculate hydrologic metrics for each storm event, including magnitude (volume), intensity (rate), duration (length), and antecedent conditions (time since previous storm). For each site, we will also calculate the total water volume and N flux summed over the duration of the project.

Within each site, we will analyze the relationship between storm characteristics and N flux patterns. Among sites, we will analyze relationships between N fluxes (total and storm specific) and land use and catchment characteristics. We will also analyze our datasets using common approaches in the literature to evaluate the intensity of the first flux phenomenon in streams with cumulative load curves and event mean concentrations.[9] Cumulative load curves sum the pollutant load and discharge volume cumulatively for each sampling time interval over the course of a storm event, and normalize each time interval for the total pollutant load and discharge volume for the storm event. Event mean concentrations are the flow-weighted average pollutant concentrations for an individual storm defined as the total pollutant load divided by total runoff volume.

<u>Results/Significance</u>

This research addresses a critical scientific management need for expanding our understanding of N export to include storm events in Connecticut streams. Research suggests that the majority of N transport occurs during storm flows[10], and that land use is typically (but variably) related to N exports in streams and rivers[11]. Thus, to predict the magnitude and temporal patterns of N loading to sensitive coastal areas, we must be able to quantify the interactions between catchment land use conditions and N flux during storm events. The overarching question this proposal seeks to answer is: How does the *distribution* and overall *magnitude* of N flux vary among storm events and between land uses?

As part of this research, we will quantify 1) the temporal distribution of N flux (dissolved, particulate, nitrate, and ammonium) and 2) the magnitude of N flux (dissolved, particulate, nitrate, and ammonium) within discrete storm events, and then to compare the temporal distributions and magnitudes of N fluxes 1) across storm events that vary in their magnitude, seasonal timing, and antecedent conditions, and 2) across catchments that vary in their impervious cover intensity. These will provide three important results for understanding N flux during storm events:

1) Distribution of N flux within storm events: Our datasets will provide the distribution of N flux within a storm event and how that distribution changes among a wide range of storm events across land use types. Some research suggests that the majority of pollutant runoff happens within the first 50% of the runoff volume, called the “first flush” phenomenon.[9] However, the “first flush” may vary between watersheds, storm events, and even among different pollutants. Developing the most efficient BMPs for the state of Connecticut, particularly under increasing storm intensity, requires understanding the timing of N flux during storm events, and how that timing changes depending on seasonal and watershed factors.

2) Magnitude of N flux between storm events: Our analyses will also allow us to calculate the total magnitude of N flux during each storm event. These data will be particularly useful for understanding how N export varies seasonally and with antecedent moisture conditions. For example, storms occurring after long periods of drought may flush larger accumulations of N to streams. The seasonal timing of N flux in streams is similarly important for developing storm water treatment strategies as our region experiences seasonal climate shifts in storm dynamics.
3) N flux across catchment land use intensities: Across a range of land use intensities, we will quantify changes in 1) the distribution of N loads (i.e., "first flush" intensity), 2) the total magnitude of N flux during storms, and 3) the cumulative magnitude of N flux across the study period. Even with similar precipitation regimes, land use intensity and distribution has wide ranging impacts on the timing and magnitude of N export. These analyses will allow comparison of N flux dynamics across typical land use conditions in Connecticut.

To date, we have selected sites, installed infrastructure, and begun sampling and water chemistry analysis. We will continue to collect and analyze samples through November 2015, and then will complete our data analysis (described above). As part of this project, we also developed a project for the Natural Resources Conservation Academy (NRCA; http://www.nrca.uconn.edu), a field program that trains Connecticut high school students in natural resource and land use management, during summer 2014. The project explored the connections between the urban University of Connecticut campus and the receiving stream, Eagleville Brook, the country's first total maximum daily load for impervious cover.

References

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Information Transfer Program Introduction

The general purpose of the Connecticut Institute of Water Resources information technology projects are to support a number of ongoing efforts, such as a seminar series, conferences, educational information and web site development and maintenance, as well as special projects and publications implemented as the need arises. All of these activities are funded through the Institute's 104B project, "Information Transfer Program."

