PFAS Pollution Prevention

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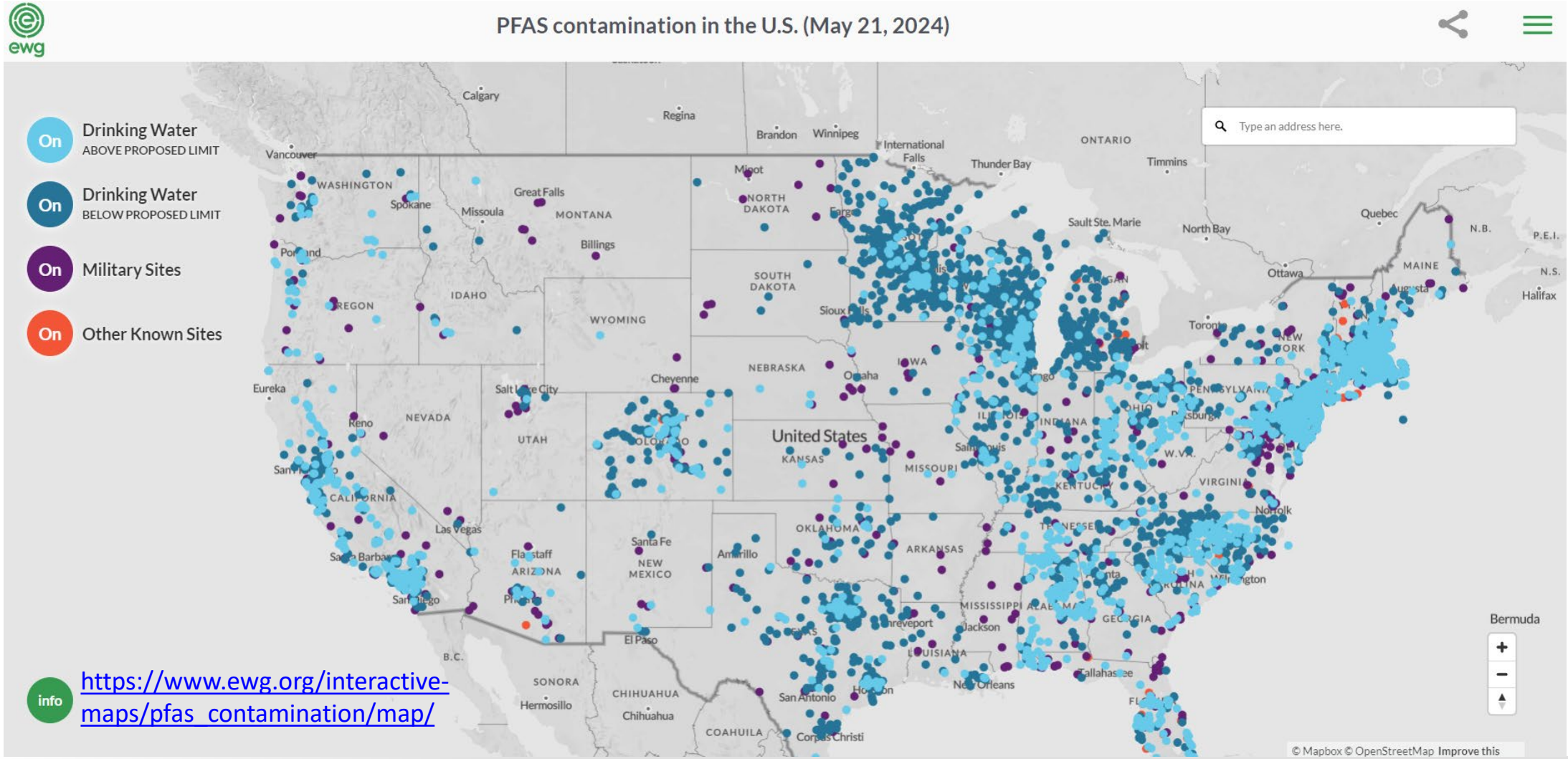
THE POWER IS YOURS!
CAPTAIN PLANET
AND THE PLANETEERS

But...

Per- and polyfluoroalkyl substances (PFASs) are a class of many thousands of chemicals containing one of the strongest bonds in chemistry

PFASs are found pretty much everywhere we look…



… and have been associated with multiple hazards

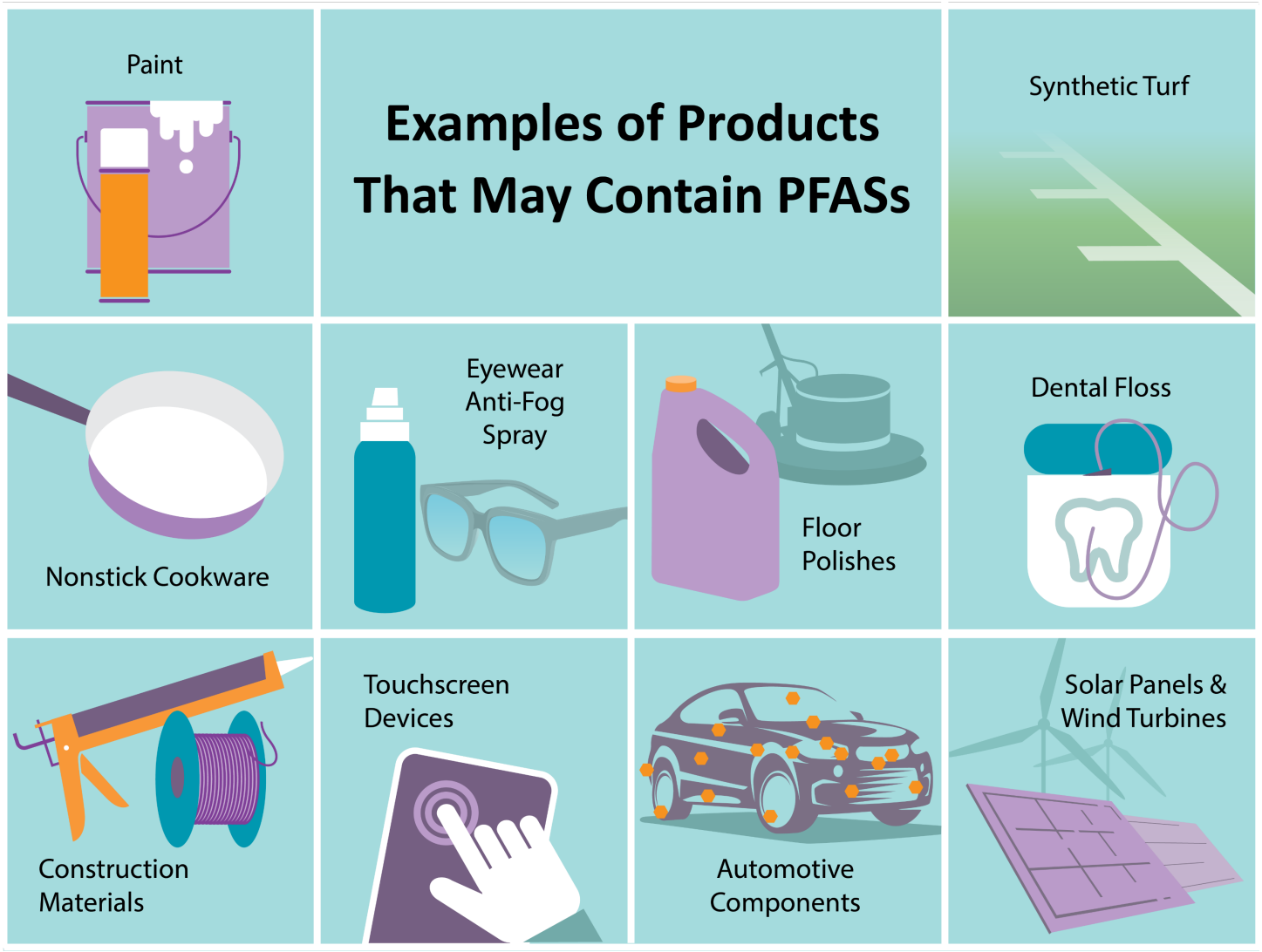
- Carcinogenicity
- Cardiovascular toxicity
- Developmental toxicity
- Endocrine toxicity
- Hepatotoxicity
- Immunotoxicity
- Nephrotoxicity
- Ocular toxicity

- Reproductive toxicity
- Environmental persistence
- Mobility in the environment
- Bioaccumulation
- Lactational and transplacental transfer

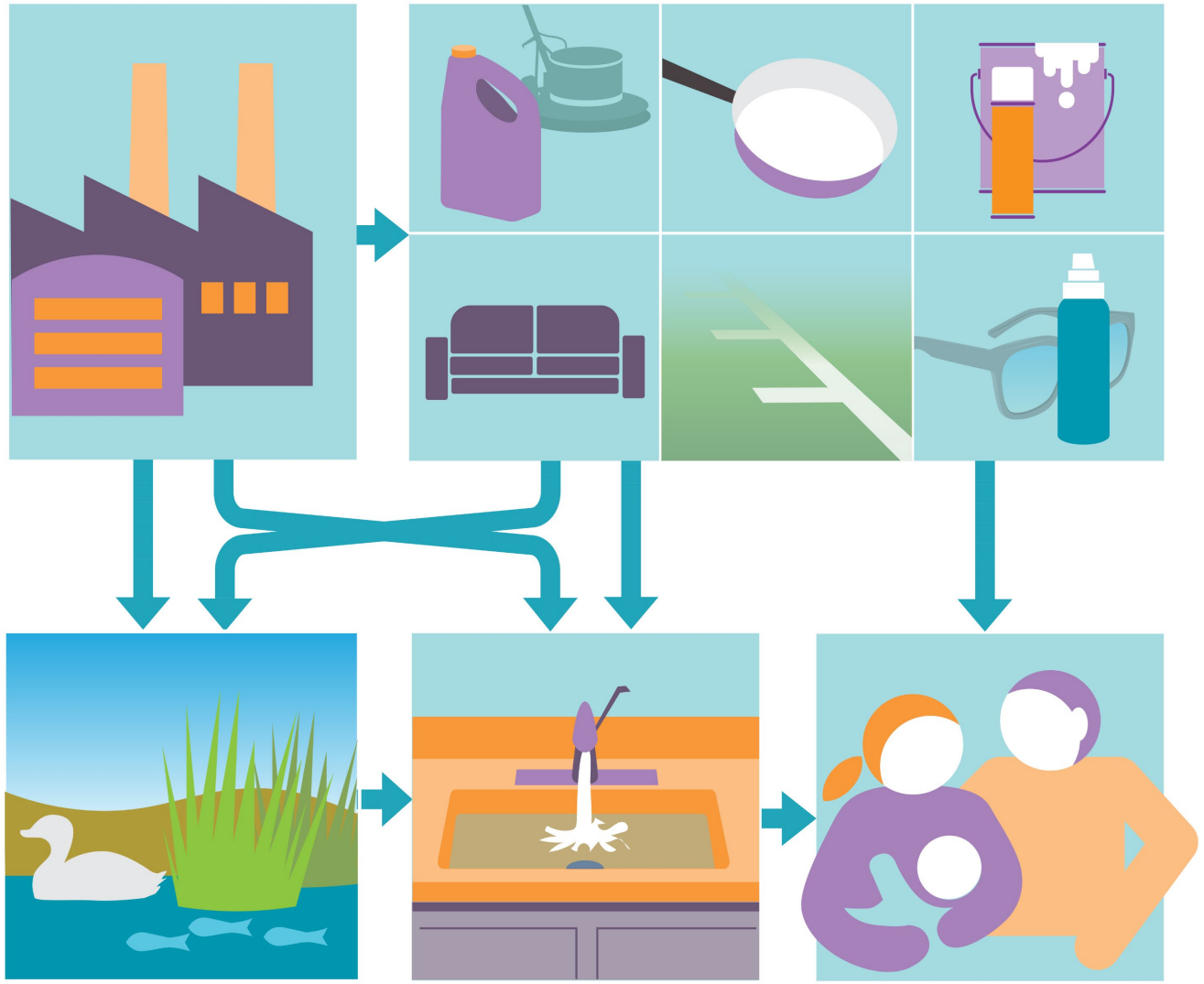
- Phytotoxicity and wildlife developmental, reproductive, and survival impairment
- Can cross the blood-brain barrier


