

Nanoplastics – What Do We Know, What Do We Need to Know?

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Unwrapped Conference

Scotts Valley, 13 June 2019

Overview

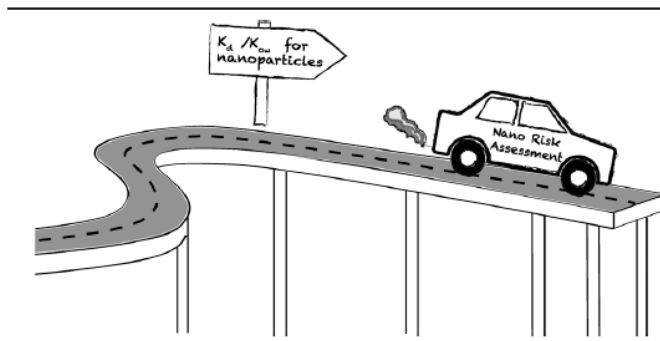
- ◆ Three lessons from nanoparticle research
- ◆ Nanoplastics
- ◆ How do we approach the problem?

Three Lessons Learned from Nanoparticle Research

- ◆ Nanoparticles are different from “normal” chemicals (pesticides, food-contact chemicals, ...).
- ◆ Nanoparticles do not have a well-defined identity.
- ◆ Studies of the behavior and effects of nanoparticles need to be designed carefully.
 - ➔ many meaningless results generated
 - ➔ a lot of time, effort and money wasted

Lesson 1

- ◆ **Nanoparticles are different from “normal” chemicals (pesticides, food-contact chemicals, ...).**
- ◆ NP properties and “fate”:
 - ➔ no solubilities, no partition coefficients
 - ➔ NPs aggregate, stick to other materials, age, ...



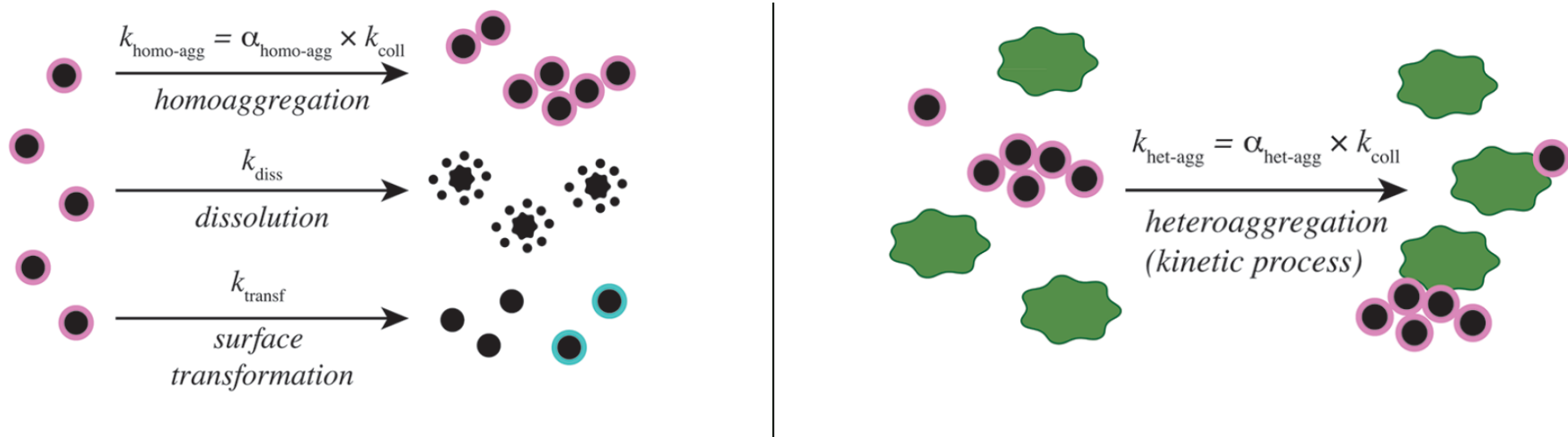
The road to nowhere: equilibrium partition coefficients for nanoparticles

Antonia Praetorius,* Nathalie Tufenkji, Kai-Uwe Goss, Martin Scheringer, Frank von der Kammer and Menachem Elimelech

This perspective demonstrates the inapplicability of equilibrium partition coefficients as fate descriptors for nanoparticles.

