Summary report of the "Plastics research in the Great Lakes: identifying gaps and facilitating collaboration" session presented during the 60th annual International Association for Great Lakes Research conference (IAGLR)

Session date: Tuesday May 16, 2017

Location: Cobo Hall, Detroit, MI

Report authored by: Sarah Zack*+, Pollution Prevention Specialist, Illinois-Indiana Sea Grant College Program, University of Illinois at Urbana-Champaign

Melissa Duhaime*, Assistant Professor, University of Michigan, Department of Ecology and Evolutionary Biology

Carolyn Foley*, Assistant Research Coordinator, Illinois-Indiana Sea Grant College Program, Purdue University

Laura Kammin, Extension Program Leader, Illinois-Indiana Sea Grant, University of Illinois at Urbana-Champaign

Session description from program book

The ecosystem impact of plastic litter (from nano- to micro- to macro-sized) in the Great Lakes is a growing area of research. While study of the fate, transport, and effects of plastic contamination in the oceans have been building for some time, similar knowledge in freshwater systems is greatly lacking. The impacts of this emerging contaminant will be difficult to manage in the future without a robust, well-coordinated, evidence-driven knowledge base. With that goal in mind, we welcome talks touching on all aspects of freshwater plastic research, including but not limited to the distribution and transport of plastic litter through the Great Lakes (or other freshwater) watershed, the potential for integration of plastics into Great Lakes food webs, modeling of ecosystem risks due to plastic pollution, description of the distribution and behavior of plastic-adsorbed organic pollutants, and technological innovation to prevent entry of plastic litter into freshwater systems. After scientific presentations have concluded, we will facilitate group discussion on the state of plastics research in the Laurentian Great Lakes. The goal of this discussion is to promote collaboration and exchange of information among academic, agency and NGO researchers and managers, and informally identify research priorities and data needs related to research of Great Lakes plastic litter.

Session summary

This session was one of the largest at the 60th annual IAGLR conference, with 18 oral presentations, 1 poster presentation, and 1 facilitated discussion period. The full list of abstracts (with author contact information) is included as Appendix 1. This session was well-attended throughout the day, with as many as 70 people attending the individual talks.

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* Denotes Session Chair

+ Corresponding author. Email address: szack@illinois.edu

During the facilitated discussion, participants were divided into groups of 6-10 people. Building off of the information presented in the main session and with a goal of drawing on the collective knowledge available in the room, the small groups were asked to answer the following:

- **List the large datasets that you know are available to researchers and outreach professionals interested in the effects of microplastics in the Great Lakes.**
- **After discussing these, list 5 critical data needs for researchers and outreach professionals interested in the effects of microplastics in the Great Lakes.**

The list of existing datasets is included in Table 1. The list of critical data needs covers many topics but can be broken into 5 main categories: chemistry, sources, impacts, protocols, and people.

1. *Chemistry:*
   In addition to greater understanding of how to identify microplastics, participants stressed the importance of determining basic chemistry of plastics including breakdown patterns in the Great Lakes (especially what breaks down quickest in sunlight). They felt it would also be useful to identify whether different plastic types or products have distinct additive packages, as this could in turn lead to better understanding of where plastics come from. Similarly, they suggest identifying the resin type and weight of the top-10 macroplastic items most commonly found in the Great Lakes. In terms of protocols, they suggest a need for libraries and protocols for analyzing microplastics by Fourier Transform Infrared Spectroscopy (FTIR).

2. *Sources:*
   Based on discussion in this session, there seems to be a great need to understand sources and fate (including transport) of microplastics found in the Great Lakes. Multiple groups suggested a need to understand effects of different land cover on microplastic pollution, the importance of wastewater treatment plants, and how erosion, water levels, and storm events affect microplastic inputs to the Great Lakes. There was specific mention of combined sewer overflow and stormwater events, and a desire to know which microplastics reach the lake bottom.

3. *Impacts:*
   Though multiple research projects are on-going, potential impacts of microplastics in Great Lakes ecosystems remain largely unknown. Participants in this session suggested a need to understand how microplastics will affect populations & food webs, particularly as pertains to commercially valuable fish. Participants expressed a desire to understand both the effects of ingestion and how long it might take for toxic compounds on plastic to absorb into fish (or conversely, if plastics might act as sponges and soak up toxic compounds). Other suggestions were to investigate the rate of ingestion for different species as well as impacts related to agricultural soil composition and quality.

4. *Protocols:*
   Participants expressed a desire for more standardized data collection/curation. Several groups expressed a need for a central repository for microplastics-related data, which should include standardized data collection and formatting. There were also several suggestions to standardize how microplastics are identified and quantified. This would help with both research and education/outreach efforts.