Yet we’re just scratching the surface

PFASs have been used in hundreds of products for decades…



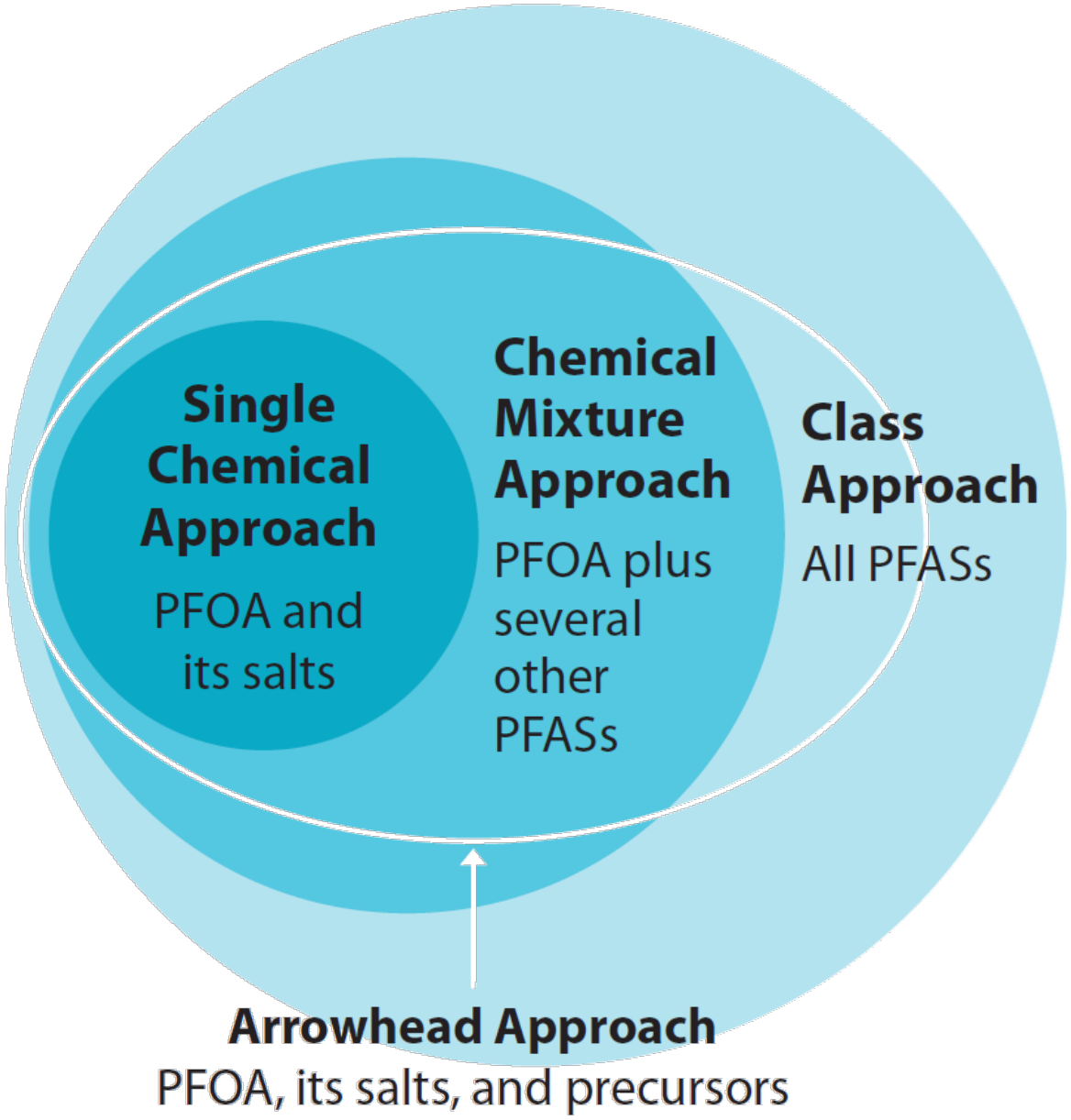
… and released to the environment during product manufacturing, use, and end-of-life




WHO YOU GONNA CALL?
GHOSTBUSTERS

We need to turn off the tap

Different approaches to PFAS regulation



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Vol. 129, No. 2 | Commentary

Regulating PFAS as a Chemical Class under the California Safer Consumer Products Program

Simona Andreea Bălan, Vivek Chander Mathrani, Dennis Fengmao Guo, and André Maurice Algazi

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Abstract

Background: Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are a group of manmade chemicals containing at least one fully fluorinated carbon atom. The widespread use, large number, and diverse chemical structures of PFAS pose challenges to any sufficiently protective regulation, emissions reduction, and remediation at contaminated sites. Regulating only a subset of PFAS has led to their replacement with other members of the class with similar hazards, that is, regrettable substitutions. Regulations that focus solely on perfluoroalkyl acids (PFAAs) are ineffective, given that nearly all other PFAS can generate PFAAs in the environment.

Objectives: In this commentary, we present the rationale adopted by the State of California's Department of Toxic Substances Control (DTSC) for regulating PFAS as a class in certain consumer products.

Discussion: We at the California DTSC propose regulating certain consumer products if they contain any member of the class of PFAS because: *a*) all PFAS, or their degradation, reaction, or metabolism products, display at least one common hazard trait according to the California Code of Regulations, namely environmental persistence; and *b*) certain key PFAS that are the degradation, reaction or metabolism products, or impurities of nearly all other PFAS display additional hazard traits, including toxicity; are widespread in the environment, humans, and biota; and will continue to cause adverse impacts for as long as any PFAS continue to be used. Regulating PFAS as a class is thus logical, necessary, and forward-thinking. This technical position may be helpful to other regulatory agencies in comprehensively addressing this large class of chemicals with common hazard traits.
https://doi.org/10.1289/EHP7431

The P-sufficient approach

"if a chemical is **highly persistent**, its continuous release will lead to **continuously increasing contamination** (…) [and] result in **increasing probabilities of the occurrence of known and unknown effects**." (Cousins et al. 2019)

The SCP regulatory framework allowed us to take a "P-sufficient approach"

There are potential **exposures** to a Candidate Chemical in the product

AND

One or more exposures have the potential to contribute to or cause **significant or widespread adverse impacts**

California Code of Regulations, Title 22, Division 4.5, Chapters 54 and 55

Adverse impact factors considered

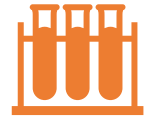
Hazard traits and toxicological endpoints

Hazard traits of the degradation, reaction, or metabolism products

Aggregate and cumulative effects

Adverse waste and end-of-life effects

Physicochemical properties and environmental fate



Similarity to known hazardous compounds

All these hazard traits are given equal consideration!

- Carcinogenicity, developmental toxicity, and reproductive toxicity
- Other toxicological hazard traits (e.g., cardiovascular, endocrine, immune system, neurodevelopmental)
- Phytotoxicity and wildlife toxicity
- Ambient ozone formation
- Bioaccumulation
- Environmental persistence
- Global warming potential
- Lactational or transplacental transfer
- Mobility in environmental media
- Particle size or fiber dimension
- Stratospheric ozone depletion potential
- Combustion facilitation, explosivity, flammability

"Because persistence is an inherent property of a chemical in the environment that results in increased exposure to the chemical and consequently potential for health risks, **it can appropriately be identified as a hazard trait**." (OEHHA 2012)

A note on definitions

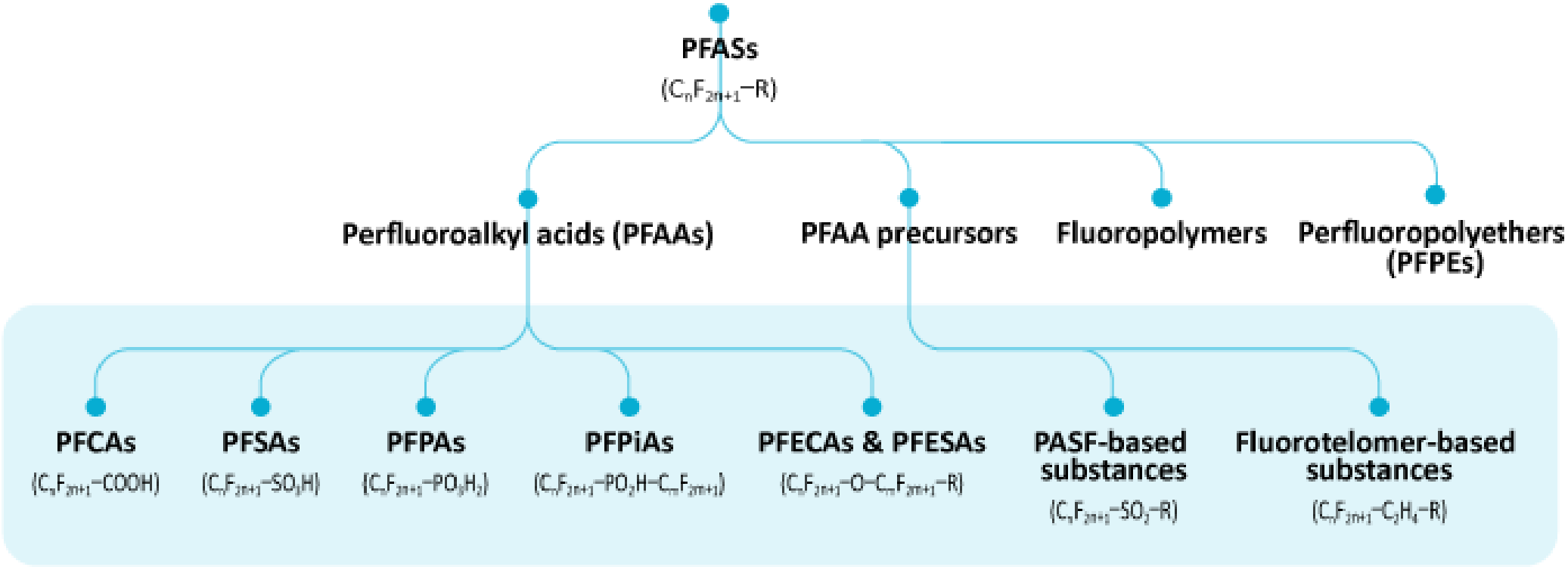
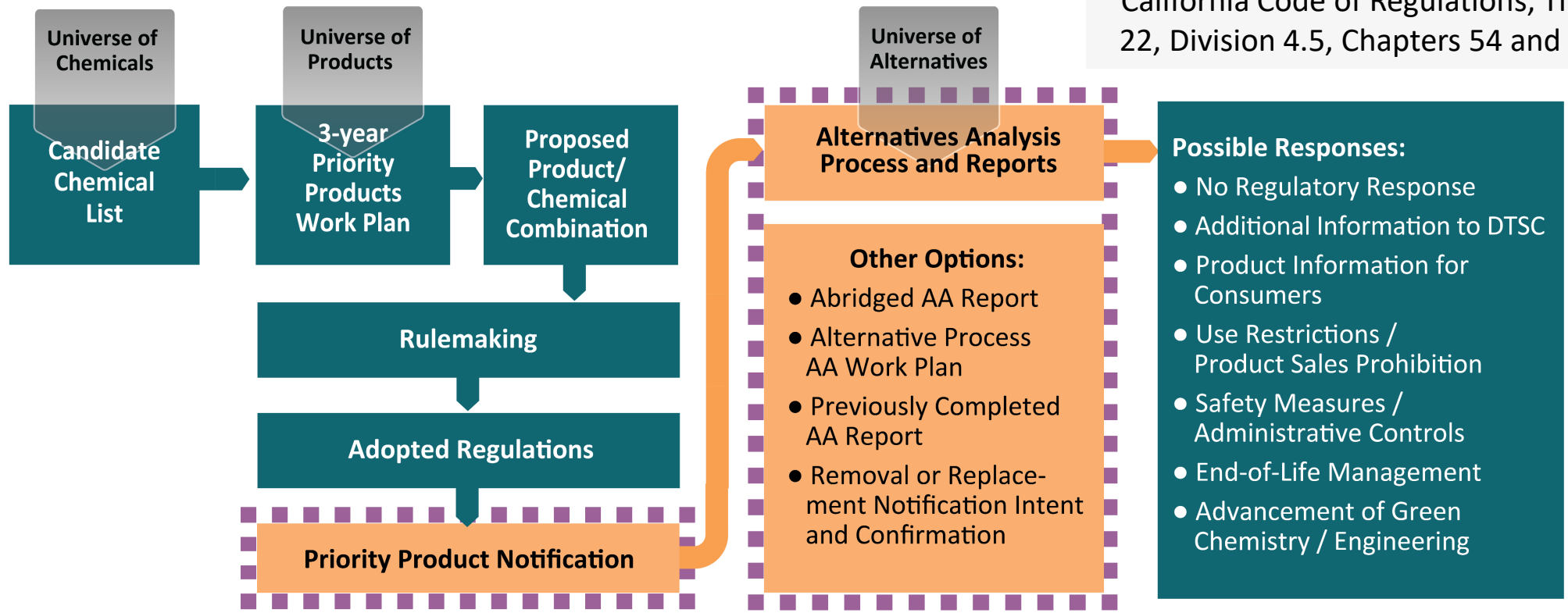


