



# Microplastics and Plastics Debris in the Great Lakes

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**Ontario Ministry of the Environment, Conservation and Parks**

# Contributions to Today's Discussions

- Highlight information available on the presence of plastic and microplastics in the Great Lakes region
  - Shoreline clean-up information
  - Microplastics monitoring
  - Occurrence in organisms
  - Reported incident response
- Debris characteristics as source indicators
- Provide guidance for discussions to address plastics and microplastics



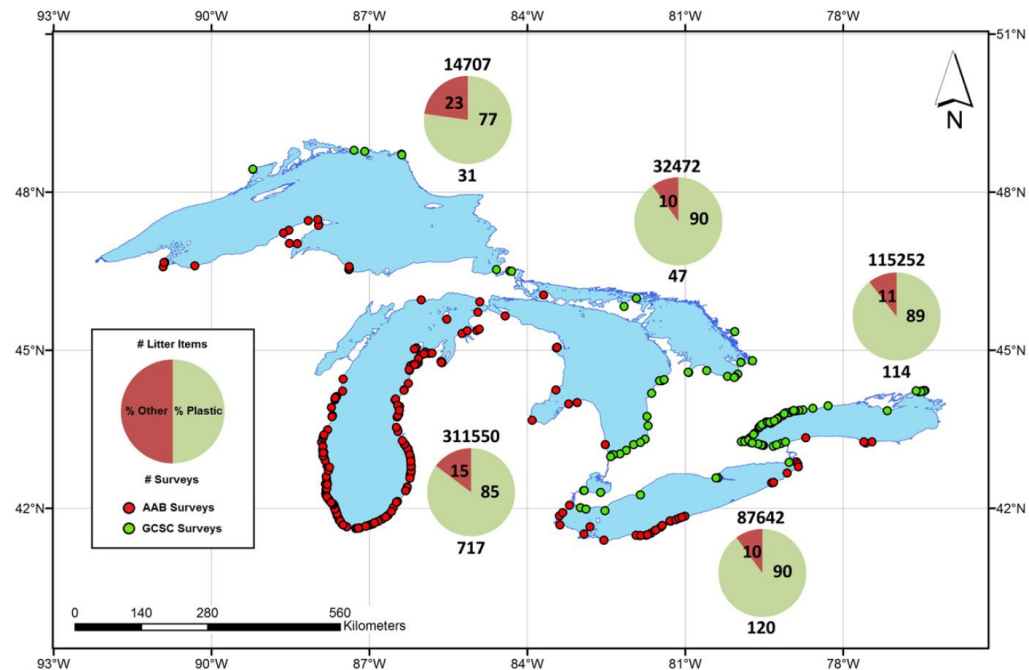
# Information on plastic/litter debris in the Great Lakes available from citizen-based cleanups

## Citizen Cleanups

- Great Canadian Shoreline Cleanup
- Adopt-A-Beach (US)
- Earth Day cleanups
- Watershed / Community / School clean ups

**Apps / online tools to aggregate and view data**

- Clean Swell
- World Cleanup
- Litterati – Clean the Planet



Driedger et al. 2015  
J. Great Lakes Research



# Canada's Dirty Dozen

## (2017 ranking)

Rank	Item	# Removed
1.	Tiny Plastic and Foam	333,289
2.	Cigarette Butts	244,734
3.	Plastic Bottles	50,285
4.	Food Wrappers	47,466
5.	Bottle Caps	38,624
6.	Paper Materials	22,877
7.	Plastic Bags	22,724
8.	Miscellaneous Packaging	18,465
9.	Straws	17,654
10.	Foam Materials	17,527
11.	Beverage Cans	17,327
12.	Rope (1 piece = 1 metre)	11,365

# Toronto Area Litter Data - 2017

Rank	Item	# Removed
1.	Cigarette Butts	49,124
2.	Tiny Plastic and Foam	31,529
3.	Bottle Caps	12,105
4.	Food Wrappers	8,626
5.	Straws	5,784
6.	Plastic Bottles	5,432
7.	Miscellaneous Packaging	3,725
8.	Foam Materials	3,521
9.	Plastic Bags	3,483
10.	Paper Materials	3,234
11.	Beverage Cans	3,163
12.	Plastic Utensils	2,069

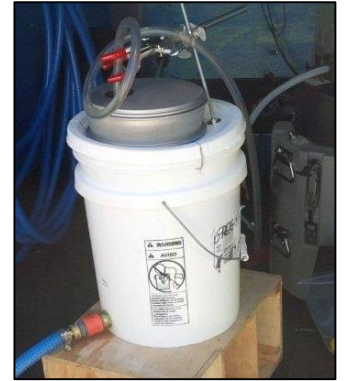
## Litter data provides:

- **Major/minor sources of litter**
- **Local to global scale information**
- **Citizen science opportunity**
  - Measure your impacts
  - Assess personal behaviour

# Information about microplastics in the Great Lakes available through scientific studies

## Scientific Studies

- Foundation / government grant-funded research
- Academic / government monitoring surveys
- Global scientific literature
  - Beach Surveys
  - Sediment, Surface Water, Organisms
  - Exposure / effects studies



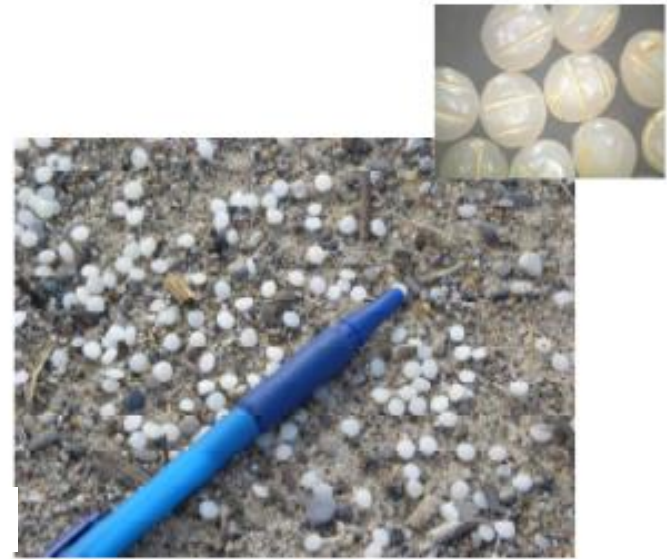
## Citizen Science / Education / Outreach Initiatives

- eXXpedition
- TRCA Watershed on Wheels
- Ontario Streams



# Pre-production pellets (“nurdles”) washing up on Great Lakes beaches

- **Noted in Lake Huron in 2007**



Lake Huron Centre for Coastal Conservation, 2010

Water Air Soil Pollut (2011) 220:365–372  
DOI 10.1007/s11270-011-0760-6

## Shores of Lake Huron awash in plastic pellets

[PATRICK WHITE](#)

