Plastic Pollution in the Ocean

Jessica Donohue
Sea Education Association
Woods Hole, MA

"Great Pacific Garbage Patch"

gre

Oprah Winfrey Sho

Share Send

The Great Garbage Pat

covers more than 70 ent of the planet's surface, making our rivers, lakes and oceans the lifeblood of our planet. Many of these bodies of water may be out of sight d out of mind, but our health depend on their

Cu tists believe the wo garbage dump isn t's in the Pacific Ocea Pacific Garbage stretches from the to Japan, and it's estimated to be *twice* the size of Texas. "This shocking thing I have seen," Oprah says.

juiceonline.com

Subtropical Ocean

aka “Garbage Patches”

Images from Sea Education Association

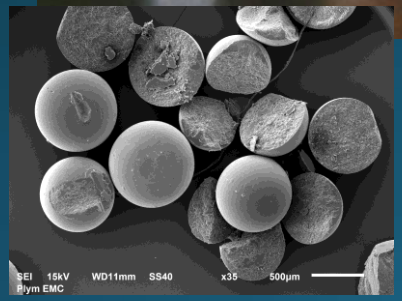
“Microplastics”

Sea Education Association

Microscopic Plastic in Wastewater

"Microbeads"

5gyres.org



R. Thompson

Clothing Fibers

Fate of plastic marine debris?

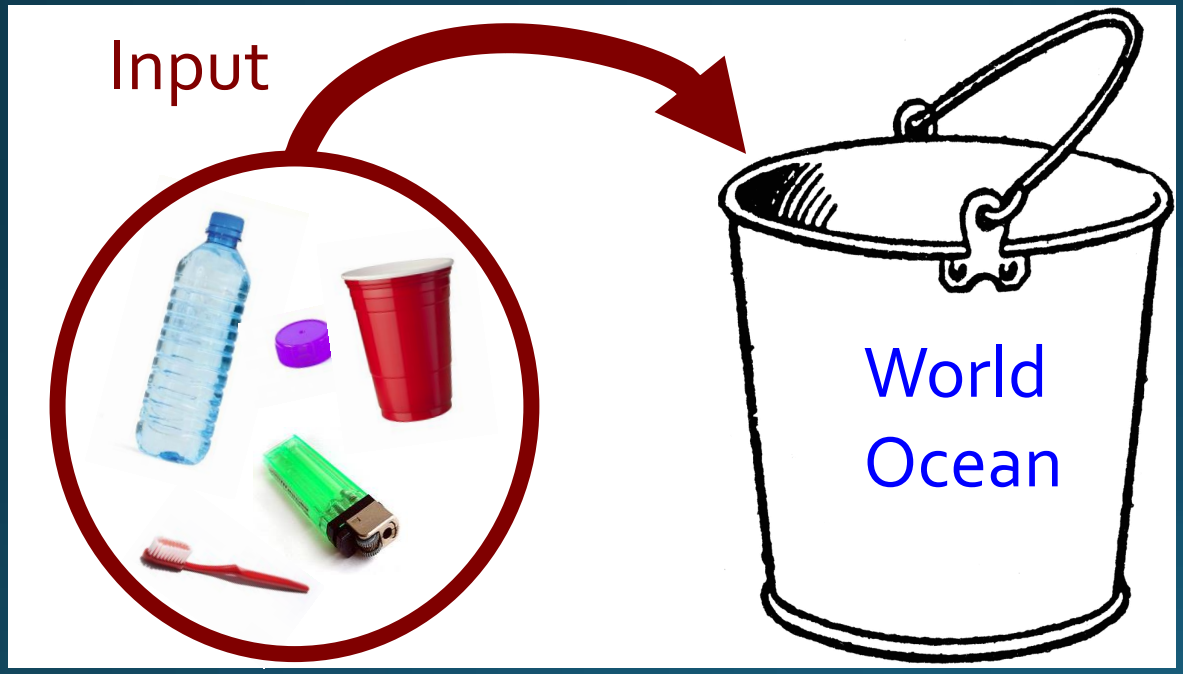
??

Size ↓

Risk ↑

How big is the problem?

Measure the amount <u>entering</u> the ocean



Measure the amount <u>in</u> the ocean

Sources of marine debris

By land…

Litter and Waste:

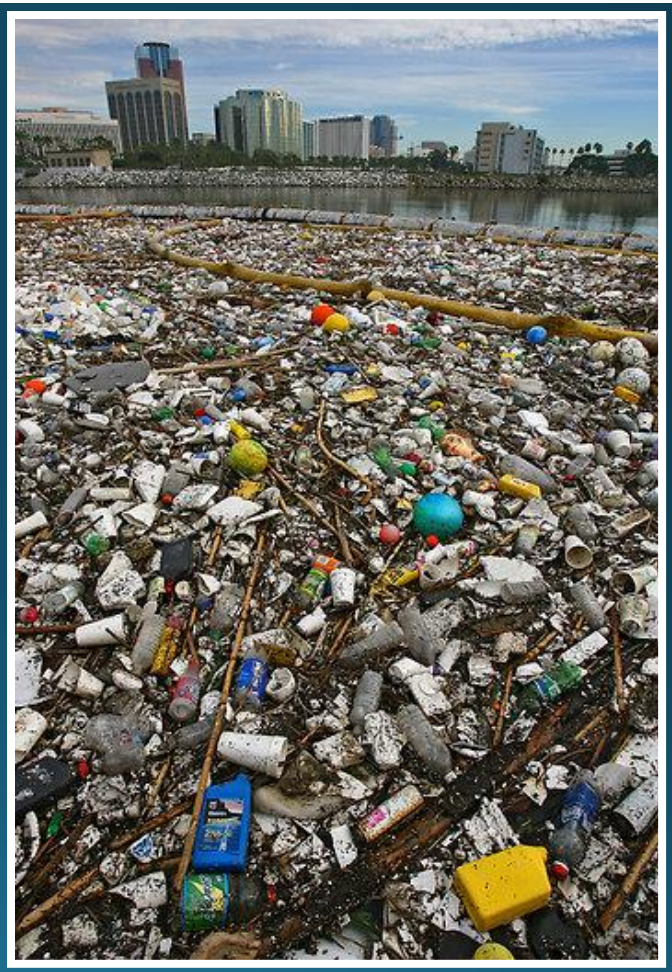
- beaches
- rivers and waterways
- drainage outflows and runoff
- winds

Catastrophic events

…and by sea

Ships and at-sea platforms:

- dumping
- lost cargo
- fishing and aquaculture activities
- recreational activities
- oceanographic activities



Los Angeles River Long Beach, CA
Rick Loomis, LA Times

Plastic waste
Land → Ocean

www.sea.edu

SEA Semester®

Environmental Studies at Woods Hole & at Sea

Surface plankton net tow

Measuring microplastics

- Net mouth: 1 m x 0.5 m
- Net mesh: 335 µm
- Tow length: 1.8 km
- Ship speed: 2 knots

