The Science behind Ocean *"Garbage Patches"*

Kara Lavender Law

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“Great Pacific Garbage Patch”

greenprophet.com

juiceonline.com

“Great Pacific Garbage Patch”

gree

The **Oprah Winfrey** Show

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The Great Pacific Garbage Patch

Water covers more than 70 percent 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 and out of mind, but our health may depend on their protection.

Currently, scientists believe the world's largest garbage dump isn't on land... it's in the Pacific Ocean. The Great Pacific Garbage Patch stretches from the coast of California to Japan, and it's estimated to be *twice* the size of Texas. "This is the most shocking thing I have seen," Oprah says.

juiceonline.com

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Oprah Winfrey Sho

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juiceonline.com

Sargasso Sea

Images from Sea Education Association

Sargasso Sea

Images from Sea Education Association

Outline

- What is marine debris?
- SEA's plastic debris data set (Atlantic)
- Geographical distribution of floating plastic debris
- 22-year trends in floating plastic debris
- Outstanding research questions

Marine Debris - Beaches

Kamilo Beach, Hawaii

Properties of Plastic

Lightweight	Buoyant in seawater
Strong	Difficult to break apart
Durable	Resists biodegradation
Inexpensive	“Disposable”

PERSISTENT in the environment

Photo: H. Takada

Plastic resin pellets

Plastic Marine Debris

Known Environmental Impacts

Entanglement

Plastic Marine Debris

Known Environmental Impacts

Entanglement

Ingestion

Irene Kinan (Oikonos.org)

www.wildcoast.blog.com

Plastic Marine Debris

Known Environmental Impacts

www.chrisjordan.com

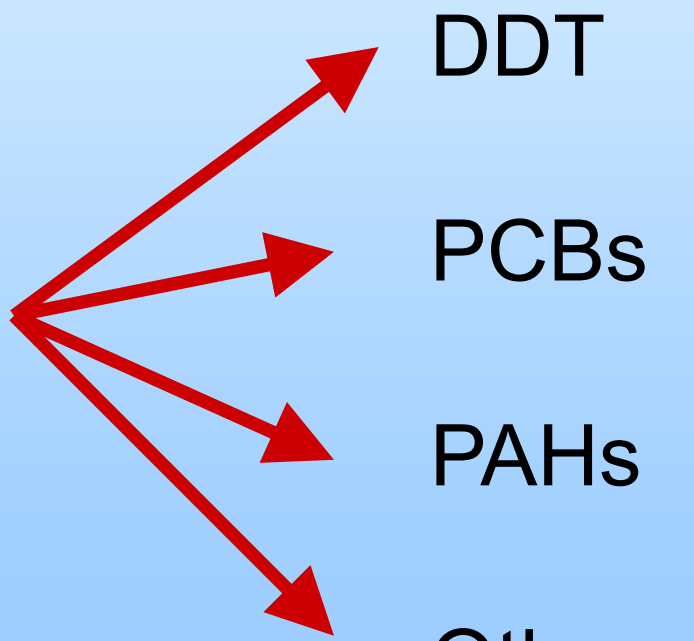
Plastic Marine Debris

Known Environmental Impacts

Entanglement

Ingestion

Organic pollutants



Plastic Marine Debris

Known Environmental Impacts

Entanglement

Ingestion

Organic pollutants

Micro-ecosystems

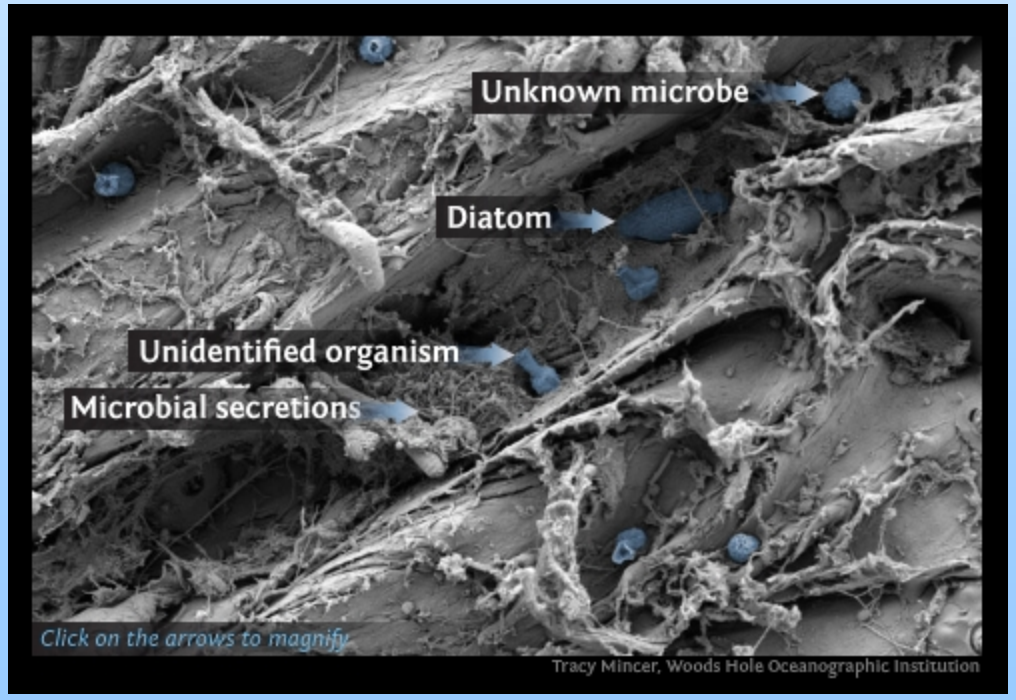
Plastic Marine Debris

Environmental Impacts??

Microbial biofilms

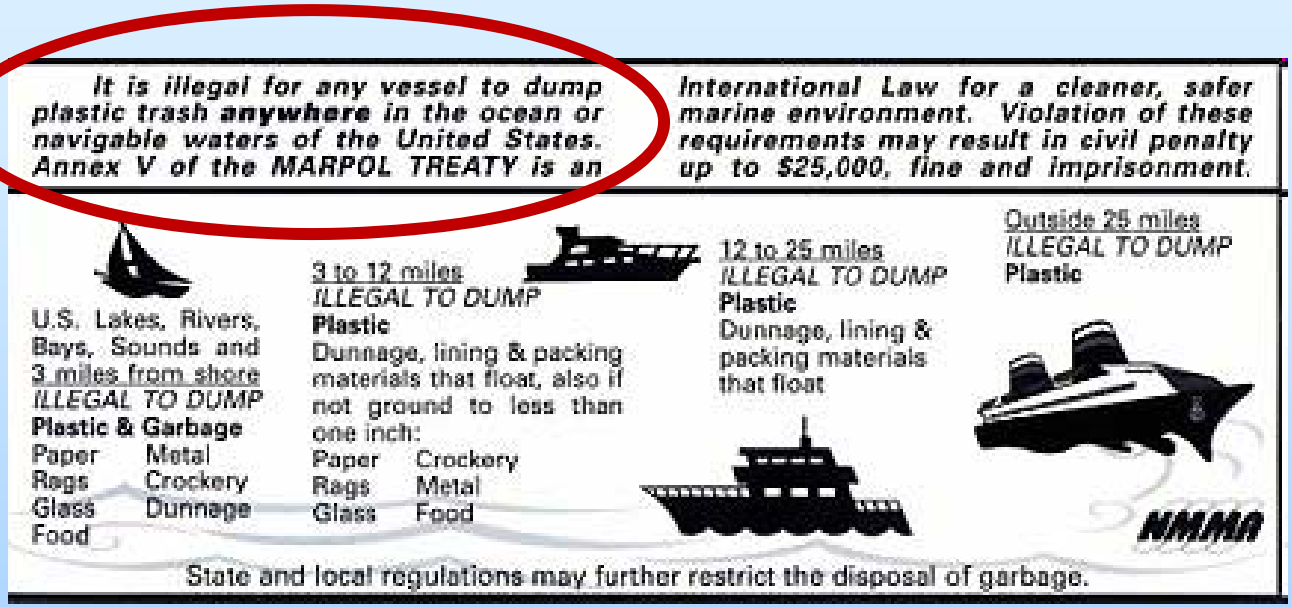
Bioaccumulation of toxins

Chemical impacts of degradation



Plastic Marine Debris

Environmental Impacts



www.nmma.org

International Regulation

MARPOL Annex V (1988)