The Globe and Mail

Published Wednesday, Oct. 13 2010, 10:22 PM EDT

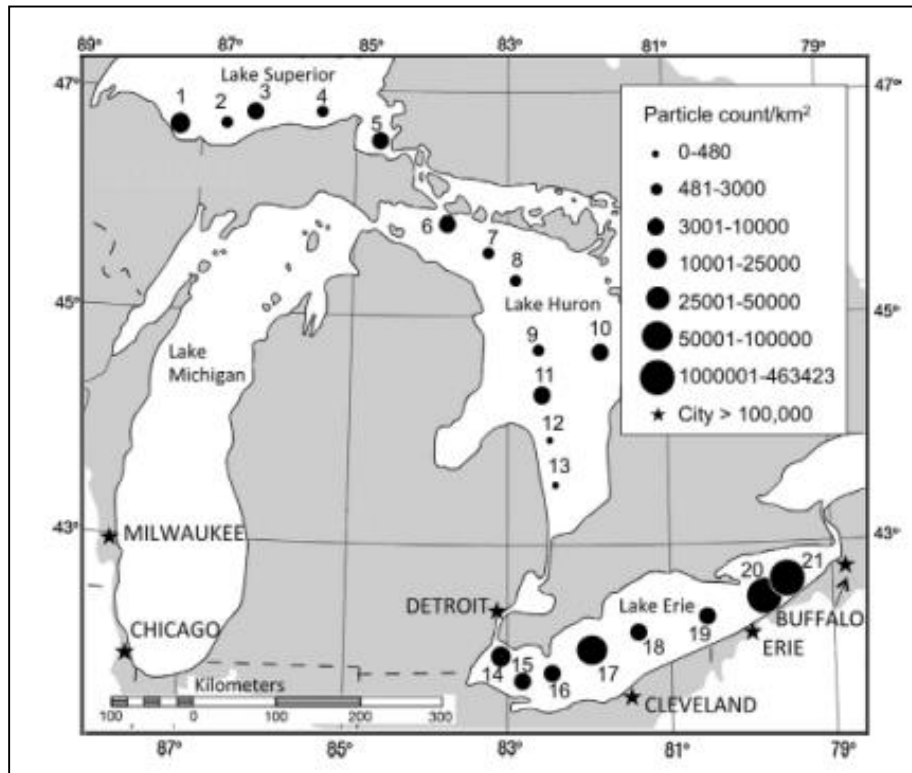
## Distribution and Degradation of Fresh Water Plastic Particles Along the Beaches of Lake Huron, Canada

7

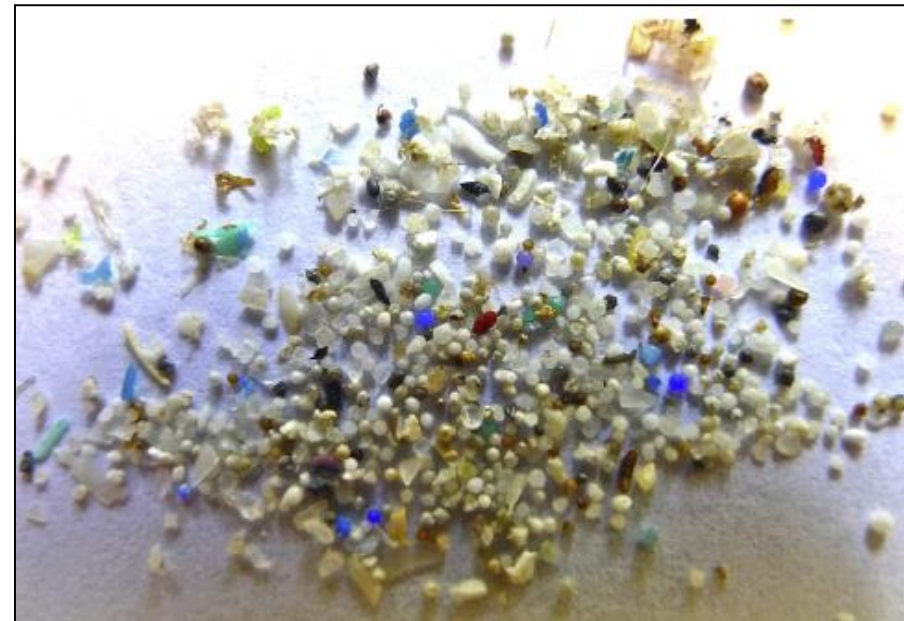
Maciej Zbyszewski • Patricia L. Corcoran

# Microbeads found in surface waters of the Great Lakes

- Lakes Superior, Huron, Erie (2012)