5. *People:*
   Participants in the discussion session suggested that there is a need to understand potential impacts of microplastics on human health, especially drinking water. There was a suggestion that microplastics should be included as one of the Chemicals of Mutual Concern in the Great Lakes Water Quality Act (Annex 3). There is also a need to further understand barriers to behavior change that may result in fewer microplastics entering Great Lakes systems.

Table 1. Existing datasets available for researchers and outreach professionals interested in the effects of microplastics in the Laurentian Great Lakes. This list is not exhaustive.

Dataset	URL for more information
5 Gyres	https://www.5gyres.org/
Adventure Scientists	http://www.adventurescience.org/microplastics.html
Alliance for the Great Lakes Adopt-A-Beach Program	https://greatlakes.org/get-involved/adopt-a-beach/
Exxpedition Great Lakes	http://exxpedition.com/expeditions/greatlakes2016/
Great Canadian Shoreline Cleanup	http://shorelinecleanup.ca/
Industry datasets	www.marinelittersolutions.com; https://plastics.americanchemistry.com/Marine-Litter/;https://oceanconservancy.org/trash-free-seas/plastics-in-the-ocean/trash-free-seas-alliance/
Litterbase	http://litterbase.awi.de/
Loyola University Chicago (John Kelly and Tim Hoellein)	http://www.luc.edu/biology/hoellein.shtml http://www.luc.edu/biology/kelly.shtml
NOAA Marine Debris Collaborative Portal	https://marinedebris.noaa.gov/research/marine-debris-monitoring-and-assessment-project
NOAA Marine Debris tracker app (citizen science)	http://www.marinedebris.engr.uga.edu/
Parsons School of Design	http://www.newschool.edu/parsons/faculty.aspx?id=4e44-6b79-4e7a-4d34
SUNY-Fredonia (Sam Mason)	http://home.fredonia.edu/earth/faculty-mason
Trash Free Waters (EPA Region 2)	https://www.epa.gov/trash-free-waters
University of Michigan	http://graham.umich.edu/activity/27029
Publications	Sci-hub.io

Participants in the discussion session were also asked to complete a 3-question exit survey. The questions were:

1. **Based on your own knowledge and on the presentations you have seen today, list efforts you know of to synthesize information related to microplastics in the Great Lakes. Use back of paper if necessary. (Suggested categories were coordinating bodies, collaborative research projects, conferences/workshops, and collaborative outreach efforts).**

2. **In the lists above, please circle the organizations/groups you personally are most likely to interact with. If you are aware of other groups not listed above that are working on microplastics, please list here.**

3. **Please circle the word that best describes your organization:**

University Non-profit State or Federal Other: _____

Of the 20 individuals who returned the exit survey, 12 were affiliated with a university, 5 were affiliated with a non-profit organization, 2 were affiliated with state or federal government, and 1 was a public school educator. This distribution is unsurprising given that the IAGLR conference is primarily a venue for academic researchers.

Respondents listed a variety of organizations involved in efforts to coordinate Great Lakes-related microplastics research or outreach (Appendix 2). Very few of these were mentioned by more than one respondent, suggesting that there is potential for organizations to work together to address this emerging topic. The organizations that respondents personally interact with are summarized in Table 2.

It is worth noting that a survey respondent noted that the Great Lakes Commission is considering a resolution related to microplastics and could use some advice on general state, provincial, or federal actions that have already been undertaken or ought to be undertaken. In addition, there was a suggestion that the chemical industry (e.g. the American Chemistry Council) could play a larger role in collaborative outreach projects.

Further Avenues to Explore

Due to the popularity of the session and the IAGLR conference, the discussion period was much shorter than anticipated. Despite coming at the end of a very full day of presentations, participants were eager to remain and provide input about this important issue. In general, coordinated efforts to address the issue of microplastics in the Great Lakes are needed, however, to ensure that a broad array of voices are being included, organizers should consider taking advantage of existing Great-Lakes-wide meetings (as opposed to multiple individual events). Travel constraints may make attendance difficult, particularly if events take place across an international border.

Overall we suggest that microplastics are a topic of continuing concern for the Laurentian Great Lakes. Many organizations recognize the importance of this topic and are attempting to coordinate research or outreach efforts. This summary is in part an effort to make some of these different organizations aware

of each other so that efforts are complementary. In addition to specific research questions identified above, participants in our discussion session and respondents to our survey specifically expressed a desire for a central repository for microplastics-related data specific to the Great Lakes, including standardized protocols and data formats.

