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Turning the Tides:
Tackling Our Ocean's Plastic Pollution Problem

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Today's Speakers

Dr. Jesse Daystar

Vice President and Chief Sustainability Officer

Carole Dubois

Senior Sustainability Consultant

Dr. Richard Venditti

Elis-Signe Olsson Professor in Pulp and Paper Science and Engineering Department of Forest Biomaterials

Cotton Incorporated

Quantis

NC STATE UNIVERSITY College of Natural Resources

Cotton Incorporated Funding Sources and Oversight

Cotton Importers

Brands / Retailers

Cotton Board

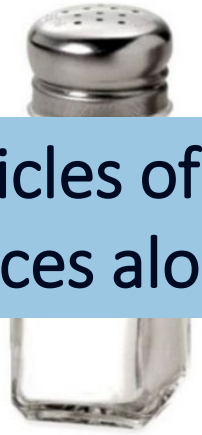
Cotton Incorporated

Research

Promotion

USDA REVIEW

Microplastics in the Environment



The average person ingests over 5,800 particles of synthetic debris annually from those 3 sources alone

159 global **tap water** samples: 81% of tap water sampled contained various levels of synthetic microplastics

12 U.S. beer brands sampled: all beer sampled contained various levels of synthetic microplastics

12 sea salt brands sampled: all salt sampled contained various levels of synthetic microplastics

PLOS ONE

RESEARCH ARTICLE

Anthropogenic contamination of tap water, beer, and sea salt

Mary Kosuth[1☯*], Sherri A. Mason[2☯], Elizabeth V. Wattenberg[1☯]

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Abstract

Plastic pollution has been well documented in natural environments, including the open waters and sediments within lakes and rivers, the open ocean and even the air, but less attention has been paid to synthetic polymers in human consumables. Since multiple toxicity studies indicate risks to human health when plastic particles are ingested, more needs to be known about the presence and abundance of anthropogenic particles in human foods and beverages. This study investigates the presence of anthropogenic particles in 159 samples of globally sourced tap water, 12 brands of Laurentian Great Lakes beer, and 12 brands of commercial sea salt. Of the tap water samples analyzed, 81% were found to contain anthropogenic particles. The majority of these particles were fibers (98.3%) between 0.1–5 mm in length. The range was 0 to 61 particles/L, with an overall mean of 5.45 particles/L. Anthropogenic debris was found in each brand of beer and salt. Of the extracted particles, over 99% were fibers. After adjusting for particles found in lab blanks for both salt and beer, the average number of particles found in beer was 4.05 particles/L with a range of 0 to 14.3 particles/L and the average number of particles found in each brand of salt was 212 particles/kg with a range of 46.7 to 806 particles/kg. Based on consumer guidelines, our results indicate the average person ingests over 5,800 particles of synthetic debris from these three sources annually, with the largest contribution coming from tap water (88%).

Introduction

The first peer-reviewed papers to document plastic pollution in the natural world were published over 45 years ago [1,2]. Since then, a robust body of work has accumulated, and the ubiquity of synthetic polymers in the environment is now undisputed. From abandoned gillnets hundreds of meters in length to plankton sized fragments, synthetic polymers have been extracted from remote corners of the Earth's biosphere. Plastics have been quantified in marine environments [3] that include segments of the pelagic biome [4] coastal habitats [5], deep sea sediments [6, 7], as well as freshwater lakes [8,9] and associated tributaries [10].

OPEN ACCESS

Citation: Kosuth M, Mason SA, Wattenberg EV (2018) Anthropogenic contamination of tap water, beer, and sea salt. PLoS ONE 13(4): e0194970. https://doi.org/10.1371/journal.pone.0194970

Editor: Zhi Zhou, Purdue University, UNITED STATES

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Data Availability Statement: Data for the study, Anthropogenic contamination of tap water, beer, and sea salt, can be found here: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/HCKDL.

Funding: Funding for this study was provided by the James W. Wright Scholarship which was provided by the University of Minnesota's School of Public Health, Division of Environmental Health Sciences. This scholarship was awarded to Mary Kosuth in 2016.

Competing interests: The authors have declared that no competing interests exist.

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Kosuth, M., Mason, S., & Wattenberg, E. (2018). Anthropogenic contamination of tap water, beer, and sea salt. *PLOS One*.

TACKLING THE VISIBLE AND THE INVISIBLE TO CLOSE THE PLASTIC LOOP

THE PLASTIC LEAK PROJECT

Carole Dubois - Quantis

Consumer awareness is rising

Plastic makes the headlines

Invisible plastic: microfibers are just the beginning of what we don't see

Mary Catherine O'Connor

The tiny pollutants in our clothes are forcing us to look harder for, and think more carefully about, the ways humans have shaped the environment

Every time we wash our clothing the synthetic fibers the are comprised of leach into our waterways, rivers and oceans. Photograph: Jeff Haynes/AFP/Getty Images

Swiss honey contains harmful plastic: TV report

Malcolm Curtis
news@thelocal.ch
@thelocalswitzer

26 March 2014
10:38 CET+01:00

Share this article

Photo: SRF

Most honey from Switzerland contains plastic particles that endanger health, according to tests conducted for a Swiss consumer affairs TV programme.

Clean Technica

About Electric Car Reviews Exclusives Power Tr

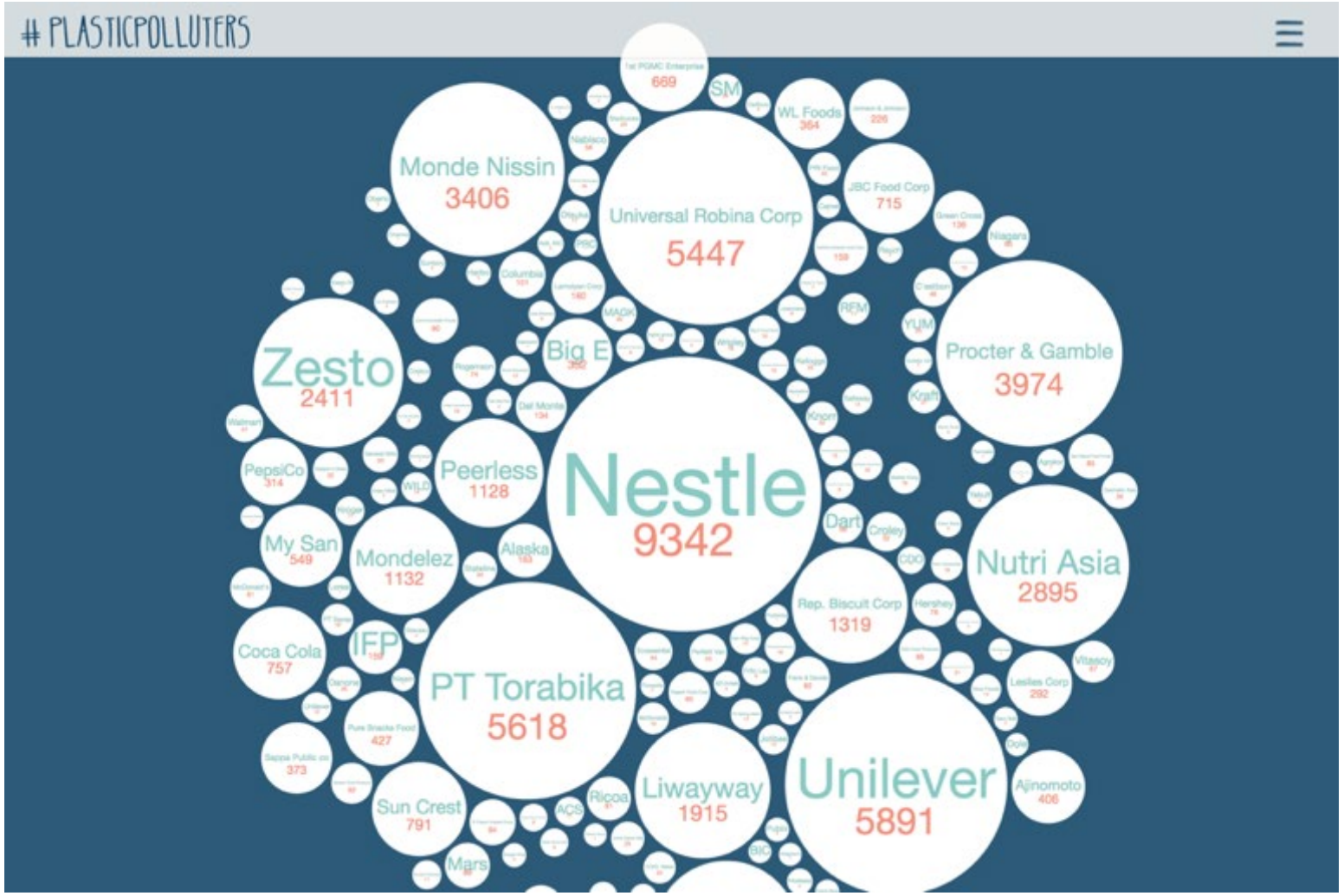
94% Of US Tap Water Has Micro Plastic Fibers In It, Study Finds (Oh, & That Sea Salt, Beer, Flour, & Honey That You Buy … It Does As Well)

Facebook Twitter Google+ Pinterest

September 10th, 2017 by James Ayre

The scale of the world's current micro plastics pollution problem can't be overstated. Plastics, and more importantly their nearly invisible half-broken-down remnants, are now everywhere. They're in the food you eat, the water you drink, and even often enough in the air you breathe.

Brands are put under pressure



http://plasticpolluters.org/

EMOTIONS

“ There will be more plastic by weight in the ocean than fish by 2050 ”

FACTS

“ You can’t manage what you don’t measure ”

WHAT

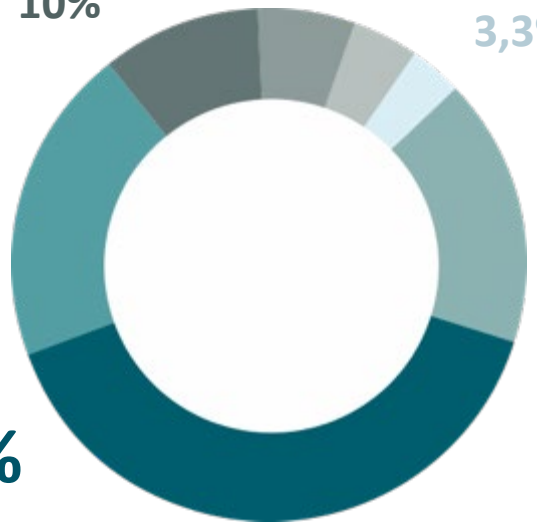
DO WE KNOW?

How much plastic is there?

Plastic production

335 MT/y *World*

60 MT/y *Europe*



Packaging **40%**

Building & construction **20%**

Automotive **10%**

Electrical & electronic **6,2%**

Household leisure & sport **4,2%**

3,3% Agriculture

17%

Others

Includes appliances mechanical engineering, furniture, medical etc.