Max: 463,000 / km²





# Sampling for Microplastics

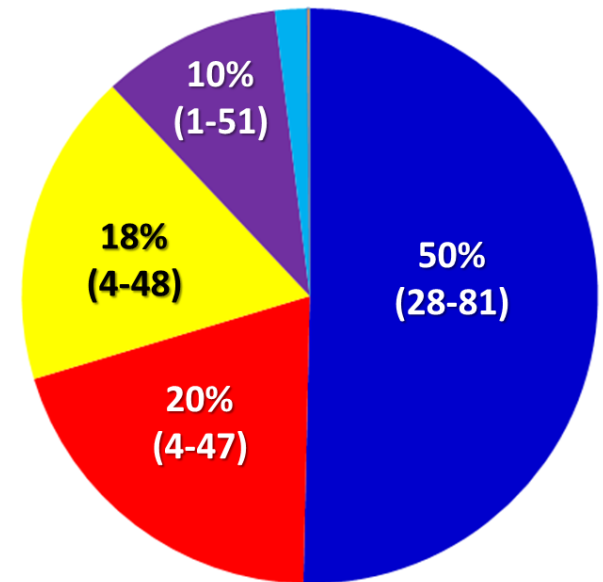
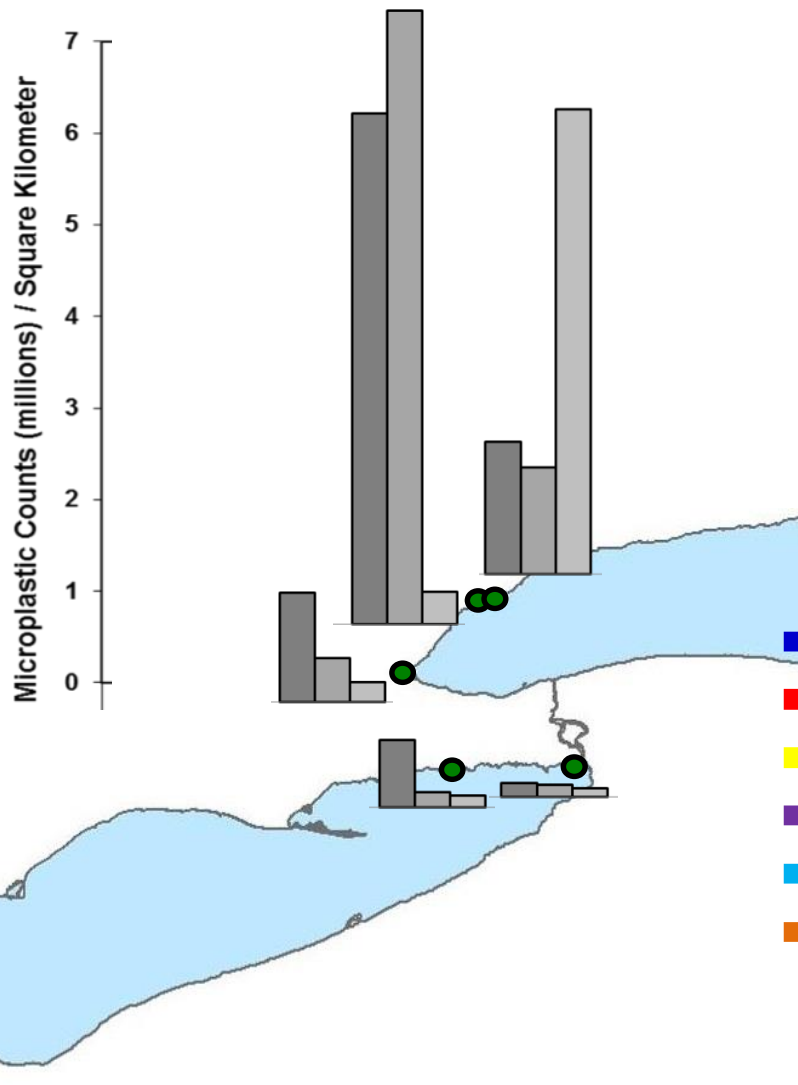
## Collection:

Water – Plankton Nets (335; 363 $\mu$ m),  
Sieves, Filtration

Sediment – Bulk Collections



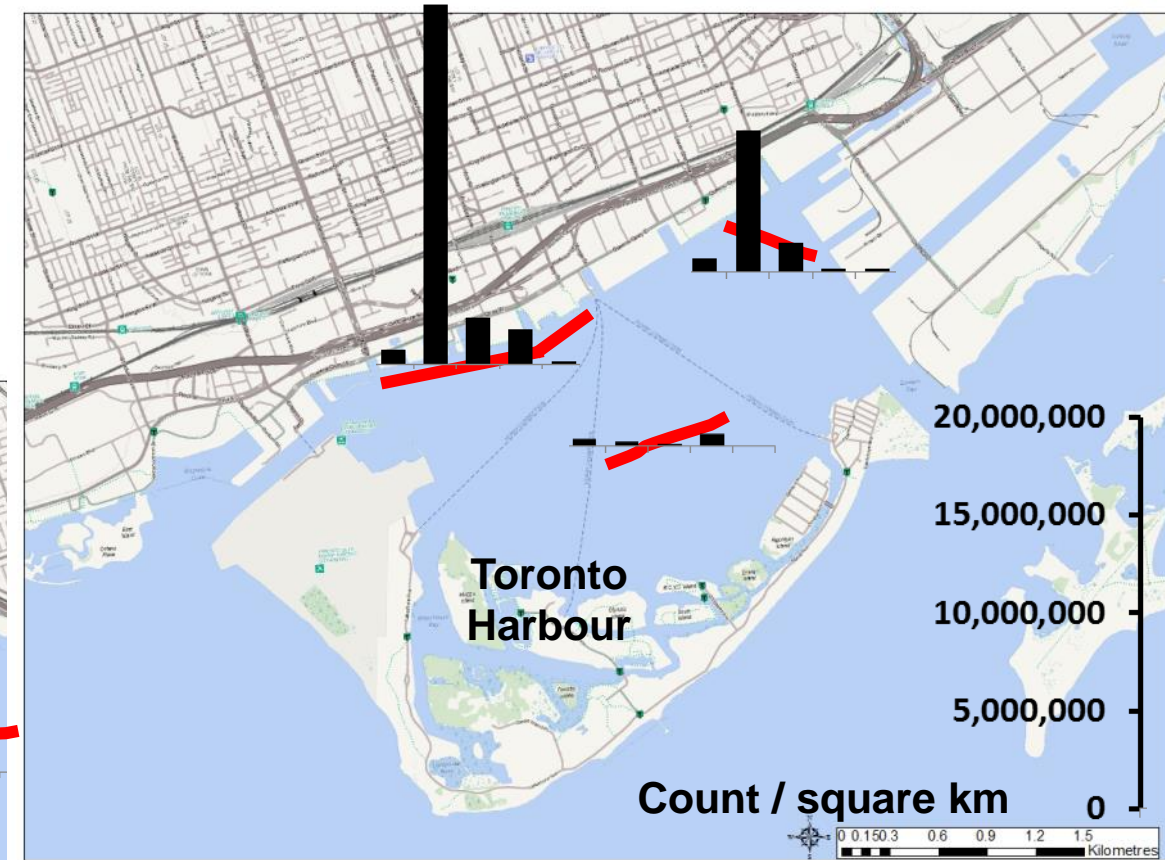
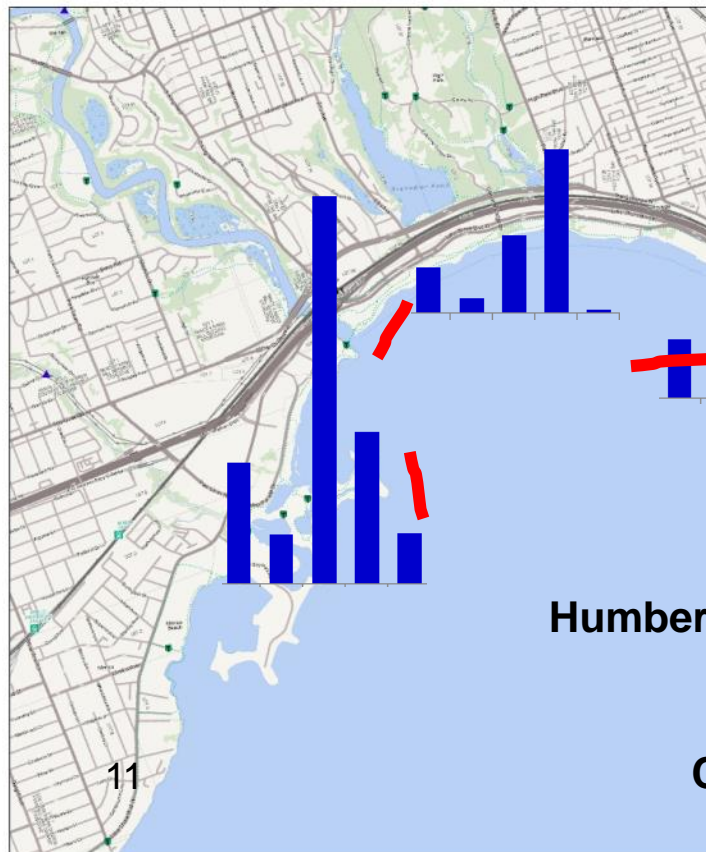
# Microplastics more abundant near urban centers - MECP 2014 Surface Water Trawl Results



