Ocean Conservancy

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Plastic Pollution in Aquatic Ecosystems

Altered Oceans Part Four: Plague of Plastic Chokes the Seas

This five-part series on the crisis in the world's oceans was published in July and August of 2006. The series — by reporters Kenneth R. Weiss and Usha Lee McFarling and photographer Rick Loomis — won the 2007 Pulitzer Prize for explanatory reporting.

By **Kenneth R. Weiss**

AUGUST 2, 2006 | REPORTING FROM MIDWAY ATOLL

The albatross chick jumped to its feet, eyes alert and focused. At 5 months, it stood 18 inches tall and was fully feathered except for the fuzz that fringed its head.

All attitude, the chick straightened up and clacked its beak at a visitor, then rocked back and dangled webbed feet in the air to cool them in the afternoon breeze.

Contamination

Macroplastics (>5 mm)

Microplastics (< 5mm)


LIFE

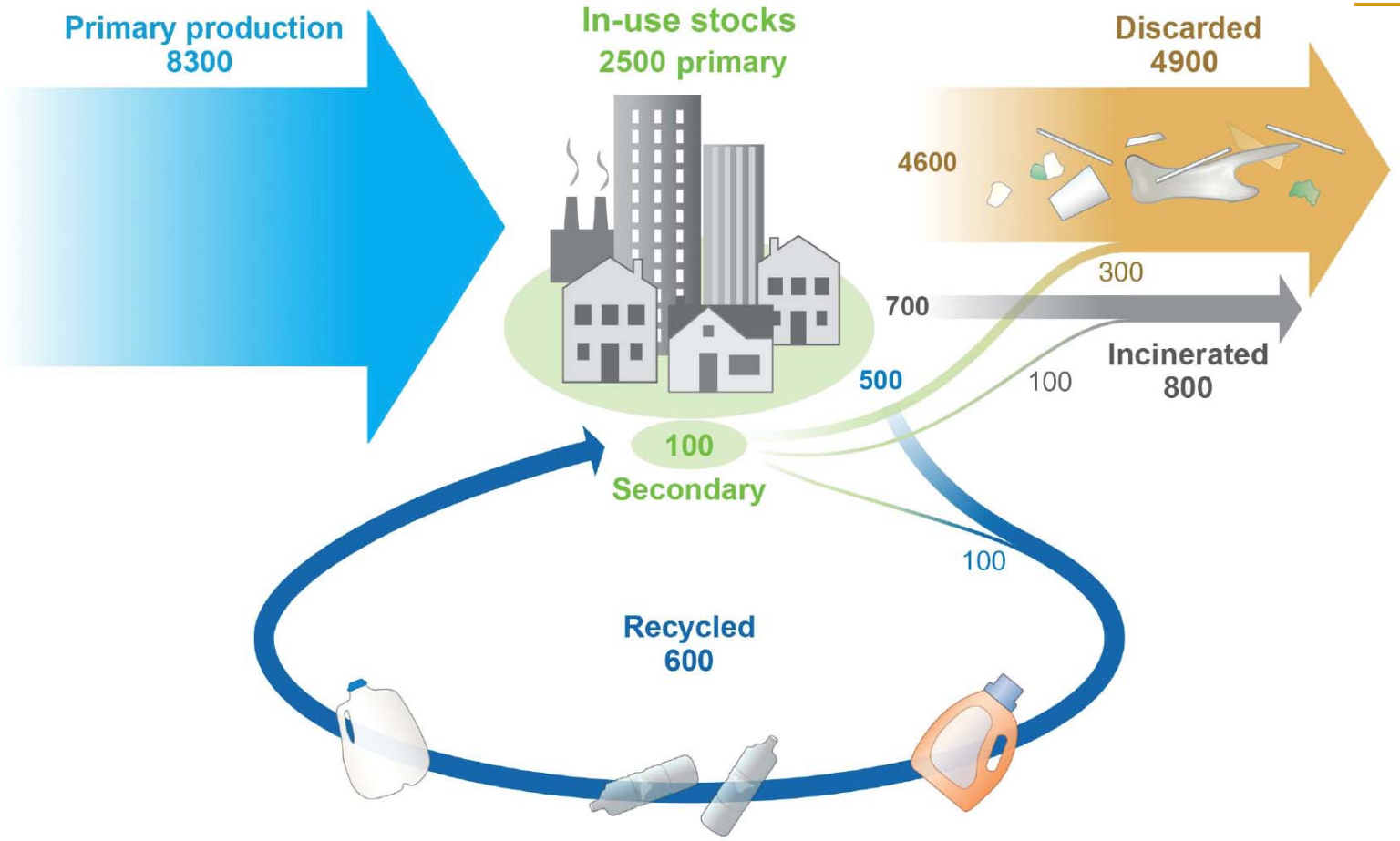
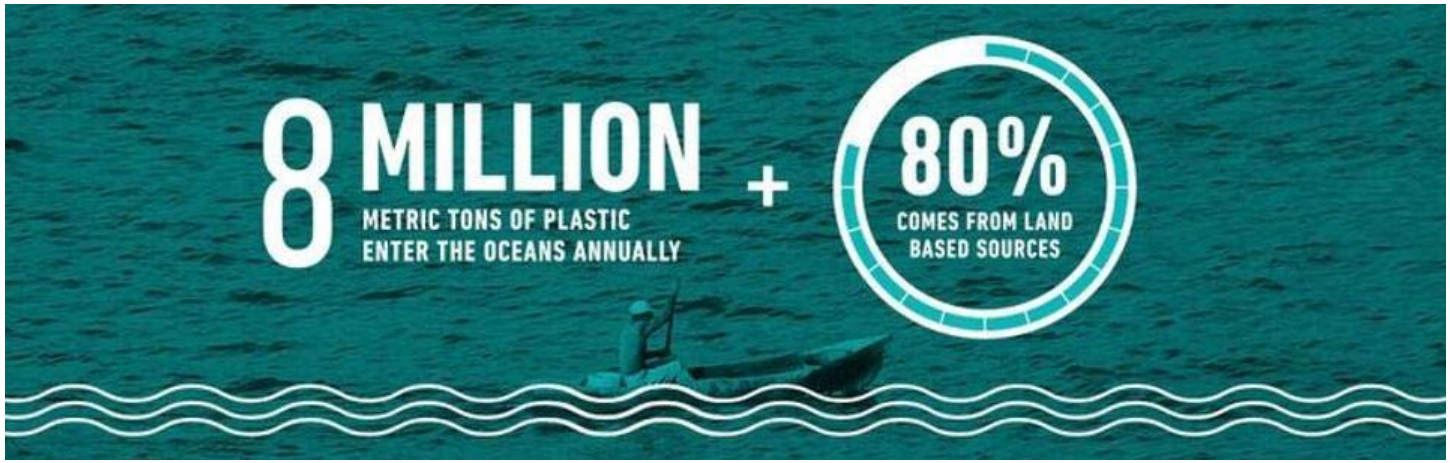


Fig. 2. Global production, use, and fate of polymer resins, synthetic fibers, and additives (1950 to 2015; in million metric tons).

