A world map in shades of blue and white, showing the outlines of continents. Overlaid on the map are five circular arrows representing ocean gyres: North Pacific Gyre, North Atlantic Gyre, South Atlantic Gyre, South Pacific Gyre, and Indian Ocean Gyre. The map is decorated with several realistic water droplets of various sizes, some with highlights and shadows, scattered across the background.

NORTH
PACIFIC GYRE

NORTH
ATLANTIC GYRE

SOUTH
ATLANTIC GYRE

SOUTH
PACIFIC GYRE

INDIAN
OCEAN GYRE

MARINE PLASTICS ... A SCIENCE-BASED PERSPECTIVE

Dr. Susanne Brander, Assistant Professor, Toxicologist

Oregon State University

Plastic use and disposal

As of 2015, ~ 6300 Mt of plastic waste had been generated, 9% of which had been recycled, 12% incinerated, and 79% accumulated in landfills / the environment. If current trends continue, ~ 12,000 Mt of plastic waste will be in landfills or the environment by 2050. (Mt = metric ton)

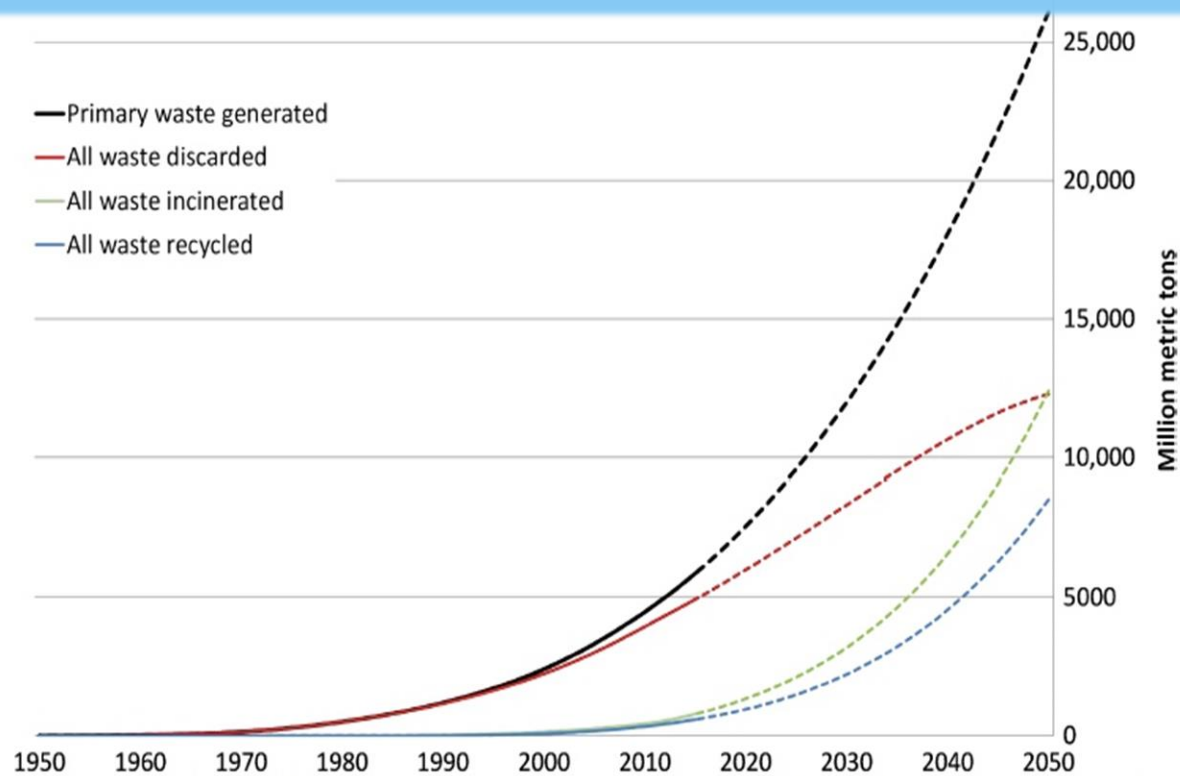
