Contamination of Plastics and Associated Chemicals in the Environment

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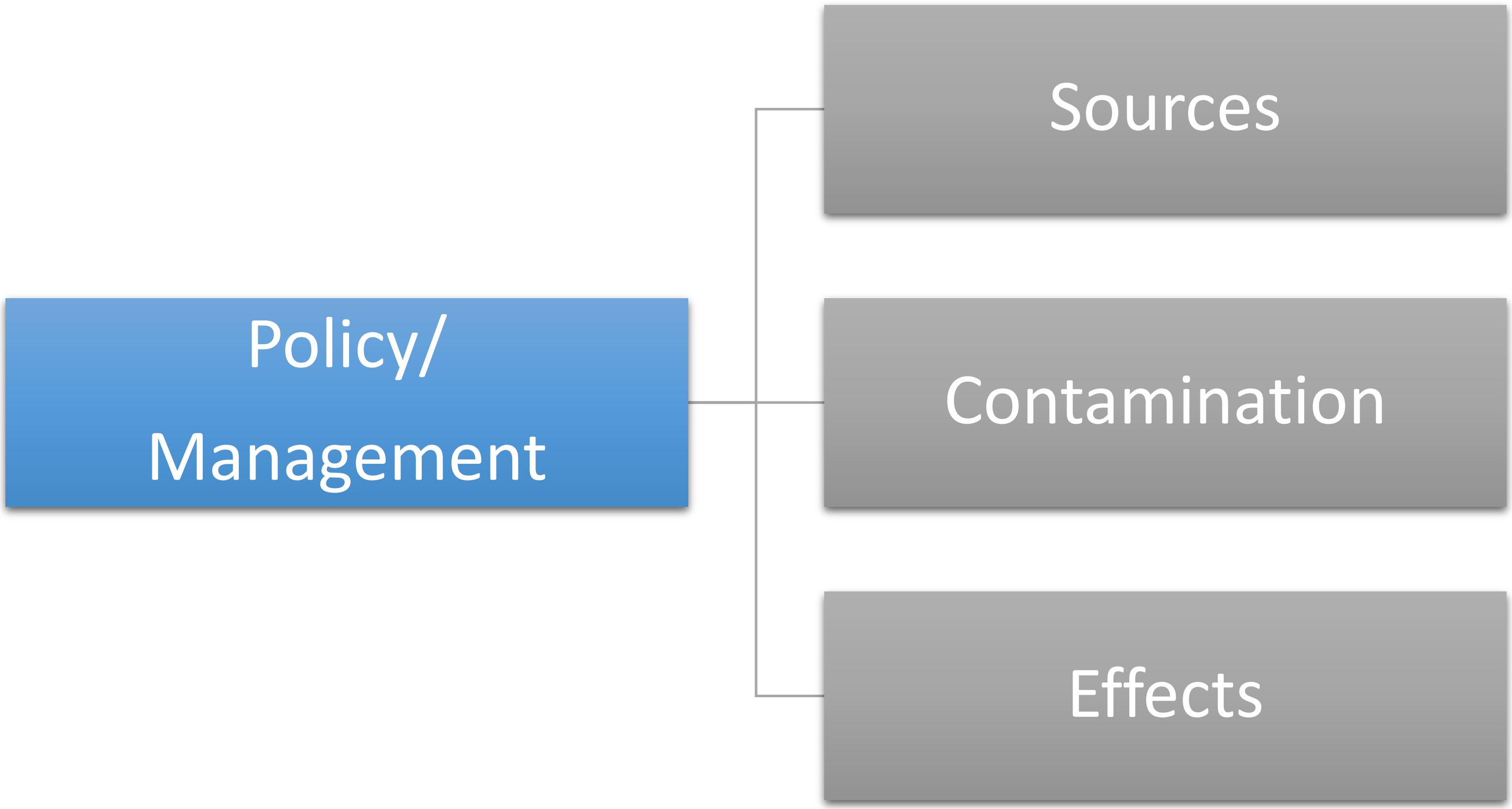
Ocean Conservancy

U of T Trash Team

UNIVERSITY OF TORONTO

Informed by Science



Ocean Conservancy

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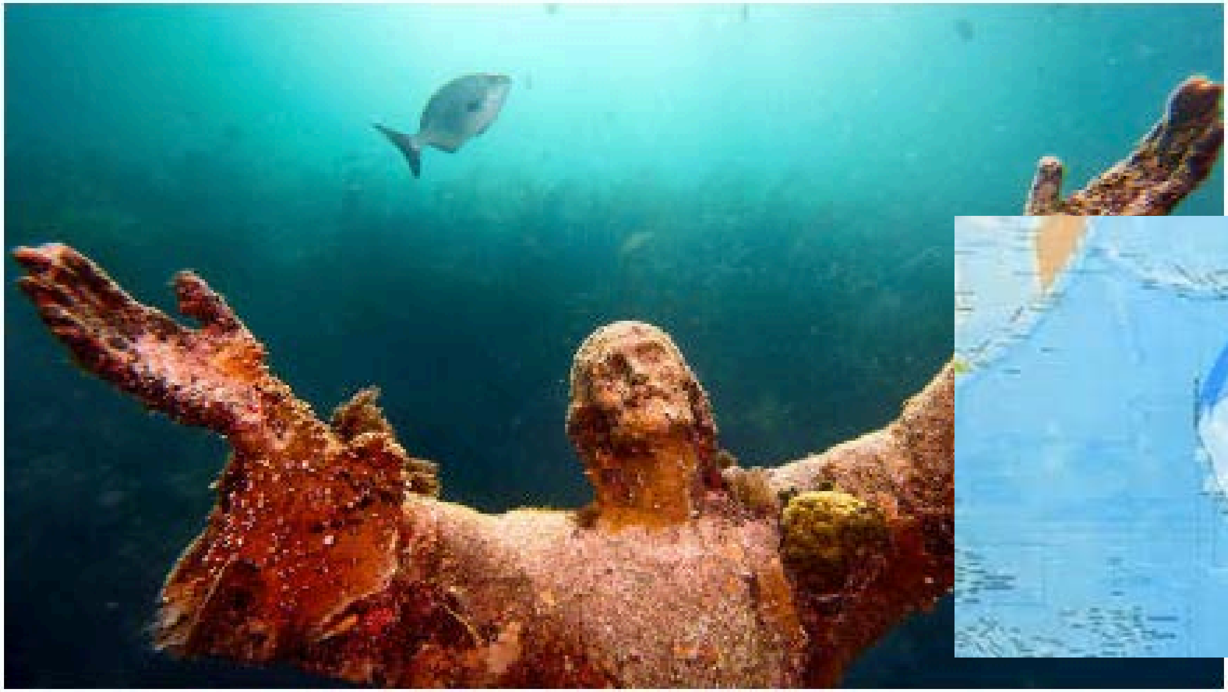
Altered Oceans Part Four: Plague of Plastic Chokes the Seas



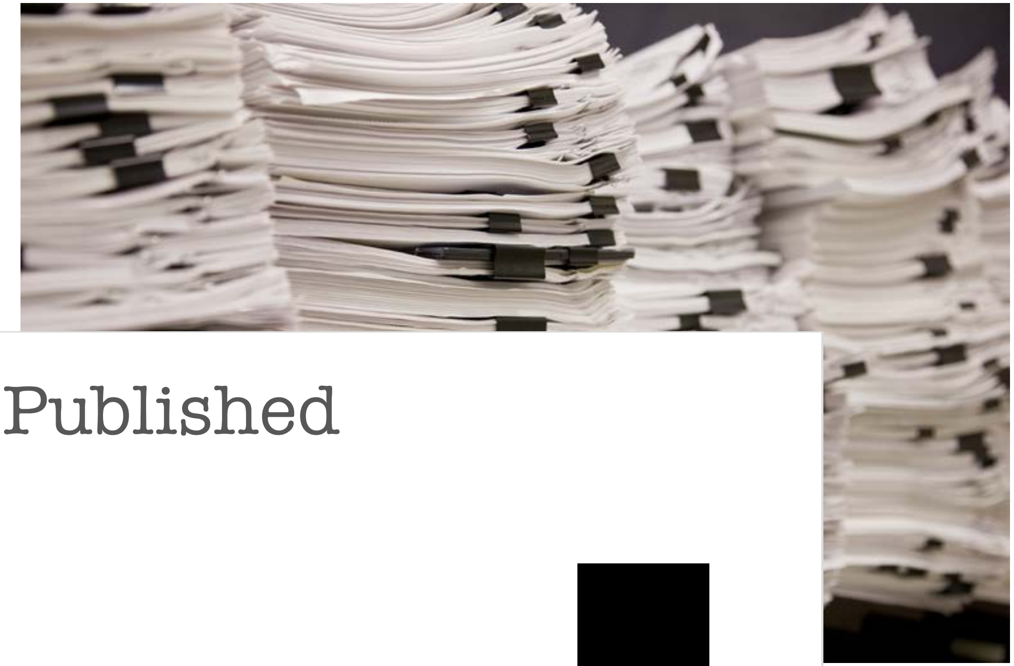
This five-part series on the crisis in the world's oceans was published in July and August of 2006. The series – by reporters Kenneth R. Weiss and Usha Lee McFarling and photographer Rick Loomis – won the 2007 Pulitzer Prize for explanatory reporting.

