



# The Problems with Plastics in the Ocean

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## ANNUAL PLASTIC PRODUCTION

In 1950:  
2 million metric tons

HAS INCREASED EXPONENTIALLY SINCE  
THE EARLY 1950'S

## GLOBAL PRODUCTION IN 2015

NOT INCLUDING FIBERS 322 MMT\*

FIBERS 61 MMT

\*MMT=million metric tons

## PREDICTED FUTURE PRODUCTION



BY 2025

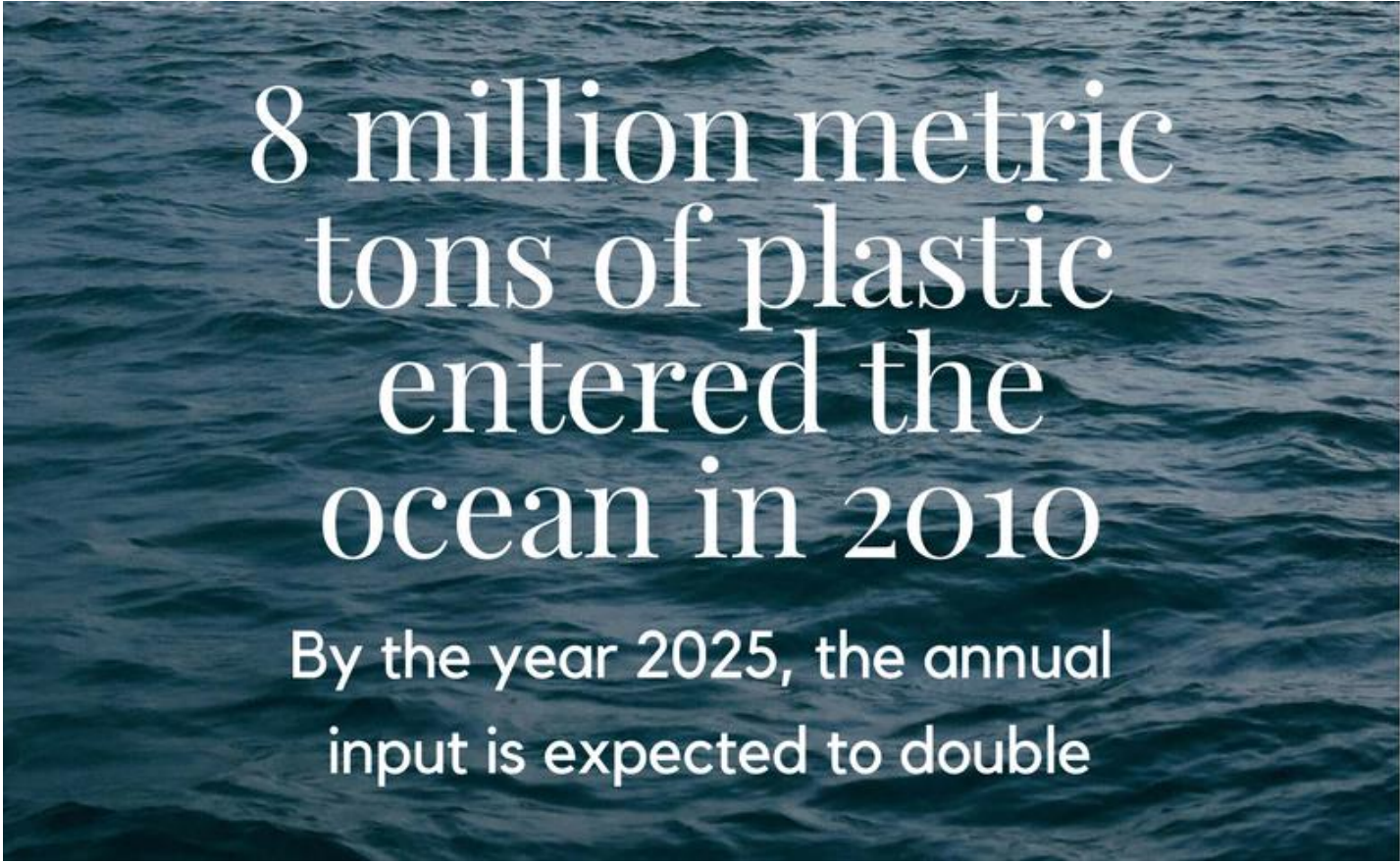
600 MILLION  
METRIC TONS



BY 2050

ONE BILLION  
METRIC TONS

- It is estimated that 8 billion tons of plastic materials have been manufactured since 1950
  - About 30% of this material is still in use, 10% has been incinerated and the remaining 60% (corresponding to 4,900 MMT) has been discarded and is now landfilled or lost in the natural environment, including the ocean.