Plastics Europe & EPRO. (2017). Plastics – the Facts 2017. https://www.plasticseurope.org/application/files/5715/1717/4180/Plastics_the_facts_2017_FINAL_for_website_one_page.pdf

Since the beginning of plastic production era (1950) we have produced 8300 Mt of plastic…

Total virgin plastic produced

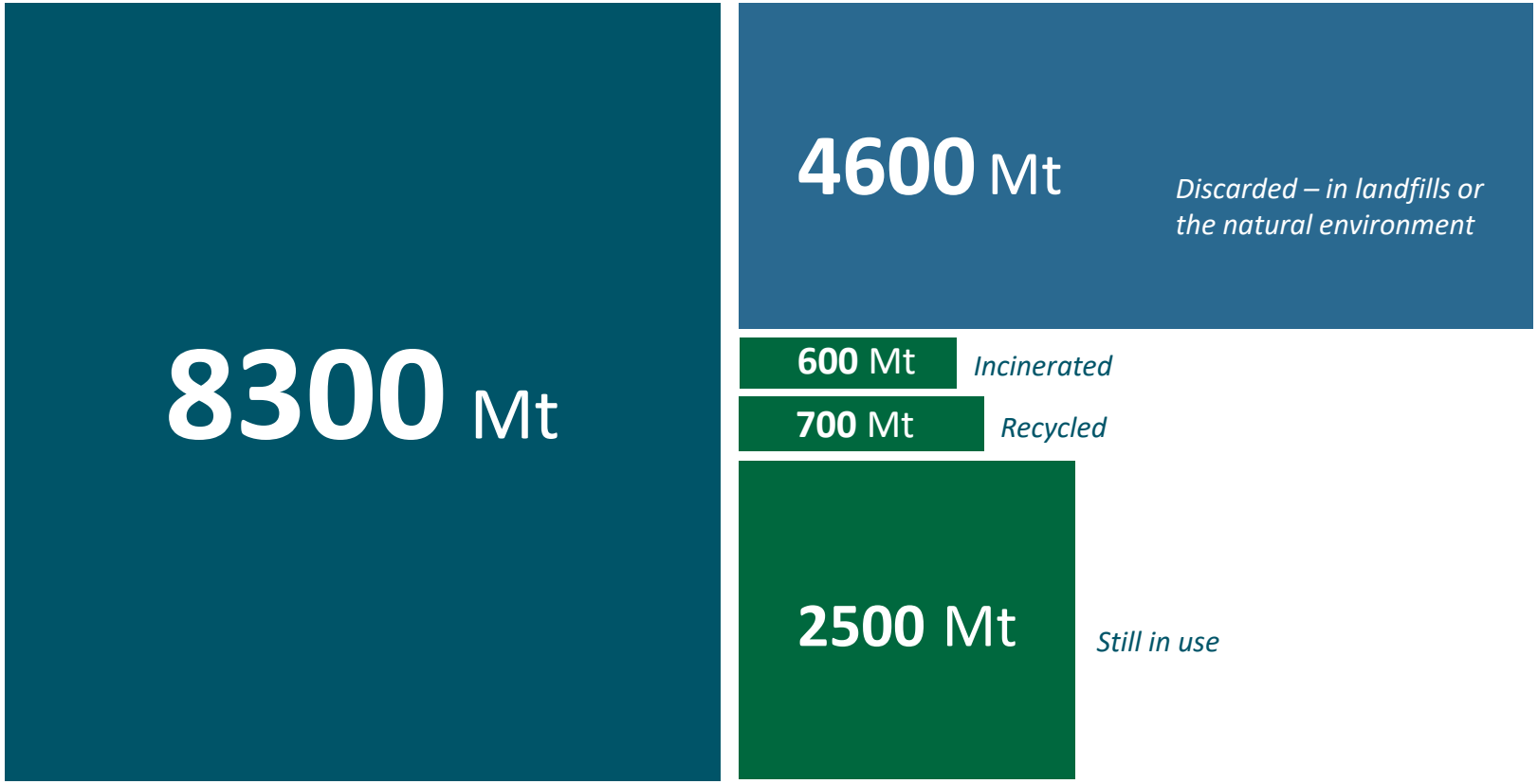
Source: "Production, use, and fate of all plastics ever made" by R. Geyer et al., *Science Advances*

… and only **7%** of the world's plastic has been recycled (1950-2015)

Total virgin plastic produced

Source: "Production, use, and fate of all plastics ever made" by R. Geyer et al., *Science Advances*

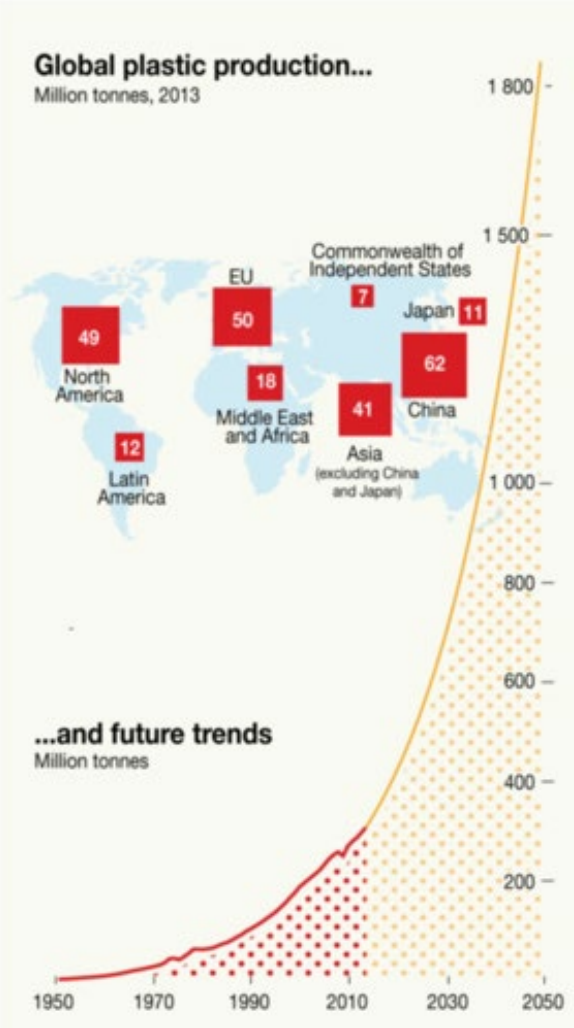
… the rest has been discarded (1950-2015).



Total virgin plastic produced

Source: "Production, use, and fate of all plastics ever made" by R. Geyer et al., *Science Advances*

Plastic pollution is going to get worse if we do not act now



Plastic production
2016

335 MT/y

Plastic production
2030

1000 MT/y

Ryan, P. G. (2015). A brief history of marine litter research. In Marine anthropogenic litter (pp. 1-25). Springer, Cham.

But big numbers do not necessarily mean big problem

The **benefits** of **plastic** versus **other materials**

Lightweight

Versatility

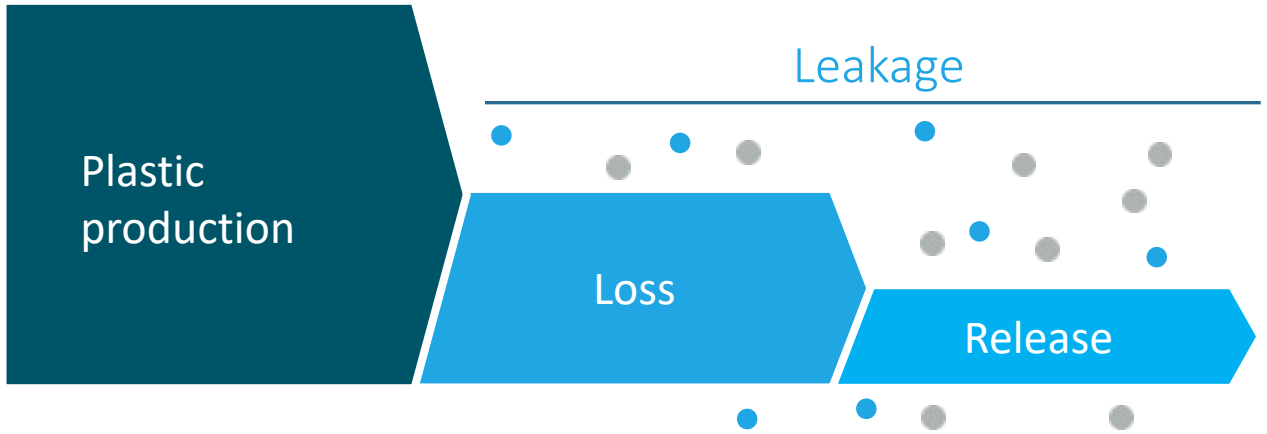
Durability

Malleability

LOW COST

Low carbon footprint

The problematic: leakages from the system



How much plastic is leaking? The visible and the invisible

Plastic production

335 MT/y

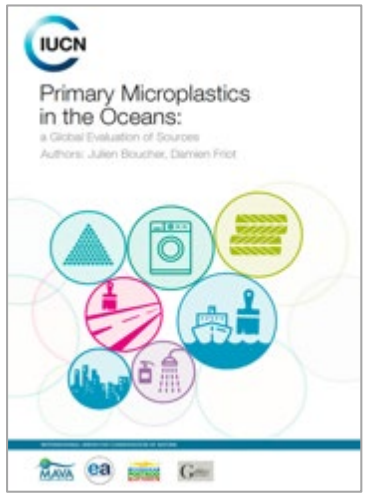
Plastic from Wastes


Plastic waste inputs from land into the ocean

Jambeck & al. 2015

8 Mt/y

Primary Microplastics



Boucher and Friot 2017

1.5 Mt/y

How much plastic is leaking? The visible and the invisible

Plastic from Wastes **Primary Microplastics**

Plastic production

335 MT/y

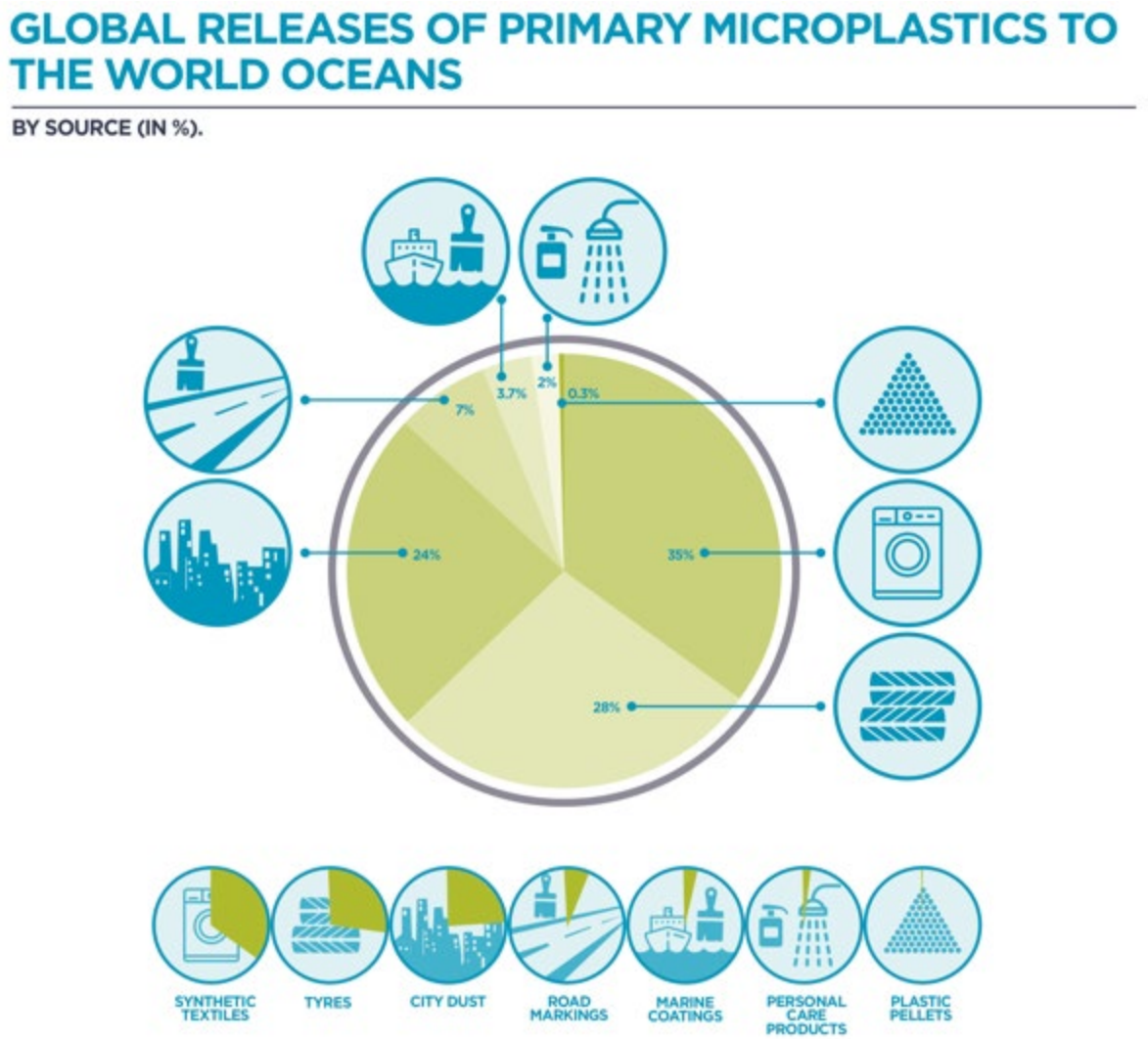
3%

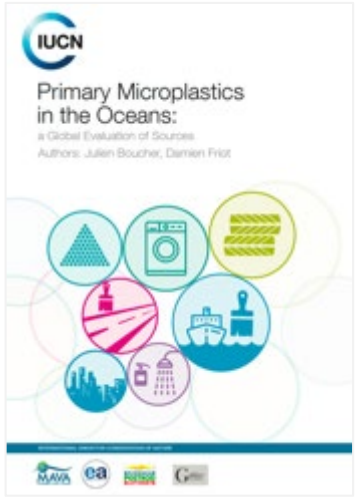
8 Mt/y

1.5 Mt/y

Boucher, J., & Friot, D. (2017). Primary microplastics in the oceans: a global evaluation of sources. Gland, Switzerland: IUCN.
Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., ... & Law, K. L. (2015). Plastic waste inputs from land into the ocean. Science, 347(6223), 768-771.