Table 2. Organizations that exit survey respondents personally interact with, grouped by respondent affiliation type.

Effort	Respondent's Affiliation Type			
	University	Non-profit	State/Federal	Other
Adopt-A-Beach	2			
Alliance for the Great Lakes	1		1	1
Exxpedition 2016	2			
Freshwater Summit		1		
Great Canadian Shoreline Cleanup	1			
Great Lakes Marine Debris Action Strategy & Portal		1		
Healing Our Waters			1	1
IAGLR	2		1	1
Inland Seas Education Association		1		
International Joint Commission			1	1
International Marine Debris in San Diego 2018	1			
New York State Department of Environmental Conservation	1			
NOAA	2			
NOAA webex/update meetings	1			
NOAA-Sea Grant	2			
Ontario Ministry of Natural Resources & Forestry	1			
SUNY Fredonia (Sam Mason)	2	1		
SUNY Oswego	2			
U. of Toronto-Western	1			
U.S. EPA			1	1
University of Michigan Water Center/Graham Sustainability Institute	2			
USGS	1			
USGS, Oswego, NY	1			
Western U. Plastics Pollution Workshop 2016	1			
Western-MOECC/Environment Canada	1			

Appendix 1: Presenters and Abstracts

MCGUIRE, M.P., University of Florida/Florida Sea Grant Extension, 150 Sawgrass Road, Bunnell, FL, 32110, USA. https://www.flseagrant.org/about/staff/mcguire/

Florida Microplastic Awareness Project: A Citizen Science Initiative.

Plastic pollution in the oceans is an increasing problem. Microplastics (plastic pieces smaller than 5 mm in size) are being found in fish and invertebrates. The Florida Microplastic Awareness Project aims to raise awareness about microplastics, in part by having citizen scientists collect and analyze coastal water samples for the presence of microplastics. Volunteers and others in the community are asked to reduce their consumption/disposal of plastics. Sixteen coordinators around the state give presentations about microplastics to potential volunteers, then conduct hands-on trainings to show water collection and analysis techniques. Volunteers are asked to collect at least four samples during the year, filter them and observe the filters to count the number of pieces of plastic present. Data are used to populate a Google Map. People are asked to take a pledge to reduce their plastic waste. Results: Data from over 800 water samples show that 88% contain at least one plastic item. On average, there are seven pieces of plastic in a liter of coastal water. 82% of the plastic items are fibers/filaments. On average, people are pledging to make 3.5 of the suggested eight behavior changes to reduce plastic waste. In follow-up surveys, people are reporting having made an average of three behavior changes.

MARTZ, M.A.[1], DOMSKE, H.M.[2], MCCARTNEY, A.X.[1] and EVANS, H.[3], [1]PA Sea Grant, Pennsylvania State University, 301 Peninsula Drive, Suite 3, Erie, PA, 16505, USA; [2]New York Sea Grant-Cornell University, 229 Jarvis Hall, SUNY at Buffalo, Buffalo, NY, 14260-4400, USA; [3]Fort LeBoeuf School District, 34 East 9th Street, Waterford, PA, 16411, USA. https://seagrant.psu.edu/content/marti-martz

Building Support for Microplastic Research Through Education and Outreach.

This presentation will highlight examples of Best Practices that have supported plastics research in the Great Lakes. Sea Grant educators from Pennsylvania and New York will discuss successful collaborative efforts that have benefited researchers and stakeholders alike. Highlighted activities include a Great Lakes regional conference, Newspaper in Education publications, school programs and public presentations where researchers and Sea Grant staff have worked together to enhance their work, identify research gaps and develop support for research funding.

CROSS, J.S., Alliance for the Great Lakes, 150 Michigan Ave., Ste. 700, Chicago, IL, 60601, USA. https://greatlakes.org/about/contact-us/

Citizen Scientist, Marine Debris and the Great Lakes.

Since 1991, the Alliance for the Great Lakes has engaged citizen scientists at Great Lakes beaches in the Adopt-a-Beach™ program. In this program volunteers remove marine debris from Great Lakes shorelines and track catalog their findings. This data is accessible to the public through an online database and can be downloaded by the public. In 2016, over 15,000 volunteers on all 5 Great Lakes and in all 8 Great Lakes states collected and entered 1,132 marine debris data sets for 342 different coastal sites.This

presentation will examine results from 2016 and historic datasets on composition and categories of marine debris from a regional, state and local perspective. It will also examine trends in data collected including the variation of smaller fragmented pieces of debris, comprised almost entirely from plastic. Finally, the presentation will discuss a collaborative project with Loyola University from 2016 which analyzed litter intervention strategies to reduce the amount of litter found at Oak Street Beach in Chicago. These strategies included novel trash receptacles, beach visitor education, and visual displays of litter abundance. Citizen scientists play a critical role in not only litter reduction but also through data collection that can contribute to a better understanding of sources of plastics in the Lakes.

