

Sources and Distribution of Microplastics in the Environment

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Litter on the beach is marine debris

TOP 10 ITEMS COLLECTED



1 Cigarette Butts
2,248,065



6 Other Plastic Bags
489,968



2 Food Wrappers
(Candy, chips, etc.)
1,376,133



7 Grocery Bags
(Plastic)
485,204



3 Beverage Bottles
(Plastic)
988,965



8 Beverage
Bottles (Glass)
396,121



4 Bottle Caps (Plastic)
811,871



9 Beverage Cans
382,608



5 Straws, Stirrers
519,911



10 Cups & Plates
(Plastic)
376,479

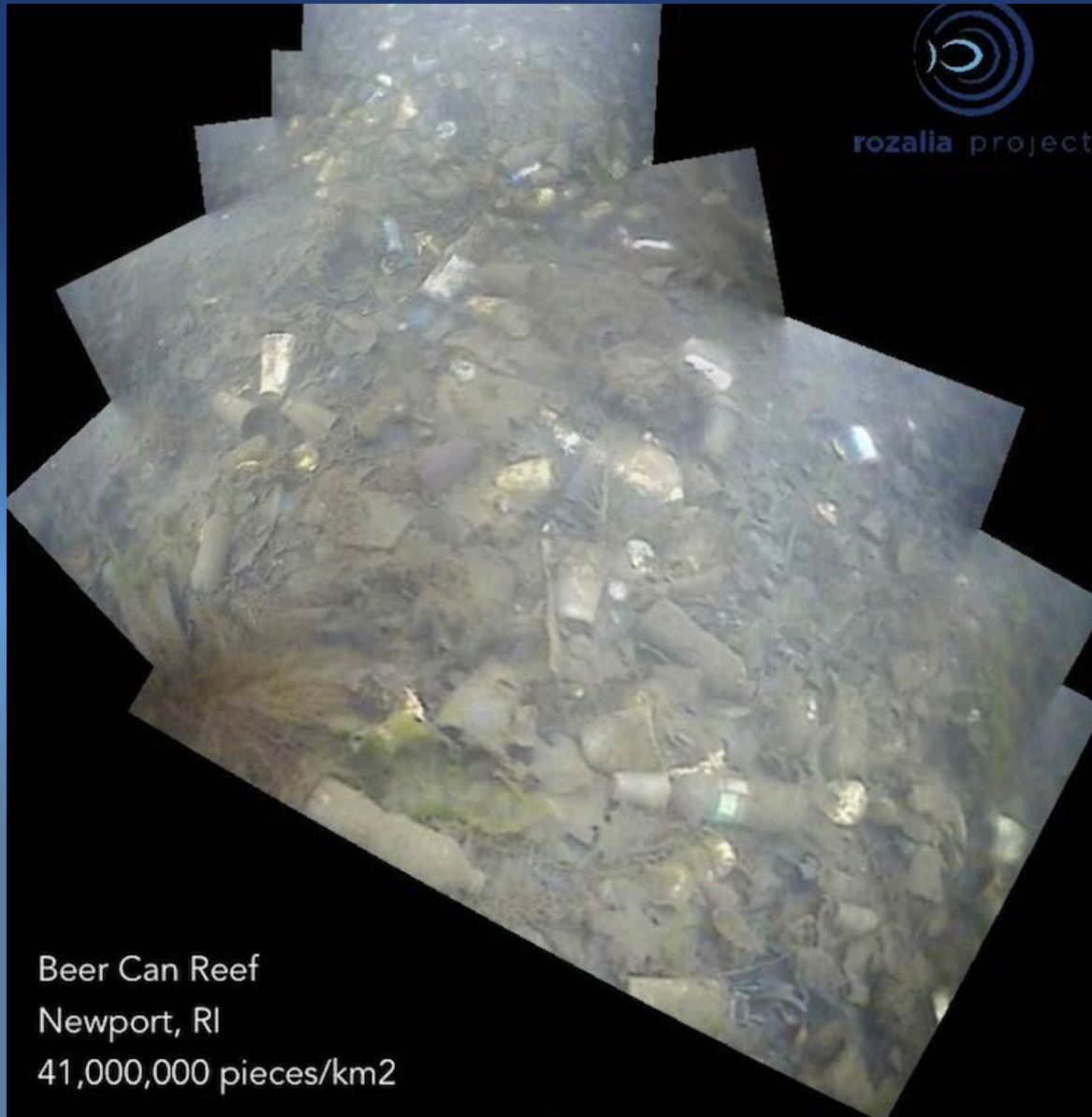


Marine debris floats across oceans

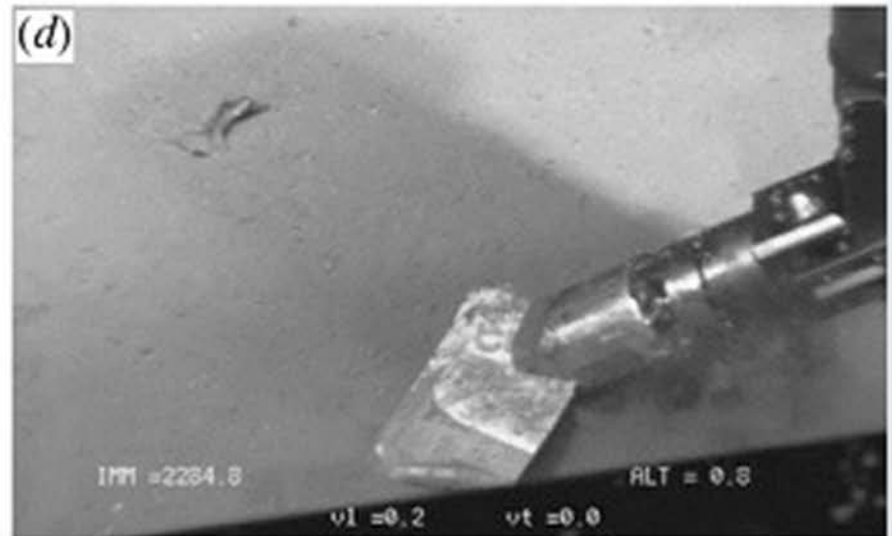


Jon Waterman/Sea Education Association (SEA)

