

Plastics in the ocean: are there solutions to this global environmental problem?

Richard Thompson, Plymouth University, UK

Image credit B. Frymire

Marine litter

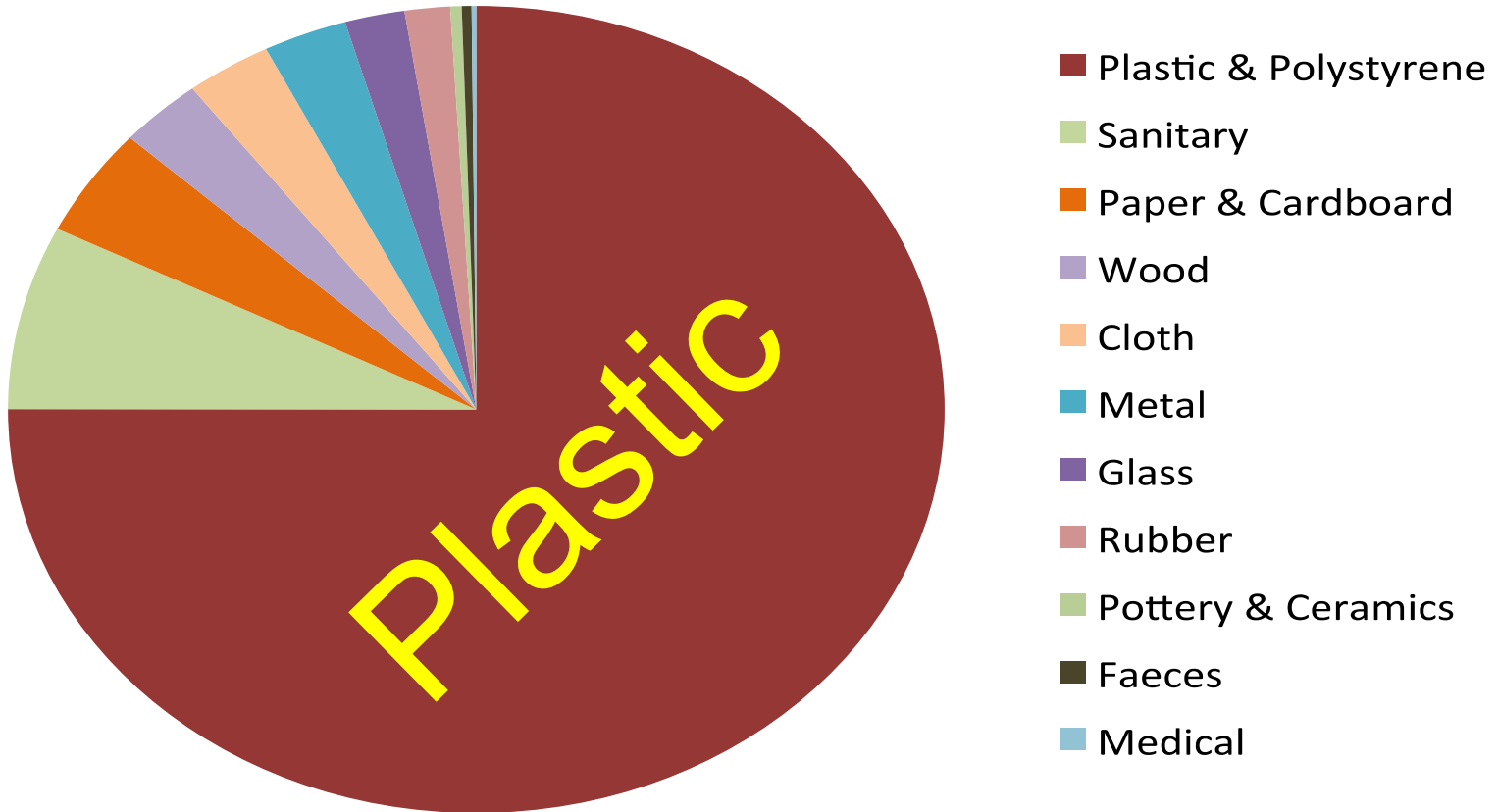


Mediterranean Sea, 1000m





Mostly plastic





Economic consequences



England

Effects on human wellbeing?



Hazard to mariners





Consequences for
wildlife

Encounters:

