WELCOME
TO THE NOVEMBER EDITION
OF THE 2018
M&R SEMINAR SERIES
BEFORE WE BEGIN

• SAFETY PRECAUTIONS
  – PLEASE FOLLOW EXIT SIGNS IN CASE OF EMERGENCY
  – AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE

• PLEASE SILENCE CELL PHONES OR SMART PHONES

• A QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION

• PLEASE FILL OUT THE EVALUATION FORM

• SEMINAR SLIDES WILL BE POSTED ON THE MWRD WEBSITE

• VIDEO STREAM OF THE PRESENTATION WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇔ MWRDGC RSS Feeds)
TIMOTHY J. HOELLEIN, Ph.D.

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**Experience:**  Assistant Professor, Dept. of Biology, Loyola University, Chicago, IL; Assistant Professor, Dept. of Natural Sciences, Baruch College, City University of New York; Research Technician, USGS. Biological Resources Division, Ft. Collins, CO. Animal Care/Water Quality Monitor, Dolphins Plus, Key Largo, FL, USA and Road Town, British Virgin Islands.

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**Profession:**  Society for Freshwater Science
American Society of Limnology and Oceanography
Ecological Society of America

**Award:**  Langerback Award. Excellence in Undergraduate Research Mentoring. Loyola Univ. Chicago
Plastic litter in freshwaters: Abundance, movement, and biological interactions

Timothy Hoellein
Associate Professor, Dept. Biology,
Loyola Univ. Chicago
Metropolitan Water Reclamation District
Nov 30, 2018
The normative power of the actual
River trash
A Remote Paradise Island Is Now a Plastic Junkyard

Henderson Island is isolated and uninhabited—but its beaches are still covered in garbage.
The Anthropocene Era – Human imprint on geologic record

Steffen et al. 2015
What are the sources, abundance, fate, and biological interactions of litter in freshwaters?

1. State of ‘garbage’ science

2. Microplastic and wastewater effluent in rivers

3. Microplastic in L. Michigan tributaries: water and fish

4. ‘Macro’ litter in Chicago area rivers

5. Applications, solutions
What are the sources, abundance, fate, and biological interactions of litter in freshwaters?

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5. Applications, solutions
Plastic production rates are accelerating
Plastic waste generation is accelerating
~92% of the plastic that was ever produced still exists... somewhere, in some form

Geyer et al. 2017
Plastic litter accumulation is **global, pervasive, increasing, and permanent**
What are the *sources, abundance, fate, and biological interactions* of litter in freshwaters?

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5. Applications, solutions
Microplastic particles (< 5 mm)

Microplastic from N. Shore Channel, Chicago
(Hoellein, McCormick)

Microplastic from open ocean
(5 Gyres Institute)
Microplastic Sources

Fragmentation

Production pellets

www.frbiz.com

www.alibaba.com

Synthetic fibers

Personal care products

http://workjournal.archipelago.gr/tag/microplastics/
Biological effects of microplastic

- **Ingestion**

- **Transfer:** prey -> predator

- **Toxic**
  - Chemicals stick to it, and leech from it

- **Selects for distinct microbial communities**

  - Image by J. Schluep
  - Cole et al. 2013, abstract image
  - Zettler et al. 2013, abstract image
  - www.ecology.com
Is wastewater effluent a source of microplastic to rivers?

puff.lbl.gov

www.sustainable-chicago.com
<table>
<thead>
<tr>
<th>Plant</th>
<th>Water Body, City</th>
<th>2013 Mean Effluent (MGD)</th>
<th>Contrib. of effluent to downstream flow (%)</th>
<th>Tertiary sand bed (Y/N)</th>
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</thead>
<tbody>
<tr>
<td>Kirie WRP</td>
<td>Higgen's Cr, Des Plaines</td>
<td>38.72</td>
<td>110.82</td>
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<tr>
<td>Wheaton WWTP</td>
<td>Springbrook Cr, Wheaton</td>
<td>7.39</td>
<td>86.18</td>
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<td>Y</td>
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<td>O'Brien WRP</td>
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<td>70.00*</td>
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<td>Goose Cr, Bloomington</td>
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<td>Springbrook WRP</td>
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<td>Plant Receiving Water Body</td>
<td>2013 Mean Effluent (MGD)</td>
<td>Contrib. of effluent to downstream flow (%)</td>
<td>Tertiary sand bed (Y/N)</td>
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<td>70.22</td>
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<td>70.00*</td>
<td>N</td>
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<td>Bloomington W Oakton Goose Cr, Bloomington</td>
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<td>13.24</td>
<td>Y</td>
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</tbody>
</table>
Pellets

fragments
Wastewater can be one source of microplastic to streams. Not in all cases. Variation among streams high.

Other research: High retention of microplastic in WWTP. Role of finishing treatment (e.g., sand filtration). Other sources (combined sewers, street runoff, atmospheric deposition, fragmentation)

McCormick et al. 2016 *Ecosphere*
Higher relative abundance of pellets downstream

Suggests role for prevention can impact pollution changes in consumer supplies, disposal
Microbeads in soaps, toothpastes
Capture fibers in washing machine
What are the sources, abundance, fate, and biological interactions of litter in freshwaters?