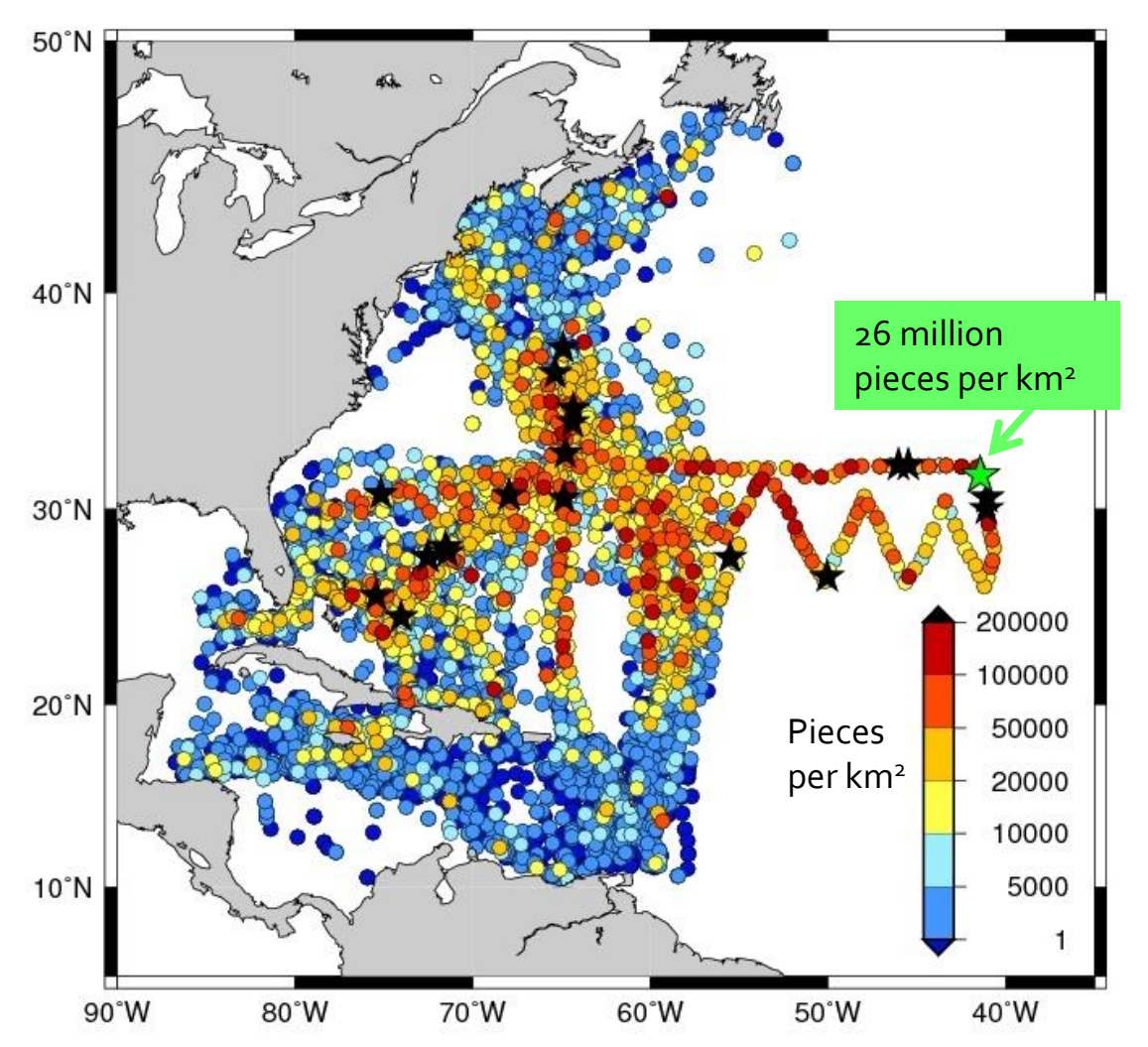
Typical plastic debris collected in plankton nets