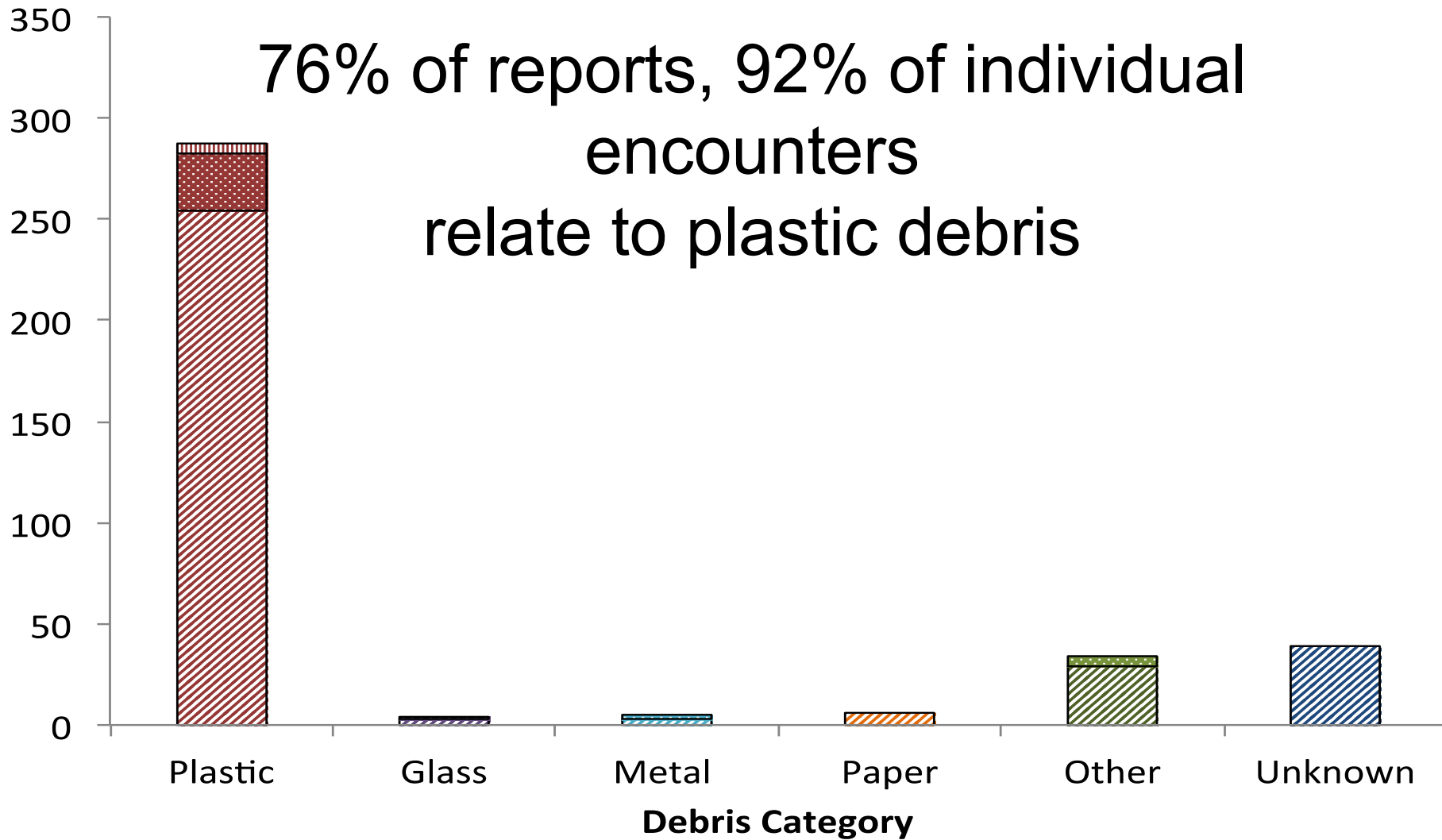
> 300 papers

~ 700 Species

17 % threatened
or near threatened
IUCN status

76% of reports, 92% of individual encounters relate to plastic debris

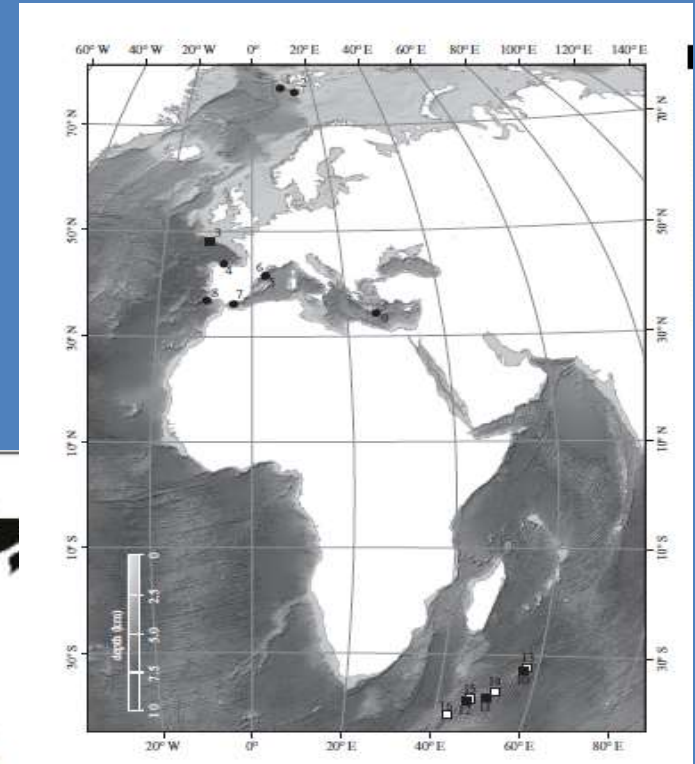
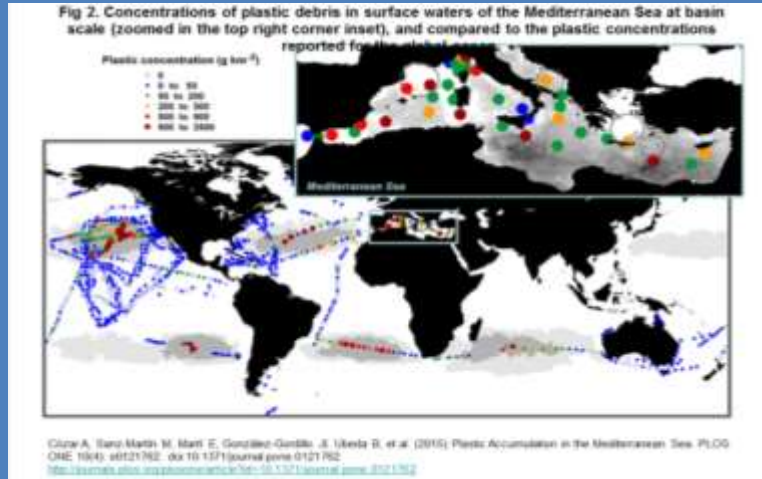
Number of papers