MCKINNON, E. and PATE, J., Love Your Greats, 11 Main Street North PO Box 94, Bayfield, ON, N0M1G0, CANADA. http://www.loveyourgreats.com/stories-action

A Citizen Engagement Approach to Water Advocacy: Experiences from eXXpedition Great Lakes 2016.

The Great Lakes suffer from considerable microplastic contamination. Despite this awareness, citizens around the lakes struggle to take action. With over 80% of plastic debris in the world's water bodies being contributed from land, the solutions for eliminating microplastics have to come from changes in consumer behaviour and by stopping contamination at the source. "eXXpedition Great Lakes 2016'' was designed as a one day mass engagement event to bring the science of microplastics to citizens across the region, allowing them to experience first hand the presence and impact of this pollution. On this day, the largest, simultaneous water sampling event in history, hundreds of volunteers collected water samples and conducted shoreline clean-ups on the Great Lakes. Sailing vessels led by female scientists specializing in plastic pollution, human and environmental health were also launched from key cities in both Canada and the United States. The approach was to utilize the power of citizen engagement to promote clean-water advocacy and action in North America. The scope and results of this event will be discussed, with an emphasis on sharing the experiences of the citizen scientists who participated.

HARDY, S.D. and BARTOLOTTA, J.F., Ohio Sea Grant, 1314 Kinnear Road, Columbus, OH, 43212, USA. https://ohioseagrant.osu.edu/about/people/scott-hardy

Barriers and benefits to desired behaviors for single-use plastic items in Northeast Ohio.

Given the growing saliency of plastic marine debris, and the impact of plastics on beaches and aquatic environments in the Laurentian Great Lakes, applied research is needed to support municipal and nongovernmental campaigns to prevent debris from reaching the water's edge. This study attempts to accomplish this goal examining the barriers and benefits to positive behavior for three plastic debris items in northeast Ohio's Lake Erie basin: plastic bags, plastic water bottles, and plastic cigar tips. An online survey and focus group were employed to gather data on the use and disposal of these plastic items in the Cleveland area, and to solicit recommendations on how to positively change behavior to reduce improper disposal. The results from this project will be used to inform a social marketing campaign broadcast throughout Cleveland in the summer of 2017, as well as to serve as a pilot for related research on plastic marine debris in other Great Lakes states.

BARROWS, P.W.[1], NEUMANN, A.[2], BERGER, L.[3] and SHAW, D.[4], [1]Marine & Environmental Research Institute, Main Street, Blue Hill, ME, 04614, USA; [2]Adventure Scientists, PO Box 1834, Bozeman, MT, 59771, USA; [3]College of the Atlantic, Eden Street, Bar Harbor, ME, 04609, USA; [4]State University of New York, Albany, NY, USA. http://www.adventurescientists.org/

Grab vs. neuston tow net: a microplastic sampling performance comparison.

With the rapid evolution of microplastic research over several decades, there is an urgent need to compare methodologies for quantifying microplastic in aquatic environments. The most common method for surface sampling is a neuston net tow. Its effectiveness for microplastic research is limited by the net's mesh size as well as the likelihood of contamination. In our study, we compared a 1 L surface grab sampling method to a 335 mm neuston net tow. Grab sampling collected over three orders of magnitude more microplastic per volume of water as well as a smaller size range of plastic than sampling with a neuston net. For studies aiming to capture and sort larger microplastics without a microscope, the neuston tow method is preferred, since it samples a greater volume of water, increasing the potential of capturing microplastic pieces. Grab sampling can capture plastic at the micro- and nano-scale and in environments where neuston nets are impractical, but the small water volume sampled may result in high variability among samples. The comparison of these techniques comes at a critical time when sampling methods need standardization for the accurate measurement of the distribution and composition of microplastic in aquatic environments worldwide.

SEILHEIMER, T.S.[1], BLISS, H.[2] and HOUSE, A.[3], [1]Wisconsin Sea Grant, Manitowoc, WI, USA; [2]Great Lakes Indian Fisheries and Wildlife Commision, Odanah, WU, USA; [3]Apostle Island Sport Fishermen's Assocation, Washburn, WI, USA. http://www.seagrant.wisc.edu/home/default.aspx?tabid=609

Beware of Great Lakes ghost nets!