By Kenneth R. Weiss

AUGUST 2, 2006 | REPORTING FROM MIDWAY ATOLL

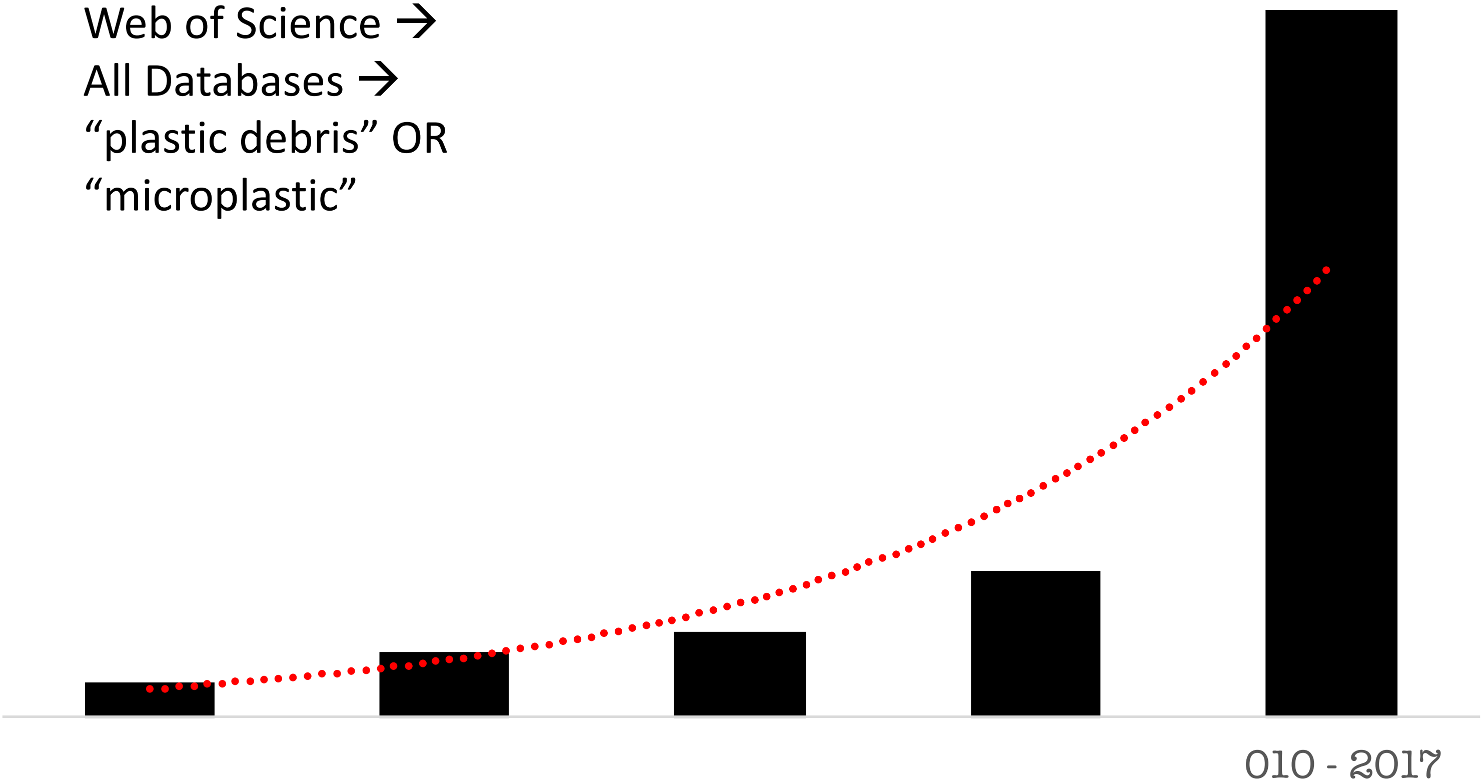
The albatross chick jumped to its feet, eyes alert and focused. At 5 months, it stood 18 inches tall and was fully feathered except for the fuzz that fringed its head.

All attitude, the chick straightened up and clacked its beak at a visitor, then rocked back and dangled webbed feet in the air to cool them in the afternoon breeze.



Manuscripts Published

Web of Science →
All Databases →
“plastic debris” OR
“microplastic”



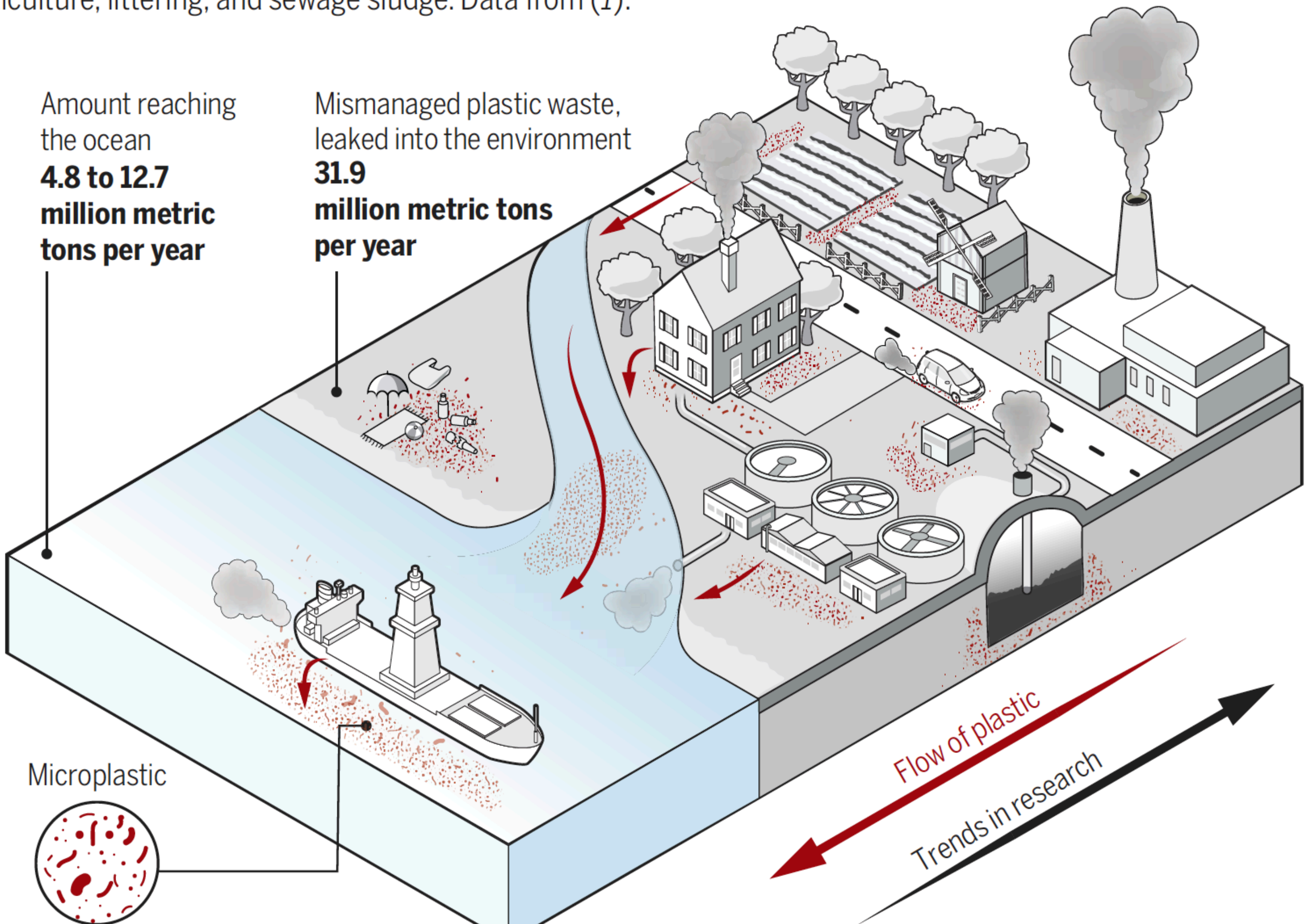
Contamination

Macroplastics (>5 mm)

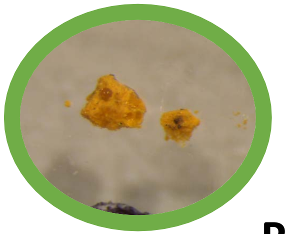
Microplastics (< 5mm)

Microplastics everywhere

High amounts of microplastics have been found not just in the sea and on beaches, but also in rivers and soils around the world, demonstrating how pervasive this modern pollution is. Sources include leakage from landfills, plasticulture, littering, and sewage sludge. Data from (*1*).



