

# Quantifying and characterizing plastic pollution in the ocean: a focus on textile sources

Jennifer Lynch, Ph.D.



Center for Marine  
Debris Research

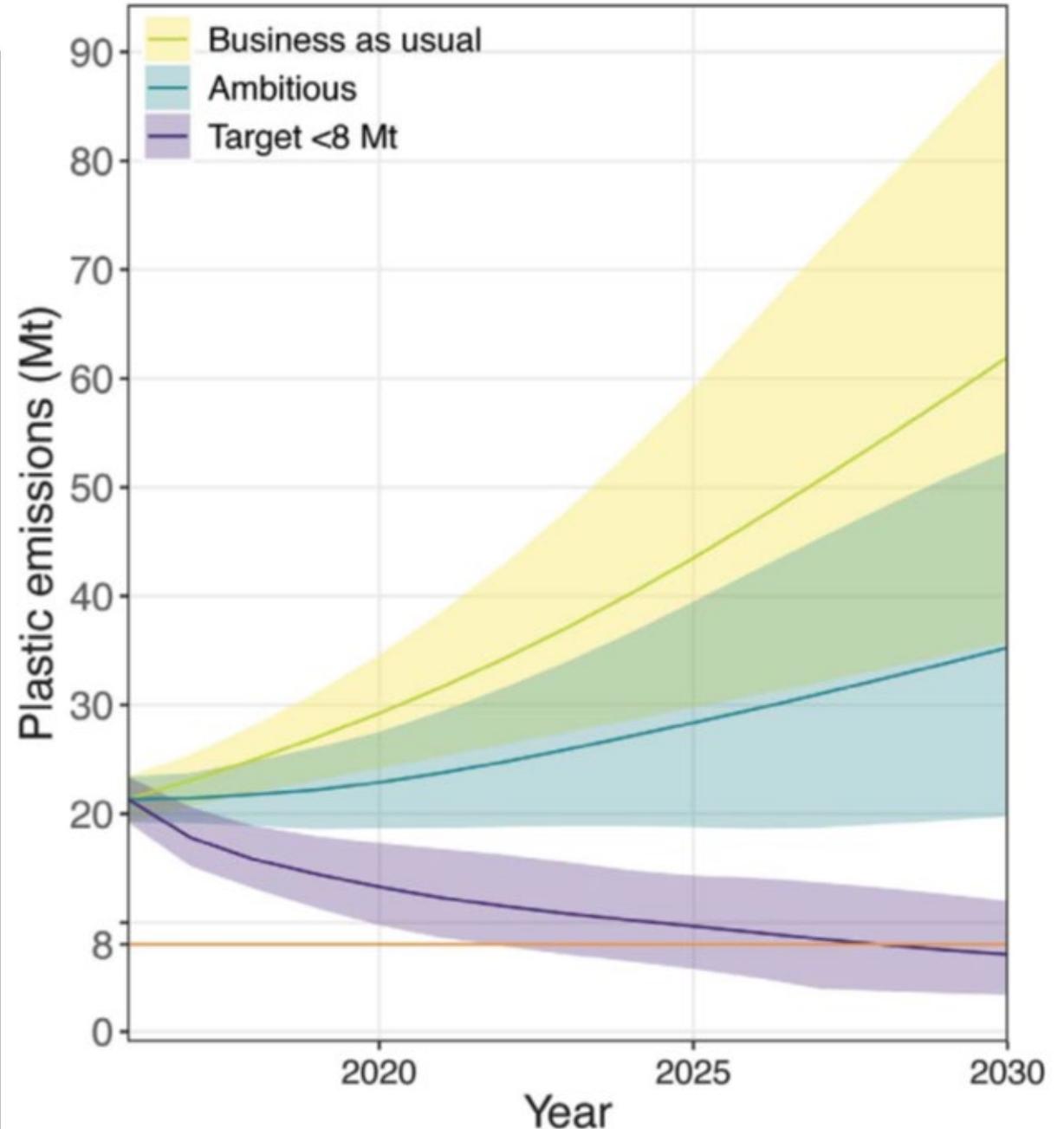
# Disclaimer



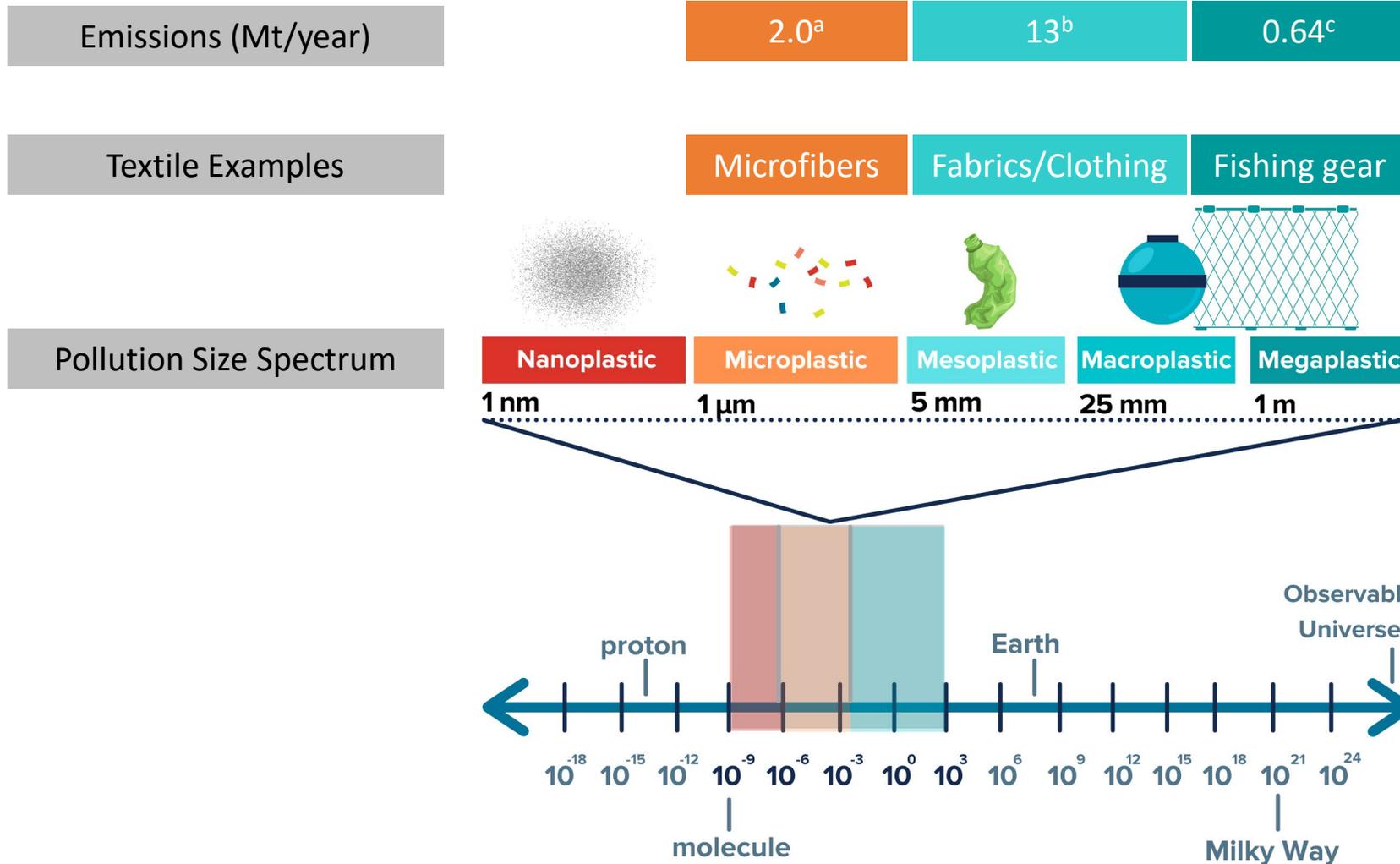
Certain commercial equipment, instruments, or materials are identified in this presentation to specify adequately the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

# Plastic Pollution

- 20-30 Mt of plastic waste enters waters/year (Borrell et al 2020)
- Add 2 to 2.9 Mt for synthetic microfibers (Gavigan et al 2020; Boucher and Friot 2017)