Lesson 2

- ◆ **Nanoparticles do not have a well-defined identity.**
- ◆ In the environment: aggregation, dis-aggregation, coatings, chemical transformation, ...



Lesson 3

◆ **Studies of the behavior and effects of nanoparticles need to be designed carefully.**

- ➔ What is the relevant nanoform? What are its properties?
- ➔ How can this nanoform be captured by a toxicity test?

◆ **Results often fragmented, piecemeal, inconsistent**

The nanotechnology safety research portfolio has become increasingly unbalanced over the past decade, with toxicology research far outstripping exposure-based research, and research into specific materials (silver and titanium dioxide for example) has not always aligned well with likely potency or impact.¹

The “Babylonian diversity” in the applied methods allows no comparability between the studies, but explains the often contradictory results of several publications.²

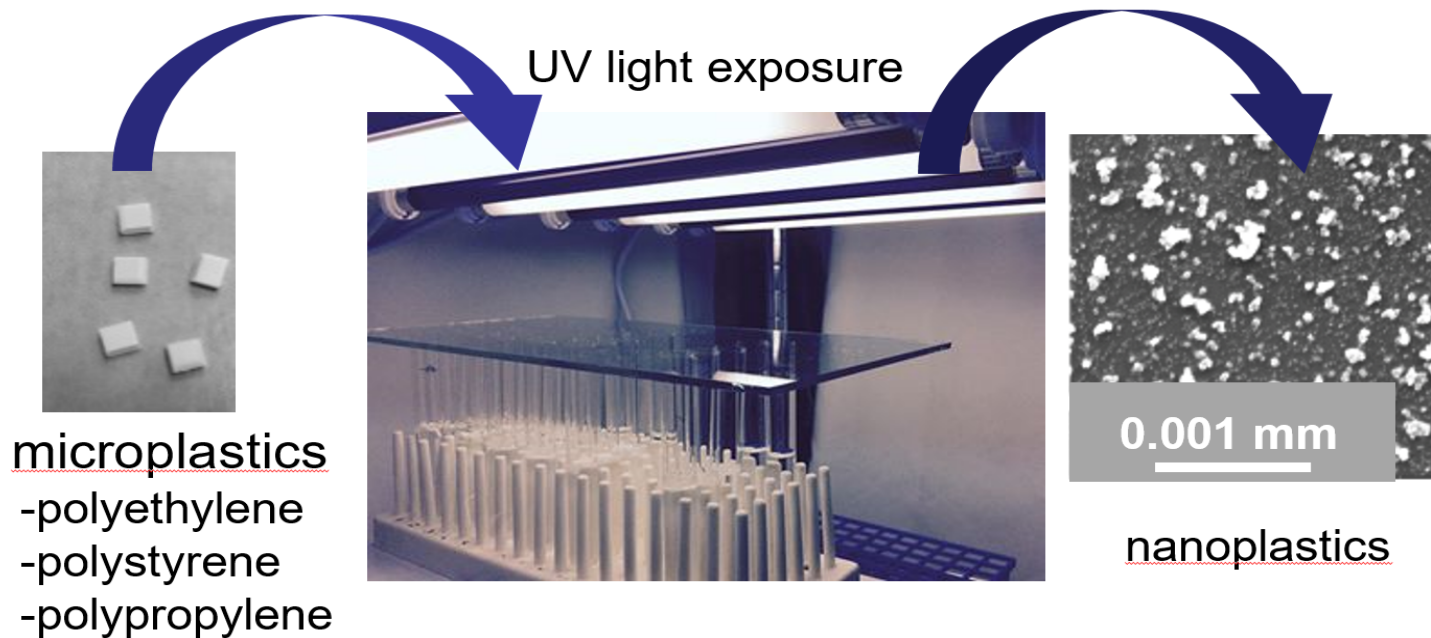
1: A. Maynard, R. Aitken (2016) *Nature Nanotechnology* **11**, 999; 2: H. Krug (2014) *Angewandte Chemie Intern. Ed.* **53**, 12305

Nanoplastics ...

- ◆ Probably not used as Engineered Nanoparticles in products
- ◆ Formed in the environment?
 - ➔ What are the amounts/numbers?
 - ➔ What are their properties and fate?
 - ➔ Aging? Agglomeration?
- ◆ What is the human exposure to be expected? Any?
- ◆ What are possible effects?