Rochman, 2018 *Science*



<u>Microplastics</u>

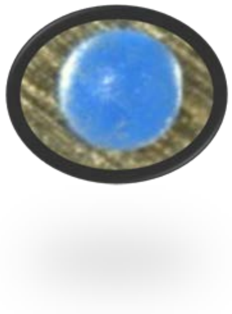
Primary vs. Secondary (broken down bits of larger plastic products)

Categories (shape) – fragments, fibers, foam, sphere, pellet, film

Polymer Type – PP, PE, PVC, PET, PS, acrylic, styrene butadiene, PC, nylon…

Chemical Additives – UV Stabilizers, Flame Retardants, Plasticizers, etc…

Size – nm to µm to mm




LIFE

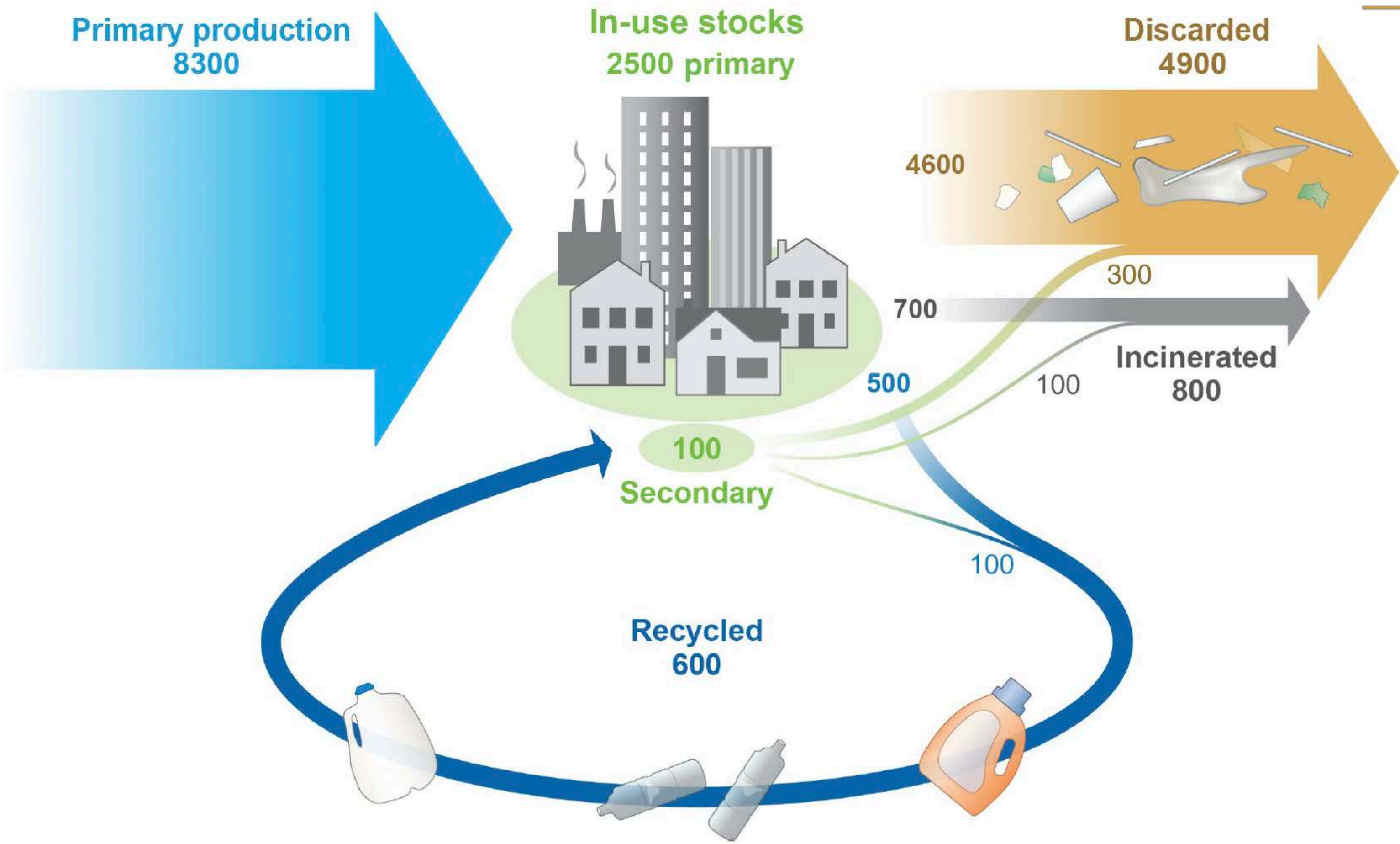
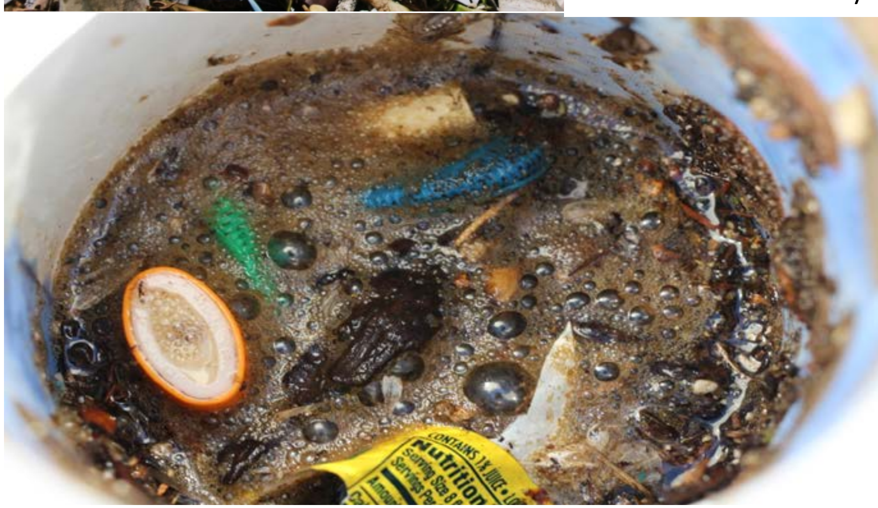


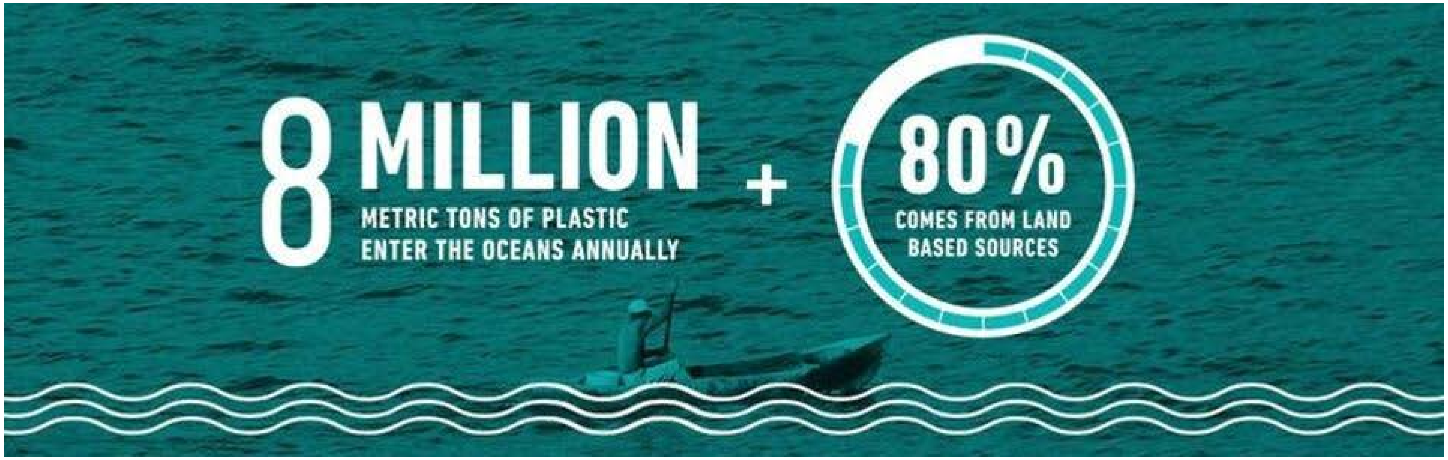
Fig. 2. Global production, use, and fate of polymer resins, synthetic fibers, and additives (1950 to 2015; in million metric tons).

Geyer et al., 2017 *Science Advances*

Photo Credit: Tim Kelly

Photo Credit: earthknight





Jambeck et al., 2015 *Science*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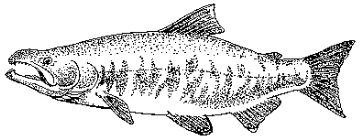
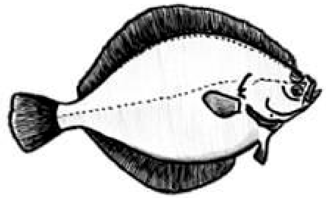
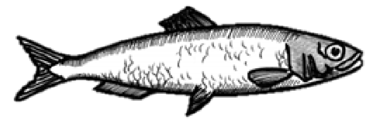
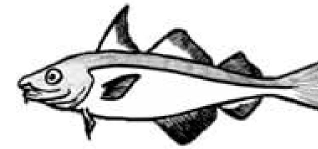
>800 species

Secretariat of the Convention on Biological Diversity, 2016

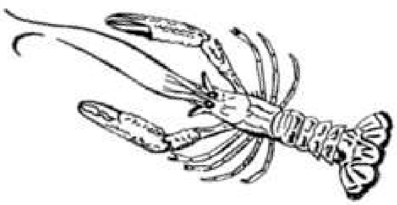
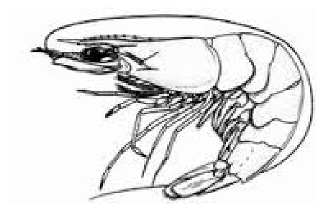
>220 species

