

The Plastic Waste Problem

What is VU's role?

Julie Peller, Professor of Chemistry

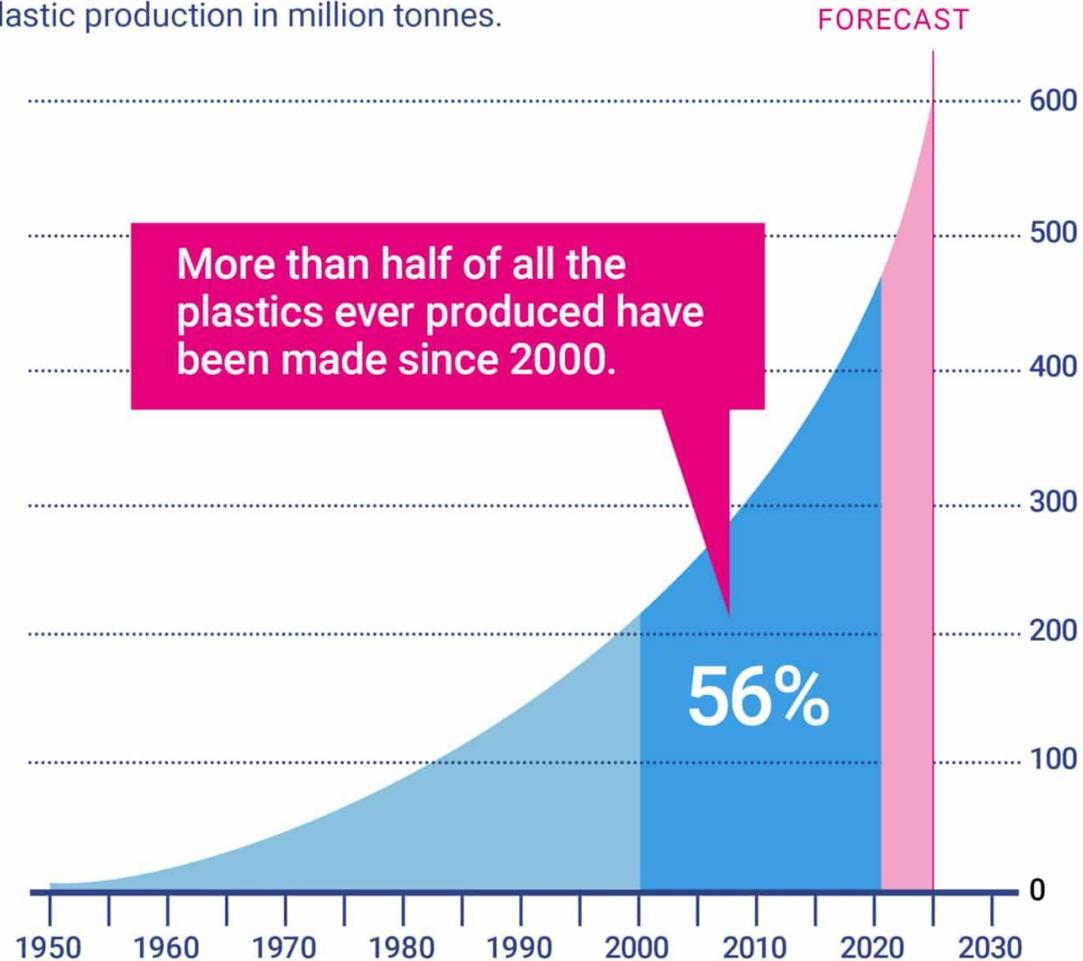
Julie Whitaker, Energy and Sustainability Coordinator



The Tremendous Rise in Production of Plastics: nature-incompatible materials

PRODUCTION OF PLASTIC

Global annual plastic production in million tonnes.



