

Ecological consequences of amphetamine pollution in urban streams

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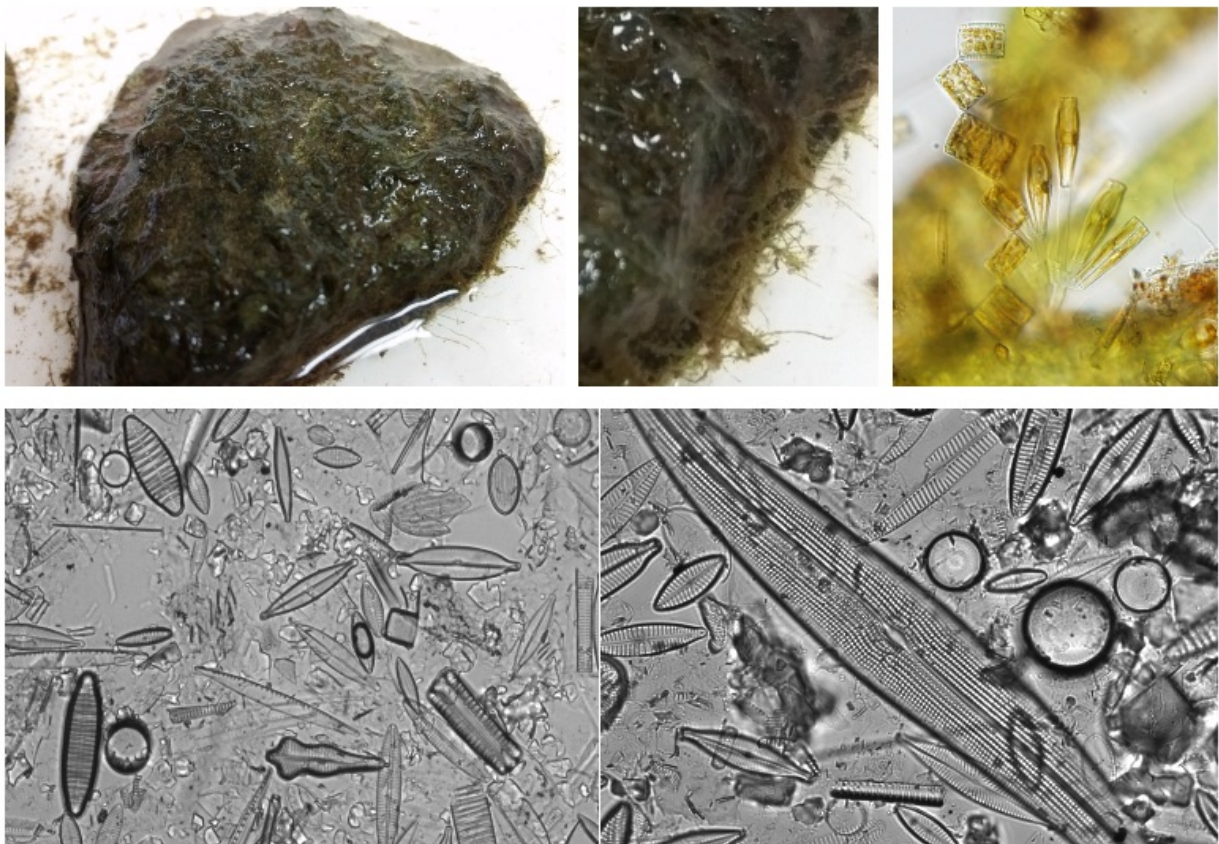


Sylvia Lee sampling in the Gwynns Falls at Carroll Park. In the Gwynns Falls, some 65% of average flow can be attributed to untreated sewage from leaking infrastructure. Credit: Joanna Blaszcak

Pharmaceutical and illicit drugs are present in streams in Baltimore, Maryland. At some sites, amphetamine concentrations are high enough to alter the base of the aquatic food web. So reports a new study released today in the journal *Environmental Science & Technology*, which is one of the first to explore the ecological consequences of stimulant pollution in urban streams.

Lead author Sylvia S. Lee conducted the work as a postdoctoral researcher at the Cary Institute of Ecosystem Studies. Lee, now with the Environmental Protection Agency, comments, "Around the world, treated and untreated wastewater entering surface waters contains pharmaceuticals and illicit drugs that originate from human consumption and excretion, manufacturing processes, or improper disposal. We were interested in revealing how [amphetamine](#) exposure influences the small plants and animals that play a large role in regulating the health of [streams](#)."

Lee and her collaborators measured concentrations of pharmaceutical and [illicit drugs](#) at six stream sites along an urban-to-rural gradient in Baltimore, Maryland. Numerous drugs, including amphetamine, were detected in stream sites, with illicit drug levels highest in the most urban streams. Sampling was performed in 2013 and 2014. Suburban and urban fieldwork focused on the Gwynns Falls watershed, which is part of the Baltimore Ecosystem Study Long-Term Ecological Research program. The two rural streams were located in Oregon Ridge watershed, the closest forested region.