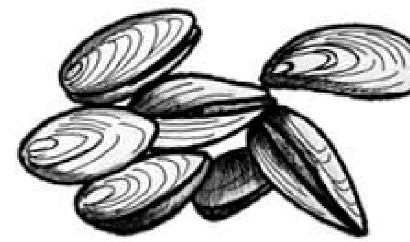
FAO Report 2017

49 species commercial fish

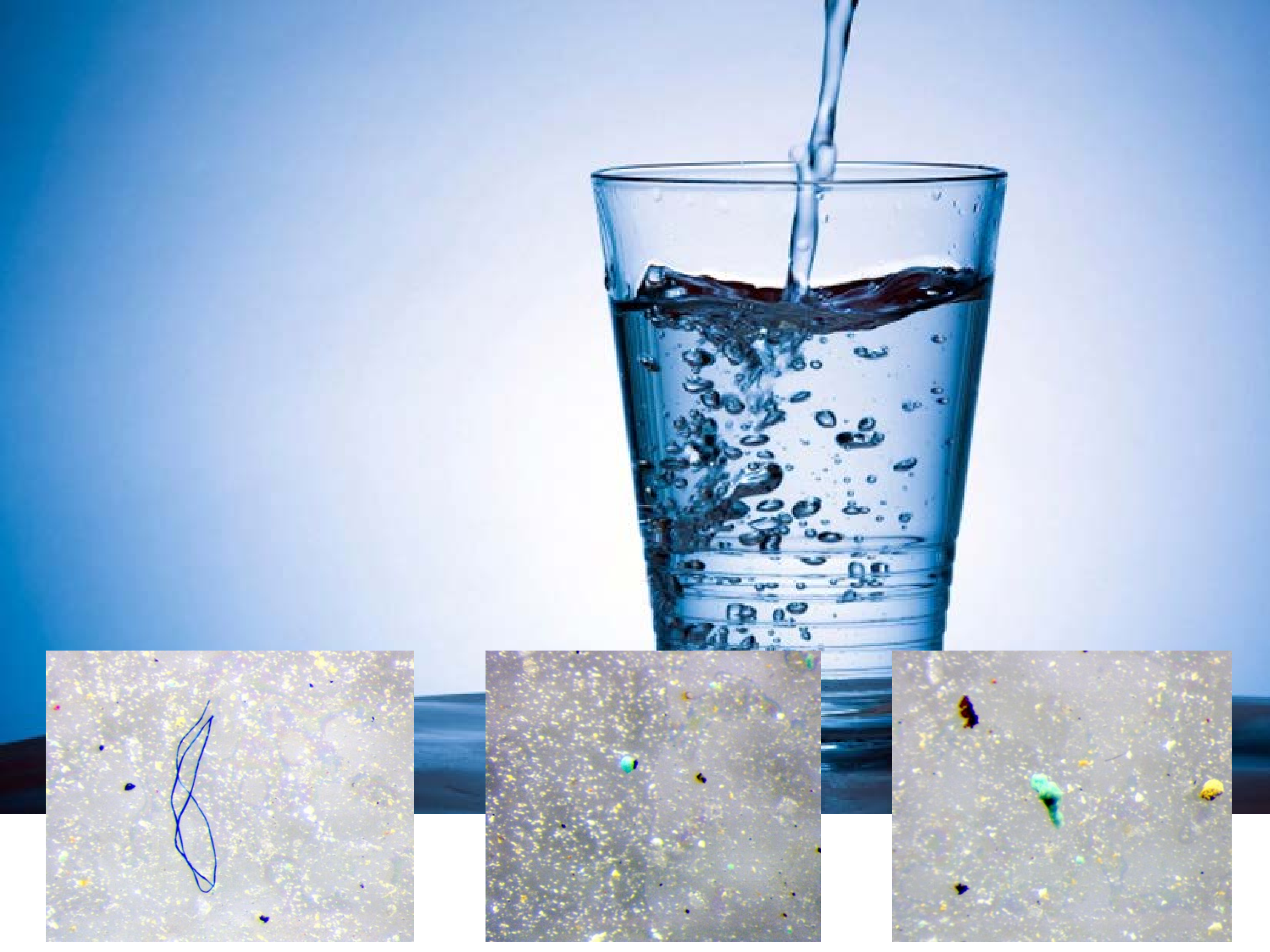
Many species of shellfish

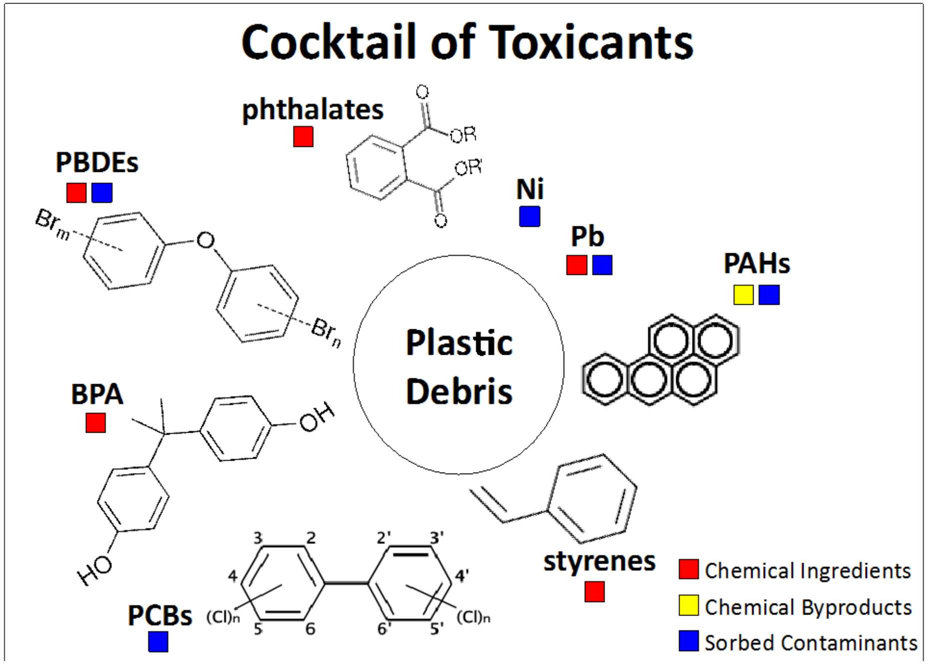


Other commercial products

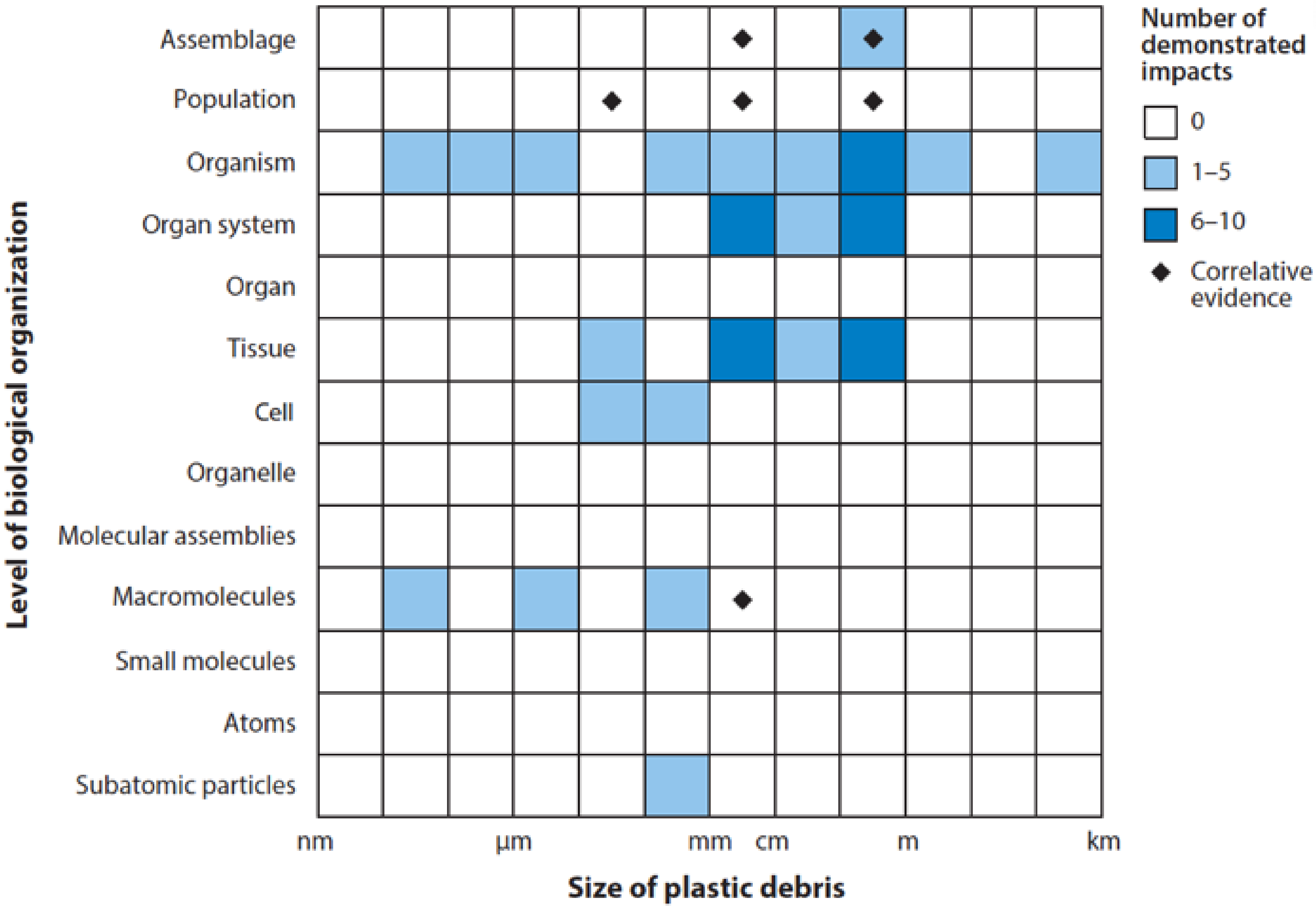
Rochman et al., 2015; van Cauwenberghe and Janssen, 2014; Li et al., 2015; Yang et al., 2015; Davidson and Dudas, 2016