<https://www.plasticsoupfoundation.org/en/plastic-facts-and-figures/>

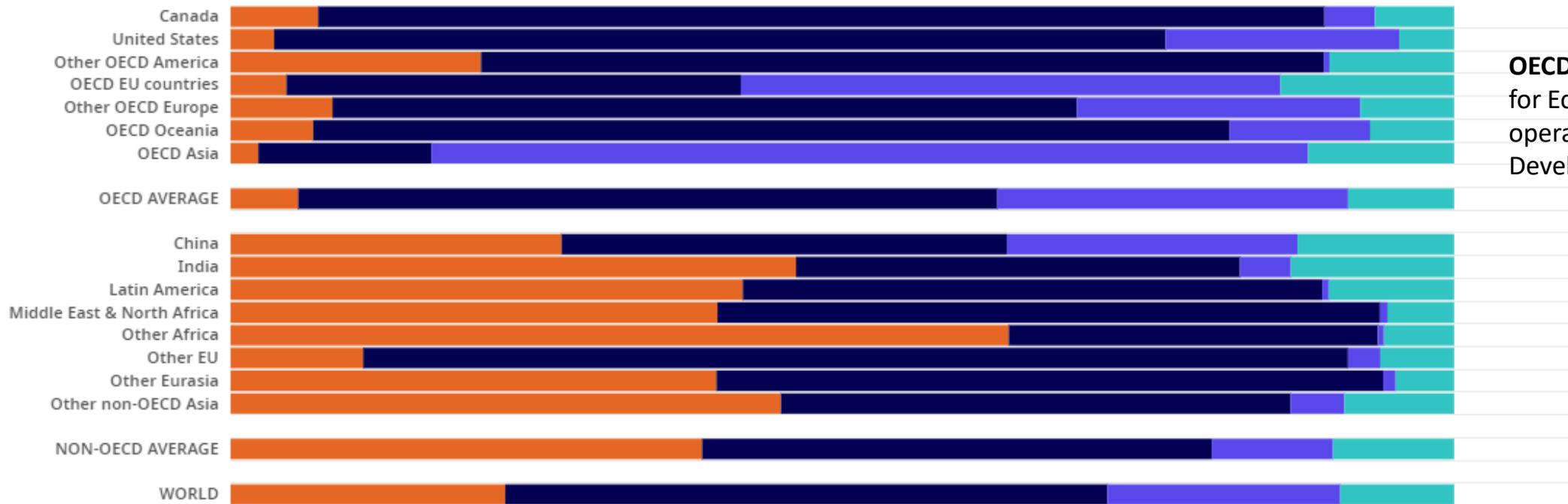
SOURCE: PLASTIC ATLAS 2019 | © PLASTIC SOUP FOUNDATION

Plastics do not decompose. What is the plan?

Globally, only 9% of plastic waste is recycled while 22% is mismanaged

Share of plastics treated by waste management category, after disposal of recycling residues and collected litter, 2019

Mismanaged & uncollected litter Landfilled Incinerated Recycled



OECD = Organization for Economic Co-operation and Development

The Petro-chemical plan

Electrification of vehicles/ Solar → Less fossil fuel sold for direct energy.

Fossil fuel industry → Make more plastic. → Fuel

More plastic, more waste. How is this handled?.

Waste to fuel (promoted as green technology) → Incineration (thermochemical processes) create more pollution (lots of chemical additives).

Environmental Injustices throughout: extraction to waste handling.

Fossil fuels to FUELS

Now, fossil fuels to plastic to FUELS

<https://www.epa.gov/eg/waste-combustors-effluent-guidelines>

<https://cendigitalmagazine.acs.org/2022/05/09/preparing-for-petrochemicals-2/content.html>



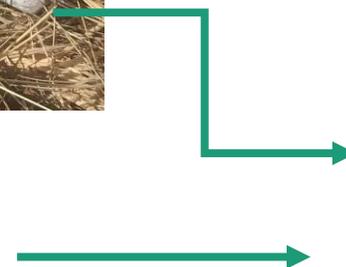
Plastic Waste is EVERYWHERE from macro to nano

“More than 1.3 billion tons of plastic will be dumped on land and in the oceans over the period from 2016 to 2040 unless the world acts,” (University of Leeds, <https://phys.org/news/2020-07-world-plastic-pollution.html>)