Geyer et al., 2017 *Science Advances*

Photo Credit: Tim Kelly

Photo Credit: earthknight



Jambeck et al., 2015 *Science*

= 16 shopping bags full of plastic for every meter of coastline


© MBARI

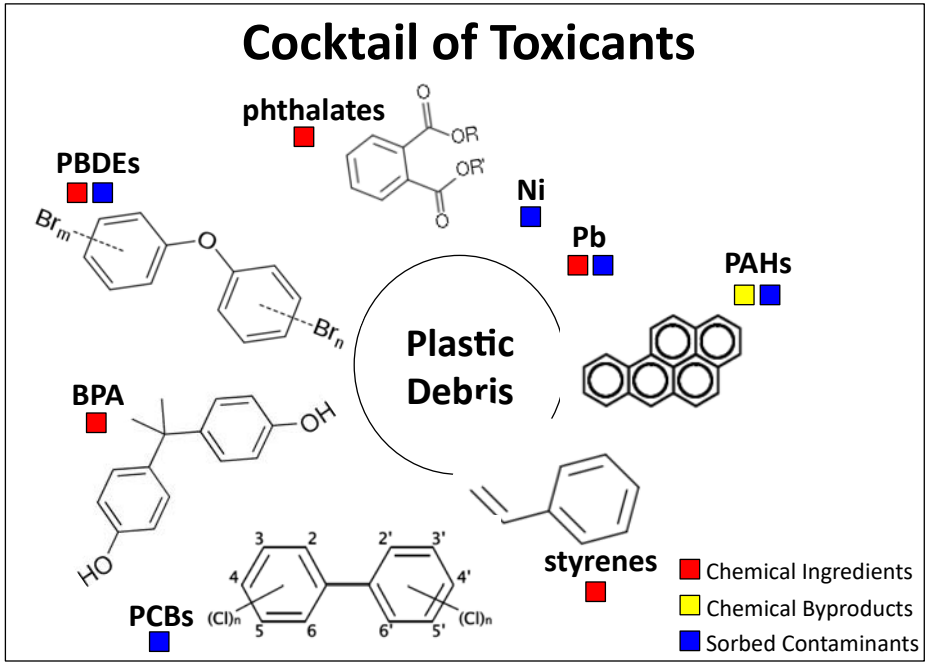
>800 species

Secretariat of the Convention on Biological Diversity, 2016

>220 species

FAO Report 2017

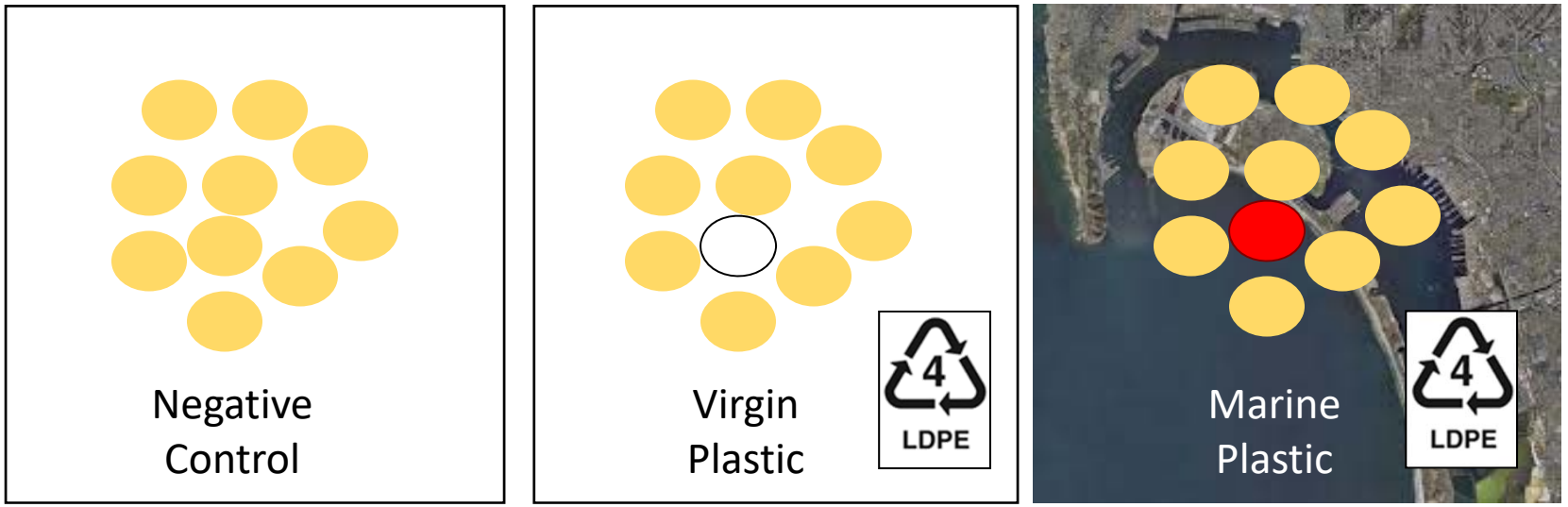
Impacts can be physical or chemical



Rochman 2015 Chapter in *Marine Anthropogenic Litter*

Impacts can be due to the plastic itself or the mixture of plastics and associated chemicals

Japanese Medaka (*Oryzias latipes*)