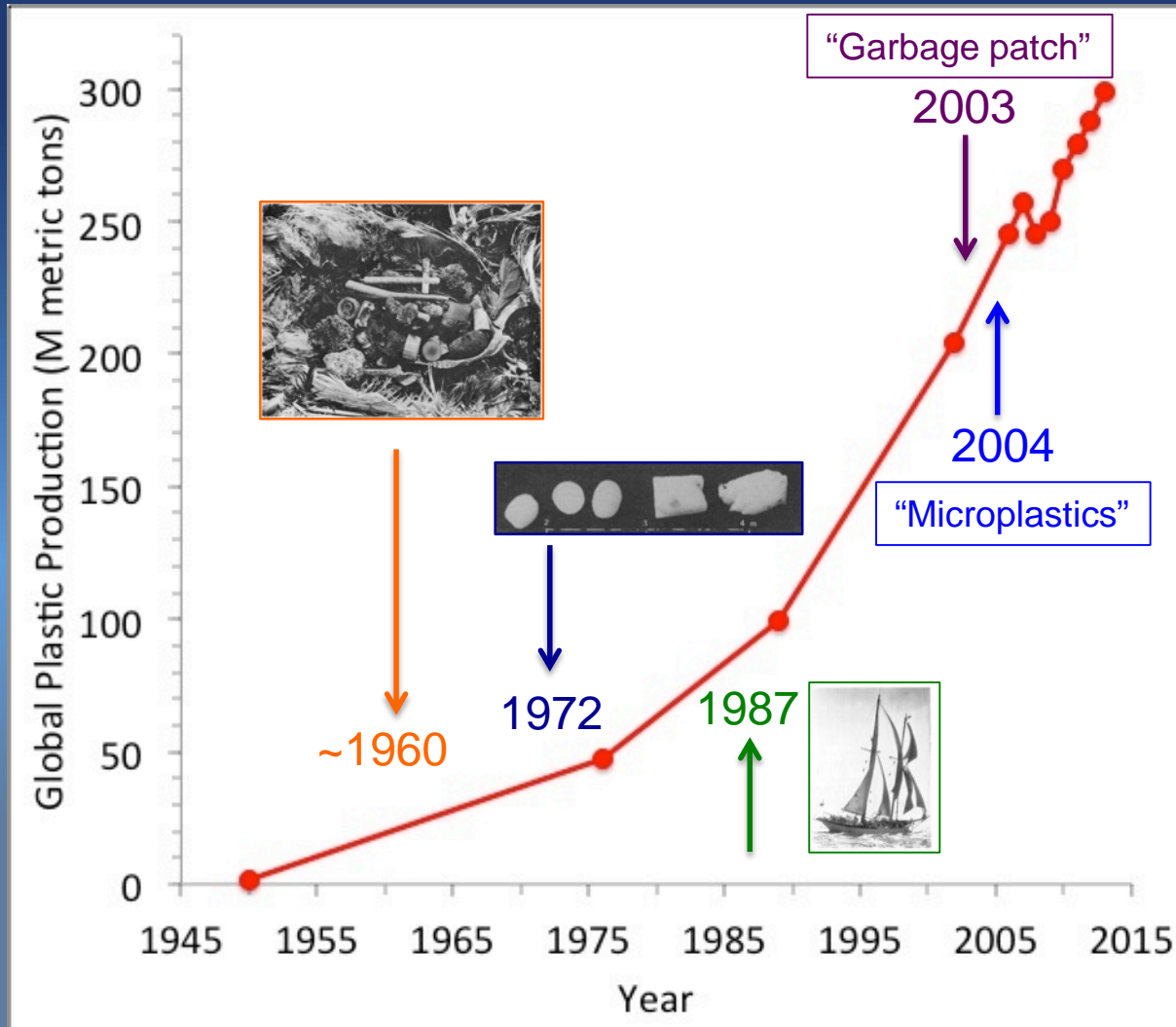
Litter on the seabed is marine debris



Marine debris is in deep and remote places



Plastics production since 1950



Kenyon and Kridler (1969)
Carpenter et al. (1972)
Wilber (1987)
Moore (2003)
Thompson et al. (2004)

Microplastics are the most abundant debris

Sea surface



Giora Proskurowski/Sea Education Association



Beaches

Nicholas Mallos/Ocean Conservancy

Microplastics are the most widespread debris

Sea surface



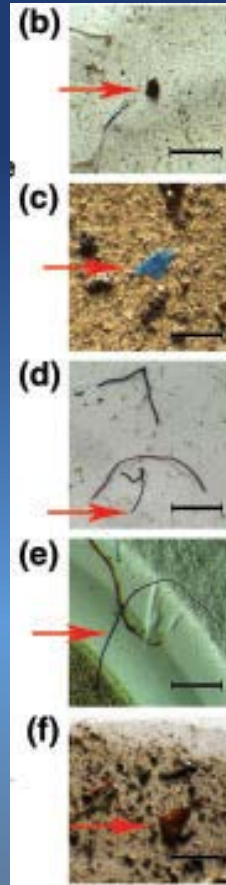
Giora Proskurowski/Sea Education Association