Macro

Microplastics

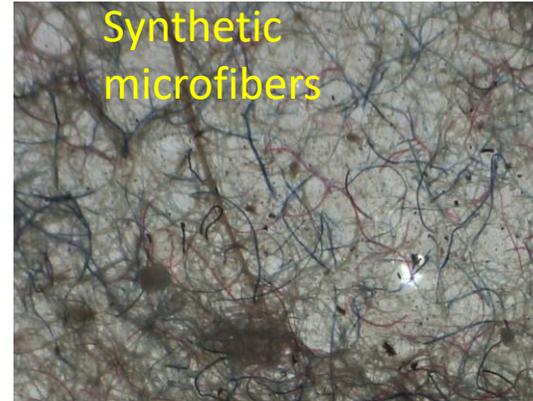
Nanoplastics



Investigations of Microplastics in the local watershed



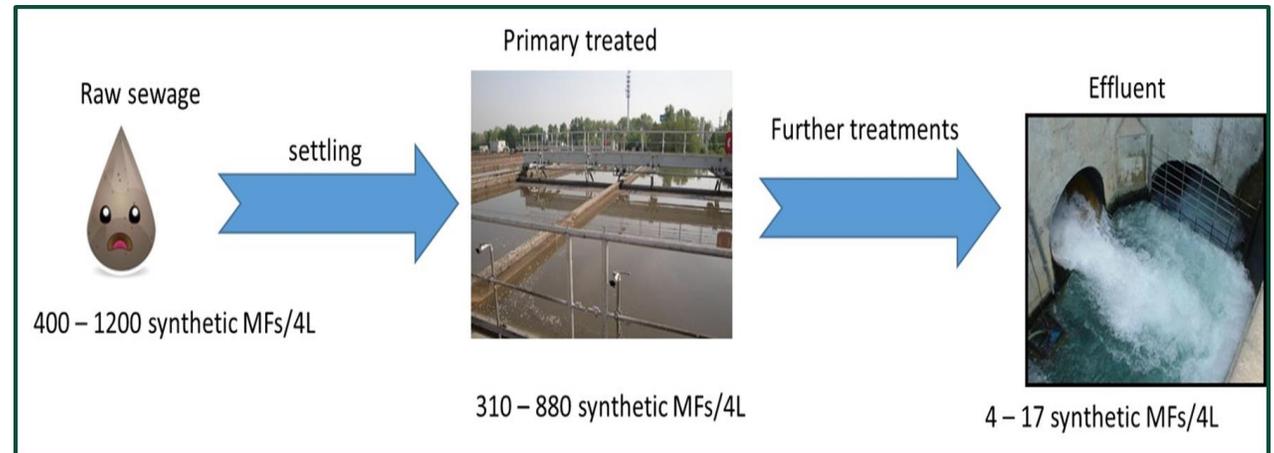
Microplastics: smaller than 5 mm



Funded Projects:

EPA Environmental Education Program (grant #00E01498-0)

NSF EAGER PROGRAM (grant # 1744004)



From this one part of the watershed, an estimate **4 billion synthetic microfibers** are carried daily. Destination: Lake Michigan

VU Chemistry studies on microplastic pollution

Environmental Science Processes & Impacts



PAPER



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Tracking the distribution of microfiber pollution in a southern Lake Michigan watershed through the analysis of water, sediment and air

Julie R. Peller,^{a,*} Laurie Eberhardt,^b Robert Clark,^a Cassie Nelson,^c Edward Kostelnik^a and Christopher Iceman^a

Chapter 4

A Review of Microplastics in Freshwater Environments: Locations, Methods, and Pollution Loads

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Sequestration of microfibers and other microplastics by green algae, *Cladophora*, in the US Great Lakes[☆]

Julie Peller^{a,*}, Meredith B. Nevers^b, Muruleedhara Byappanahalli^b, Cassie Nelson^c, Bharath Ganesh Babu^d, Mary Anne Evans^e, Eddie Kostelnik^a, Morgan Keller^a, Jenna Johnston^d, Sarah Shidler^f

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Article

The Reactivity of Polyethylene Microplastics in Water under Low Oxygen Conditions Using Radiation Chemistry

Julie R. Peller^{1,*}, Stephen P. Mezyk², Sarah Shidler³, Joe Castleman¹, Scott Kaiser¹ and Gregory P. Horne⁴

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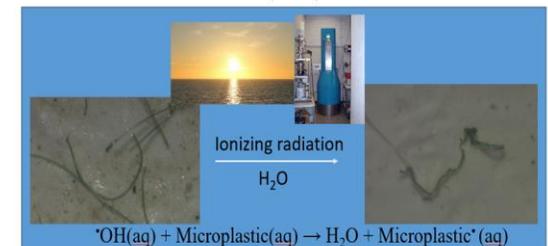
⁴ Center for Radiation Chemistry Research, Idaho National Laboratory, P.O. Box 1625, Idaho Falls, ID 83415, USA; gregory.horne@inl.gov