Fish Diet

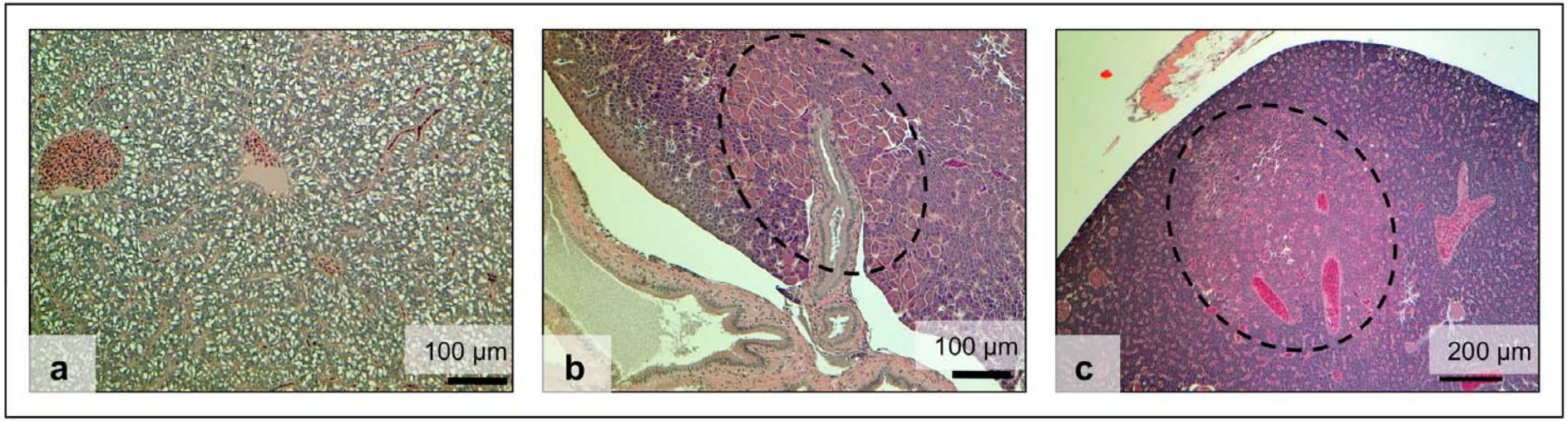
Virgin Plastic

Marine Plastic

Rochman et al., 2013, *Nature Scientific Reports*

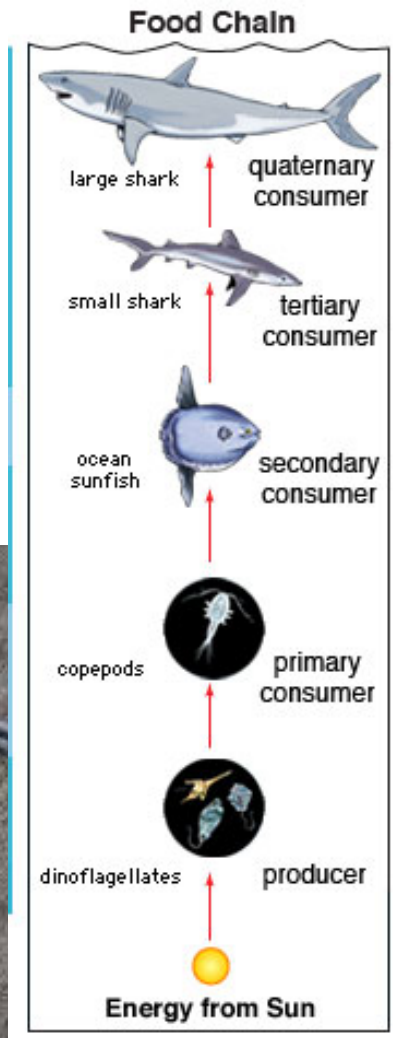
Liver Toxicity

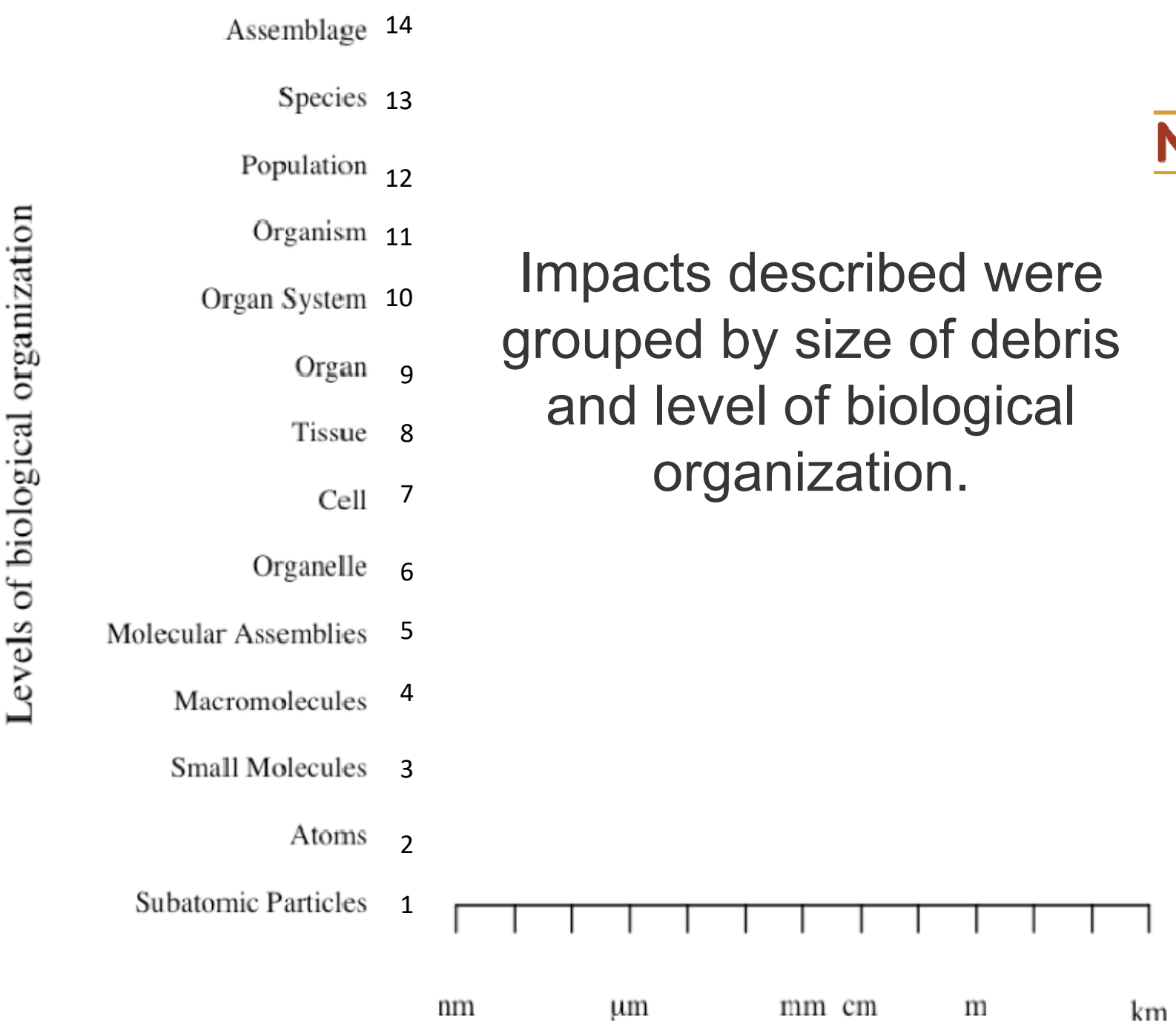
Treatment	# Fish	Severe Glycogen Depletion	Lipidosis	Single Cell Necrosis
Control	24	0%	21%	0%
Virgin-plastic	24	46%	29%	0%
Marine-plastic	19	74%	47%	11%