Image adapted from Wang et al. (2017) ES&T 51(5):2508-18

The SCP regulations are not the same as a product ban

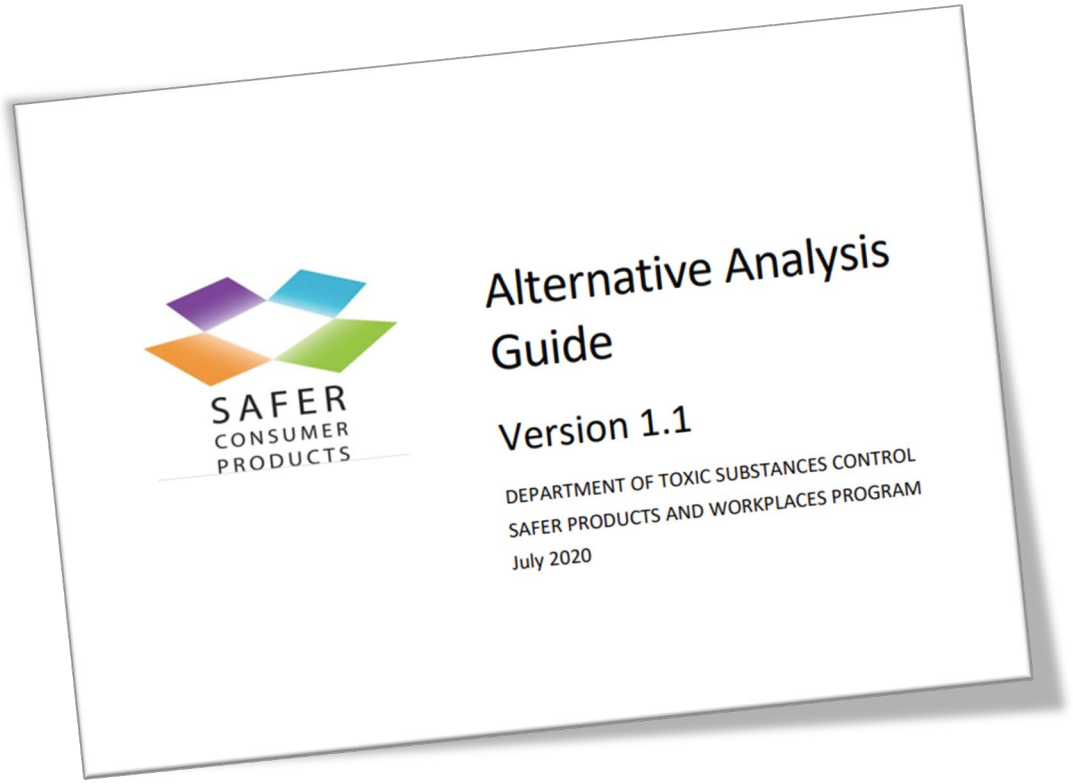
California Code of Regulations, Title 22, Division 4.5, Chapters 54 and 55



Goal of SCP: encourage innovation and green chemistry

The focus is on Alternatives Analysis and having manufacturers answer key questions:

- Is it necessary?
- Is there a safer alternative?
- What are the tradeoffs?

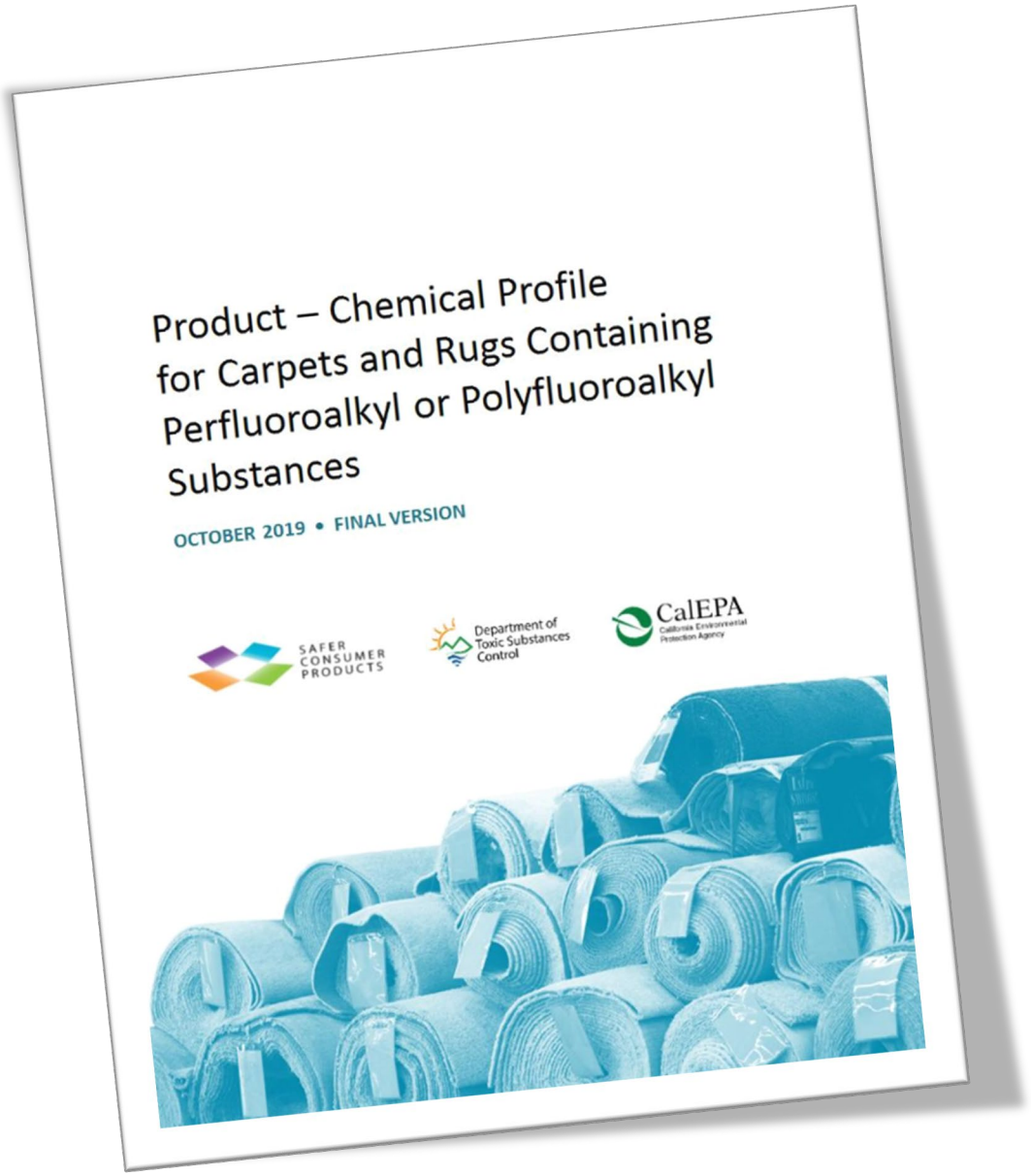


https://dtsc.ca.gov/scp/alternatives-analysis-guide-version-1-0-downloads/

Progress to date

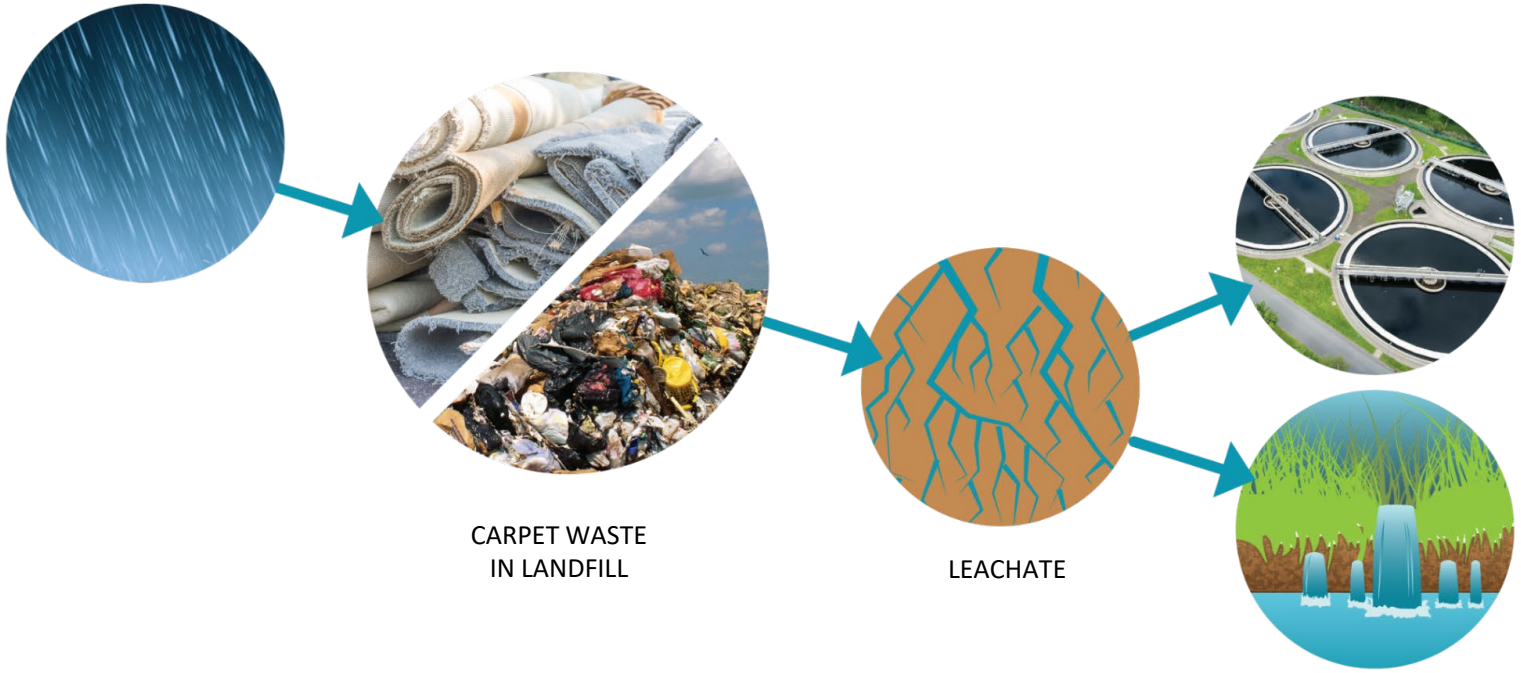
Priority Product as of July 1, 2021:

Carpets and rugs containing PFASs



Why carpets and rugs?

- Significant source of human exposure (especially kids)
- >3% of the volume of waste in California
- 75% of discarded carpet is landfilled in California (257 million pounds in 2016)
- Likely source of PFASs in landfill leachate



Outcome

- Regulation effective 7/1/21.
- Manufacturers of carpets and rugs containing PFASs were required to notify DTSC by 8/30/21.
- We received no notifications.
- We’re conducting compliance testing.

How to test for all PFASs?