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Laboratory Radiation Chemistry Methods to Induce Rapid Aging of Microplastics in Water to Assess Fundamental Chemical Reactivity Changes

Julie Peller, Principal Investigator, Valparaiso University

Stephen Mezyk, Co-Principal Investigator, California State University, Long Beach
NSF award number 2035499 (2020)



Objectives:

- To determine important radical-induced degradation mechanisms and corresponding reaction rates using ionizing radiation

- To determine the chemical adsorption/desorption properties of chemically transformed (aged) plastics



Educational/outreach publications

Detecting Microplastics in Soil and Sediment in an Undergraduate Environmental Chemistry Laboratory Experiment That Promotes Skill Building and Encourages Environmental Awareness

Laura Rowe,¹ Maria Kubalewski, Robert Clark, Emily Statza, Thomas Goyne, Katie Leach, and Julie Peller¹

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Supporting Information

ABSTRACT: Environmental pollution is both a worldwide and a local issue, and microplastic pollution in particular is receiving increased attention due to its prevalence and bioaccumulation potential affecting the food chain. This laboratory experiment uses current, research-based methods such that the students can determine the extent of microplastic pollution in local soil samples. This laboratory experiment can be used as either a 2 or 3 week mini-research-project for first-year undergraduate students in either an introductory chemistry course for nonmajors or a general chemistry course for majors. The laboratory experiment gives students exposure to sieving, density gradients, and exposure to the Fenton reagent to isolate microplastics from soil samples, which are then analyzed and quantified under stereomicroscope magnification. Several general chemistry topics common to most first-year chemistry courses (density and solution concentration calculations, etc.) are emphasized during the laboratory experiment. From postexperiment assessments, students showed a marked improvement in select skill sets and knowledge of the microplastic pollution problem, and some students recognized their microplastic



DETECTING MICROPLASTICS IN A GREAT LAKES WATERSHED WITH UNDERGRADUATE STUDENTS

TRILLIONS OF TINY BITS OF PLASTIC – KNOWN AS MICROPLASTICS – CONTAMINATE OUR ENVIRONMENT. AMONG THESE ARE MICROFIBRES – VERY SMALL THREAD-SHAPED PLASTICS – ROUTINELY RELEASED FROM EVERYDAY WASHING OF SYNTHETIC FABRICS. THE REALITY IS THAT MANY OF THESE PLASTIC PARTICLES CONTINUE TO END UP IN RIVERS AND OCEANS, AND POSE A DANGER TO AQUATIC ORGANISMS. WITH THE HELP OF UNDERGRADUATE RESEARCH STUDENTS, DR JULIE PELLER, FROM VALPARAISO UNIVERSITY IN INDIANA, USA, IS ASSESSING THE MICROFIBRE POLLUTION IN SURFACE WATERS, WITH A FOCUS ON THE GREAT LAKES



FUTURUM



Professor Julie Peller

Julie Peller, Valparaiso University, Indiana, USA

Detecting microplastics on aquatic vegetation in the Great Lakes

research OUTREACH

The public outreach magazine for the research community

References

- Peller, J.; Naveen, M.; Byappanahalli, M.; Nelson, C.; Babu, B.; Evans, M.; Kozelnik, E.; Keller, M.; Johnson, J.; and Shuler, S. (2021). Sequestration of microfibers and other microplastics by green algae, *Cladophora*, in the US Great Lakes. *Environmental Pollution*, 276, 116495. Available at: <https://doi.org/10.1016/j.envpol.2021.116495>
- Peller, J.; Eberhardt, L.; Clark, R.; Nelson, C.; Kozelnik, E. and Isenian, C. (2019). Tracking the distribution of microfiber pollution in a southern Lake Michigan watershed through the analysis of water, sediment and air. *Environ. Sci. Processes and Impacts*, 21, 1549–1559. Available at: <https://doi.org/10.1039/C9EM00192A>
- Peller, J. (2021). Detecting Microplastics in a Great Lakes Watershed with Undergraduate Students [online]. *Futurum Inspiring the Next Generation*. Available at: <https://www.futurum.org/inspiring-the-next-generation/detecting-microplastics-in-a-great-lakes-watershed-with-undergraduate-students> [Accessed 21 07 2021]

It seems that one way to reduce the discharge of synthetic microfibres and other microplastics into surface waters is to employ an additional processing step in wastewater treatment. Based on our study, we speculate that passing the treated wastewater over algae may be a fairly simple way to collect most of the microplastics that remain in the final effluent. While this requires additional investment, it seems plausible.