Rochman et al., 2013, *Nature Scientific Reports*

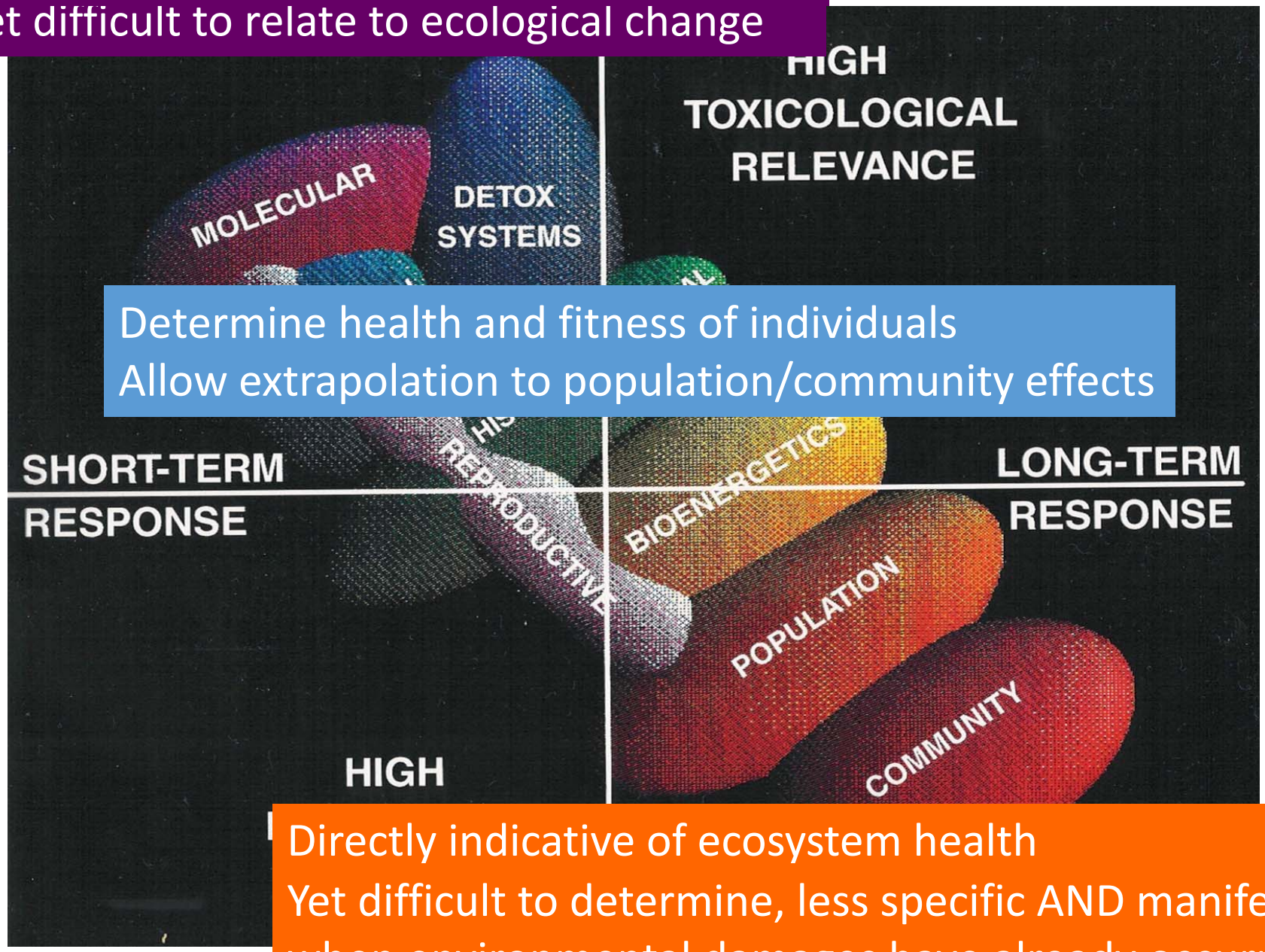
Are there ecological impacts?





Impacts described were grouped by size of debris and level of biological organization.

Specific, sensitive, and reproducible
Yet difficult to relate to ecological change



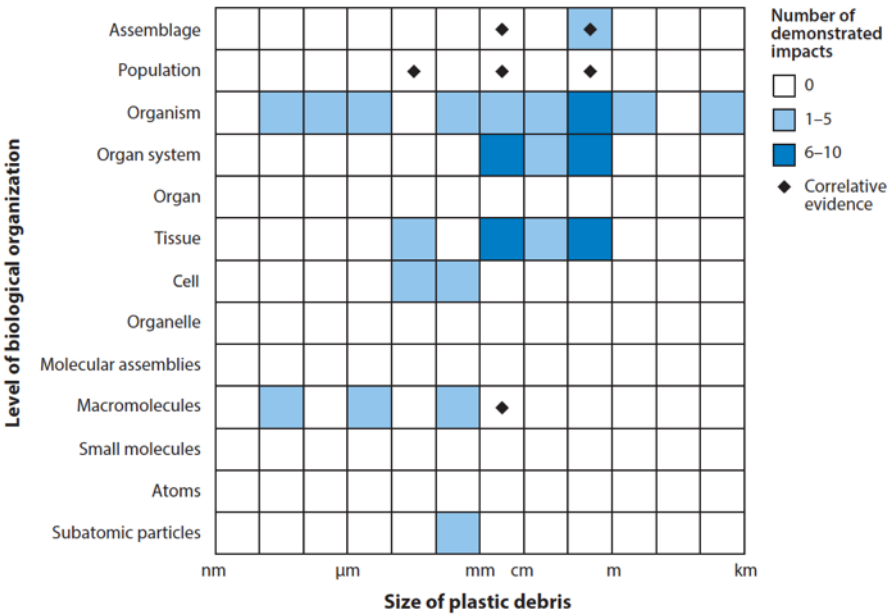
Determine health and fitness of individuals
Allow extrapolation to population/community effects

Directly indicative of ecosystem health
Yet difficult to determine, less specific AND manifest when environmental damages have already occurred