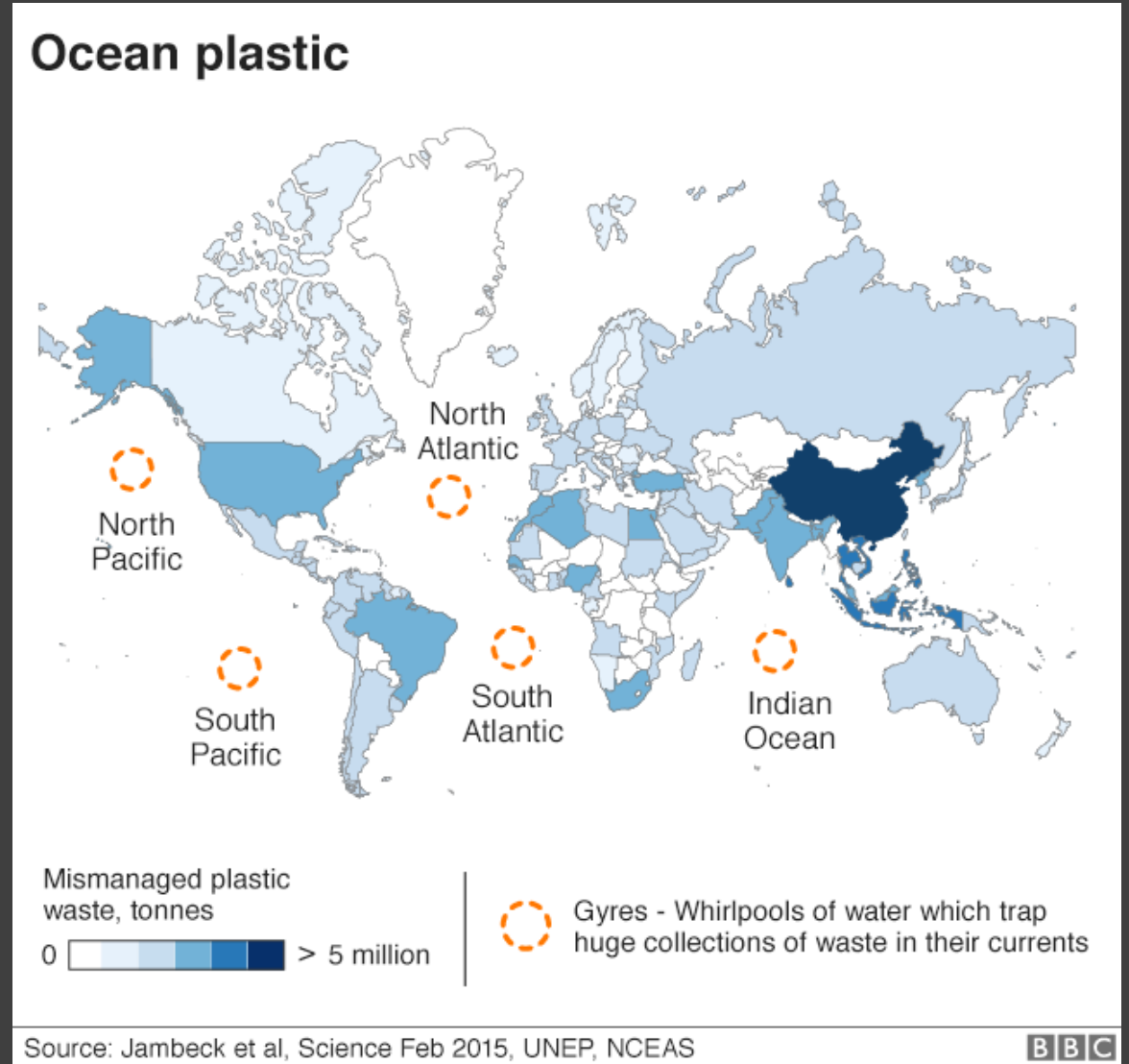
8 million metric  
tons of plastic  
entered the  
ocean in 2010

By the year 2025, the annual  
input is expected to double

8 million metric tons equates to 5 grocery bags  
of plastic per foot of shoreline of the 192  
countries studied.

