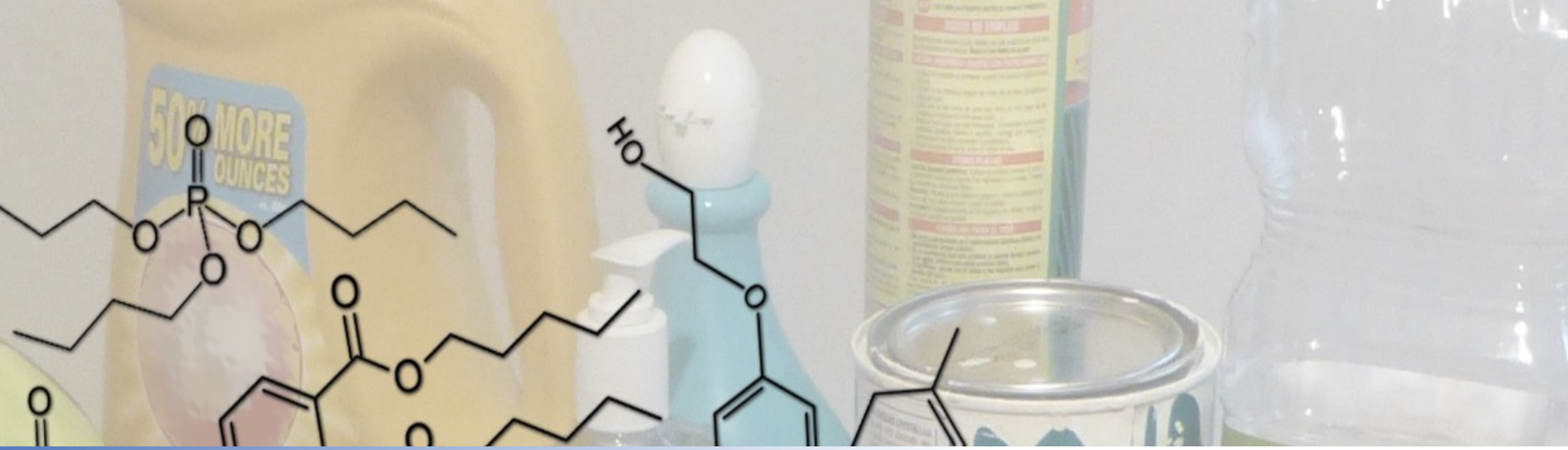


Characterization of human exposure and health effect of microplastics and their encapsulated chemicals

Olivier Jolliet, with inputs from Eva Proetzl, A-M Boulay, E. Corella Puertas, Shannon Nelson, Patrick West
Technical University Denmark, Quantitative Sustainability Assessment & University of Michigan, SPH

Introduction

10,000 metric tons of plastic debris are introduced each year in the Great Lakes Basin alone

Average human consumption of microplastics in drinking water: **0.08 g/yr**
Plus exposure via e.g. fish & food

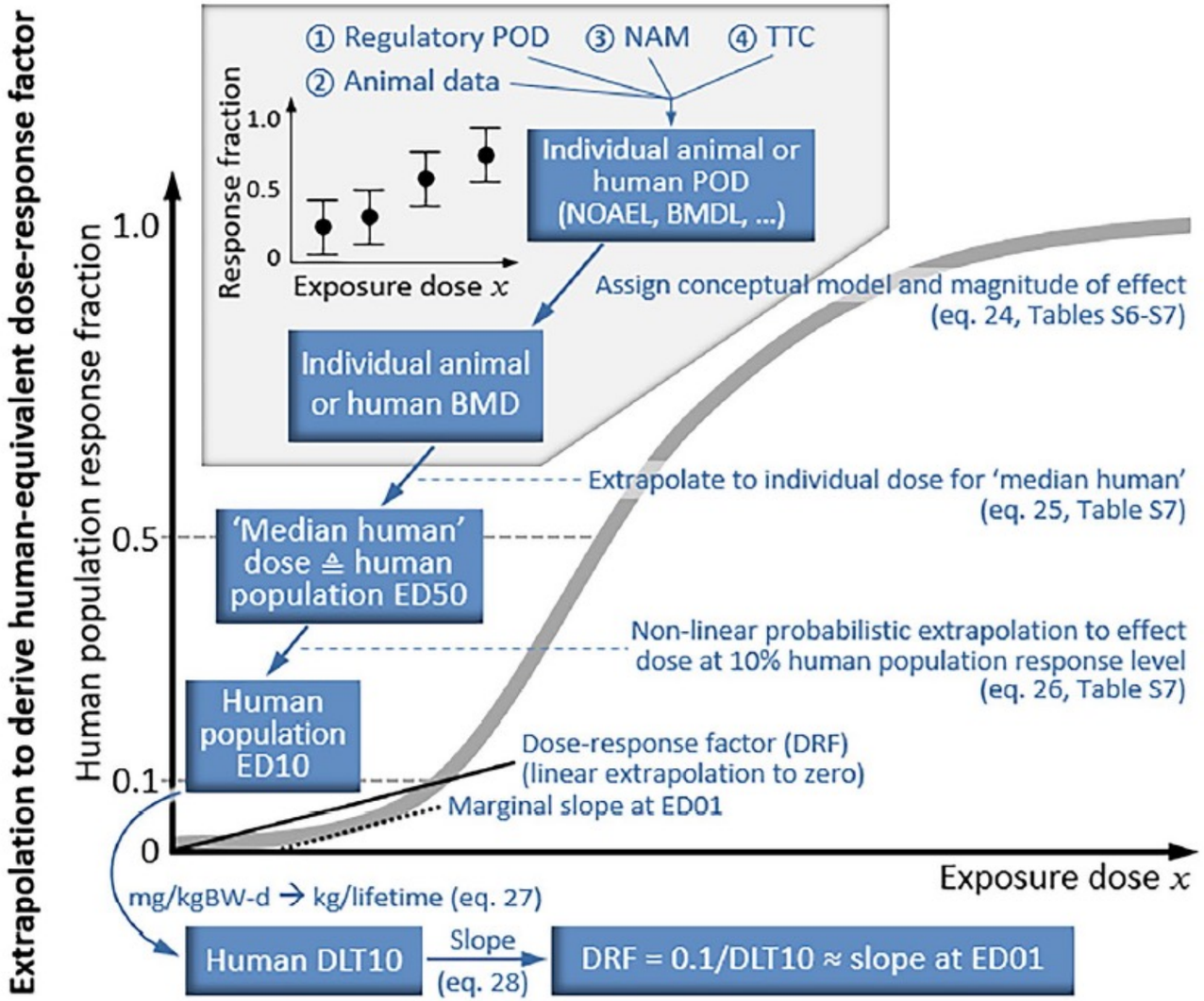
Does it matter for human health?