Plastic pollution in the Great Lakes can come in many forms, but ghost nets can be dangerous to boaters and anglers. Ghost nets are lost commercial or subsistence fishing nets, usually gill nets, that have been lost due to weather, ice, or fouling. These unmarked nets can then become hazards, especially to anglers using trolling gear. Wisconsin Sea Grant, the Apostle Islands Sport Fishermen's Association, Great Lakes Indian Fish and Wildlife Commission, and the NOAA Marine Debris Program have partnered in a campaign to raise awareness about ghost nets in the upper Great Lakes and to more efficiently remove them. The project introduces anglers and boaters to the risks associated with marked commercial nets and ghost nets. Best management practices help commercial, tribal, and subsistence fishers to avoid conditions where nets could be lost. Anyone encountering a ghost net is encouraged to report the net, so it can be quickly removed. Removal of current ghost nets and fewer future nets will make the upper Great Lakes a safer place for recreation and enjoyment. With the proper education, you will say "I ain't afraid of no ghost net."

CORCORAN, P.L., RYAN, K. and BAZAL, S., University of Western Ontario, 1151 Richmond St. N., London, ON, N6A5B7, CANADA. https://www.uwo.ca/earth/people/faculty/corcoran.html

Microplastics in Bottom Sediments of the Thames River, Ontario.

Bottom sediments of the Thames River, Ontario, were sampled to determine abundances, distribution and types of microplastics in urban and rural regions. Using a Petite Ponar grab sampler, 13 samples were collected from between Mitchell and London; 4 from between Tavistock and Thamesford; 8 from between Innerkip and London; and 9 from between London and Lighthouse Cove. The samples were processed in the Sample Separation Laboratory (Earth Sciences) at Western University. Each sample was weighed, dried, and then mixed with a sodium polytungstate (SPT) solution of 1.5 g/cm3. The samples were magnetically stirred, then poured into a separatory funnel through which grains with densities >1.5 g/cm3 and <1.5 g/cm3 were drained onto 25 µm filter paper. The lower density fraction was rinsed with distilled water through a 0.053 µm sieve and was emptied into a petri dish for visual identification using a stereomicroscope at magnifications of 15x-225x. Randomly selected microplastic particles were prepared for analysis by Fourier Transform Infrared Spectroscopy (FTIR).Preliminary results show that the main microplastic particles are fibres, with lesser amounts of fragments and microbeads. Initial numbers suggest that the total microplastics identified in each sample is affected by proximity to urban centres.

RIOS MENDOZA, L.M., JOHNSON, C. and NYECK, M., University of Wisconsin Superior, Belknap and Catlin, Superior, WI, 54880, USA. https://www.uwsuper.edu/directory/lorena-rios-mendoza_lriosmen

Small plastic particles with huge environment impacts in our freshwater systems.

Microplastics are becoming one of the most cited emergent contaminants in the last decade. These tiny synthetic polymers are associated with human activity. The inadequate disposal of plastics has made this material a ubiquitous pollutant on beaches, rivers, lakes, and oceans around of the world. Microplastic particles are a new type of pollution reported in the Great Lakes with unknown impacts in the ecosystem and human health. Little information is currently available on the composition, distribution, or fate of microplastic debris in the western end of Lake Superior and St. Louis River Estuary. The aims of this research are to identify possible sources, abundance, and the potential of microplastics to be ingested by fish. In this study we collected a total of 35 samples during summer, 2016. There were 17 samples from surface waters using a manta trawl, 4 samples from effluent water from four wastewater treatment plants, and 7 beaches (samples from 100 m and 1 m2). To determine the type of synthetic polymer we are using a FTIR Micro Spectrophotometer. The microplastics were classified by color, size, pellets, fibers, and fragments. The first results from the analysis of 12 manta samples showed in average 18 fibers, 25 fragments, and 4 microbeads (from cosmetic products) per sample.

KNAUFF, R. and HOFFMAN, M., Rochester Institute of Technology, Rochester, NY, 14618, USA. https://people.rit.edu/mjhsma/

Three-Dimensional Modeling of Plastic Transport in the Great Lakes.

We model the input and three-dimensional transport of plastic particles in the Great Lakes. We assume that particle release into the Great Lakes is proportional to nearshore population and then input neutral density particles which are propagated around the Lakes using currents from NOAA's operational nowcasts. The nowcasts do not contain vertical velocity fields, so vertical velocities are first computed and then used in the transport model to advect the simulated particles. The predicted particle distributions are then compared to previously published samples for verification. In addition, the three-dimensional results are compared to particle distributions from previously published two-dimensional simulations to quantify the effect of vertical velocity on both the modeled distributions and the derived floating plastic mass estimates.