Impacts can be physical or chemical

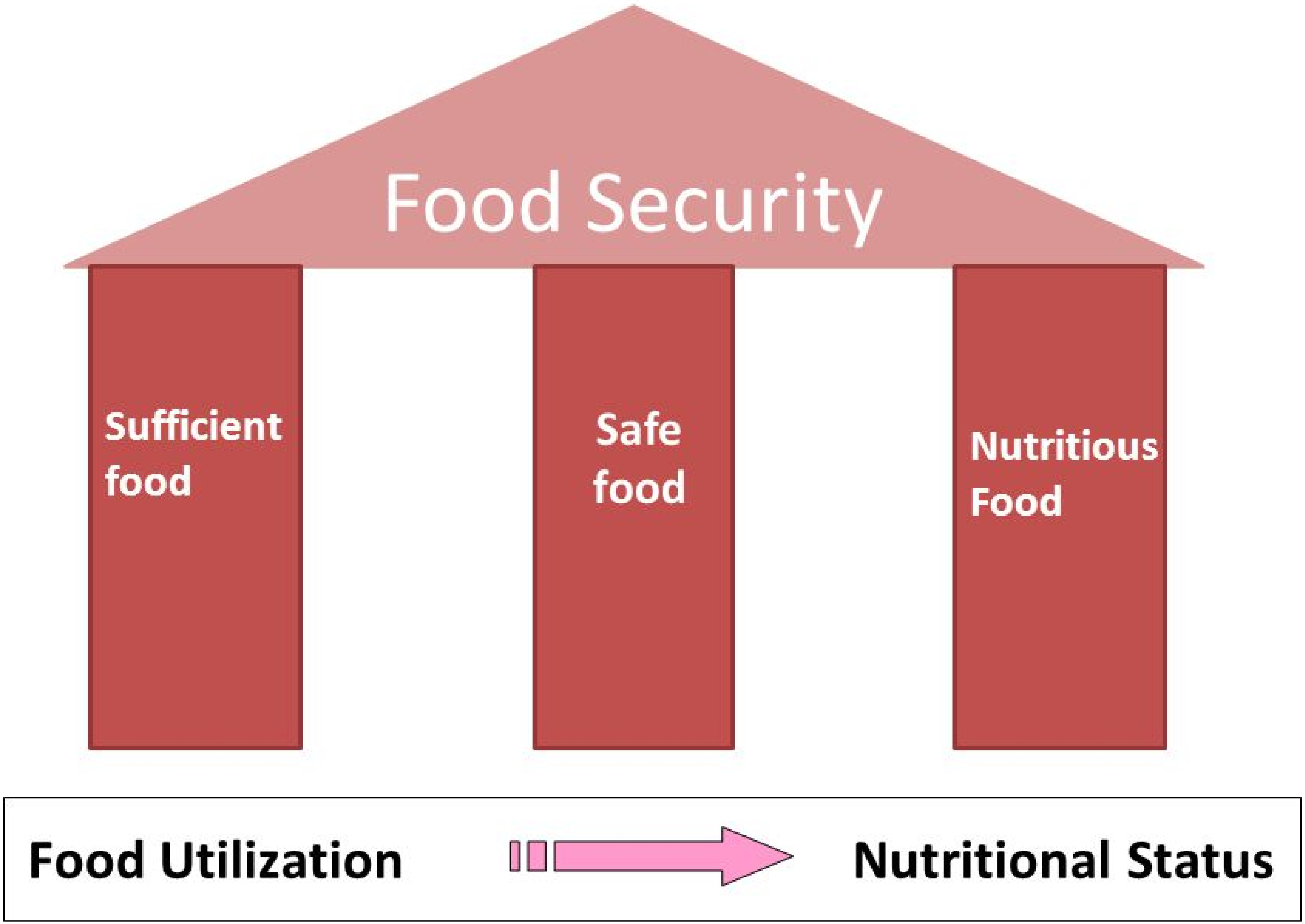


Rochman 2015 Chapter in *Marine Anthropogenic Litter*



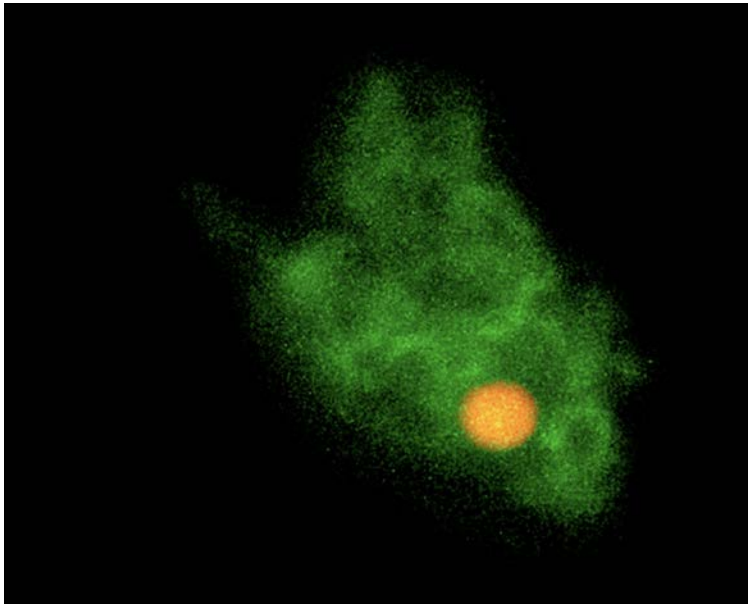
Law, *Ann. Rev. Mar. Sci.* 2017,
adapted from Rochman et al. *Ecology* 2015

Pillars of Food Security

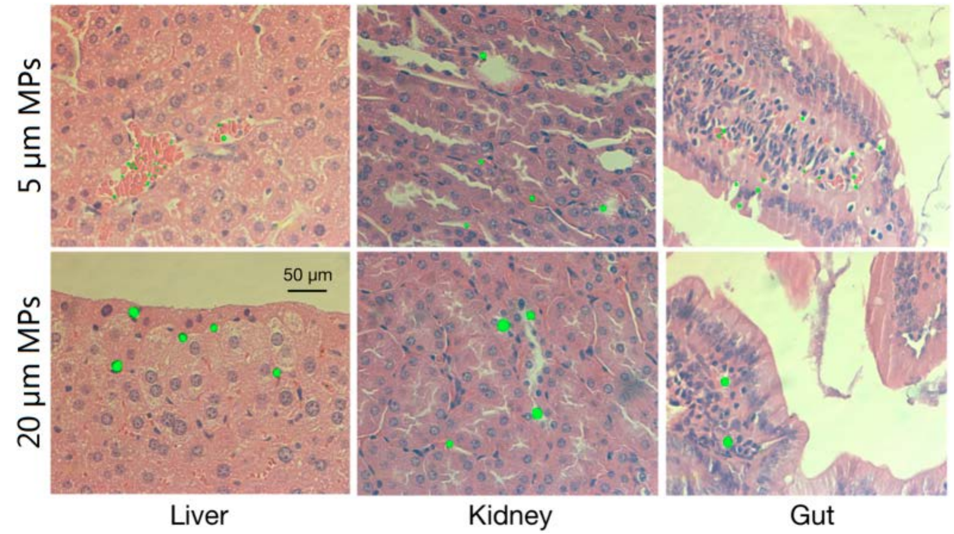


FAO (Food and Agricultural Organization)

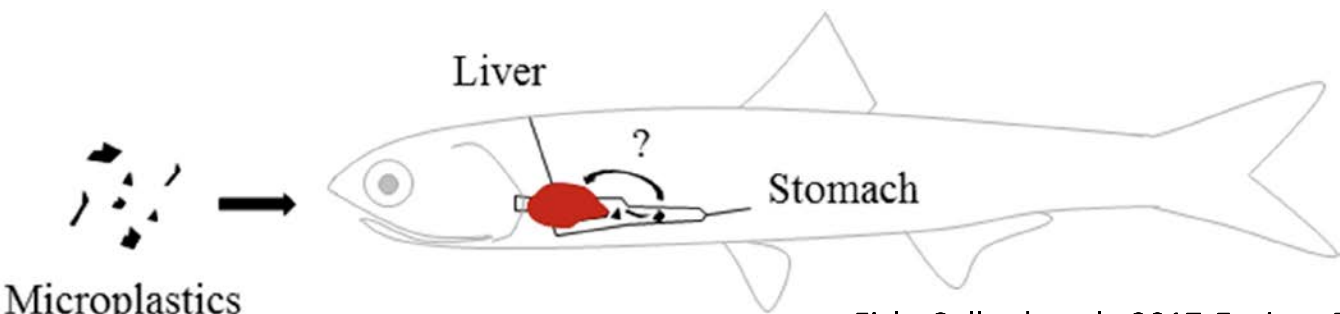
Fate of microplastic and nanoplastics in the body



