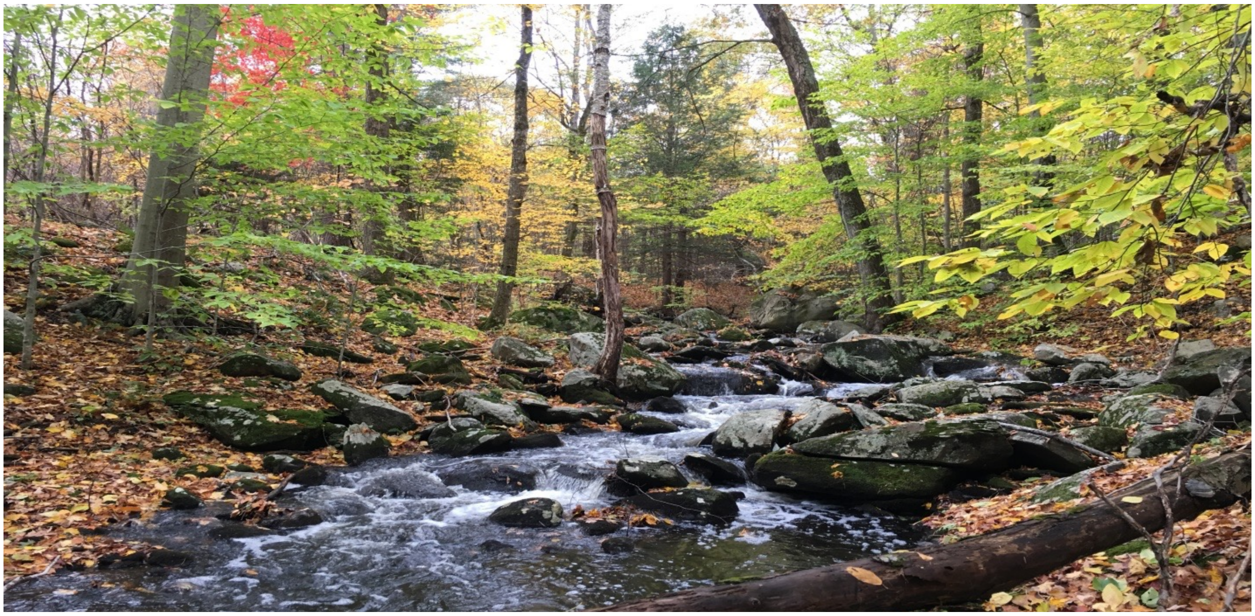

Studying the Streams of the Greater Northfield Watersheds

Research, Intern Training and Public Engagement

Investigators:

Dr. Justin Richardson
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Greater Northfield Watershed Association

Dr. William Copeland
Greater Northfield Watershed Association
Mount Grace Land Conservation Trust

Goal:

To investigate comparative ecosystem health and nutrient release profiles for Wait Brooks (both East and West Wait Brooks) and Mill Brook in Northfield MA. To accomplish this goal, we will conduct a spatial survey of stream water, sediments, and riparian flora and fauna. Relevant historical and ongoing human disturbance background will be developed with project partners.

Why study the Wait Brooks and Mill Brook?

The East and West Wait Brooks offer an excellent opportunity to examine a headwaters with minimal urbanization and known tracts of forestry. Furthermore, they offer a shallow surficial geology of glacial till with some river deposited materials and limited historical pollution above Bennett Brook. The Mill Brook, as its name implies, has served as a water source for Mills and is very different from the Wait Brooks. The Mill Brook has historical disturbance from industrial activities which may include pollution inputs prior to environmental regulation (particularly the Clean Air and Clean Water acts of 1970). The Mill Brook also drains different geologic materials, with extensive river deposited sediments lower in its run, especially close to the Connecticut River. Lastly, the greater urbanization within the Mill Brook watershed can be a source of excess nutrients (from septic systems and fertilizer runoff from homes, farms and gardens), toxic metals (from car emissions and industrial activities, past and present) and increased light and water temperatures (sun exposure). These two contrasting watersheds offer an opportunity to see how natural systems function and how they may be impacted by human influences.

Questions:

1) What nutrients, toxic metals, or organic contaminants are present in the stream water and sediments of the Wait Brooks and Mill Brook and at what levels? How do these levels compare with the expectation for such streams? How can this information be used to ensure that these water resources are adequately protected?

2) Is there a seasonality to the mobility of toxic metals or excess nutrients?

3) How are biological features of the riparian zone - flora and fauna - associated with stream history and biogeochemistry.

Brief Description of the Internship

This internship is a field-based inquiry into the environmental chemistry and ecosystem features of streams and will make use of the laboratory capabilities of the Geosciences Department at UMass Amherst to process samples. To capture the time variation in metals, organic contaminants, and nutrients in river water, samples will be taken from several sites along the brooks chosen for study biweekly. In the spring, Dr. Justin Richardson, Dr. William Copeland, and the research interns will also collect sediment samples and take note of native and exotic plants along the stream reaches.