CT IWR Technology Transfer

Basic Information

Title:	CT IWR Technology Transfer
Project Number:	2014CT288B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	2nd
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	None
Principal Investigators:	Glenn Warner, James D Hurd

Publications

There are no publications.

Web Site: Our Institute maintains the CTIWR web site, which we update as needed. It includes information about the WRI program, our Institute and its Advisory Board members, a listing of the current year's seminars, a list of sponsored projects and publications, and access to electronic copies of our "Special Reports" series. We also use the web to announce special events and our RFP in addition to secure access to grant proposals and information for the Advisory Board's review. We continue to cooperate with the University of Connecticut's digital archives department, which maintains our electronic reports as a part of its "Digital Commons @ University of Connecticut" project. This past year we have worked on making available through the Publications area of the CTIWR website the results of previously funded research projects in digital format. This work is continuing. Additional work will continue on website design and upgrades throughout the coming year.

Digital Media Applications. We have started to identify potential topics to include as components to the CTIWR website as digital media applications to serve primarily as educational products. The first topic we are focusing on is the basic hydrologic cycle as it pertains to the Connecticut landscape. We are considering Adobe Flash software to produce animations, but are also considering other software and media possibilities.

Conferences. The Institute co-sponsored the annual Connecticut Conference on Natural Resources (CCNR) held each March during spring break recess at the University of Connecticut. CTIWR contributes $500 to support the conference.

Service and Liaison Work. Currently**,** the Director actively serves on the following water related panels, committees or workgroups:

- Participant, Connecticut Water Planning Advisory Group.
- Participant, Connecticut Water Planning Advisory Group, Other State's Planning Workgroup
- Participant, Connecticut Water Planning Advisory Group, Drought Plan Workgroup

Training Potential. We had anticipating hiring an undergraduate student to work on a summer research project of their choosing, however, we were not successful in identifying a student to conduct a project. We are anticipating the hiring of a student during the next project period.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	8	0	0	0	8
Masters	2	0	0	0	2
Ph.D.	0	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	10	0	0	0	10

Notable Awards and Achievements

The Laws and By-Laws of the University of Connecticut (Article XIII) require that “All centers and institutes will be reviewed on a five-year cycle to determine their continued contribution to the University’s mission.” During the Fall of 2013, the Connecticut Institute of Water Resources was required to submit a 5-year report to the University’s Office of the Provost for review. Below is the email sent by Dr. Mun Y. Choi, Provost & Executive VP for Academic Affairs at The University of Connecticut, announcing our successful completion and renewal of the Connecticut Institute of Water Resources for an additional five year period beginning September 2014.

Dear Dr. Warner,

The Connecticut Institute of Water Resources (CT IWR) was reviewed during the 2013 fall semester by the Academic Center/Institute Review Committee, chaired by Dr. Marysol Asencio. The report of the Review Committee is attached.

I am pleased to add my endorsement to that of the Review Committee and hereby notify you that the Connecticut Institute of Water Resources will be renewed for a five-year period beginning September 2014. Over the next five years, the Review Committee and I recommend that CT IWR explicitly address the following items during the next review cycle: 1. How the Institute's research catalyzes additional grant activities. 2. Increase the level of scholarly output. 3. Increase participation from UConn faculty and colleagues from other Connecticut colleges and universities. Please accept my thanks and sincere congratulations on the many accomplishments of the Institute. CT IWR is a valuable resource to Connecticut, and the Institute makes valuable contributions to UConn and its community. The Board of Trustees will be informed of this recommendation at a forthcoming meeting.

Best, Mun

Mun Y. Choi, Ph.D. Provost & Executive VP for Academic Affairs (provost.uconn.edu/) University of Connecticut 352 Mansfield Road 1st Floor Gulley Hall Storrs, CT 06269 (860)486-4037