Mussels: Browne et al., 2008 *ES&T*



Mice: Deng et al., 2017 *Scientific Reports*



Fish: Collard et al., 2017 *Environ Pollut*

Chemical Impact

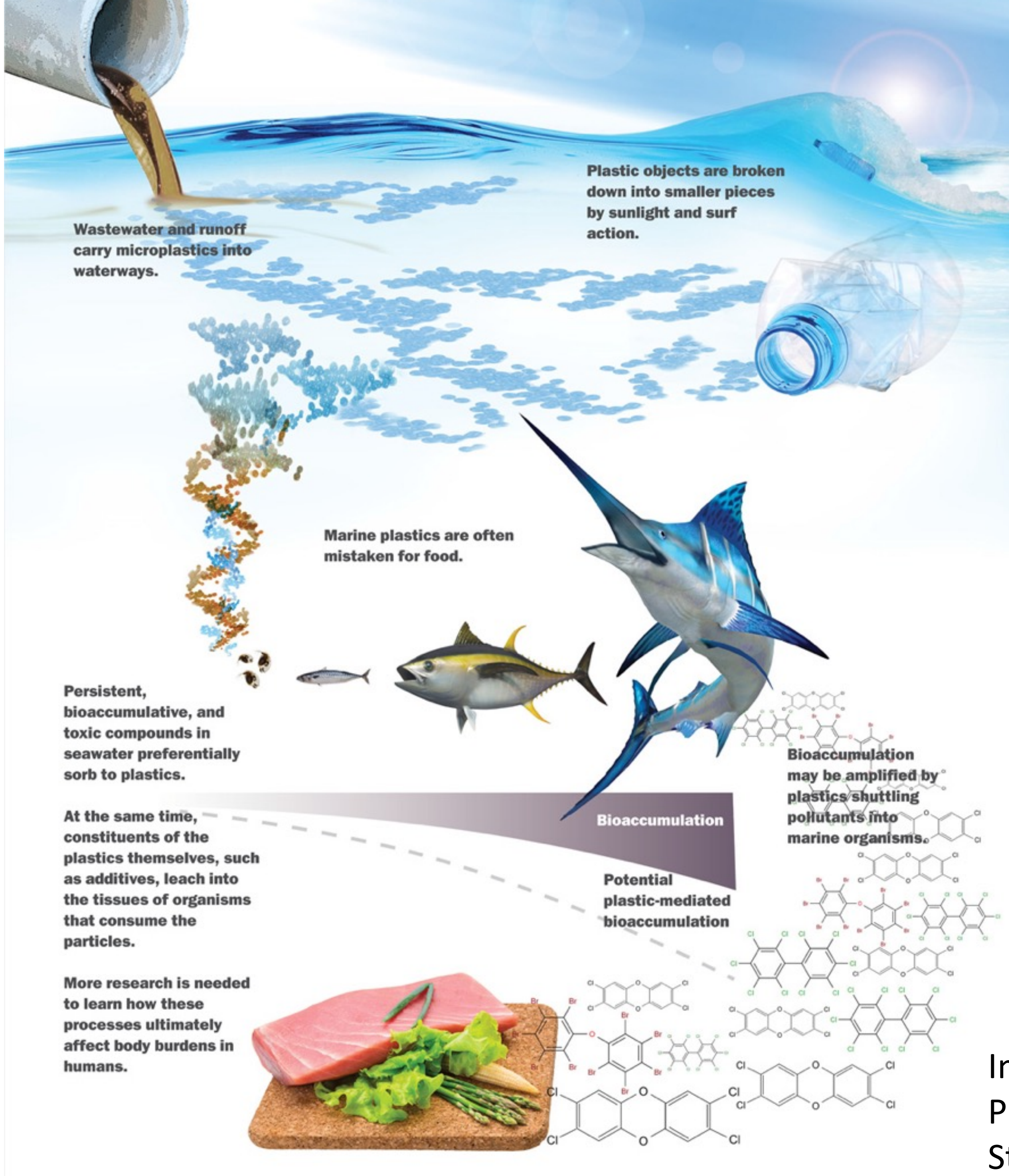
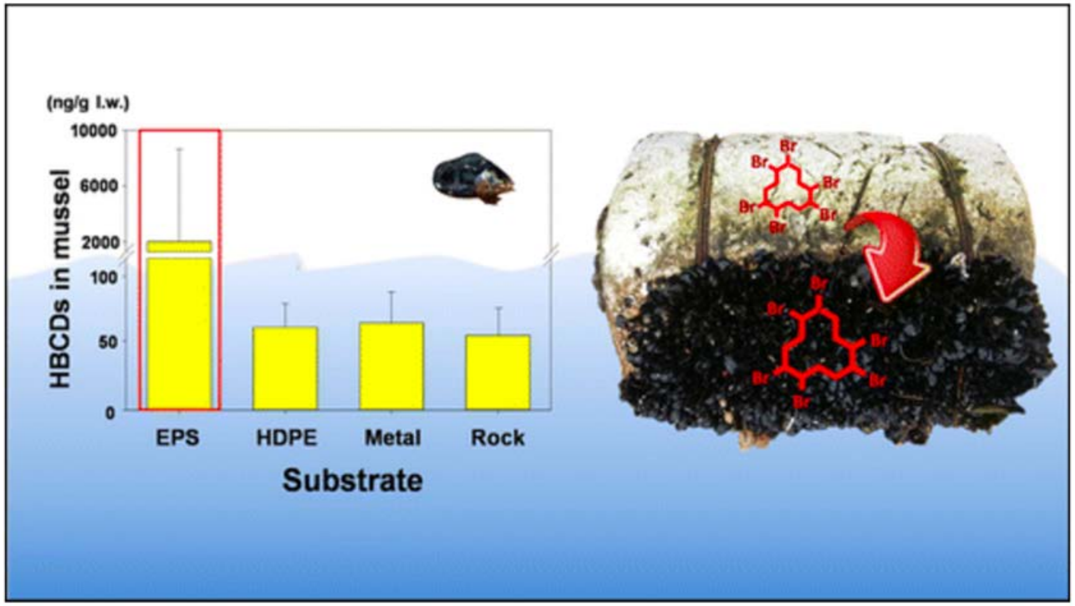
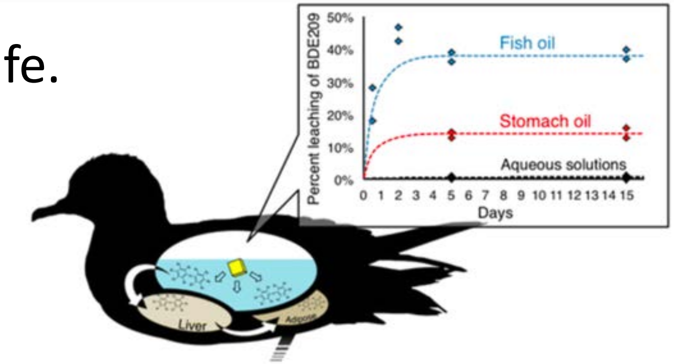


Image by Rolf Halden, Professor at Arizona State University

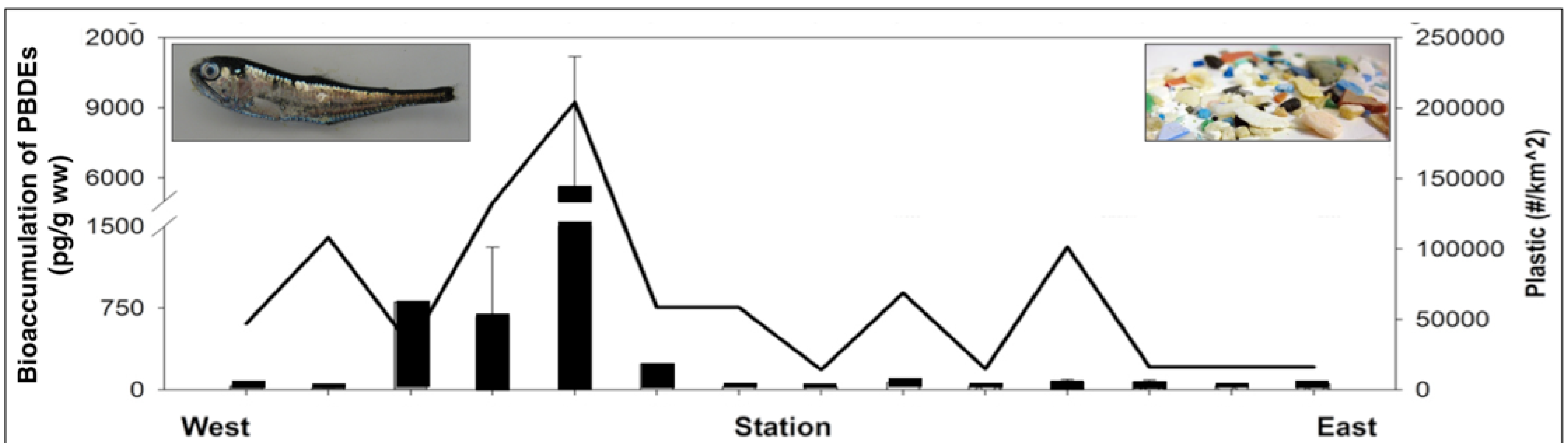
Chemicals from microplastics can transfer to wildlife.