Objectives

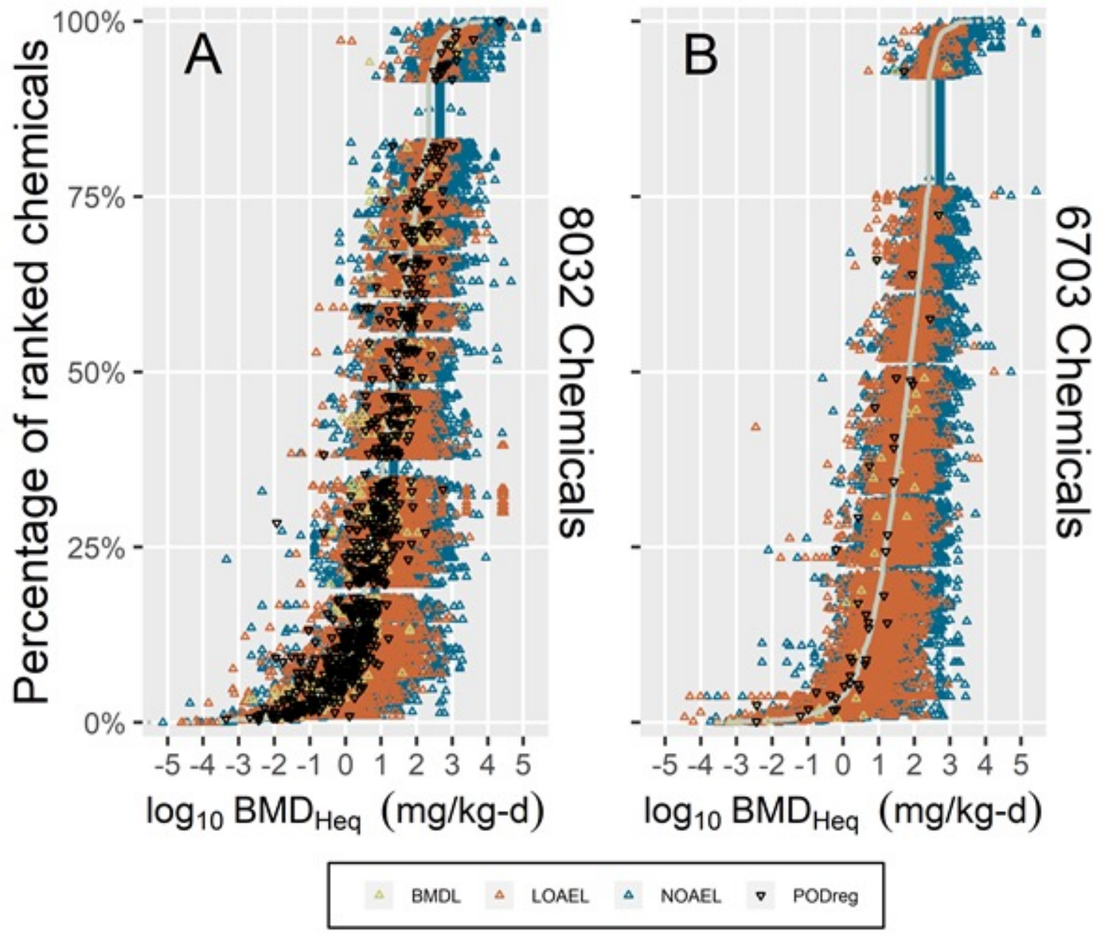
1. **Direct effect:** Determine a dose-response and an effect factor for microplastics and related risk and LCA metrics

2. **Chemical release:** Propose and illustrate a screening framework for determining the **mass of a chemical** that will be released into the body through the ingestion of plastics & their impact on human health.