1. State of ‘garbage’ science
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5. Applications, solutions
Polyethylene (PE) – packaging material – bottles, shopping bags, toys
Polyacrylonitrile – textiles, filtration membranes, fish rods, badminton rackets
Polyacetal – eyeglass frames, fasteners, knife handles, automotive industry, and electronics
Polyvinyl Acetate – emulsifier for porous materials; cloth, wood glue, primer for drywall
Polyethylene Terephthalate (PETE) – textiles; also called polyester
### Taxa and Functional Feeding Groups

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Common Name</th>
<th>Functional Feeding Group</th>
<th>Trophic Fraction</th>
<th>Abundance</th>
<th>Size Range (cm)</th>
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</thead>
<tbody>
<tr>
<td><em>Dorosoma cepedianum</em></td>
<td>Gizzard Shad</td>
<td>Detritivore</td>
<td>2.40</td>
<td>6</td>
<td>3.6 – 11.4</td>
</tr>
<tr>
<td><em>Catostomus commersonii</em></td>
<td>White Sucker</td>
<td>Detritivore</td>
<td>2.46</td>
<td>16</td>
<td>4.5 – 12</td>
</tr>
<tr>
<td><em>Pimephales promelas</em></td>
<td>Fathead Minnow</td>
<td>Omnivore</td>
<td>2.80</td>
<td>10</td>
<td>5.6 – 6.5</td>
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<tr>
<td><em>Carpoides cyprinus</em></td>
<td>Quillback</td>
<td>Omnivore</td>
<td>2.59</td>
<td>1</td>
<td>9.0</td>
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<tr>
<td><em>Notropis stramineus</em></td>
<td>Sand Shiner</td>
<td>Omnivore</td>
<td>2.37</td>
<td>17</td>
<td>3.9 – 6.9</td>
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<tr>
<td><em>Notropis hudsonius</em></td>
<td>Spottail Shiner</td>
<td>Omnivore</td>
<td>2.74</td>
<td>20</td>
<td>4.4 – 6.7</td>
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<tr>
<td><em>Hybognathus hankinsoni</em></td>
<td>Brassy Minnow</td>
<td>Zoobenthivore</td>
<td>3.09</td>
<td>1</td>
<td>5.6</td>
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<tr>
<td><em>Labidesthes sicculus</em></td>
<td>Brook Silverside</td>
<td>Zoobenthivore</td>
<td>3.35</td>
<td>15</td>
<td>4.6 – 6.6</td>
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<tr>
<td><em>Micropterus salmoides</em></td>
<td>Largemouth Bass</td>
<td>Zoobenthivore</td>
<td>3.84</td>
<td>3</td>
<td>6.3 – 6.8</td>
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<tr>
<td><em>Micropterus dolomieu</em></td>
<td>Smallmouth Bass</td>
<td>Zoobenthivore</td>
<td>4.09</td>
<td>4</td>
<td>6.3 – 7.7</td>
</tr>
<tr>
<td><em>Micropterus sp.</em></td>
<td>Bass sp.</td>
<td>Zoobenthivore</td>
<td>4.09</td>
<td>1</td>
<td>5.6</td>
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<td><em>Percina caprodes</em></td>
<td>Logperch</td>
<td>Zoobenthivore</td>
<td>3.43</td>
<td>5</td>
<td>5.8 – 7.1</td>
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<td><em>Morone chrysops</em></td>
<td>White Bass</td>
<td>Zoobenthivore</td>
<td>4.40</td>
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<td>4.5 – 12.8</td>
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<td><em>Fundulus diaphanus</em></td>
<td>Banded Killifish</td>
<td>Zoobenthivore</td>
<td>3.18</td>
<td>4</td>
<td>4.5 – 7.6</td>
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<td><em>Notropis atherinoides</em></td>
<td>Emerald Shiner</td>
<td>Zoobenthivore</td>
<td>2.80</td>
<td>2</td>
<td>6.5 – 9.6</td>
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<tr>
<td><em>Neogobius melanostomus</em></td>
<td>Round Goby</td>
<td>Zoobenthivore</td>
<td>3.30</td>
<td>14</td>
<td>4.1 – 9.4</td>
</tr>
<tr>
<td><em>Cyprinella spiloptera</em></td>
<td>Spotfin Shiner</td>
<td>Zoobenthivore</td>
<td>3.44</td>
<td>4</td>
<td>5.0 – 8.1</td>
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<tr>
<td><em>Lepomis gibbosus</em></td>
<td>Pumpkinseed</td>
<td>Zoobenthivore</td>
<td>3.27</td>
<td>1</td>
<td>8.2</td>
</tr>
</tbody>
</table>

- 161 fish spanning 18 taxa across tributaries (so far)
- ~ 93% fish contained microplastic in the digestive tracts
Microplastic is in almost all fish – highest in predators

- Pumpkinseed: ~52
- Largemouth Bass: ~32
- Brook Silverside: ~21
- Emerald Shiner: ~...
- Round Goby: ~...
- Smallmouth Bass: ~...
- Banded Killifish: ~...
- Spotfin Shiner: ~...
- White Bass: ~...
- Bass Sp.: (n = 1)
- Quillback: ~5
- Sand Shiner: ~...
- Spottail Shiner: ~...
- Fathead Minnow: ~...
- Brassy Minnow: ~...
- White Sucker: ~3
- Gizzard Shad: ~...