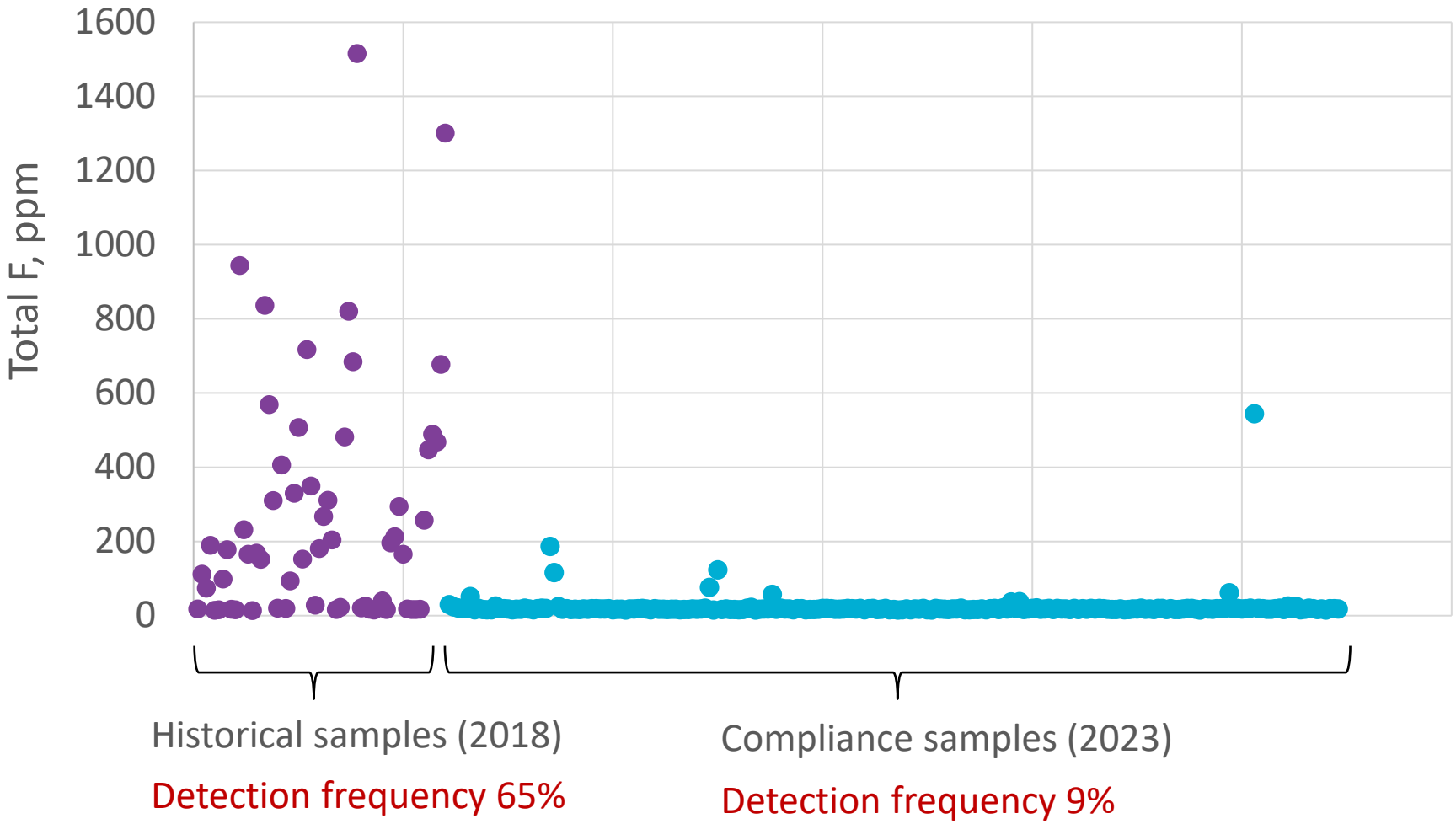
Targeted methods

- Perfluoroalkyl acids & small molecule precursors e.g., PFOA, PFHxA, GenX
- Side-chain fluorinated polymers
  - Used in food packaging, textiles, etc.
  - E.g., “C6”
- Fluoropolymers
  - Used in cookware, membranes in jackets, footwear, etc.
  - E.g., PTFE

Total fluorine methods

- E.g., combustion ion chromatography (CIC)

Preliminary results for carpet and rug fibers



Priority Product as of April 1, 2022:

Treatments containing PFASs for use on converted textiles or leathers

- Products sold for use on carpets, furnishings, clothing, shoes, etc.
- Including: aerosols, wipes, liquids, gels
- Aftermarket treatments only; not products sold for use during manufacturing

Why aftermarket treatments?

- Source of human exposure through dust ingestion (especially children) and inhalation
  - Exceptionally high exposure found by Beesoon et al. 2012
- PFASs used in these products detected at high levels in Canadian biosolids
  - 30x greater than sum of all other PFASs measured (Letcher et al. 2020)

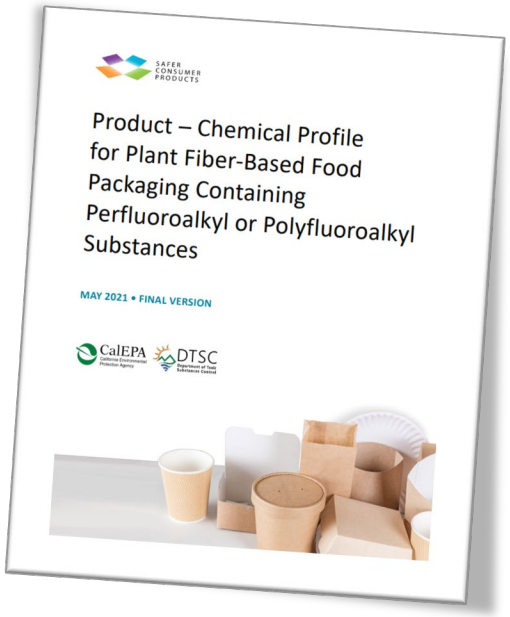
Outcome

- Regulation effective 4/1/22.
- 30 manufacturers have confirmed replacement of PFASs or removal of products from the California market.
- We’re beginning compliance testing.

Impact:

up to 100 metric tons of PFASs prevented from reaching California homes and workplaces each year

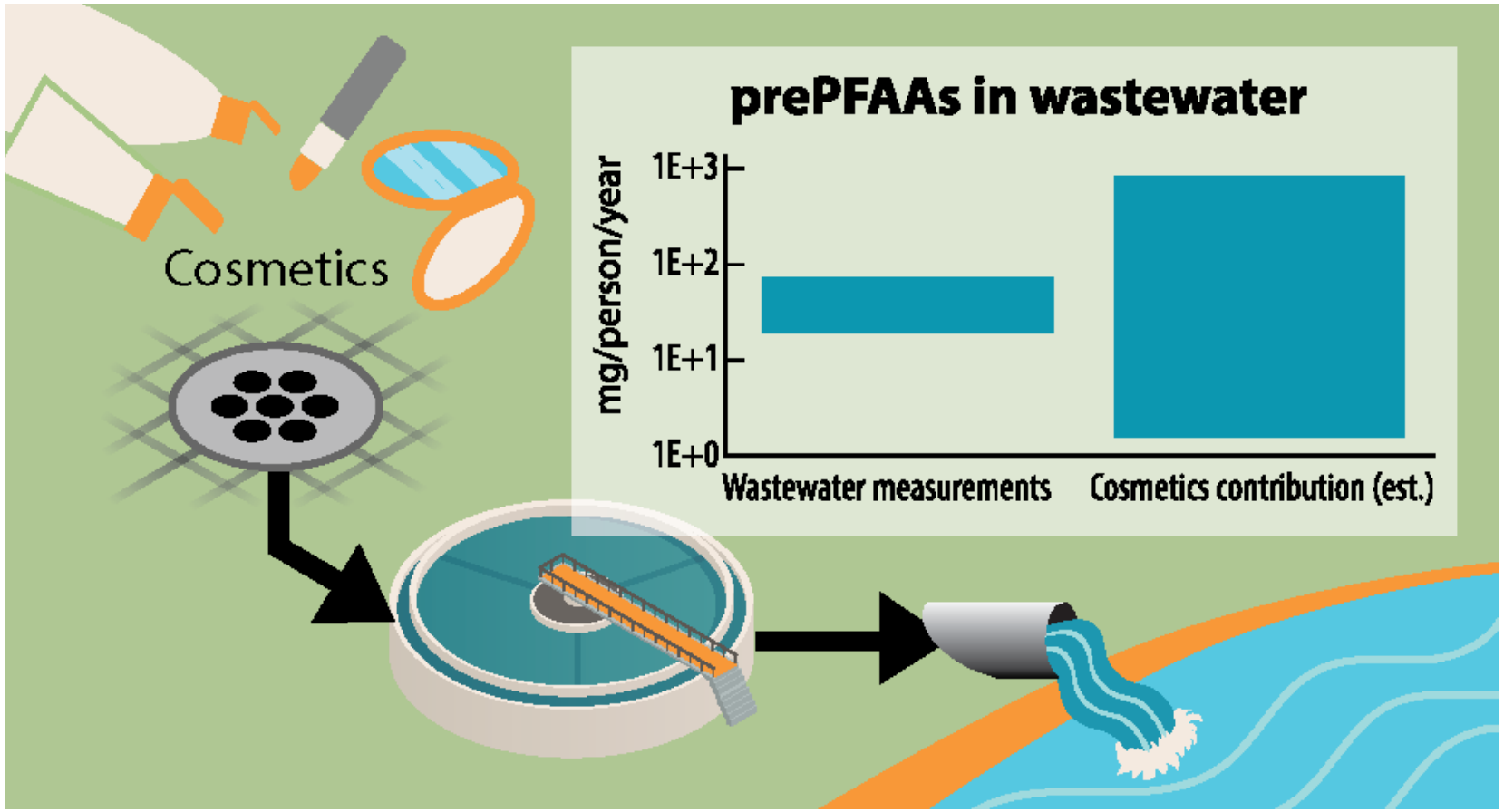
AB 1200 (Ting) banned plant fiber-based food packaging with intentionally added PFASs as of January 1, 2023



https://dtsc.ca.gov/scp/food-packaging-containing-pfass/

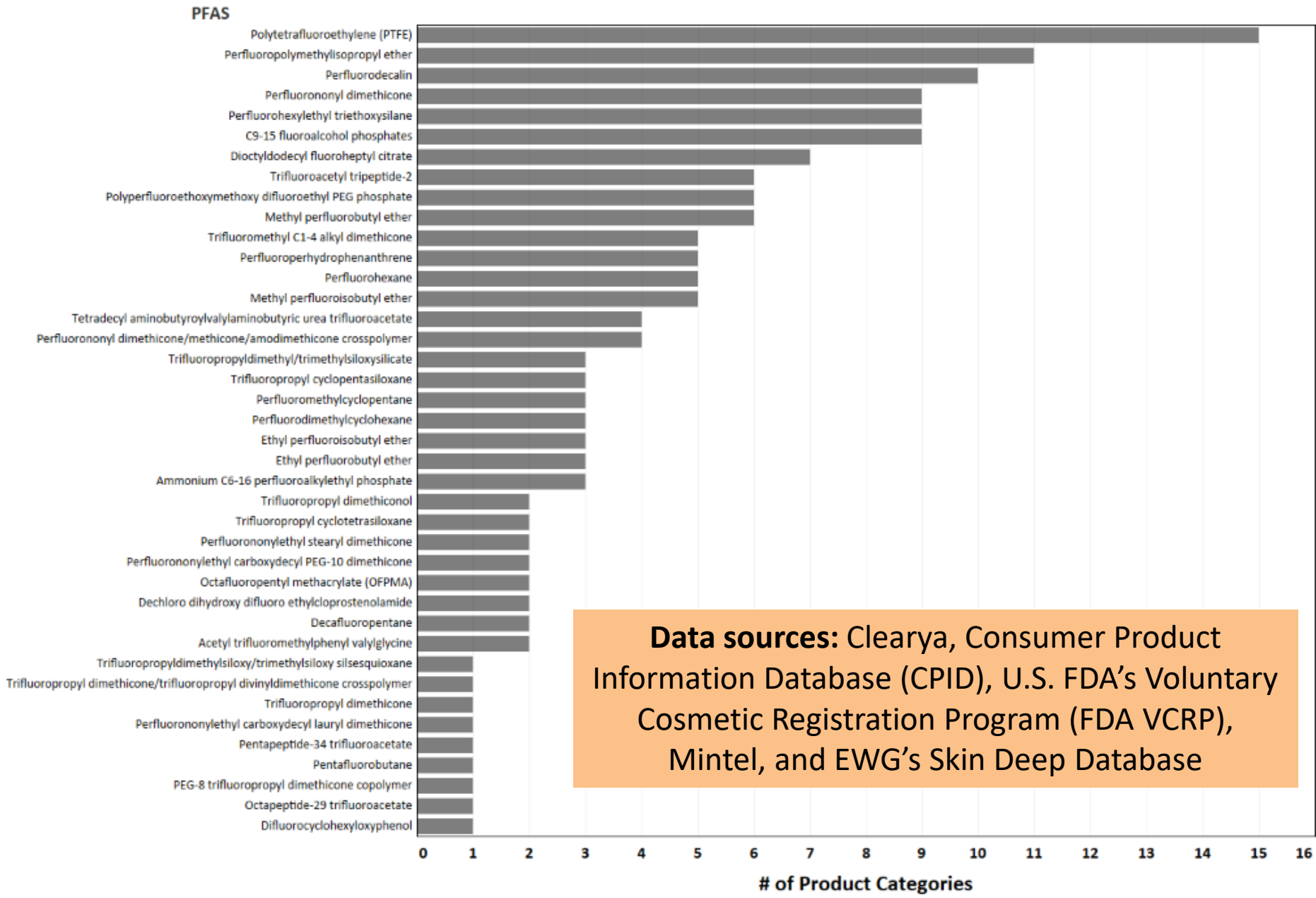
Are cosmetics a significant source of PFAS exposure?