Human toxicity in LCA : Dose-response (Aurisano et al, 2022, EHP final review)



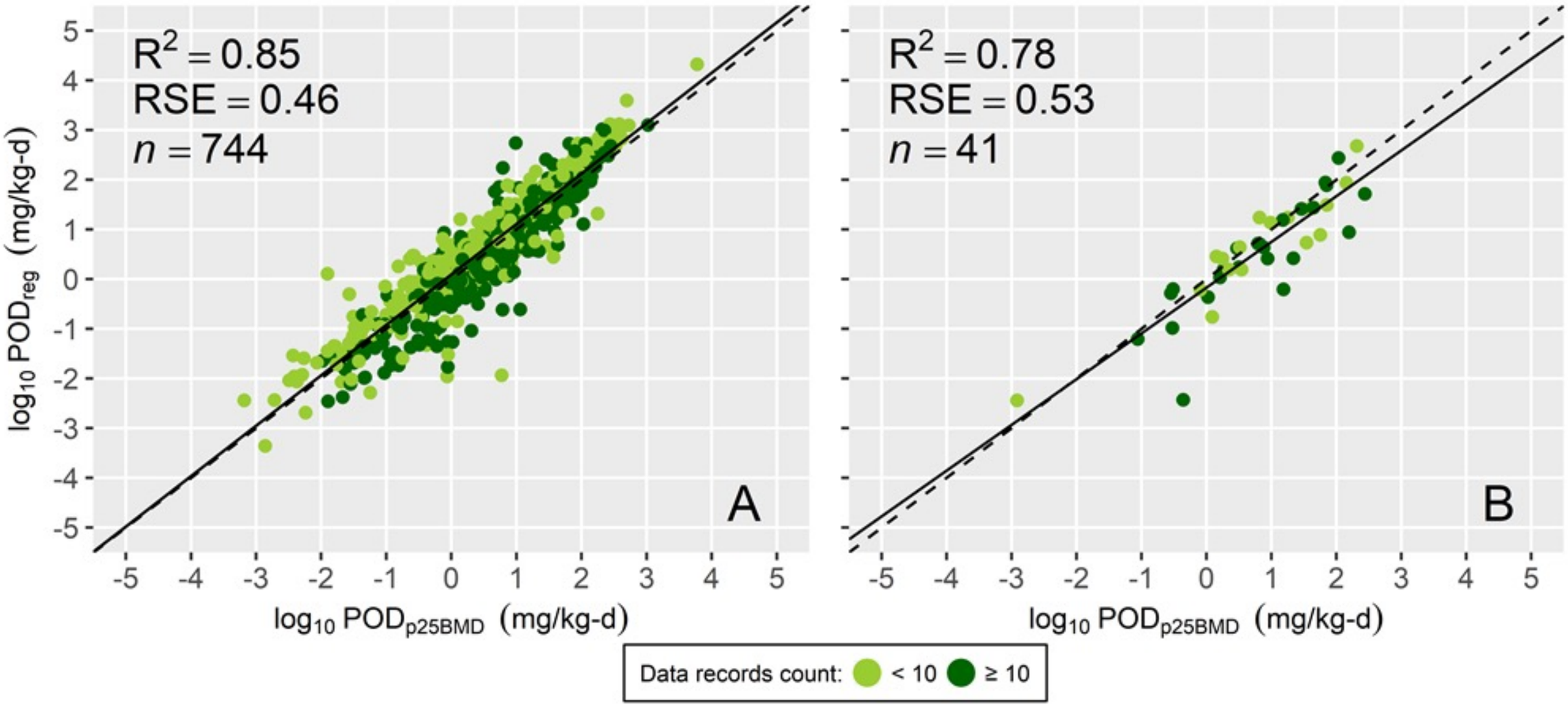
From 1000 to 8000 chemicals: Based on in vivo chronic data (non-) developmental



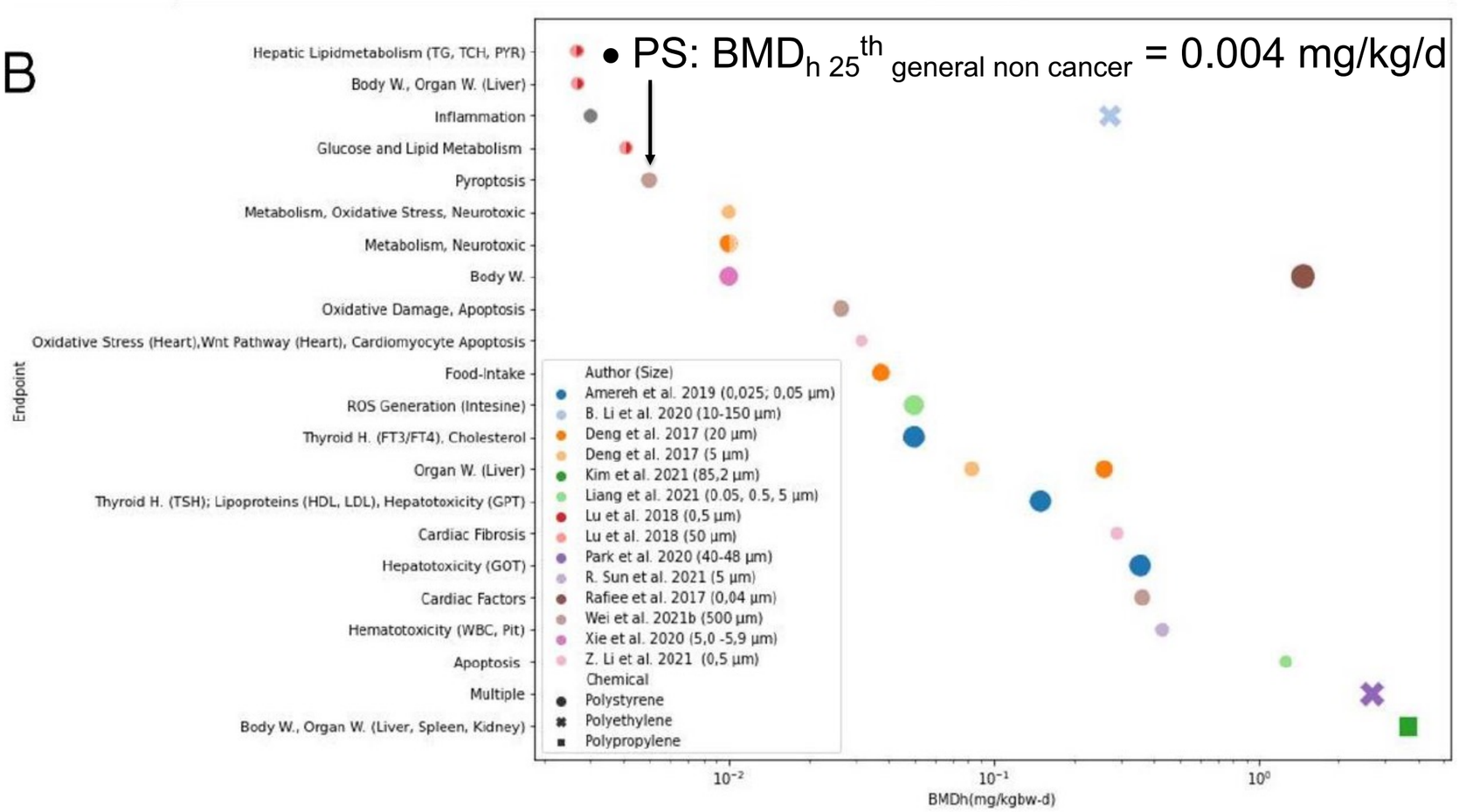
Point of Departure – POD regulatory versus POD_{BMD25}