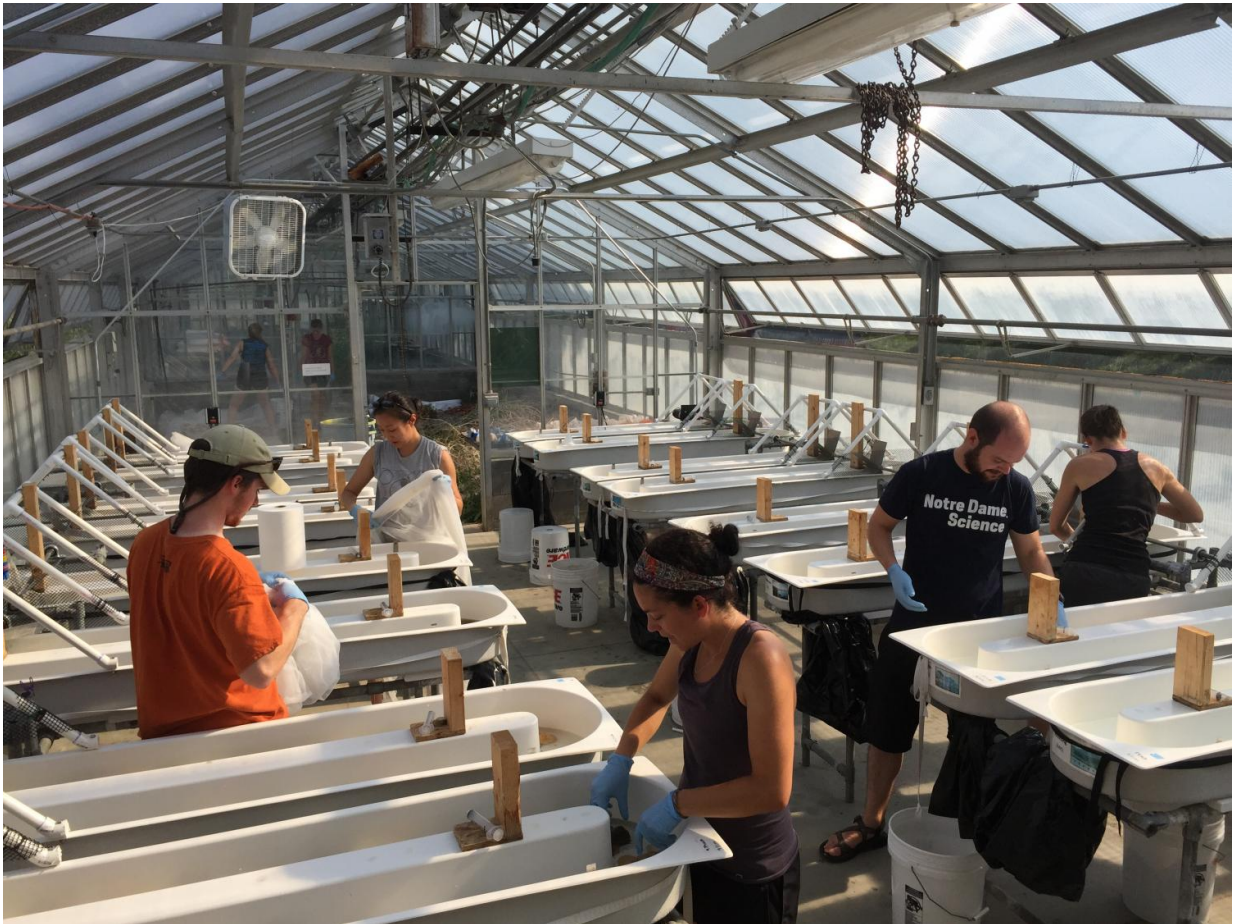


Biofilms are complex communities composed of algae, fungi, and bacteria all living and working together. In streams, biofilms contribute to water quality by recycling nutrients and organic matter. They are also a major food source for invertebrates, which, in turn, feed larger animals like fish. Credit: Sylvia Lee

Field sampling was then followed up with an artificial stream experiment to determine how amphetamine - a biologically active, highly addictive, and widely used drug - affects stream life. In recent years, there has been an increase in the use of amphetamine medications in the treatment of conditions like attention-deficit hyperactivity disorder. At the same time, stimulants like methamphetamine, ecstasy, and cocaine are also used illicitly.

Co-author Emma J. Rosi-Marshall, a freshwater ecologist at the Cary Institute, comments, "We have every reason to suspect that the release of stimulants to aquatic environments is on the rise across the globe, yet little is known about the ecological consequences of this pollution. We found that when artificial streams were exposed to amphetamine at a concentration similar to what we found in parts of the Gwynns Falls watershed, there were measurable and concerning effects to the base of the [aquatic food web](#)."

After recreating natural stream attributes in the Cary Institute's Artificial Stream Facility, four streams received a target amphetamine concentration of 1 $\mu\text{g L}^{-1}$ and four streams were maintained as controls. Researchers monitored ecosystem effects over three weeks. Among their findings: in streams with the amphetamine addition, the growth of biofilms was significantly suppressed, the composition of bacterial and diatom communities changed, and aquatic insects emerged earlier.



The Artificial Stream Facility at the Cary Institute provided a controlled environment for testing the ecological consequences of amphetamine exposure on stream life. Credit: Erinn Richmond

The field component of this study is one of the first to report amphetamine in wastewater-impacted environments at concentrations approaching $1 \mu\text{g L}^{-1}$. The laboratory component confirms that amphetamine is present in the Gwynns Falls watershed at concentrations that have the potential to affect stream ecosystem structure and function.

Rosi-Marshall concludes, "As society continues to grapple with aging wastewater infrastructure and escalating pharmaceutical and illicit drug

use, we need to consider collateral damages to our freshwater resources. More work is needed on the ecological fate of these pollutants and the threat they pose to aquatic life and water quality. Ultimately, solutions will lie in innovations in the way we manage wastewater."

More information: Sylvia S. Lee et al, Occurrence and potential biological effects of amphetamine on stream communities, *Environmental Science & Technology* (2016). [DOI: 10.1021/acs.est.6b03717](https://doi.org/10.1021/acs.est.6b03717)

Provided by Cary Institute of Ecosystem Studies

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