Microplastic

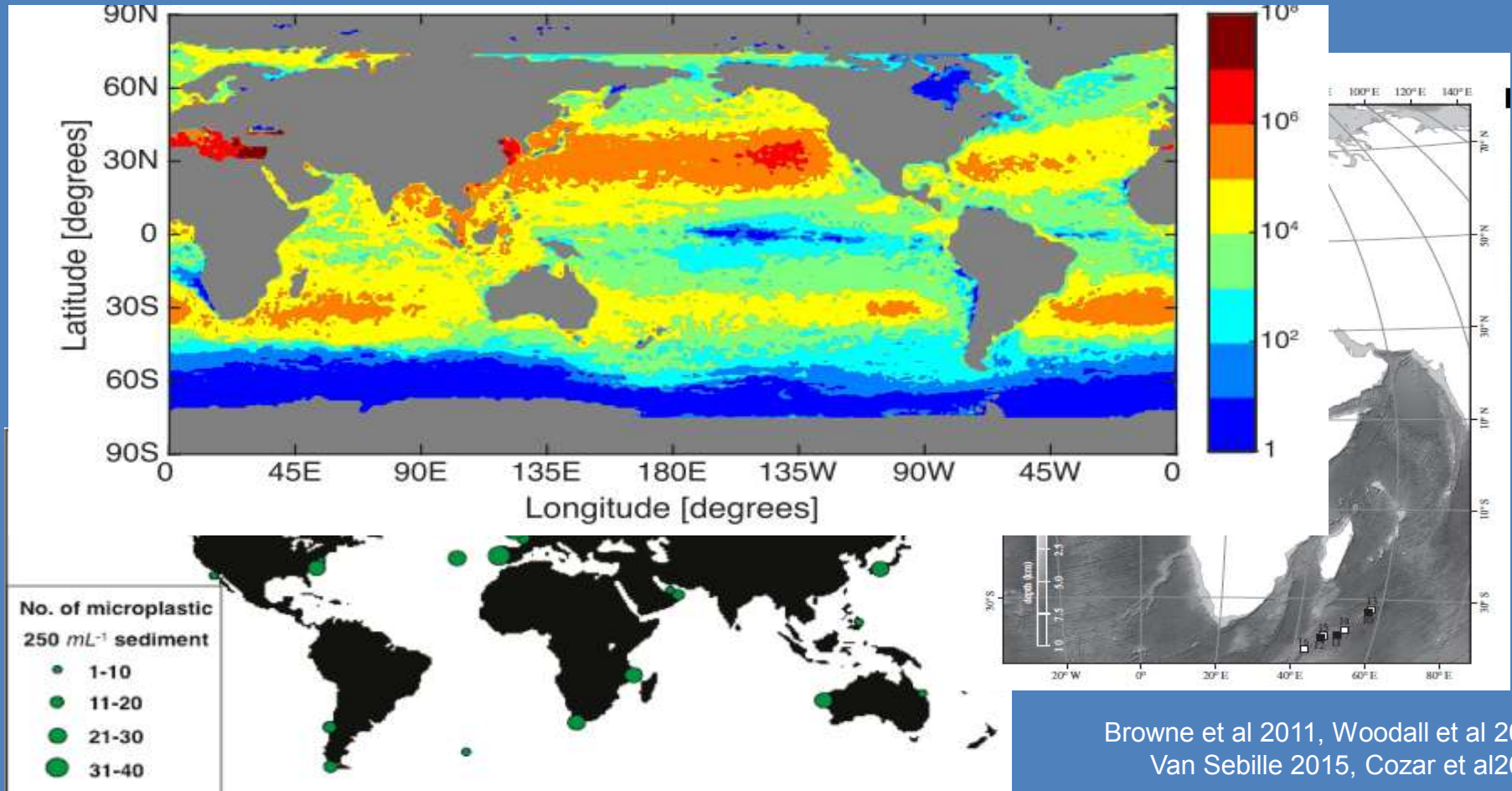


Distribution: global sea surface, intertidal, deep sea



Browne et al 2011, Woodall et al 2014
Van Sebille 2015, Cozar et al 2015

Distribution: global sea surface, intertidal, deep sea



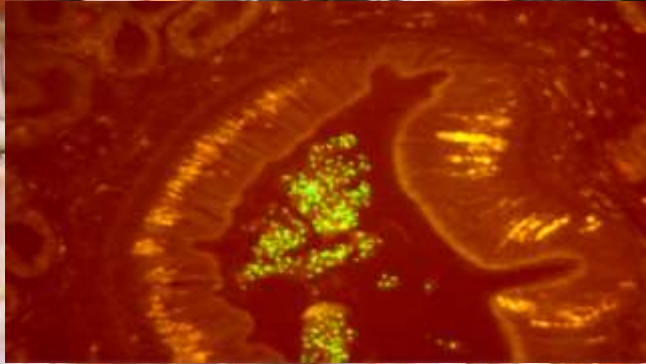
Sea birds:
21% of species 'entangled'
38% of species 'ingest'



Northern Fulmar
95% of population
contain ingested debris

Key research: van Franeker IMARES

Microplastics: numerous species ingest some retain, ~ 10% of published reports



Key research: Thompson / Browne / Murray / Cowie

Plastic Resin Pellets as a Transport Medium for Toxic Chemicals in the Marine Environment