240 pieces

~ 130,000 pieces per km²

Open ocean measurements

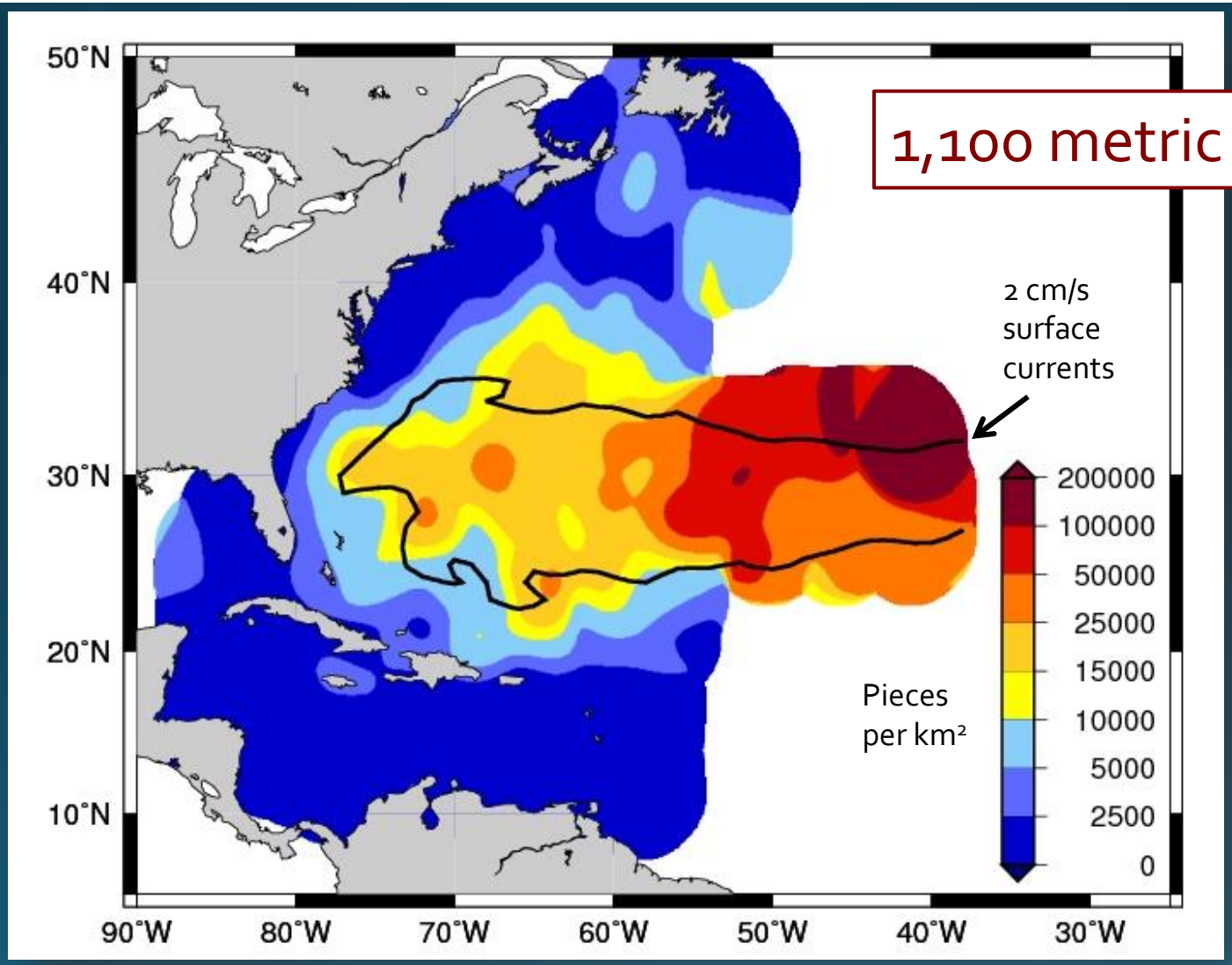
> 6600 surface net tows from 1986-2010



Law et al., 2010

Open ocean measurements

Plastic and ocean surface currents

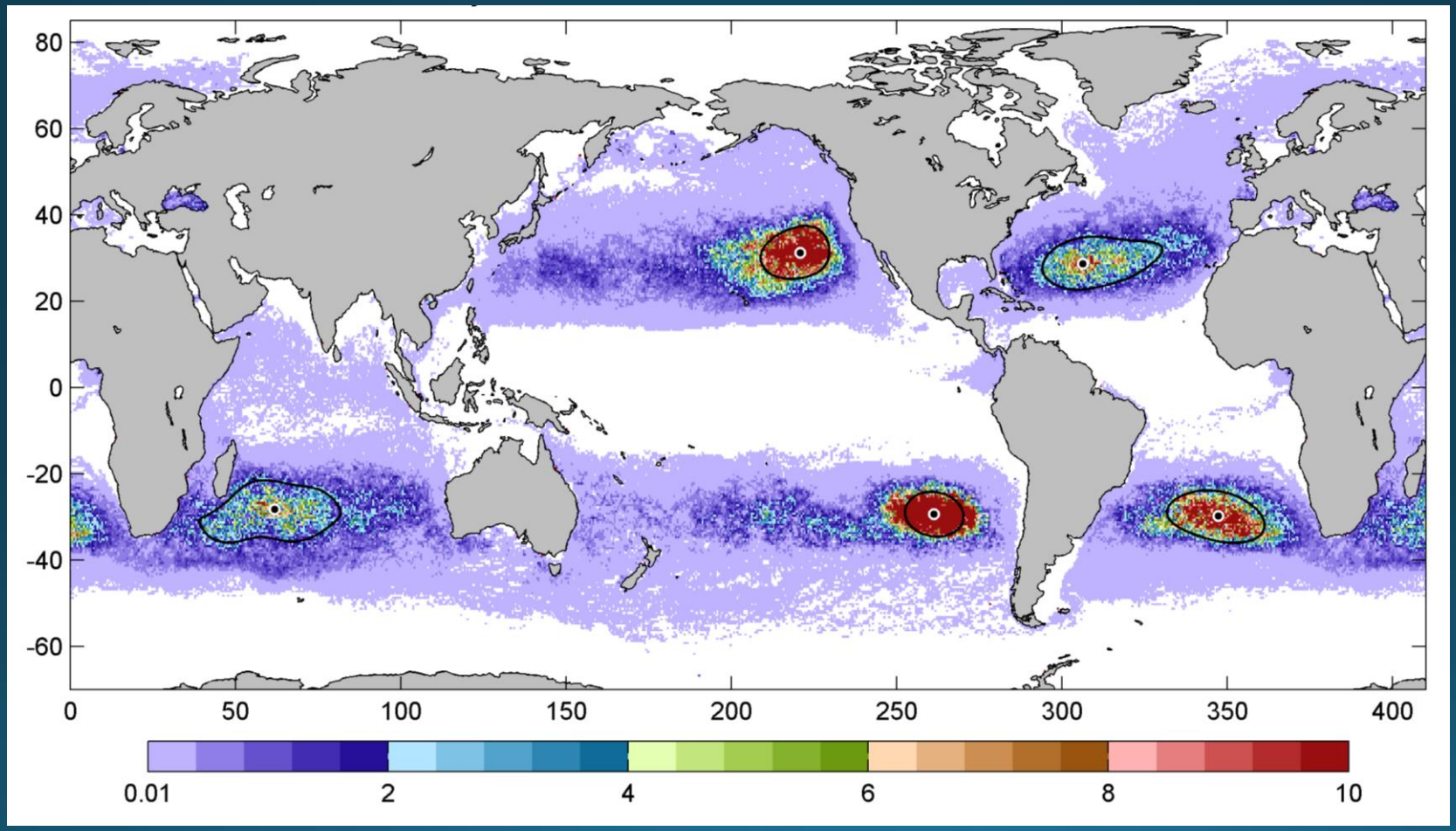


1,100 metric tons

Law et al., 2010

Numerical modeling

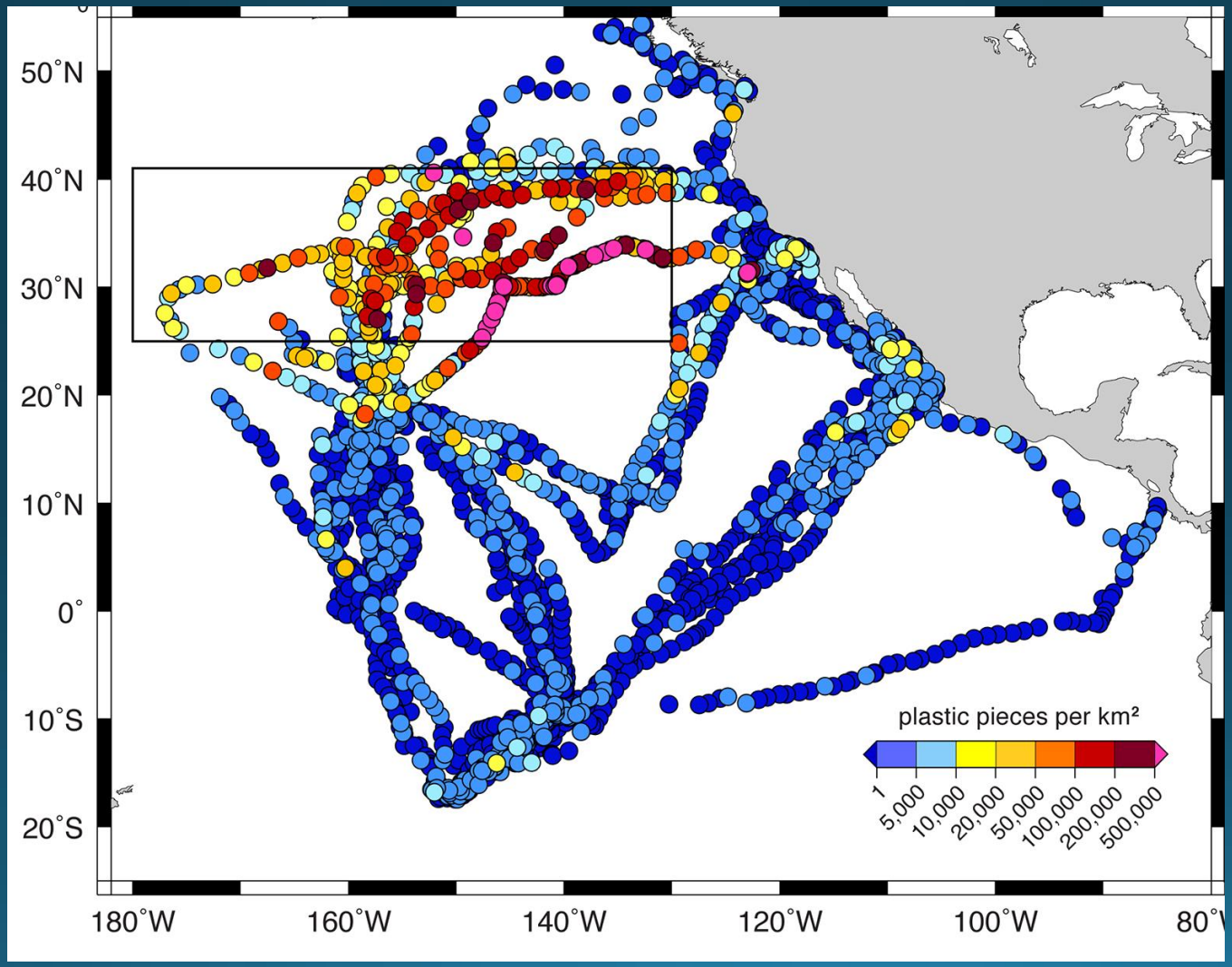
Predicted accumulation zones



Maximenko et al. (2012)