Responsibilities of the Interns

Members of the intern team are expected to communicate with other team members and the field site supervisors to schedule orientation sessions, field work schedule, use of equipment, data sharing and transportation as needed. The research interns may choose to conduct field measurements with portable equipment if desired but will also need to travel to UMass Amherst to help conduct sample analyses (Optical Emission Spectrometry and Mass Spectrometry). Everyone who uses field equipment must demonstrate proficiency before taking it into the field.

Skill sets to be developed by the intern

- Collection of water samples using United States Geological Survey (USGS) techniques.
- Basic stream morphology and stream bed sampling techniques
- Basic riparian ecology observation and identification of common riparian trees, shrubs, herbs and aquatic fauna
- Use of field kit to determine basic water parameters (pH [acidity], Electrical Conductivity, Dissolved oxygen).
- Basic analysis, articulation and presentation of the findings from the stream survey in graphic, written and verbal form to a public audience.

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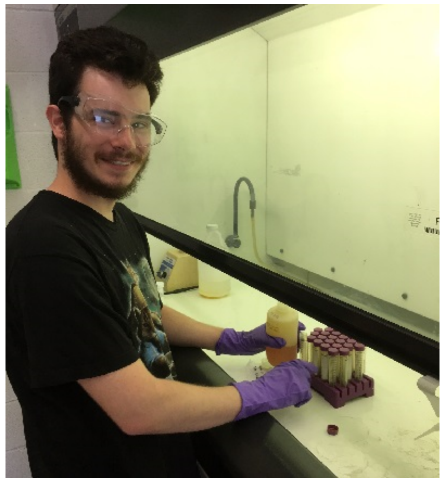
UMass Amherst PhD student LeAnn Zuñiga sampling a river

Field Activities

1. Collection of water samples from late winter to early summer, twice a month.
    - Reasoning: To determine changes in water parameters during the spring flushing event, which is a critical time for pollutant and nutrient release and rapid changes in water quality and temperature. Fluctuations in these and other parameters - pH, dissolved oxygen and suspended particles - have important ecosystem effects.
2. Collection of stream bed sediments in eddy pools, once during the project.
    - Reasoning: Pollutants, both metals and organic contaminants, can have low solubility but adhere to mineral surfaces. Pools in streams collect and deposit both coarse and fine particles (which have the highest surface area for pollutants to adhere). Although sediments are temporarily buried in eddy pools, they can be mobilized during high flow events.
3. Field survey of riparian biota
    - Reasoning: An examination of riparian plants and animals will assist in correlating site historical influences to ecosystem and water quality data sets.

Laboratory Analyses



Left – GCC alum and UMass Amherst alum Brendan Braithwaite digesting soil samples for toxic metals.

1. Dissolved and solid phase nutrients

    a. Calcium, potassium, sodium, magnesium - Alkali and Alkaline earth metals. Essential for life but overabundance causes precipitation reactions and may lead to toxicity if very elevated. Highly soluble in natural waters.

    b. Phosphorus – an important element for all organisms but can cause algal blooms and eutrophication in high abundance. Moderately soluble in natural waters.

    c. Manganese – an essential element, but can negatively impact cell signaling and plant growth at high levels. Moderately soluble in natural waters, redox sensitive.

2. Toxic metals

    a. Lead – widely dispersed heavy metal from leaded gasoline, vehicles, industrial emissions. Toxic to plants, microbes. Highly insoluble in most natural waters.

    b. Mercury – widely dispersed metal from atmospheric deposition of fuel combustion and trash incineration, some pesticides. Was dumped into rivers by paper and textile mills. Typically low concentrations but can be toxic to fish and fish-eating organisms. Highly insoluble in most surface waters.

    c. Arsenic – Used in industrial processing (e.g. tanneries), was used as a pesticide. Some localized geologic formations. Highly mobile in natural waters.

3. Persistent Organic Pollutants

    a. Polychlorinated Biphenyls (PCBs) and dioxins are a family of bioaccumulating compounds produced by industry, trash incineration and leakage from landfills. Many are known to cause cancer, developmental malformations and endocrine disruption. PCBs are found at high levels in sediments and fish of the Housatonic river downstream of the GE plant but are also found in the Millers River below a landfill in Baldwinville, MA.

    b. Trichloroethane (TCE) is an industrial solvent produced in large quantities for use as a degreaser, in dry cleaning and some food processing. Because of its volatility it is primarily known as a deep groundwater contaminant (e.g., Joint Base Cape Cod). It is a neurotoxin and probable carcinogen in humans but little is known about ecologic impacts.