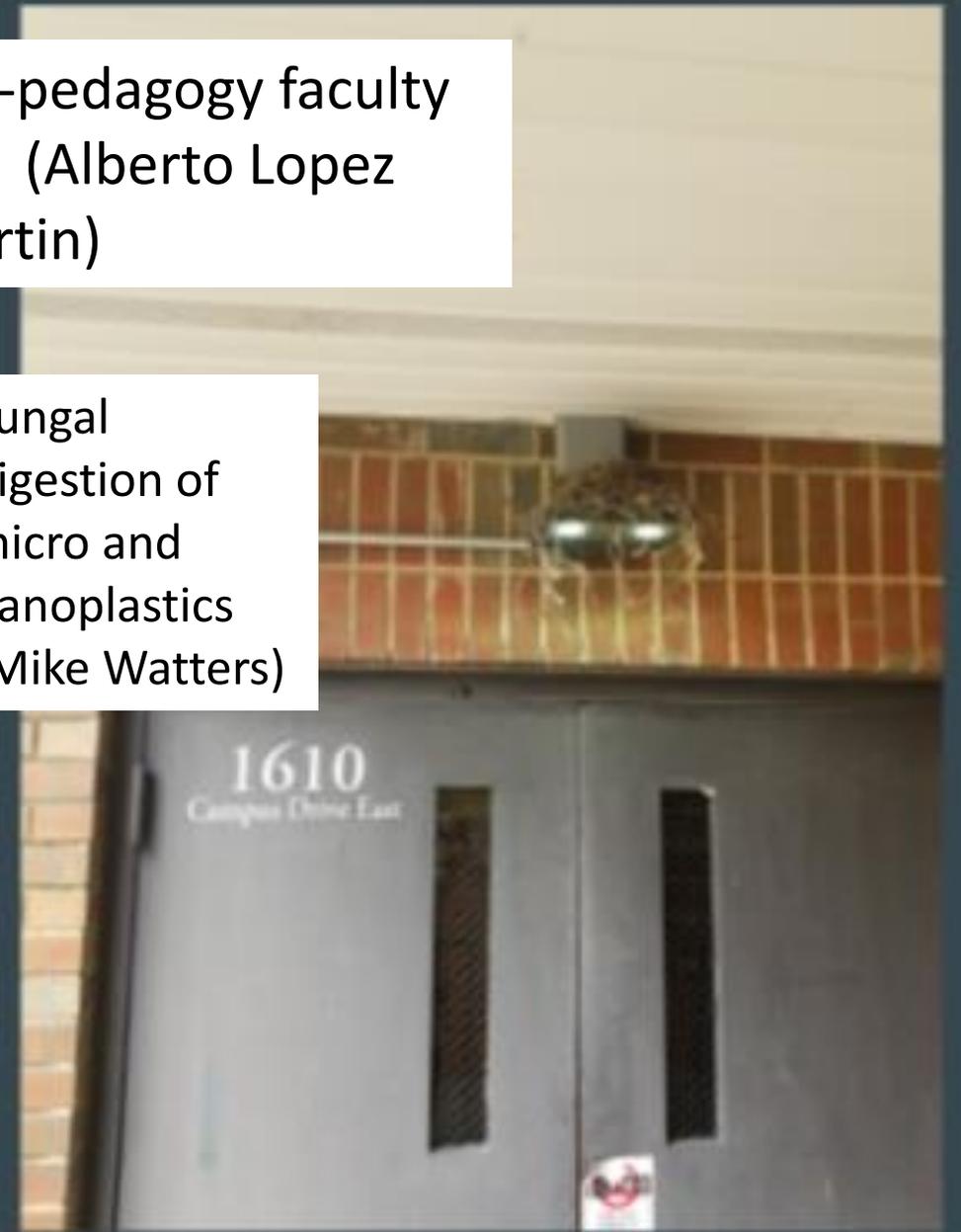


Plastic Prevalence and Distribution in Bird Nests in Valparaiso, IN

Addi Burke, Thomas Paul, Cole Philips, Ethan Peck, Dr. Laurie Eberhardt

Eco-pedagogy faculty
FLC (Alberto Lopez
Martin)

Fungal
digestion of
micro and
nanoplastics
(Mike Watters)





Opinion: I thought I'd seen it all studying plastics. Then my team found 2,000 bags in a camel.