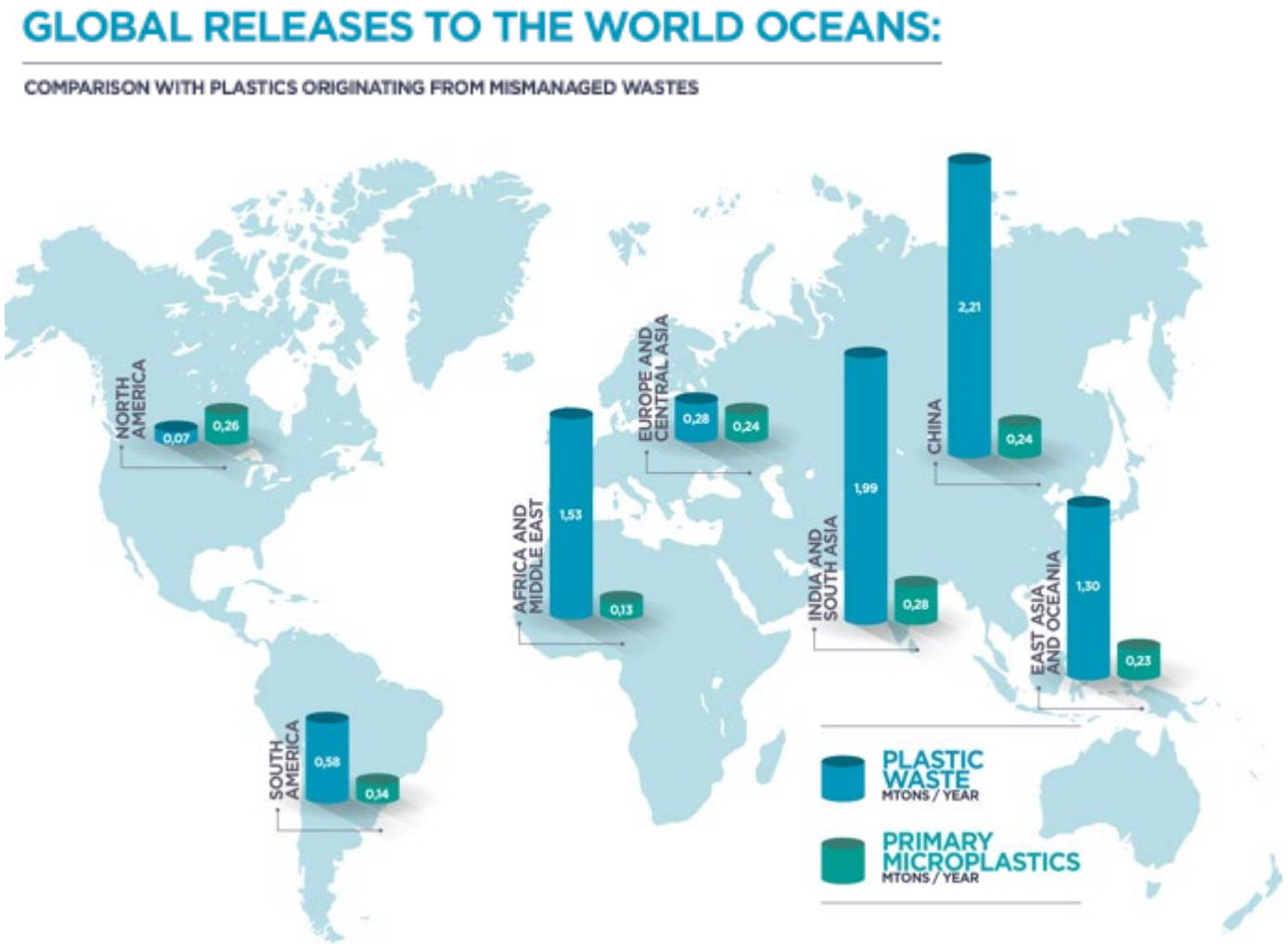
Focus on primary microplastics

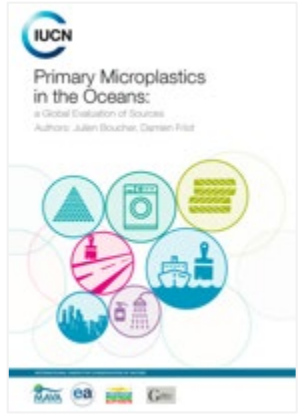




Boucher, J., & Friot, D. (2017). Primary microplastics in the oceans: a global evaluation of sources. Gland, Switzerland: IUCN.

Plastic release is a regional issue:
Microplastics outweigh plastic from wastes in some regions





WHY

DO WE NEED BETTER METRICS ?

A tool to measure the contribution of industries & products

We know the big numbers…

…but, what about **YOUR** numbers ?

A tool to measure the contribution of industries & products

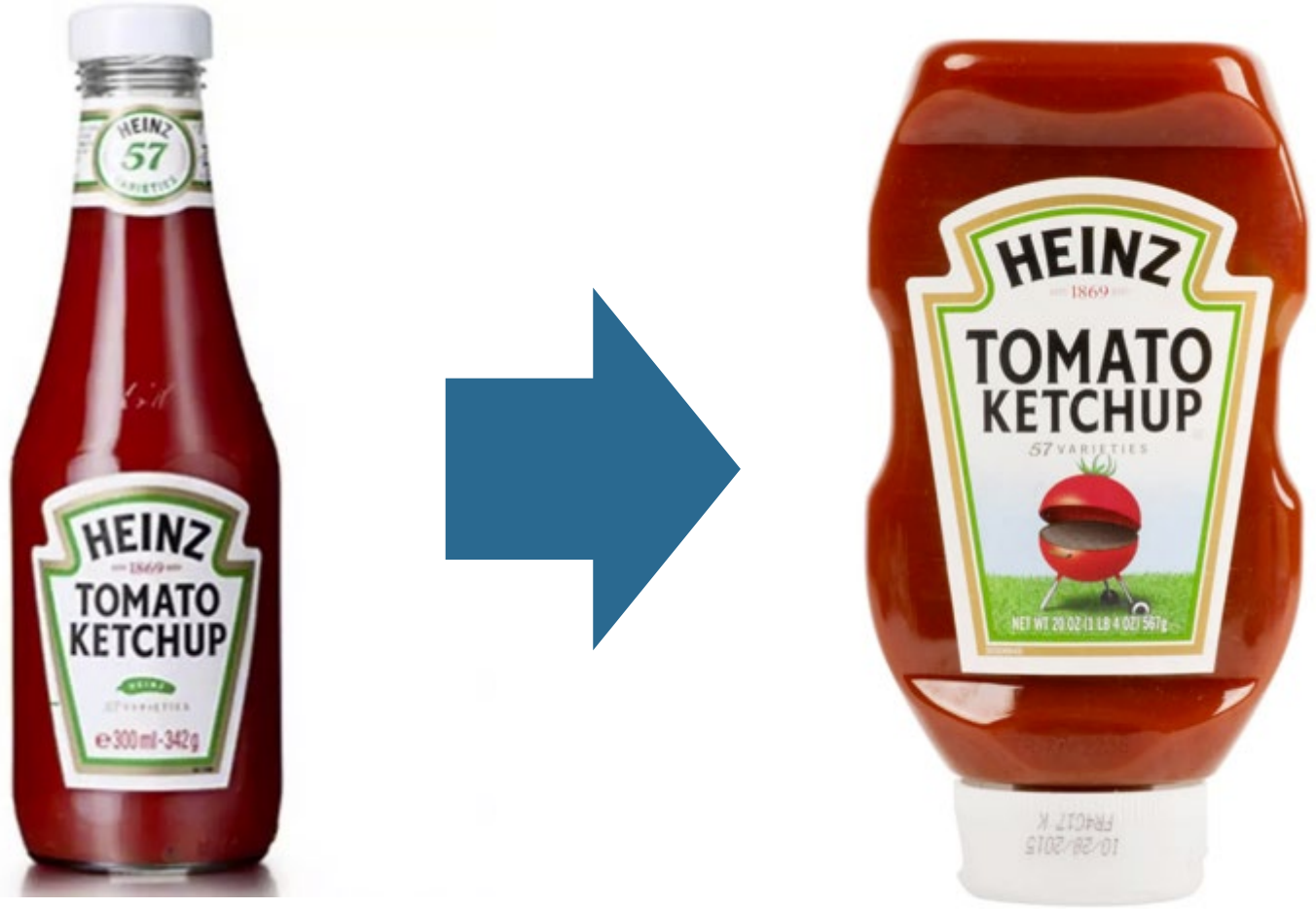
+ How much plastic is released throughout your value chain ?

+ Is it macro- or micro- plastics ?

+ What are the impacts ? (versus carbon and other impacts)

+ Where should you set priorities for action (product design vs. market stewardship)?

How is plastic currently considered in the product development process ?



What about Life Cycle Assessment (LCA) ?

LCA does not account for plastic as a pollutant. Only the indirect impacts of plastic are accounted for.

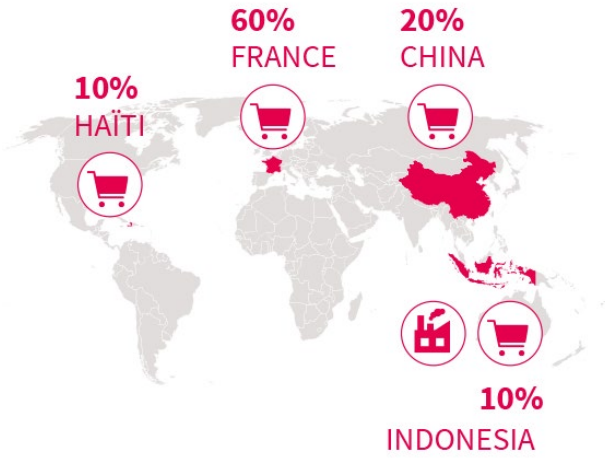
Carbon Footprint | Water Footprint | Ecosystem Quality | Natural Resources | Human Health

What about Life Cycle Assessment (LCA) ?

LCA does not account for plastic as a pollutant. Only the indirect impacts of plastic are accounted for.

Generic Case:
The plastic leakage of a polyester t-shirt and its packaging

1 million t-shirts
150 t polyester
10 t packaging (PE film)



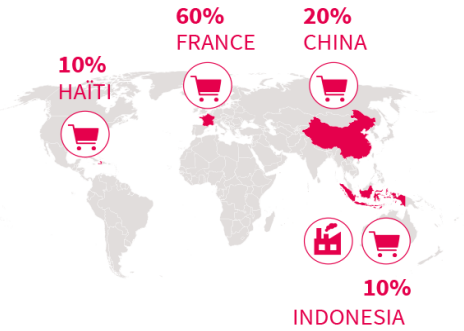
Quantis & Environmental Action (2018). Tackling the visible and the invisible to close the plastic loop. https://quantis-intl.com/wp-content/uploads/2018/03/ocean_plastics_pollution_quantis_ea_2018.pdf

1 million t-shirts
150 t polyester
10 t packaging (PE film)

(=) **1 450 kg** plastic release

The plastic footprint is an assessment of the quantity of both **microplastics** and **macroplastics** released to the environment along the whole value chain.

T-shirts are produced in Indonesia and sold in 4 markets with different market shares.



This matrix allows to map **hotspots** and set priorities for action. Hotspots here are due to higher market share of t-shirt sold in France and poor waste management facilities in China and Indonesia.

	PRODUCTION	TRANSPORT	USE	END OF LIFE
	Microplastics released during product production	**Microplastics** released from abrasion of tires during transport	**Microplastics** released from textile fibers during washing	**Macroplastics** released from mismanaged waste of used t-shirt and packaging
TOTAL **PLASTIC RELEASE**	**20** kg plastic	**60** kg plastic	**660** kg plastic	**710** kg plastic
INDONESIA				
CHINA				
FRANCE				
HAÏTI				

This matrix shows the contribution (in %) of the different life cycle stages and regions to the 1 450 kg plastic potentially released to the oceans.