Nicholas Mallos/Ocean Conservancy

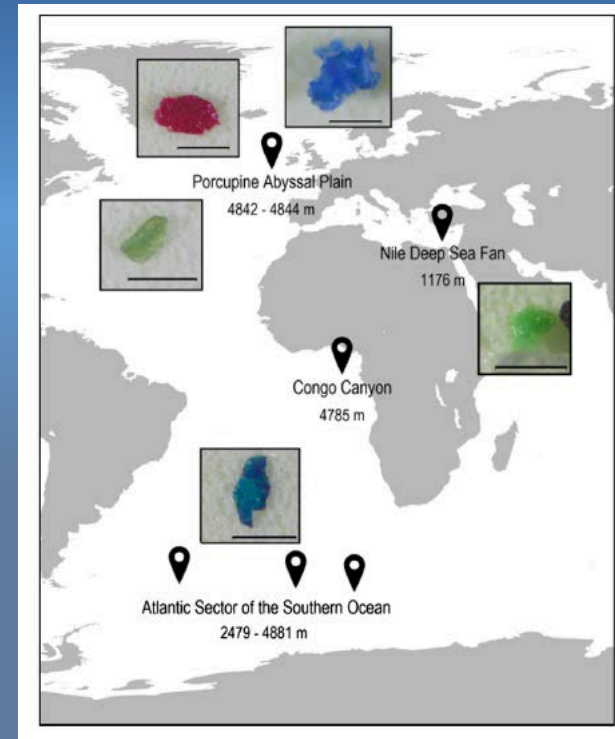
Beaches

Arctic sea ice



Obbard et al. (2014)

Deep-sea sediments



Van Cauwenberghe et al. (2013)

The need for synthetic science



NCEAS Marine Debris Working Group

2011-present



NCEAS

National Center for Ecological Analysis and Synthesis

University of California, Santa Barbara, U.S.A.

www.nceas.ucsb.edu

- Scientifically based
- Solutions oriented
- Applicable to management and policy



