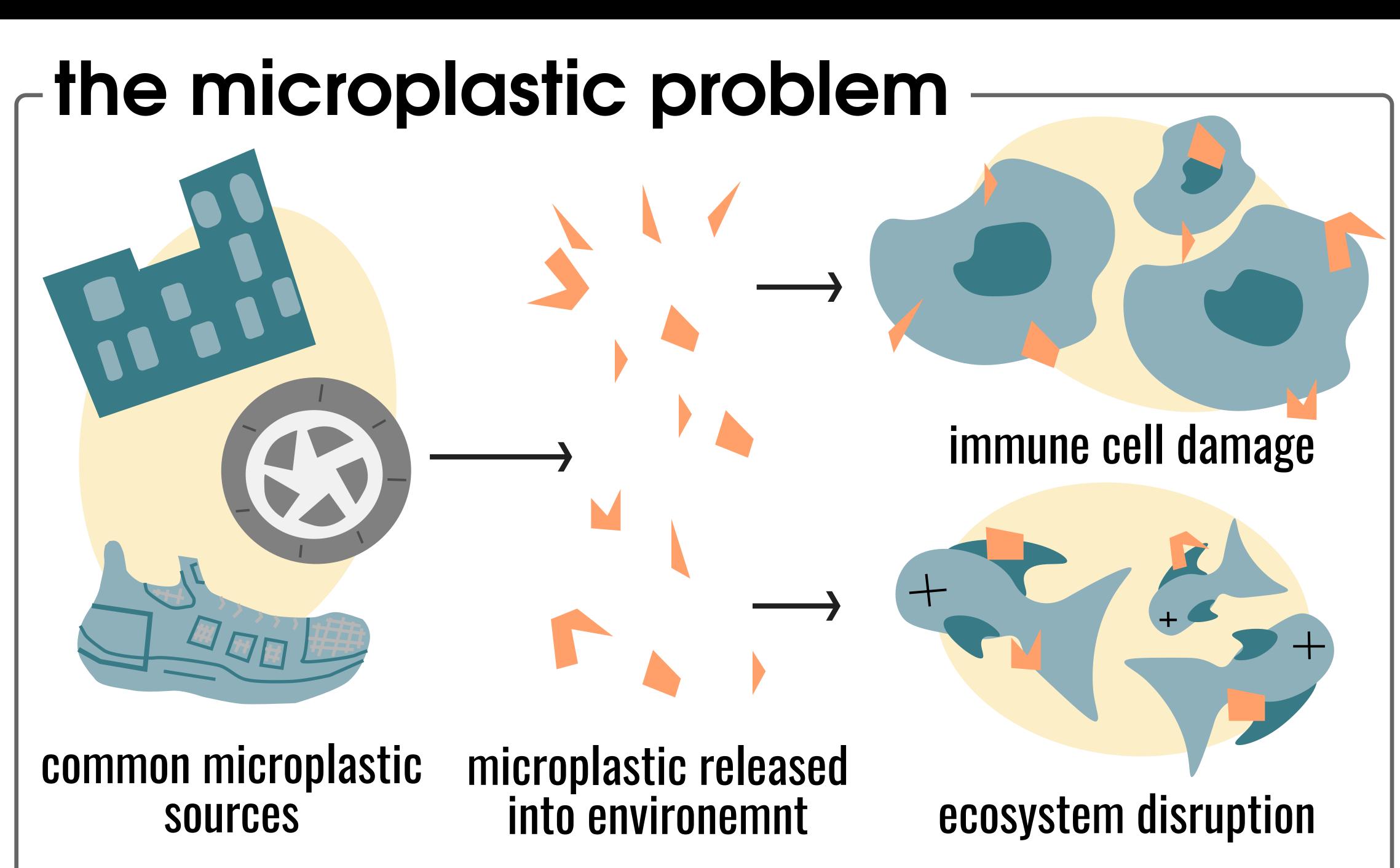# The Future Footwear Project
Quantifying Footwear-Generated Microplastics

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the microplastic problem

common microplastic sources → microplastic released into environemnt → immune cell damage / ecosystem disruption