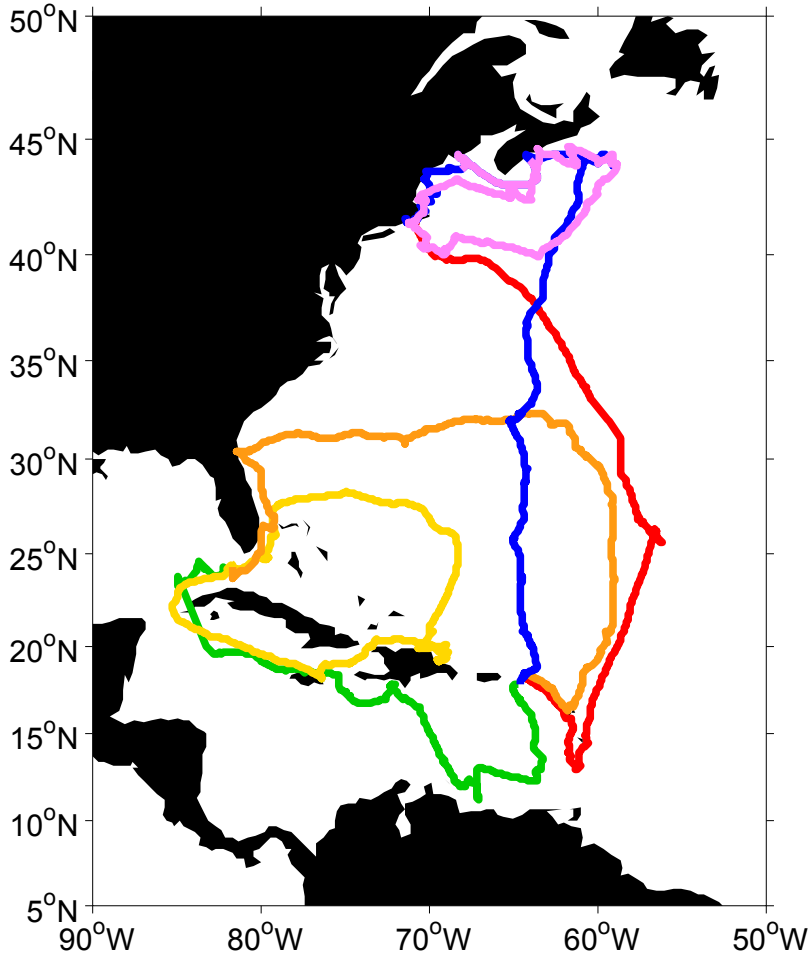
SEA Semester

Undergraduate research cruises

SSV *Corwith Cramer*

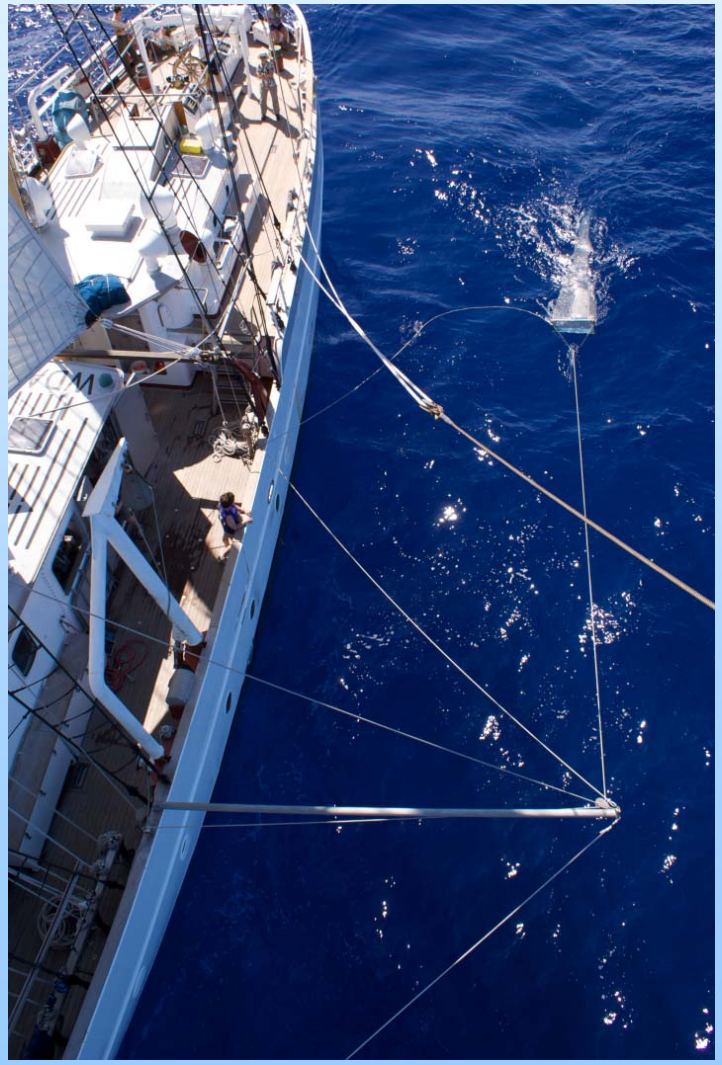
SSV *Robert C. Seamans*

Cruise Tracks
Atlantic Ocean & Caribbean Sea



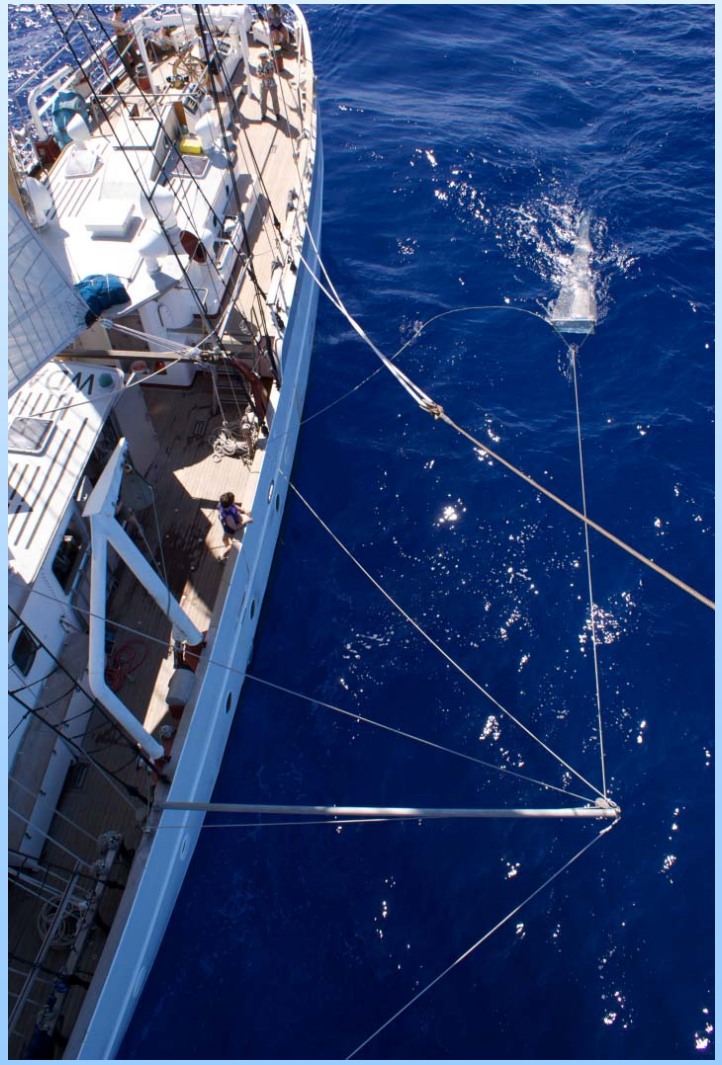
- Six-week long SEA Semester cruises
- Annually-repeated cruise tracks
- Data collected by > 7000 undergraduates

Surface Plankton Net Tows



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

Surface Plankton Net Tows



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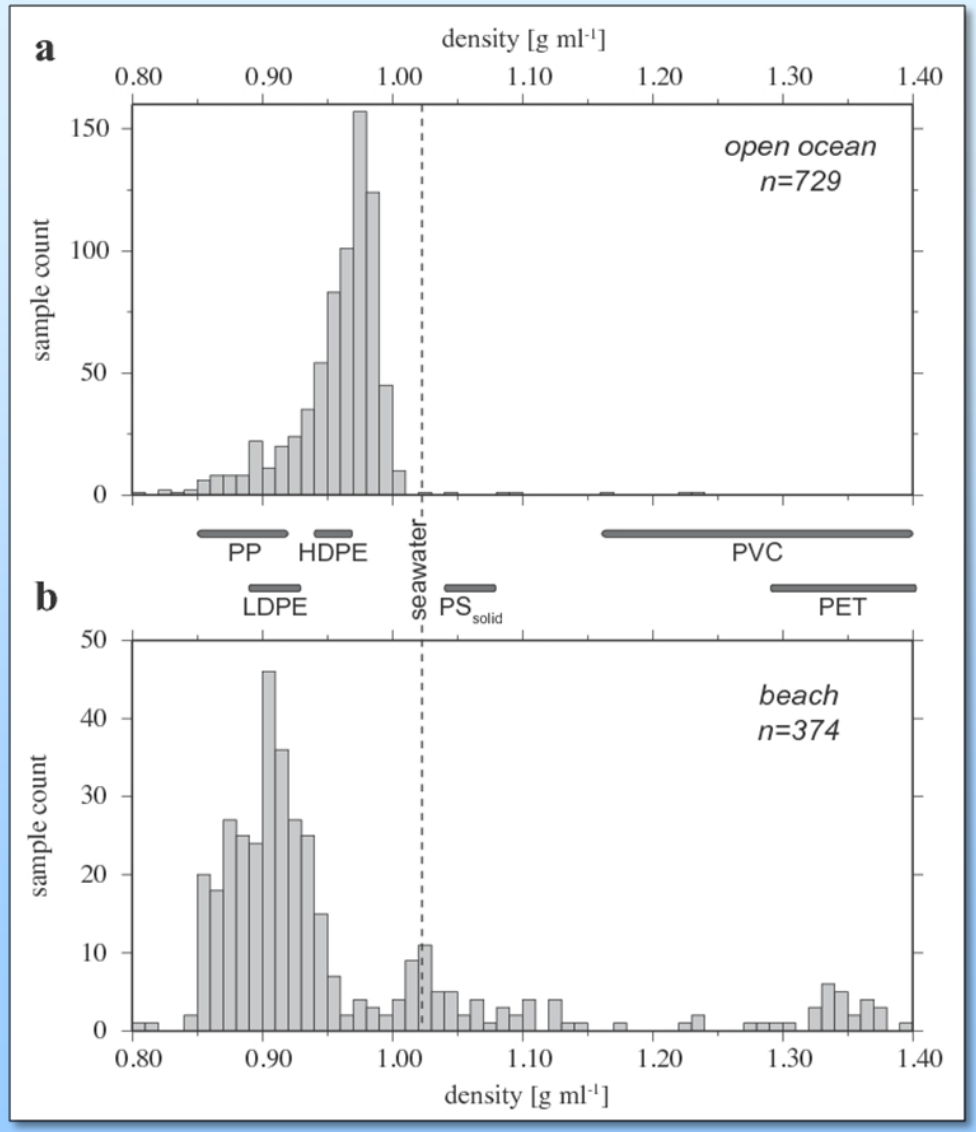
Typical Samples