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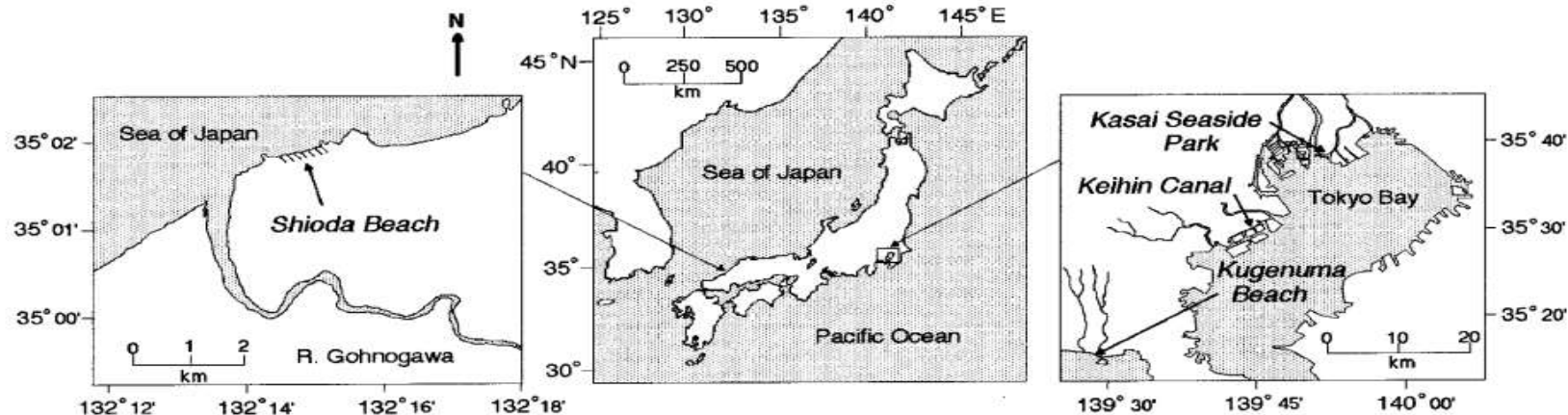
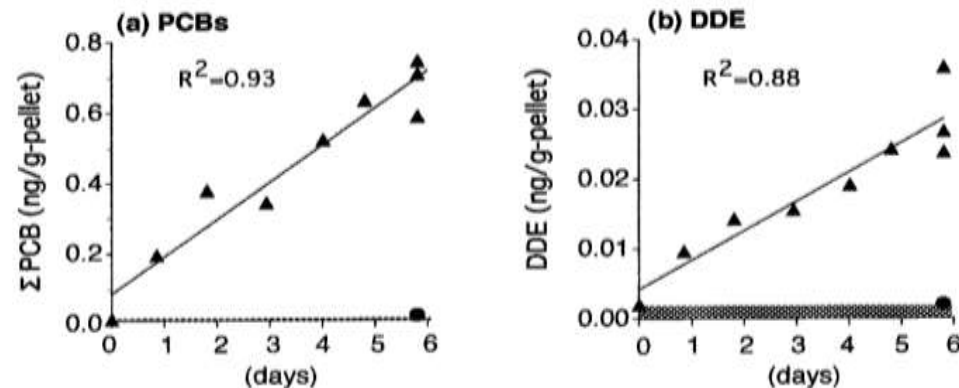
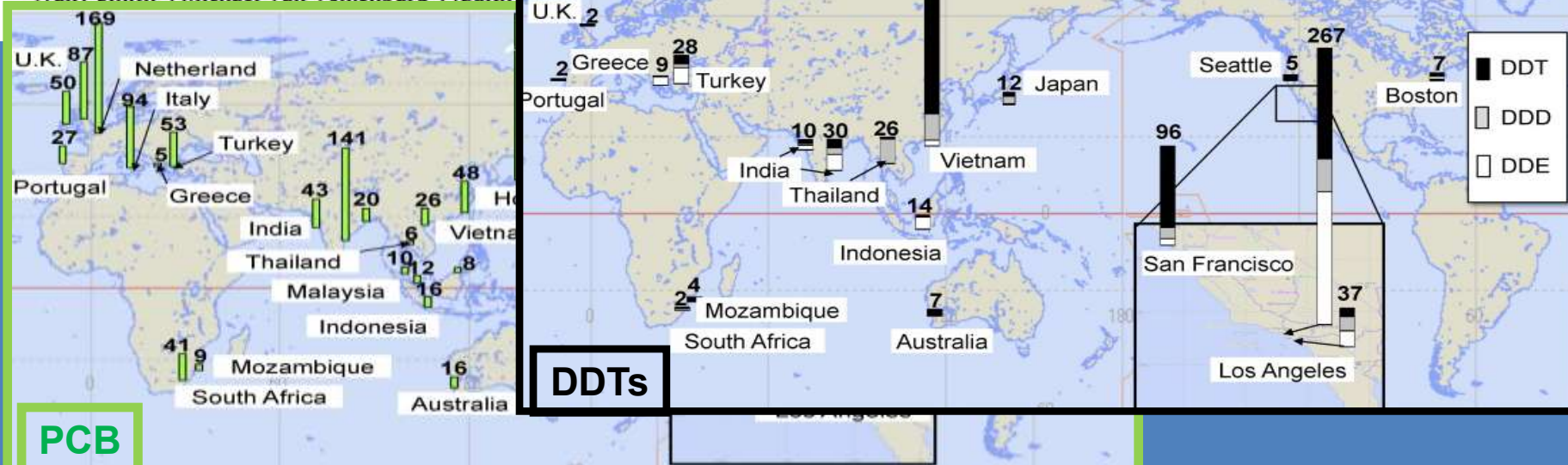


FIGURE 1. Sampling locations.