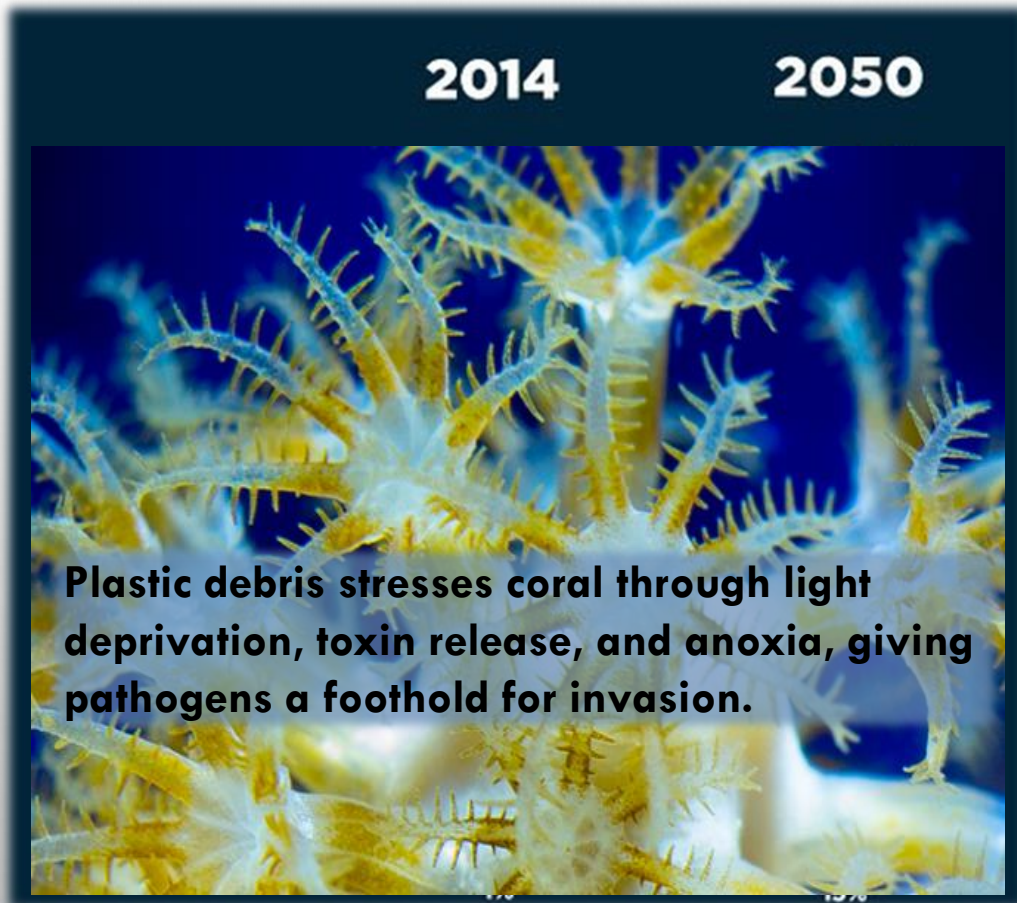


Fig. 3. Cumulative plastic waste generation and disposal (in million metric tons). Solid lines show historical data from 1950 to 2015; dashed lines show projections of historical trends to 2050.

Plastics

- Plastic production is outpacing the capacity for disposal, recycling, and reuse
- We are unable to effectively remove small plastic debris on a large scale once it is already in the water
- Over 40,000 aquatic / marine organisms affected
- Primary and secondary sources of microplastics
- Tendency to accumulate in coastal zones, estuaries
- Adsorb pollutants from water, contain industrial chemicals, are made from fossilfuels
- Smaller plastic debris items have greater surface area, affects capacity to adsorb chemicals

Plastics as Pollutants



Plastic is not only a problem for aquatic life

Plastic production is also inherently linked to climate change because it is made from fossil fuels

