FERN NEWS

AN INITIATIVE OF THE HEALTHY HEADWATERS LAB

ANNUAL NEWSLETTER OF THE FARM AND FRESHWATER ECOLOGY RESEARCH NETWORK

November 2021

Written by Emily Browne & Lauren Weller
Photographs by Shayenna Nolan

RESEARCH OVERVIEW

Over the last year, our Healthy Headwaters Lab researchers have been working on farms across Essex County to better understand the impacts of farming practices across the soil and freshwater interface. Our team has been collaborating with local farmers and partners to establish baseline datasets in farm and freshwater ecology research in the Essex region. Our main focus has been to understand how stream and soil environments are connected, and how these systems are impacted by urban and agricultural land uses.

2020 BY THE NUMBERS

WE COLLECTED:
480 SOIL SAMPLES
42 TILE SAMPLES
201 DRAIN SAMPLES
63 WETLAND SAMPLES

WE ANALYZED:
560 EEMS
288 COTTON STRIPS
48 MICROBIOMES

MEET THE TEAM

FERN RESEARCHERS WORKING ACROSS THE LAND-WATER INTERFACE IN WINDSOR-ESSEX

Catherine Febria

Director of the Healthy Headwaters Lab

Lauren Weller

MSc Student and FERN Program Coordinator

Jess Ives

Research Facilitator

Shayenna Nolan

USRA Student, Director of Communications

Emily Browne

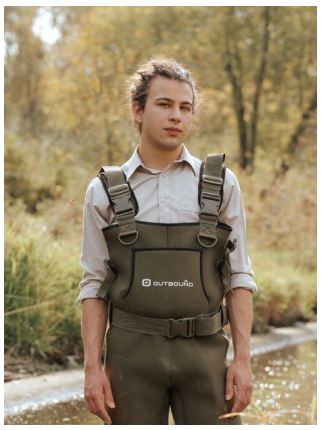
Undergraduate Thesis Student and Research Assistant