How much of the PFAS load measured at WWTPs can be attributed to cosmetics?



Bălan et al. (2024)

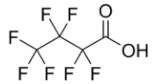
We found 40 distinct PFAS ingredients in 16 cosmetic product subcategories

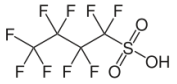


Data sources: Clearya, Consumer Product Information Database (CPID), U.S. FDA's Voluntary Cosmetic Registration Program (FDA VCRP), Mintel, and EWG's Skin Deep Database

Bălan et al. (2024)

The PFAS universe


PFBA


PFBS

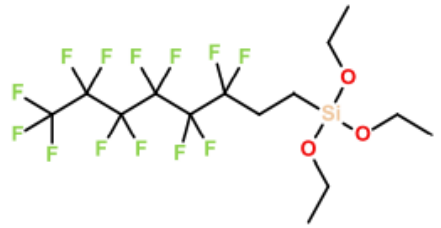

PFHxA

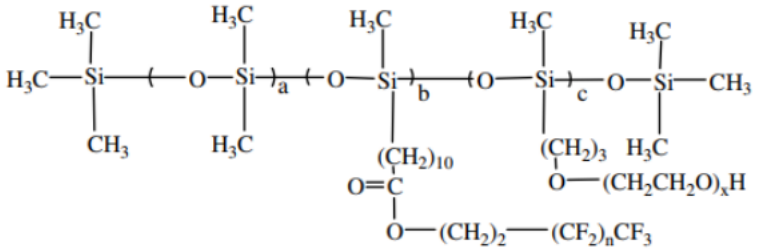

PFOA


PFNA

Etc.

Perfluoroalkyl acids (PFAAs)


Perfluorooctyl triethoxysilane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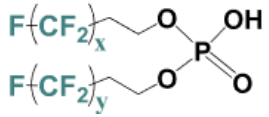
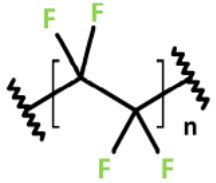
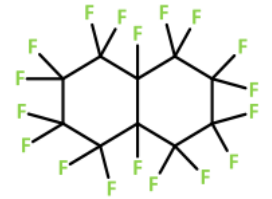

diPAP

Etc.

Perfluoroalkyl acid precursors (pre-PFAAs)

Used in products

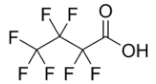

PTFE

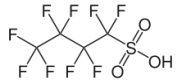

Perfluorodecalin

Etc.

Fluoropolymers and more

What we typically measure


PFBA


PFBS

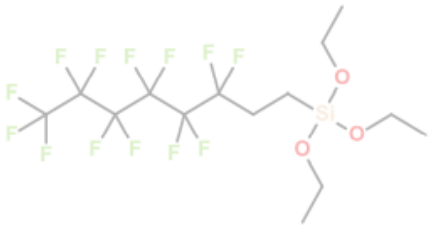

PFHxA

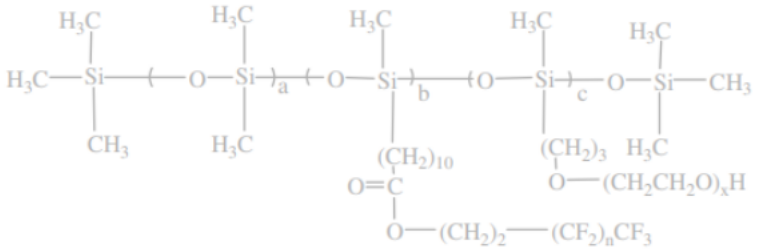

PFOA


PFNA

Etc.

∑ PFAAs, ng/L


Perfluorooctyl triethoxysilane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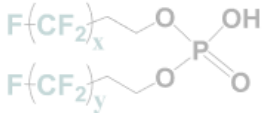
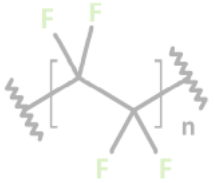
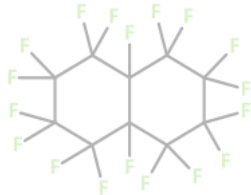

diPAP

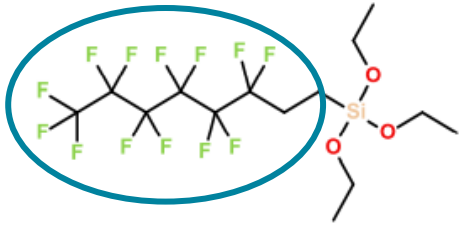
Etc.


PTFE


Perfluorodecalin

Etc.

Total Oxidizable Precursor (TOP) assay



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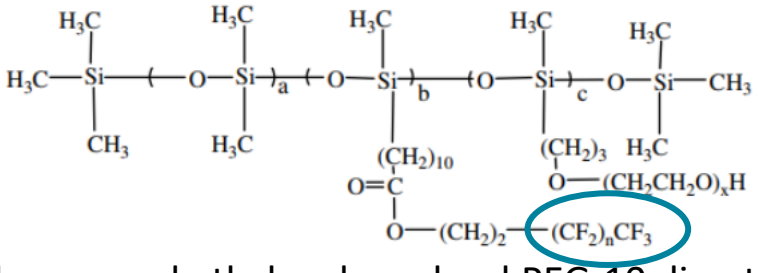
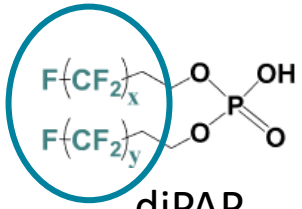


Perfluorononyl ethyl carboxydecyl PEG-10 dimethicone

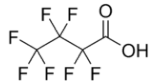


diPAP

Etc.

The mass of the fluorinated side-chain groups in cosmetics can be compared to TOP assay data for wastewater

Extractable or Adsorbable Organic Fluorine (EOF or AOF)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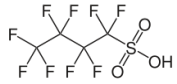
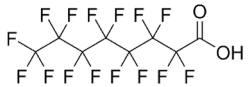
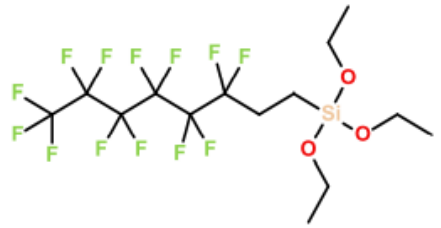

PFBS


PFHxA


PFOA


PFNA

Etc.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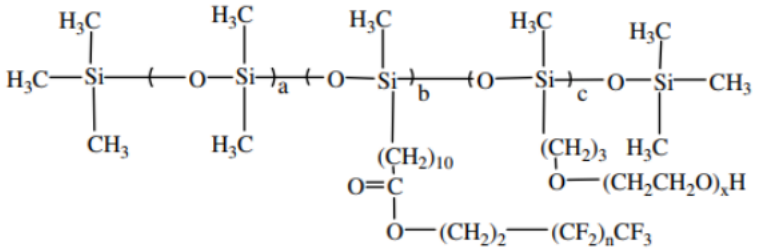
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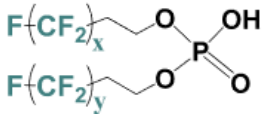
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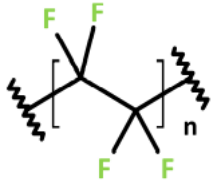
Etc.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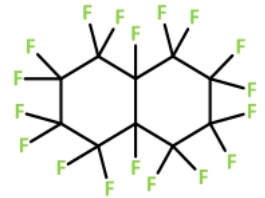
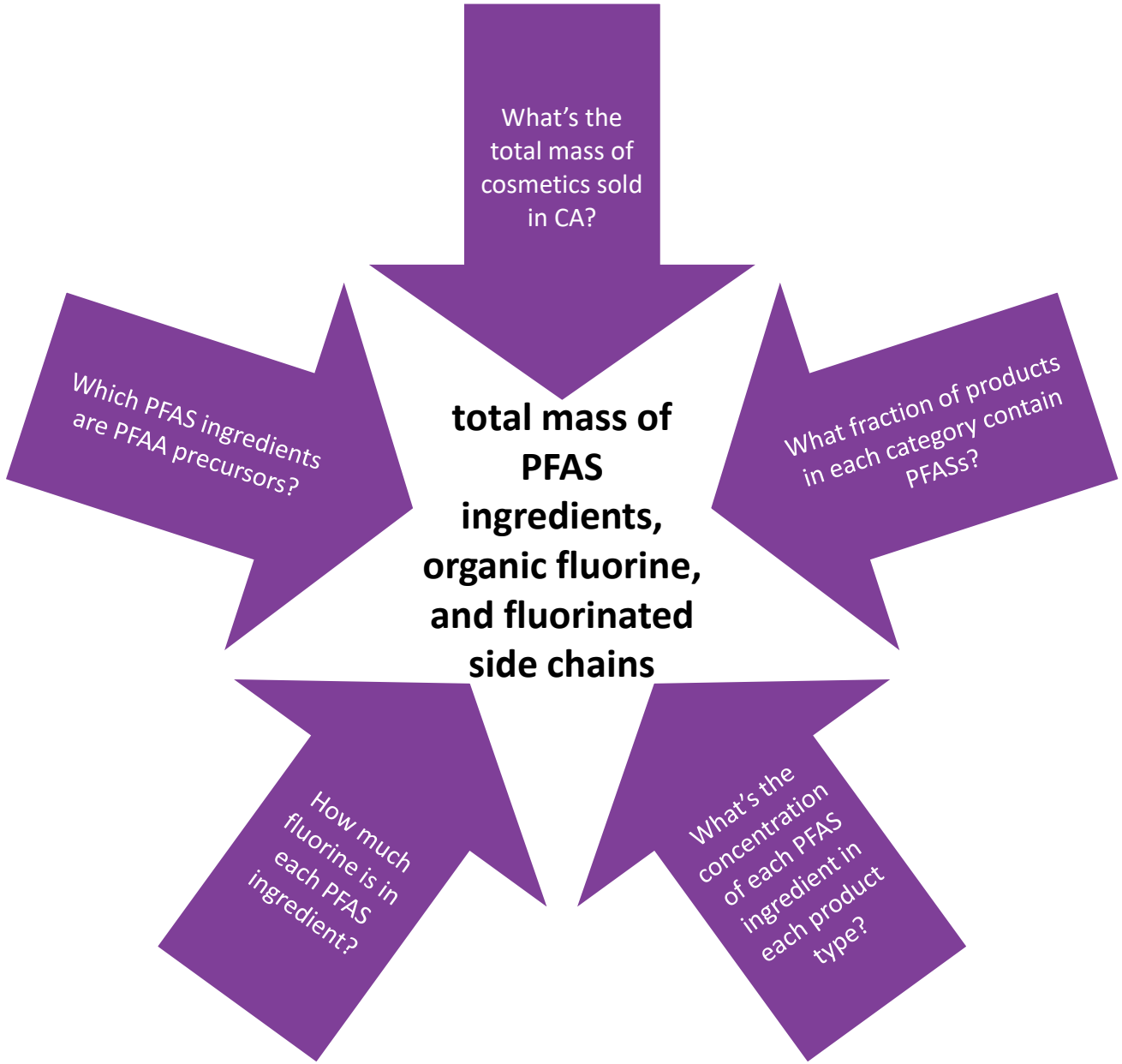

Perfluorodecalin

Etc.