**Methods need to be developed
for most/all of these questions.**

Microplastic Weathering Studies



Microplastics break down into billions of nanoplastics following simulated solar exposure (UV-A light).

unpublished results, courtesy of Nathalie Tufenkji, Laura Hernandez, McGill University, Montreal

Method Development: Detection

ACCOUNTS
of chemical research

Cite This: *Acc. Chem. Res.* XXXX, XXX, XXX–XXX

Article
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Separation and Analysis of Microplastics and Nanoplastics in Complex Environmental Samples

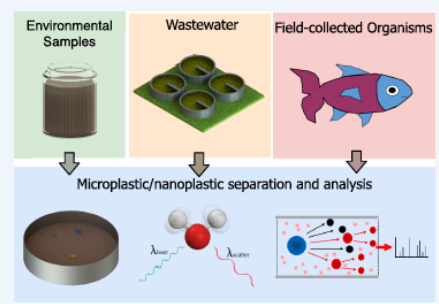
Published as part of the *Accounts of Chemical Research* special issue “Water for Two Worlds: Urban and Rural Communities”.

Brian Nguyen,^{†,§} Dominique Claveau-Mallet,^{†,§} Laura M. Hernandez,[†] Elvis Genbo Xu,[†] Jeffrey M. Farner,[†] and Nathalie Tufenkji^{*,†}

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S Supporting Information

CONSPECTUS: The vast amount of plastic waste emitted into the environment and the increasing concern of potential harm to wildlife has made microplastic and nanoplastic pollution a growing environmental concern. Plastic pollution has the potential to cause both physical and chemical harm to wildlife directly or via sorption, concentration, and transfer of other environmental contaminants to the wildlife that ingest plastic. Small particles of plastic pollution, termed microplastics (>100 nm and <5 mm) or nanoplastics (<100 nm), can form through fragmentation of larger pieces of plastic. These small particles are especially concerning because of their high specific surface area for sorption of contaminants as well as their potential to translocate in the bodies of organisms. These same small particles are challenging to separate and



B. Nguyen et al. (2019) *Accounts of Chemical Research* **52**, 858–866

Method Development: Detection

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“A common theme in our Account is that new techniques are required to answer key questions in the field of microplastic and nanoplastic research.”

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Method Development: Toxicity Testing

- ◆ Plastic particles in high numbers (any size):
“physical obstruction”
- ◆ Nanoparticles: may enter cells
- ◆ Toxicity testing: what are the relevant nanoforms?
- ◆ What are relevant doses?

How Do We Approach the Problem?

Paulo Di Oliveira

Passport Ocean

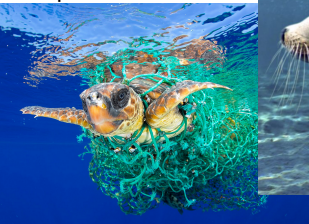


**macro-
plastic**

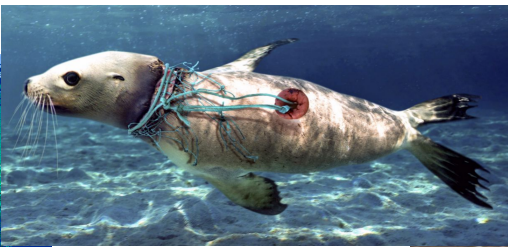
very high
concern

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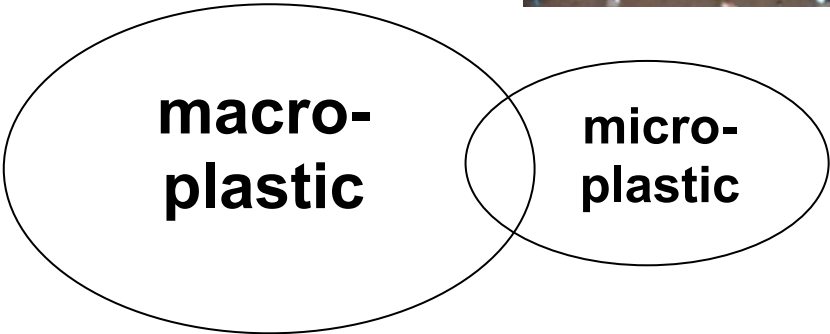
Passport Ocean