Eastern Pacific Ocean

> 2500 surface net tows from 2001–2012

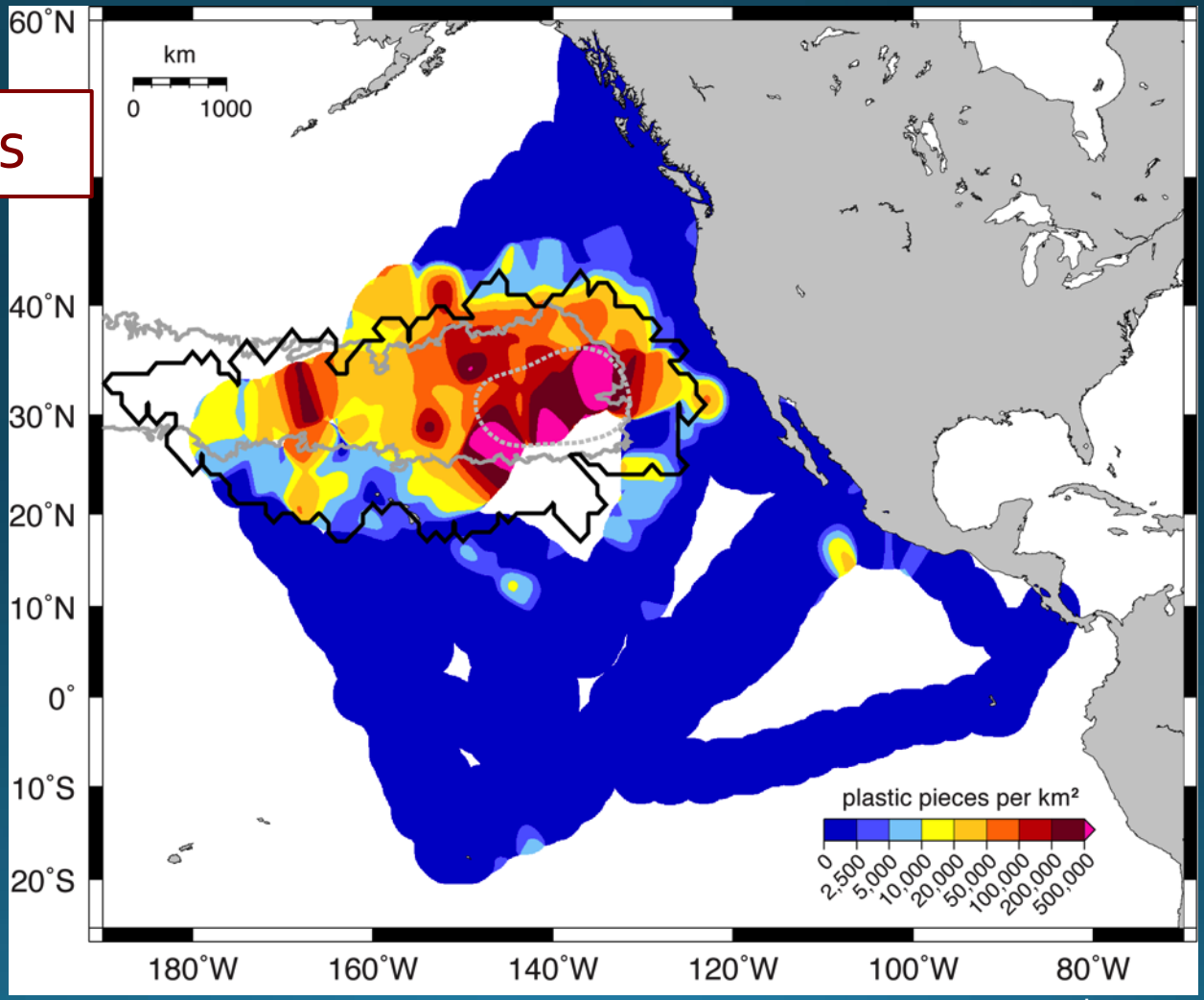


Law et al., 2014

Observed vs. modeled

Surface plastic concentration

21,290 metric tons



Lebreton et al. (2012)

Maximenko et al. (2012)

van Sebille et al. (2012)

Law et al., 2014

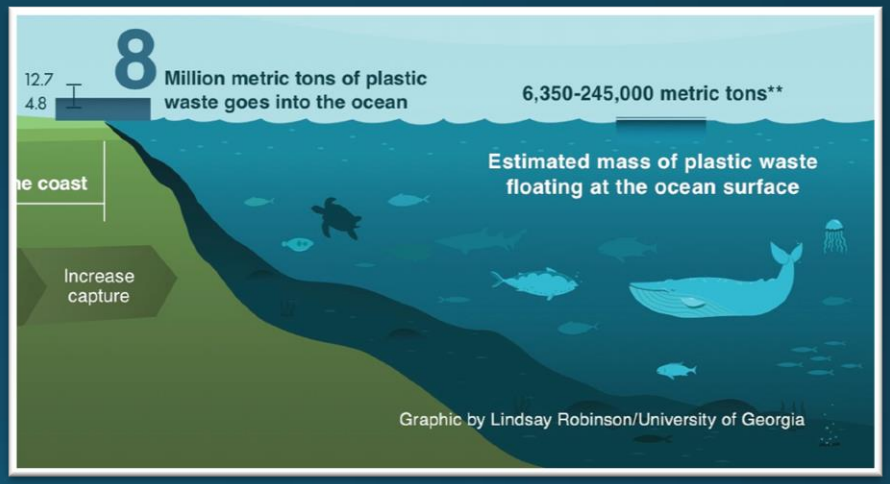
Where is all the plastic?

Input from Land:

8 million metric tons per year

Floating at sea surface:

