Workshop Summary: Ecosystem Level Effects of Microplastics in the Experimental Lakes Area (ELA) of Canada

Ocean Conservancy
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Addressing Marine Plastics
A Systemic Approach

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MICROPLASTICS BACKGROUND

Microplastics (plastic particles <5mm in size) have been acknowledged as a truly ubiquitous contaminant in recent years. Studies demonstrating the presence of microplastics in freshwater rivers, lakes and in atmospheric deposition have shown that microplastics are not just an ocean contaminant, and thus extend beyond the realm of marine science.

The term "microplastics" comprises a diverse suite of contaminants, incorporating a broad size range, shape and type of plastic polymers. As a result of their widespread contamination, diverse microplastics contaminate hundreds of species of wildlife globally, causing concern regarding wildlife and ecosystem health. Several researchers are working to try to understand the ecological effects from microplastics across several levels of biological organization. Still, experiments in tanks and mesocosms are difficult to extrapolate to the real world.

While the field of microplastics is growing rapidly, and today there is no doubt that there is widespread contamination and that this contamination impacts individual organisms, more research is needed to understand their environmental fate and how they impact ecosystems in nature. The International Institute for Sustainable Development's Experimental Lakes Area (IISD-ELA) in Ontario, Canada provides an amazing space to probe and answer questions about how microplastics move through ecosystems and their effects at the ecosystem scale. IISD-ELA is one of the world's most influential water research facilities. It includes 58 lakes and their watersheds set aside for scientific research. Thus, IISD-ELA provides an unparalleled opportunity to increase our understanding of the ecological effects of microplastics across all levels of biological organization, in addition to increasing our understanding about any effects to ecosystem processes and their fate within the biological and physical components of an ecosystem.

In December 2018, Ocean Conservancy and University of Toronto convened a group of aquatic ecologists and physical limnologists from IISD-ELA, academia and government to brainstorm and plan for a whole ecosystem experiment on microplastics at IISD-ELA.

WORKSHOP ACTIVITIES

The workshop commenced with introductions and an overview of IISD-ELA to ensure all researchers understood the opportunity at hand, and to familiarize one another with the fields of scientific expertise in the room. Workshop participants included Chelsea Rochman (University of Toronto; Ocean Conservancy), Michael Rennie (Lakehead University), Diane Orihel (Queen's University), Paul Helm (MECP), Michael Paterson (IISD-ELA), Matthew Hoffman (Rochester Institute of Technology), Jennifer Provencher (ECCC) and Nicholas Mallos (Ocean Conservancy).

While all researchers are experts in some discipline pertaining to microplastics, this convening marked the first time several of them had the opportunity to meet and/or collaborate. Attendees reviewed the state of the science that was relevant to our collaboration on microplastics at ELA, and they also received an overview on the background of ELA regarding its history, resources for research, logistics of working there and detailed information about mesocosm experiments. The relevance of this work to the mission of the Canadian Government, Ocean Conservancy and the Global Environment Facility was shared with participants.

The researchers brainstormed key questions that the collective group felt were important to answer in the field of microplastics that are relevant to ELA. These include questions about mitigation, fate and effects of microplastic in aquatic habitats. With these questions and considerations in mind, the researchers then discussed experimental designs for different studies:

1) Studying the background concentrations in the region,
2) Conducting mesocosm experiments to inform a whole ecosystem experiment; and
3) A whole lake experiment.

The first step required by the researchers coming out of the workshop was to decide upon the lakes that will be used for the study; specifically, which one will be used as the control and for the whole lake experiment. Nine lakes in total need to be chosen for the research: three lakes with no research or recreational activity as low-use lakes; three lakes with research activity only as moderate-use lakes; and three lakes with recreational and research activity for high-use lakes. In addition, the researchers will choose three sites to deploy passive and active air samplers to measure atmospheric deposition of microplastics.

WORKSHOP OUTCOMES AND EXECUTING BASELINE FIELD RESEARCH

Coming out of the workshop, it was decided that the researchers will commence a sampling campaign in July 2019 to measure baseline and background contamination of microplastics at IISD-ELA. The hypotheses driving this baseline sampling are:

1. Boreal lakes at IISD-ELA will have microplastics in water, sediments and atmospheric fallout, but concentrations will be less than in the Great Lakes.
2. There will be a positive correlation between anthropogenic activity and microplastics concentration in lake samples. If this hypothesis is not supported,, the discrepancy may mean that atmospheric transport is a greater source of microplastics than nearby anthropogenic activity.

In total, the researchers will sample nine lakes with a gradient of anthropogenic activity. The sampling will be conducted by an undergraduate and graduate student from University

of Toronto and Queens College, respectively, with the help of a PhD student who is a part of Dr. Rochman's laboratory. Microplastics analysis will be conducted by undergraduate students from the Rochman Lab and an undergraduate in the Rennie Lab at Queen's University. To determine whether there are any differences among lakes and between different use patterns, statistics will be performed to see if the concentrations of microplastics vary within a lake and along a gradient of anthropogenic use.

The findings from these baseline analyses will provide the foundation on which the researchers conduct the full ecosystem-level analysis in subsequent summers at IISD-ELA.