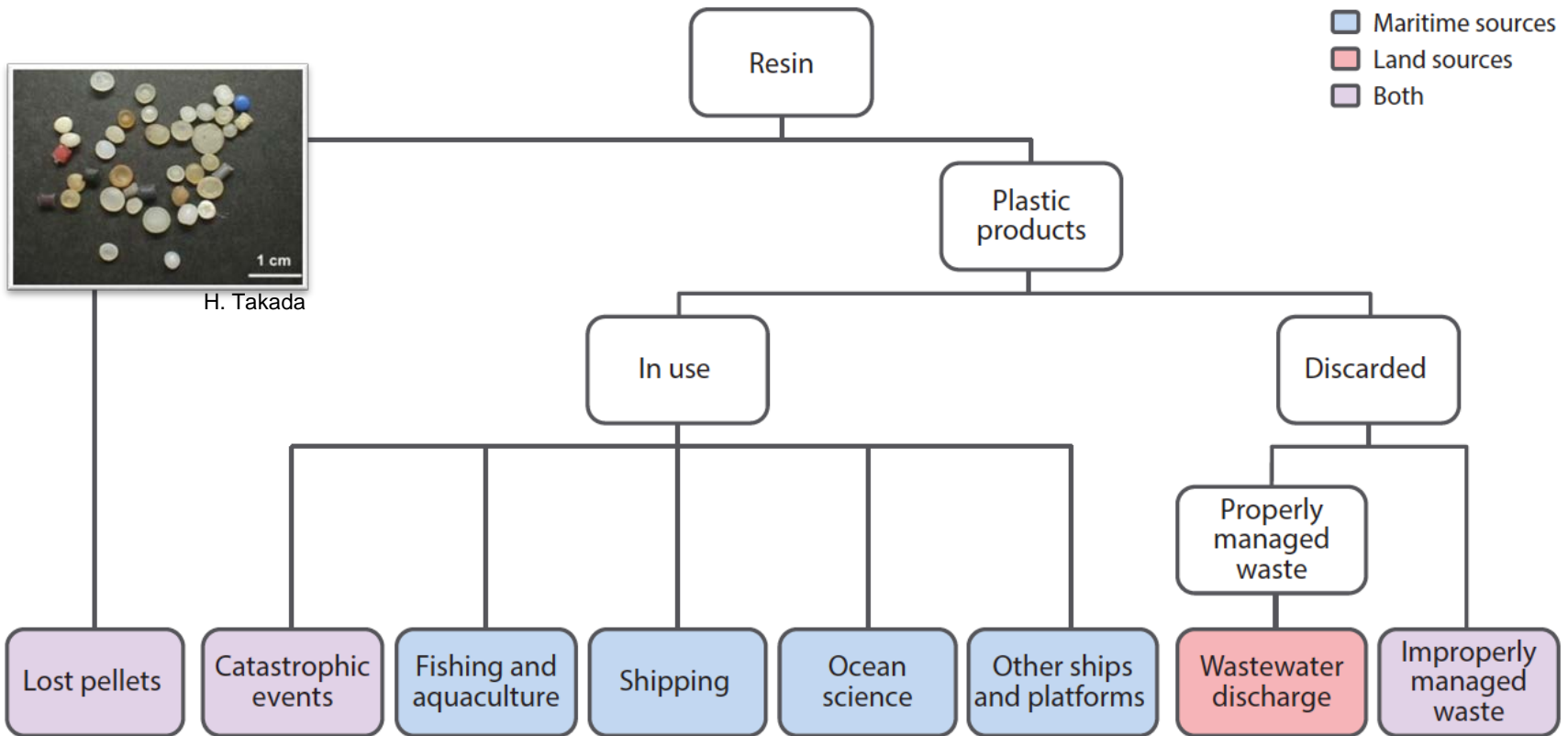
Ocean Conservancy



Research and Synthesis Goals

- I. Quantify the sources of plastic to the marine environment

I. Sources of plastic to the ocean

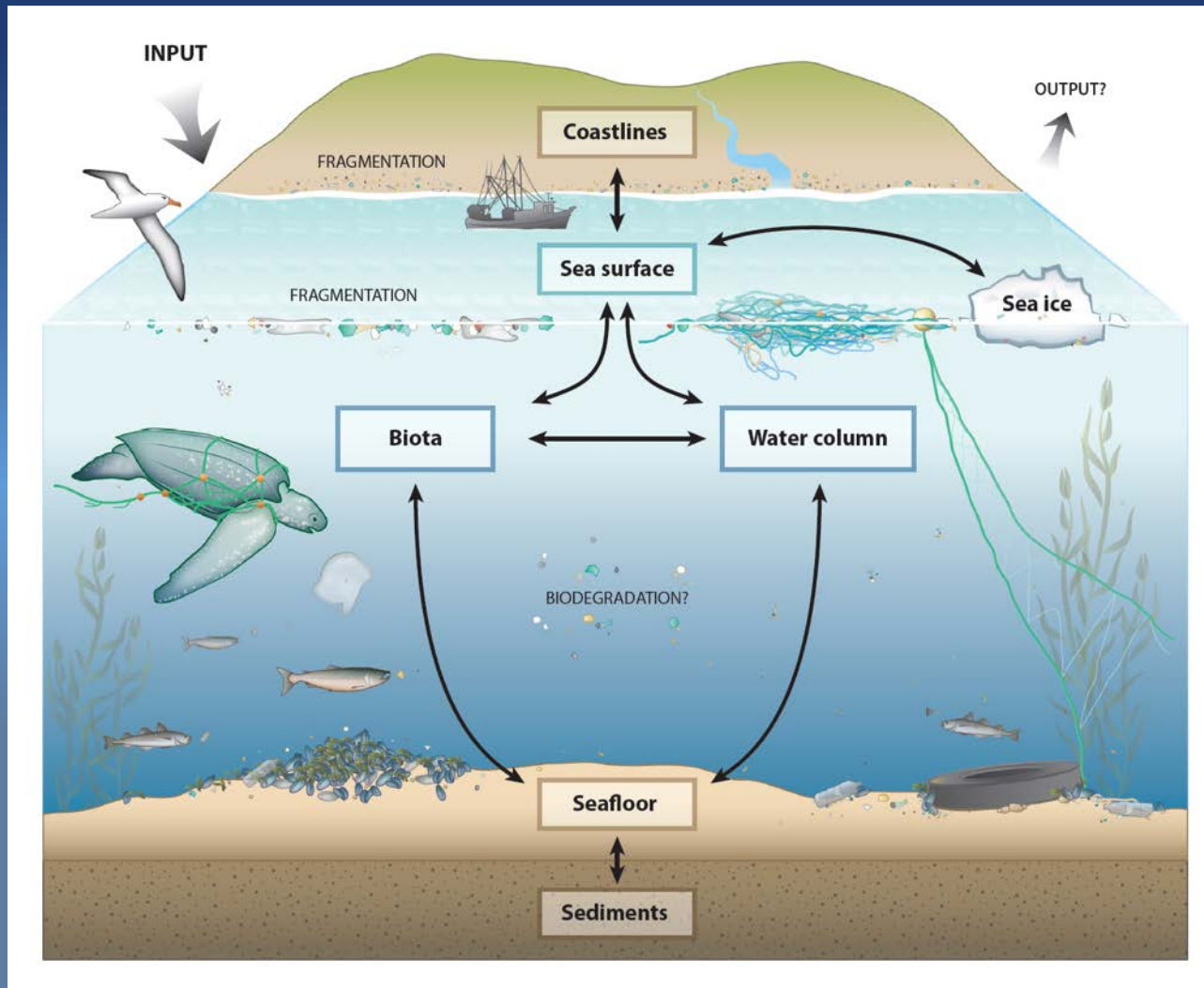




Research and Synthesis Goals

- I. Quantify the sources of plastic to the marine environment
- II. Quantify plastic debris in the marine environment from environmental data

II. A mass balance framework





Research and Synthesis Goals

- I. Quantify the sources of plastic to the marine environment
- II. Quantify plastic debris in the marine environment from environmental data
- III. Synthesize and analyze the risks and impacts of debris in the environment