6,350-245,000 metric tons

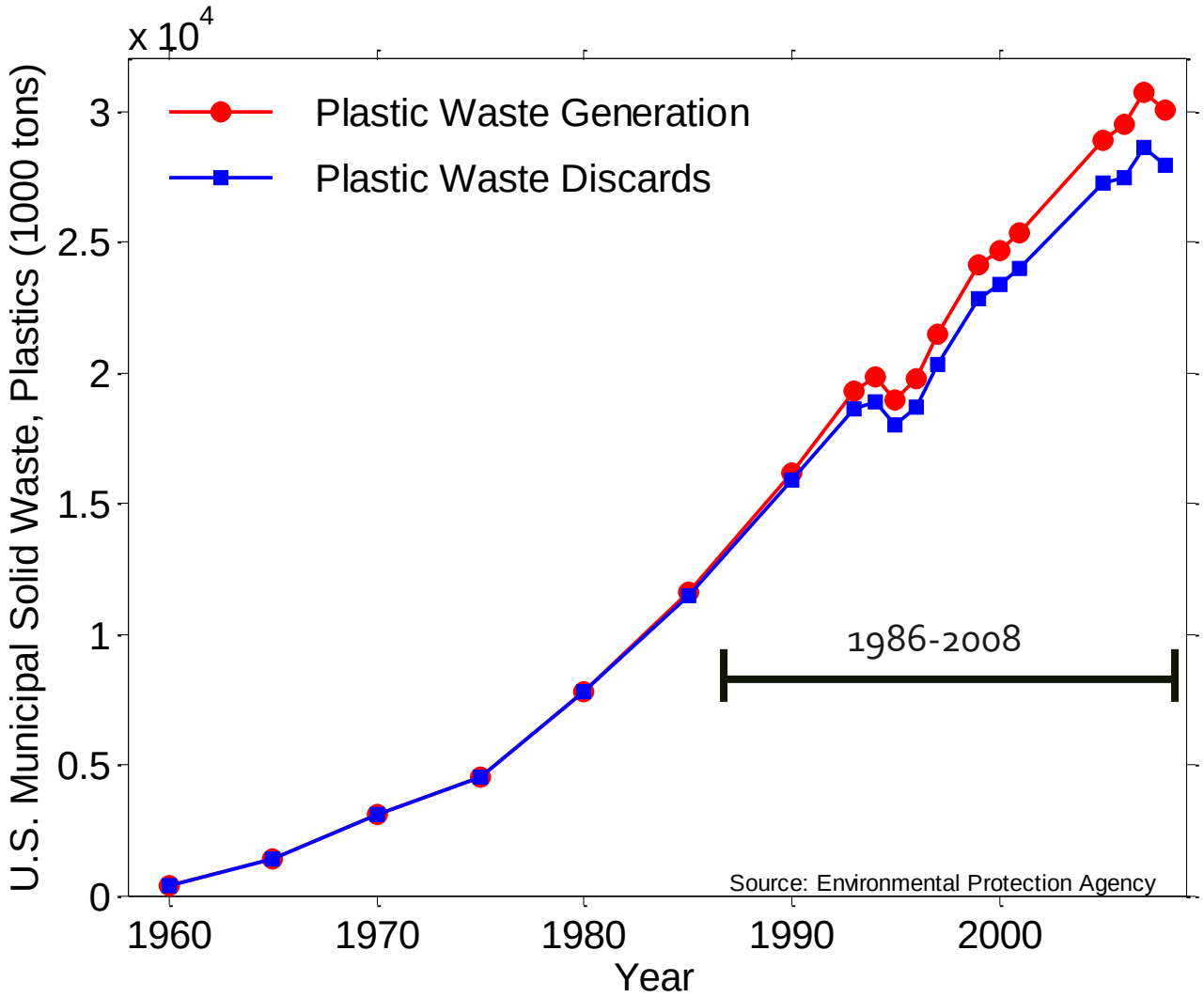


Where is the missing plastic?

- Subsurface ocean?
- Seafloor?
- Beaches and coastlines?
- Biota?

Is the problem growing in time?