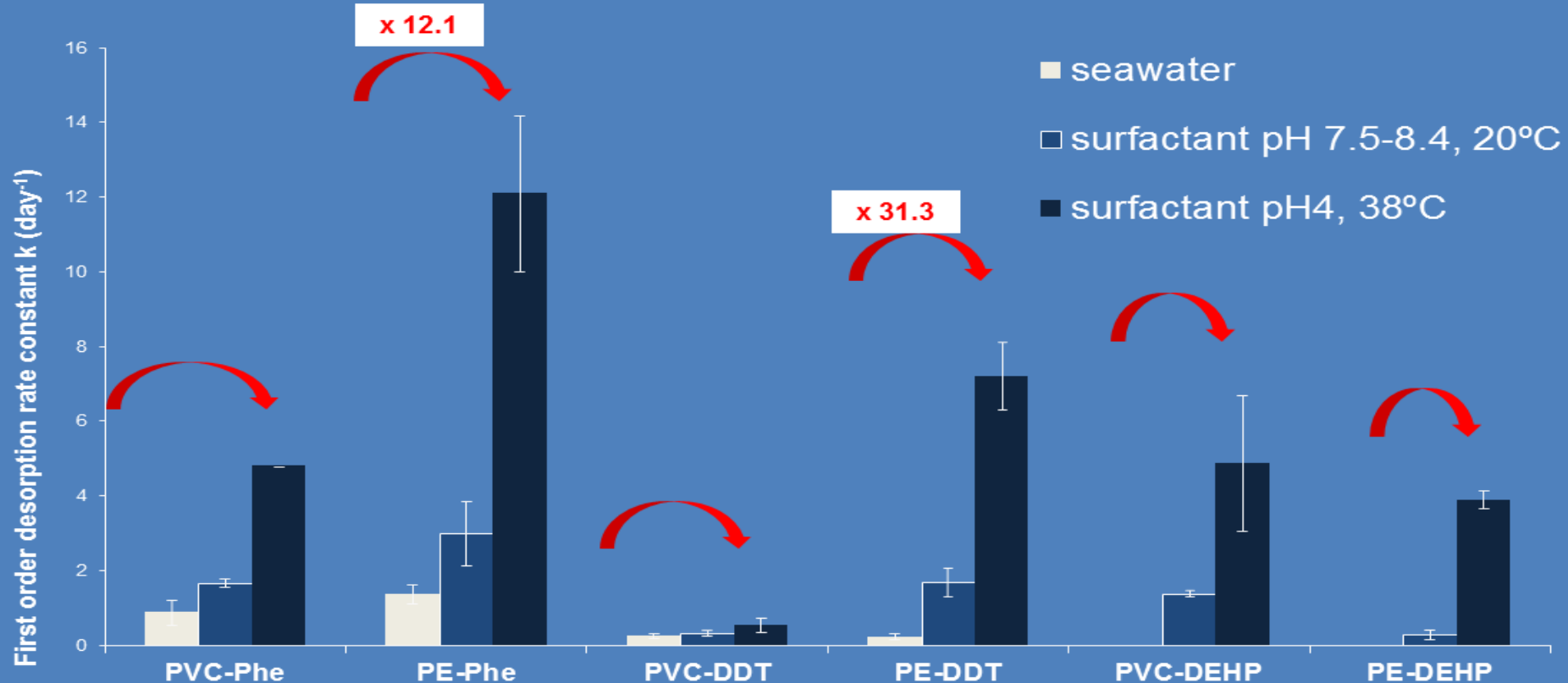
International Pellet Watch: Global monitoring of persistent organic pollutants (POPs) in coastal waters. 1. Initial phase data on PCBs, DDTs, and HCHs

Yuko Ogata^a, Hideshige Takada^{a,*}, Kaoruko Mizukawa^a, Hisashi Hirai^a, Satoru Iwasa^a, Satoshi Endo^a, Yukie Mato^a, Mahua Saha^a, Keiji Okuda^a, Arisa Ruchaya Booyatumanondo^d, Mohamad Pauzi Zakaria^e, Satoru Suzukiⁱ, Charles Moore^j, Hrissi K. Karapantou^k, Wally Smithⁿ, Michael Van Velkenburg^o, Judith