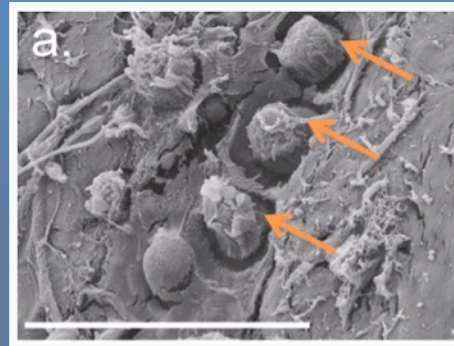
III. Known Ecological Risks



www.chrisjordan.com



Sea Education Association



Zettler et al., *ES&T* 2013



DDT
PCBs
PAHs
PBDEs

See Rochman et al., *Ecology* 2015



Research and Synthesis Goals

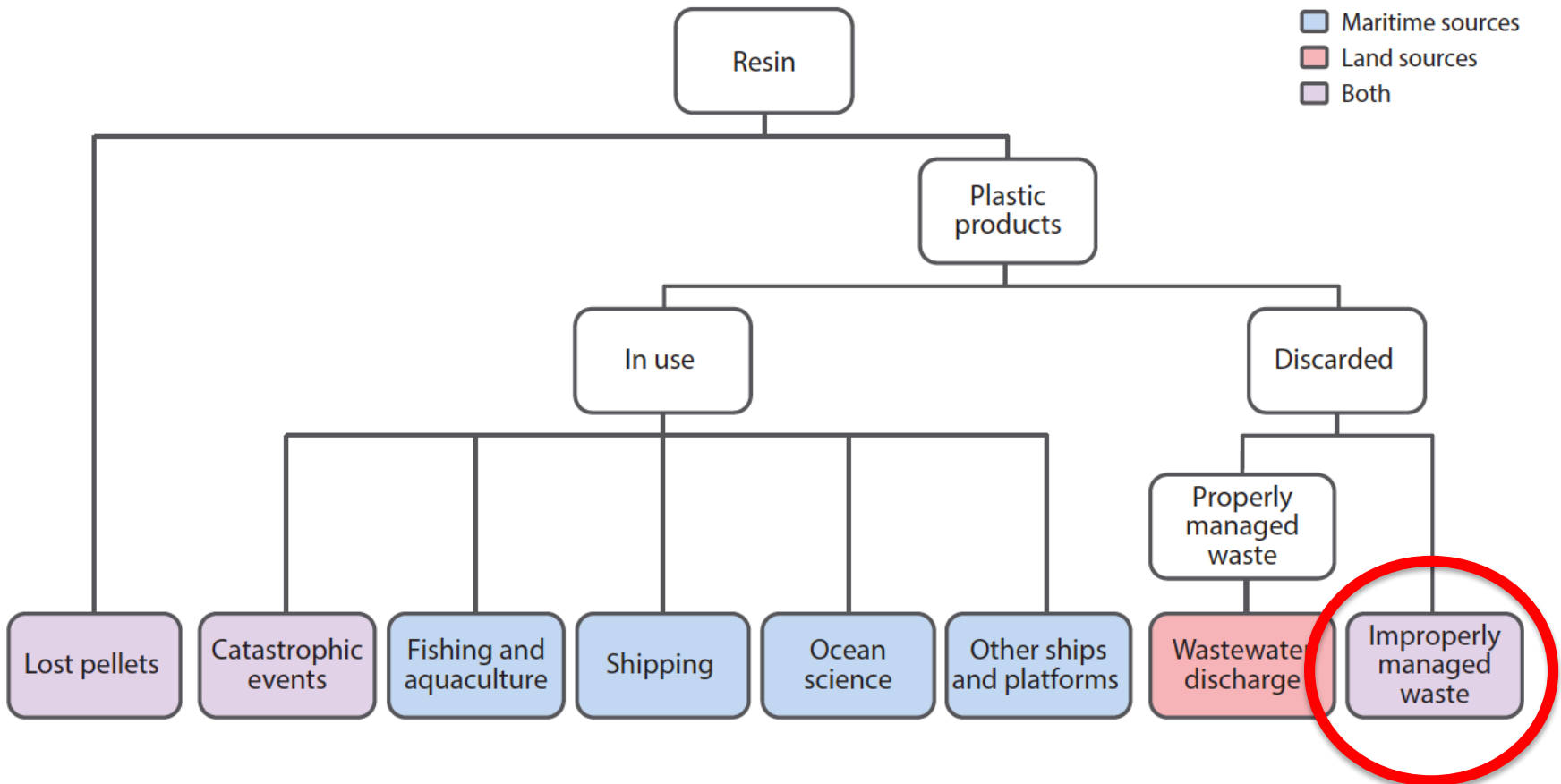
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- II. Quantify plastic debris in the marine environment from environmental data
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- IV. Create a risk assessment framework for plastic debris



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I. Sources of plastic to the ocean