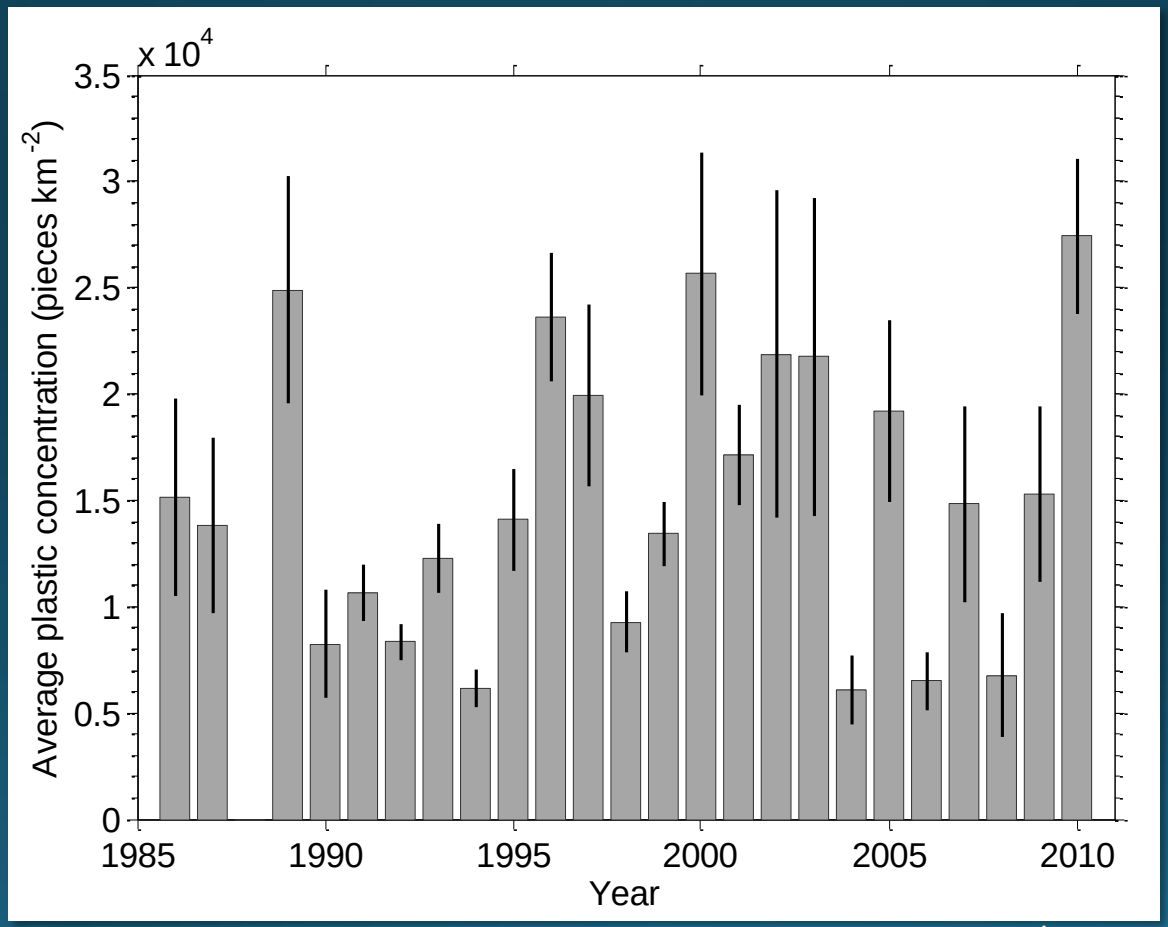
U.S. waste generation



Plastic concentration vs. time

In accumulation zone

North Atlantic, 1986–2010

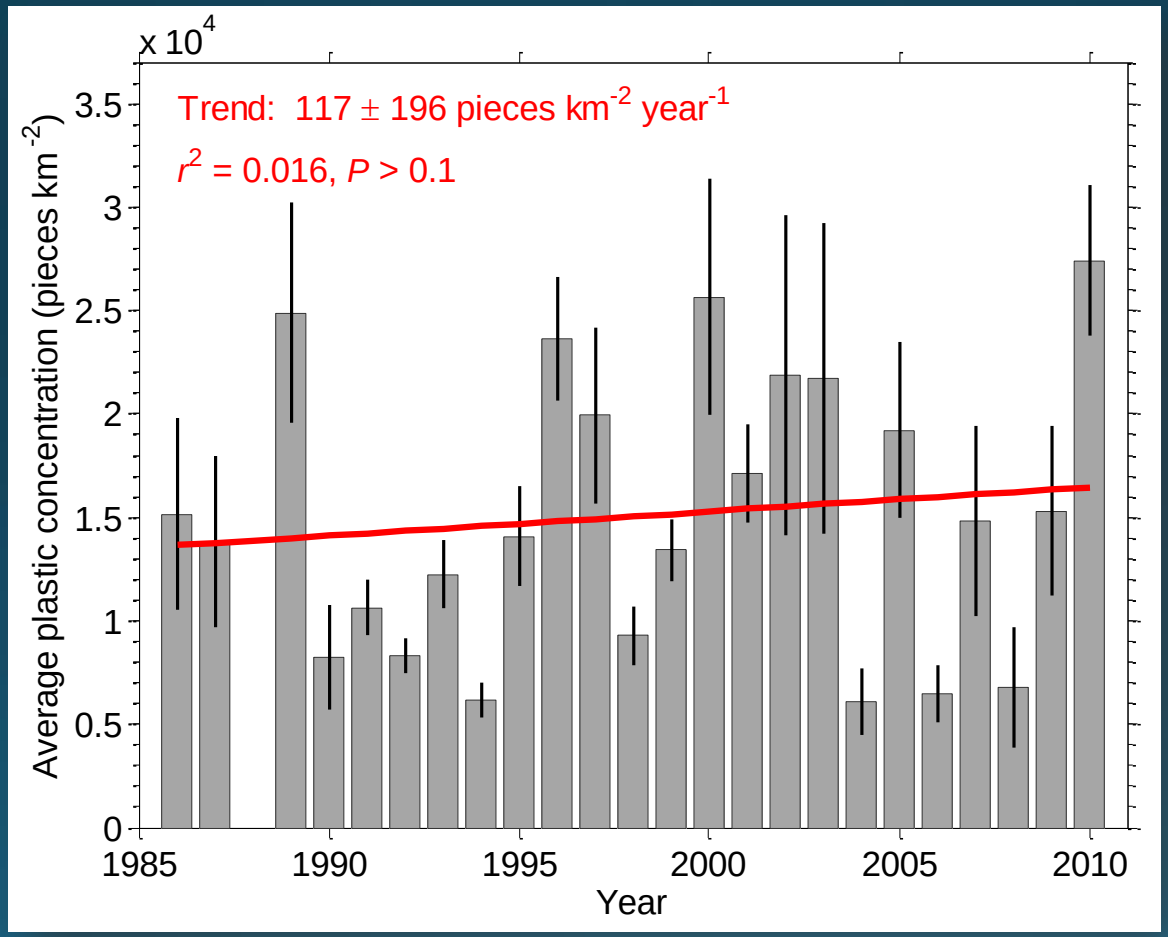


Law et al., 2010

Plastic concentration vs. time

In accumulation zone

North Atlantic, 1986–2010



Law et al., 2010

Trend in resin pellets

North Atlantic, 1986-2010

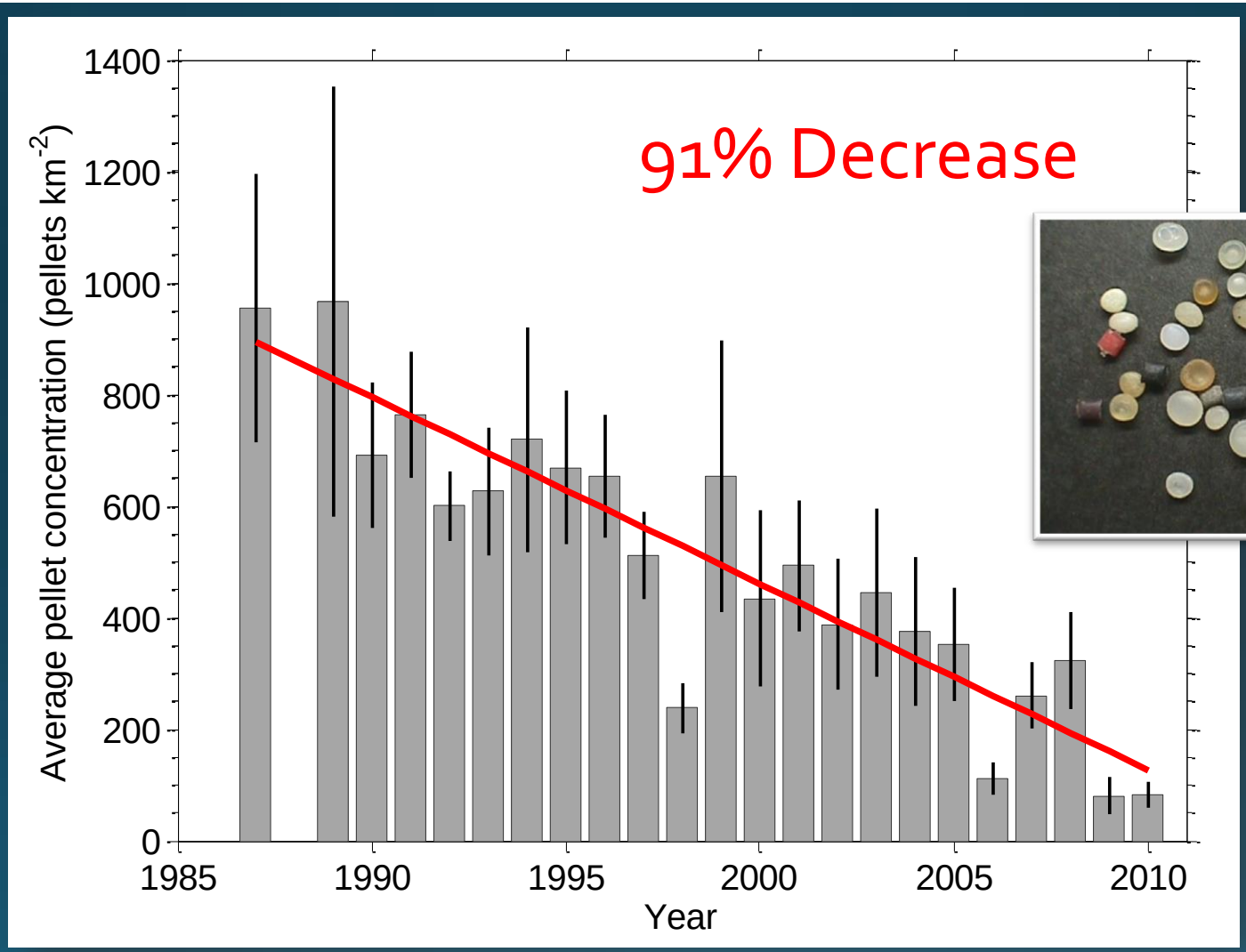


Photo: H. Takada

Law et al., 2010

Near-term mitigation

Global scale

Improve waste management infrastructure

Ted Siegler/DSM
Bien Hoa, Vietnam

Rasta Fariz
Sidoarjo, Bali, Indonesia

envclubarm.wordpress.com

Long-Term Solutions:
Local Scale: What can I do?

1. Reduce waste
   - REDUCE consumption of single-use "disposable" items.
   - REUSE and RECYCLE what is used. COMPOST.
   - Demand "extended producer responsibility".
2. Limit the source
   - Clean up litter, anywhere.
   - Participate in beach clean-ups.
   - Check cosmetic labels for microplastic scrubbers.
3. Educate friends, family, teachers
4. Pursue policy initiatives

Next Steps:
Current research at SEA

- Understanding degradation mechanisms and timeline
  - Studying archived samples
  - Field and lab experiments
- Size, form (line, film, fragment, pellet, foam) and polymer type of microplastics:
  - Variations in time
  - Changes with proximity to sources
- Outreach – schools, summer camps, public events

Acknowledgements

Kara Lavender Law
Emelia DeForce (MO BIO)
Deb Goodwin
Skye Morét-Ferguson
Giora Proskurowski (U. Wash.)
Erik Zettler

Chris Reddy	WHOI
Nikolai Maximenko	U. Hawaii
Jan Hafner	U. Hawaii
Tobias Kukulka	U. Delaware
Jenna Jambeck	U. Georgia
Chris Wilcox	CSIRO (Australia)
Roland Geyer	UC-Santa Barbara
Ted Siegler	DSM Environmental
Ramani Narayan	Michigan State Univ.
Anthony Andrady	NC State Univ.