PCB

Rate of release of POPs increases in gut conditions



Uptake of additive chemicals by birds

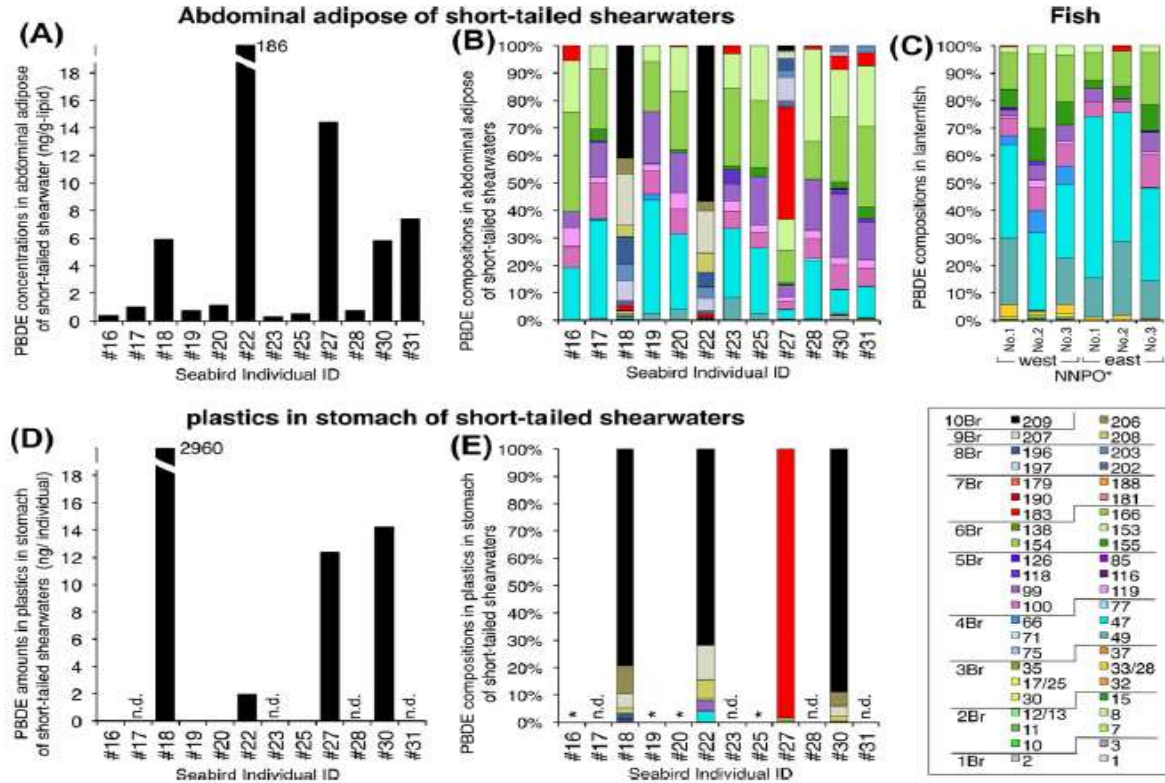
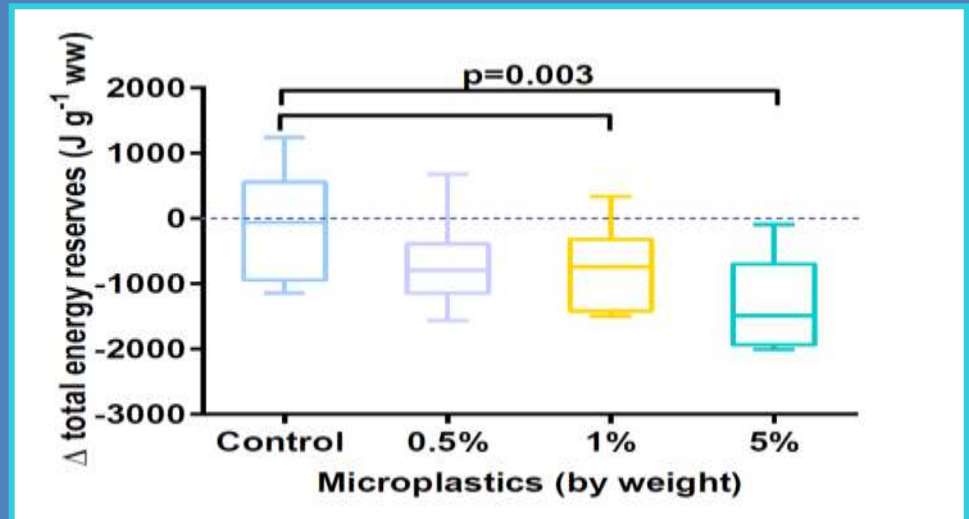


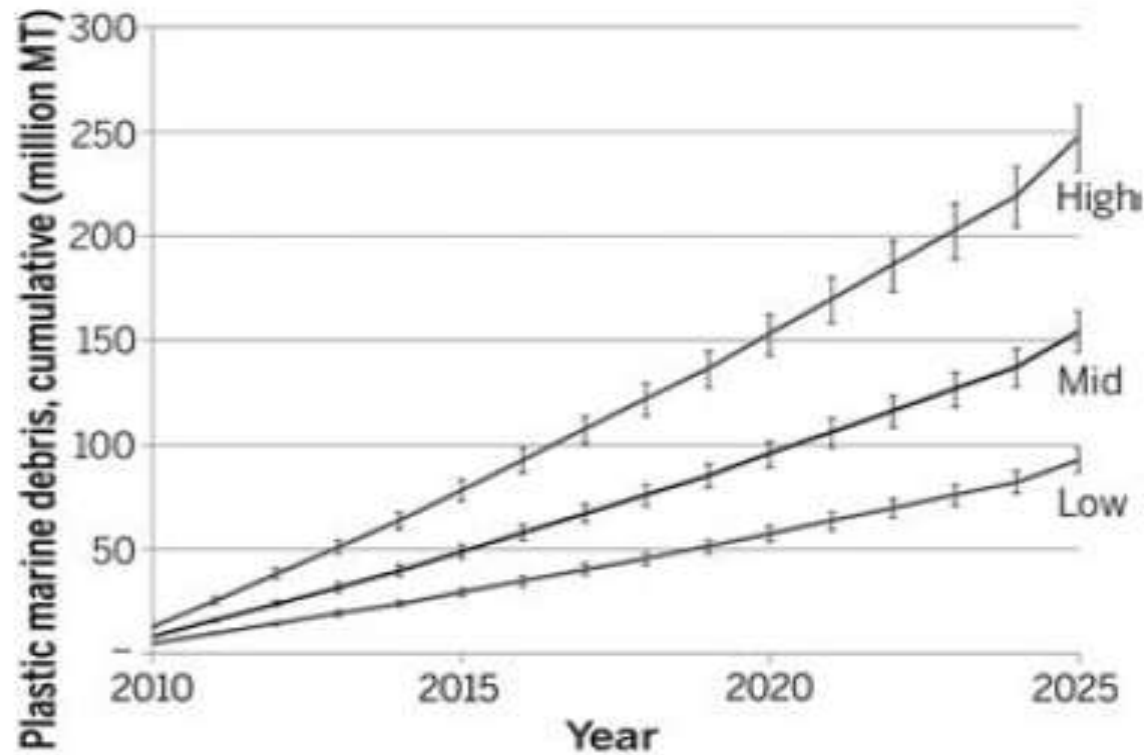
Fig. 2. PBDE concentrations and compositions in (A and B) abdominal adipose of short-tailed shearwaters, (D and E) the plastics in their stomachs, and (C) their prey. n.d., not detected. *Profile is not shown because only trace concentrations of one congener (BDE47 or BDE71) were detected; **NNPO: Northern North Pacific Ocean.