Samples collected by Sea Education Association

Physical Characteristics of Debris



It's small:

- 88% < 10 mm
- 95% < 0.05 g

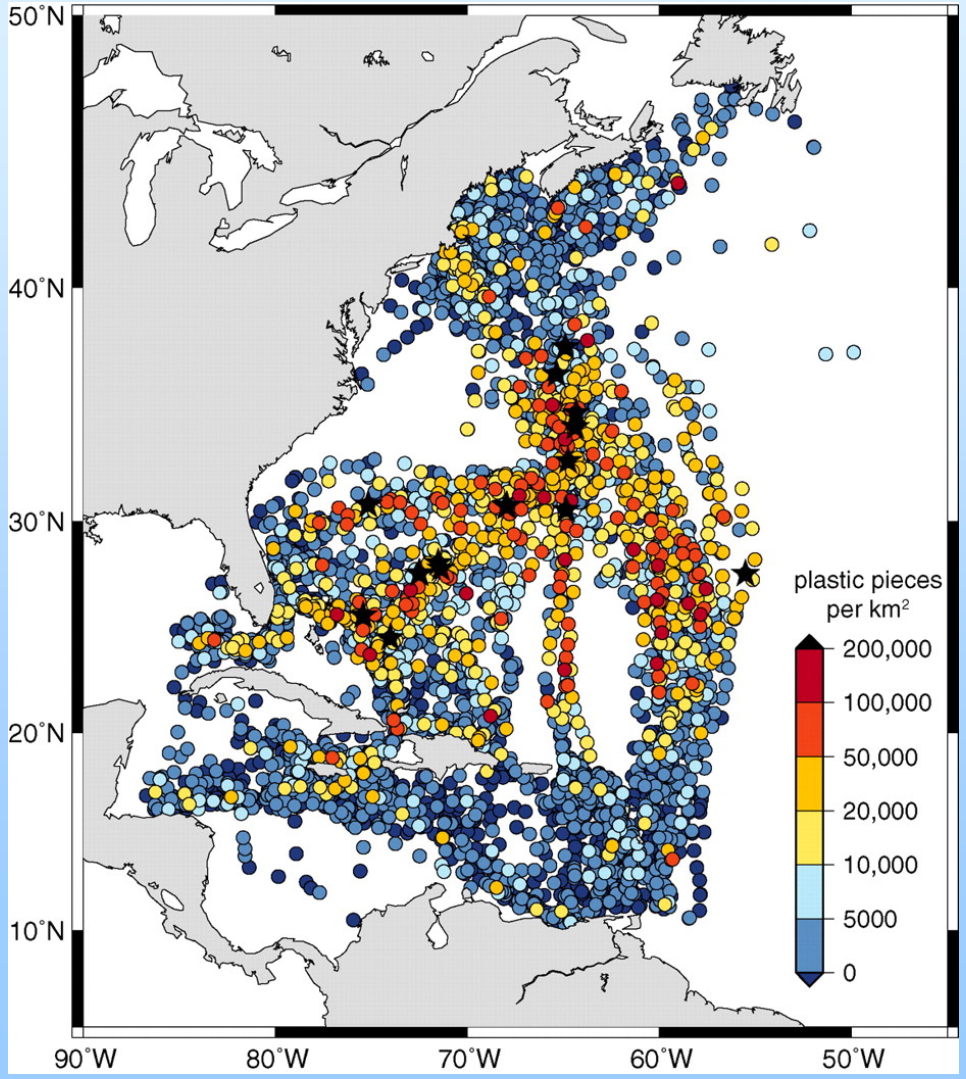
It floats:

- 99% less dense than seawater
- HDPE, LDPE, PP

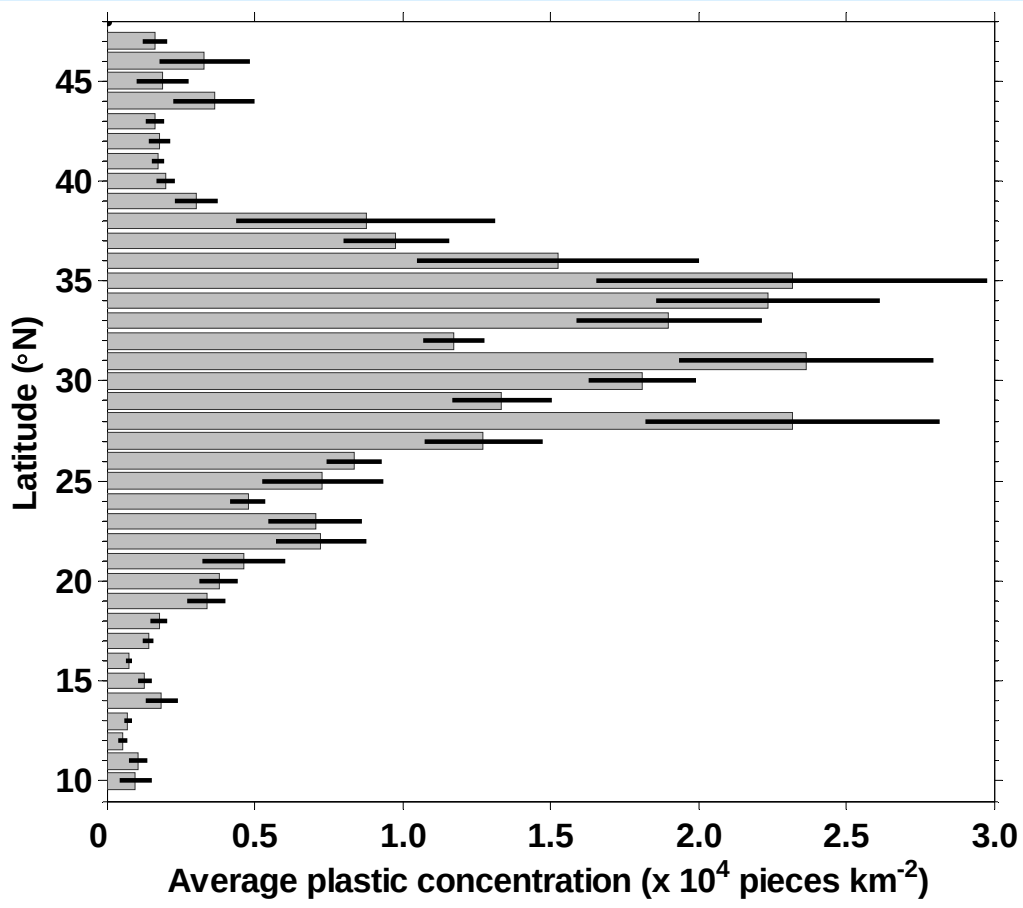
Moret-Ferguson et al., *Mar. Poll. Bull.*, 2010