Jang et al., 2016 *ES&T*



Tanaka et al., 2015 *ES&T*;
Tanaka et al., 2013 *Mar Pollut Bull*



Rochman et al., 2014 *Science of the Total Environment*

Next Big Questions and Research Needs for Microplastics:

- Identify local entry points for microplastics into the environment
- Identify largest reservoirs for “missing” plastic debris
- Understand the fate of microplastics and associated chemicals in the environment
- Determine ecologically relevant impacts of microplastics:
  - Environmentally relevant laboratory studies, laboratory ecosystem study (mesocosm), field studies, multi-stressor
- Identify impacts to human health and food security
- **Improve methods for quantifying and characterizing microplastics in complex matrices.**

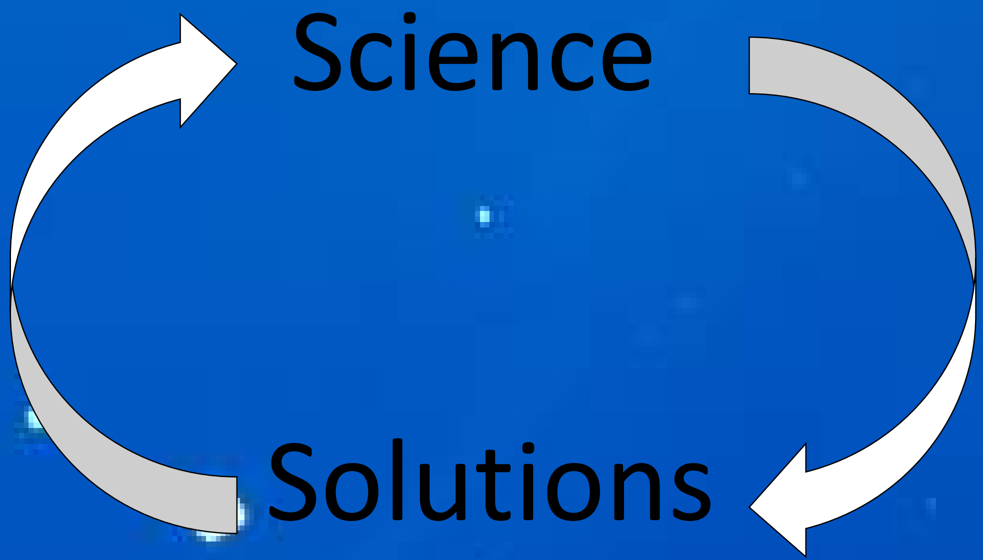
Method Development to better quantify and characterize microplastics

Widespread Contamination in habitats and animals – including seafood.

Evidence of effects to wildlife – particularly macroplastics – including to populations and communities.

Evidence of effects of microplastics in lab animals, populations and communities.

Continue to aim toward a better understanding of sources, fate and impacts to humans and wildlife populations.



In the meantime, we have enough science to begin to mitigate now and prevent future sources of plastic pollution.

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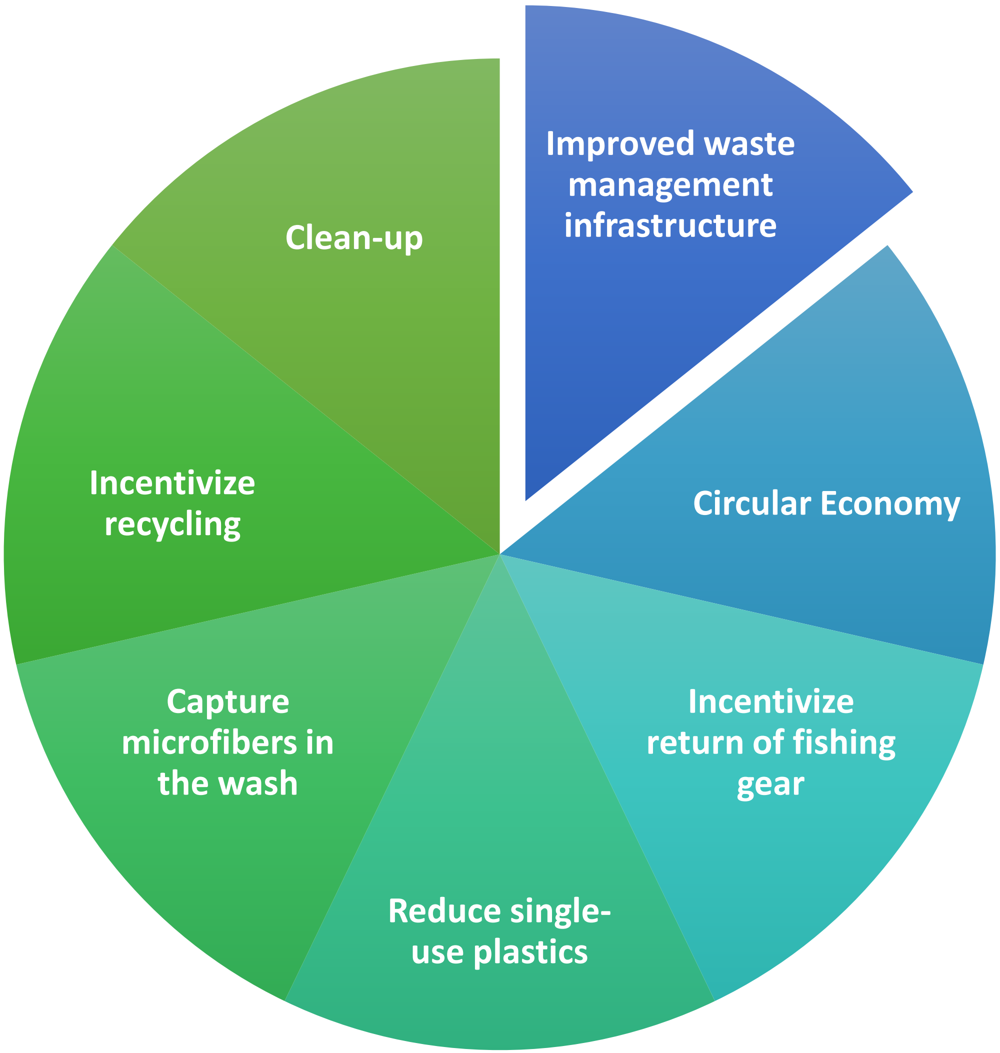
14 LIFE BELOW WATER

clean seas
turn the tide on plastic

Mitigation Strategies

How do we reach reduction targets?



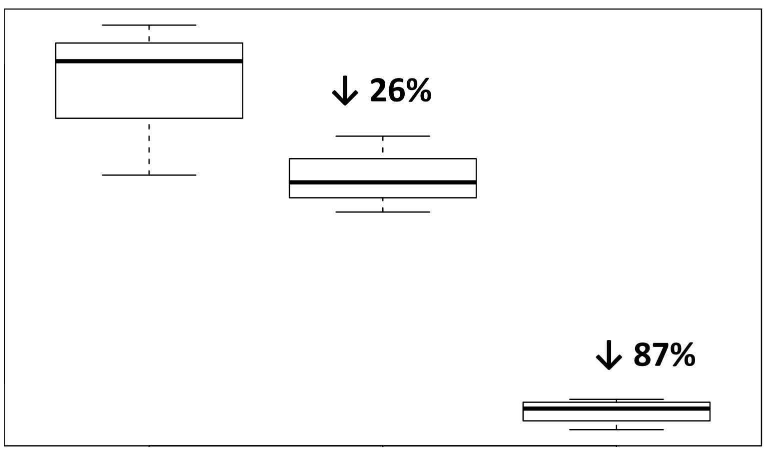
Steph Borrelle

SESYNC
NATIONAL
SOCIO-ENVIRONMENTAL
SYNTHESIS CENTER


Think
Globally
Act
Locally

Testing microfiber mitigation

2 strategies: **both reduce microfibers** in washing machine effluent



Cora ball

Lint LUV-R

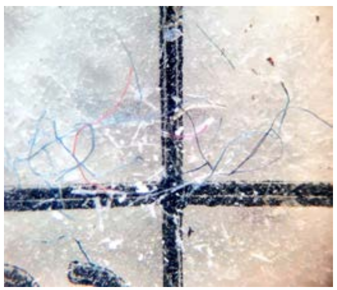
Photos: coraball.com / www.environmentalenhancements.com

Hayley McIlwraith

Jack Lin

McIlwraith, et al. *in review*

City of Toronto example



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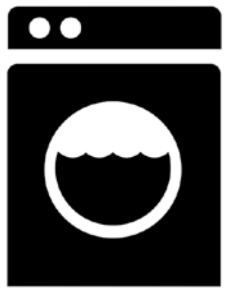

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90,700 to 138,000 microfibers per wash load

(our study)

219 wash loads per household per year

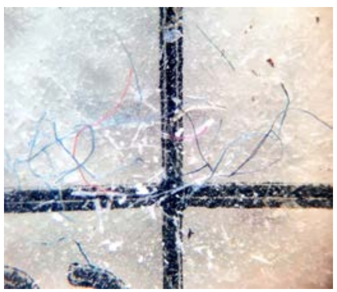
(NRC, 2011)

