Emerging Organic Pollutants: From College Campuses to Cayuga Lake

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Background:

College students are heavy users of ADHD medication, antidepressants, and birth control pills, relative to the general population. These emerging pollutants enter the sewage treatment system and may be only partially removed, potentially harming aquatic life.

Research Questions:

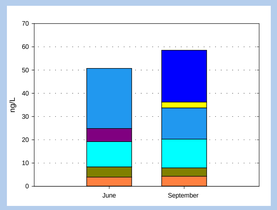
- **Do college students contribute a significant load of select compounds to the Ithaca wastewater treatment system?**
- **What compounds remain in the wastewater effluent?**
- **Do the current concentrations of pharmaceuticals in the lake pose a threat to the environment?**
- **Do microplastics, and any attached compounds, transfer up trophic levels and cause toxicity?**

Approach:

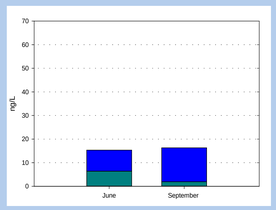
- **Study the compounds in the drinking water intake, influent, effluent and lake water**
- **Assess variations when students are absent, present, and during final exams**
- **Investigate the predator-avoidance behavior of fathead minnows *(Pimephelas promelas)* at relevant concentrations of select compounds**

Initial Findings -- 2014 Sampling

Pre-Drinking Water Treatment



Cornell: Fall Creek



Ithaca: Sixmile Creek

Water entering the drinking water system (raw water) has low levels of many compounds. Data on removal of compounds by the drinking water treatment process is not yet available.

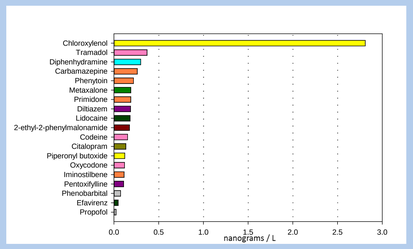
Legend

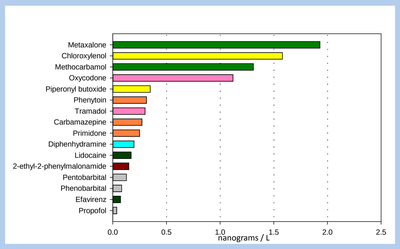
- Antibiotic
- Anticonvulsant
- Antidepressant
- Antihistamine
- Antiviral
- Cardiovascular
- Metformin
- Muscle Relaxant
- Opioid
- Other
- Other Pharmaceutical
- PCDU

Fathead Minnow

Preliminary results suggest that there are no observable behavior effects in fathead minnows at the concentrations of two neurotactive compounds (limonene and carbamazepine) that are found in the lake.

Influent: Pre-Wastewater Treatment



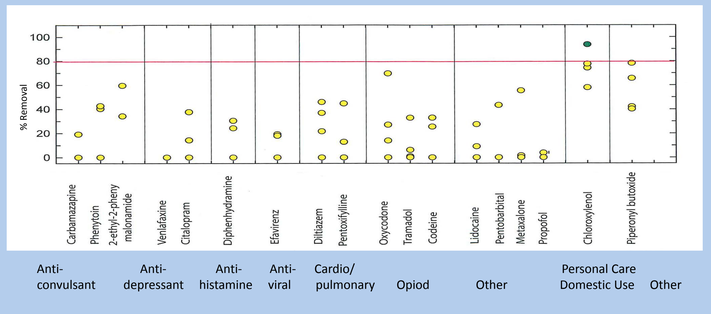


June, after students have left

December, during college finals

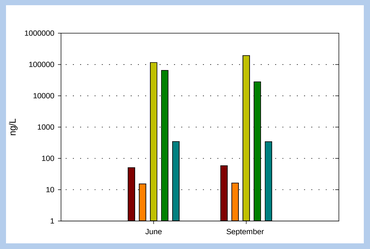
The level of many compounds in the influent is several magnitudes higher than the raw water (below). Seasonal differences may be influenced by the absence and presence of college students.

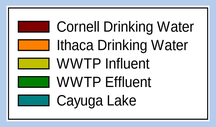
Effluent: Post-Wastewater Treatment



The red line signifies an 80% removal rate of pharmaceuticals (change in concentration between influent and effluent samples). Many pharmaceuticals are poorly removed by the wastewater treatment process.

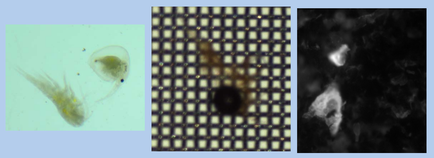
Comparison of All Sites





The level of many compounds in Cayuga Lake is higher than in the tributaries.

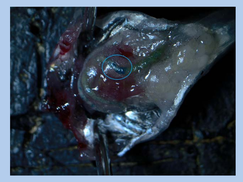
Microplastics in Cayuga Lake



Daphnia from the lake (left), material digested from zooplankton sampling, (middle) were verified as plastic using fluorescing microscopy. (right).

Next Steps

- Analysis of compounds in treated drinking water
- Analysis of samples for illicit drugs
- Comparison of water samples from Burlington, VT (Univ. of Vermont) and Ithaca during finals week
- Test biosolids for compounds and conduct mass balance to determine what compounds are degraded
- Study trophic transfer and toxicity of microplastics to daphnia and fathead minnows



Plastics from Crest toothpaste in the gut of fathead minnows (experimental exposure).

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