General non-cancer

Reproductive/developmental



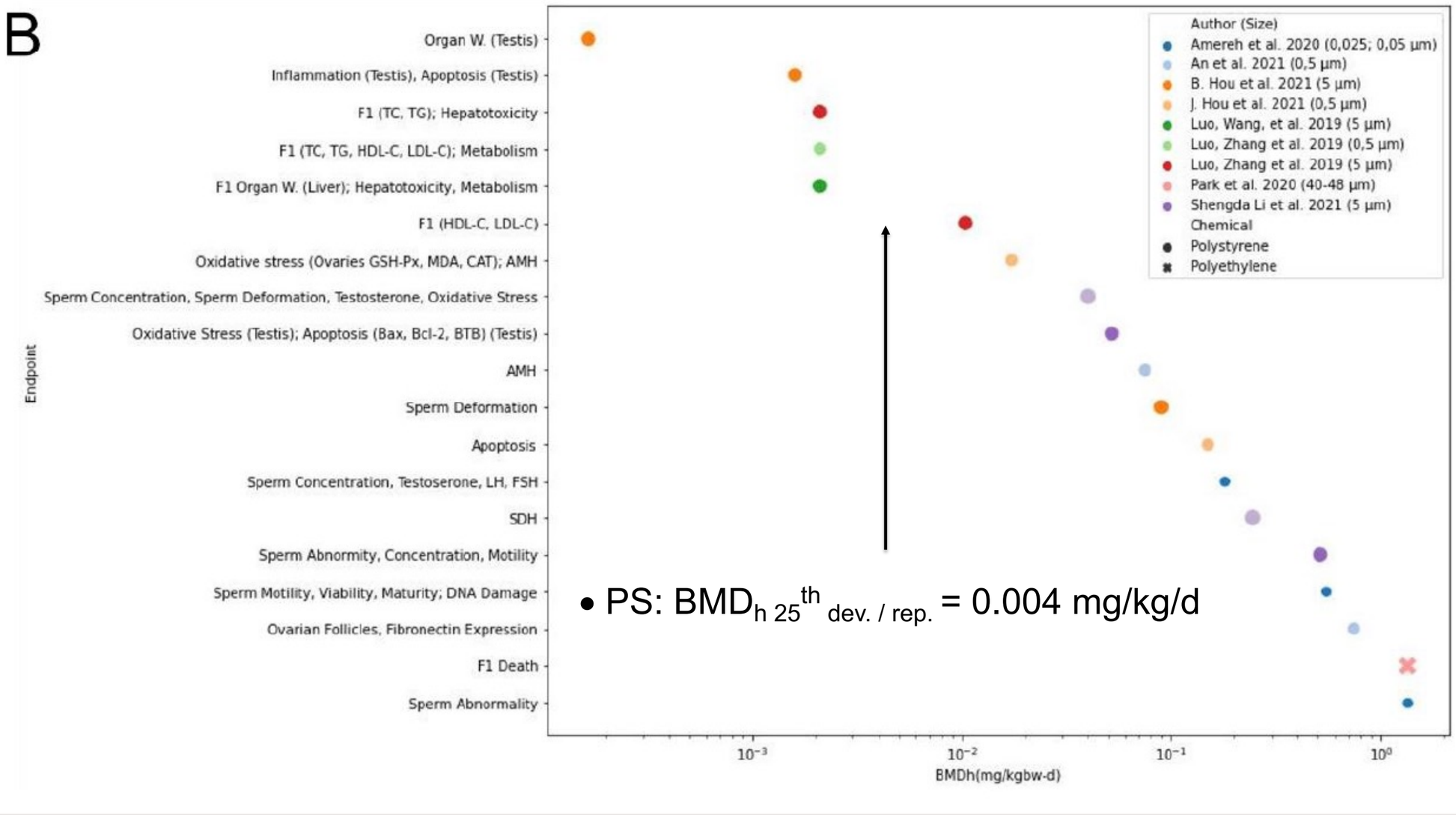
Point of departure for polyethylene nanoparticles, general non cancer