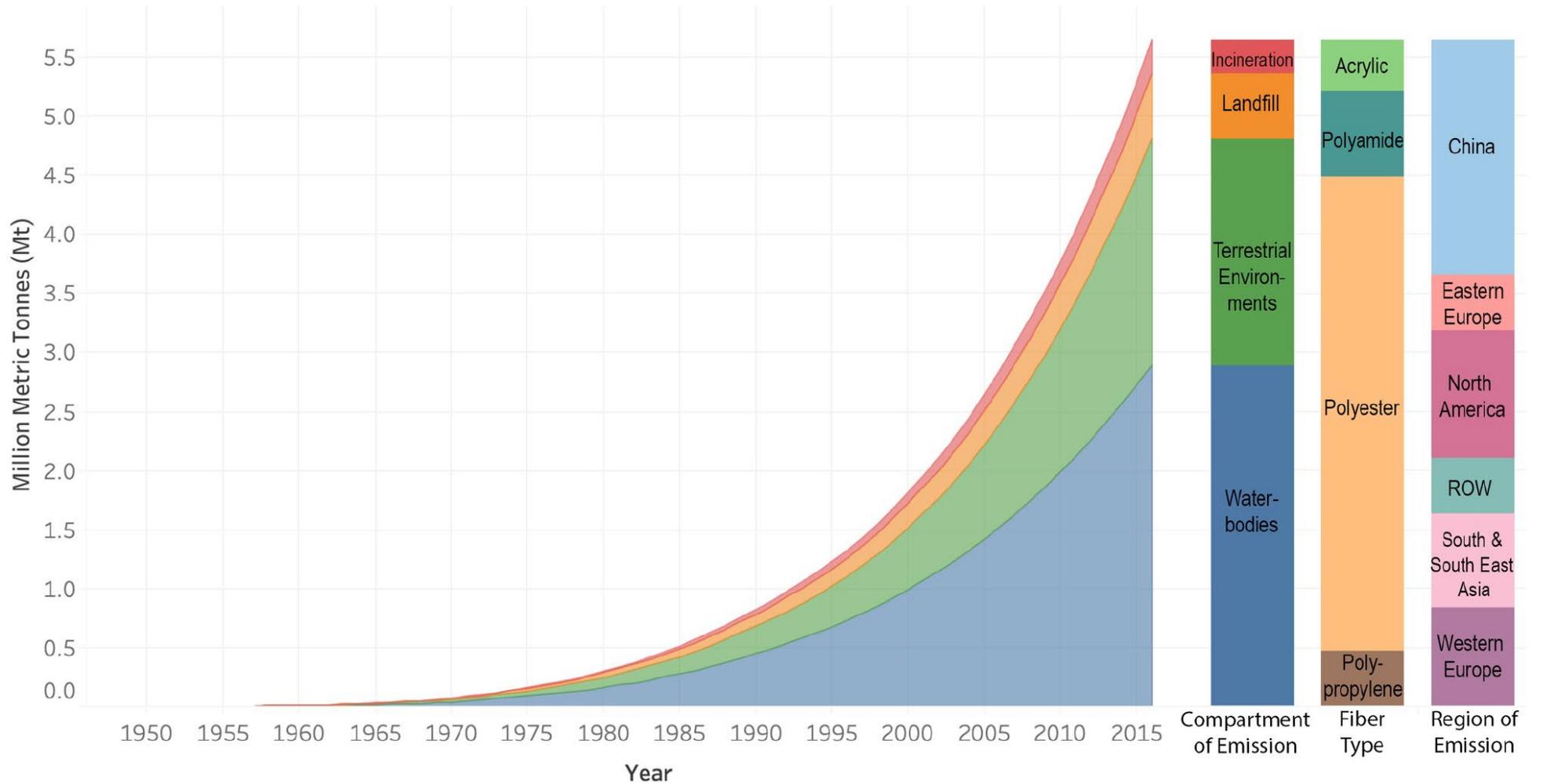


# Plastic Pollution from Textiles



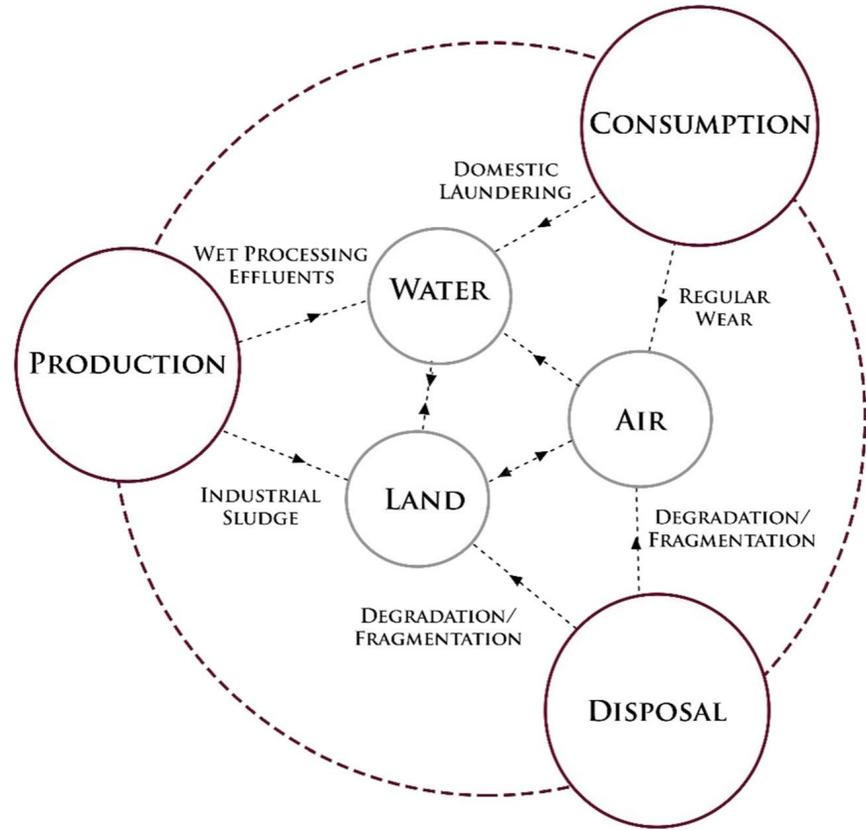
<sup>a</sup>Boucher and Friot 2017  
<sup>b</sup>Mishra et al 2019  
<sup>c</sup>Macfayden et al 2009