Plastic can combine with other stressors to cause disease and mortality

@theplastictide

MacAuthor 2017, *Science* 358: 843

Lamb et al. 2018, *Science* 359: 460-462

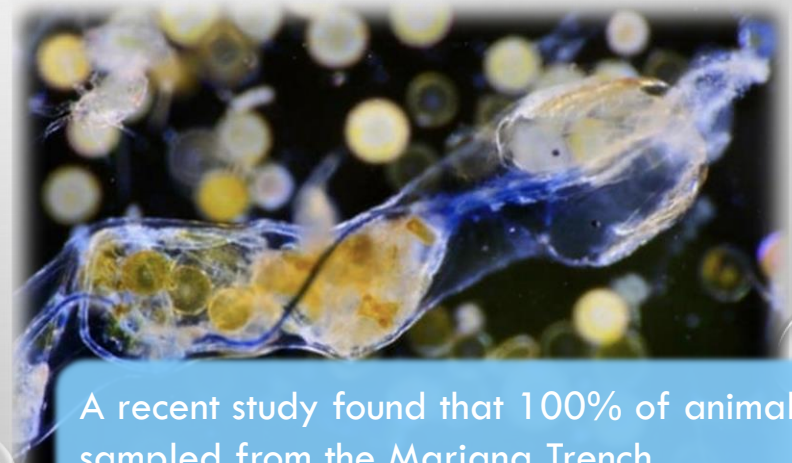


Encyclopedia Britannica

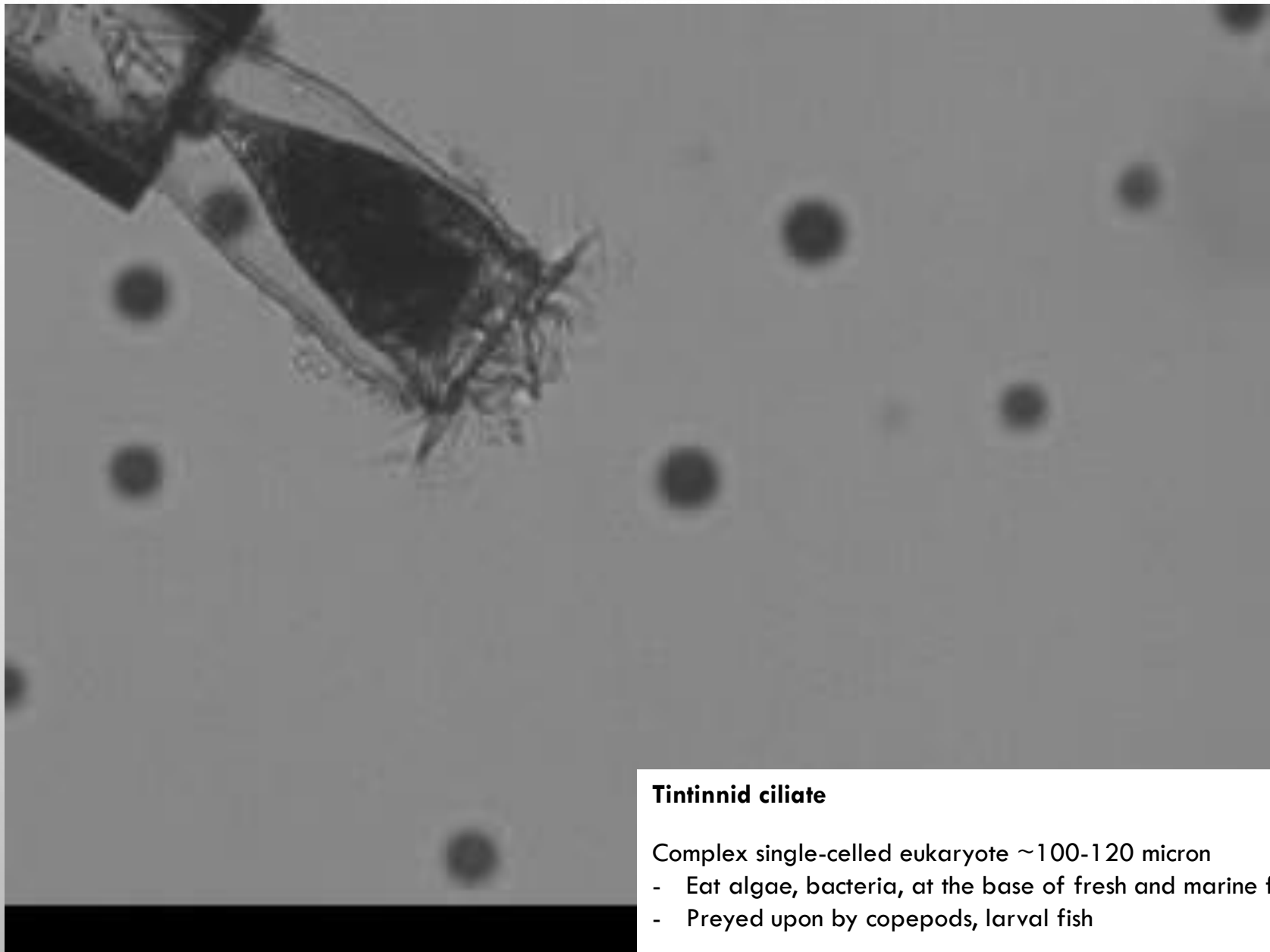
Research summary

- Plastics and fibers (increasingly) are found in many species of freshwater marine organisms examined thus far
- Ingestion of small plastic pieces can affect growth in some larval fish, can cause hepatic stress, and may affect other important functions like immune response.
- Plastic consumption occurs across food webs, sometimes beginning with small pieces in zooplankton and microzooplankton, with transfer upward to larger organisms.

Athey et al. in review, *Limno Ocean Letters*
Jamieson et al. 2017, *Nat Eco Evo*: 0051
Greven et al. 2016, *Env Tox Chem* 35:3093-3100
Rochman et al. 2013, *Sci Reports*: 3
Cesa et al. 2017, *Sci Total Env* 598: 116-1129
Botterell et al. 2018. *Env Poll* 245:98-110
Setala et al. 2018. *Microplastic Contam Aq Env*, Elsevier
Brander et al. unpublished (research in progress)



A recent study found that 100% of animals sampled from the Mariana Trench contained plastic.