Categories (potential sources)

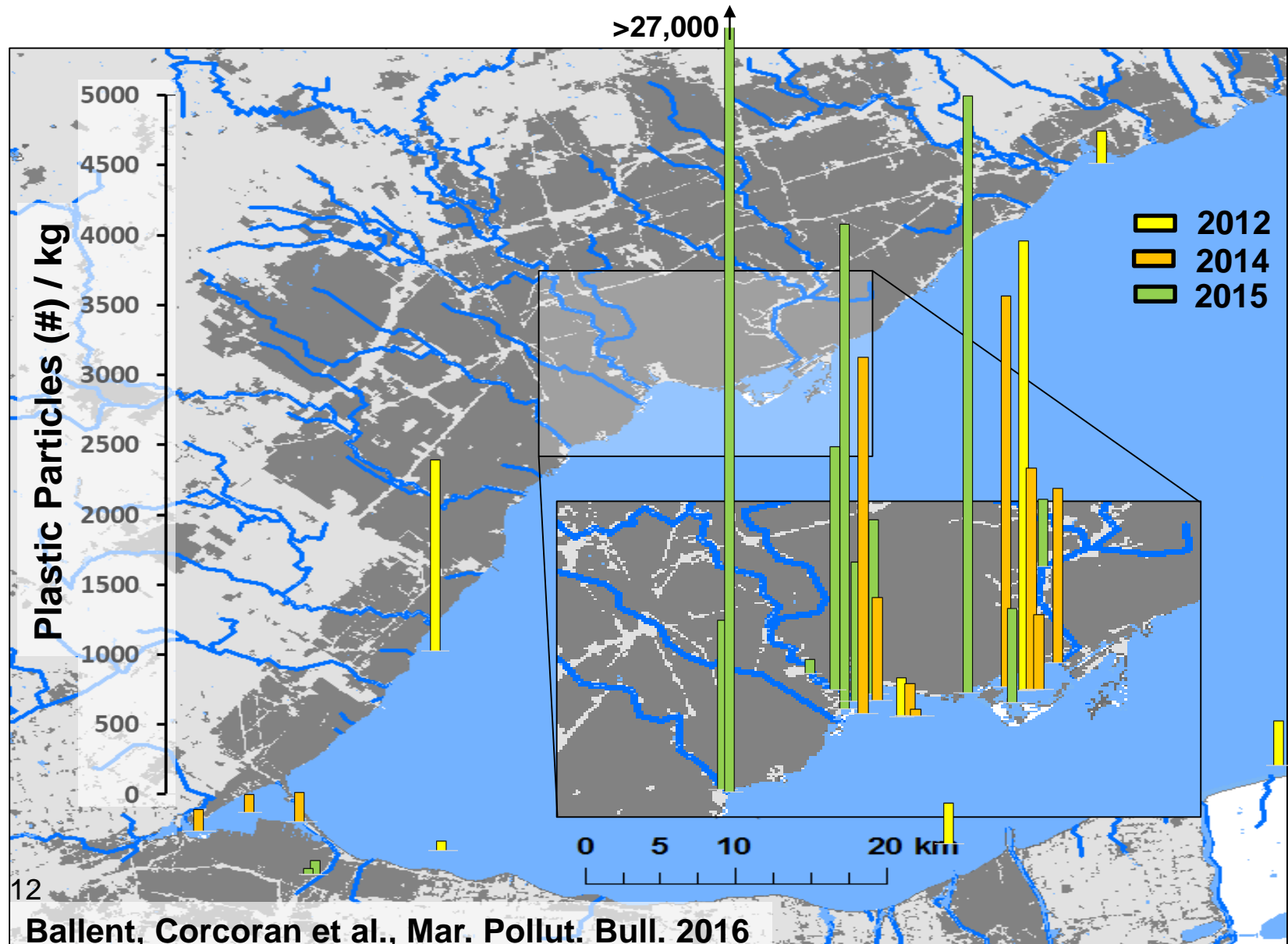
- Fragments** (litter, commercial processes)
- Microbeads** (personal care products)
- Line/Fibers** (rope, line/net, clothing, cig butts)
- Foam** (packing, food containers, insulation)
- Film** (plastic bags, wrapping)
- Production Pellets / "Nurdles"**