Quantis & Environmental Action (2018). Tackling the visible and the invisible to close the plastic loop. https://quantis-intl.com/wp-content/uploads/2018/03/ocean_plastics_pollution_quantis_ea_2018.pdf

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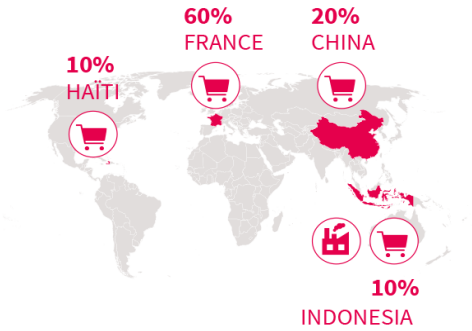

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	PRODUCTION	TRANSPORT	USE	END OF LIFE
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TOTAL **PLASTIC RELEASE**	**20** kg plastic	**60** kg plastic	**660** kg plastic	**710** kg plastic
INDONESIA	1%	1%	7%	19%
CHINA	-	2%	13%	16%
FRANCE	-	2%	17%	1%
HAÏTI	-	0%	8%	13%

This matrix shows the contribution (in %) of the different life cycle stages and regions to the 1 450 kg plastic potentially released to the oceans.

Quantis ea

Quantis & Environmental Action (2018). Tackling the visible and the invisible to close the plastic loop. https://quantis-intl.com/wp-content/uploads/2018/03/ocean_plastics_pollution_quantis_ea_2018.pdf

The Plastic Leak Project

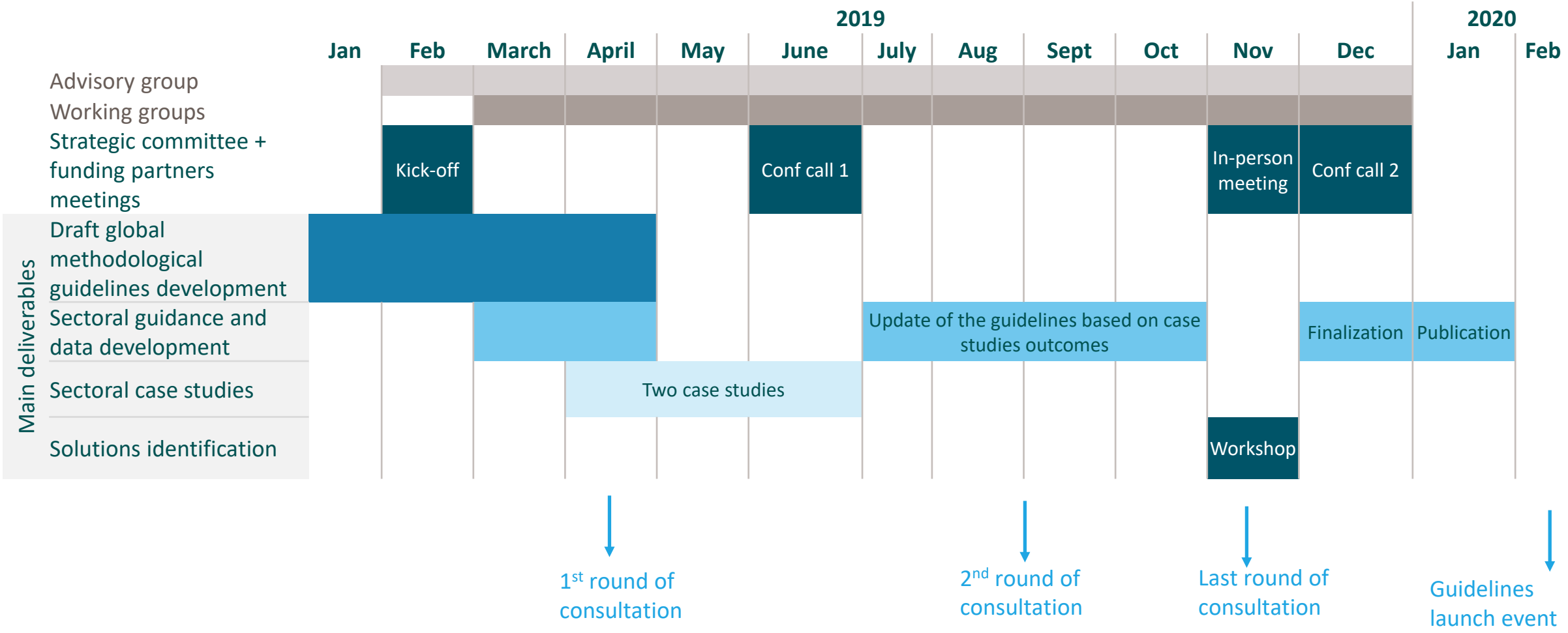
A collaborative, multi-stakeholder initiative to identify, measure and develop scalable solutions to close the tap on plastic leakage.

Started on February 11th, 2019 Paris

Please contact me would you like to join!

+ Measure leakage from your plastics value chain
+ Deliver meaningful and robust metrics with a streamlined methodology, next to carbon or other impacts
+ Evaluate and develop scalable solutions to reach near-zero leakage
+ Guide companies to move from passion to fact-based actions
+ Create and nurture a community of leaders committed to solving plastic leakage problem

Project timeline & deliverables



Advisory board discussions going on with small groups all over the year

Governance

PROJECT LEADERS

STRATEGIC COMMITTEE

ADVISORY COMMITTEE

PROJECT MEMBERS

Expected project leadership, advisors and members

Advisory committee

Massachusetts Institute of Technology

Expected project leadership, advisors and members

Strategic committee

Quantis, ea, IUCN, UN environment, wbcsd

Organizations confirmed

ExxonMobil, adidas, cyclos, Braskem, Cotton Incorporated, ECOEMBES, EASTMAN, Arla, SympaTex, MARS, DECATHLON, DOW, PlasticsEurope, european bioplastics, ETRMA

Join the Plastic Leak Project

+ Participation package: 30,000 €

BENEFITS OF JOINING

Global leadership
Gain visibility as a participant in a collaborative effort to find a solution to one of today's most pressing topics. Benefit from powerful communications.

Strategic decision-making
Define where and how to best tackle the plastic problem within your value chain, ensuring company resources are wisely invested and the best outcomes are achieved.

Metric-based reporting
Upgrade your sustainability reporting with metrics-based plastics data aligned with other sustainability metrics

Fill the knowledge gap
Pioneer a new science-based approach towards finding the right solutions to the plastic crisis

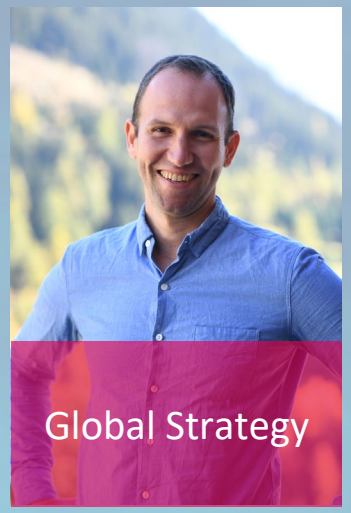
Global Guidelines
Set the standard on assessing plastic leakage

Exclusive network
Team up with other key industry stakeholders to implement plastic field - level and eco-design actions

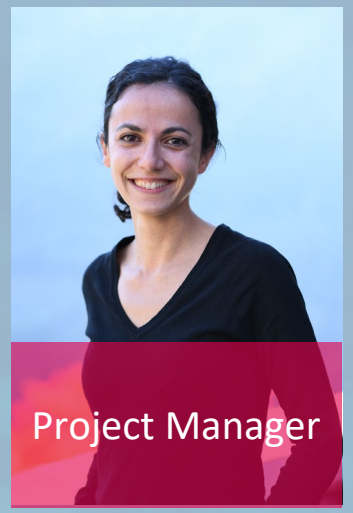
We encourage you to contact us to discuss a contribution and desired deliverables that fit your specific needs

The Quantis and EA team

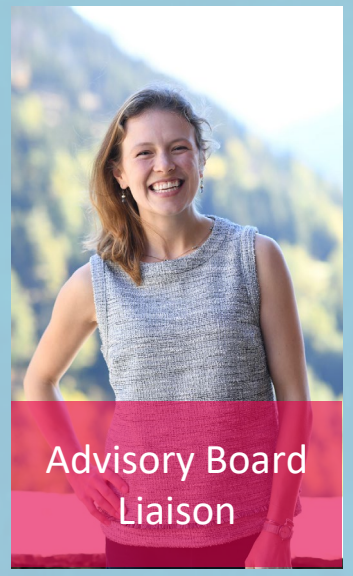
Carole Dubois



Jon Dettling



Laura Peano



Melissa Zgola

Julien Boucher

Ready to join us?

Get started with the project that will drive solutions and influence the future of how we tackle the plastic problem.

Contact us

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Senior Sustainability Consultant
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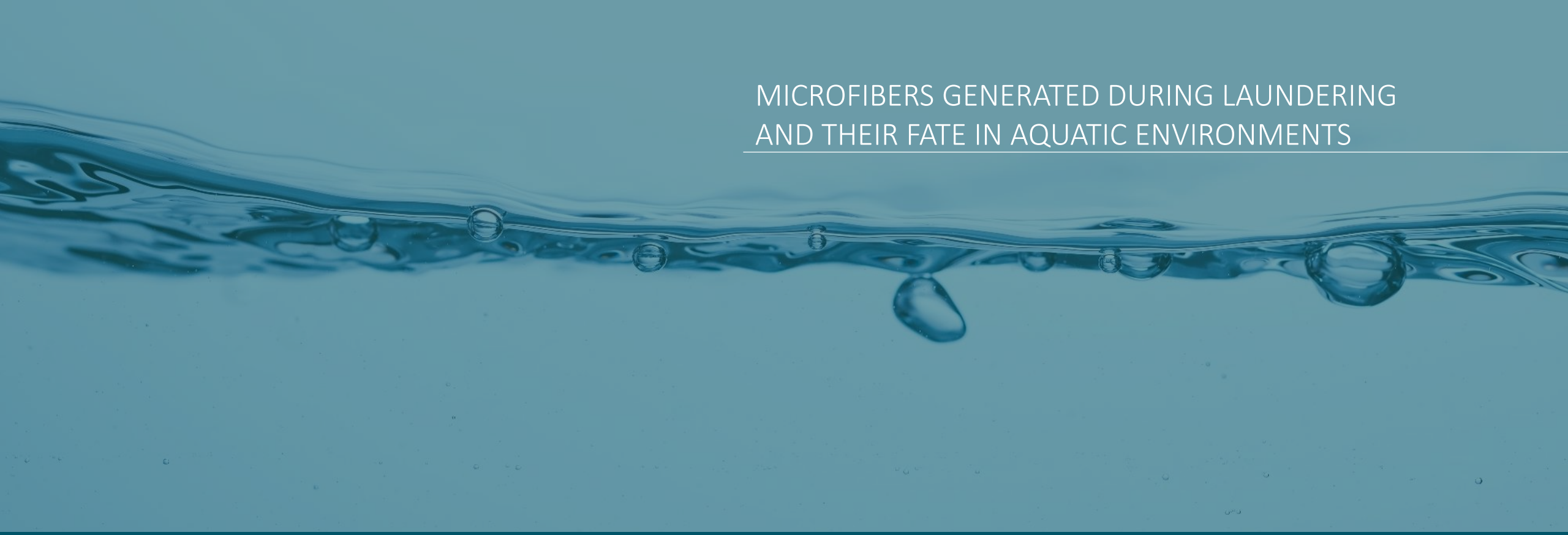
Julien Boucher
Partner
Shaping Environmental Action
julien.boucher@shaping-ea.com



MICROFIBERS GENERATED DURING LAUNDERING AND THEIR FATE IN AQUATIC ENVIRONMENTS

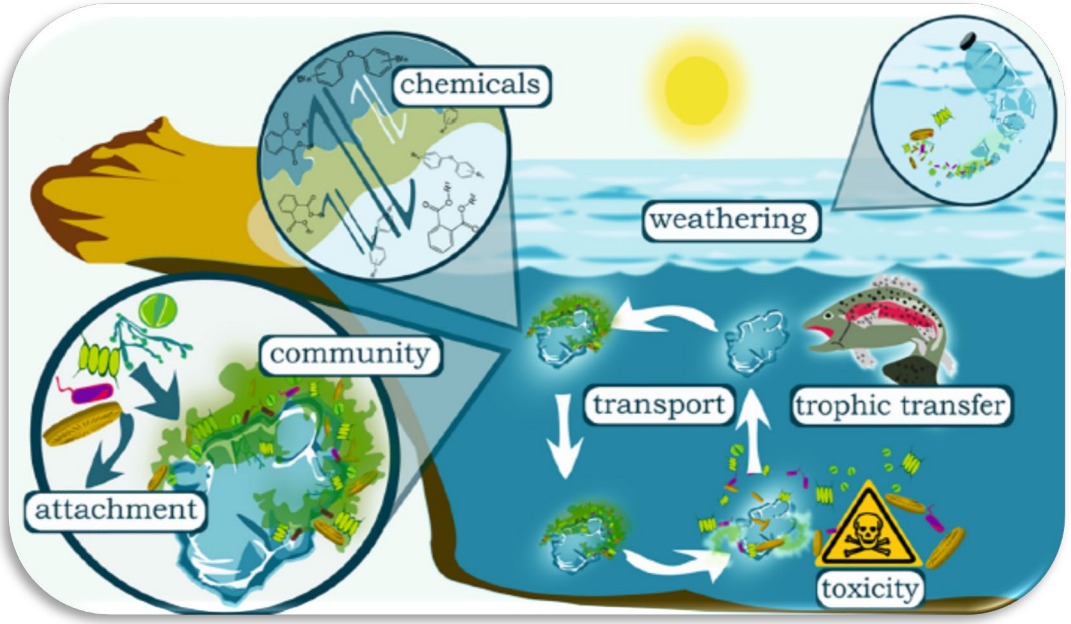
Richard Venditti – NCSU Professor

Joel Pawlak, NCSU Professor

Marielis Zambrano, NCSU Phd Candidate

NC STATE UNIVERSITY

Are we eating microplastics/microfibers?