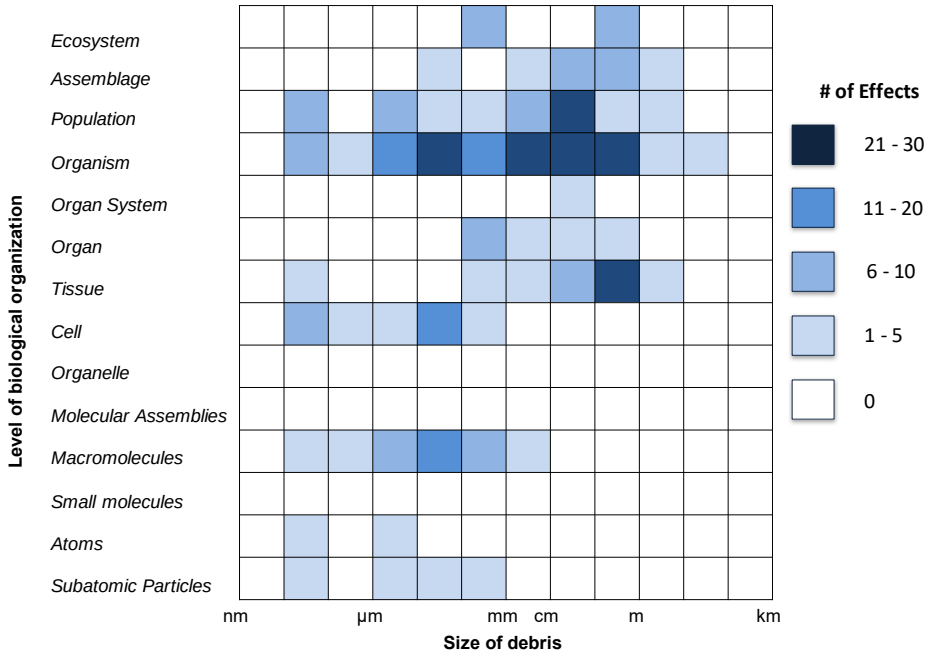
Adams et al. 1989

The Evidence Demonstrating Impacts to biota is Growing

THEN

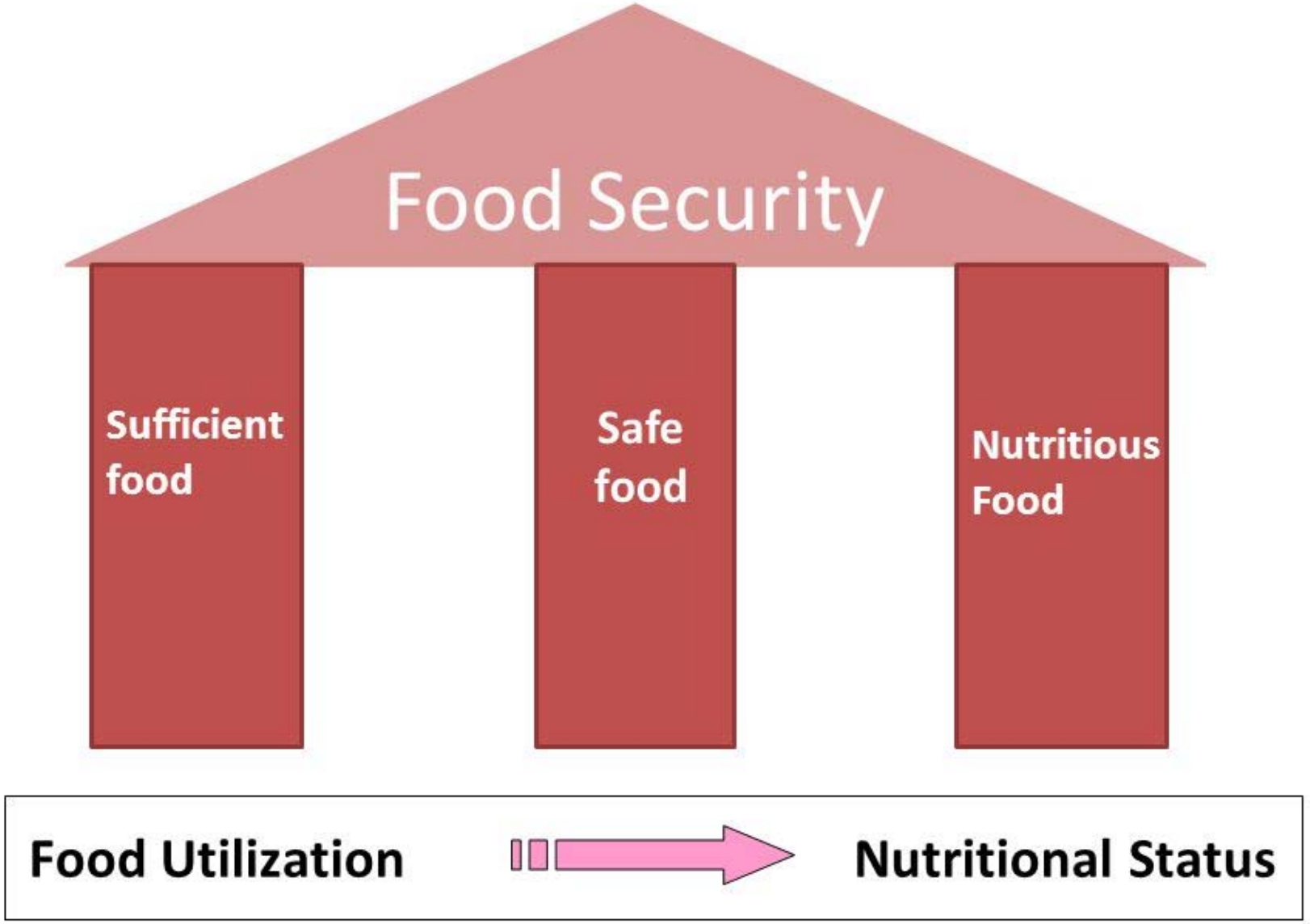


NOW



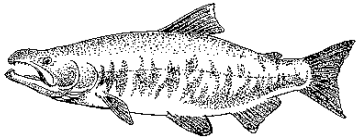
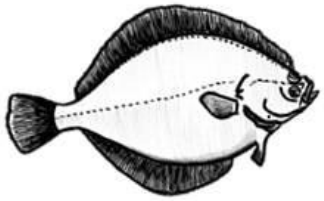
Law, *Ann. Rev. Mar. Sci.* 2017,
adapted from Rochman et al. *Ecology* 2015

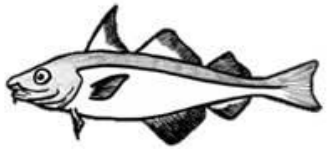
Pillars of Food Security



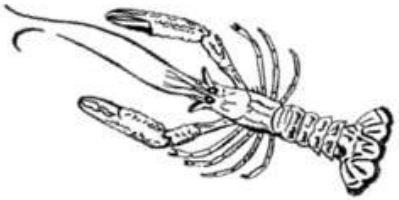
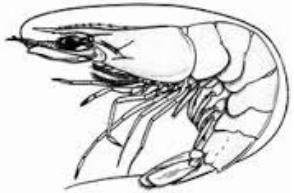
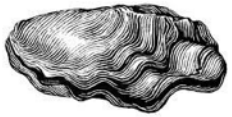
FAO (Food and Agricultural Organization)

49 species commercial fish

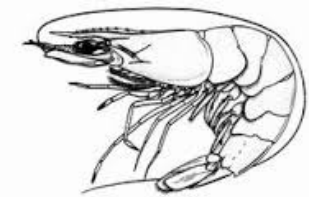


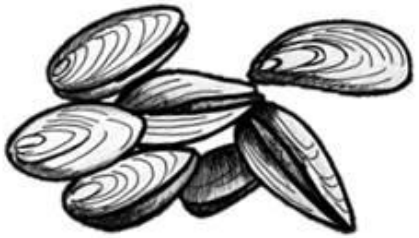
Many species of shellfish


Other commercial products

Rochman et al., 2015*;* van Cauwenberghe and Janssen, 2014; Li et al., 2015; Yang et al., 2015; Davidson and Dudas, 2016