Source: Improperly managed waste on land

Jambeck et al., *Science* 2015



Measuring floating plastic in the ocean



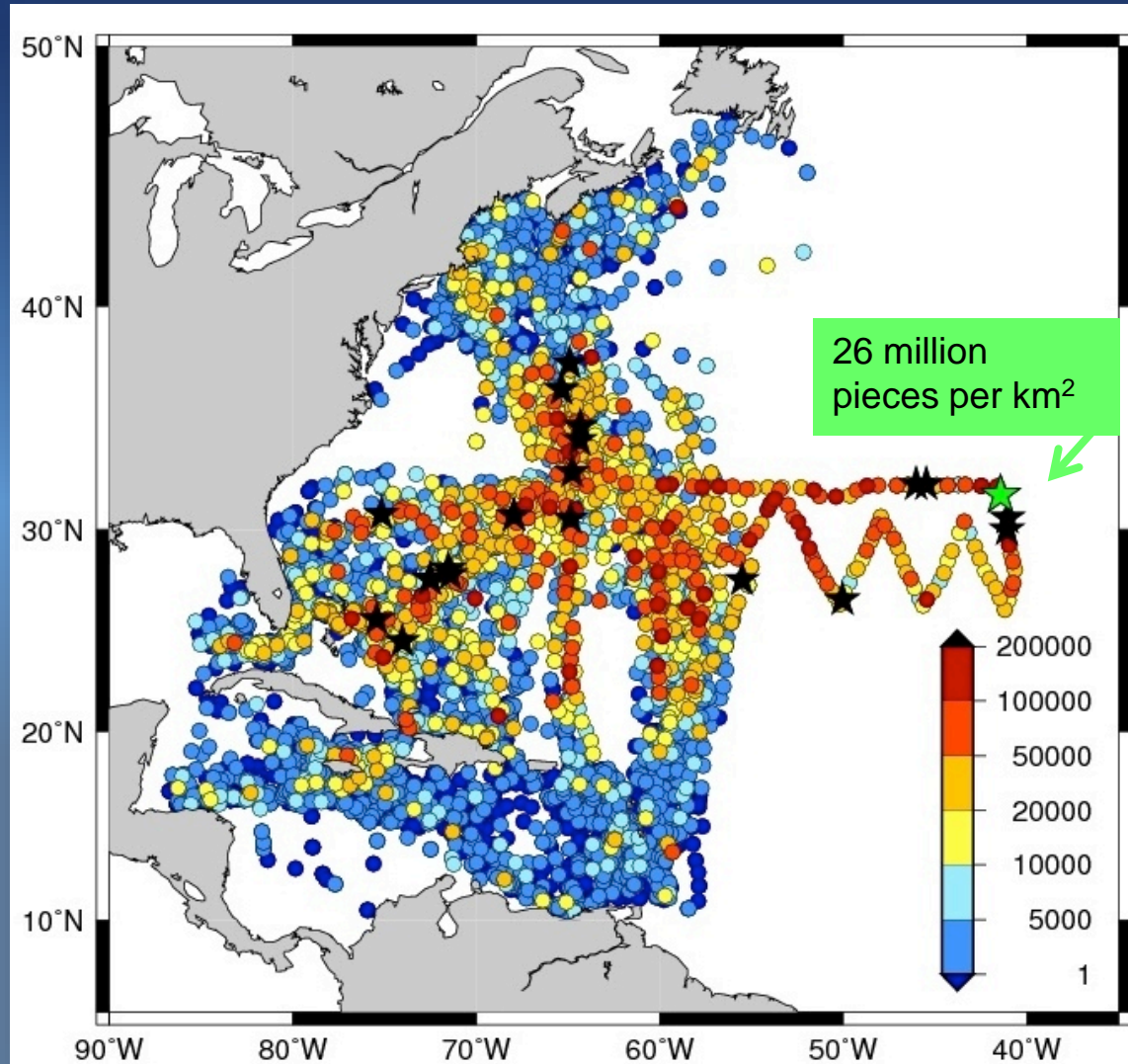
Measuring floating plastic in the ocean



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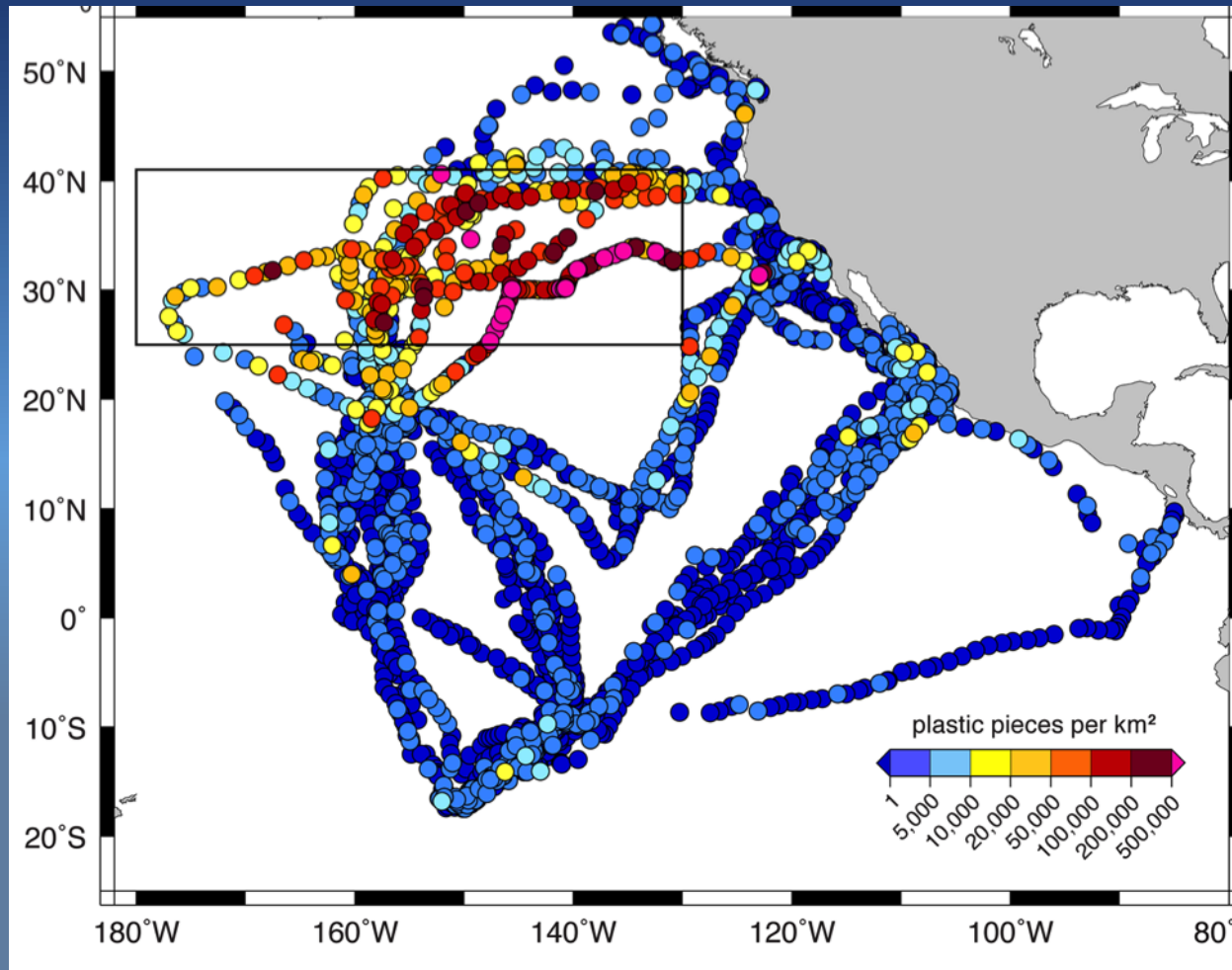
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Quantifying floating plastic in the ocean