- Anthropogenic debris such as plastic and fibers from textiles have been found in seafood sold for human consumption. In USA and Indonesia, 25-28% of the fish evaluated contained plastics and fibers (Rochman et al., 2015)

- Microplastics (MPs) were also observed in human stools in a preliminary study made with 8 participants from different countries and different diets. No fibers were reported, but, 100% contained MPs, mainly PET particles (Schwabl et al., 2018).

Source: Schwabl et al. (2018), Rummel et al. (2017), Rochman et al. (2015)

HOW MUCH MICROFIBERS ARE GENERATED IN WASHING CLOTHES?

Natural vs synthetic textiles – microfibers generated during home laundering

3X Cycles

Load

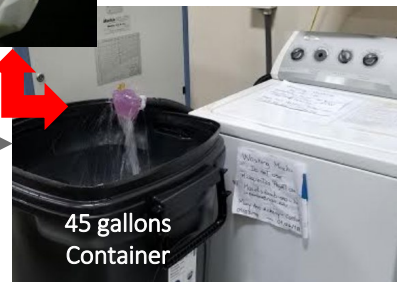
4 Lb of Fabric
Pre-Cleaned

Normal Cycle

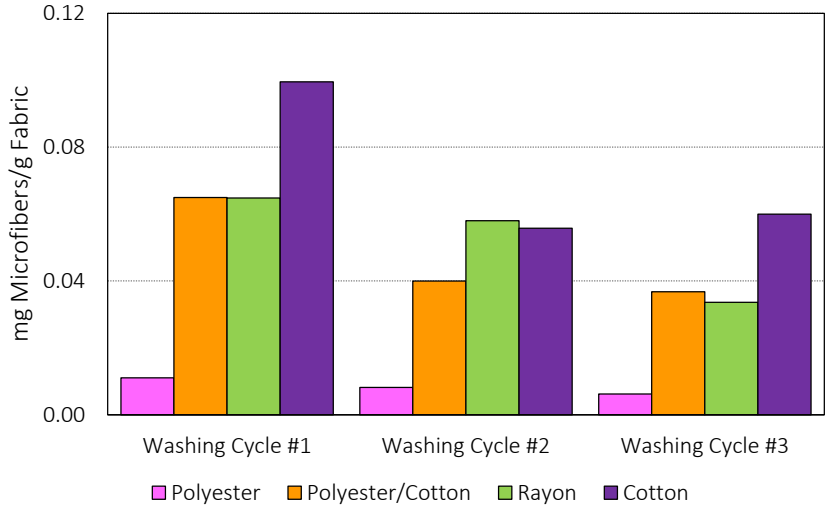
Wet Fabric

High (Heavy) Cycle
60 min

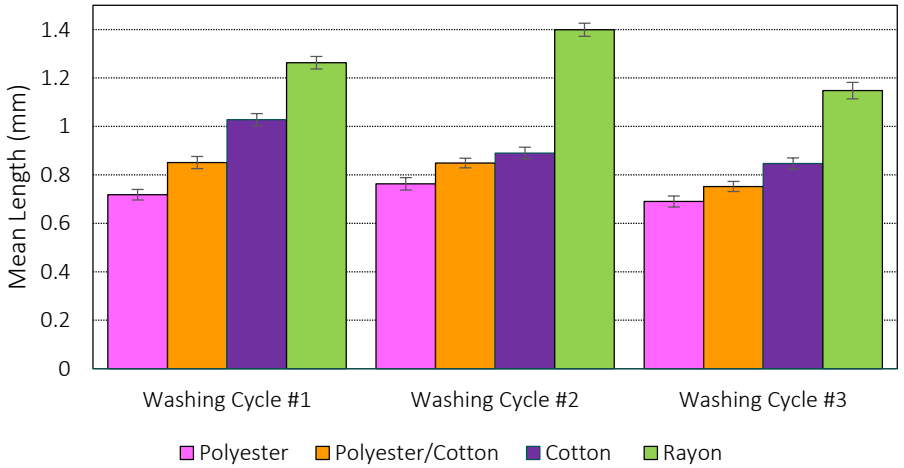
Dried Fabric

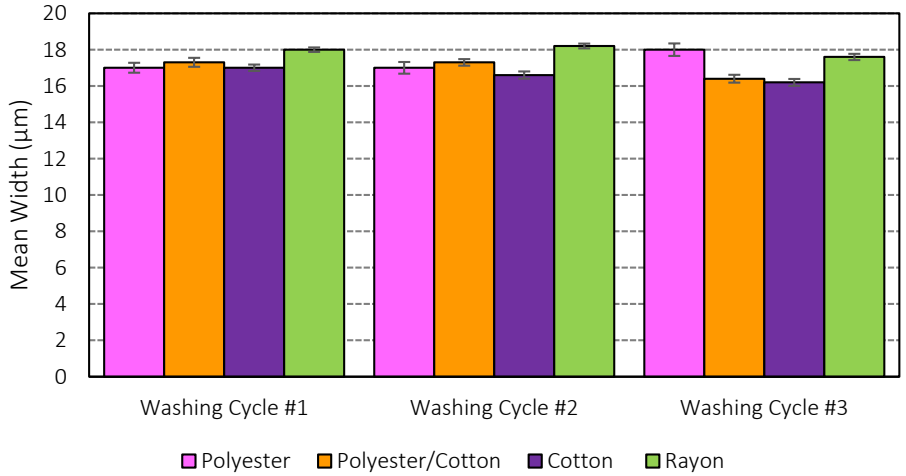


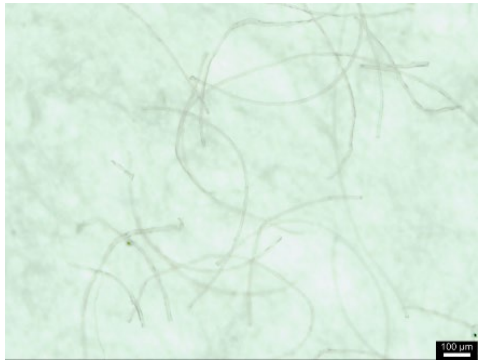
Microfibers Released during Home Laundering in the US per year estimated at 6000 tons



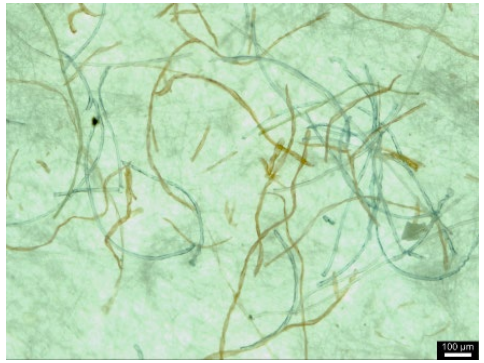
What is the size of the microfibers released during laundering?



