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# Effects of dissolved organic carbon on methylmercury bioavailability in stream ecosystems

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## Basic Information

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| **Title:** | Effects of dissolved organic carbon on methylmercury bioavailability in stream ecosystems |
| **Project Number:** | 2016NH205G |
| **USGS Grant Number:** | |
| **Start Date:** | 9/1/2016 |
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| **Funding Source:** | 104G |
| **Congressional District:** | 2nd Congressional district of New Hampshire |
| **Research Category:** | Water Quality |
| **Focus Categories:** | Surface Water, Geochemical Processes, Toxic Substances |
| **Descriptors:** | None |
| **Principal Investigators:** | Kathryn L Cottingham, Celia Y. Chen, James Shanley |

## Publications

There are no publications.

**Effects of dissolved organic carbon on methylmercury bioavailability in stream ecosystems (2016NH205G)**

**Problem:** Neurotoxic methylmercury bioaccumulates through aquatic food webs and is a primary cause for fish consumption advisories in the Northeast. The mobilization, transport and bioavailability of mercury in aquatic ecosystems is strongly tied to organic matter dissolved in the water, yet levels of methylmercury in fish are difficult to predict. Previous studies have noted that relationships between stream methylmercury and dissolved organic carbon (DOC) in streams change over time. There is also a seemingly contradictory effect of DOC on uptake by the biota: at low concentrations of organic carbon, methylmercury bioaccumulation increases, whereas at higher concentrations, uptake into fish is attenuated. This project is testing the hypothesis that differences in the chemical structure of the DOC that is transporting MeHg in streams lead to the temporal changes and non-linearity in bioaccumulation noted in previous studies.

**Objectives:**

1) Identify and characterize fractions of DOC that associate with MeHg and Hg in streams,
2) Determine the effects of DOC quality and quantity on MeHg uptake by primary producers at the base of the stream food web.

**Methods:**

DOC isolation: Dissolved organic carbon was isolated from two streams with contrasting watershed landscape features (wetland/no wetland) in September 2016, using methods described in Dittmar (2009). Briefly, large (40 L) samples were filtered through 0.45 µm cartridge filters, then acidified to pH 2 with HCl and passed through a reverse phase cartridge at a rate of 4 ml/min. Cartridges were rinsed with dilute HCl, then eluted in 10 mL MeOH. The extracts were dried first under nitrogen, then freeze dried. These samples are being characterized and used for MeHg uptake experiments with periphyton biofilms at the base of the foodweb, to understand the effects of DOC from different sources on MeHg bioavailability.

Biofilm growth: Racetrack-style artificial streams were assembled in 25 gallon troughs using aquarium pumps for circulation, with ceramic tiles placed along the bottom. Streams were housed in an environmental chamber (25ºC, 16:8 L:D), inoculated with biofilm scraped from rocks collected from several tributaries, and maintained by periodic addition of nutrients (diluted COMBO medium).

Mapping: Watershed landscape features were assessed along stream buffer zones using high resolution aerial imagery from 2009 (NAIP, true-color) and high-resolution lidar elevation models (NH Granit) in ArcGIS. Landscape characteristics will be related to water chemistry components on completion of field sampling (summer 2017).

Field work: Water samples were collected from 27 sites in the Lake Sunapee watershed in May, 2017, and will be sampled again in August, 2017. Sites were selected to cover a range of watershed features (%wetland, %forest, %open canopy, and open water connectivity). Samples

are filtered to give dissolved (<0.45µm) and whole water fractions, and will be analyzed for methylmercury and total mercury, and for dissolved organic carbon quality and quantity.

We will be deploying *in situ* ceramic tiles for biofilm growth in streams in late May, 2017, for collection later in the summer. Invertebrates (mayflies, which are grazers), will also be collected from the streams in August.

DOC quality and quantity: Filtered water samples from field collection are analyzed by 3D excitation-emission fluorescence spectroscopy, and by ultraviolet spectroscopy within 48 h of collection. Whole and filtered water samples are also analyzed for total organic carbon within 28 days of collection. Fluorescence excitation-emission matrix (EEM) data will be analyzed in Matlab using the "Dr. EEM" toolbox, and correcting for instrument and inner filter effects.

**Principal findings**: As we are in the first year of the award and have not yet completed a field season, we have not reached a stage of reporting findings. Our preliminary data on dissolved organic carbon isolated from streams and on field collection of stream water suggests there is a wide range of organic carbon quality in this system, indicating we will have suitable data to address the problem stated above.

**Publications and presentations**: We are in the early stages of this project and have not yet published or presented our findings. We have organized a meeting in late May, 2017, to meet with our USGS collaborators and the Lake Sunapee Protection Association to discuss the goals of this research, progress to date, and proposed future plans.

**Notable awards and achievements**: Co-PI Celia Chen and investigator Vivien Taylor received a CompX grant through the Neukom Institute at Dartmouth to compare findings from Lake Sunapee with other watersheds. The goal of the CompX grant is to model the effects of landscape and organic carbon on methylmercury cycling in streams from different watersheds, using data collected in this study and by our USGS collaborators. The CompX grant also enables us to increase our sampling coverage on Lake Sunapee, and to improve our GIS and modeling capabilities.

**Outreach and information transferred**: We are in the early stages of this research and have not yet undertaken any outreach activities. We are in contact with the Lake Sunapee Protective Association and will be meeting with them later in May 2017 to talk with them about our prior studies and current research, and to determine whether certain findings are likely to be of particular interest to their members in order to develop targeted outreach activities for this time next year.

**Students supported**: (1) Paul Vickers (2$^{nd}$ year undergraduate), is working full-time on the project spring term, and part-time in the winter and summer terms.

**Faculty and staff supported**: (4)

Kathy Cottingham (Professor)

Celia Chen (Research Professor)

Vivien Taylor (Research Scientist)

Kate Buckman (Research Scientist)