N. Atlantic:
1,100 tons

Quantifying floating plastic in the ocean



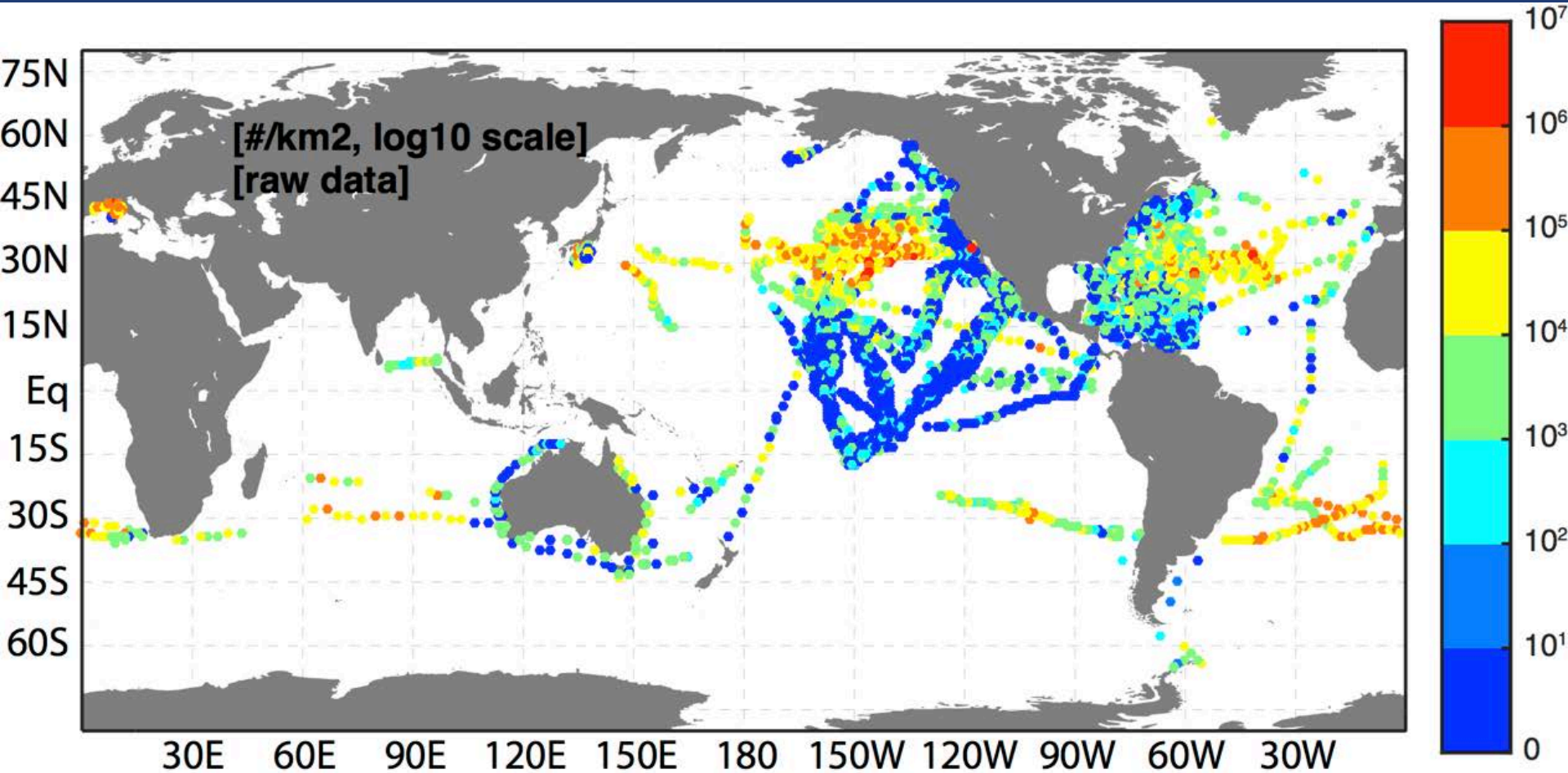
N. Pacific:
21,000 tons





Plankton net data

1971 – 2013; > 11,000 tows



How much small plastic is floating in the global ocean?