Henry L. and Grace Doherty Charitable Foundation

This work would not have been possible without the dedication of
more than 7000 SEA students,
shipboard crew and faculty,
and the innumerable hours spent picking plastic from plankton nets.

SEA Semester®

S·E·A

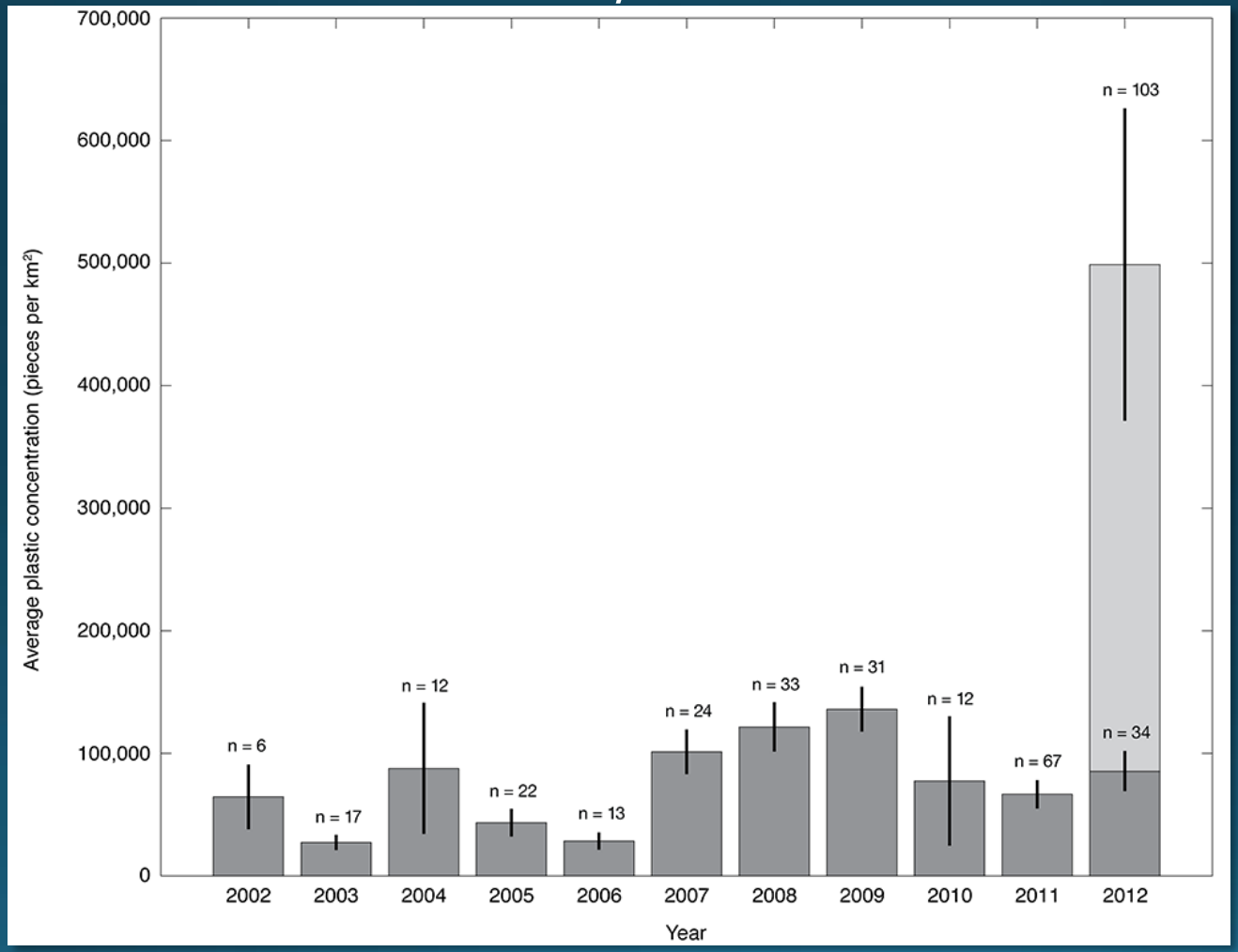
www.sea.edu

jdonohue@sea.edu

Trends in plastic concentration

In defined accumulation zones

North Pacific, 2002–2012



Law et al., 2014

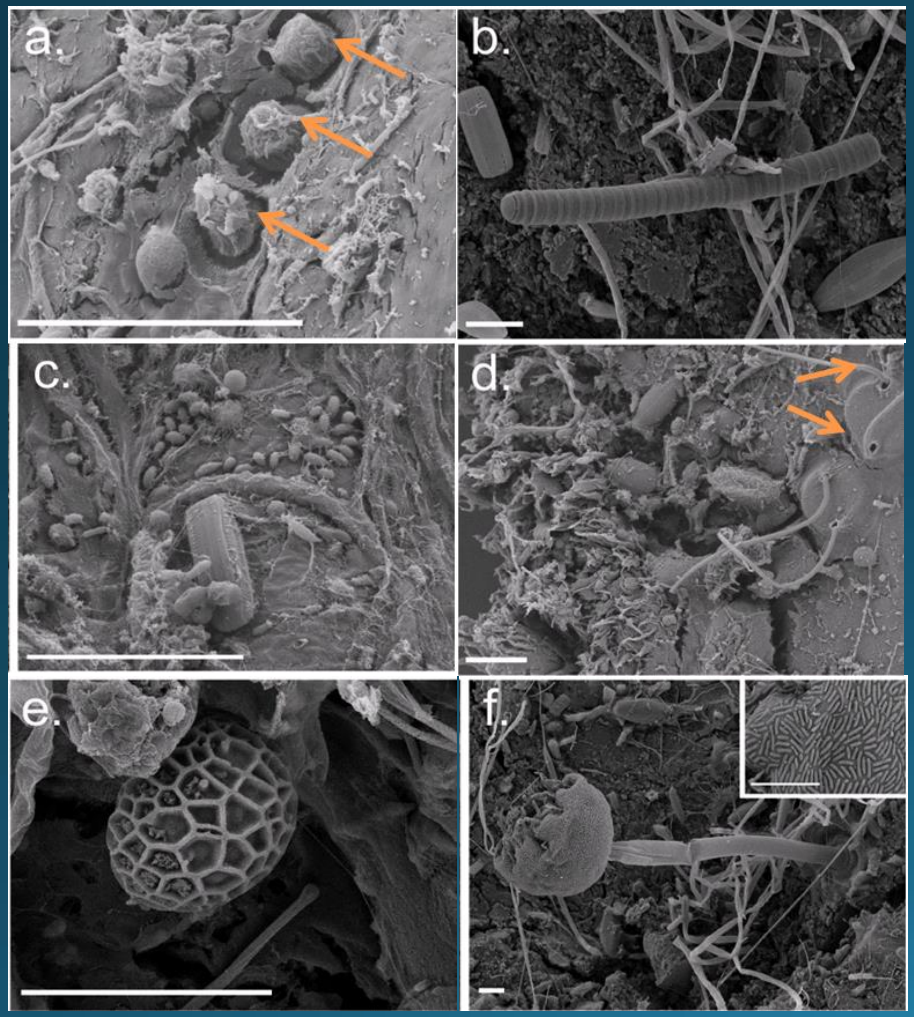
SEA Semester®

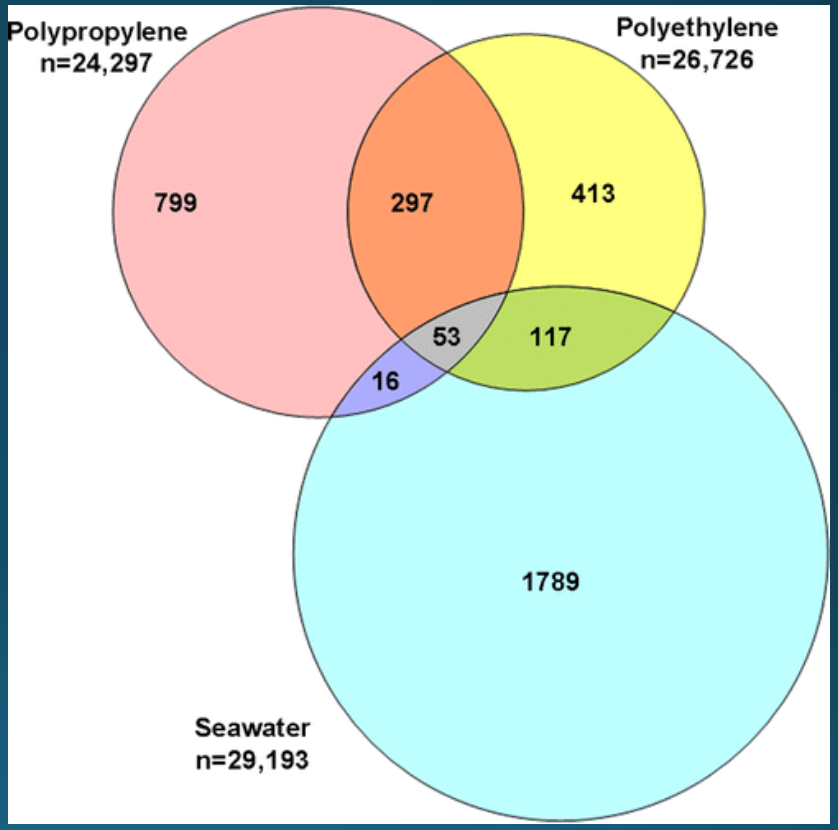
S·E·A

www.sea.edu

Ecological impacts of plastic marine debris

The "Plastisphere"