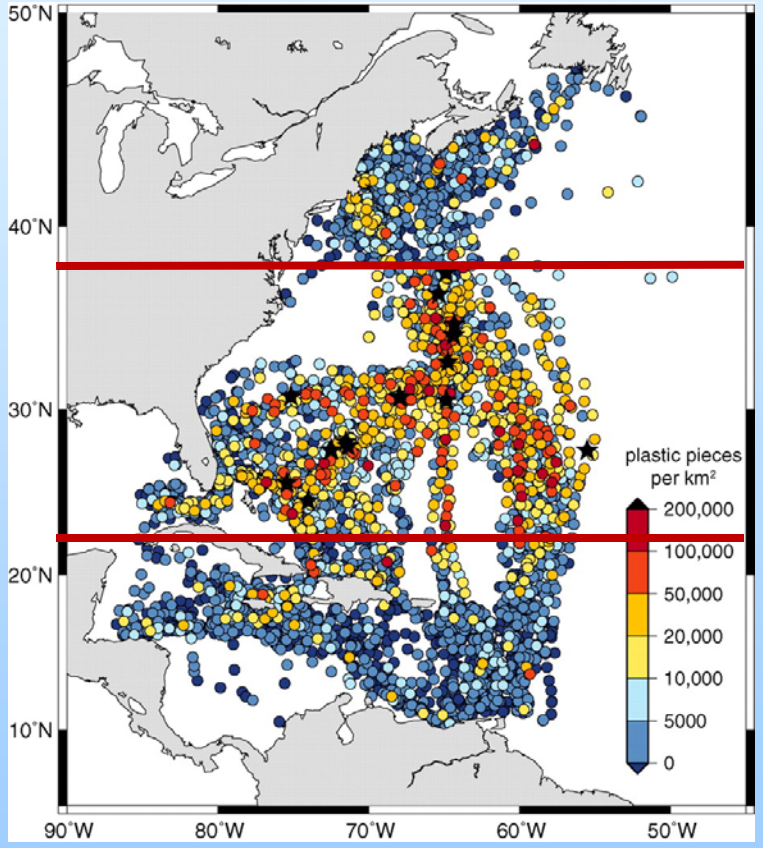
6100+ Surface Net Tows

Collected from 1986-2008



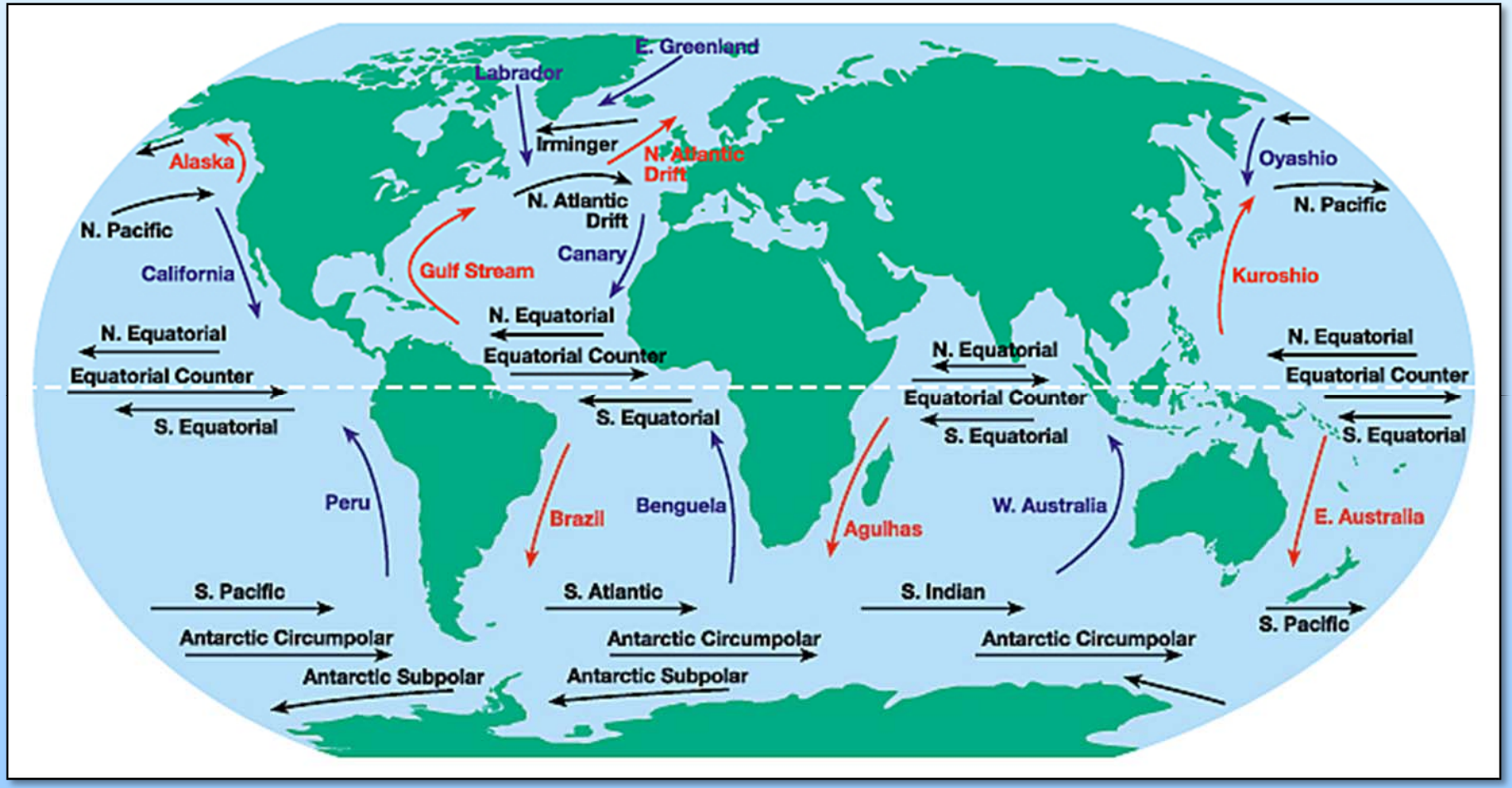
Distribution in Latitude





83% collected between 22°N and 38°N

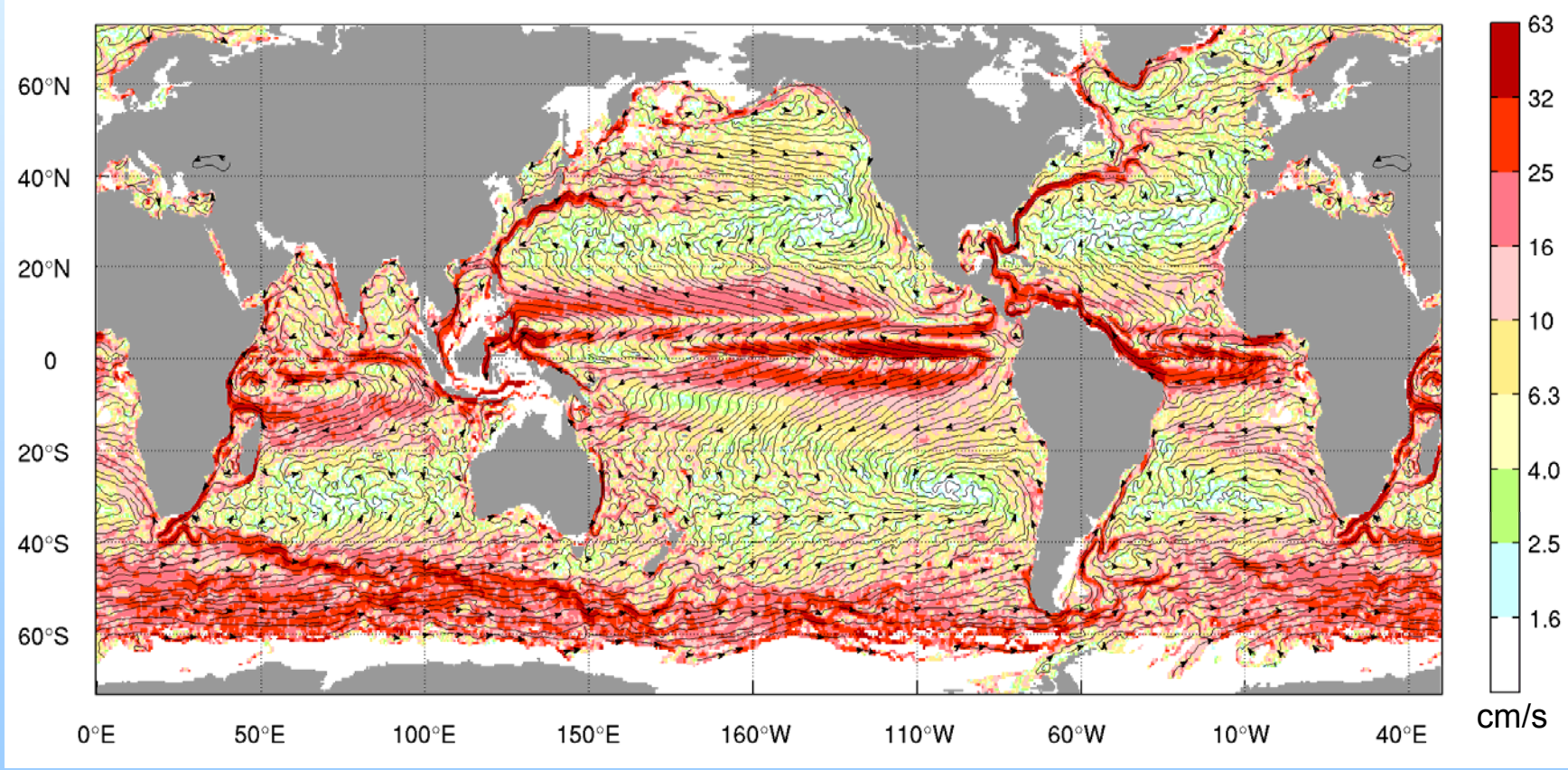
Major Ocean Surface Currents