Legend:
- Zoobenthivore
- Omnivore
- Detritivore
What are the sources, abundance, fate, and biological interactions of litter in freshwaters?

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5. Applications, solutions
1. Villa Nova Park
2. Winans Meadow
3. Gwynn Oak Park
4. Gwynn Oak Park (Powder Mill Branch Tributary)
5. Carroll Park
Before Collection

After Collection

Lisa Kim

Anna Vincent
Much more litter in debris dams.
Mostly plastic
Overhanging structures trap litter.

Pliability and lightweight plastic -> higher retention in debris dams.

Moves and ‘sticks’ during floods.
Plastic and leaf litter breakdown – biofilm and invertebrate communities
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1. Microbeads

National level: To ban the manufacture and introduction into interstate commerce of rinse-off cosmetics containing intentionally-added plastic microbeads by July 1, 2017

State level: 9 states have also banned the manufacture and sale of products containing microbeads in personal care products

Sales of shower gels, toothpaste and facial scrubs containing microbeads to be banned from July 1, 2018

Government will introduce a ban of cosmetics containing microbeads from sale by the end of 2017

Government intends to be free of microbeads in cosmetics by the end of 2016
2. Plastic shopping bags

% Customers Using Disposable Bags

<table>
<thead>
<tr>
<th></th>
<th>Pre-Tax</th>
<th>Post-Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago</td>
<td>82.0</td>
<td>48.8</td>
</tr>
<tr>
<td>Non-Chicago</td>
<td>91.5</td>
<td>91.6</td>
</tr>
</tbody>
</table>

% Customers Using Reusable Bags

<table>
<thead>
<tr>
<th></th>
<th>Pre-Tax</th>
<th>Post-Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago</td>
<td>13.2</td>
<td>33.2</td>
</tr>
<tr>
<td>Non-Chicago</td>
<td>5.4</td>
<td>5.6</td>
</tr>
</tbody>
</table>
3. Cigarettes

- Chicago (2.719 million)
- Evanston (75,570)
- Highland Park (pop = 29,902)
- Glencoe (pop = 8,854)
- Milwaukee (pop = 599,164)
- Gary (pop = 78,450)
4. Washing machine water

Cora Ball - Microfiber Catching Laundry Ball

Protect the ocean environment with this easy-to-use laundry ball that catches microfibers shedding off our clothes in the washer.

Pre-order info
Created by Rozalia Project

Knee-high pantyhose = cheap washing machine drain hose filter!
5. Plastic straws

McDonald's to test plastic-straw alternatives in U.S. later this year

Zlati Meyer, USA TODAY
4-5 minutes

CLOSE

A bill proposed in California would make it illegal for restaurant servers to give guests plastic straws unless requested — with the threat of a $1,000 fine or jail time attached. Buzz60
6. Institutional policies
7. Community Engagement

A) Chicago (2.719 million)

B) Evanston (75,570)

Highland Park (pop = 29,902)

Glencoe (pop = 8,854)

Milwaukee (pop = 599,164)

Gary (pop = 78,450)
8. Education

Anna Vincent

Micah Zaker

Task 2: Construct a model to explain how the bottle cap on my plastic water bottle might find its way inside the bird. Include a minimum two (2) sentence explanation for your model (found on page 3).

Drawn Model

How do you know the garbage is?
9. Infrastructure

Thank you MWRD, regional citizens, governments
Many sources, many solutions

We all contribute to pollution. All are welcome and valued in contributing to solutions.

Education, engagement, and change is possible with optimism and inclusivity.
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Thank you

**Senn High School:**
- Brandon Cifuentes
- Aamina Siddiqui
- Fatima Ghulam

**Loyola Undergraduate Students:**
- Lisa Kim
- Brenainn Turner
- Amanda McCormick
- Anna Vincent
- Loren Hou
- Elizabeth Berg

**Loyola Graduate Students:**
- John Kelly
- Sherri Mason
- John Scott
- Lara Smetana
- Paul Chiarelli
- Jennifer Tank
- Olga Lyandres
- Elie Rivkin
- Abby Barrows
- Caleb McMahan

**Post-doctoral Scholars**
- Rachel McNeish
- Sam Dunn

**Collaborators:**
- John Kelly
- Sherri Mason
- John Scott
- Lara Smetana
- Paul Chiarelli
- Jennifer Tank
- Olga Lyandres
- Elie Rivkin
- Abby Barrows
- Caleb McMahan

**Institutions**

**Cities, Parks**
- Saugatuck Pines & Trails
- Menominee
- Manistee Michigan
- Baltimore County, Maryland
- Milwaukee
- Alliance for the Great Lakes
- Friends of the Chicago River
- The Field Museum

**Funding**
- Marine Debris Program, NOAA
- Illinois Sea Grant
- NSF CAREER