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POLLUTION

The pervasiveness of microplastics

Plastic particles are showing up in our food and in our bodies. Is that a problem?

by Alex Scott

FEBRUARY 4, 2019 | APPEARED IN VOLUME 97, ISSUE 5



SEPTEMBER 15, 2014

C&EN

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A taste of your favorite crystal structures P.36

Our Attachment to Plastic Bags

What to do about the cheap, ugly, messy convenience P.12

Published by THE AMERICAN CHEMICAL SOCIETY

Our addiction to plastic is killing wildlife, polluting ecosystems and possibly harming humans

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22 August 20

The World their potent microplastic



Plastic waste in

Microplastics found in human blood for first time

Exclusive: The discovery shows the particles can travel around the body and may lodge in organs



Microplastics cause damage to human cells in the laboratory. Photograph: David Kelly/Photograph David Kelly

Microplastic pollution has been detected in human blood for the first time, with scientists finding the tiny particles in almost 80% of the people tested.



The rise in Plastic Production will worsen the plastic waste problem

Plastics originate from fossil fuels, which took millions of years to form. Therefore, the virgin materials should be deemed highly valuable.

*Circular Economy

What happens if we continue to accept plastics, especially those that were designed for a single use?

We have been collecting data to assess VU's role in the plastic waste problem.

International and National and Local Efforts to Eliminate Single Use Plastics

- **Solutions exist!! Simple solutions exist**
universities are striving toward zero waste
- Plastic materials have only been around since early/1950s
- MORAL OBLIGATION
- Best steps forward
 - REDUCE (purchases, packaging)
 - REUSABLES (Yes to refillable water bottles!)
 - REFUSE (plastic bags, cups, utensils, etc.)
 - STUDY AND IMPROVE PROCEDURES