# Microfiber Magnitude



**Fig 1. Cumulative microfiber emissions from 1950 to 2016.** The right columns describe compartmental, compositional, and regional characteristics of the cumulative mass of microfiber emitted by 2016.

# Sources of Microfibers



Ramasamy and Subramanian 2021



Browne et al 2011



Fishing gear = PE, nylon, PP fibers

# Environmental Impact

## “Throwaway” Fashion

Fashion is one of the most polluting industries in the world, in terms of both its large production and the nonbiodegradable waste it leaves behind (Brodde 2017).

“Plastic microfibers are considered one of the dominant forms of microplastic pollution (particles < 5 mm) in the world’s oceans... with evidence pointing to textiles as a potentially important source.” Vassilenko et al 2021

5 trillion microfiber particles circulate in marine surface waters (Smith et al 2018)

No location exposed to the Earth's atmosphere or waters has escaped microfiber pollution. Mishra et al 2019

Zooplankton, coral, fish, crabs, mussels, whales, and many others ingest microplastics directly (Cauwenberghe and Janssen, 2014).

Humans may be impacted by inhalation and consumption (25, 26). Microfiber inhalation may cause lung inflammation, but human health impacts are not well understood (27).

Studies observing adverse effects of microfibers are more numerous than studies not showing an effect [4]. Kapp and Miller 2020

“Adverse effects may include entanglement of feeding appendages, gut blockage and malnutrition in zooplankton or lower levels of the food web” Vassilenko et al 2021

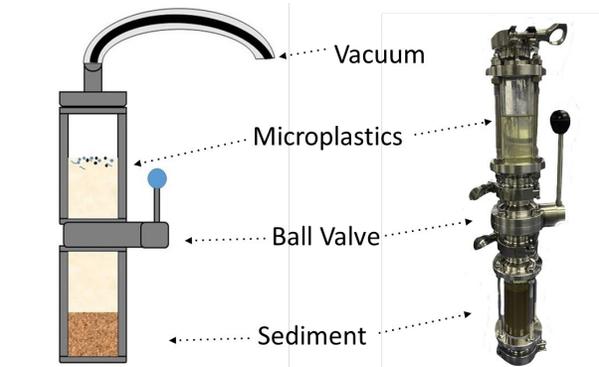
Organisms are harmed through “decreased feeding ability, abnormal reproduction, decreased nutrition, and poorer health. Liver toxicity in fish, decreased reproductive potential in oysters, and decreased survival and predator aversion ability in beach hoppers (Sussarellu et al., 2016;Tosetto et al., 2016).” Mishra et al 2019