http://www.windows2universe.org/earth/Water/ocean_currents.html

Surface Circulation

10-year average from ocean measurements



Maximenko et al., *J.Atm.Ocean.Tech.,* 2009

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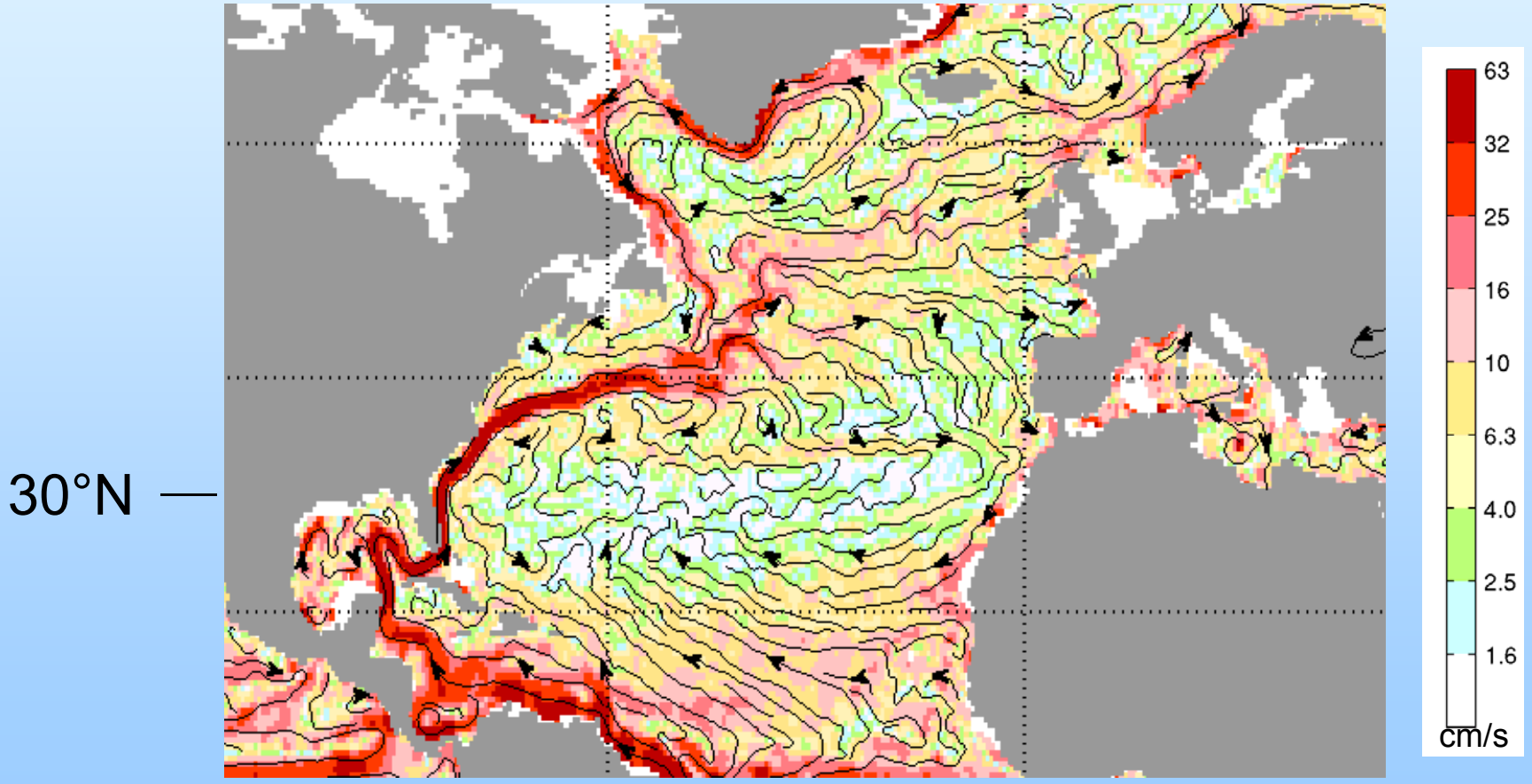
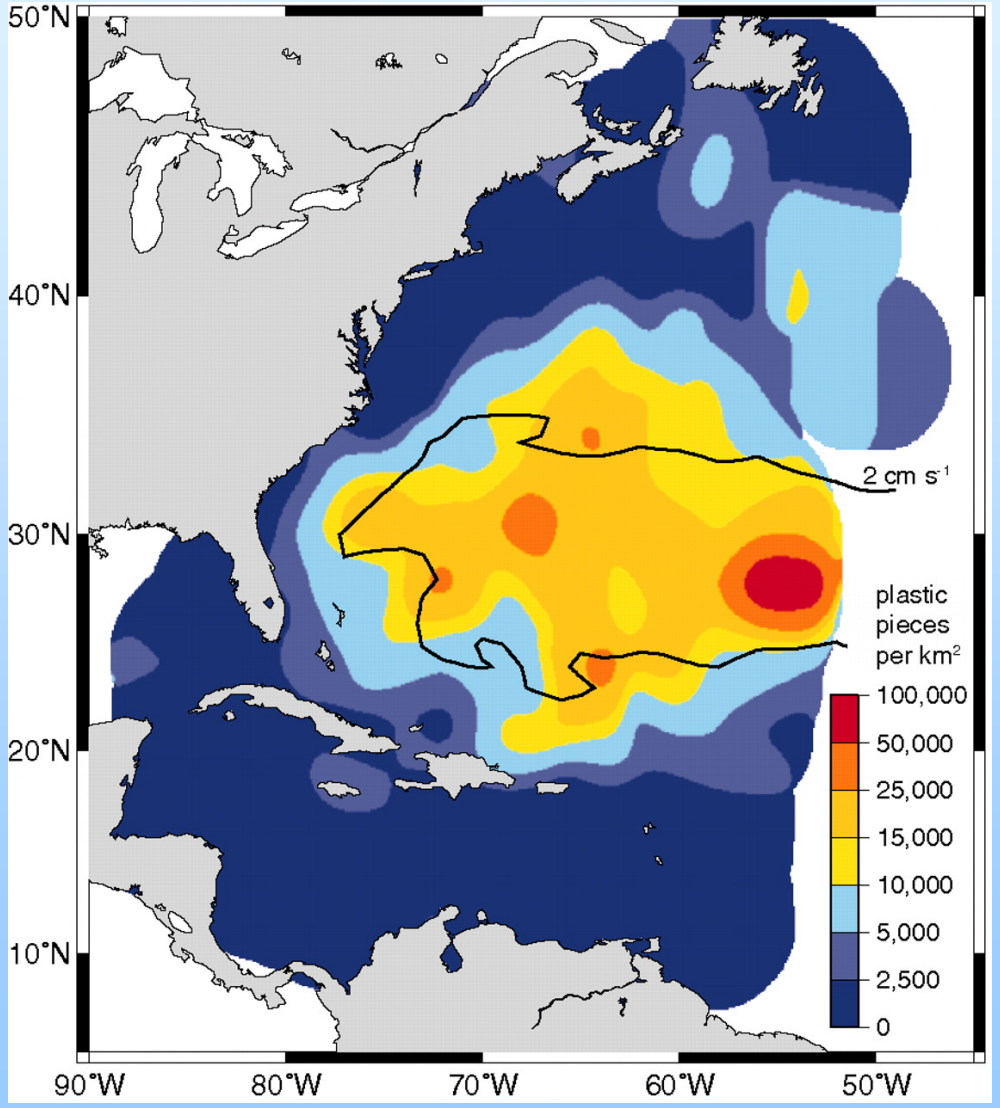