Eva Proezl, with support
E. Corella Puertas,
A-M Boulay,
O.Jolliet
R. Judson

Figure 13: Human benchmark dose (BMD_h) values (mg/kg bodyweight/day) for nonreproductive effects derived for different endpoints in selected *in vivo* rodent studies for oral application of micro- and nanoplastics are presented on a logarithmic scale (log10). A) all BMD_h for nonreproduc-

POD for polyethylene nanoparticles, developmental / reproductive



- PS: $BMD_{h\ 25^{th}\ dev.\ /\ rep.}$ = 0.004 mg/kg/d

ED10 and effect factor

Table 1: Summary of results for Polystyrene micro-and nanoplastics for reproductive and nonreproductive effects

Polystyrene	25th %-ile (mg/kgbw/d)	ED10 (mg/kgbw/d)	Uncertainty ED10 (P97.5/P50)	DLT10 (kg/lifetime)	DRF (Incidence risk/kg)	Probabilistic RfD (mg/kg bw/day)	SF DALY/case	EF DALY/kg
Non-reproductive	0,00410	0,00117	19,15	19,75451	0,005062	3,81834E-05	2.4	0.012
Reproductive	0,00417	0,00119	27,64	20,0922	0,004977	3,88353E-05	44.1	0.21

SF

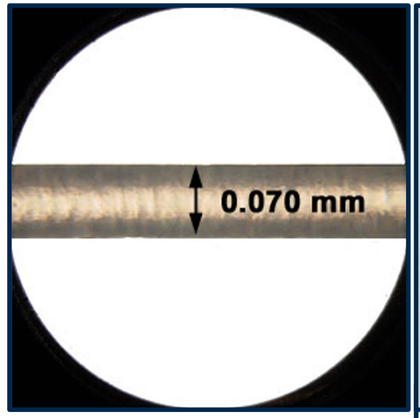
Disease category	DALY/incidence [year]
Cancer	11.5
Reproductive/ development[b], average	44.1
Other non-cancer, average	2.4