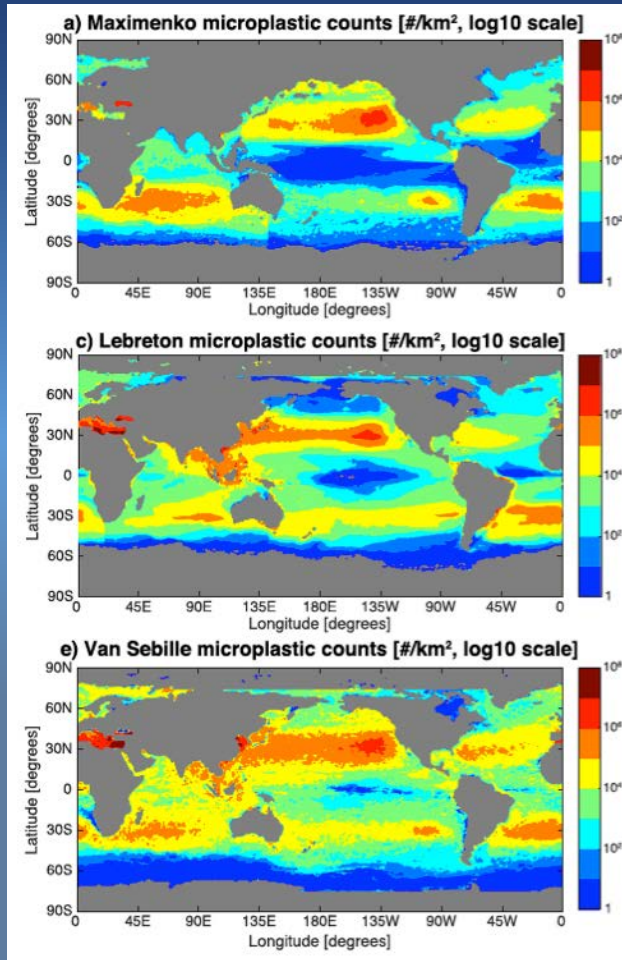
Global Estimate

93,000 tonnes

152,000 tonnes

236,000 tonnes

Model #1



Model #2

Model #3



Input from land vs. Global inventory

Input from Land:

8 million metric tons per year



Los Angeles River, Rick Loomis, LA Times

Floating at sea surface:

93 – 236 thousand metric tons



North Atlantic, Sea Education Association

WHERE IS ALL THE PLASTIC??

How much LARGE plastic is FLOATING?



Jon Waterman/SEA



How much plastic is on SHORELINES?



← Large debris

Microplastics →



See Browne et al., *ES&T* 2015

How much plastic is in MARINE LIFE?



Chris Jordan

← Consumer items

Microplastics →



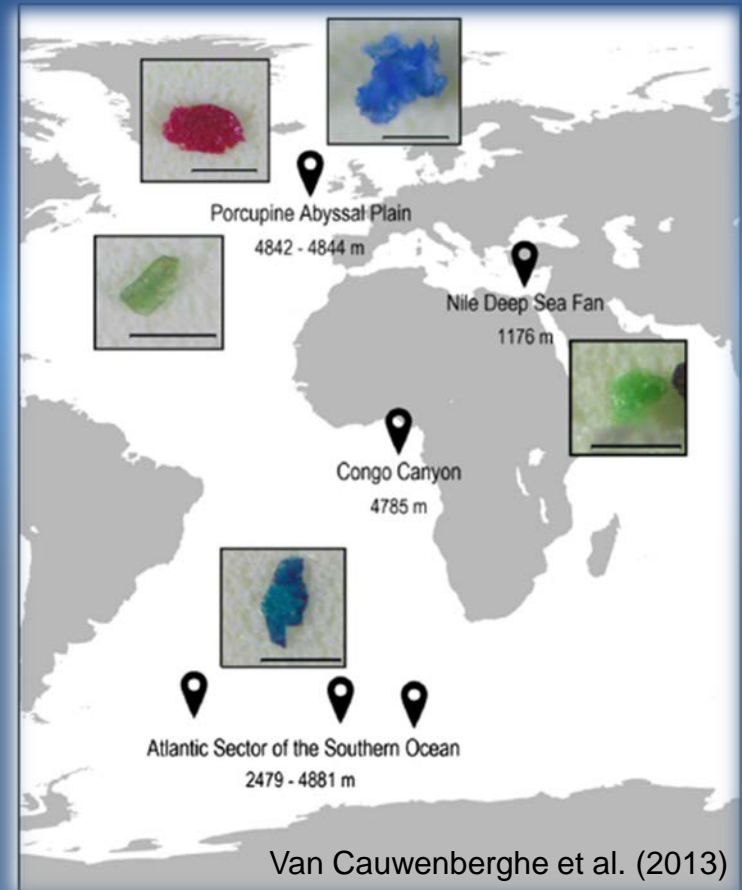
David M. Lawrence/SEA

How much plastic is on the SEAFLOOR?



← Large debris

Microplastics →



Input from land vs. Global inventory

Input from Land:

8 million metric tons per year



Los Angeles River, Rick Loomis, LA Times



Floating at sea surface:

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North Atlantic, Sea Education Association

Where is all the plastic??

Fate of plastic marine debris?



??

Short-term mitigation

Global scale

Improve waste management infrastructure



Ted Siegler/DSM
Bien Hoa, Vietnam



Rasta Fariz
Sidoarjo, Bali, Indonesia



Long-term solutions

Local scale: What can I do?

1. Make less waste

- REDUCE consumption of single-use items.
- REFUSE cosmetic products with plastic microbeads.
- REUSE what you can, then RECYCLE.
- Demand end-of-life responsibility from manufacturers.

2. “Last-Chance Capture”*

- Clean up litter, anywhere and everywhere.
- Participate in beach clean-ups.

3. Implement REDUCTION and RECYCLING initiatives in your school or workplace

4. Pursue policy initiatives

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U. Hawaii

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Ramani Narayan

Anthony Andrady

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CSIRO (Australia)

UC-Santa Barbara

DSM Environmental

Michigan State U.

North Carolina State U.



Ocean Conservancy

Henry L. and Grace
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This work would not have been possible without the dedication of more than 8,000 SEA students, shipboard crew and faculty, and the innumerable hours spent picking plastic from plankton nets.



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