Maximenko et al., *J.Atm.Ocean.Tech.,* 2009

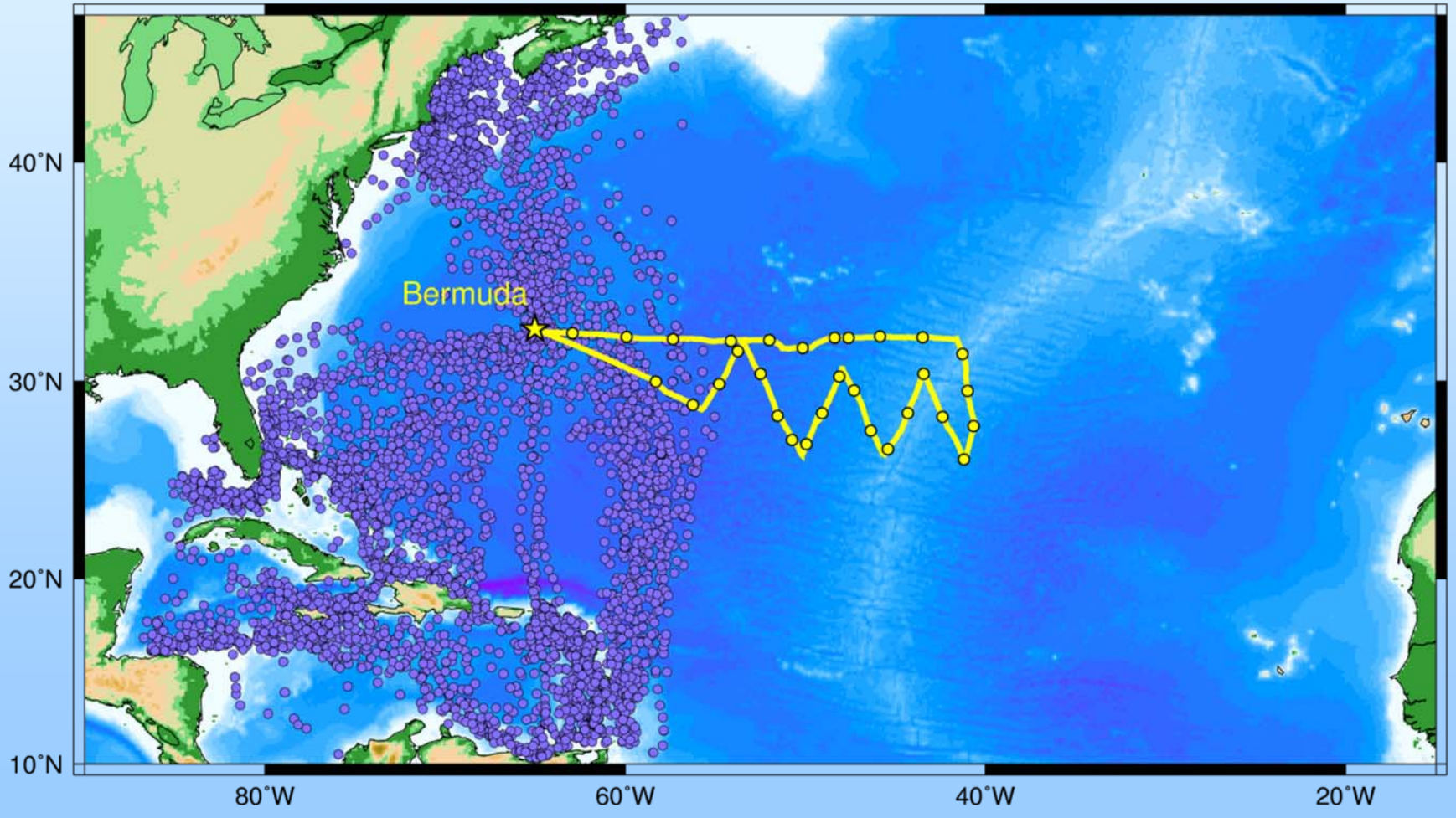
Plastic Debris and Circulation



Plastics at SEA

North Atlantic Expedition 2010

Building on 25 years of plastic pollution research at Sea Education Association



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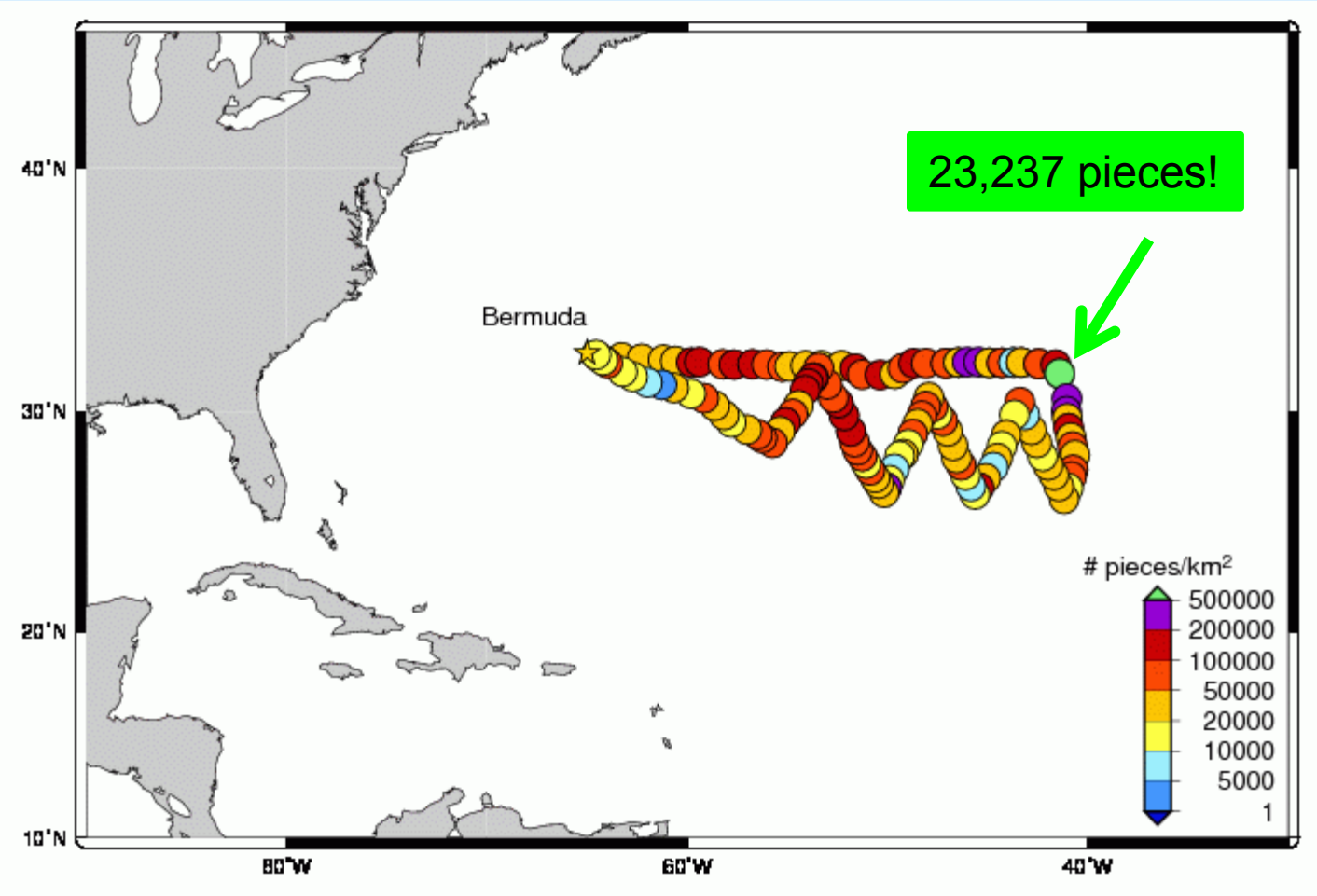


Plastics at SEA

North Atlantic Expedition 2010

Building on 25 years of plastic pollution research at Sea Education Association

Home | About the Expedition | Daily Journal | Science Results | Shipboard Life | Expedition Team | Gallery