# Methods to Quantify & Characterize

## 1. Larval Fish Guts



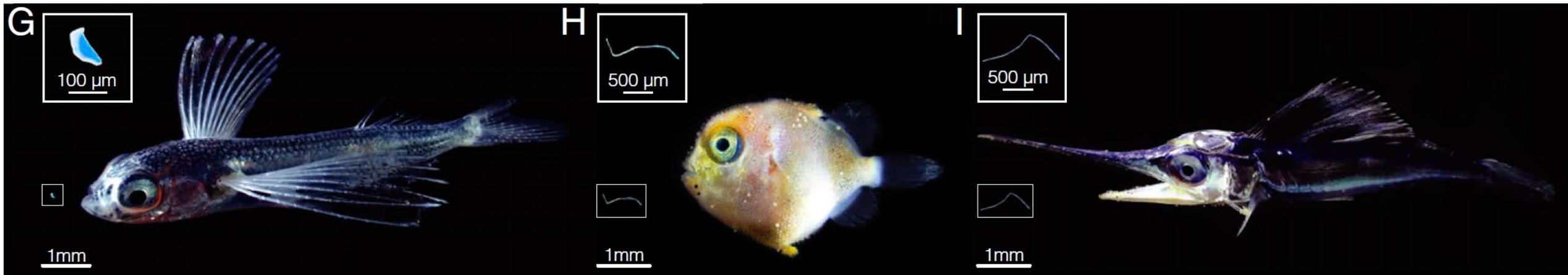
## 2. Deep-Sea Sediment



## 3. Mega-sized Derelict Fishing Gear



# Larval Fish Guts

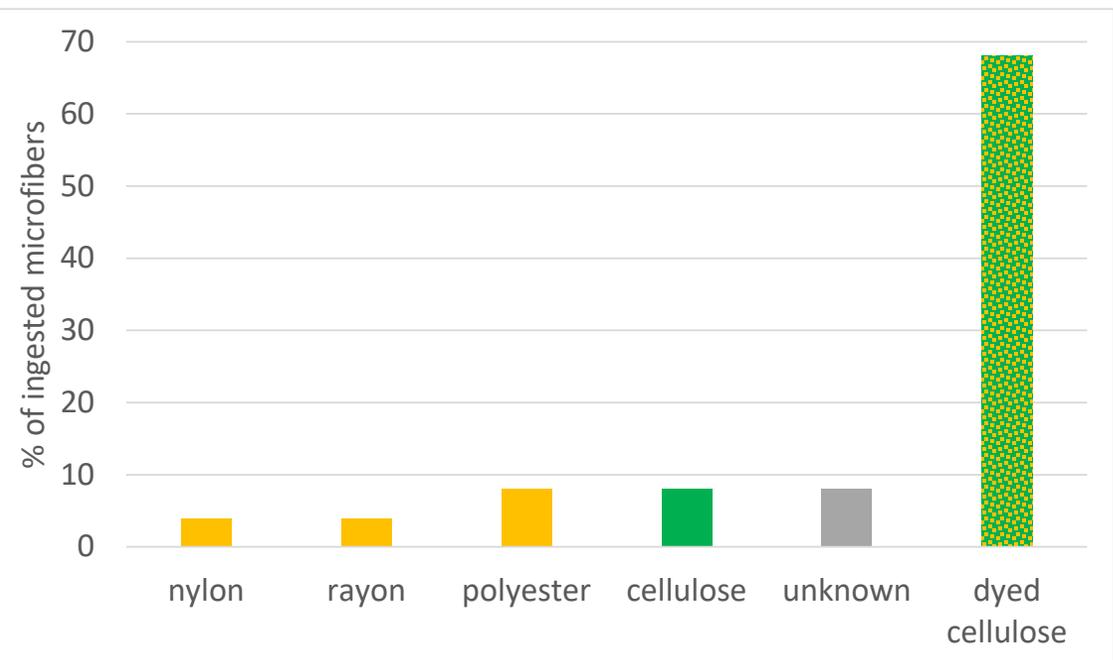


- 658 micro-dissections – 6.3 % had ingested polymers
- 42 pieces – 93% were microfibers
- 25 microfibers analyzed by ATR FT-IR and/or Raman microscopy

## Prey-size plastics are invading larval fish nurseries

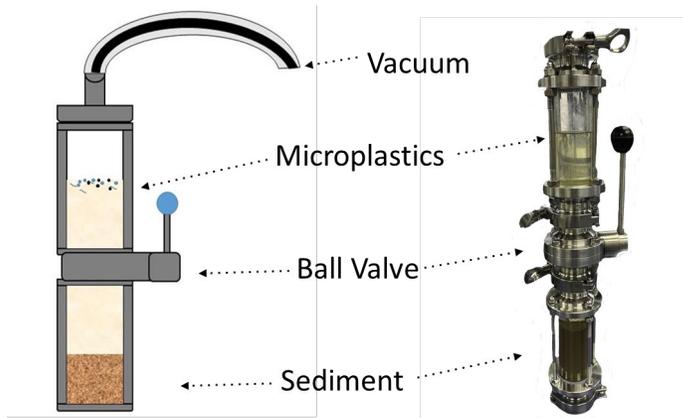
Jamison M. Gove<sup>a,1,2</sup>, Jonathan L. Whitney<sup>a,b,2</sup>, Margaret A. McManus<sup>c</sup>, Joey Lecky<sup>a,d</sup>, Felipe C. Carvalho<sup>a</sup>, Jennifer M. Lynch<sup>e,f</sup>, Jiwei Li<sup>g</sup>, Philipp Neubauer<sup>h</sup>, Katharine A. Smith<sup>b,c</sup>, Jana E. Phipps<sup>a,b</sup>, Donald R. Kobayashi<sup>a</sup>, Karla B. Balagso<sup>a</sup>, Emily A. Contreras<sup>a,b</sup>, Mark E. Manuel<sup>l,j</sup>, Mark A. Merrifield<sup>k</sup>, Jeffrey J. Polovina<sup>a</sup>, Gregory P. Asner<sup>g</sup>, Jeffrey A. Maynard<sup>l</sup>, and Gareth J. Williams<sup>m</sup>