Paulo Di Oliveira



Sea Education Association

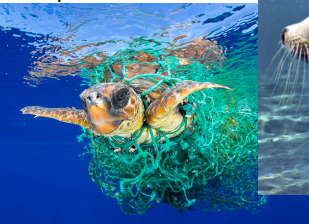


very high concern

high concern

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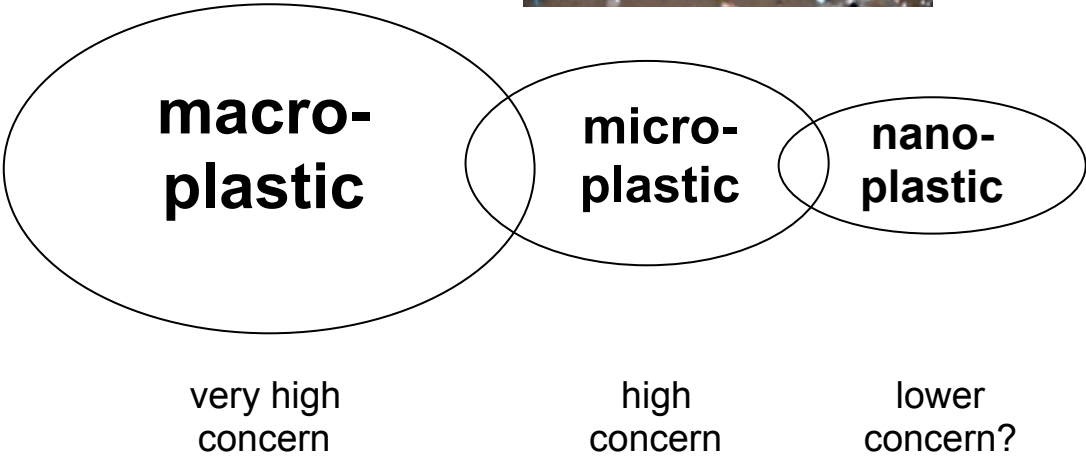
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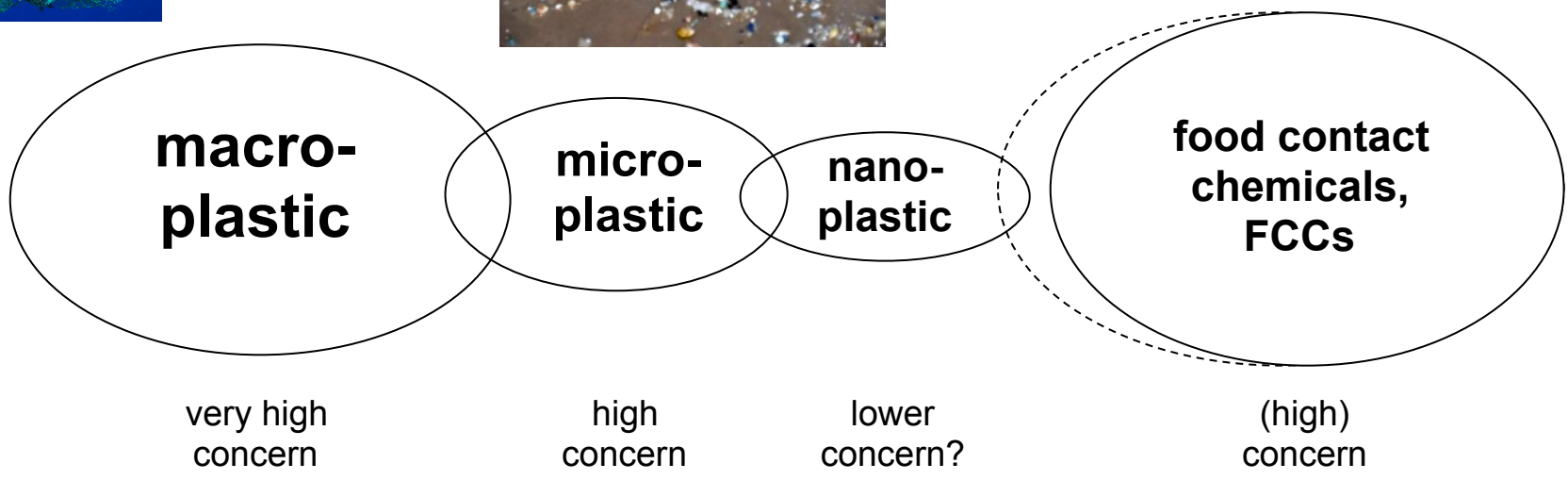
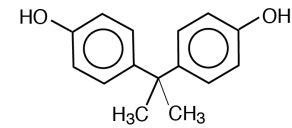
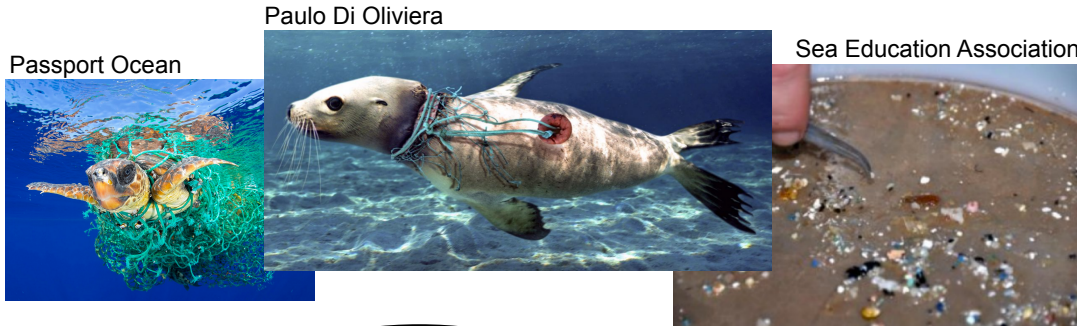
Paulo Di Oliveira