# Greatest abundances near points of input to the lakes – MECP trawl results from 2015



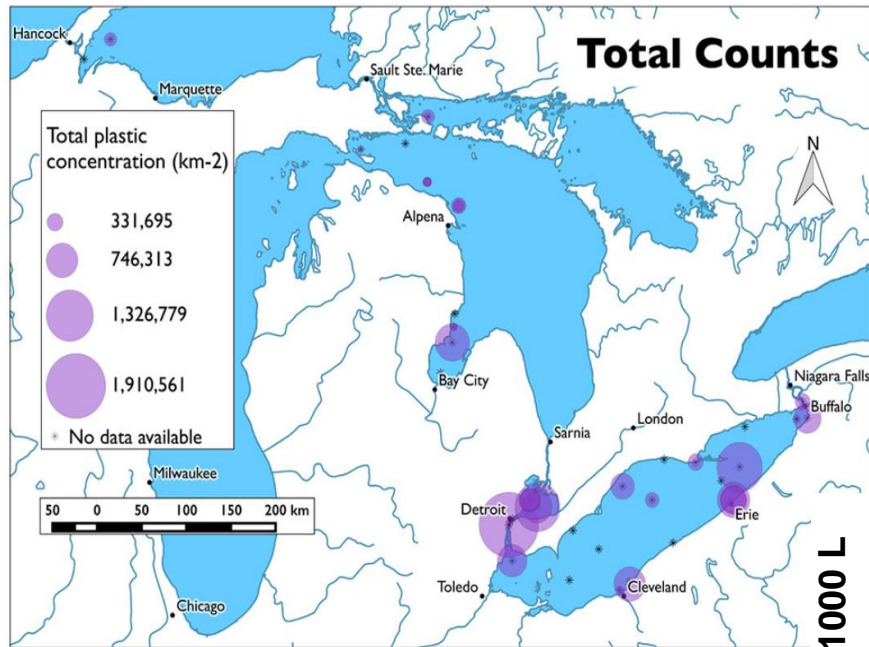


# Relatively high microplastic concentrations in bottom sediment near Toronto

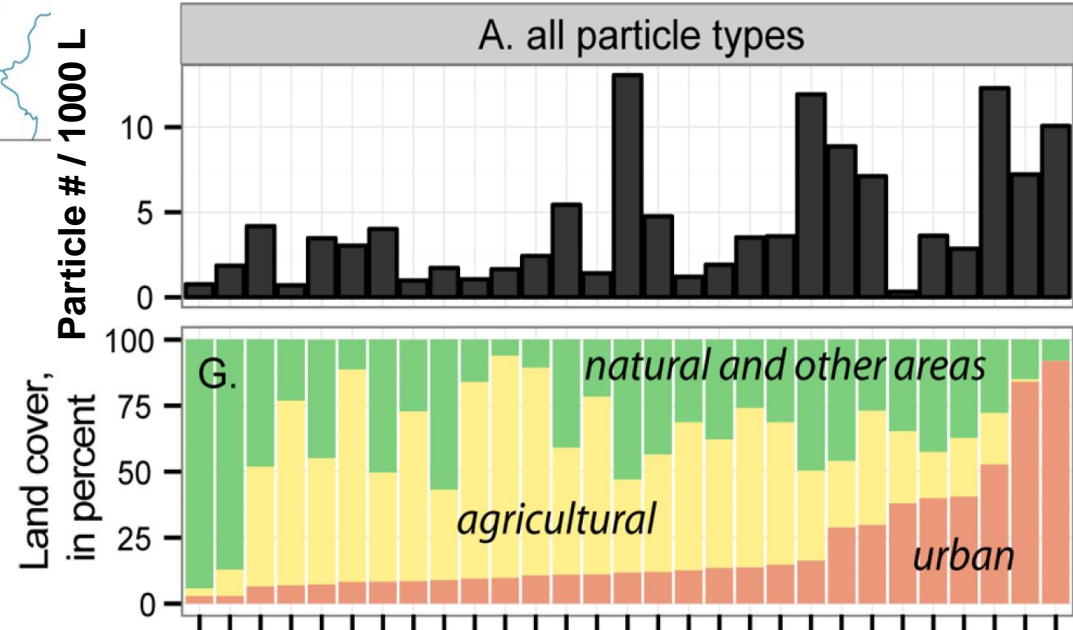




# Ontario findings are consistent with measurements in other areas of the Great Lakes



Cable et al., 2017; Frontiers in Environmental Science



Baldwin et al., 2016, Environmental Science & Technology

# Current categorization of microplastic is broad, inconsistent

## Typical Categories

- Fragment
- Foam
- Fiber
- Film
- Pellets

Source specific?

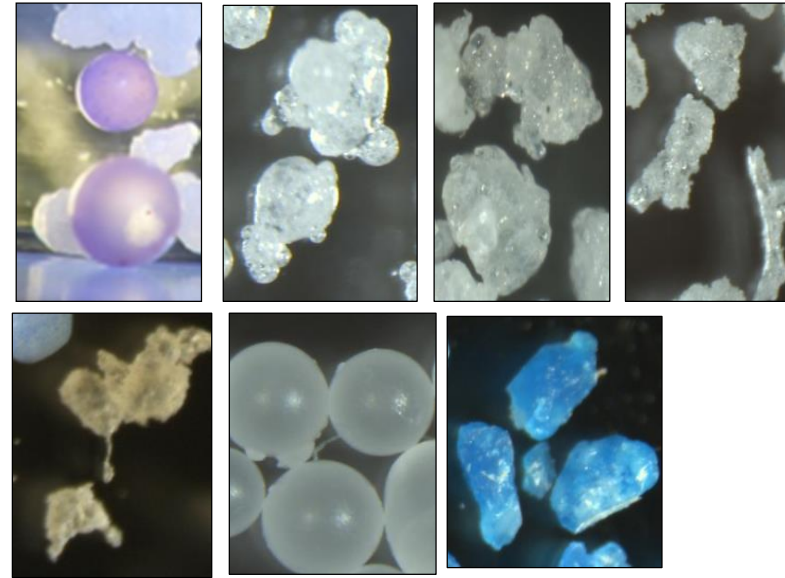
Guide management decisions?

## Alternative Categories

- Fragment
- Commercial Fragments
- Spherical Microbeads
- Irregular Microbeads
- Foam
- Fiber
- Film
- Pre-production Pellets

More source-specific ✓

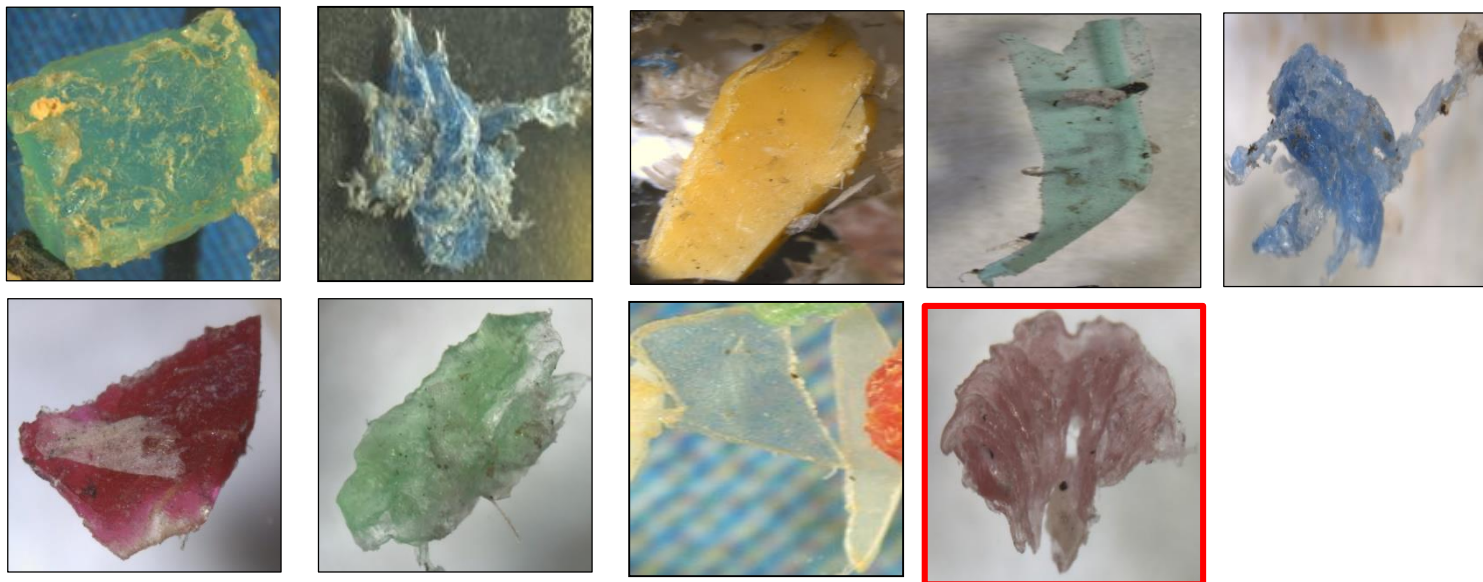
Potential to guide management decisions ✓