<sup>a</sup>Pacific Islands Fisheries Science Center, National Oceanic and Atmospheric Administration, Honolulu, HI 96818; <sup>b</sup>Joint Institute for Marine and Atmospheric Research, University of Hawai'i at Mānoa, Honolulu, HI 96822; <sup>c</sup>Department of Oceanography, University of Hawai'i at Mānoa, Honolulu, HI 96822; <sup>d</sup>Lynker Technologies, Leesburg, VA 20175; <sup>e</sup>Chemical Sciences Division, National Institute of Standards and Technology, Waiamanalo, HI 96795; <sup>f</sup>Center for Marine Debris Research, Hawai'i Pacific University, Waiamanalo, HI 96795; <sup>g</sup>Center for Global Discovery and Conservation Science, Arizona State University, Tempe, AZ 85281; <sup>h</sup>Dragonfly Data Science, Te Anau, Wellington 6011, New Zealand; <sup>i</sup>Marine Debris Program, National Oceanic and Atmospheric Administration

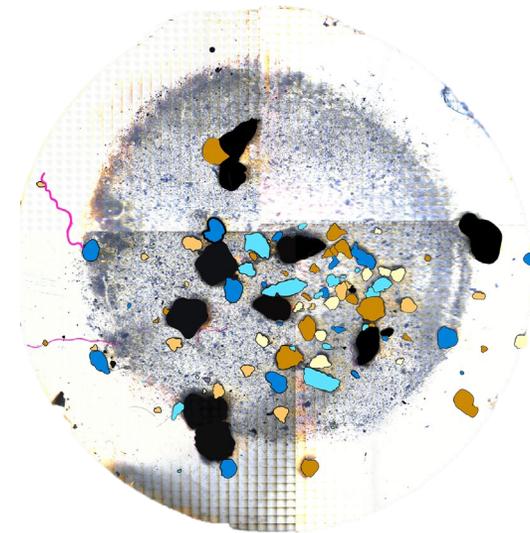


# Deep-Sea Sediment

Novel Density Separation Device



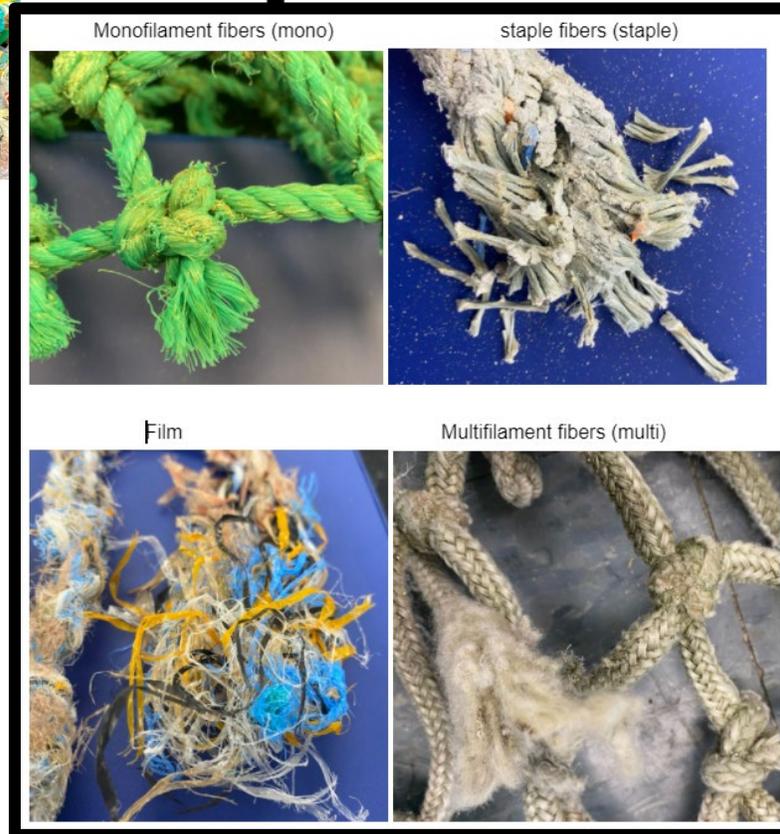
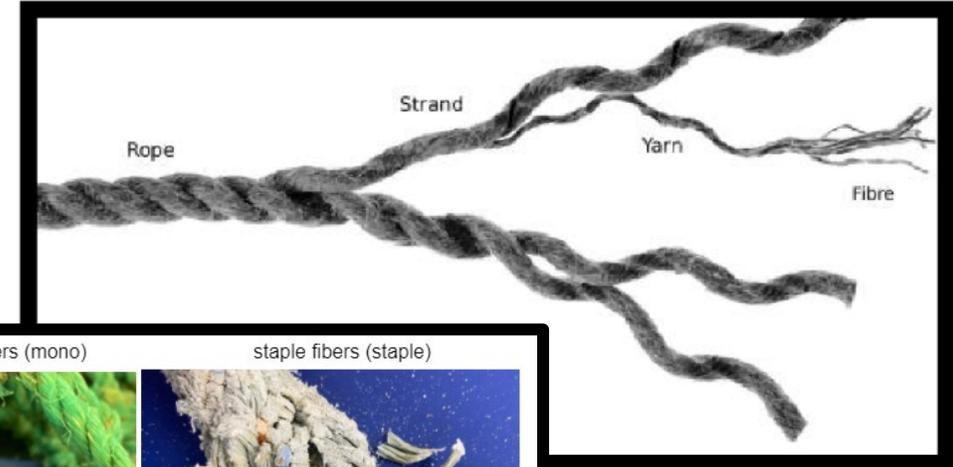
Automated micro-FTIR