80% of individuals sampled

--Murray and Cowie, 2011

63% of individuals sampled

--Devriese et al., 2015

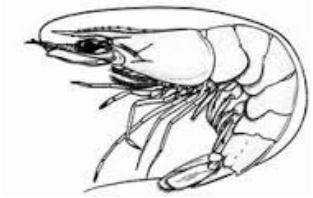
75% of individuals sampled

--Santana et al., 2016

Estimated Human Exposure

11,000 and 100,000 particles/yr

--Van Cauwenberghe and Jansen 2014, GESAMP 2016



175 particles/year

--Devriese et al. 2015

Chemical Impact

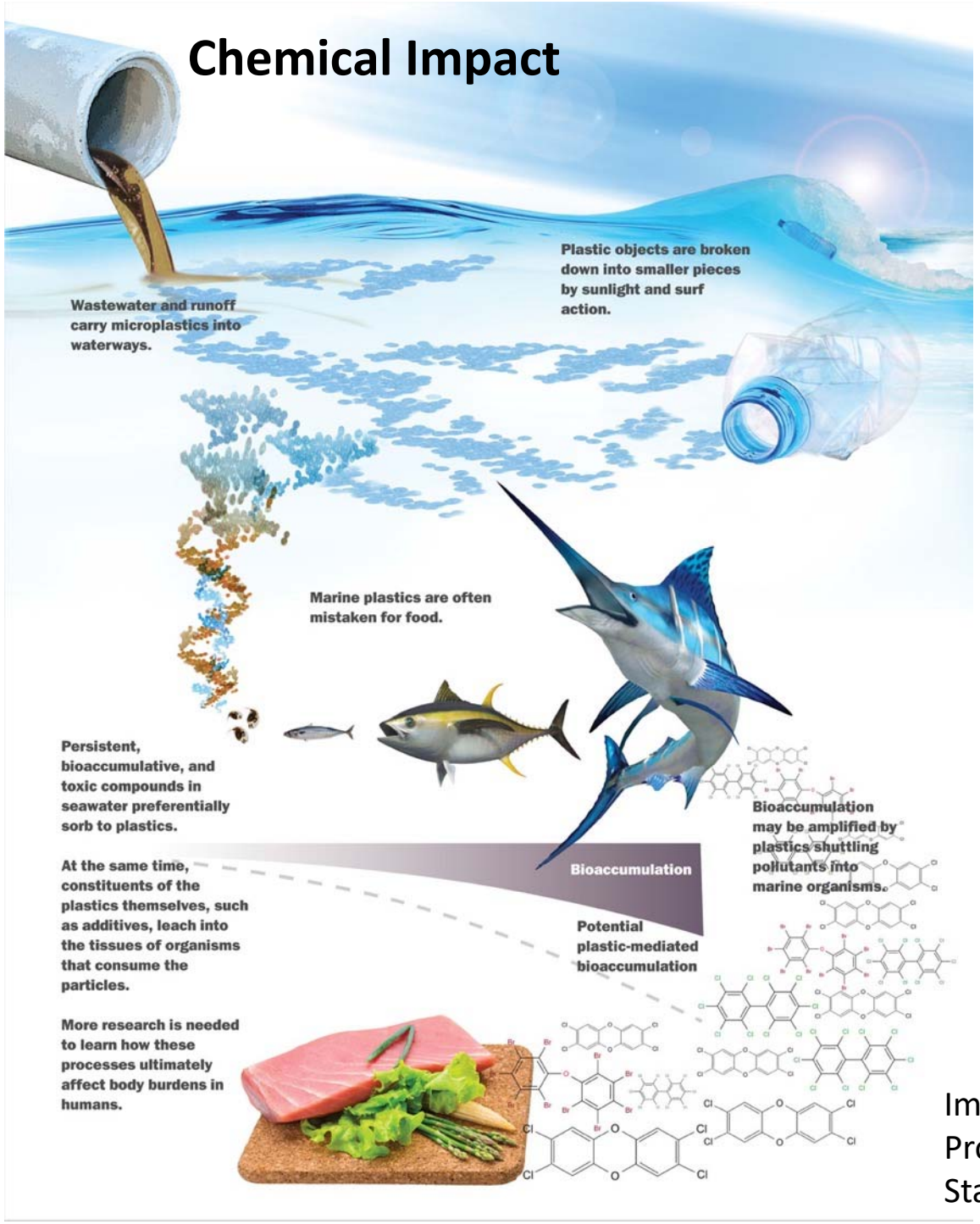


Image by Rolf Halden, Professor at Arizona State University

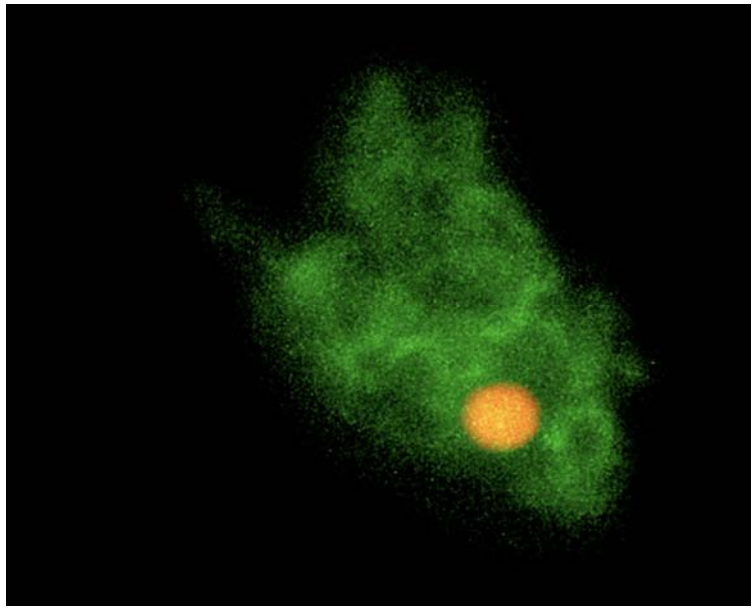
Fate of microplastic and nanoplastics in the body

TABLE 6.1
Fate of microplastic and nanoplastics in mammalian bodies as a function of particle size

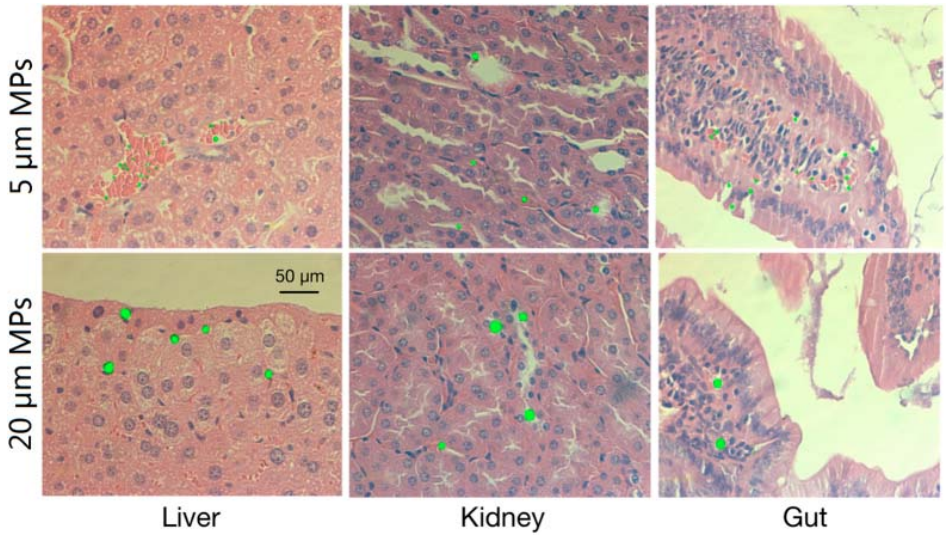
Microplastics (0.1–5000 µm)		Nanoplastics (1–100 nm)
> 150 µm	no absorption	
< 150 µm	in lymph absorption ≤ 0.3%	
= 110 µm	in portal vein	
≤ 20 µm (≤20000 nm)	access into organs	
		≤ 100 nm access to all organs, translocation of blood-brain and placental barrier
		Absorption up to 7%