EF = 0.1 / DLT10 x SF

Exposure dose = 0.08 g/yr
= 0.003 mg/kg/d

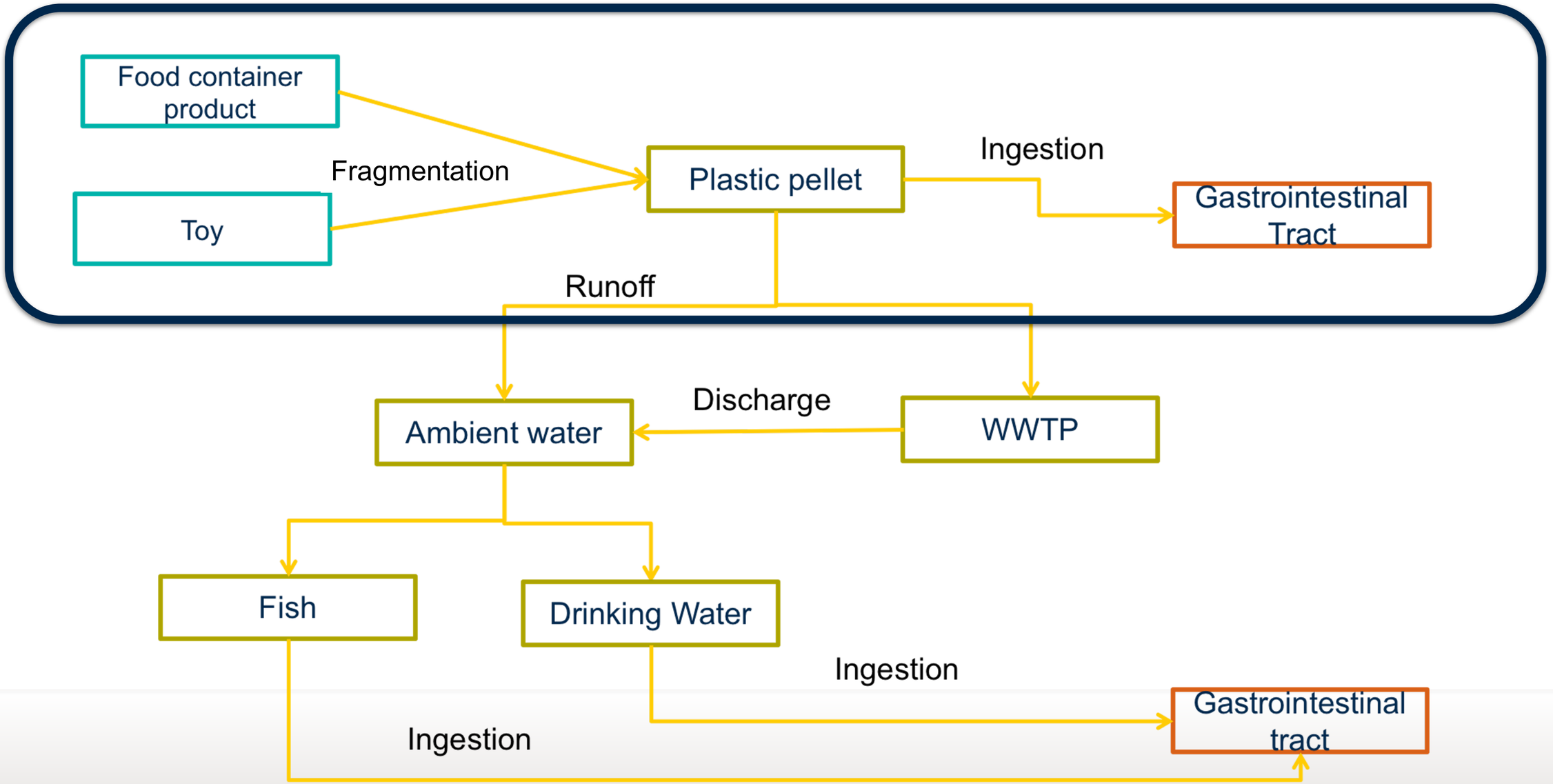
2. Chemicals in plastic

Thin human hair

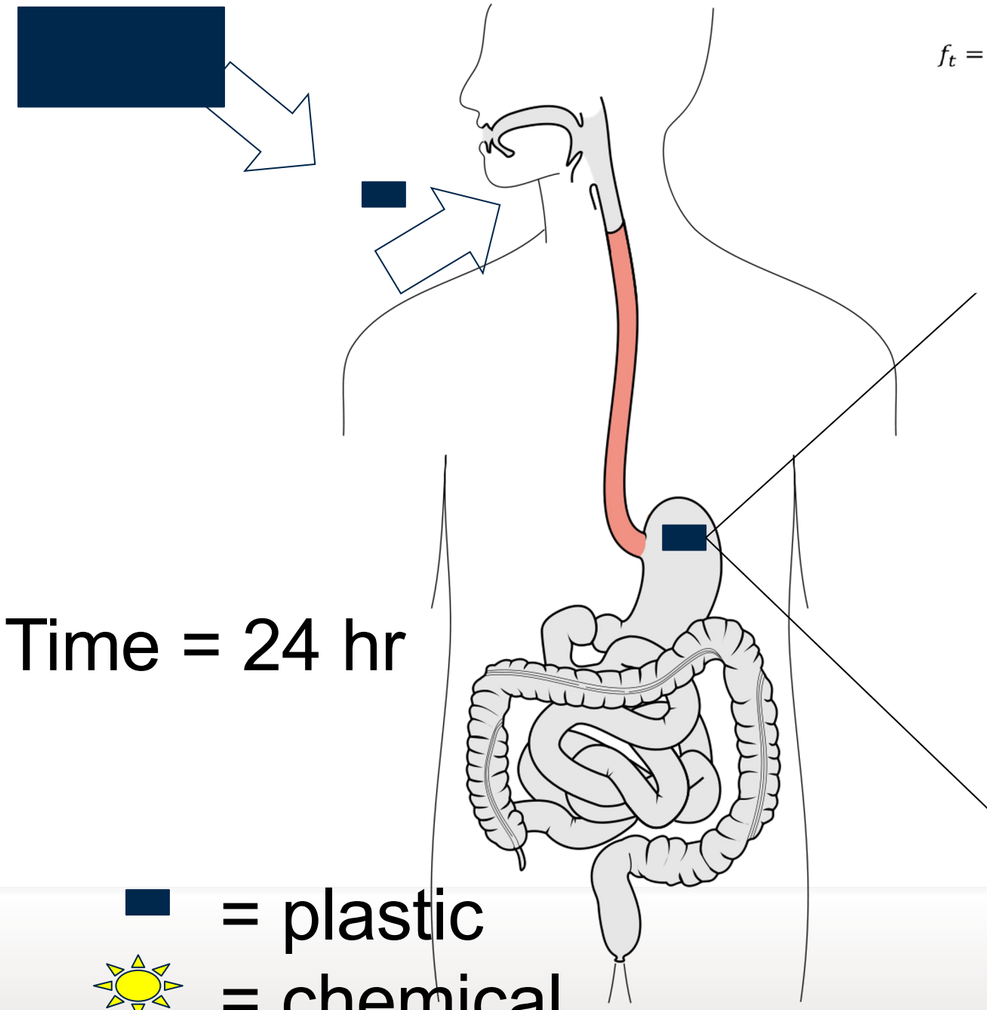


- Vary plastic size (4) - mm to micron
- Vary products (4)
  - Hard plastic doll
  - PVC toy mouthing
  - LDPE - India rice - central
  - Polystyrene - water bottle, 1 L
- GI tract – assumed EtOH of water (0)
- Chemicals in toys model