Expedition Summary
June 10-July 14, 2010

Number of plastic pieces counted: 48,571

Number of plankton net tows: 128

Distance traveled: 3817 nautical miles

Fuel consumed: 2032 gallons

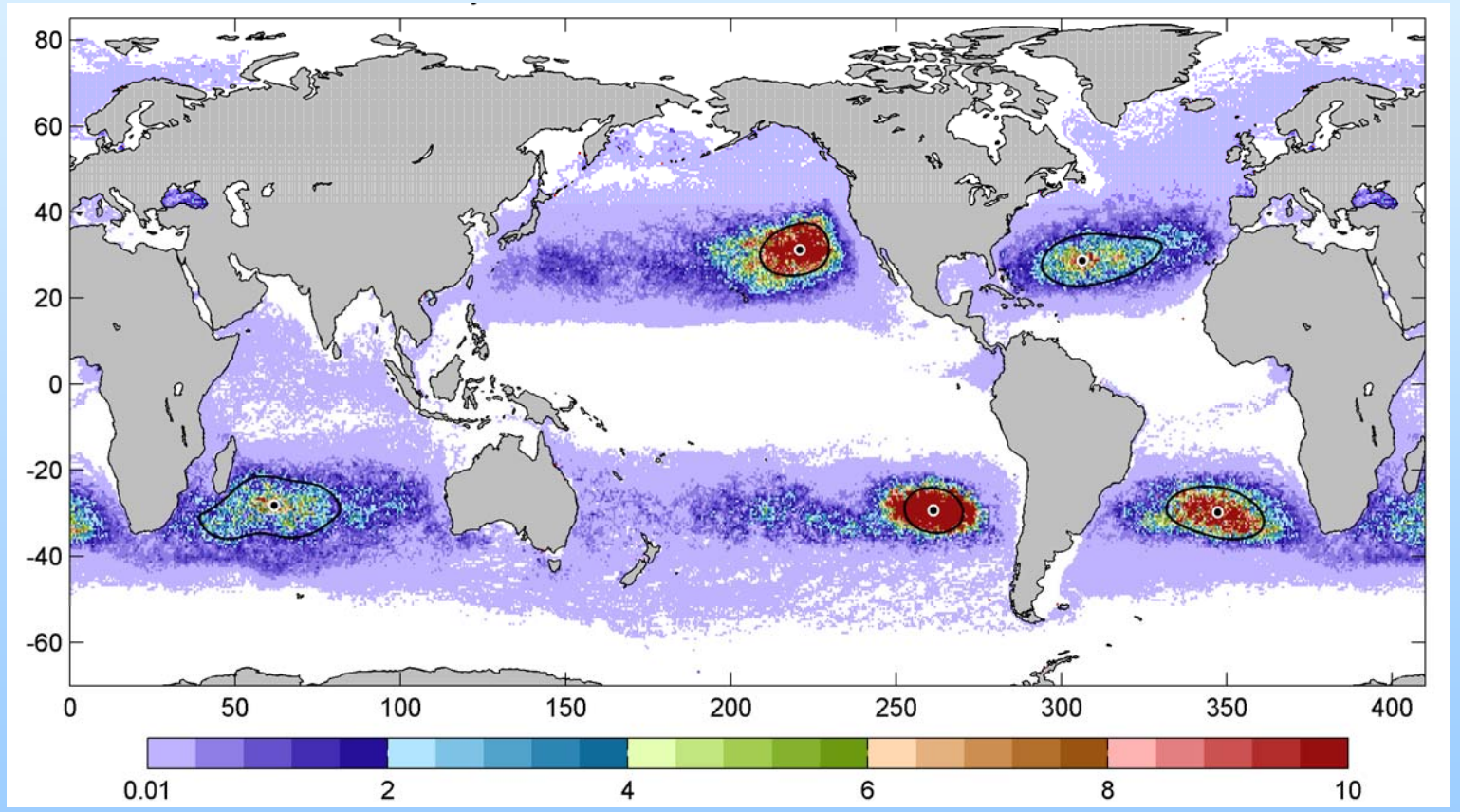
Days at sea: 34

People on board: 33

www.sea.edu/plastics

Subtropical accumulation zones

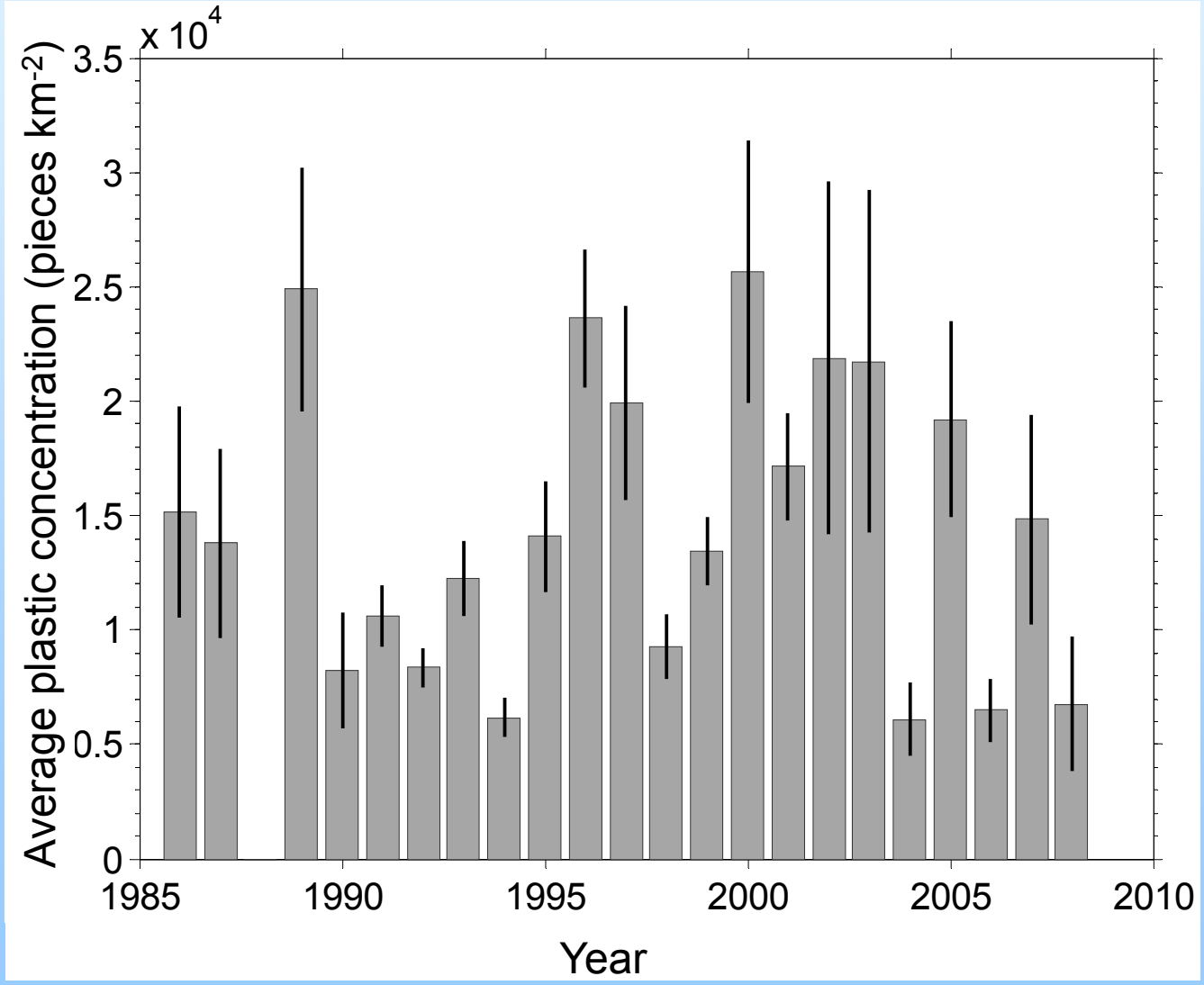
Numerical model predictions



Dohan and Maximenko, *Oceanography*, 2010

Trend in Plastic Concentration

In accumulation zone, 1986-2008



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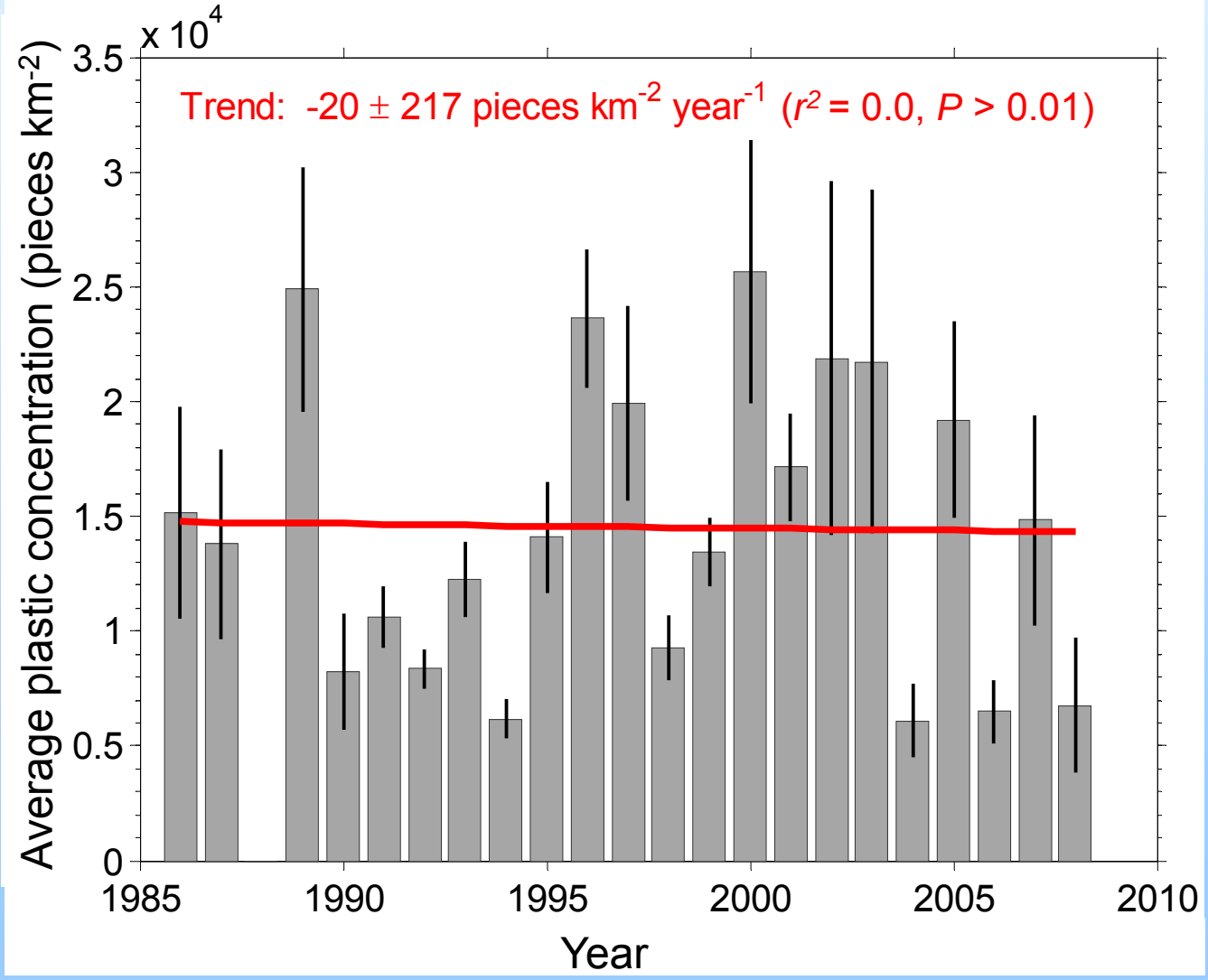
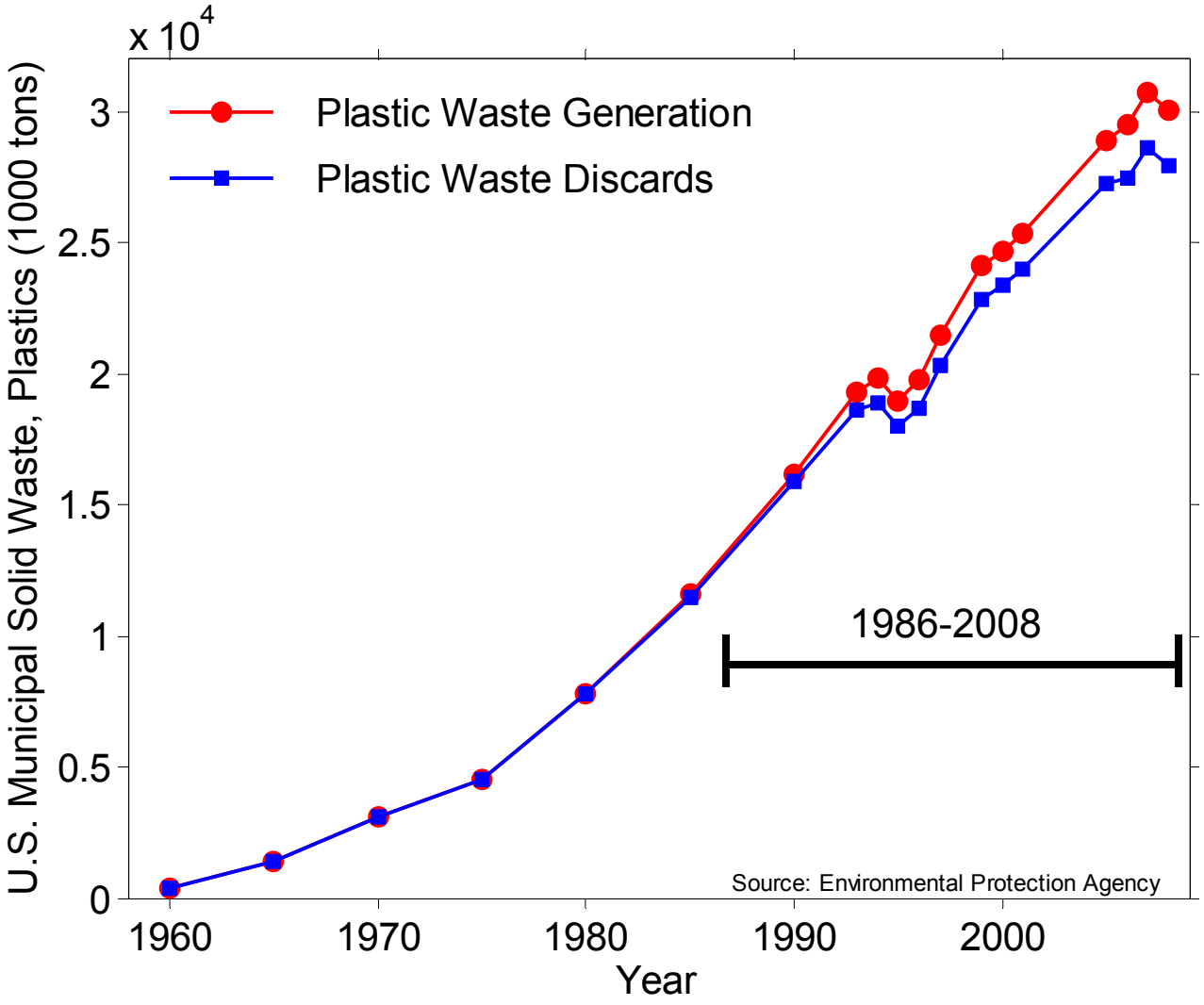