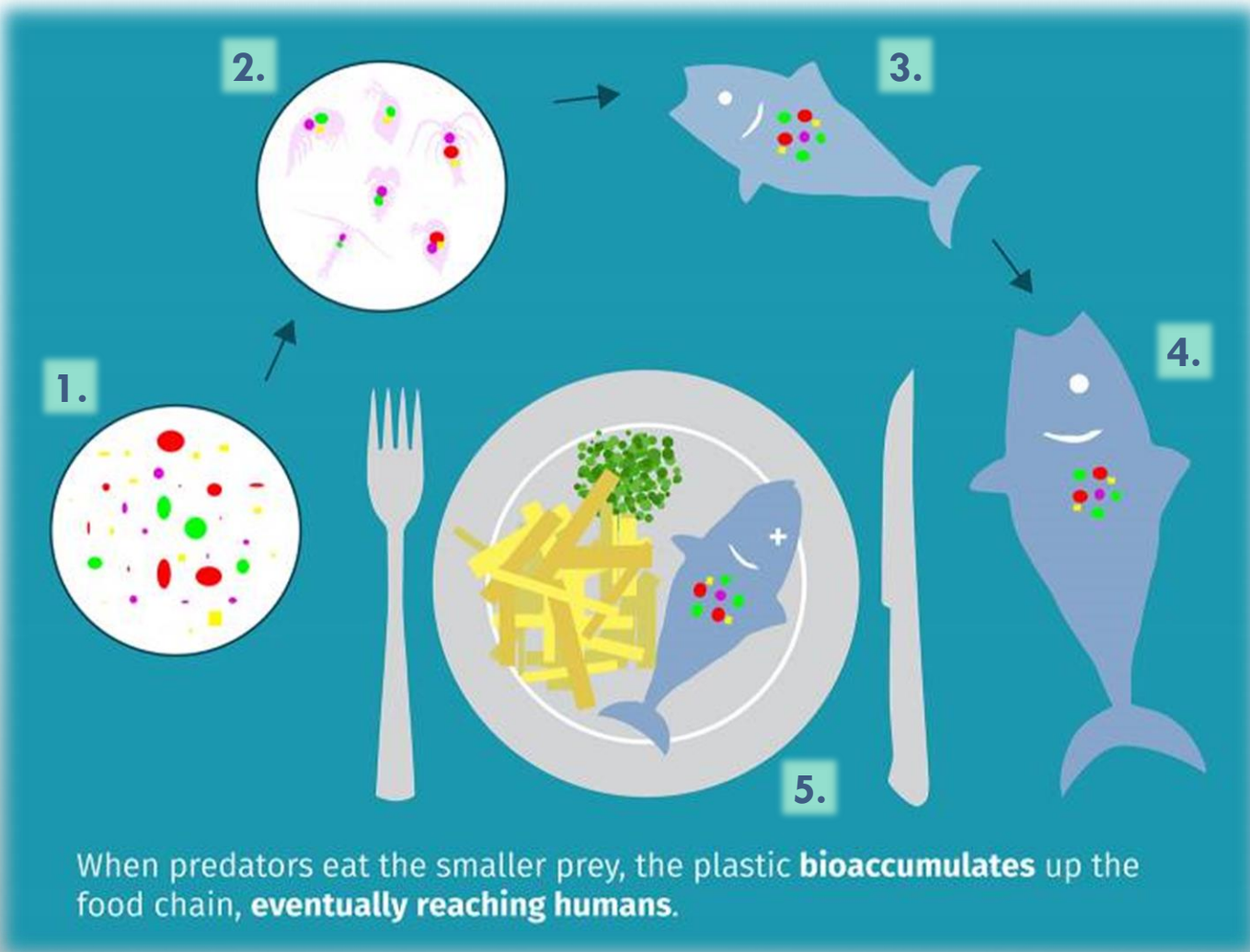
Tintinnid ciliate

Complex single-celled eukaryote ~100-120 micron

- Eat algae, bacteria, at the base of fresh and marine food webs
- Preyed upon by copepods, larval fish