FAO Report 2017

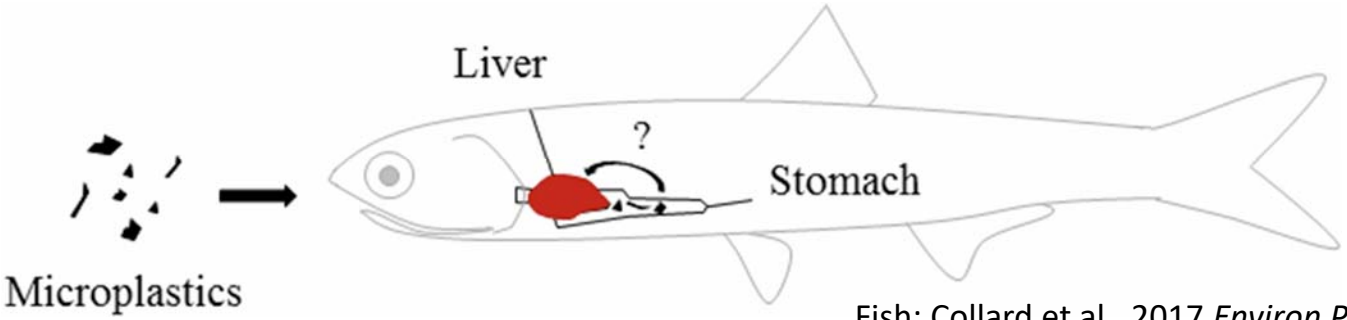
Fate of microplastic and nanoplastics in the body



Mussels: Browne et al., 2008 *ES&T*



Mice: Deng et al., 2017 *Scientific Reports*



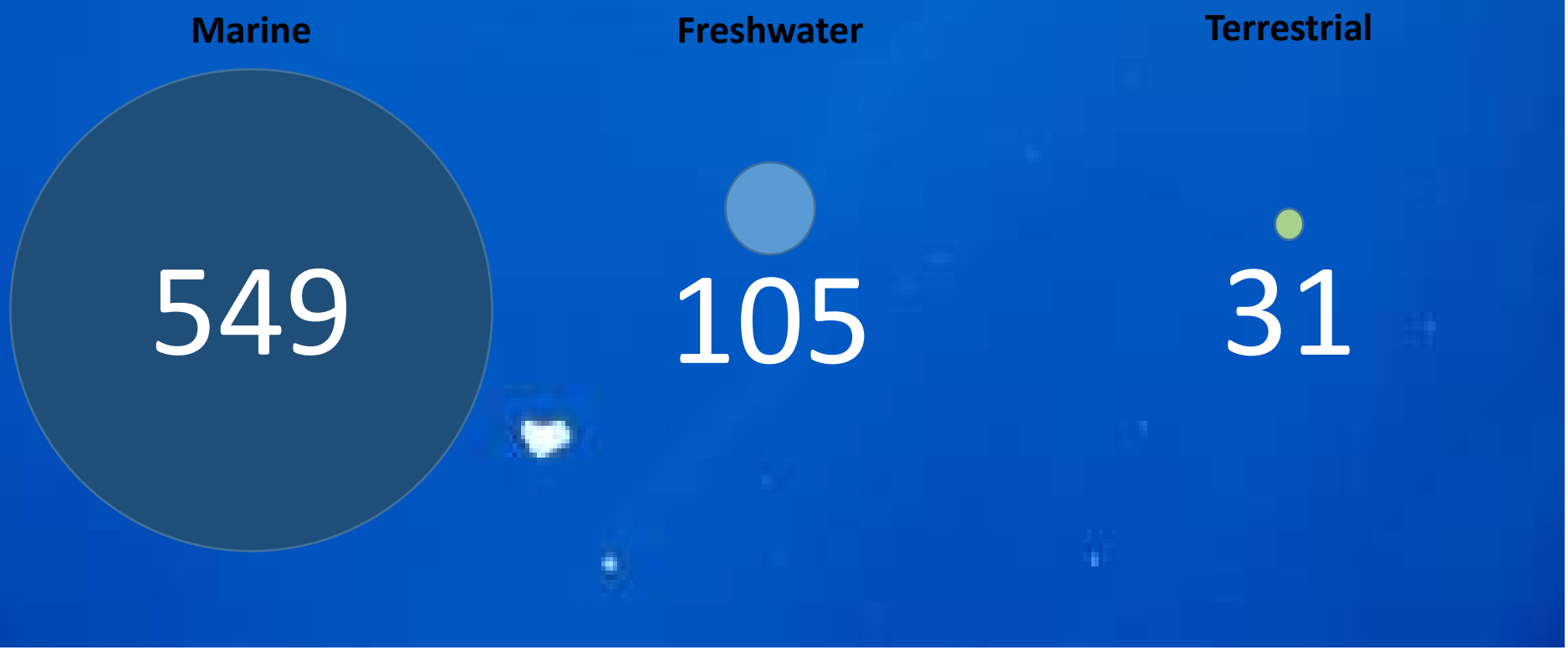
Fish: Collard et al., 2017 *Environ Pollut*

Widespread Contamination in habitats and animals – including seafood.

Evidence of effects to wildlife – particularly macroplastics – including to populations and communities.

Evidence of effects of microplastics in lab animals, populations and communities.

Continue to aim toward a better understanding of sources, fate and impacts to humans and wildlife populations.



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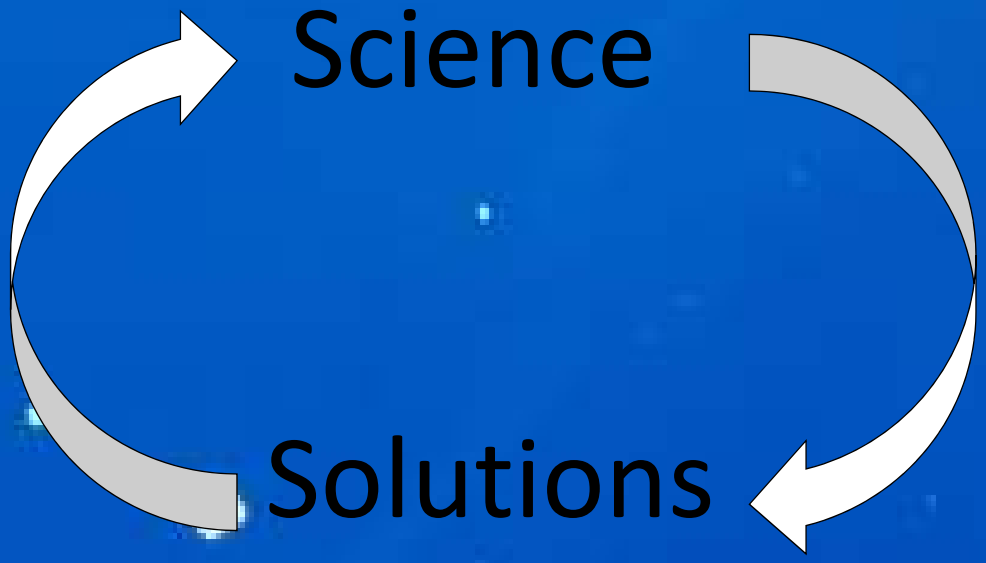

In the meantime, we have enough science to begin to mitigate now and prevent future sources of plastic pollution.


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Thank you!
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What's next for research?

- Fate of plastics and associated chemicals in marine ecosystems and seafood products

- Ecologically-relevant studies to assess impacts to wildlife and fish stocks

- Impacts to food safety and nutritional value

What's next for policy?