## How to categorize microbeads?

- Irregular microbeads likely included as “Fragments”
- Spherical microbeads sometimes included as “Pellets” (along with pre-production pellets)

# Fragment shape/type (morphology/taxonomy) may provide an indication of sources



**Fragments:** Litter/debris-derived & “other” polymeric material

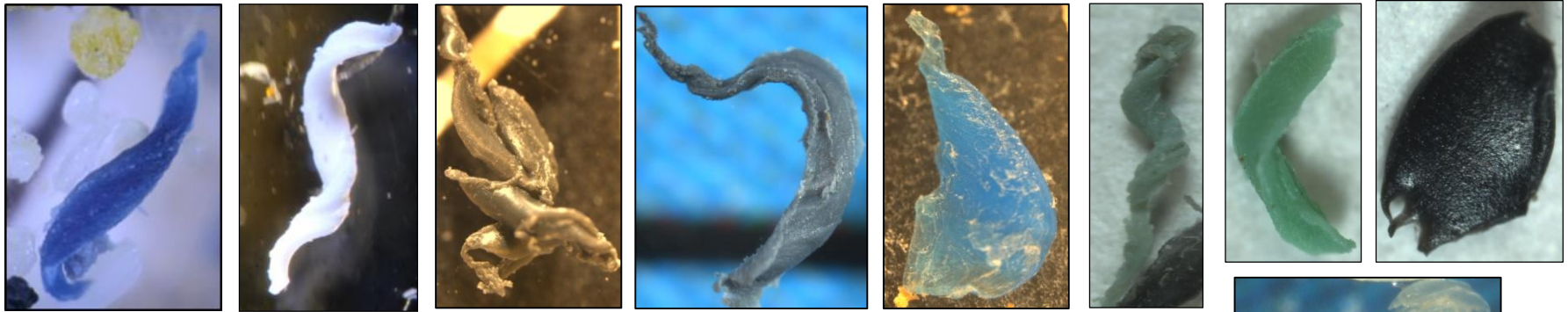
## Evidence

- Residential street debris
- Taken from larger litter items
- Broken up pieces

## Character

- Irregular, jagged, angular edges
- Hard, unable to compress
- Glossy or dull, multi-colours
- May be abraded, contain patterns
- Soft black tar-like material

# Particles with character indicative of commercial activities found with regularity



## Commercial Fragments:

Plastic product manufacture/recycling, building material cutting



## Evidence

- Plastics recycler site spill materials
- In-house cuttings
- Verbal communications

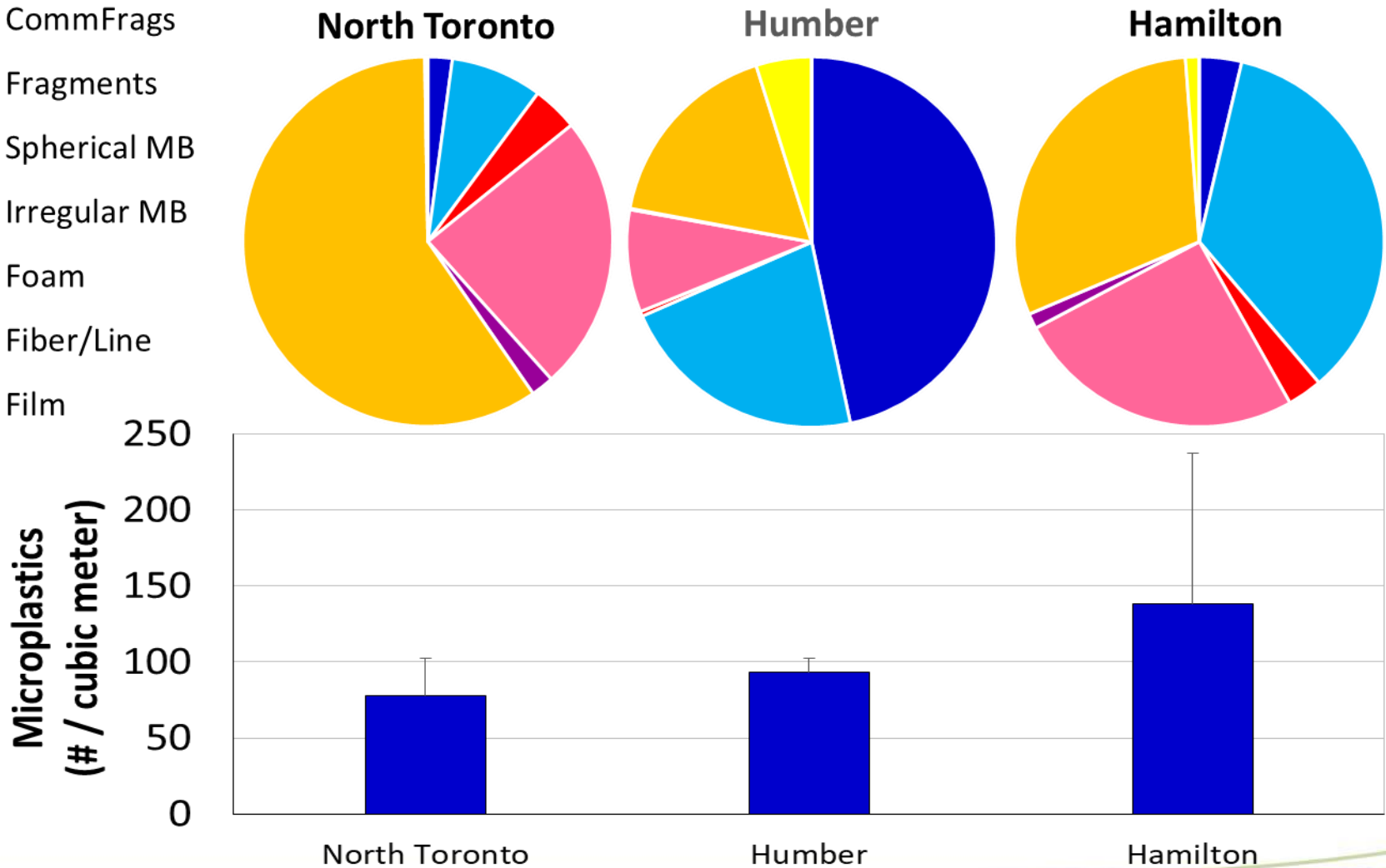
## Character

- Twisted and curled, shaved off
- Accordion pattern from cutting
- Range of colours, firm and rigid
- Melted drops, clumps; cooled, hard
- Uni-directional flow striations