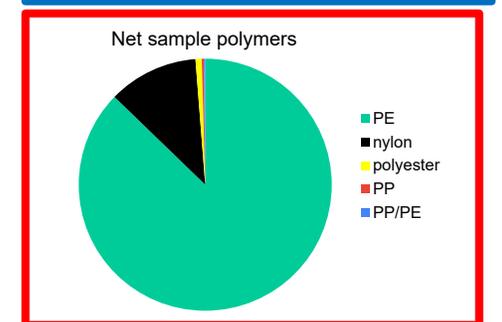
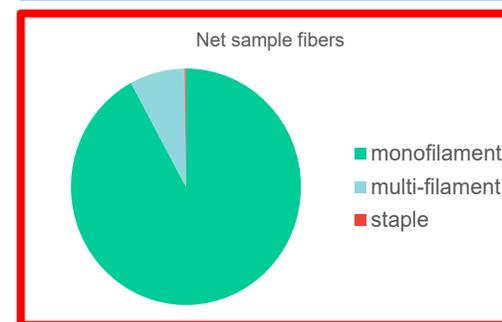
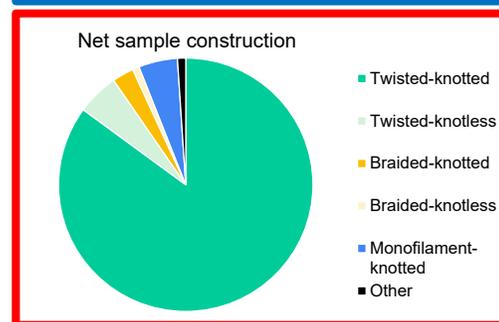
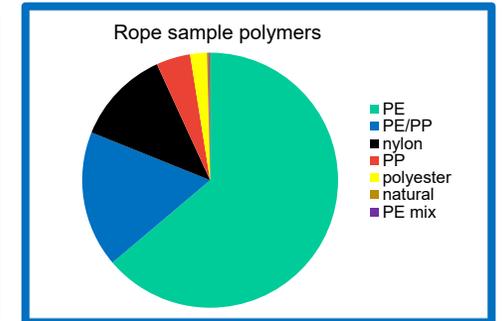
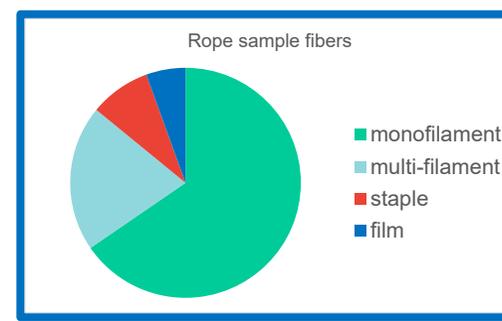
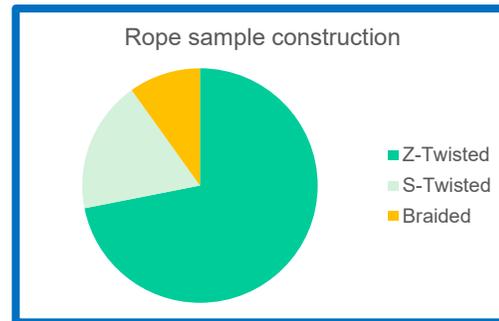
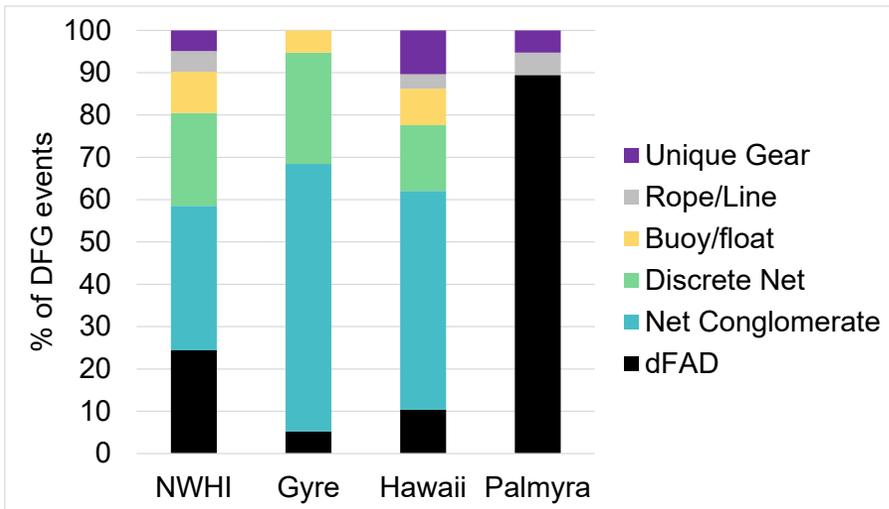
- Polyester
- PVC
- HDPE
- Polystyrene
- Polypropylene
- Nylon
- Crumb Rubber
- Cellulose Acetate