MCNEISH, R.E.[1], MASON, S.A.[2], HOELLEIN, T.J.[1] and KELLY, J.J.[1], [1]Loyola University Chicago, 1032 West Sheridan Road, Chicago, IL, 60660, USA; [2]The State University of New York at Fredonia, 280 Central Ave, Fredonia, NY, 14063, USA. http://remcneish.weebly.com/

Sources of Microplastic Contamination in Lake Michigan and Interactions with Aquatic Biota.

Microplastic is a contaminant of concern worldwide which can reduce aquatic organisms' feeding capacity, adsorb persistent organic pollutants, and support pathogenic bacteria. Most microplastic research focuses on marine environments, but recent research showed microplastic concentrations in the Great Lakes are comparable to or higher than marine habitats. We investigated the sources of microplastic entering Lake Michigan and its biological interactions. Eight major tributaries of Lake Michigan were sampled for microplastic in surface waters, benthic sediments, and aquatic biota. Surface water microplastic concentrations were ~13 x greater in an agriculture dominated watershed compared to a forested watershed, and showed the same abundance, variation, and composition as coastal marine environments. Neogobius melanostomus (round goby) had the highest concentration of gut microplastic (~ 20 pieces/fish) compared to all other fish taxa, and had a positive correlation between body size and number of microplastic pieces per fish (r2 = 0.71). Results show microplastic is common in aquatic food webs of major Lake Michigan tributaries, and that agriculture dominated watersheds may be key sources of microplastic. Ongoing work will incorporate these data with microplastic in sediment and macroinvertebrate taxa.

HOUSE, N.[1], MINIHKEIM, S.[1], WALSH, M.G.[2] and HELLQUIST, C.E.[1], [1]Dept. Biological Sciences, State Univ. of New York Oswego, 7060 State Route 104, Oswego, NY, 13126, USA; [2]United States Geological Survey, Great Lakes Science Center, Lake Ontario Biological Station, Oswego, NY, 13126, USA. https://www.oswego.edu/biological-sciences/content/c-eric-hellquist

The Abundance of Microplastics in Forage Fish of Lake Ontario.

Microplastics are becoming more widely recognized as pollutants in the Great Lakes. To date, we have sampled Round Goby (benthic, n=73), Deepwater Sculpin (benthic, n=14), Slimy Sculpin (benthic, n=18),

and Alewife (pelagic, n=95) from 13 locations throughout Lake Ontario (depth 6-125 m). Digestive tracts were dissolved in KOH to isolate microplastics. Plastics were highly prevalent in all samples (99% occurrence). Fibers were the most abundant plastic recovered (81%), followed by fragments (16%), and large spheres (3%). For Round Goby, Deepwater Sculpin, Slimy Sculpin, and Alewife, respectively, we recovered 3.8, 1.9, 7.1, and 3.7 fibers and 1.04, 0.07, 0.44, and 0.7 fragments per fish. No large spheres were found in Round Goby and all other species had less than 0.5 per fish. Round Gobies contained 37% of the total plastics recovered (36% fibers and 49% fragments). Deepwater Sculpin contained 3% of the total plastics recovered (3% fibers, 0.6% fragments, and 16% spheres). Slimy Sculpin contained 14% of the total plastics recovered (16% fibers, 5% fragments, and 6% large spheres). Lastly, 46% of total plastics were found in Alewives (45% fibers, 45% fragments, 78% large spheres). The high prevalence of plastics in forage fish diets lakewide confirms that microplastics are entering the Lake Ontario food web.

BARRETT, H.A., WIGDAHL-PERRY, C.R. and MASON, S.A., The State University of New York at Fredonia, 280 Central Ave., Fredonia, NY, 14063, USA. http://home.fredonia.edu/earth/faculty-mason

The Effects of Plastic Pollution on Zooplankton.

Concern over plastic pollution has been growing over the last ten years, particularly with respect to micro-plastics. Although the consumption of micro-plastics has been well documented, little is known on how their presence might affect the behavior of zooplankton. Zooplankton are microscopic organisms that feed on algae, common in lakes around the world, and are a major food source for fish. As filter feeders, they sift through the water column for algal cells where they could possibly be ingesting micro-plastics. As a main source of food for fish, this could be another vector for plastics to enter the food chain and reducing the amount of transferred energy through trophic levels. This presentation will discuss and on-going feeding study aimed at understanding the potential impact of micro-plastics on Great Lakes zooplankton communities.