Impact Pathway Diagram



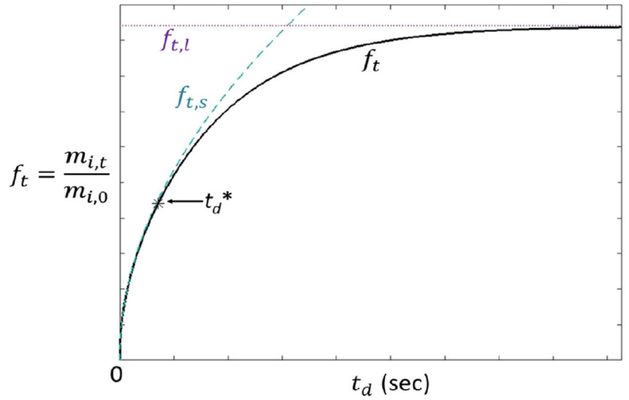
Concept



Time = 24 hr

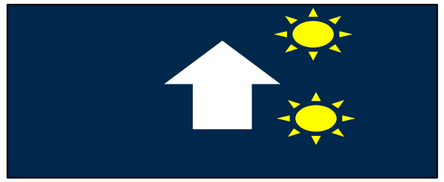
= plastic

= chemical



1

Diffusion to surface



$$f_{t,\,s} = \frac{m_{i,t}}{m_{i,o}} = 2/d_p \times (D_p t_d/\pi)^{1/2}$$

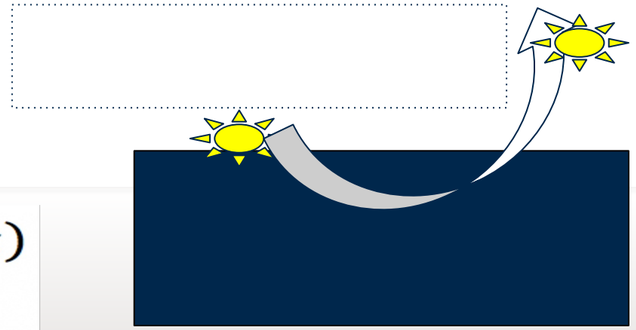
2

Surface to water inside GI

Boundary layer

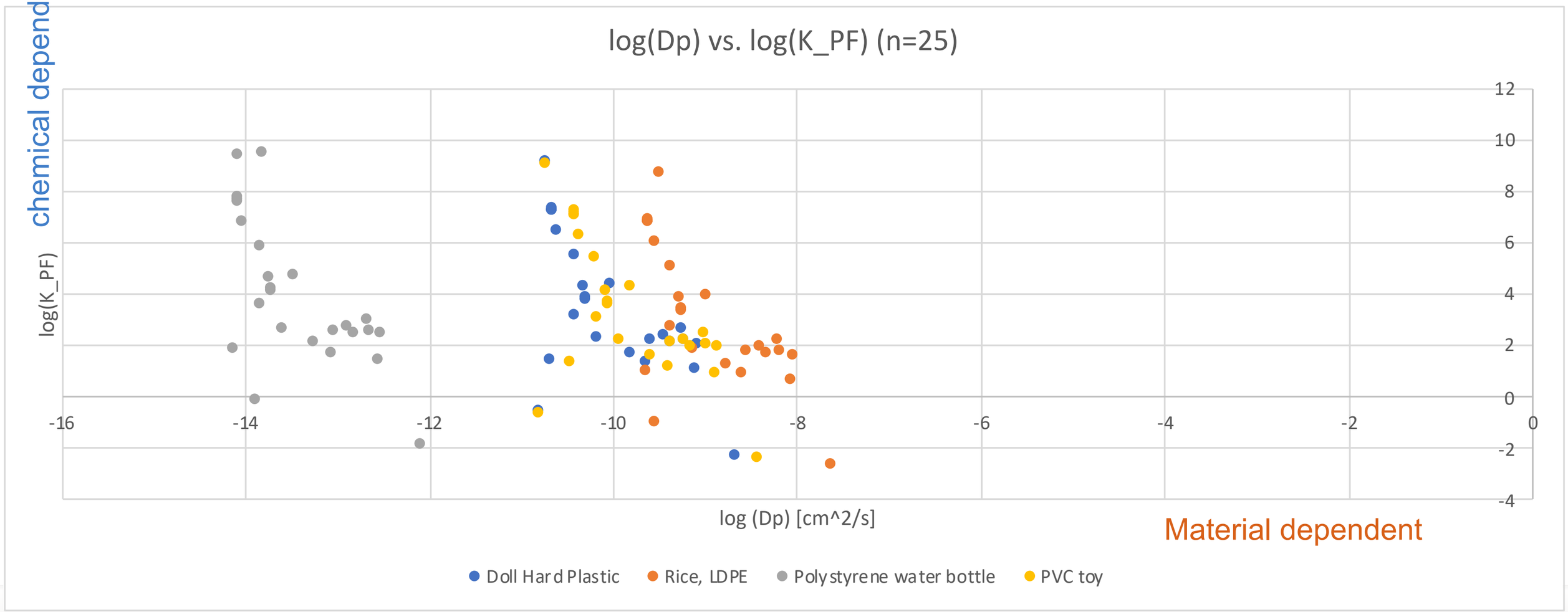
$$f_{t,s} = 1 - \exp(-R * t)$$

$$R = \frac{\varphi_w}{d_p * K_{pf}}$$



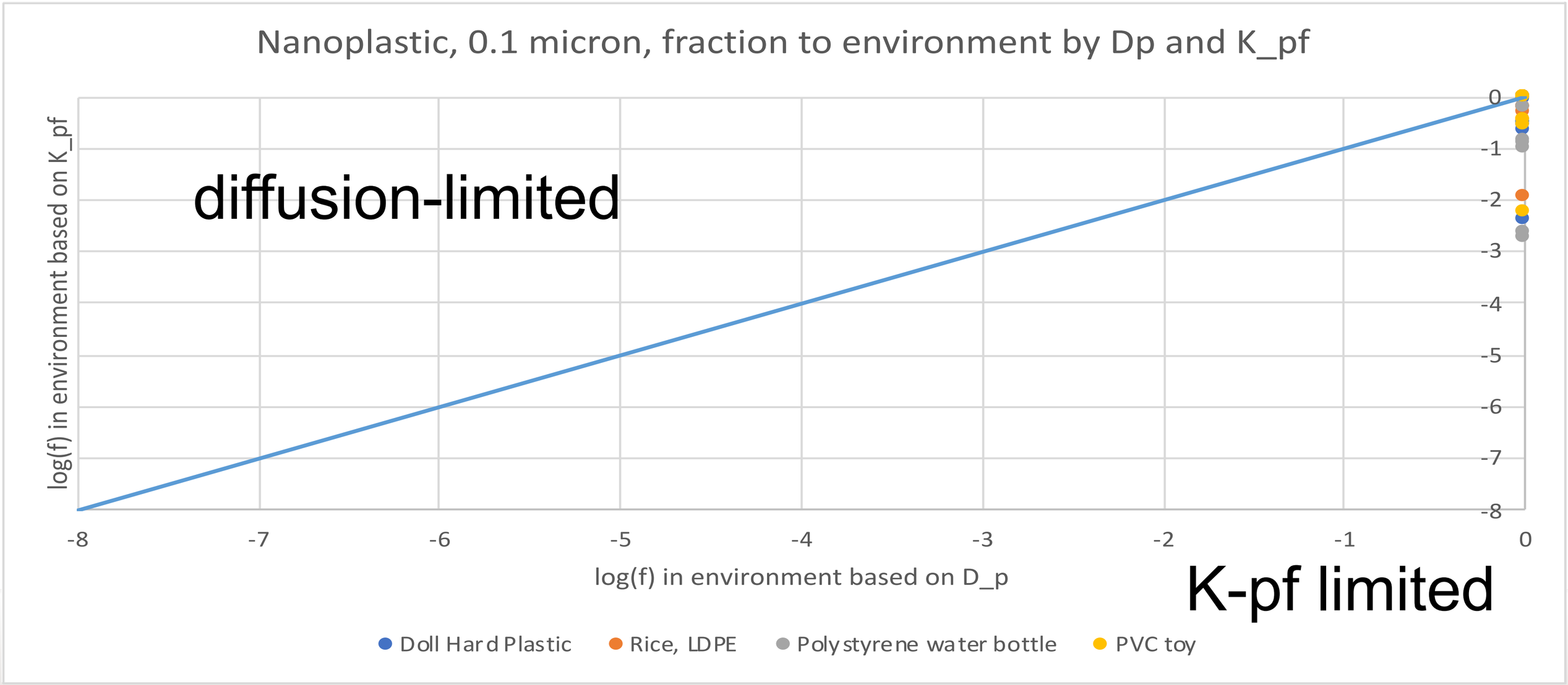
Log(D_p) – vs. Log(K_{pf})

chemical dependent



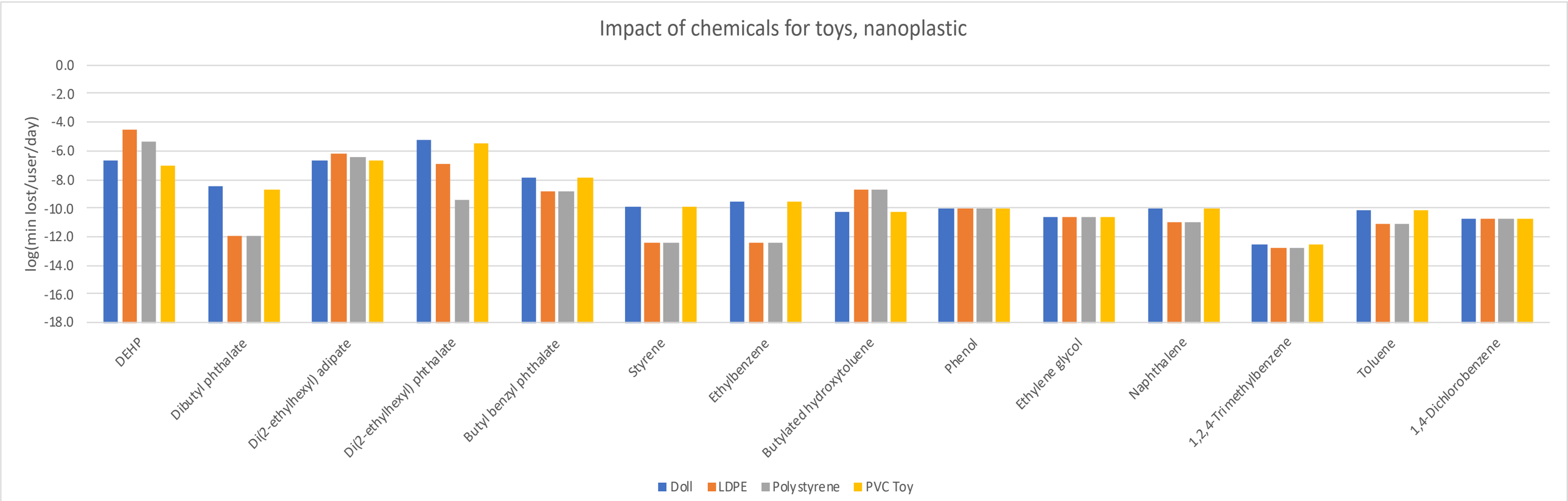
Material dependent

Effect of particle size on f



Impact based on material and particle size

- Constant product mass intake (0.08 g/yr)
- Max =10^{-4} min lost/user-day



Conclusion

- Preliminary results shows the feasibility to determine effect factor for polystyrene microplastics
- Check with our toxicologist – values only indicative at this stage
- Also possible to determine chemical release from microplastic
- So far seems limited in impact magnitude, but to be confirmed
- Adapt diffusion model for 3D object and combined diffusion/partition (more realistic)
- → would be interested to conduct a high throughput screening of a wide range of chemicals in various packaging materials and foods!

Peter Fantke | pefan@dtu.dk

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