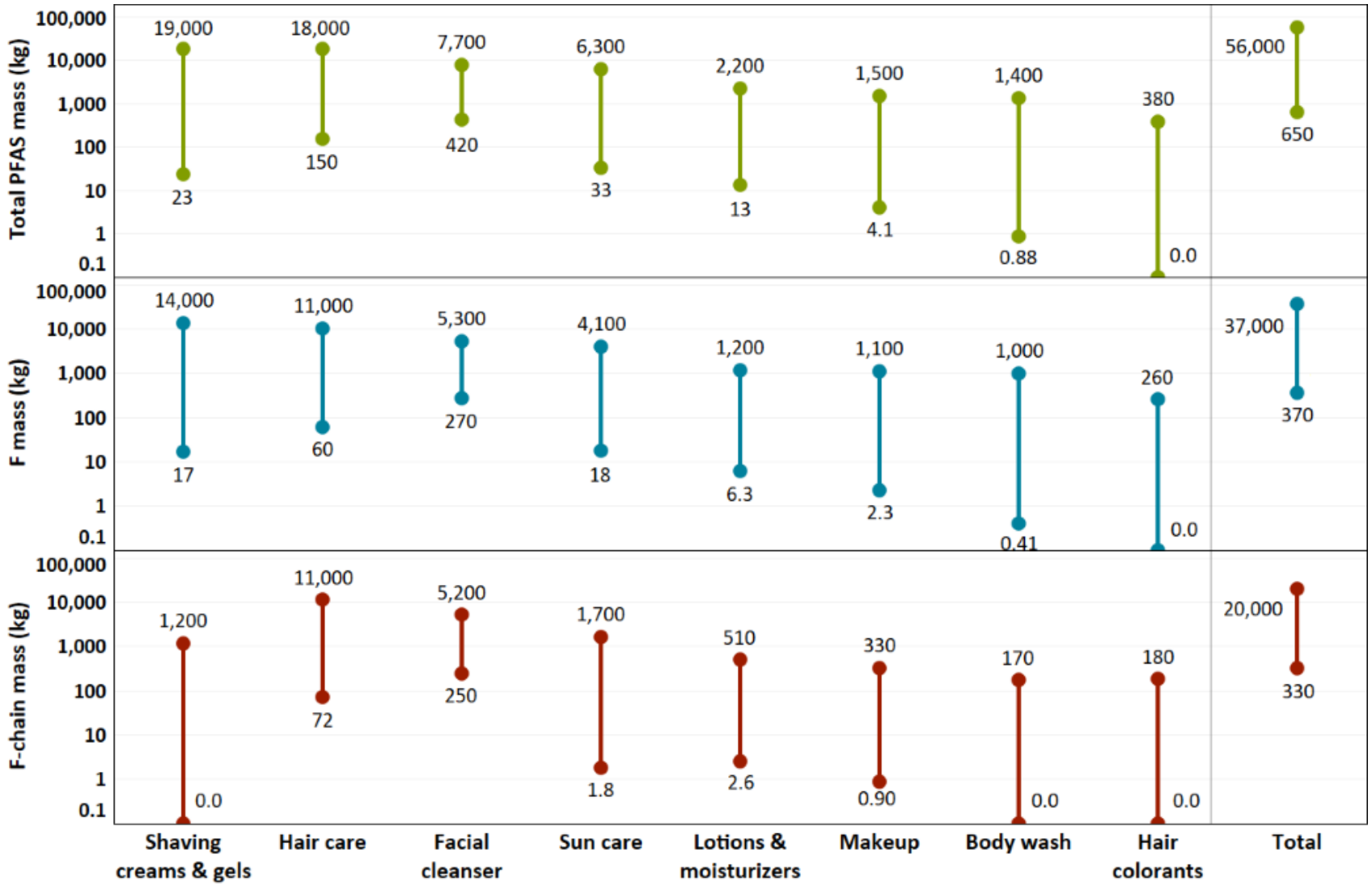
Total organic fluorine

For cosmetics sold in California during a one-year period in 2019-2020, we calculated the…



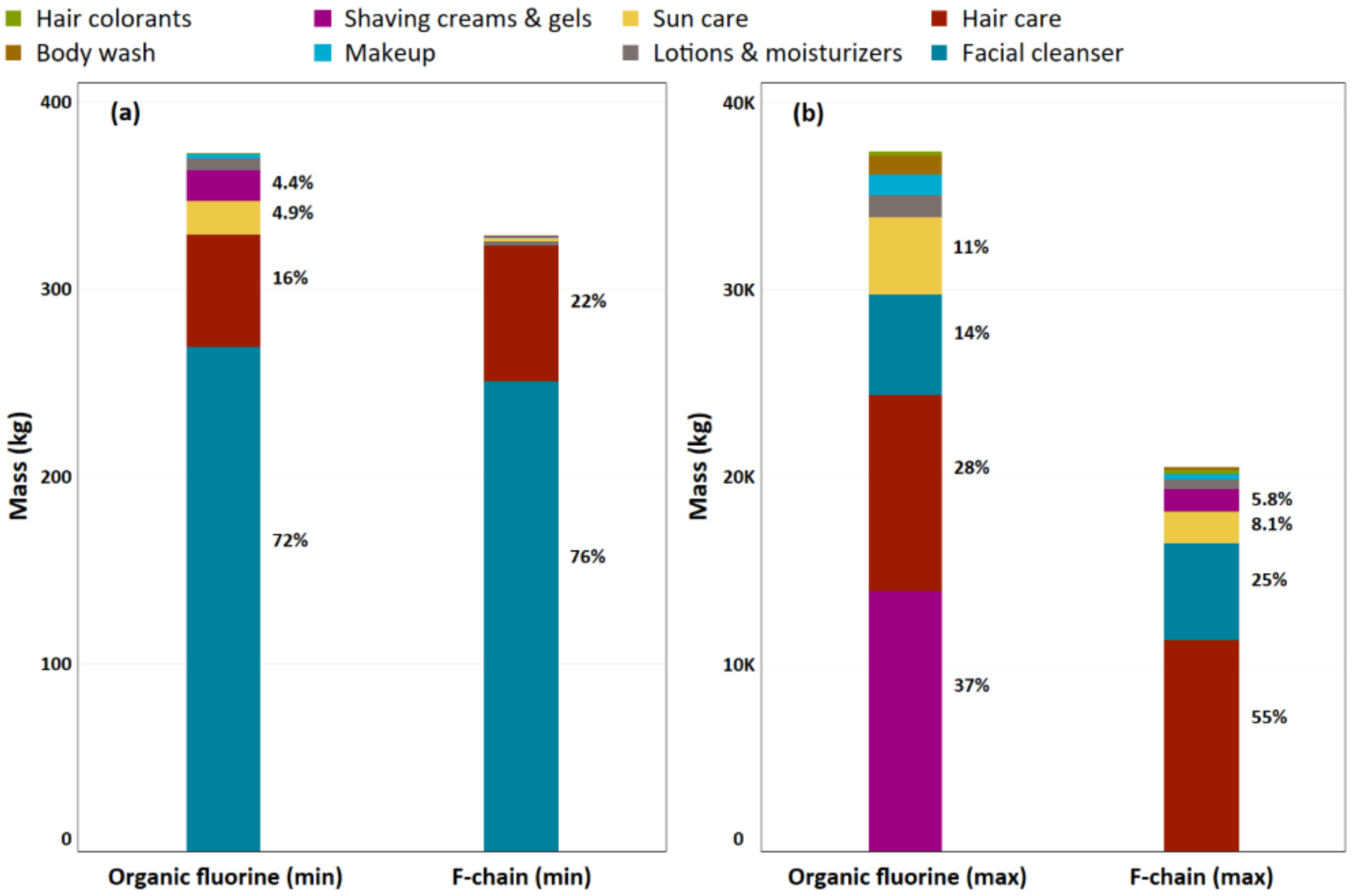
Bălan et al. (2024)

Cosmetics sold in California during a one-year period contain 650 to 56,000 kg PFASs, including 330 to 20,000 kg fluorinated side chains



Bălan et al. (2024)

Shaving creams and gels, hair care, facial cleansers, and sun care accounted for >90% of the total organic fluorine in cosmetics

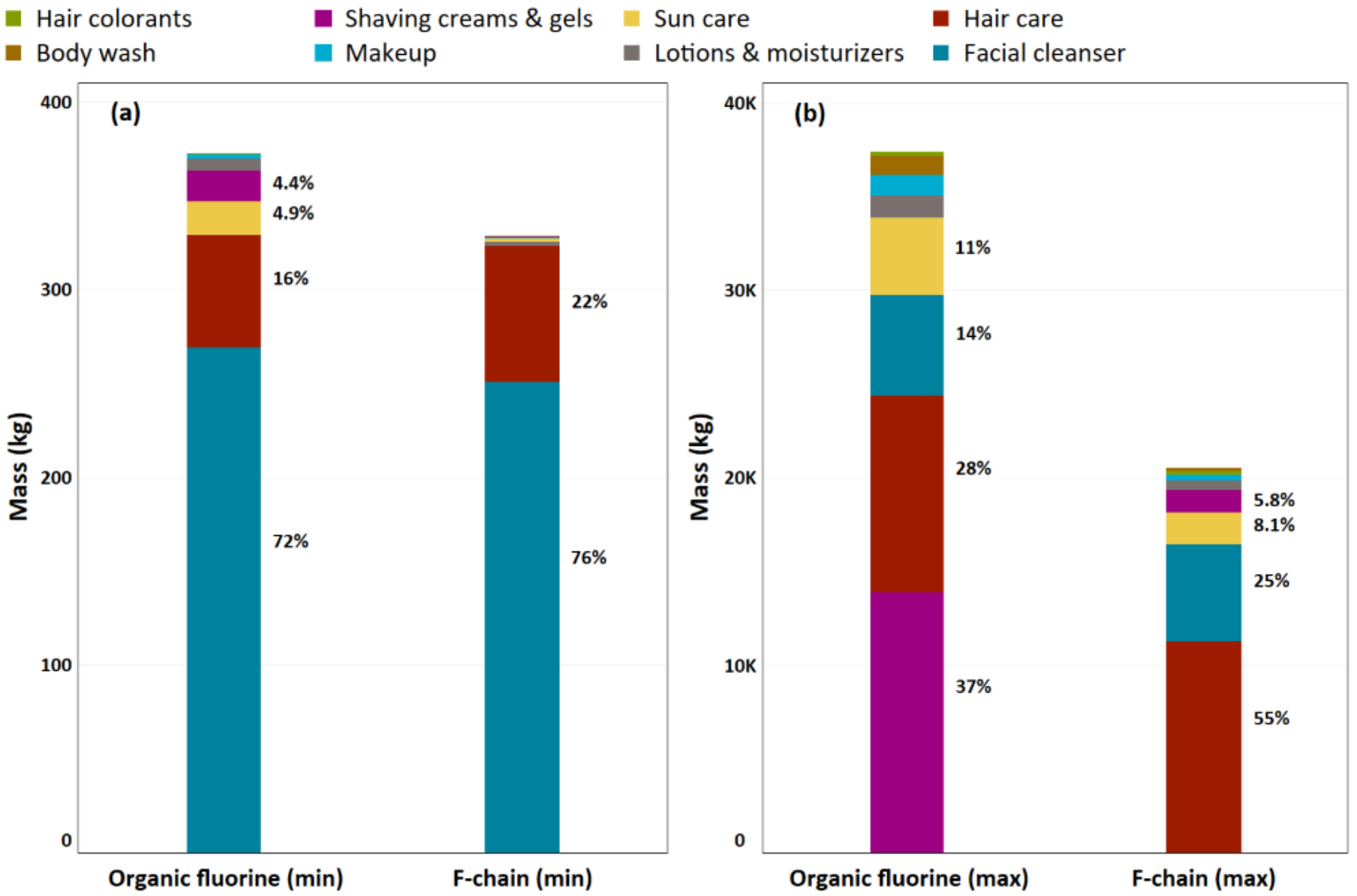


Bălan et al. (2024)