Plastic is everywhere and we use it a lot. The average American is estimated to consume about 300 lbs of plastic every year! [1] These plastics break down and release "microplastics" which persists in the environment and are extremely difficult to remove. These tiny particles range from 0.05 - 5 millimetres in length. Although their total impact has not been fully assessed, studies have found them nearly everywhere on the planet. Their presence has been linked to a host of environmental problems including ecosystem disruption as well as human health problems including immune cell damage. [2,3] Previous estimates have relied largely on soil and water samples to trace microplastics back to their origins, and have consistently identified footwear outsoles as one prominent contributor to the total microplastic generation alongside other common sources such as car tires, city dust, and artificial turf. However the estimates for the amount of microplastic generation from footwear are varied widely

[1] Freinkel (2011), Plastics: A Toxic Love Story. [2] Boucher & Friot (2007). Primary Microplastics in the Oceans. [3] Vrisekoop (2019). Plastics Health Summit.

the first real life wear test

In order to directly assess the scope of footwear's contribution to microplastic generation, this project was the first to directly measure shoe outsole loss during real life wear. A five month wear test was designed to compare observed microplastic loss with existing estimates. This data was then used to estimate the footwear industry's contribution to global microplastic generation. With our data and models, we hope to inspire shoe companies to understand their impacts to make sustainable shoe design choices in the future.

the goals

1. How much microplastic comes off of shoe outsoles?

2. Which outsole characterstics contribute to the most wear loss?

the method system

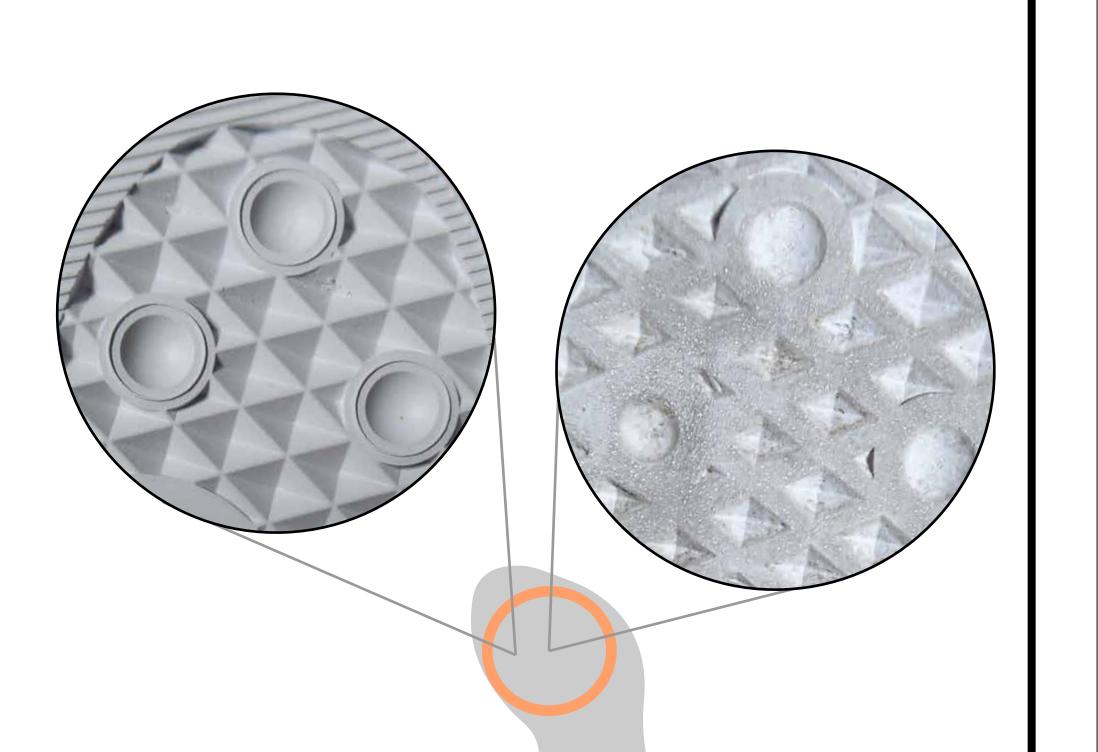| identify variables	pre-measurements	wear test	shoe cleaning	post-measurements
Rubber hardness, outsole geometry, and rubber material were identified for their potential impact on rubber wear rate.	Intial mass and tread height of shoes were taken and pre-surveys were completed by volunteers.	60 pairs of shoes were given to volunteers for a 5-month period. Data surveys were sent on a bi-weekly basis.	Our cleaning process was conducted to clean off debris that the shoes may have picked up from wear.	Final mass of shoes were taken along with tread depth, and post-surveys were completed by volunteers.

the findings

- Rubber hardness, outsole geometry, and rubber material did not have a significant impact on shoe wear.