GRIGORAKIS, S. and DROUILLARD, K.G., Great Lakes Institute for Environmental Research, 401 Sunset, Windsor, ON, N9B3P4, CANADA. http://www1.uwindsor.ca/glier/ken-drouillard

Effect of microplastics on dietary assimilation efficiency of PCBs by fish.

Plastic pollution has resulted in microplastics becoming ubiquitous within marine and freshwater environments. Persistent organic pollutants (POPs) have the ability to sorb onto plastic. Furthermore, fish (and other organisms) have been shown to not only ingest microplastics in their native habitats, but to also assimilate POPs from microplastics in a lab setting. However, the degree to which POPs from microplastics assimilate in fish is unknown. As a result, this study aims to determine: (1) the assimilation efficiency (AE) of PCBs sorbed onto microplastics in fish and, (2) the relative contributions to whole body PCB assimilation between microplastics and their diet. To accomplish this, commercial fish pellets and microbeads each had a unique set of PCB congeners sorbed onto them. Microbeads were amended to fish pellets to create 6 treatment groups (0, 5, 10, 15, 20, 25% by weight) and goldfish were fed a single treatment pellet. After 48h the fish were sacrificed and their tissues were analyzed for PCBs. Because of the unique set of congeners, it is possible to determine the relative contribution that microplastic-sorbed PCBs have on whole body assimilation of PCBs.

HöökK, T.O., FEINER, Z.S., FOLEY, C.J. and MALINICH, T.D., Purdue University Department of Forestry and Natural Resources, West Lafayette, IN, 47907, USA. http://web.ics.purdue.edu/~thook/

Meta-analysis of effects of microplastics on aquatic organisms.

Microplastics (plastic particles less than 5 mm in size) have emerged as a global contaminant of concern in marine and freshwater ecosystems. A number of studies have documented consumption of microplastic particles by a wide variety of aquatic invertebrates and diverse ontogenetic stages of fishes. Such in situ consumption, has elevated concern that ingestion of microplastics may have deleterious effects on the health of aquatic organisms. In turn, a relatively recent proliferation of species-specific studies have quantified the effects of microplastics on factors such as mortality, growth, reproduction, and consumption of aquatic invertebrates and fishes. We performed a meta-analysis to examine patterns of lethal and non-lethal effects of microplastics across >40 laboratory experiments to ascertain relative risks for aquatic organisms associated with exposure to microplastics. In this presentation, we will outline our meta-analysis approach, summarize preliminary findings about the general effects of microplastics, and discuss implications of results, including caveats and considerations for future research.

LOWE, S.E., NOAA Marine Debris Program/Freestone, Oak Harbor, OH, USA. https://marinedebris.noaa.gov/contact-us

Progress Summary of the Great Lakes Marine Debris Action Plan.

Marine debris is any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes. Throughout the Great Lakes, marine debris threatens wildlife, natural resources, and the environment. Coordinated by NOAA and launched in 2014, the Great Lakes Land-based Marine Debris Action Plan is bringing science, government, industry and NGOs together in a regional partnership to clean up the Great Lakes. The plan's five-year goal: to research the problem of marine debris, guide science-based policies and management decisions, and coordinate actions to prevent and reduce marine debris. The action plan consists of 53 actions which are to be completed within five years (2014-2019). During the first three years of the plan, contributors to the Great Lakes Land-based Marine Debris Action Plan began work on 32 actions and successfully completed 11 actions. Ten actions will be started in the future. Information presented will include progress highlights as well as the plan's alignment with other national and international efforts on marine debris.

HARRIS, C.S., American Chemistry Council, Plastics Division, Washington, DC, USA. Plastics Producers Solutions on Marine Litter: 2016 Progress Report. http://www.marinelittersolutions.com/

A 2015 study published in Science estimated that 4.8 to 12.7 million metric tons of plastic waste enter our oceans annually, with the origin of marine litter closely related to populations concentrated near oceans and the quality of waste management systems. Although research shows the environmental cost of using plastics is nearly four times less than would result if plastics were replaced with alternative

materials in key applications, marine litter must be reduced. In March 2011, leaders from 47 plastics associations across the globe launched a Declaration of the Global Plastics Associations for Solutions on Marine Litter, a public commitment to help tackle the global problem of plastic litter in the marine environment. These industry leaders identified six areas for initiatives aimed at contributing to sustainable solutions: education, research, public policy, sharing best practices, plastics recycling/recovery, and plastic pellet containment. By December 2015, 260 projects had been planned, were underway, or completed; an increase of more than 165% in the number of projects since the Declaration was announced. The projects vary widely, from enhanced recycling to beach clean ups, and from global research to awareness and education campaigns; and include examples of innovative approaches to private sector engagement.