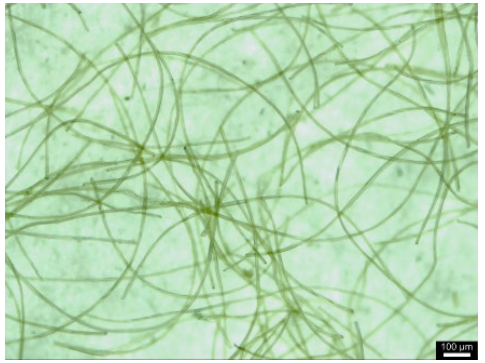




100 % Polyester



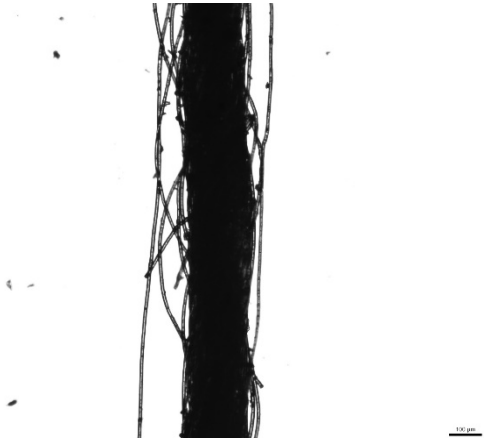
50/50 Polyester/Cotton



100 % Rayon

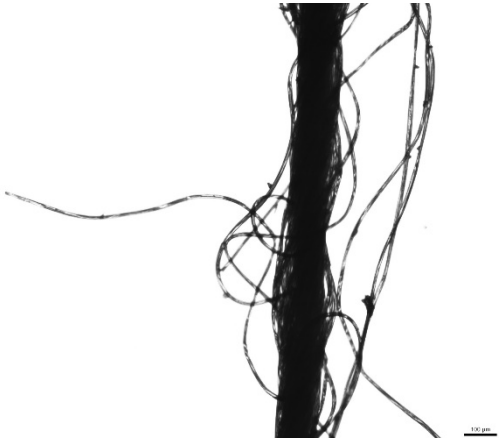
100 % Cotton

Microfibers are broken from the surface of the fabric or yarn during washing

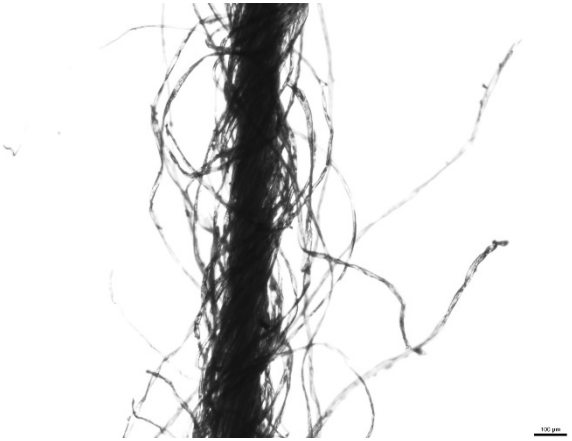


100 % Polyester
Spun Yarn

50/50 Polyester/Cotton
Spun Yarn



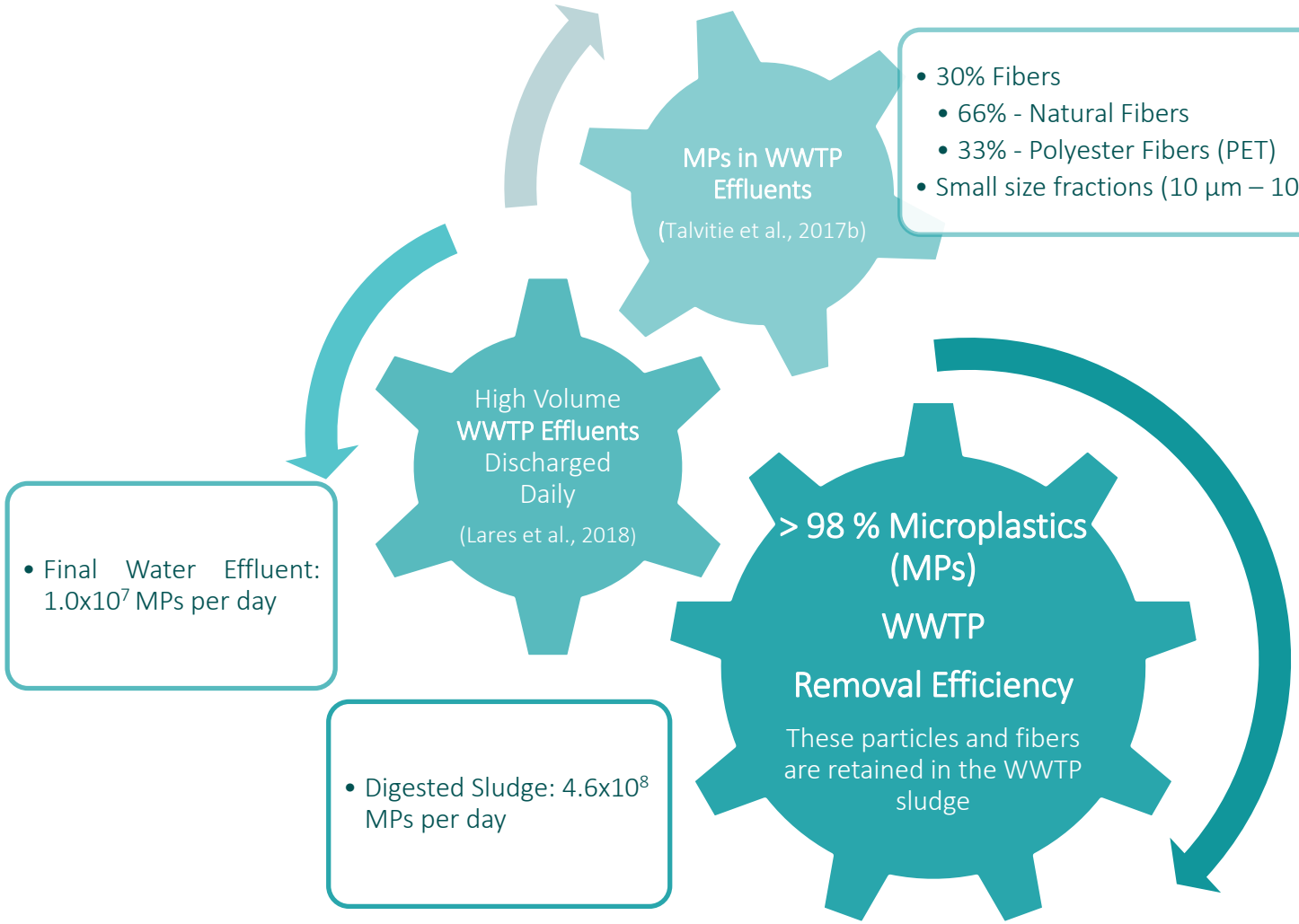
100 % Rayon
Spun Yarn



100 % Cotton
Spun Yarn

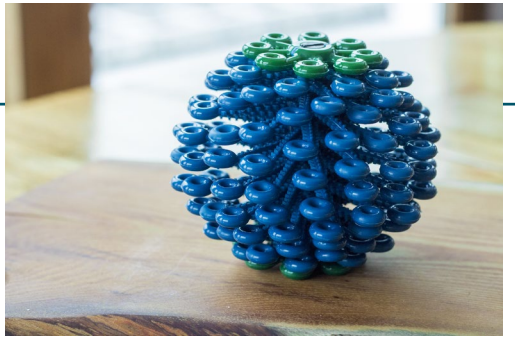
WHERE ARE THESE MICROFIBERS GOING?

Are these microfibers passing through the WWTP?



Source: Magnusson et al. (2014), Lares et al. (2018), Talvitie et al. (2015), Talvitie et al. (2017a) Talvitie et al. (2017b), Mason et al. (2016), Mintenig et al. (2017), Wolff et al. (2018).

What about trapping microfibers during washing?



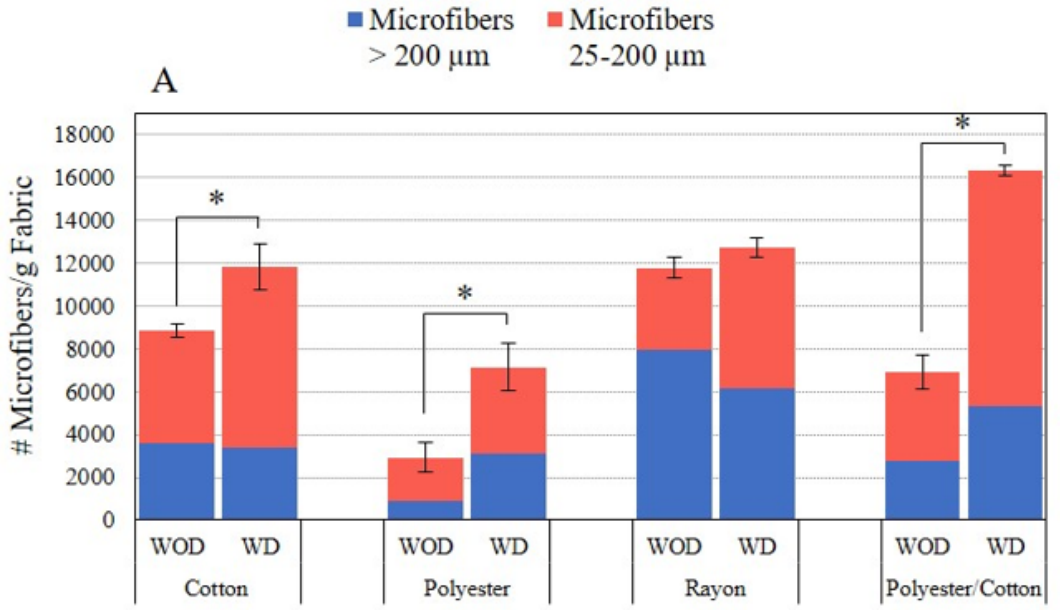
OPTIONS TO TRAP MICROFIBERS FROM THE WASHING MACHINE

The GUPPYFRIEND washing bag, the Coral ball, and the LUV-R filter used to capture the microfibers

McIlwraith et al. (2019) showed that the

- Lint LUV-R filter trapped 87% of fibers, has pore size of 150 µm
- Coral Ball trapped only 26%

Nevertheless, our results shows that there is an important portion of microfibers with a size below 200µm that cannot be addressed by these trapping mechanisms.



DO TEXTILE MICROFIBERS DEGRADE IN AQUATIC ENVIRONMENTS?

Aerobic biodegradation of textile spun yarns in aquatic environments

Samples

- Blank
- 100% Cotton
- 100% Polyester
- 100% Rayon
- 50%/50% Polyester/Cotton
- Reference Microcrystalline Cellulose

Inoculum

Completed — **Lake Water**
Lake Raleigh, NC
ISO 14851

Completed — **Seawater**
Wilmington, NC
ASTM D6691

On Going — **Activated Sludge**
Neuse River WWTP, NC
ISO 14851

Biodegradation Measurements

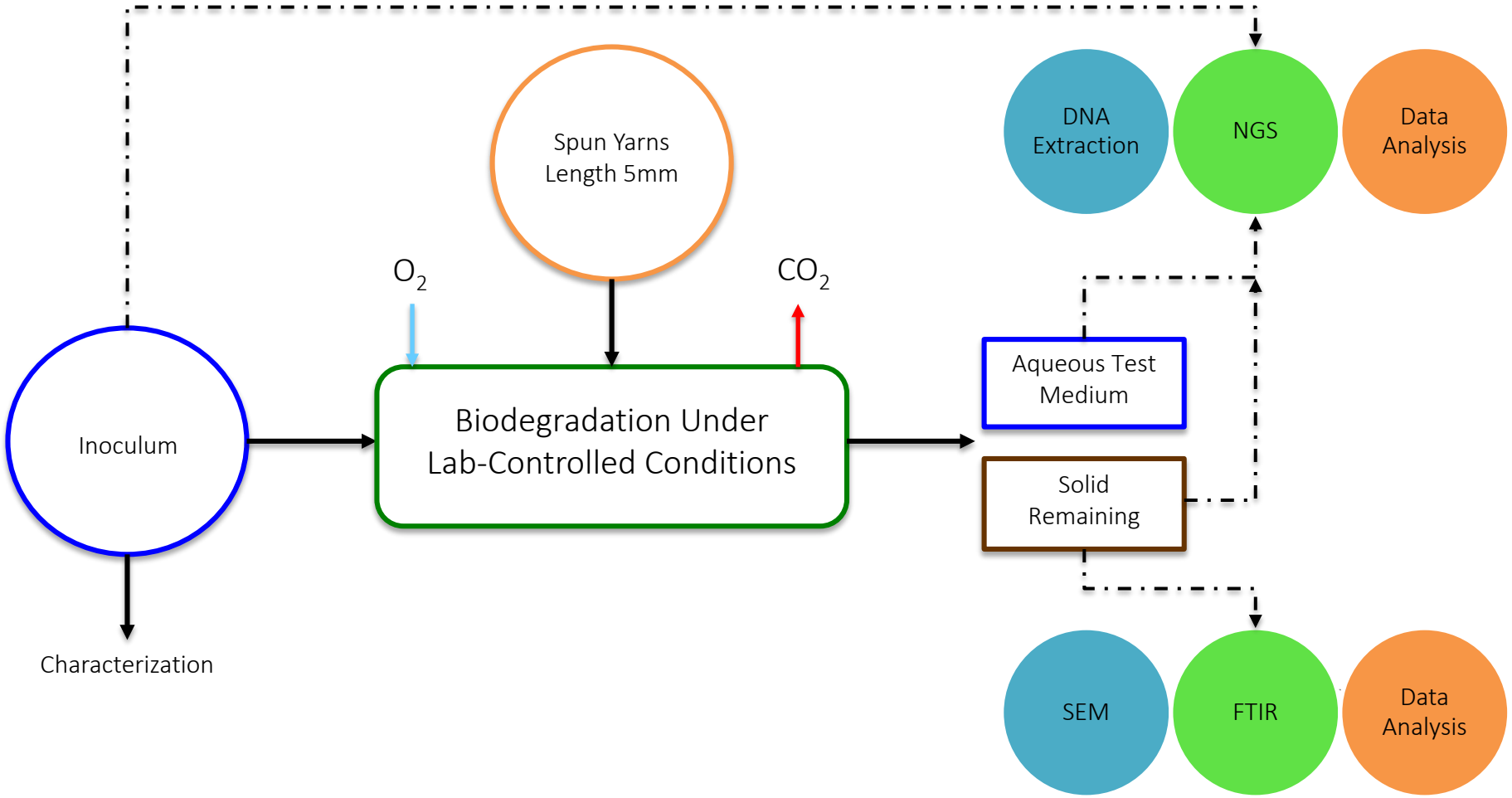
http://www.envitreat.com/rsa/

Respirometer System
RSA PF-8000

$$\% \text{ Biodegradation} = \frac{\text{Ou}}{\text{ThOD}} * 100$$

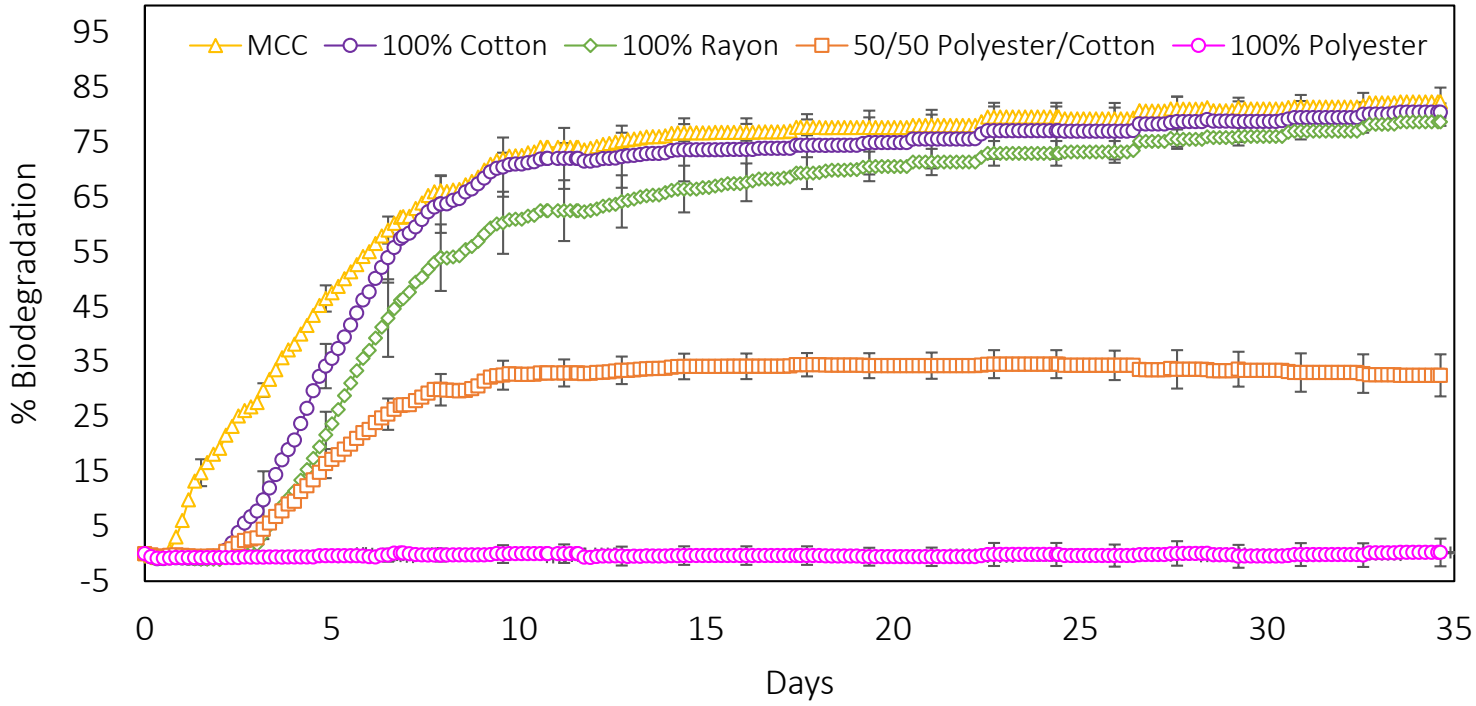
Ou - Oxygen Uptake
ThOD - Theoretical Oxygen Demand