- Rate of microplastic shedding decreased as the distance traveled increased.

- The first rate of microplastic loss from real shoe wear estimates are shown below, along with comparisons from previous studies.

Before (left) & after (right) shoe wear that indicates outsole loss

1.4 - 40.0
grams of microplastic generated/person/year based on our wear test

as compared to...

17 - 175
grams of microplastic generated/person/year based on Lassen's estimate (2015)

109.1
grams of microplastic generated/person/year based on Fraunhofter's estimate (2018)

8,900 - 400,000
metric tons of microplastic generated globally/year from footwear based on our wear test estimate

which is the same as...

1 to **28**
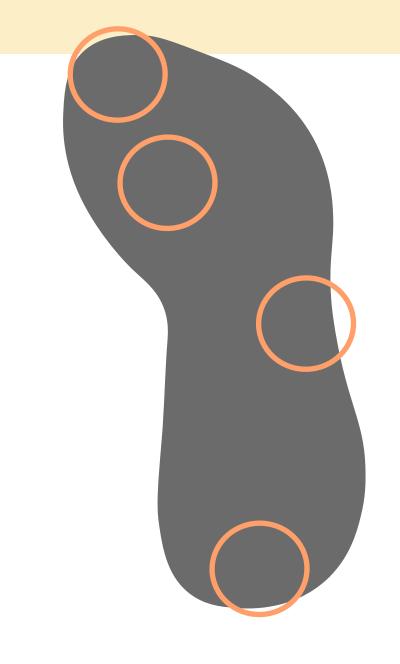
large garbage trucks

the data

shoe mass

350.450 g

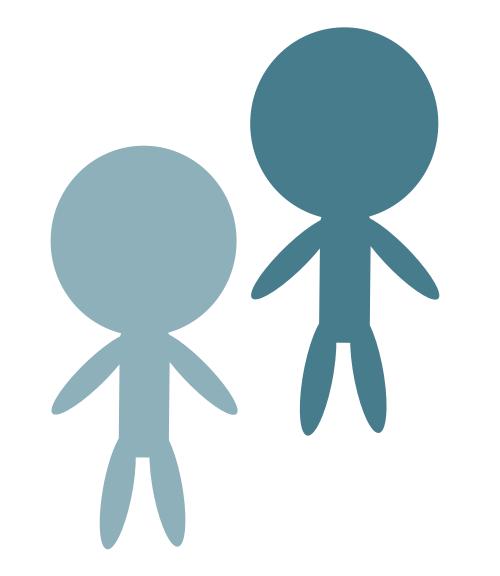The shoes were weighed before and after distribution with the shoe laces and insoles removed.

tread height

Tread measurements were taken from 4 focal points on each shoe outsole (orange circles) to calculate a mass value to compare with our directly measured mass.

surveys

Pre-, post-, and bi-weekly surveys were given to volunteers to track their shoe-wearing habits and create a shoe-user profile:

avg. age: 29.9 yrs
avg. weight: 157.1 lbs
shoes in rotation: 5.4 shoes
avg. miles reported: 130
top 3 shoe-used surfaces: concrete, blacktop, dirt

final thoughts

Our project highlights significant discrepancies in existing assessments of footwear-based microplastic generation. The results suggest that there seems to be significantly less microplastic stemming from shoe outsoles than previously estimated. This was most likely caused by other microplastic sources that we were unable to identify.

While this project provides an in-depth exploration of everyday footwear outsole loss, there were several limitations associated with our evaluation such as the reliability of self-reported data from wear testers, not having comparable values from controlled environments, the lack of understanding of weather conditions and strain during wear use, the short length of our wear test, and the uncertainty around our parameters during our global extrapolation. Future research can be conducted to further explore footwear's contribution to microplastic generation.

Use the QR code or url below to check out the whole project!

www.futurefootwearproject.com