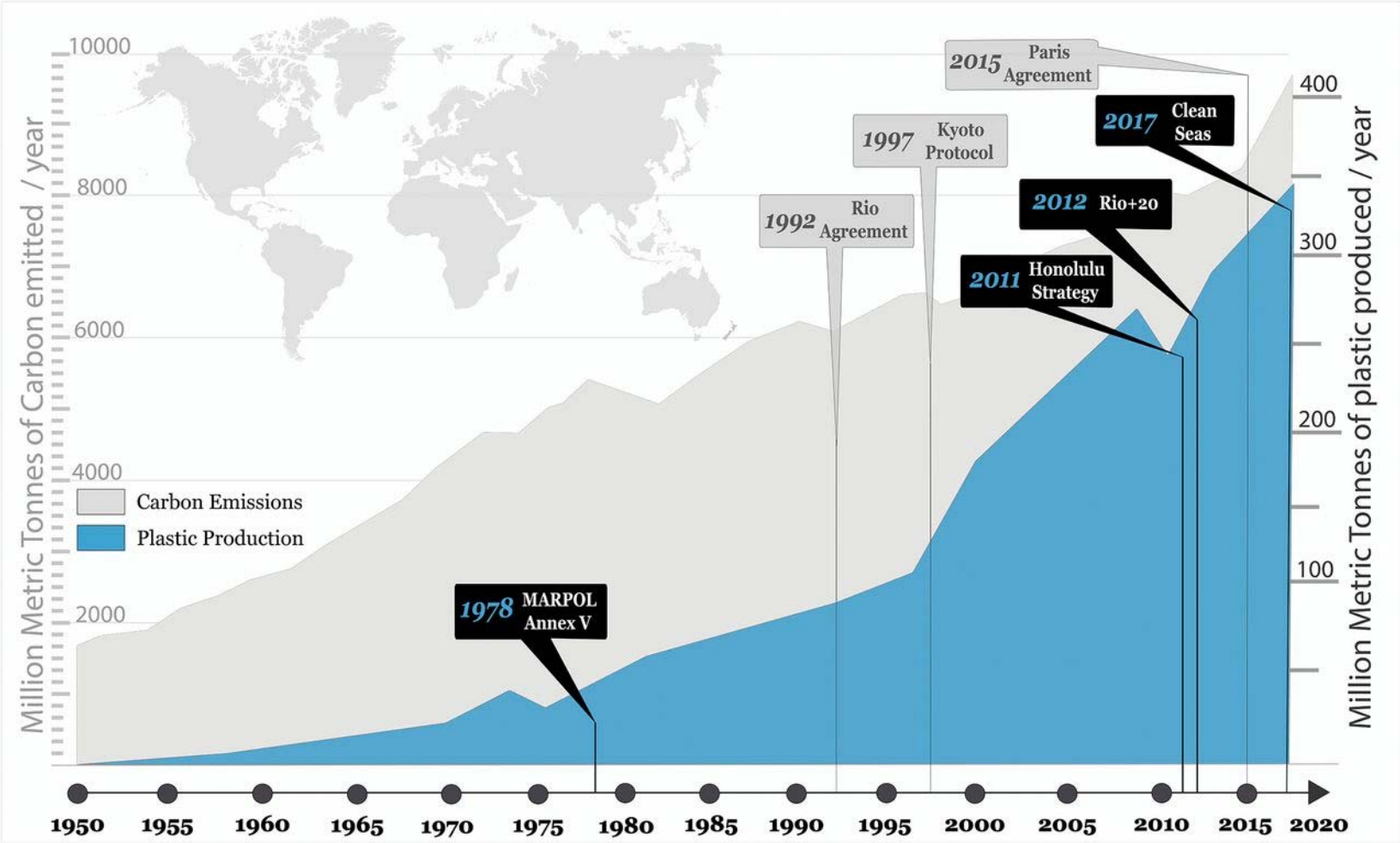
- 8 million metric tons of plastic enters the ocean each year (Jambeck et al., 2015 *Science*)

- Most policies occur on a very local scale, but plastic pollution does not observe borders, so why should policy?

FOAM FREE DC

- Policy is needed that scales with the magnitude of the problem.

What can we learn from other issues?



Stephanie B. Borrelle, Chelsea M. Rochman et al. PNAS 2017;114:9994-9997

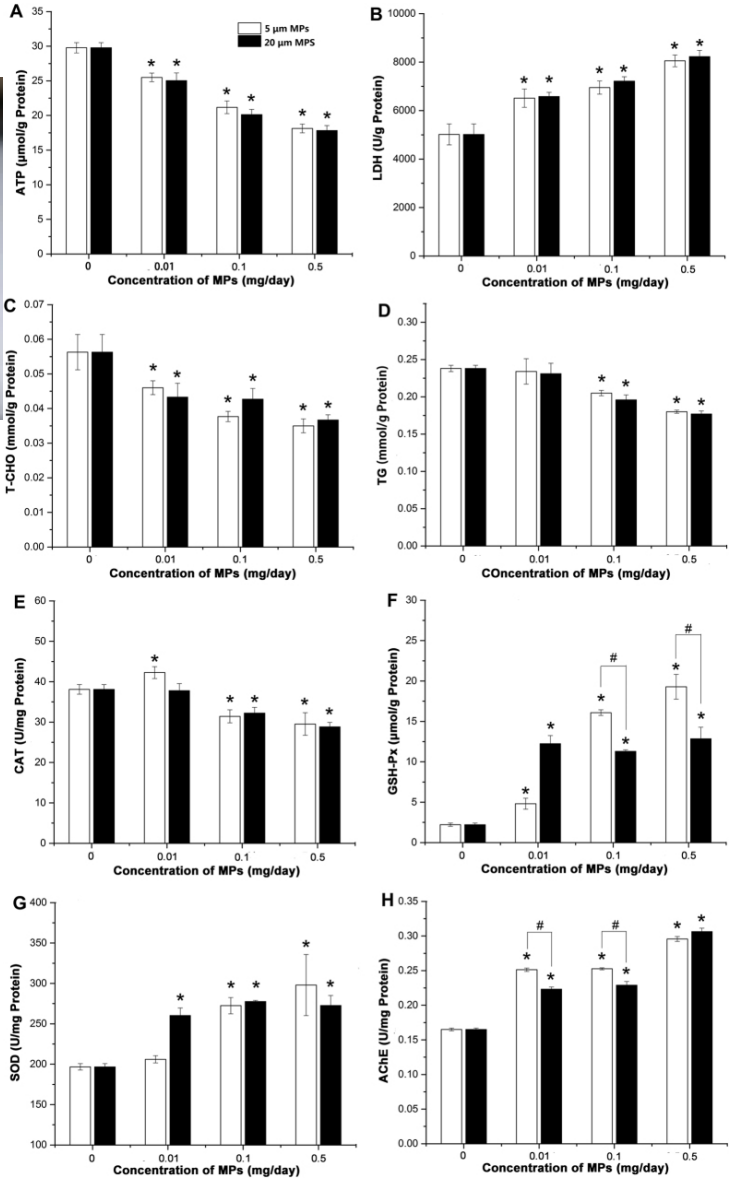
Why we need an international agreement on marine plastic pollution

Stephanie B. Borrelle[a,1], Chelsea M. Rochman[b,1,2], Max Liboiron[c], Alexander L. Bond[d], Amy Lusher[e], Hillary Bradshaw[c], and Jennifer F. Provencher[f]

- Reduction targets for plastic pollution
- Signatories from member states
- Annual reporting on success

- Global fund to support infrastructure and innovation

Physical Impact of the Particle



Mice: Deng et al., 2017 *Scientific Reports*