# • What are the main sources of plastic waste?

- The largest inputs of plastic waste to the ocean come from coastlines of Asia, mainly China, and the United States
- The plastic input due to river transport corresponds to between 9 and 50% of total plastic transport to the ocean
- In 2015, the three industrial sectors most responsible for plastic waste production were packaging (46.7%), textiles (13.9%) and the consumer-institutional product sectors (12.3%)



- 
- Plastic represents between 45 and 95% of marine litter



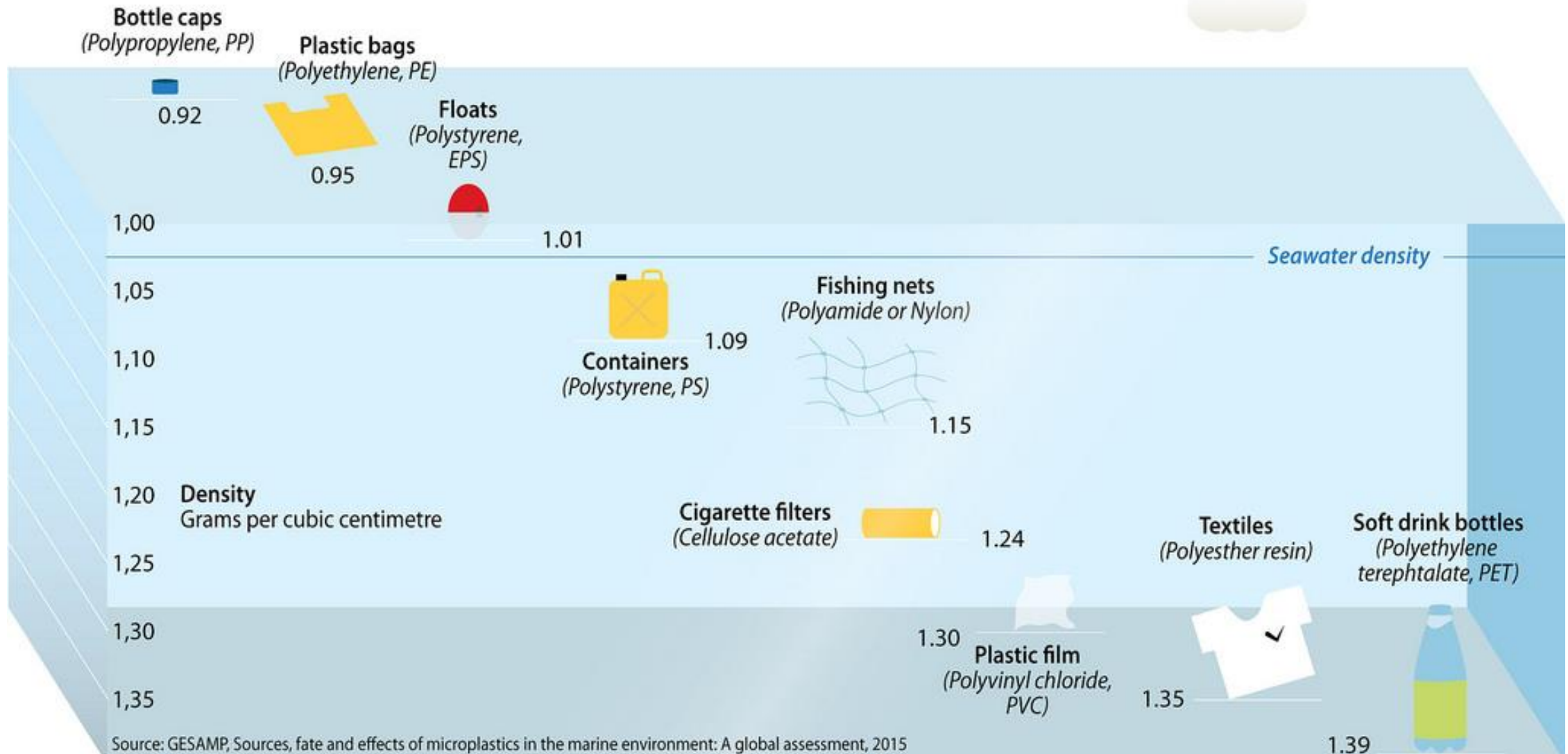
## Sizes of plastic debris

- Macroplastics (larger than 5 mm)
- Microplastics (smaller than 5 mm)
  - Fragments
  - Fibers
  - Microbeads/pellets
  - Film

# • How much plastic is there in the ocean?

- The ocean is under-sampled and the overall amount of plastic present in different ocean compartments is currently unknown.
- Most of the data on the abundance and mass of plastic particles in the ocean have been collected with trawled nets that were originally developed to sample plankton at the surface of the ocean. These nets generally have a mesh size of 330 or 100  $\mu\text{m}$  and do not efficiently sample smaller fragments.
- Currently, data are missing on plastic concentration in the water column and in sediments.
- We still don't know where more than 95% of ocean plastic debris ends up.