Ryan Graham

MSc Student

Alyssa Frazao

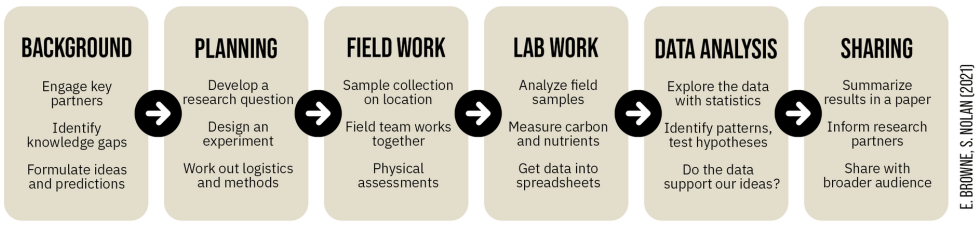
Field Technician

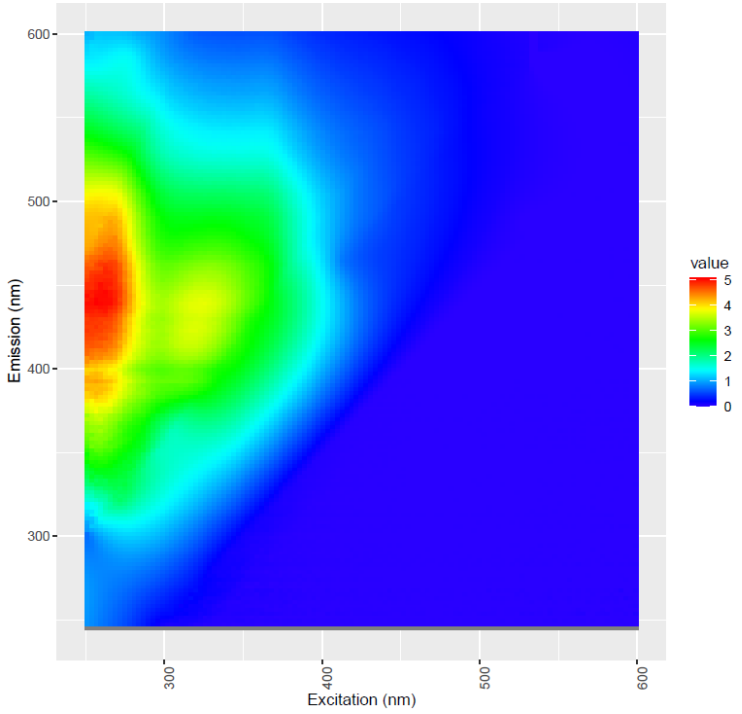


Dante Bresolin

Undergraduate Thesis Student

THE SCIENTIFIC PROCESS



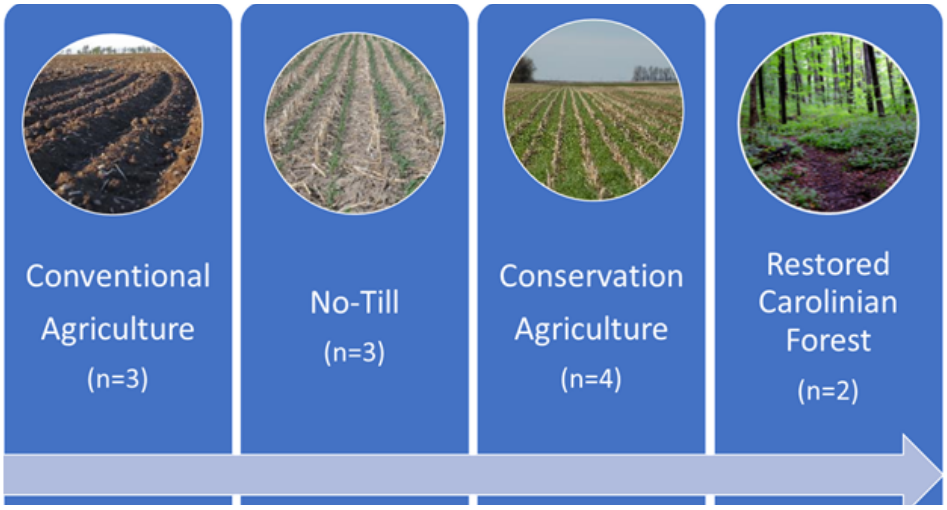


UNDERSTANDING CARBON COMPLEXITY

Dissolved organic matter (DOM) acts as a bridge between the terrestrial and aquatic environments and is fundamental to many biogeochemical processes in both environments. DOM is hundreds of uncharacterized carbon compounds undergoing decomposition and exists on a continuum of complexities. We can study and understand DOM's underlying complexity by examining the fluorescent properties of DOM. This image displays an EEM of an Essex County forested topsoil.
(see page 5 for more on this)

Our wetland study aimed to investigate how the DOM in soil varied spatially and with depth in the wetland soils, and compared that to the water. The preliminary findings show that wetland soils had greater concentrations of DOM compared to the agricultural soils and that the water in the wetlands is affected by surrounding agricultural practices. The topsoil of wetlands is a hotspot for DOM and it decreases with depth. Variation in the DOM between wetlands may reveal that not all wetlands are equal and could inform restoration efforts.

Studying urban and agricultural streams in Essex County consisted of an integrative ecosystem approach that assessed the organic matter in stream ecosystems through DOM present and the processing of organic matter through microbes and macroinvertabrates. Monthly assessments revealed that urban and agricultural streams have similar functions and the ecosystem degradation is similar for both environments. Our preliminary findings suggest the main differences in these two impacted stream ecosystems are the mechanisms driving the processes. The urban streams have more algal-derived carbon, where the agricultural streams have more humic or terrestrial-derived carbon. There were also slight differences in the microbial communities present in the agricultural and urban streams.



ENVIRONMENTAL GRADIENT OF AGRICULTURAL MANAGEMENT PRACTICES

Our team often conducts studies that occur along a gradient. This means there is a range of situations that exist with the two extremes on each end, called end members, and intermediates between. In the agricultural management practices study the conventional tillage and forest sites are the two end members, with no-till and conservation till occurring between these. This gradient is defined by disturbance to the soil, with conventional tillage where the soil is broken up each year on one end, and a Carolinian forest site where the soil is untouched and natural growth occurs at the other end.

As we move forward, we continue to expand our knowledge on Agricultural and Freshwater ecosystems. Our current and upcoming projects for 2021 include studying the biodiversity health of riparian ecosystems impacted by agriculture, improving our understanding of agricultural practices on soil condition, and unpacking how seasonality impacts urban and agricultural streams.
Join us at our Spring FERN Symposium where team members and partners will present more details about their work (event details TBD).