Zettler *et al.*, 2013

Fate of plastic marine debris?

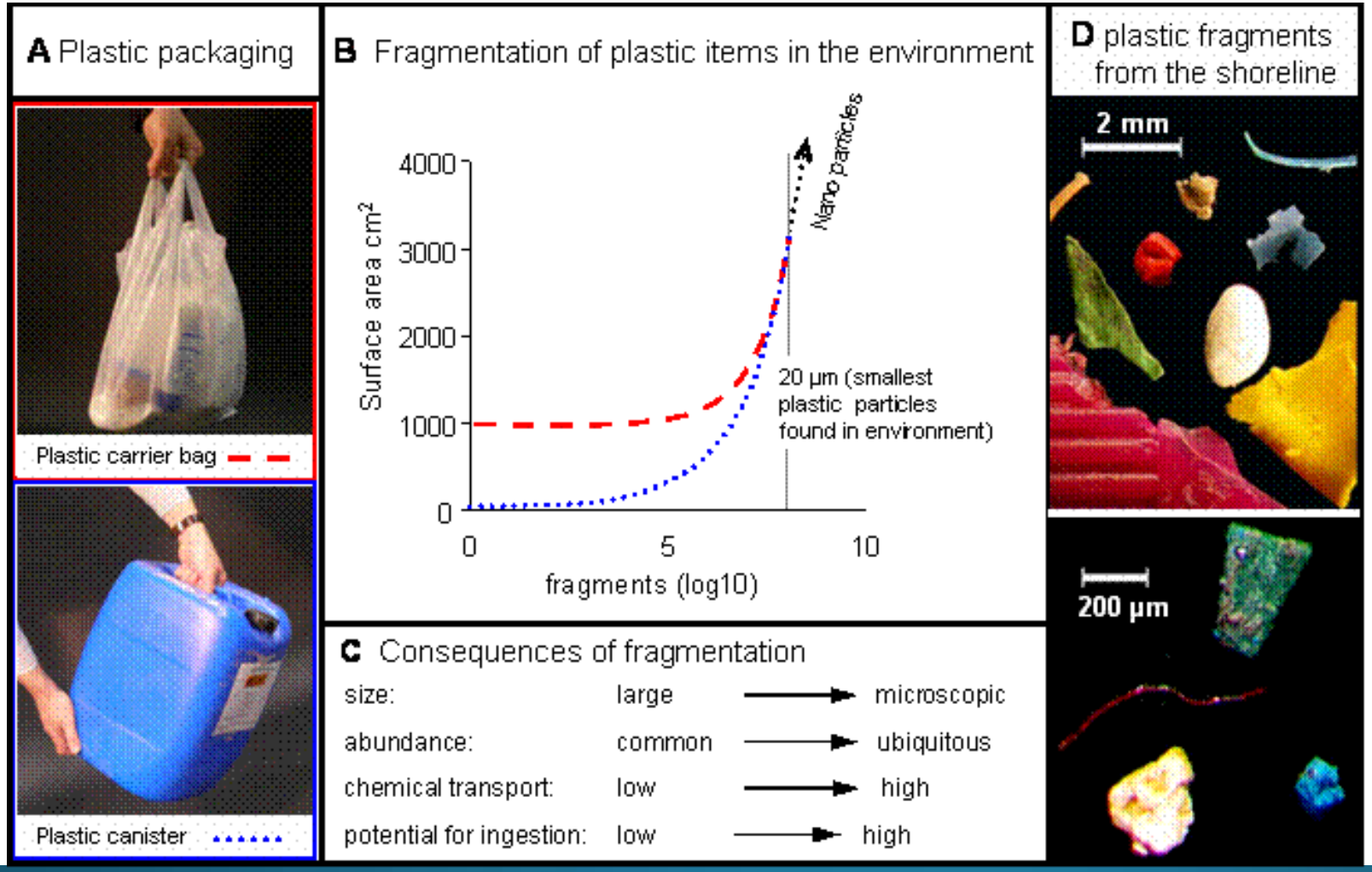


Figure courtesy of R. Thompson

A DOCUMENTARY ABOUT PLASTIC POLLUTION
IN OUR OCEANS

INTO THE GYRE

A 590FILMS PRODUCTION

CINEMATOGRAPHY BY SCOTT ELLIOTT & BEN SCHELLPFEFFER WRITTEN BY SCOTT ELLIOTT & JULIA ELLIOTT

EDITED, PRODUCED & DIRECTED BY SCOTT ELLIOTT

IntoTheGyre.com
www.facebook.com/IntoTheGyre

Official Selection
Woods Hole Film Festival
21st 2012

Winner Best Environment Film
San Francisco Frozen Film Festival
2012

WINNER
the film festival of colorado
JUNE 2012

Best Film
Scinema
Festival of Science Film
2012

IntoTheGyre.com