Aerobic biodegradation of textile spun yarns in aquatic environments



SEM Scanning Electron Microscopy, **FTIR** Fourier-Transform Infrared Spectroscopy,
NGS Next Generation Sequence, **qPCR** Quantitative Polymerase Chain Reaction,

Aerobic biodegradation of textile spun yarns in lake water



Biodegradation curves of textile yarns (ISO 14851)

Determination of the Ultimate Aerobic Biodegradability of Plastic Materials in an Aqueous Medium

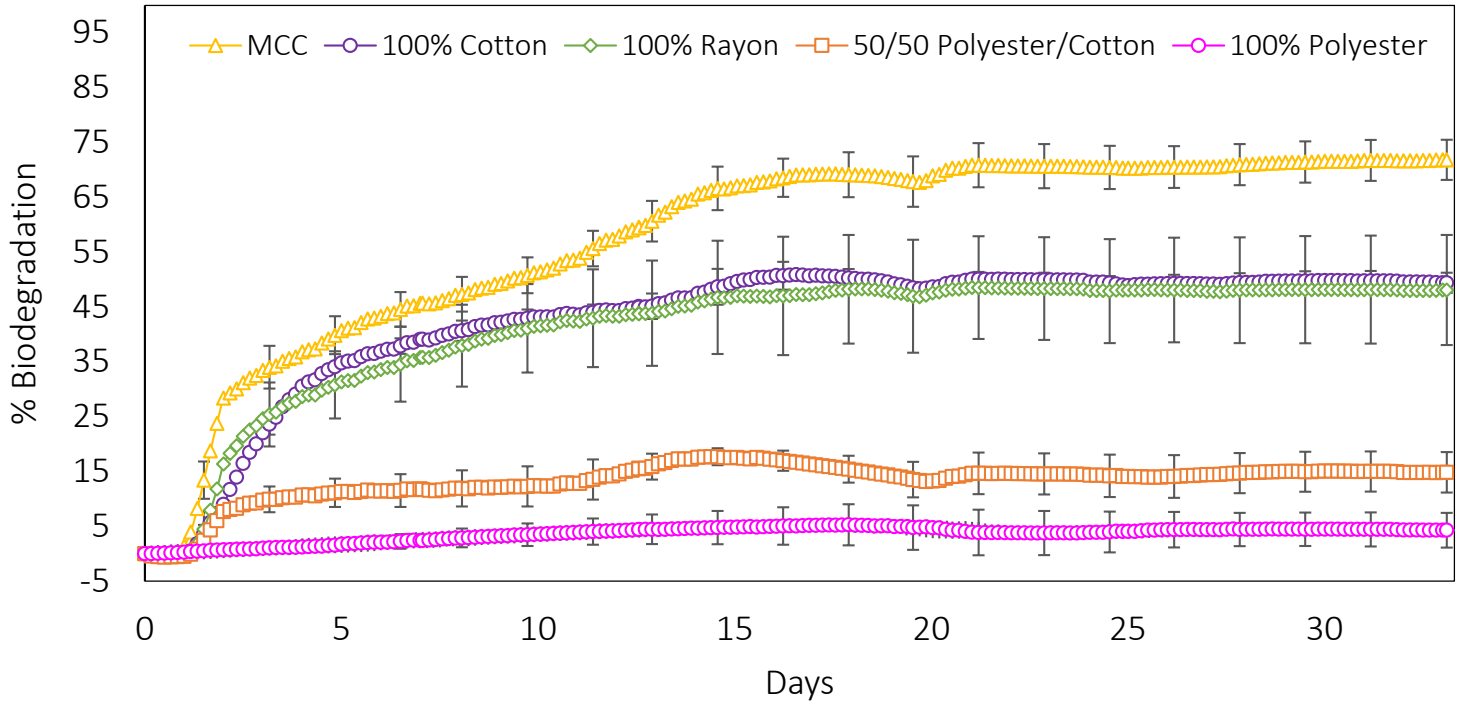
3 duplicates of each sample

Inoculum – Lake Raleigh Water

Measurements – RSA PF-8000 (Oxygen Uptake)

Material Added – 80 mg of yarns/500 ml Test Medium

Aerobic biodegradation of textile spun yarns in seawater



Biodegradation curves of the Textile Yarns (ASTM D6691)

Determination of the Ultimate Aerobic Biodegradability of Plastic Materials in an Aqueous Medium

4 duplicates of each sample

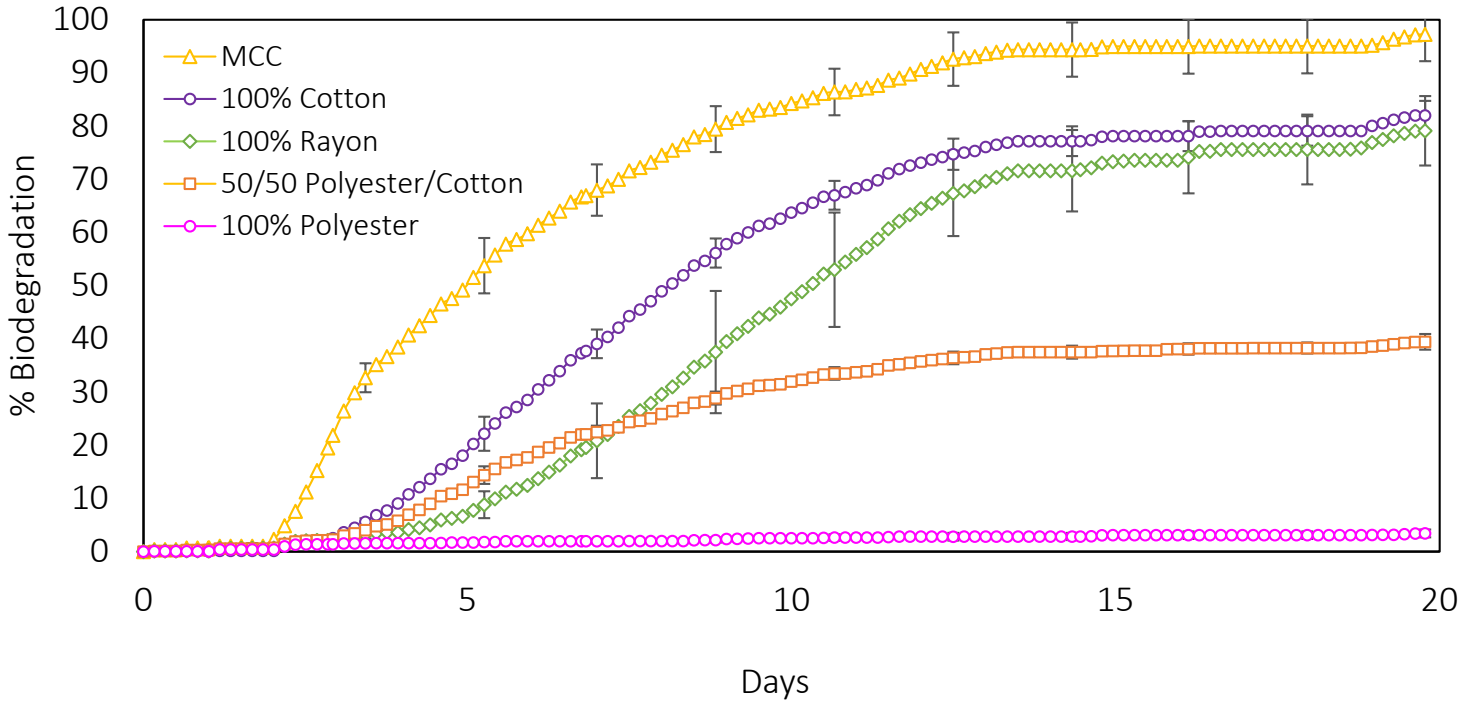
Inoculum – Seawater

Measurements – RSA PF-8000 (Oxygen Uptake)

Material Added – 80 mg of yarns/500 ml Test Medium

Aerobic biodegradation of textile spun yarns in aquatic environments

Preliminary Data
Pending
Nitrification
Interferences



Biodegradation curves of textile yarns (ISO 14851)

Determination of the Ultimate Aerobic Biodegradability of Plastic Materials in an Aqueous Medium

4 duplicates of each sample

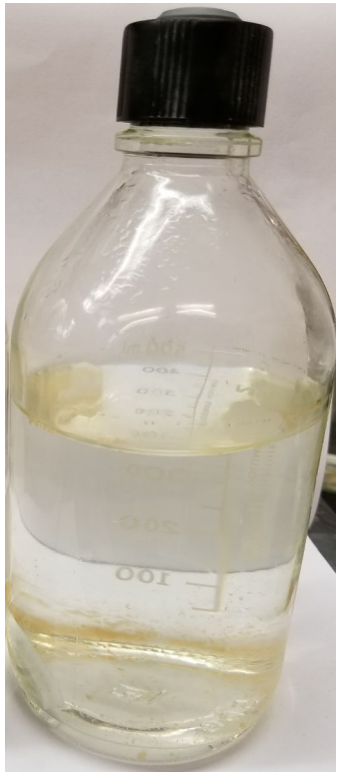
Inoculum – 30 ppm Activated Sludge from Neuse River WWTP

Measurements – RSA PF-8000 (Oxygen Uptake)

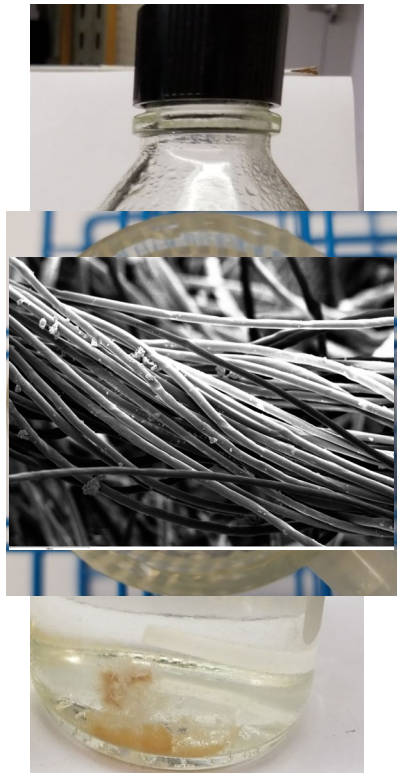
Material Added – 80 mg of yarns/500 ml Test Medium