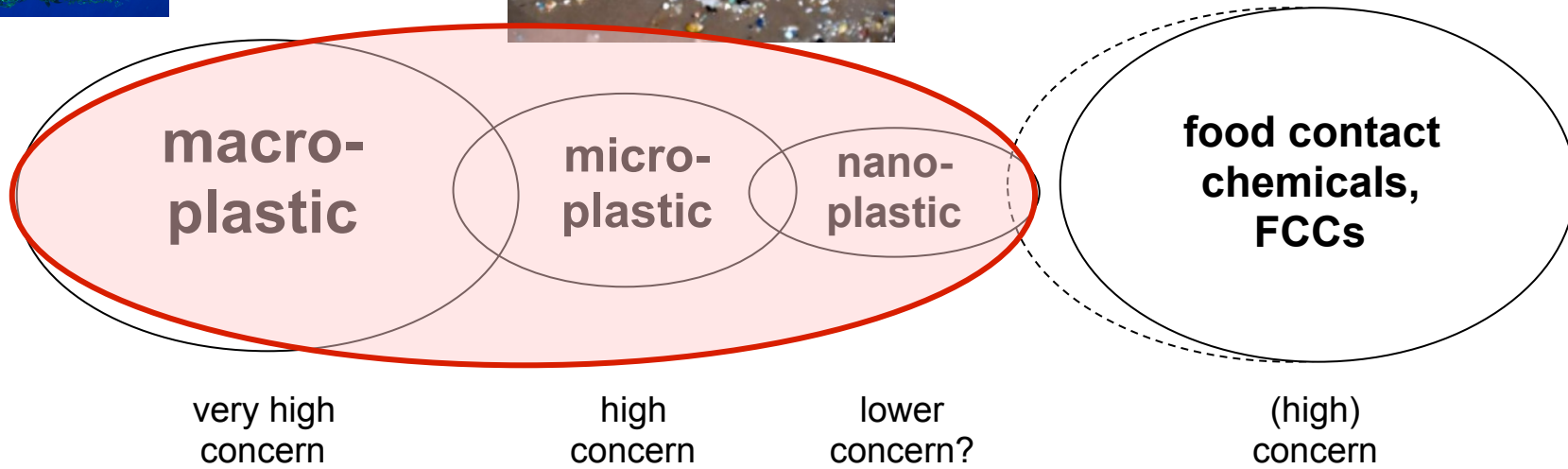
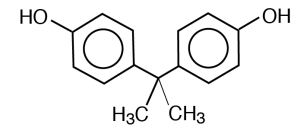
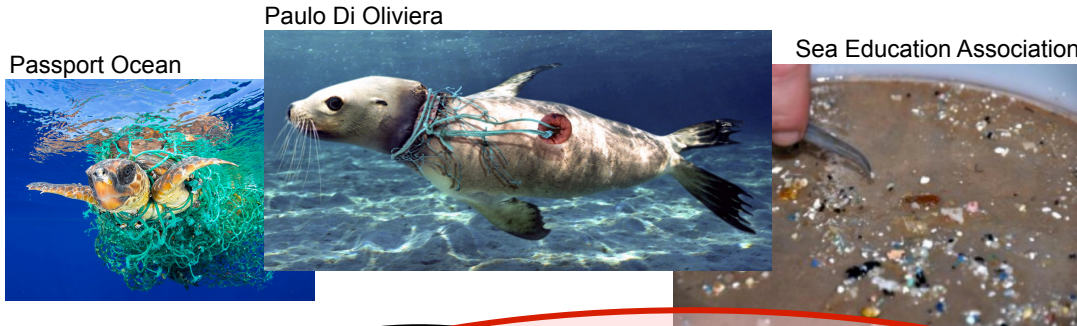
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