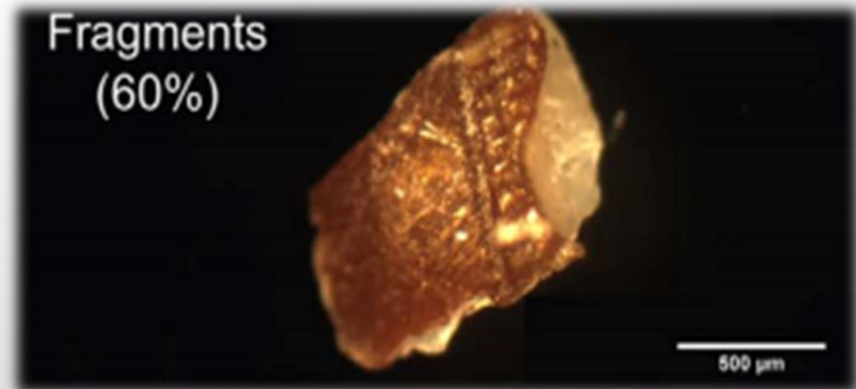
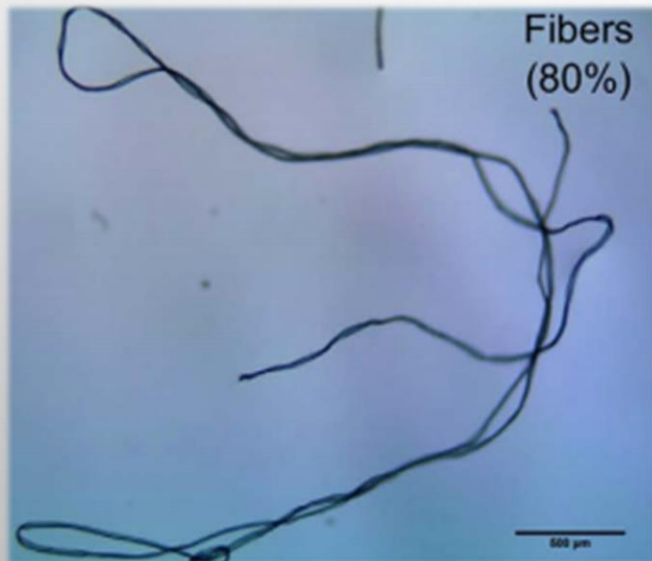
Widely distributed in marine and freshwater

Use cilia to create a current when randomly encountering food items



Fish from markets ...