Aerobic biodegradation of textile spun yarns in aquatic environments

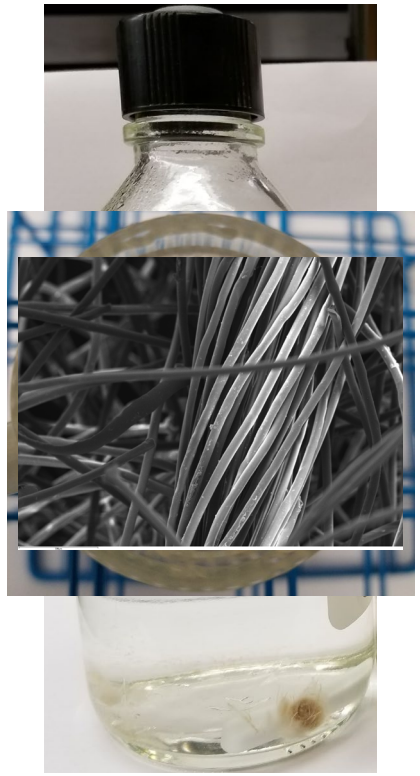
Cotton Yarns



Rayon Yarns



50/50 Polyester/Cotton Yarns



Polyester Yarns

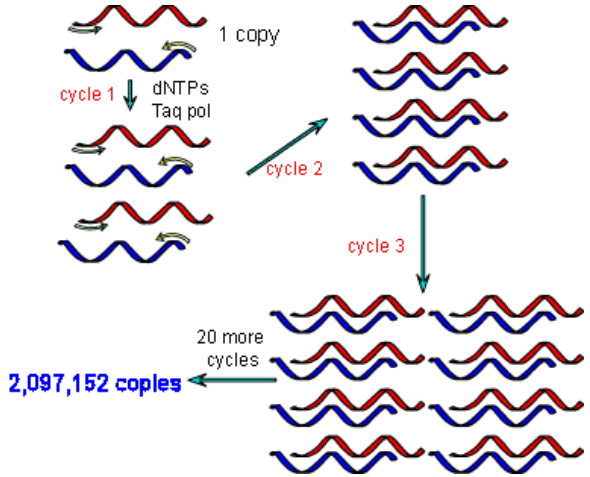
Residual Solids After Degradation

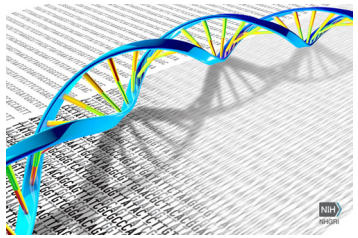
Aerobic biodegradation of textile spun yarns in aquatic environments - summary

Experiment		1	2	3
Inoculum		Lake Water	Seawater	30 ppm of Activated Sludge from Neuse River WWTP
Test Material Added/Bottle		80 mg	80 mg	80 mg
Test Medium Volume		500 ml	500 ml	500 ml
Experiment Time Frame		35 days	33 days	20 days
BOD Blank		62.40±4.95 mg/l	8.79±4.78 mg/l	26.66±1.40 mg/l
% Biodegradation	Reference Material (MCC)	79.63±0.18%	70.94±0.38%	97.25±5.06%
	100% Cotton Yarns	77.15±0.37%	49.3±0.15%	82.01±2.74%
	100% Rayon Yarns	73.43±0.24%	48.16±0.93%	79.11±6.52%
	50%/50% Polyester/Cotton Yarns	33.86±0.22%	14.57±0.36%	39.42±1.47%
	100% Polyester Yarns	Not Appreciable	4.23±0.34%	3.41±0.74%

CAN TEXTILE MICROFIBERS IMPACT THE MICROBIOME IN AQUATIC ENVIRONMENTS?

Microbial communities involved in the aerobic biodegradation of textile spun yarns





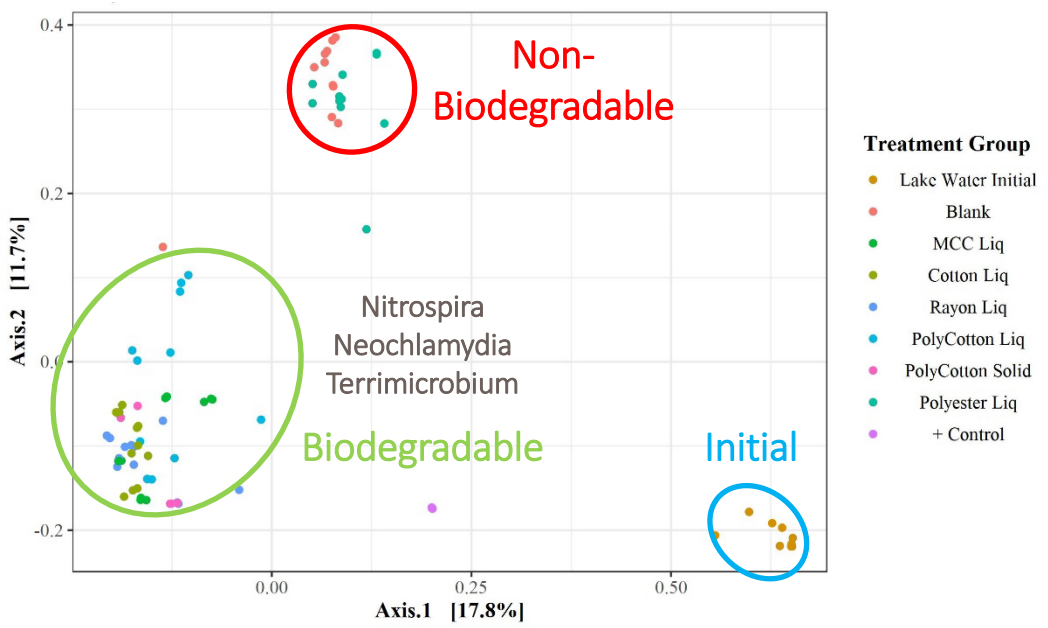
Sample Collection → Isolate/Purify Genomic DNA → Amplify DNA from 16S rRNA regions from Genomic DNA → Sequence using Next Generation Sequencing → Data Analysis

Bacteria

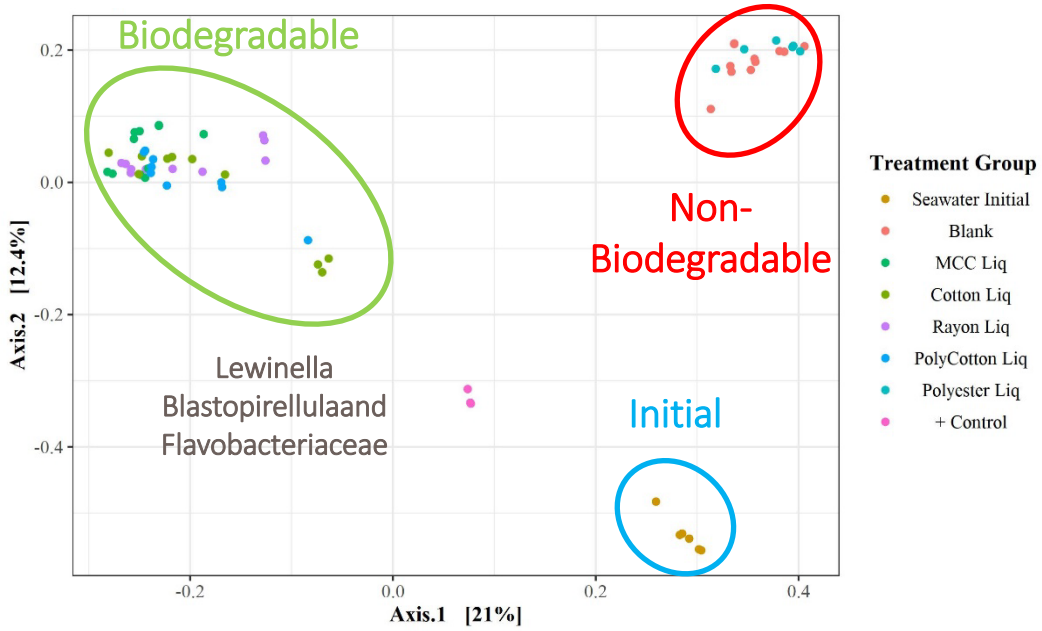
MultiQC
NEPHELE
QIIME
DADA2
Phyloseq
DeSeq2

https://www.illumina.com/informatics/sequencing-data-analysis.html, http://www.scq.ubc.ca/polymerase-chain-reaction/

Microbial communities involved in the aerobic biodegradation of textile spun yarns



Lake Water Biodegradation Experiment



Seawater Biodegradation Experiment

Do textile microfibers degrade in aquatic environments?

- Natural-based fabrics release a greater amount of microfibers during laundering than synthetic fabrics.
- These microfibers have the potential to escape the WWTP due to their small size.
- Natural-based fibers such as cotton and rayon can be highly assimilated by the microorganisms in aquatic environments.
- The aerobic aquatic biodegradation extent of the textile fibers decrease as follows:

  Cotton > Rayon > Polyester/Cotton > Polyester (near zero).
- The biodegradation of textile spun yarns not only depends on the morphology and chemical structure of the fibers but also on the microorganisms present in the environment.

https://www.inkreadible.com/compostable-biodegradable-labels

Acknowledgements

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Dr. Cong Tu

City of Raleigh North Carolina

Neuse River

Wastewater Treatment Plant

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Dr. Carlos Goller

Dr. Robert M. Kelly

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Tackling Our Ocean's Plastic Pollution Problem

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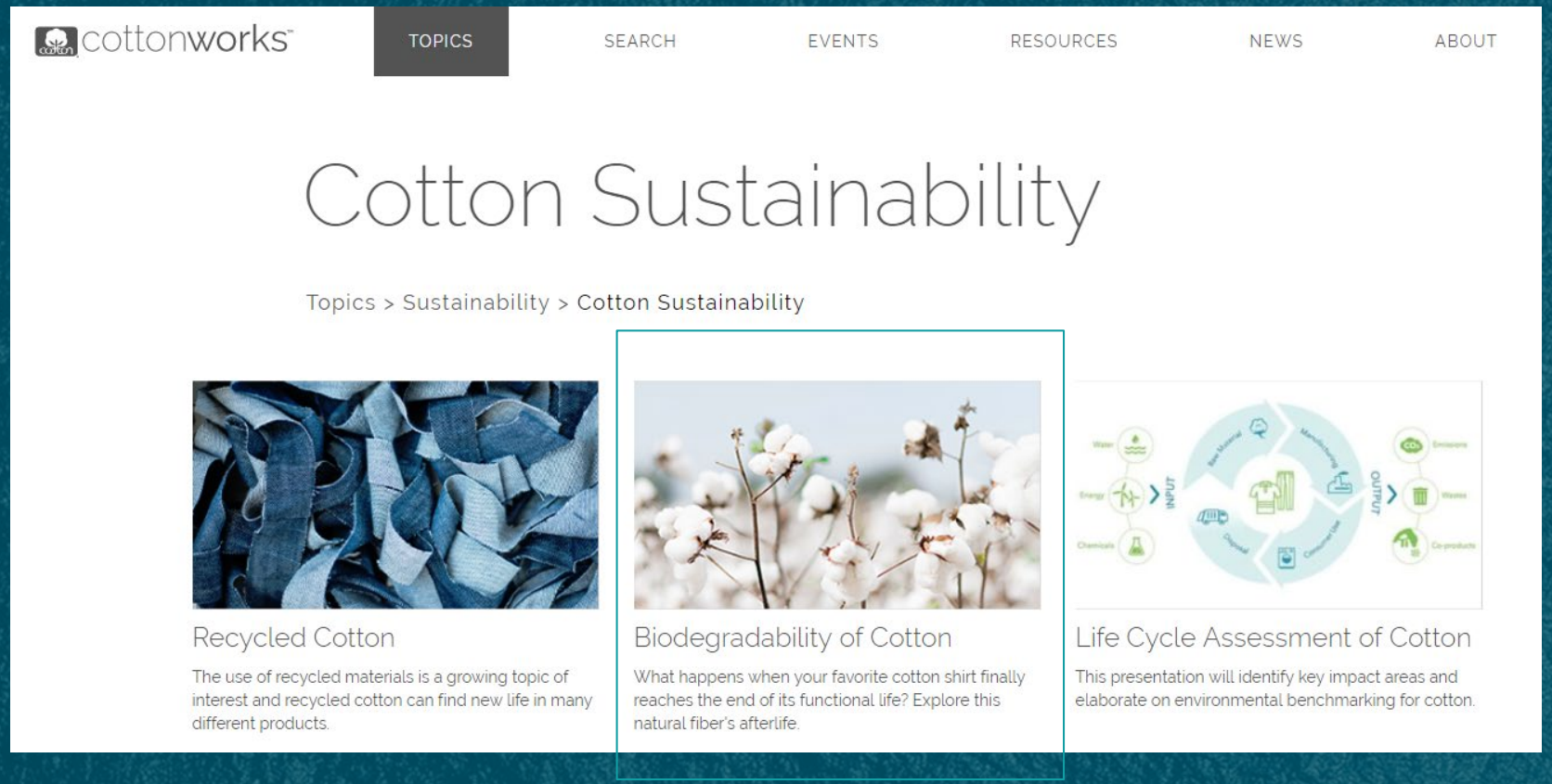

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