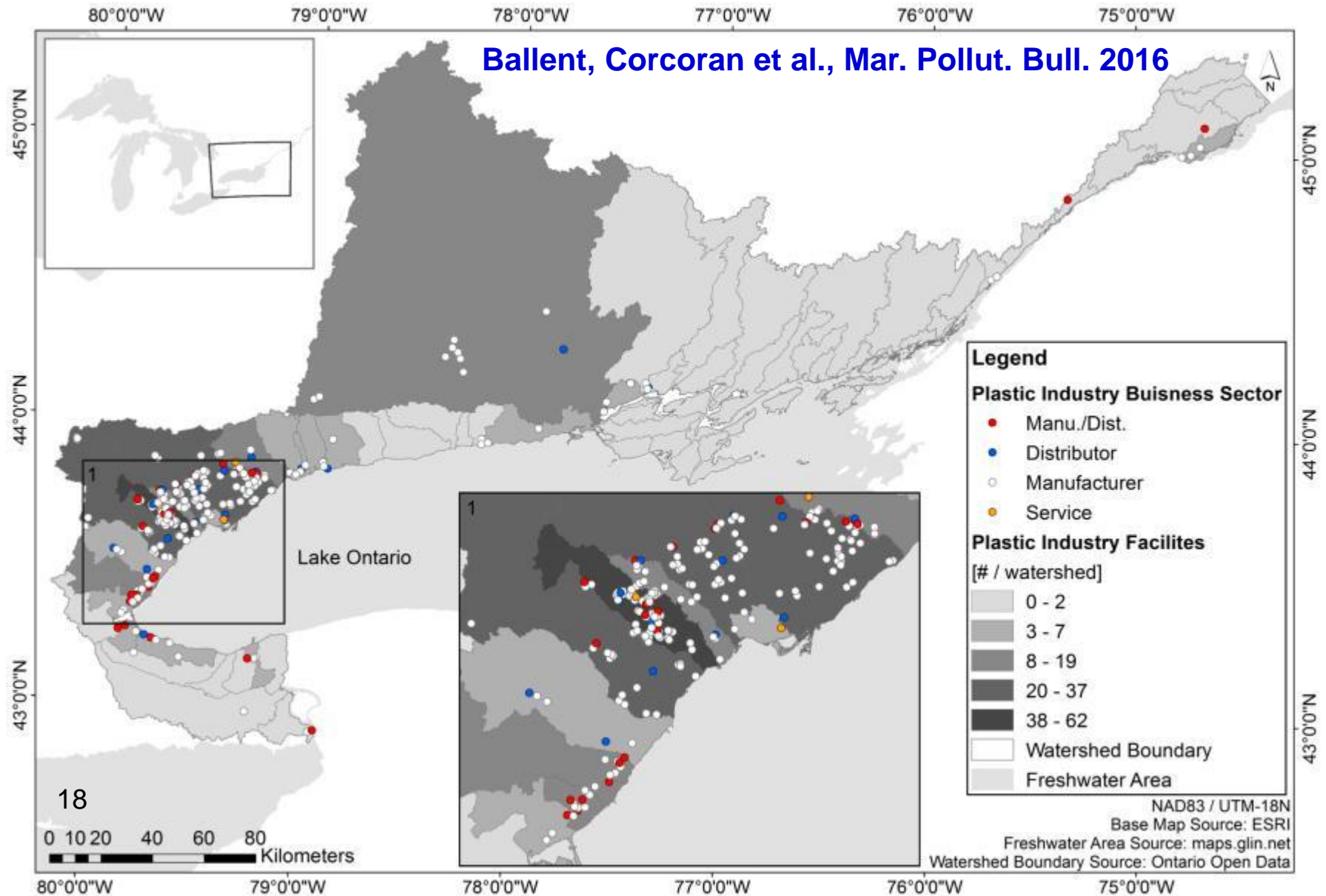
# Refined categories indicate different sources to WWTPs