- **16 out of 64 fish** in United States contained debris
- **21 out of 76 fish** in Indonesia contained debris
- Mainly plastic debris in Indonesia, fibers in the United states





Credit: Marcus Eriksen, 5 Gyres Institute

What about humans?

Recent study tested stool samples

- Up to nine plastic types identified in each participant
- Average of 20 pieces per 10 grams (~2.5 tablespoons)
- Participants came from Finland, Italy, Japan, Netherlands, Poland, Russia, UK, Austria

- In another study of beer, water, and sea salt, results indicate the average person eats over 5,8000 particles from these three sources annually (88% from tap water). Honey also contains microplastics.

Kosuth et al. 2018. PLoS One: 13:e0194970.

Liebezeit & Liebezeit 2013. Food Add Contam 30:2136-40

Presented at the United European Gastroenterology conference in Vienna Oct 2018

<https://www.cnn.com/2018/10/23/health/microplastics-human-stool-pollution-intl/index.html>



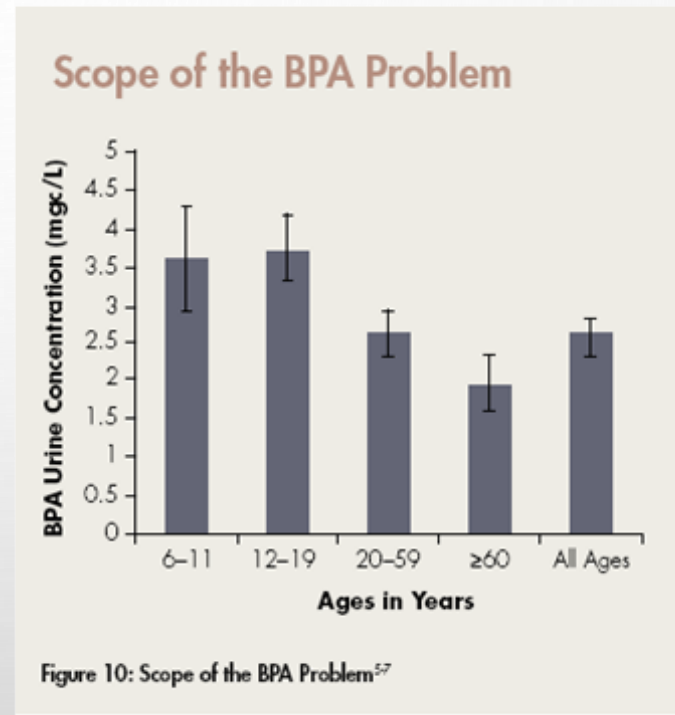
We know about the effect of chemicals associated with plastics on human health, but not much about the effects of the presence of plastic itself.

Human health

Higher levels of urinary BPA were associated with a higher odds of obesity and abnormal waist circumference

Body fatness: increase in the odds of obesity with increasing quartiles of BPA

Found higher odds of abnormal WC-to-height ratio of BPA for quartiles 2 vs 1



<https://www.arhp.org/publications-and-resources/clinical-proceedings/RHE/Plastics>