Makeup accounted for less than 3% of the total fluorine

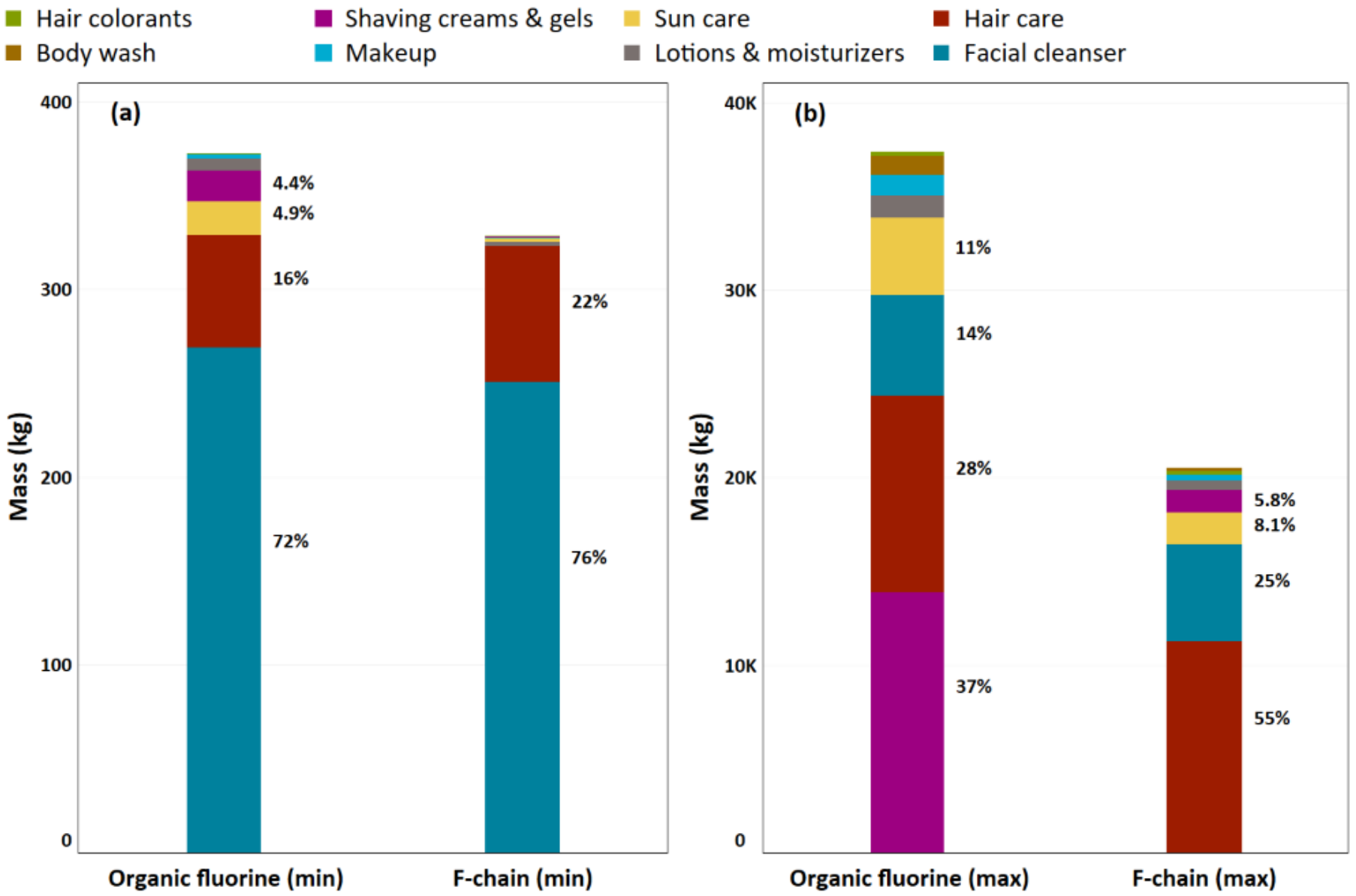
"Makeup" includes:

- blush
- bronzer and highlighter
- eye brow
- eye liner
- eye shadow
- face powder
- foundation and concealer
- lip cosmetics
- mascara



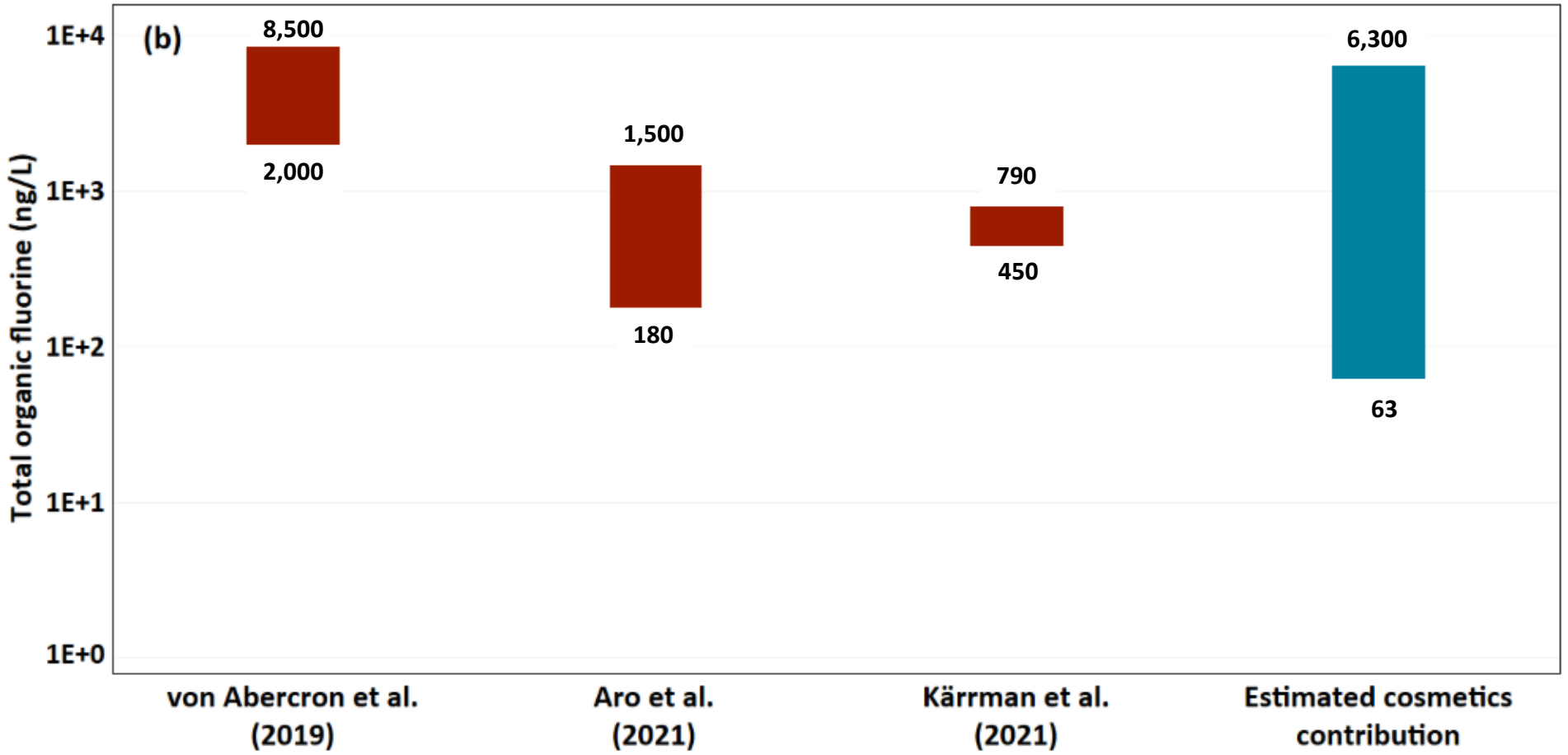
Bălan et al. (2024)

Hair care products and facial cleansers contribute over 80% of the PFAA precursors (makeup contributes less than 1.6%)



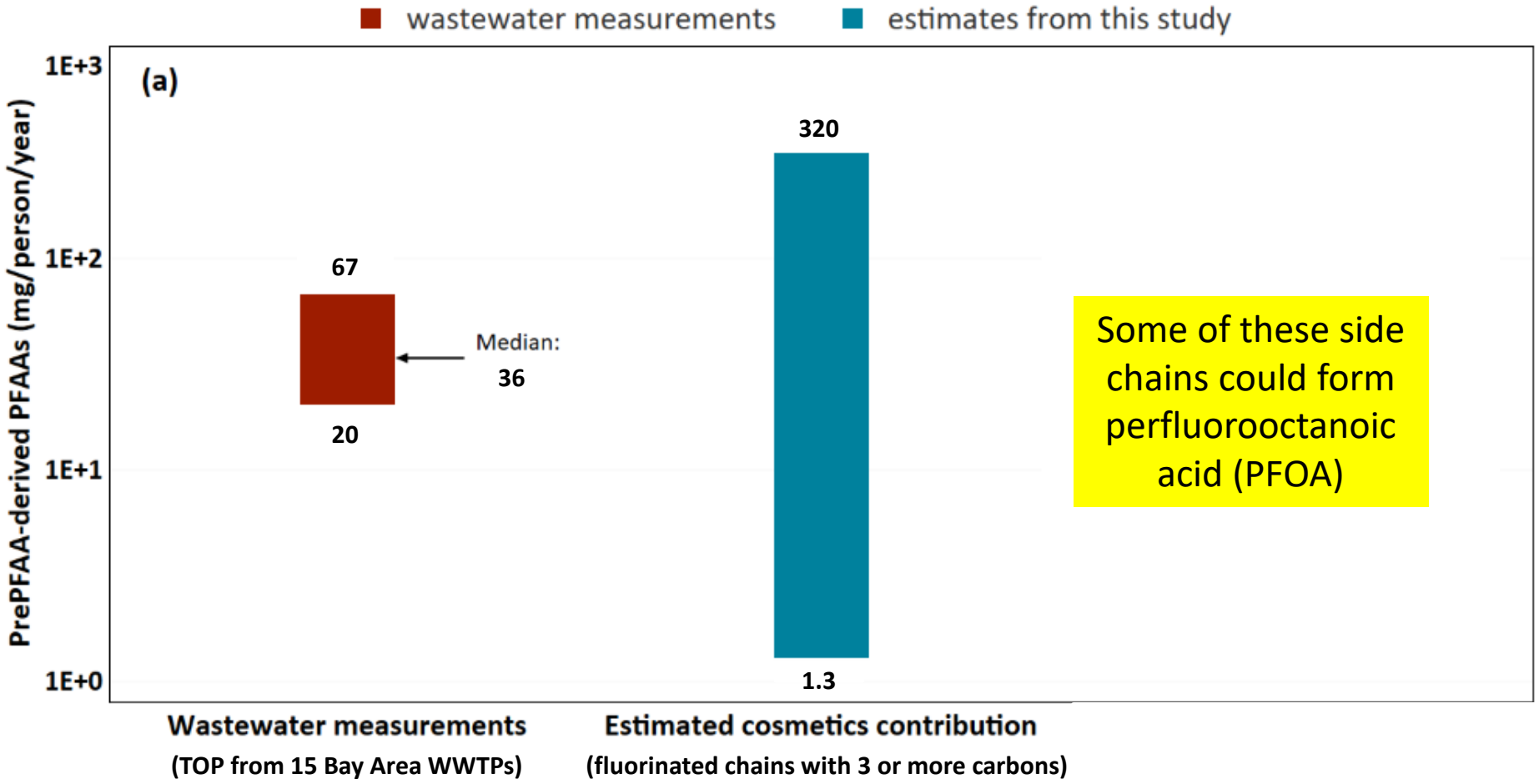
Bălan et al. (2024)