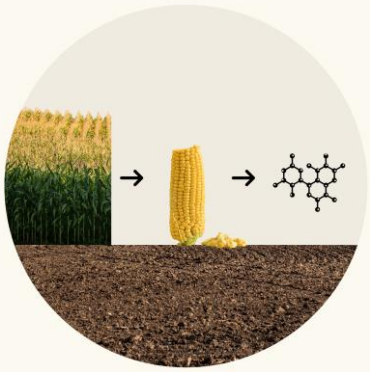
To study agricultural soils, we are comparing farm fields across a gradient of management practices in Essex County from conventional tillage to Carolinian forests. The agricultural fields were all tile drained, offering us a unique opportunity to study how soil management affects freshwater systems as both the soil and tiles can be surveyed individually to understand DOM and nutrient dynamics associated with specific field scale management practices. Preliminary results showed no significant difference in the soil DOM among the different management practices, but the water leaving the fields was more humic than the soils in the field. There were 3 DOM components which all decreased with depth in the soil profile. This study suggests that carbon complexity may offer a more mechanistic understanding of systems which could help to understand and manage nutrient dynamics and inform restoration efforts in Essex County.

What is DOM and how can light help us understand it?

A guide to understanding EEMS

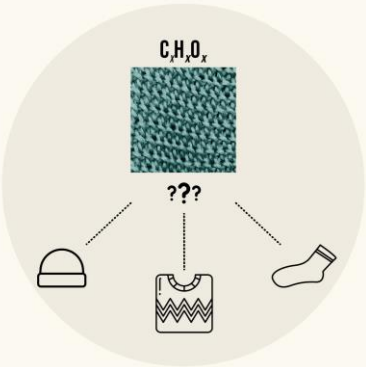
Written by L.A. Weller
Illustrated by S. Nolan
2021

1. Dissolved Organic Matter (DOM) acts as a bridge between terrestrial and aquatic environments, and is fundamental to many biogeochemical processes in both environments.

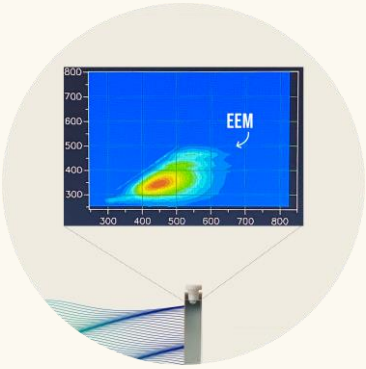


2. What we refer to as DOM is in fact hundreds of mostly uncharacterized compounds varying in size and complexity. Recently we have come to understand these compounds as known substances undergoing decomposition.

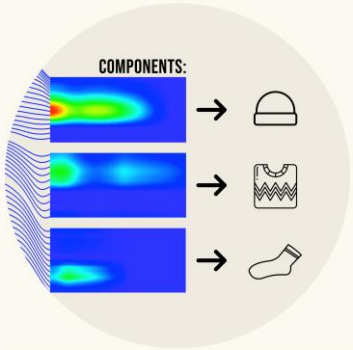
3. Picture a pile of knitted items each at different stages of being unraveled. Some may have originally been sweaters but now only have the arms or maybe just the body left.



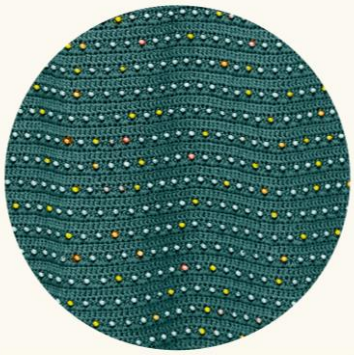
4. Chemical analysis can show us the 'wool blend' or in this case the chemical composition but establishing what item of clothing is being unravelled can be challenging.



5. Fortunately, DOM has fluorescent properties that allow us to study and understand its underlying complexity. Light at certain wavelengths is passed through a liquid sample to create an Excitation Emission Matrix (or EEM for short).



6. EEMs can be analyzed identify to specific components present in the DOM. By comparing the components present in the DOM to those found in other studies using an open database, we can begin identifying our unraveling knit items and sorting them into piles.



7. Furthering the knit metaphor, imagine that carbon itself is the yarn, and any buttons or baubles are the nitrogen, phosphorus, and other minerals.

8. Historically, we have focused more on these than the sweater itself but carbon, which plays a major role in binding and modulating nutrients, may in fact be an overlooked key to managing nutrient dynamics in both freshwater and agricultural systems.

Weller, L., Nolan, S., and Febria, C. 2021. What is DOM and how can light help us understand it. A guide to understanding EEMS.
DOI: 10.6084/m9.figshare.16919992

Thank you

Thank you to all of our partners! The Healthy Headwaters Lab strives to understand and improve freshwater ecosystems and involve community and decision-makers to help drive impactful science. It was a challenging year for everyone and research was no exception. Thank you for your perseverance, we couldn't have achieved our goals without your help and we look forward to working with you and are so grateful to have you as part of your team!

NATURE CONSERVANCY CANADA

THE CITY OF WINDSOR ONTARIO, CANADA

Essex Region Conservation Authority
sustaining the place for life

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