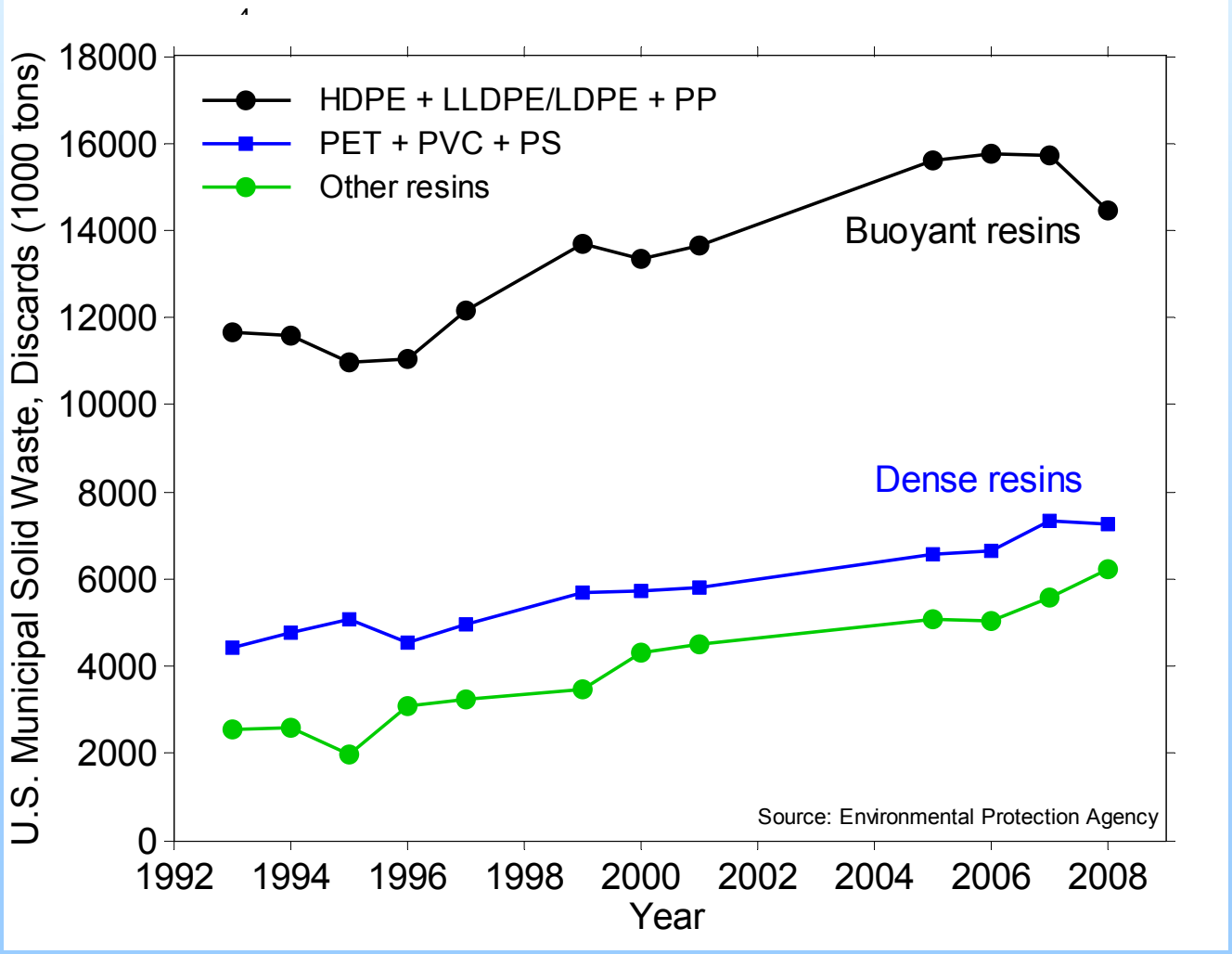
Quantifying the Source



Investigating the Trend
Floating Plastic Debris

- Sampling Bias
- Variability in surface ocean currents
- Change in source: material composition

Plastic Resins in Municipal Solid Waste

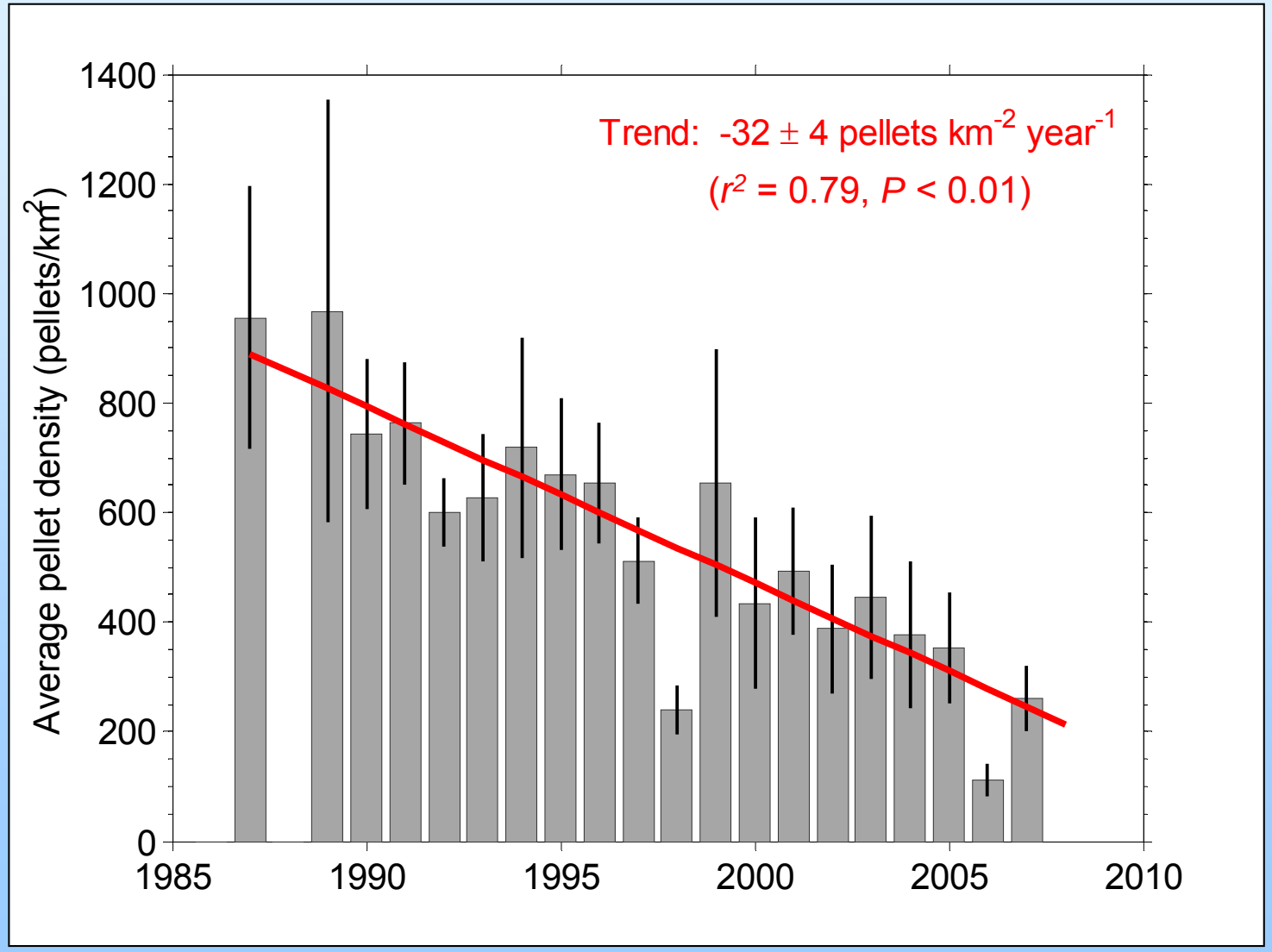


Investigating the Trend
Floating Plastic Debris

- Sampling Bias
- Variability in surface ocean currents
- Change in source: material composition
- Removal Mechanisms:
  - Fragmentation
  - Sedimentation
  - Shore deposition
  - Ingestion

Trend in Resin Pellets

Entire region, 1986-2008



Outstanding Questions

- How much plastic is in the ocean?
- Where is it located?
- What is the fate of plastic marine debris?
- What are the biological implications?
- What are the chemical implications?

Scientific Summary

- SEA's 22-year plastic marine debris data set is the longest and most extensive record of plastic marine debris in any ocean
- These data provide an important baseline
- Plastic debris accumulates in the subtropical convergence of the western North Atlantic
- Despite a likely increase in source input, a robust increasing trend in floating plastic debris has not been observed in the North Atlantic accumulation zone

Are "*Garbage Patches*" a problem?

- Let's just clean it up!

- Won't new "biopolymers" prevent the problem from getting worse?

<u>The solution:</u>

CONTROL at the SOURCE

Reduce, Reuse, Recycle

Acknowledgements

Skye Morét-Ferguson

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University of Hawai'i, Manoa

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 more than 100,000 pieces of plastic from plankton nets.

www.sea.edu