Cosmetics can explain some of the total organic fluorine measured at WWTPs



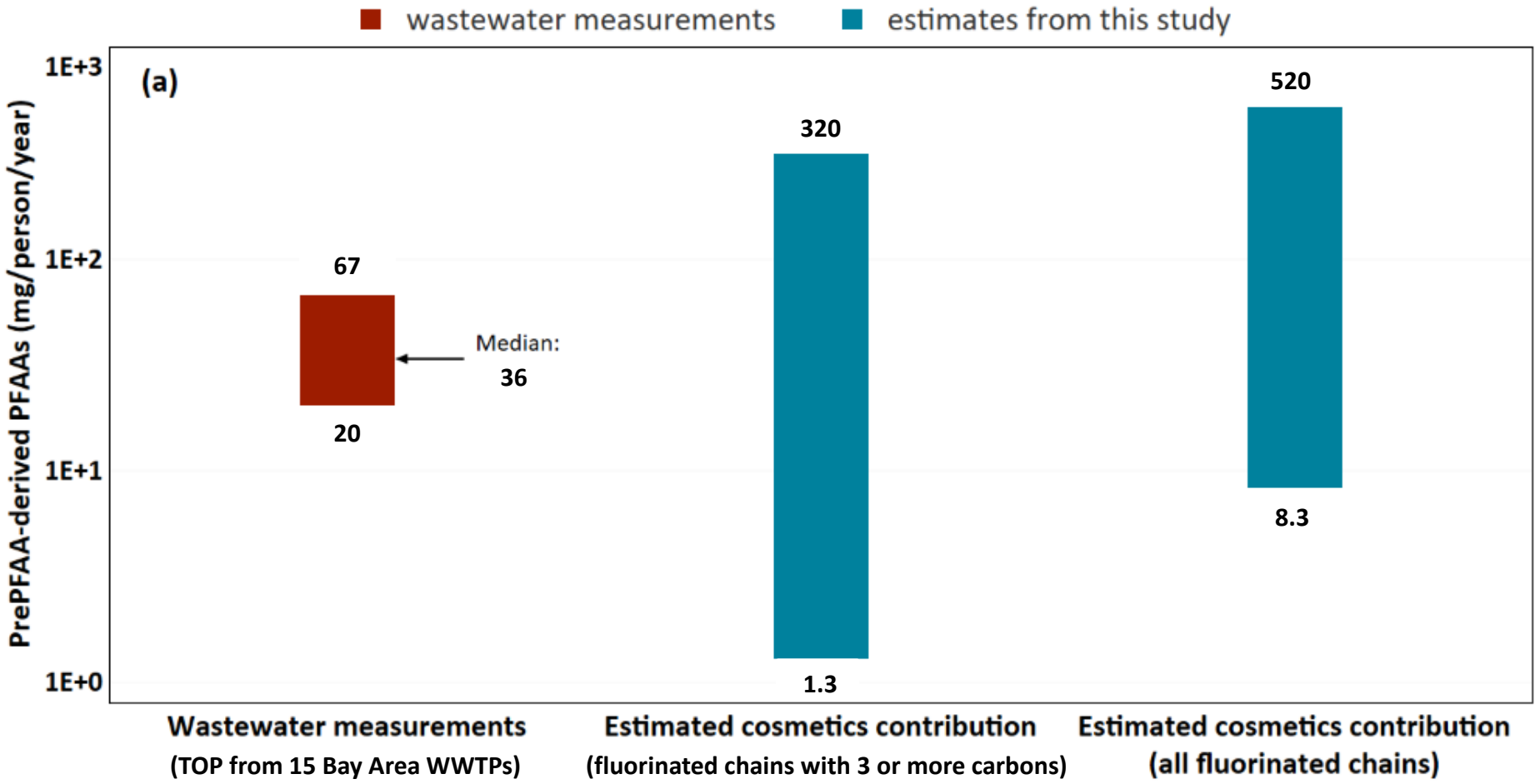
Bălan et al. (2024)

Cosmetics contribute at least 4% of the precursor-derived PFAAs measured at WWTPs in the SF Bay Area

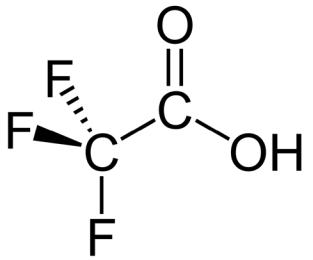


Bălan et al. (2024)

… plus 280 to 8,000 kg/yr ultra-short chains (one or two carbons)



Some of this will convert to trifluoroacetic acid (TFA)



Bălan et al. (2024)

It takes a village

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  - Chris Leonetti
  - Vivek Mathrani
  - Abigail Noble
  - Diana Phelps
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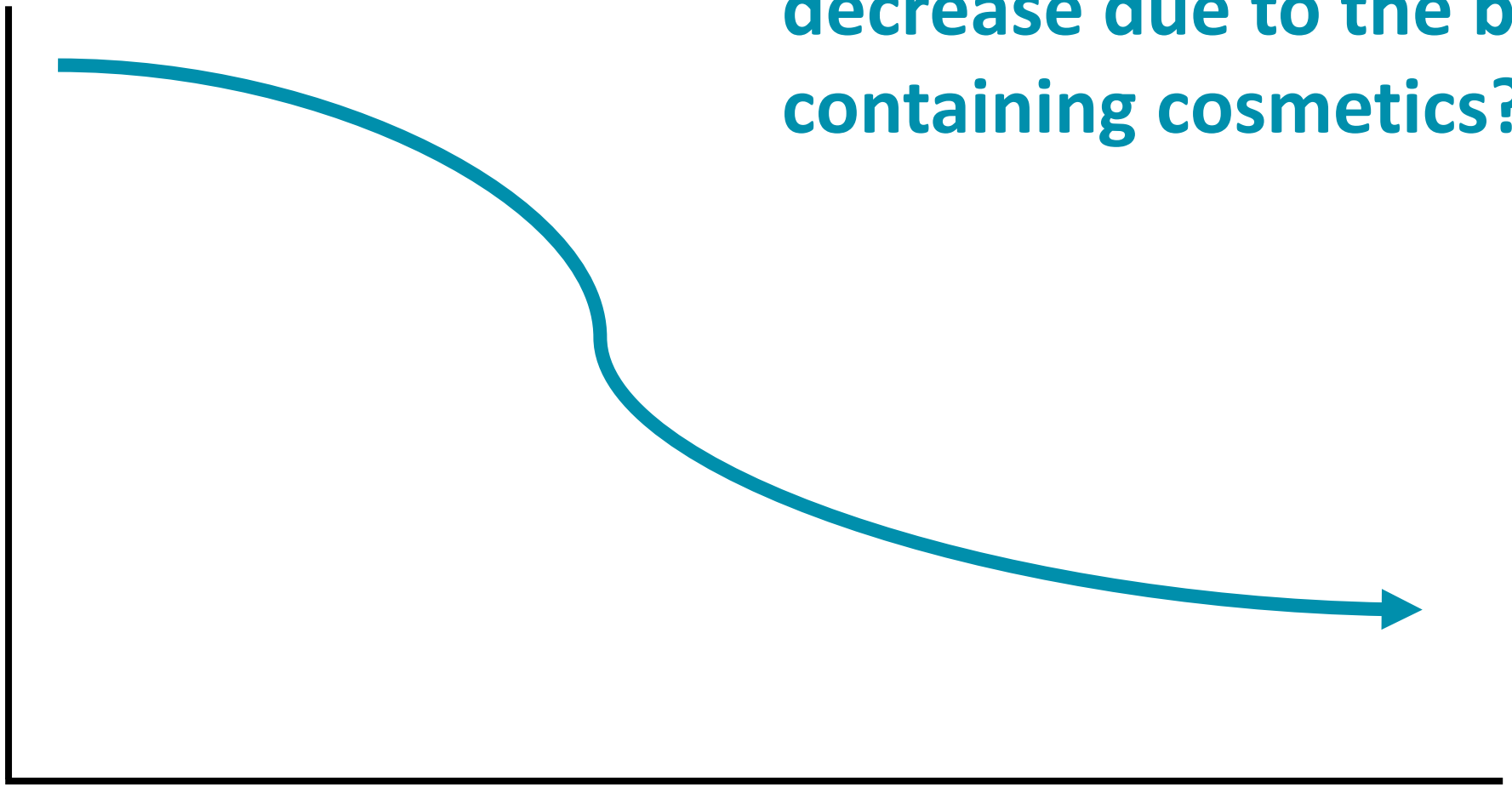
  - Michelle Herrmann (U.S. FDA)
  - David Andrews (EWG)
  - SFEI team

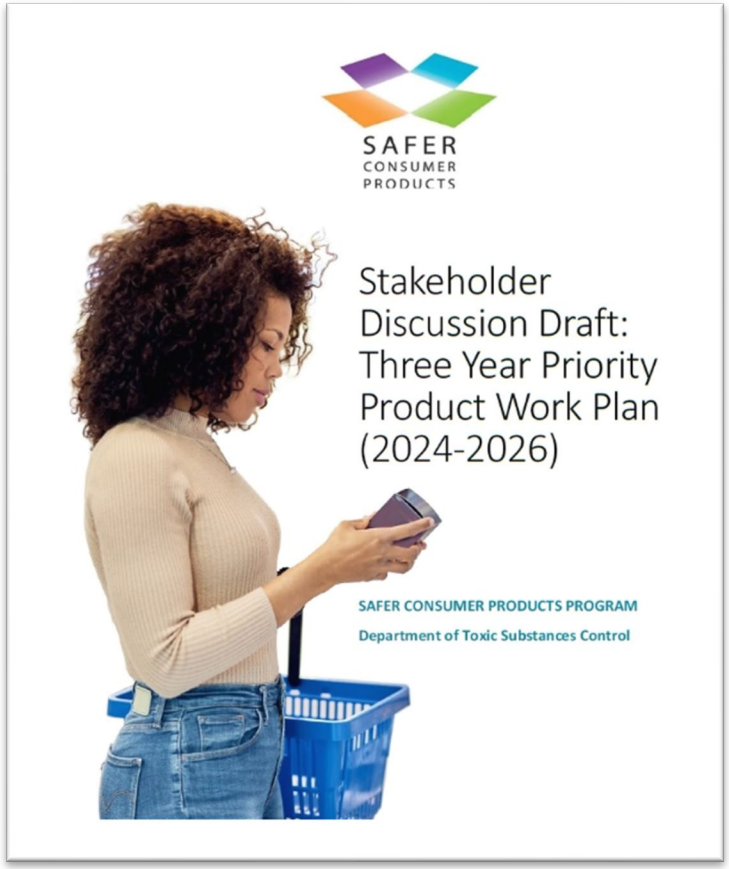
Will the PFAS levels in wastewater decrease due to the ban on PFAS-containing cosmetics?



What’s next for SCP?

Many other possibilities under the 2024-2026 Work Plan

- The Work Plan mentions PFASs in:
  - Artificial turf
  - Paints
  - Toilet paper
  - Various motor vehicle parts, accessories, maintenance and repair materials
  - Electronics
  - Pet food packaging
  - Sporting and athletic equipment
- For quarterly updates, see the SCP Timeline.



Preliminary Research: Candidate Chemicals in Artificial Turf

- Not captured under “carpets and rugs.”
- Added to the 2021-2023 Priority Product Work Plan.
- Read our background document.
- Submit your comments by September 30.
- Register for our August 27 workshop.

Let’s stay in touch!

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SCP home page: https://dtsc.ca.gov/scp

Work with us: https://dtsc.ca.gov/scp/safer-consumer-products-career

By our powers combined...