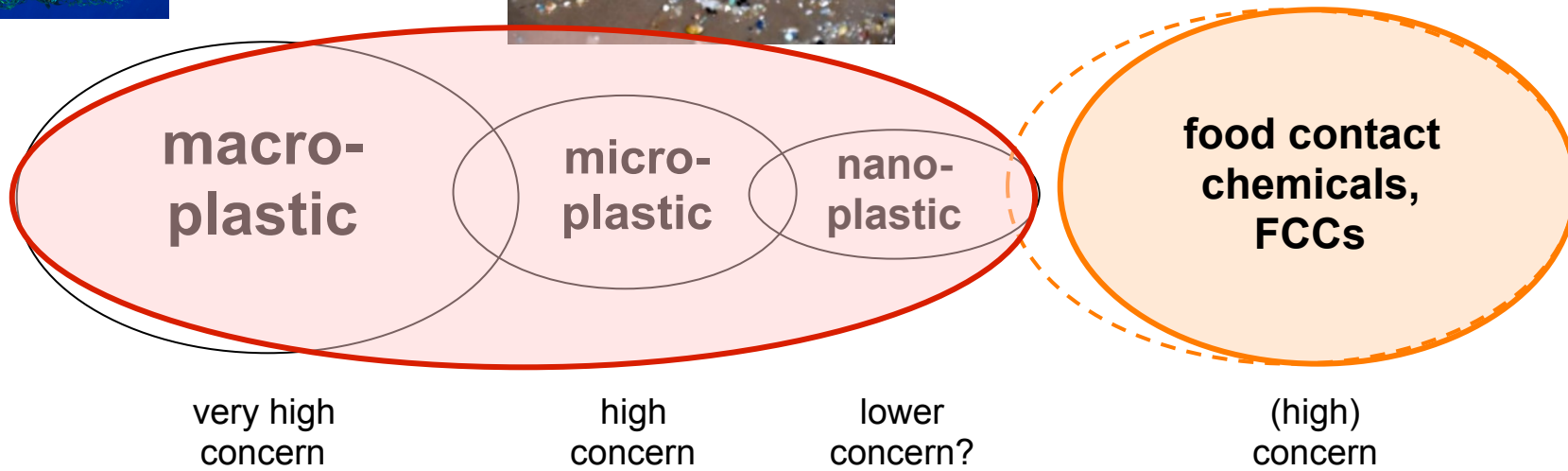
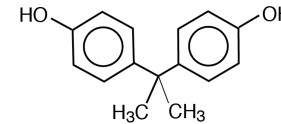
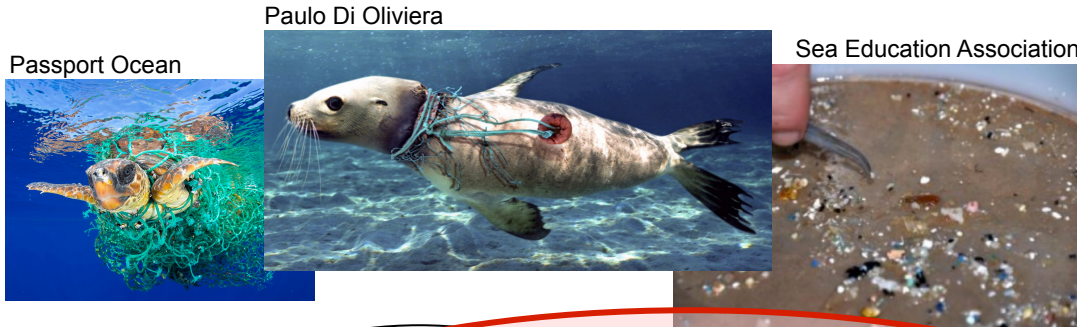