Physical effects (independent of any chemical effects)

1% PVC significantly reduced energy reserves by 30%

5% PVC significantly reduced energy reserves by 50%





Plastic debris
cumulative

Oceans
could contain
250 million tonnes
by 2025

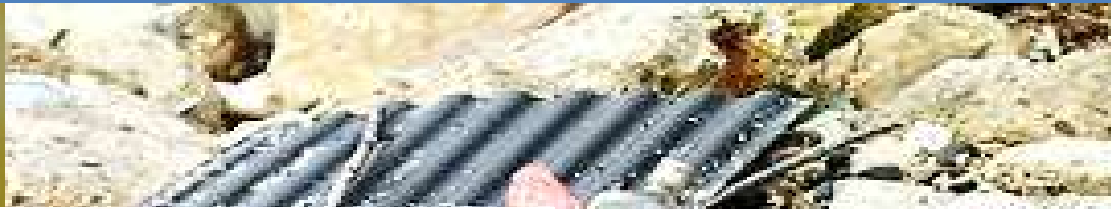
Fig. 2. Estimated mass of mismanaged plastic waste (millions of metric tons) input to the ocean by populations living within 50 km of a coast in 192 countries, plotted as a cumulative sum from 2010 to 2025. Estimates reflect assumed conversion rates of mismanaged plastic waste to marine debris (high, 40%; mid, 25%; low, 15%). Error bars were generated using mean and standard error from the predictive models for mismanaged waste fraction and percent plastic in the waste stream (12).

Enough about problems
what can be done?

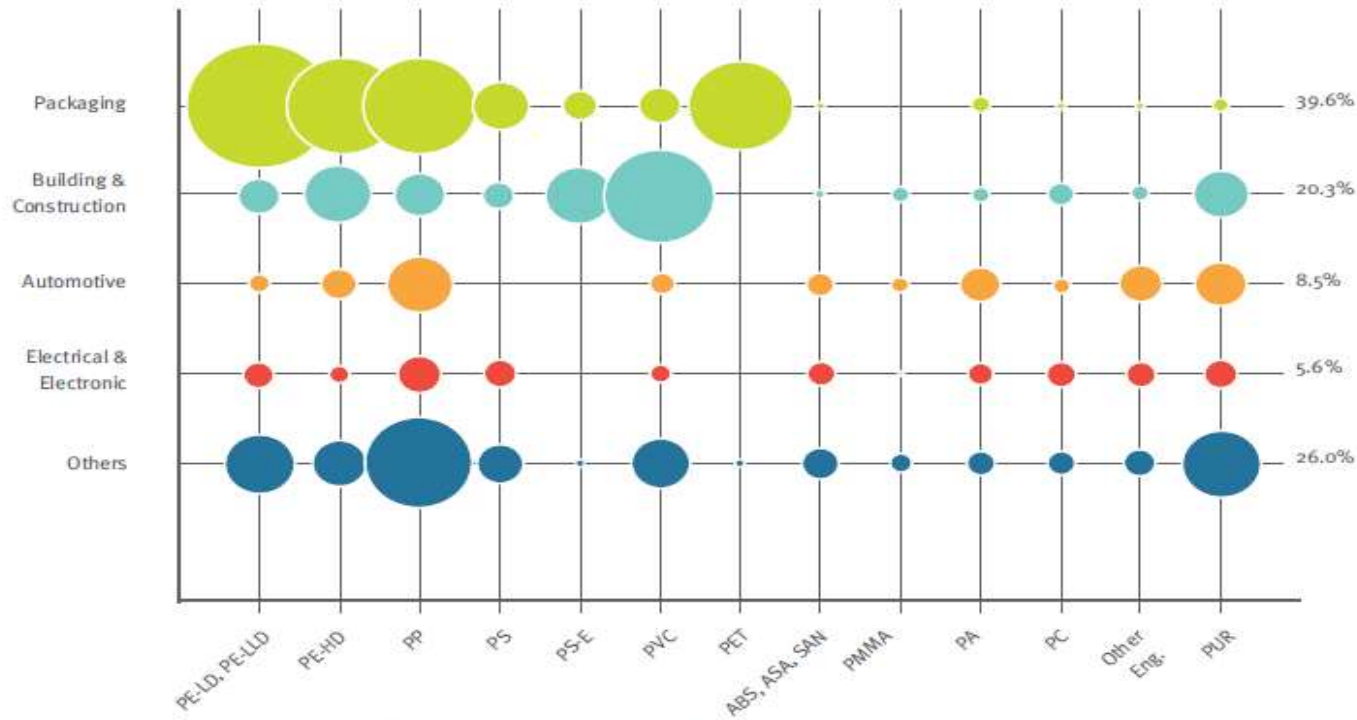


Source, Tanya's Travel

Keep the benefits – without the debris



Packaging, building & construction and automotive are the top three markets for plastics



European plastics demand* by segment and polymer type 2013

Source: PlasticsEurope (PEMRG) / Consultic / ECEBD

* EU-27+NO/CH

Approx 40%
Packaging mostly
single use

60 years of research and development
60 years of behavioural training - to throw away



There is no '*away*' this is not sustainable



Albania

A. Giret

Sources of debris

Around 50% is single-use items
(plastic packaging, convenience)