# Which plastics float and which sink in seawater?





# Microplastics are in the air

90% are fibers

They can fall out at a rate of 118 per square  
meter per day

#plasticaware

#MicroplasticAwarenessMonth

plasticaware.org





## Ways that marine life encounter plastics

- Entanglement
- Ingestion
- Alteration of habitat quality



A composite image showing a sea turtle on the left and a whale on the right, both entangled in a dense, tangled mass of green and blue fishing nets. The background is a dark, teal color.

## Entanglement

- Difficult to quantify the extent of the issue
- Entanglement in marine litter, including ghost fishing nets, has been documented in
  - 28% (32) of marine mammal species (mostly seals/sea lions and baleen whales)
  - 86% (6) of sea turtle species
  - 16% (51) of seabird species



## Ingestion

- Ingestion of marine litter has been documented in
  - 23% (26) of marine mammal species (mostly toothed whales)
  - 100% (7) of sea turtle species
  - 36% (111) of seabird species

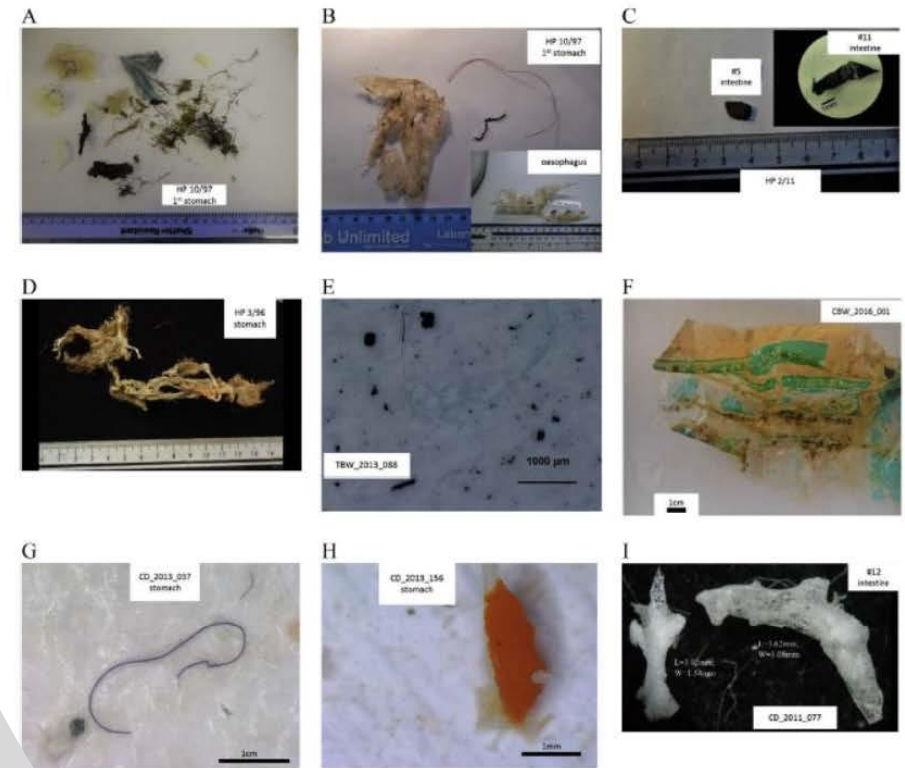
# Manatees

- More than 6,500 manatee necropsies were conducted from 1993-2012
  - 114 animals had signs of entanglement
  - 634 had debris in their GI tract
    - 412 had monofilament
    - 214 had “plastics of various types”
  - 50 deaths were directly attributed to ingestion or entanglement