- CommFrag
- Fragments
- Spherical MB
- Irregular MB
- Foam
- Fiber/Line
- Film

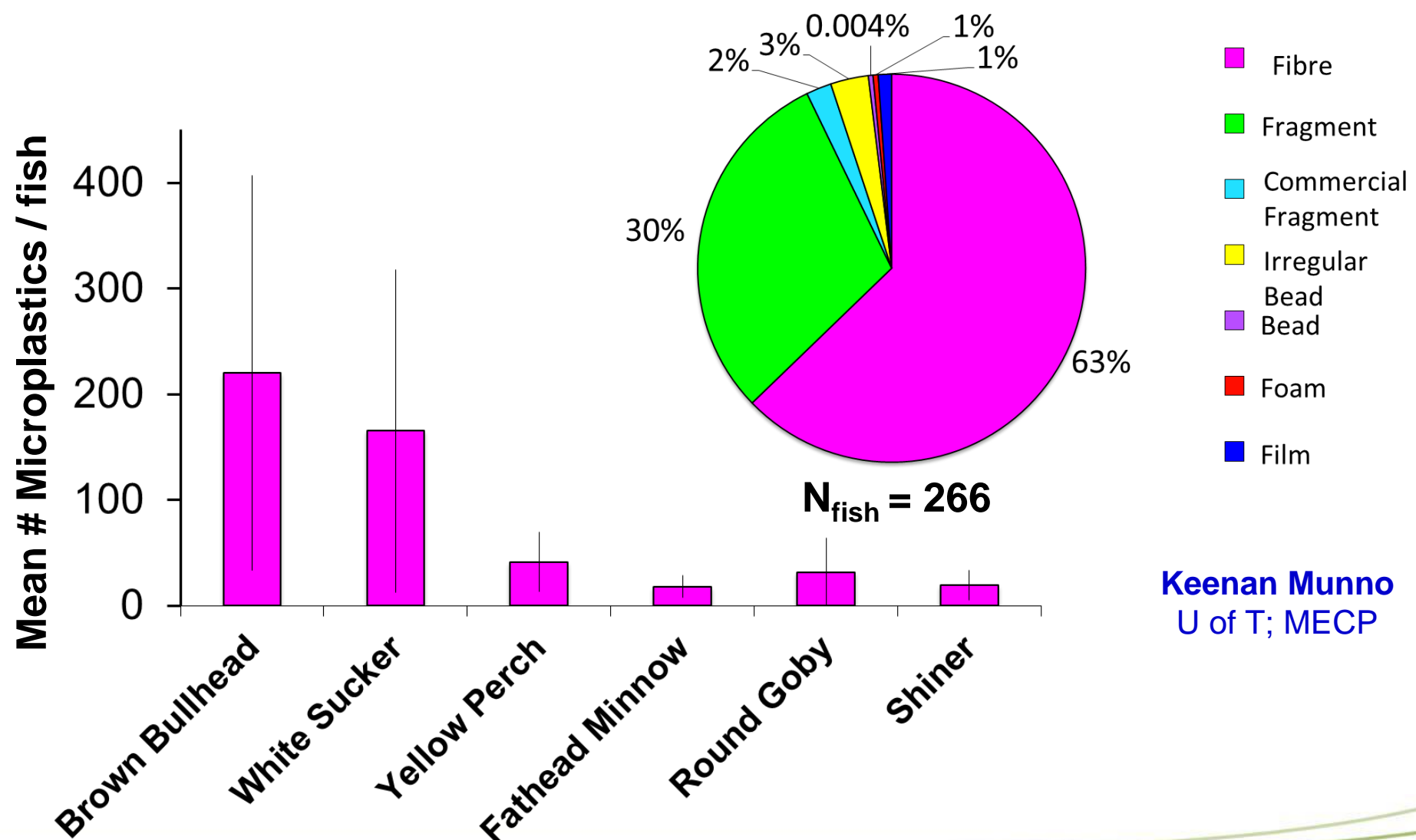


# Locations of plastics-based businesses align with abundance and particle type observations

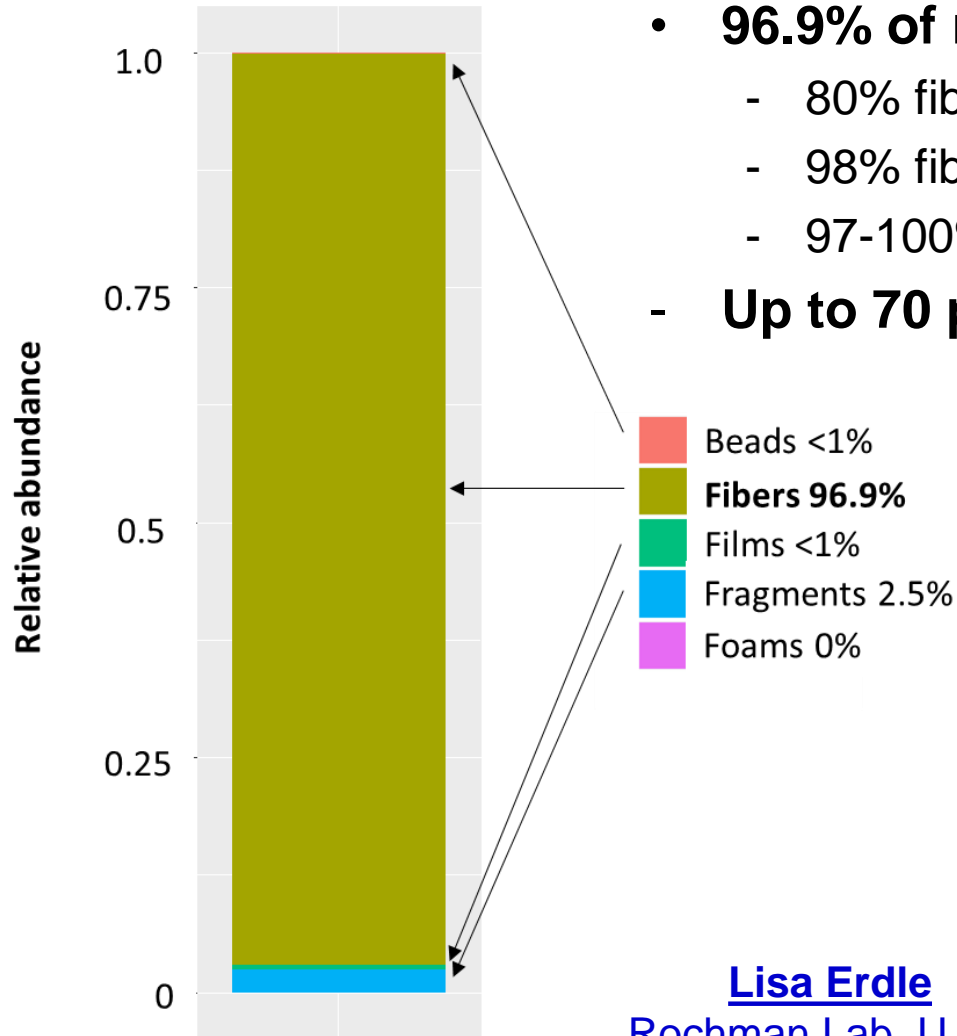
Ballent, Corcoran et al., Mar. Pollut. Bull. 2016



# Inputs of plastics to nearshore Lake Ontario evident in Toronto area fish



# Offshore Great Lakes fish: Microfibers are the dominant form of microplastics



- **96.9% of microplastics in fish are fibers**
  - 80% fibers (Rochman et al., 2015)
  - 98% fibers (Wieczorek et al., 2018)
  - 97-100% fibers (McNeish et al., 2018)
- **Up to 70 plastic particles per fish**



Lake trout  
(*Salvelinus namaycush*)



Rainbow smelt  
(*Osmerus mordax*)

**Lisa Erdle**  
Rochman Lab, U of T



# Some activities have generating complaints of plastics entering the environment

**Environmental Officers respond to incidents, complaints** (e.g. to Spills Action Center)

- **Recycling and transportation, storage**
  - E.g. Insufficient containment, maintenance
- **Building material debris on neighbouring properties**
  - E.g. polystyrene “snow”



(A photo of the white plastic "nurdles" found in the Eramosa River by Bryan McNeill. - Submitted photo. TheRecord.com, Dec. 29, 2017)



# Polystyrene “snow” easily enters waterways



**Polystyrene  
insulation board;  
cutting, preparing  
for stucco**



# Environmental occurrence studies provide useful information on the wide variety of sources to consider

- **Citizen cleanups provide an indication of the most numerous debris items in watersheds and along shorelines**
- **Microplastics monitoring in the Great Lakes surface water indicates the following major particle types:**
  - Fragments (from both litter/debris and commercial activities)
  - Fibers
  - Microbeads (from personal care products)
  - Foam (polystyrene)
- **MECP incident / complaint responses an indicator of management aspects for consideration**



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