How Do We Approach the Problem?



stop plastic pollution

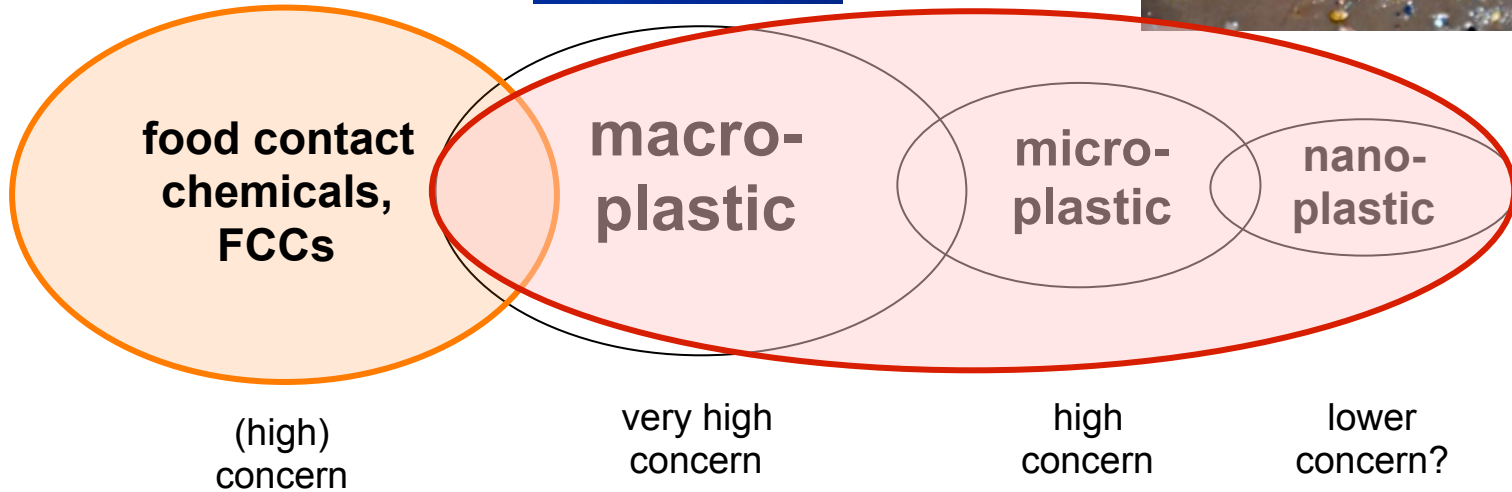
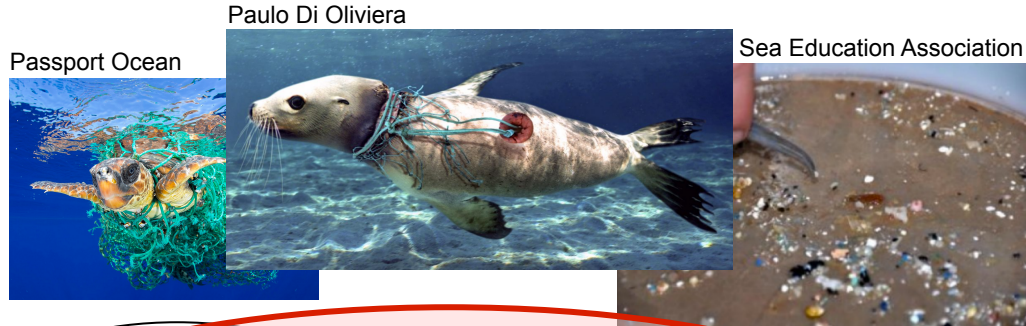
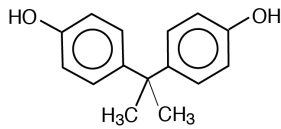
How Do We Approach the Problem?



stop plastic pollution

reduce exposure to FCCs

How Do We Approach the Problem?



reduce exposure to FCCs

stop plastic pollution

Thanks to:
Nathalie Tufenkji, Miriam Diamond,
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