In summary

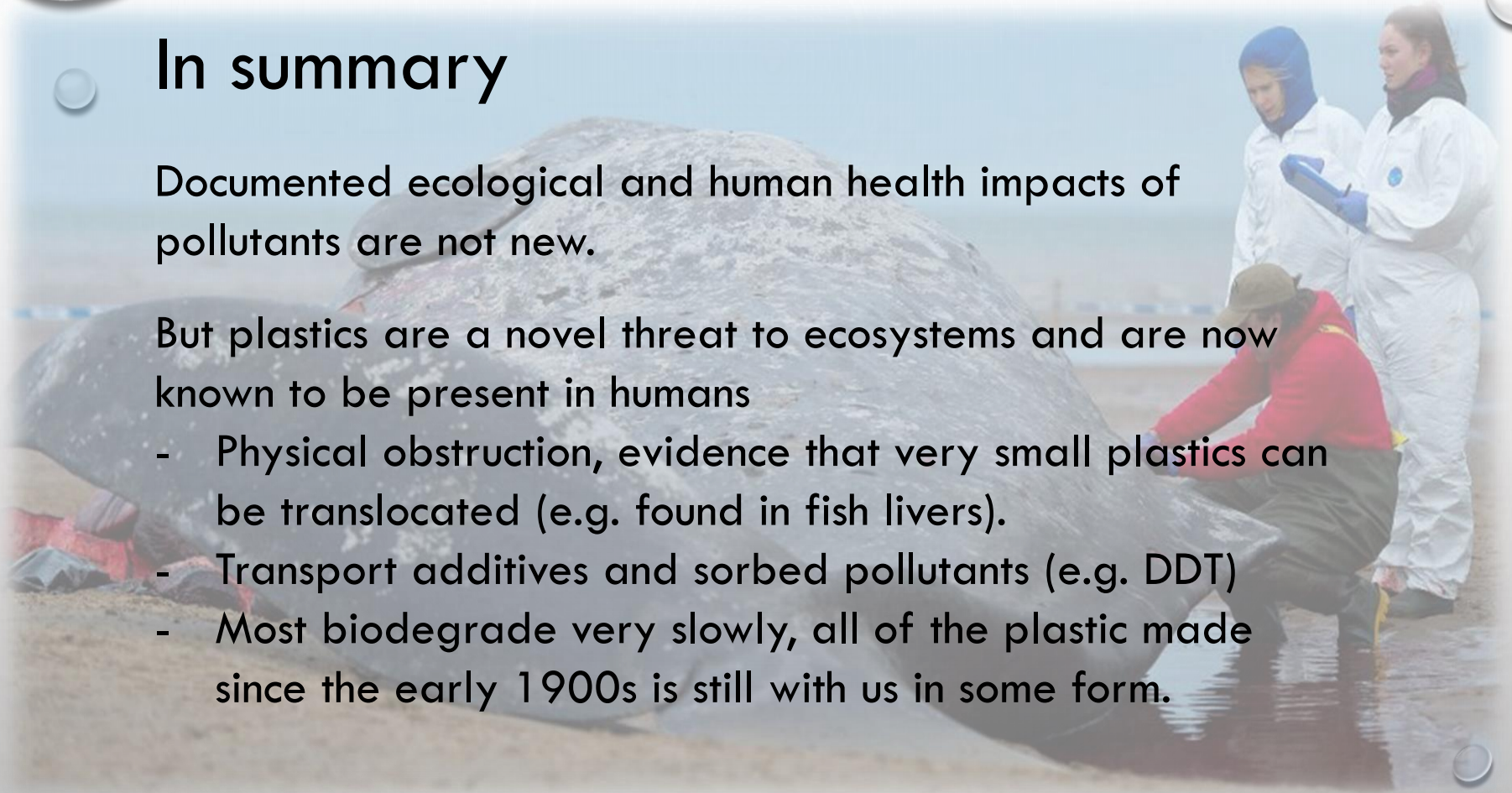
Documented ecological and human health impacts of pollutants are not new.

But plastics are a novel threat to ecosystems and are now known to be present in humans

- Physical obstruction, evidence that very small plastics can be translocated (e.g. found in fish livers).
- Transport additives and sorbed pollutants (e.g. DDT)
- Most biodegrade very slowly, all of the plastic made since the early 1900s is still with us in some form.

Wildlife officials in Indonesia found a beached whale with 1,000 pieces of plastic in its stomach, including a pair of flip-flops and 115 drinking cups.

<https://www.theguardian.com/environment/2018/nov/20/indonesia-dead-whale-had-1000-pieces-of-plastic-in-stomach>



UNCW
Chemical analysis of ingested plastics and associated organic pollutants in wild-caught black sea bass, *Centropristis striata*



Questions?