Polymer	% Recovery	
	Shaw et al. in prep.	Cashman et al. 2020 (silt)
PP	84 ± 23 %	40 ± 29 %
HDPE	95 ± 14 %	34 ± 29 %
Cellulose Acetate	34 ± 8 %	-
Polyester	66 ± 45 %	23 ± 25 %

# Derelict Fishing Gear

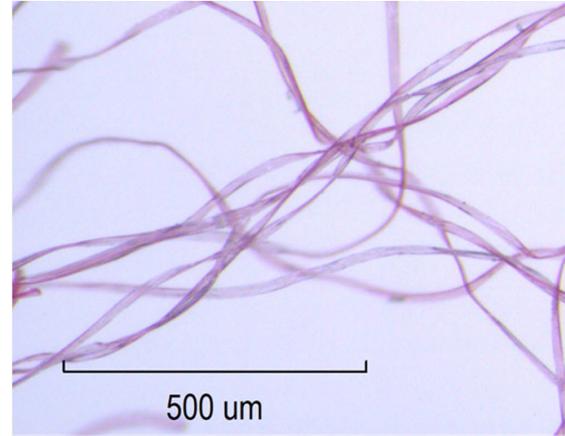


# Derelict Fishing Gear



# Conclusions

- Textiles are a major source of microfibers to the environment
- Anthropogenic microfibers contaminate the entire globe, including our air, water, food, and bodies
- Testing standards are missing for microfiber pollution
- Environmental monitoring may detect the successes or failures of societal changes



# Acknowledgements

- Unpublished data shown are the result of huge efforts by the following
  - For larval fish
    - Dr. Jonathan Whitney, NOAA
    - Dr. Suja Sukumaran, Thermo Fisher Scientific
    - Dr. Bridget O'Donnell, Horiba
    - Dr. Win Cowger, Open Specy
    - Rachylle Hart, NSF REU Program
  - For sediment
    - Ray Aivazian III, Seed.World
    - Dr. Katy Shaw, NIST
    - Rachel Sandquist, HPU CMDR
    - Dr. Scott Gallager and Cameron Fairclough, WHOI & COV
    - Dr. Brett Howard, ACC
  - For fishing gear
    - Raquel Corniuk, HPU CMDR
    - Andrew McWhirter, HPU CMDR
    - Dr. Sarah-Jeanne Royer, HPU CMDR
    - Hank Lynch, Makanakai Marine Services
    - HIMDAP partners, longline fishermen



@MarineDebrisResearch



@debrisresearch



@company/center-for-marine-debris-research