    c. Furans, another persistent organic chemical family that may be produced by combustion or trash and other materials

    d. 6-ppd quinone, a recently identified compound that arises from auto tire degradation. It is highly toxic to salmon and probably other

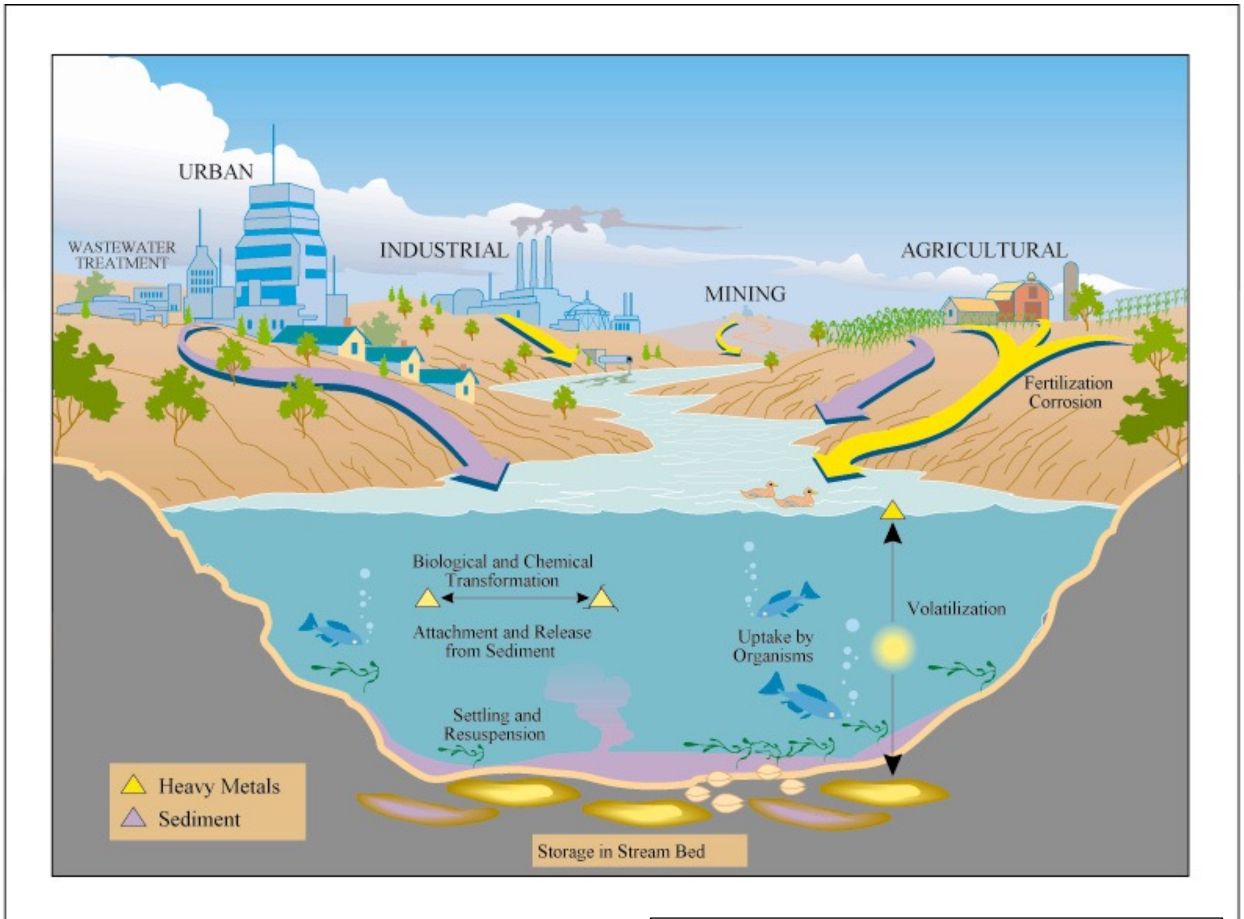


Diagram by United States Geological

Plant communities of interest:

Examples of wooded riparian zones:

- Maples – Silver and Red
- Alders, Poplars, Willows, Cottonwood
- Swamp White Oak, Black Gum

Examples of grass and marsh dominated riparian zones:

- Sedges– Carex species
- Cattails – Typha
- Goldenrod – Solidago species

Invasive plants likely to be found in riparian zones:

- Japanese knotweed (Reynoutria japonica)
- Phragmities (Phragmites australis)
- Tree of Heaven (Ailanthus altissima)
- Oriental Bittersweet (Celastrus orbiculatus)
- Japanese Barberry (Berberis thunbergii)

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Intern recruitment from area colleges has started. As this project gets underway, we will be posting about it here: field work with photos as it happens beginning in March, followed by lab results and the stories they tell. We are hoping for in-person community engagement events over the summer.