1,179,057 households

(Statistics Canada, 2017)

<u>23 to 36 trillion microfibers</u> emitted per year

City of Toronto example



X

Lint LUV-R

X

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(our study)

219 wash loads per household per year

(NRC, 2011)

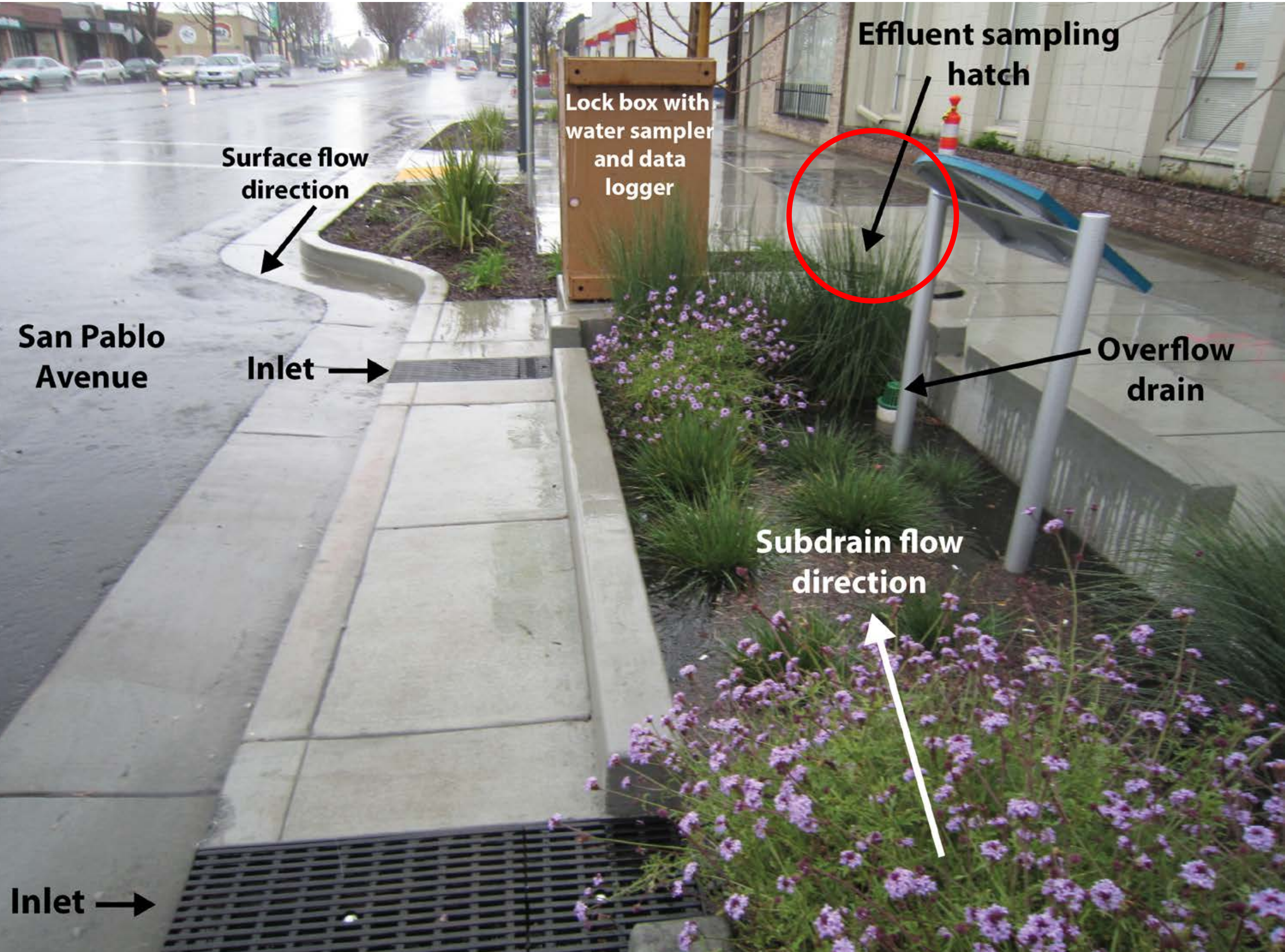
1,179,057 households

(Statistics Canada, 2017)

<u>23 to 36 trillion microfibers</u> emitted per year

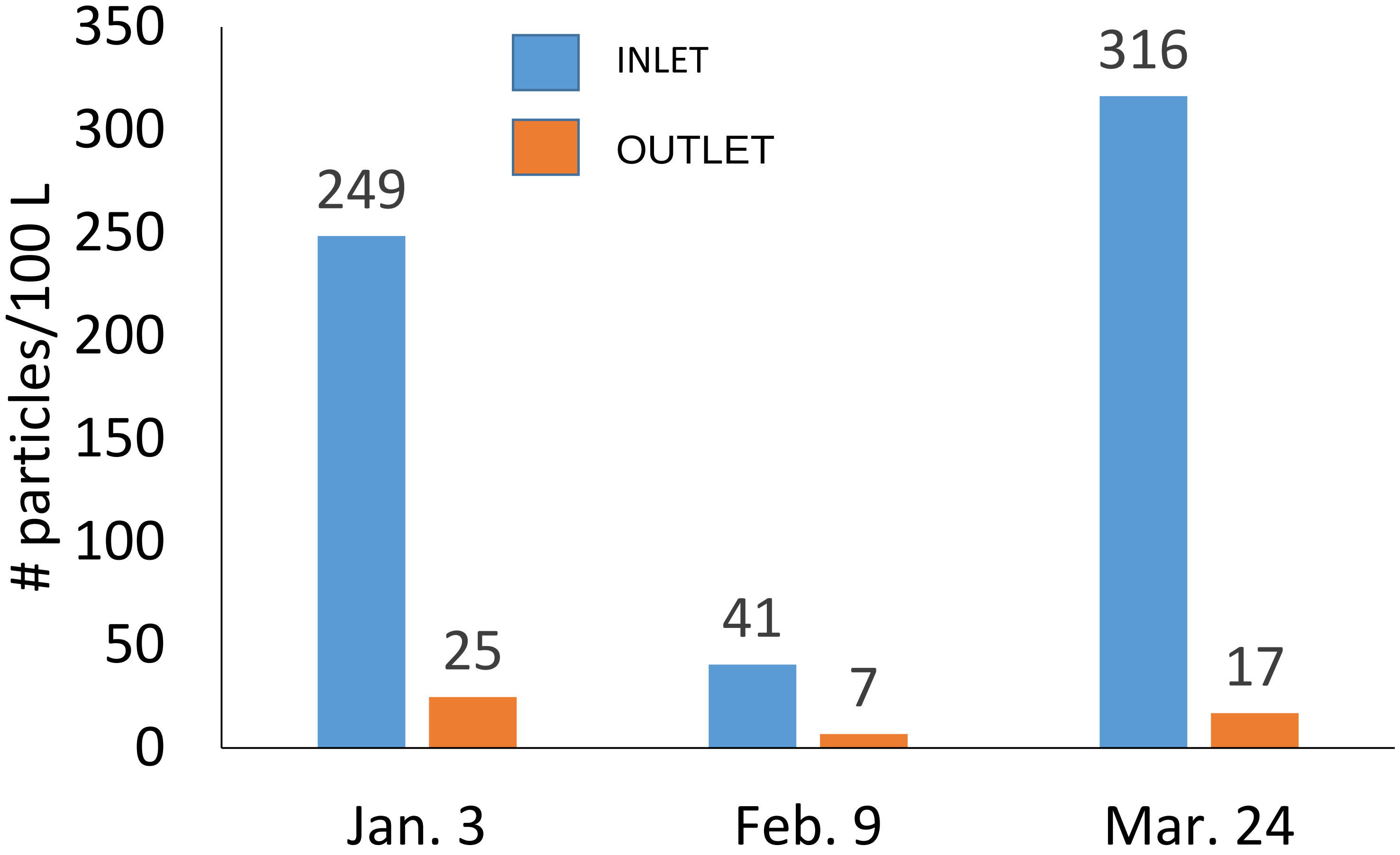
↓ 6 to 9 trillion microfibers

↓ 20 to 31 trillion microfibers


Effluent sampling hatch
Lock box with water sampler and data logger
Surface flow direction
San Pablo Avenue
Inlet
Overflow drain
Subdrain flow direction
Inlet

Treatment Efficiency

- Mean 92% reduction (n=3)



Single-use Bans:

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Environment and Climate Change Canada

SESYNC National Socio-Environmental Synthesis Center

Ocean Conservancy

Ontario Ministry of the Environment and Climate Change

University of Toronto

Smith Fellows

NCEAS

UC Davis

NSERC CRSNG

NSF

Rochman Lab postdocs, students and staff
MOECC: P. Helm, D Poirier, K. Stevack, L. Kennedy, T. Watson-Leung
ECCC: A DaSilva, L Jantunen, J. Parrott
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Miriam Diamond & Lab
Dave Sinton & Lab
Bob Andrews & Lab
HORIBA Scientific
Erik van Sebille, Kara Lavender Law, Jenna Jambeck, Roland Geyer
Susan Williams, Bodega Marine Lab
Teh Lab, UC Davis
Eunha Hoh, SDSU

Thank you!

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