[POSTER] CHOU, N., MALINICH, T.D. and HöökK, T.O., Purdue University, 195 Marsteller St, West Lafayette, IN, 47906, USA. http://web.ics.purdue.edu/~thook/

Let Minnow if you Find Micro-Plastics.

Micro-plastic particles are prevalent within the Great Lakes and other bodies of water throughout the world. Their high densities suggest frequent encounters with fish foragers. Due to their small size, micro-plastics may be consumed by larval fish. In turn, such consumption could lead to various deleterious effects, including decreased consumption of natural prey and reduced growth. We tested the consumption of two age groups (7 day, 14 day) of fathead minnows, Pimephales promelas, when exposed to 2 sizes of micro-plastic beads (18 µm, 50 µm) and a natural food source (Artemia spp.). Finding no consumption of beads in these trials, we then considered potential non-consumptive effects of micro-plastics by raising larvae (for 15 or 30 days) with natural prey at three density levels of micro-plastic beads (18 µm). An analysis of stomach contents of larvae revealed that some minnows had consumed plastic beads. However, no effect on consumption of natural prey was detected and growth and survival rates did not differ among treatments. We suggest that future experiments should test for differences in foraging behaviors between different fish species as well as between different types of plastic particles (i.e. fibers vs beads) that may be encountered.

Appendix 2. List of organizations that are leading microplastics-related initiatives in the Great Lakes. A * denotes that this effort was identified for this particular grouping by more than one respondent.

Coordinating bodies:

- International Joint Commission*
- U.S. EPA* (though one respondent noted that while they believe the EPA was/should be involved the individual was unaware of efforts)
- NOAA - Marine Debris Action Plan*
- Environment and Climate Change Canada
- Department of Fisheries and Oceans Canada
- NOAA-Sea Grant*
- Ohio Sea Grant
- Alliance for the Great Lakes (Adopt-A-Beach)*
- Canadian Great Lakes Network
- Great Canadian Shoreline Cleanup

Conferences/Workshops:

- IAGLR*
- International Joint Commission workshops
    - Great Lakes public forum
    - Great Lakes week
- International Working Groups
- Great Lakes & St. Lawrence Cities initiatives (https://glslcities.org/initiatives/microplastics/)
- NOAA Marine Debris Action Plan workshops
    - GL Marine Debris Action Plan Update Meetings* (NOAA webex/update meetings? Same thing?)
    - Marine Debris International 2017 (https://5imdc.wordpress.com/)
    - International Marine Debris in San Diego 2018 (https://marinedebris.noaa.gov/save-date-6th-international-marine-debris-conference)
- Sea Grant workshops* (Ohio Sea Grant - Gibraltar Island, OH; Ohio State University)
- Western University Plastics Pollution Workshop 2016
- Latornell (http://www.latornell.ca/)
- Healing our Waters (http://www.healthylakes.org/)
- Freshwater Summit (http://www.gtbay.org/our-programs/freshwater-summit/)
- Exxpedition 2016

Organizations/Individuals Involved with Collaborative Research Projects:

- USGS
- Ohio Department of Natural Resources (fish diets)
- Ontario Ministry of Natural Resources & Forestry
- New York State Department of Environmental Conservation
- Sea Grant* (Ohio Sea Grant)
- Loyola University (John Kelly, Tim Hoellein)*
- State University of New York-Fredonia (Sam Mason)*
- University of Michigan Water Center Graham Sustainability Institute
- University of Wisconsin-Superior (Lorena Rios-Mendoza)
- Inland Seas
- "Those Canadians"

Specific Research Collaborations Mentioned:

- State University of New York-Oswego and the USGS in Oswego, NY
- State University of New York and 5 Gyres
- Western-MOECC and Environment Canada
- U. of Toronto and Western University
- Canada C3 project starting soon

Collaborative Outreach Projects:

- Great Lakes Areas of Concern Public Advisory Committees
- Lakewide management plans
- NOAA Tracker App
- Alliance for the Great Lakes*
- Beach cleanups
    - Great Canadian Shoreline Cleanup
    - NOAA Marine Debris - local beach cleanups
    - Alliance for the Great Lakes Adopt-A-Beach
- Inland Seas Education Association (trip to share microplastics information and research)
- Healing our Waters
- Great Lakes Boat Float
- Exxpedition 2016
- Sea Grant
    - Michigan Sea Grant
    - Ohio Sea Grant
    - New York Sea Grant
    - Wisconsin Sea Grant