# More recent studies include smaller plastics

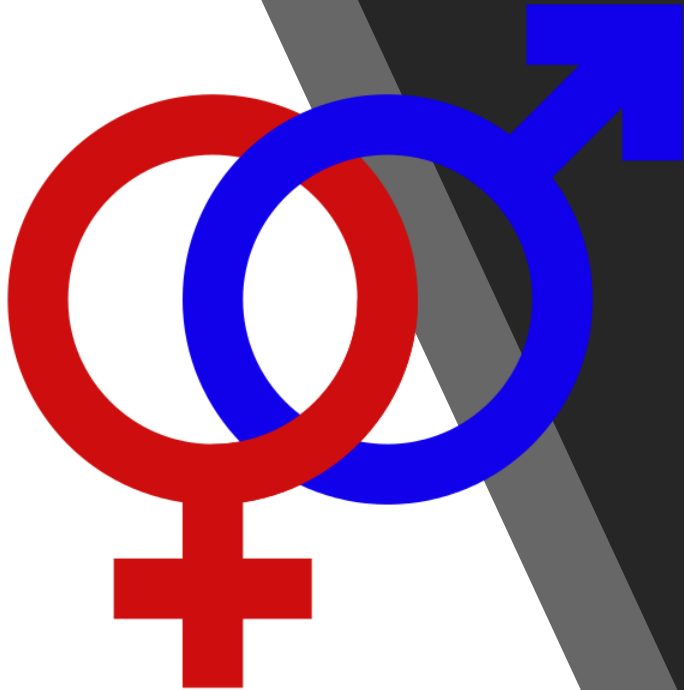
- Of 528 stranded or bycaught cetaceans necropsied
  - 8.5% (45 individuals representing 11 species) had marine debris in their digestive tracts
  - Plastics included bags, rope, pieces of hard plastic, PET
  - 21 toothed whales were analyzed for microplastics. All contained at least one. Most microplastics were fibers.



Macroplastic and microplastic items ingested by cetaceans stranded on Irish coasts between 1990 and 2015. Images A,B,C,D are from coastal species (HP=Harbour porpoise), E,F deep diving species (TBW = True's beaked whale; CBW=Cuvier's beaked whale) and G,H,I pelagic species (CD=Common colphin). Labels on images refer to Supplementary material, Table S1.



# Alteration of habitat quality



- Could microplastics in beach sand affect sex ratios of sea turtle hatchlings?
  - Beckwith et al. (2018) suggest plastics would increase temperature of beach sand
  - Carson et al. (2011) found that sand containing plastics actually warmed more slowly and reached lower maximum temperatures than sand that did not contain plastic.



# How might plastics impact marine animals?



Physical damage from entanglement or ingestion



Ingestion can lead to blockage of digestive tract/starvation



Entrapment can lead to starvation, predation, or drowning



Toxic chemicals in or on plastics



Energetic cost of getting rid of plastic

# Physical damage

- A dead sei whale found in the Elizabeth River (VA) in 2014 was found to have swallowed a broken DVD case which lacerated its stomach
- A dead Magellanic penguin had its stomach perforated by a plastic straw
- A hawksbill sea turtle in Kenya died from infection thought to be related to hard, sharp plastic pieces embedded in its intestines





# Entanglement/drowning

E.g. 300 olive ridley sea turtles were found drowned in a ghost fishing net in Mexico in 2018



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# Plastic-related toxins were found in plankton and baleen whales

Phthalates measured in plankton and fin whale blubber (5 stranded animals) in the Mediterranean

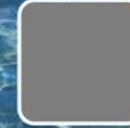


## Phthalates in Florida bottlenose dolphins

- Urine samples were collected from 17 resident dolphins in Sarasota Bay as part of a routine health assessment
  - Dolphin age ranged from 2 to 34 years
  - 71% of dolphins had at least one phthalate metabolite in their urine

● **TOXINS ARE IN THE OCEAN**

**PLASTICS ARE IN THE OCEAN**



**TOXINS REALLY LIKE TO STICK TO PLASTIC...**

**ANIMALS EAT PLASTIC**



**TOXINS GET INTO ANIMALS**



[www.plasticaware.org](http://www.plasticaware.org)  
#plasticaware



- Pacific oysters had decreased egg production and sperm motility. Fewer larvae survived; those that did grew slowly compared to controls.
- Researchers attributed these results to potential energetic cost

Potential impacts of consuming/  
exposure to microplastics

# Microplastics have been found in

- ✓ Tap water
- ✓ Bottled water
- ✓ Beer
- ✓ Sea salt
- ✓ Oysters
- ✓ Mussels
- ✓ Etc....







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# Microplastics Found in Human Poop for the First Time

The pesky particles were present in all eight stool samples gathered for pilot study



Questions?

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