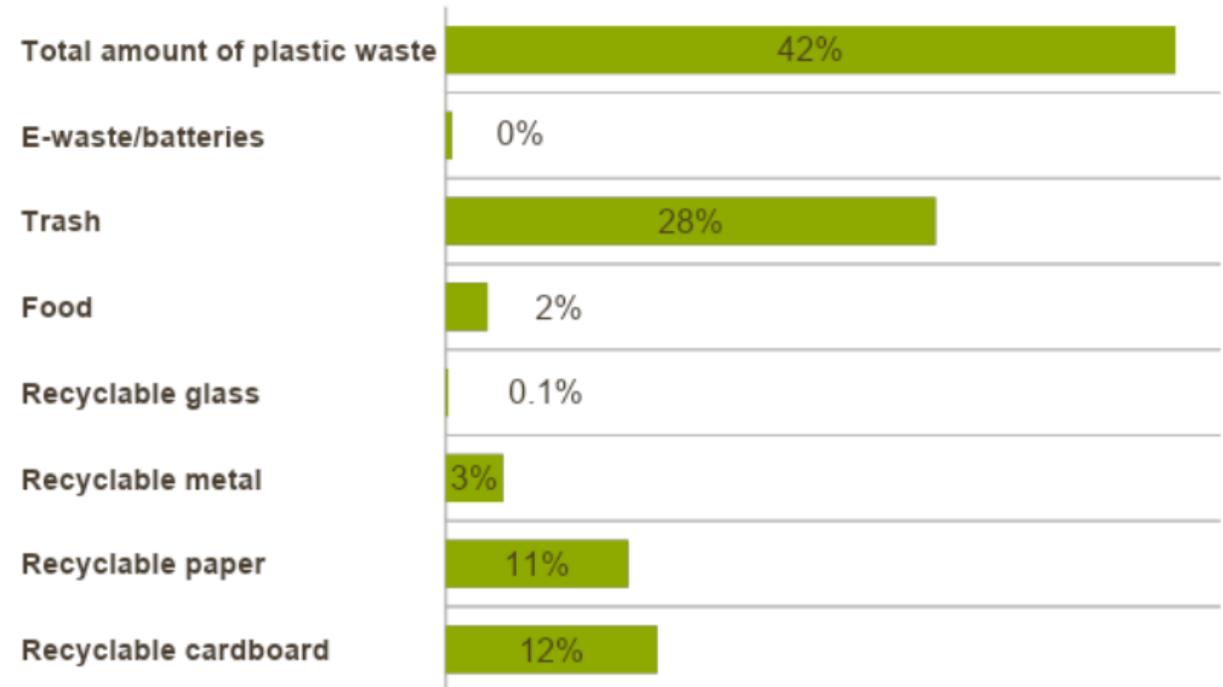
VU-Porter County Plastic Waste Project

- Perform a waste audit
- Compile data and learn about good and bad practices.
- EDUCATE
- Make changes
- Expand into community
- University - leadership



Overall Picture of Waste Created at VU (not cafeteria)

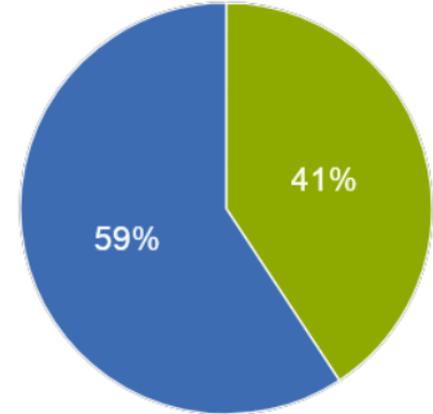
Total volume of each category



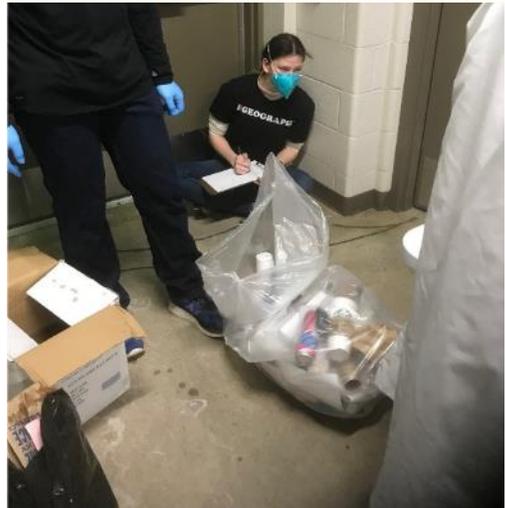
A significant portion of campus plastic waste is a result of waste collection procedures on campus.



Recyclable vs. landfill waste (volume)

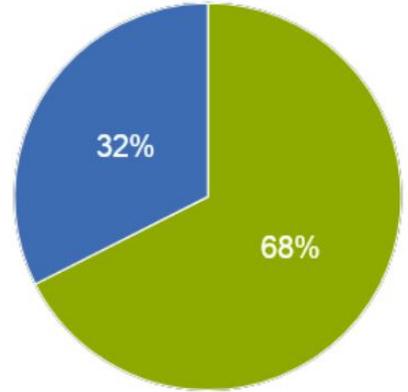


■ Total amount of curbside recyclable waste ■ Total amount of landfill waste



Unfortunately, we expect that most recyclables are NOT actually recycled.

Recycling Contamination (Volume)



■ Total amount of curbside recyclable waste ■ Total amount of landfill waste

Will we choose to take part in solutions to plastic waste?

Why is this important?

- Faith-based institution
- Care for the earth; environmental and public health
- Ethical leadership
- Service to one another, students, community
- Partnership with businesses, organizations



VU Plastic waste solutions

- ✓ Participation and support **at all levels: Board, Administration, Faculty and Staff, Students**
- ✓ Recommendations must turn into actions
 - Change waste collections to reduce/eliminate plastic bags
 - Fall Semester Green Campus campaign; green campus gatherings
 - Eliminate single use plastics on campus; institute other changes toward zero waste (save \$\$ - cut waste in half)
 - Changes in food services
- ✓ Work with the county's waste reduction district
- ✓ Work with other community partners



Join our breakout session to find out more about our campus audit.

Participate in devising solutions.

Let's do better for our students, our campus, our community, our earth.

THANK YOU!!!