Together with Rope and netting,
Cigarette butts

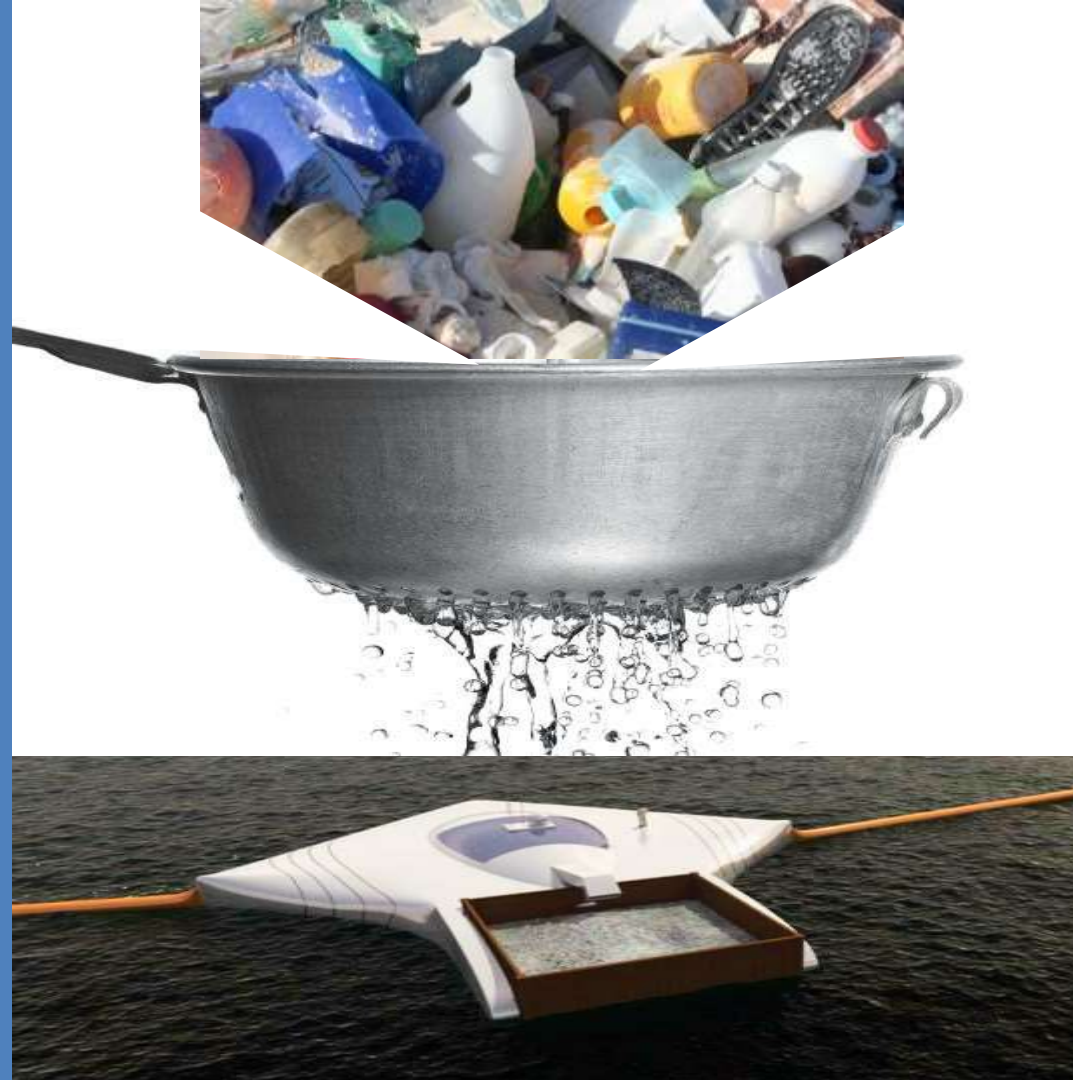


Redirect the flow

Block the holes

Clean-up

Photo sources:
Success hacker, jschneid,





Redirect the flow

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Conflicting drivers



Redirect the flow

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Potentially conflicting drivers

Will bioplastics reduce litter / waste?



'This new packaging is fully recyclable, and is said to reduce carbon emissions by as much as 25% over the product lifecycle.'

Resource IN

Waste OUT

Potentially conflicting drivers

Can biodegradables reduce litter impacts?



‘Biodegradables ?’

(EN 13432, ASTM D6400-99) = pre shredded plastic
degrades in commercial composting plant in 180 days, 56
– 71 °C, 50-60% humidity, aerobic, pH 7-8

Resource IN

Waste OUT

Microbeads in cosmetics



150 ml bottle can contain 2.8 million plastic particles

Consider end-of-life at product design stage

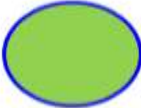
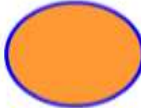
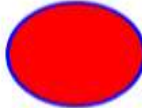
Design for product life and end-of-life

Polyester-Cotton Blend	Polyester	Acrylic
		
		
Average (Mean) Fibre Dimensions for Each Fabric Type		
Fibre diameter: 17.74 μm	Fibre diameter: 11.91 μm	Fibre diameter: 14.05 μm
Fibre length: 4.99 mm	Fibre length: 7.79 mm	Fibre length: 5.44 mm
Estimated Fibres Released Per Wash (6kg)		
137,951	496,030	728,789

Towards a more circular economy

1) Design for product life, and end-of-life 2) label accordingly



			
Minimum material	✓ yes		X no
Easy to recycle	✓ yes		X no
Recycled content	✓ yes		X no

Resource IN

Waste OUT

Marine Debris:

- 1) is a symptom of inefficient outdated business model
- 2) is not directly coupled to societal benefits
- 3) damages resources (economy, wildlife, services)
- 4) Synergistic benefits (resource efficiency / waste reduction) achieved by product re-design
- 5) Solutions exist – but there is no single solution
- 6) is a highly visible, accessible, emotive problem – harness this interest and focus it on better product design and waste management

Richard Thompson - Thank you

**SEA
CHANGE
WITH
PLYMOUTH
UNIVERSITY**



International Marine Litter Research Unit

Furthering our understanding of litter on the environment and defining solutions



Team



Publications



Impact



Contact