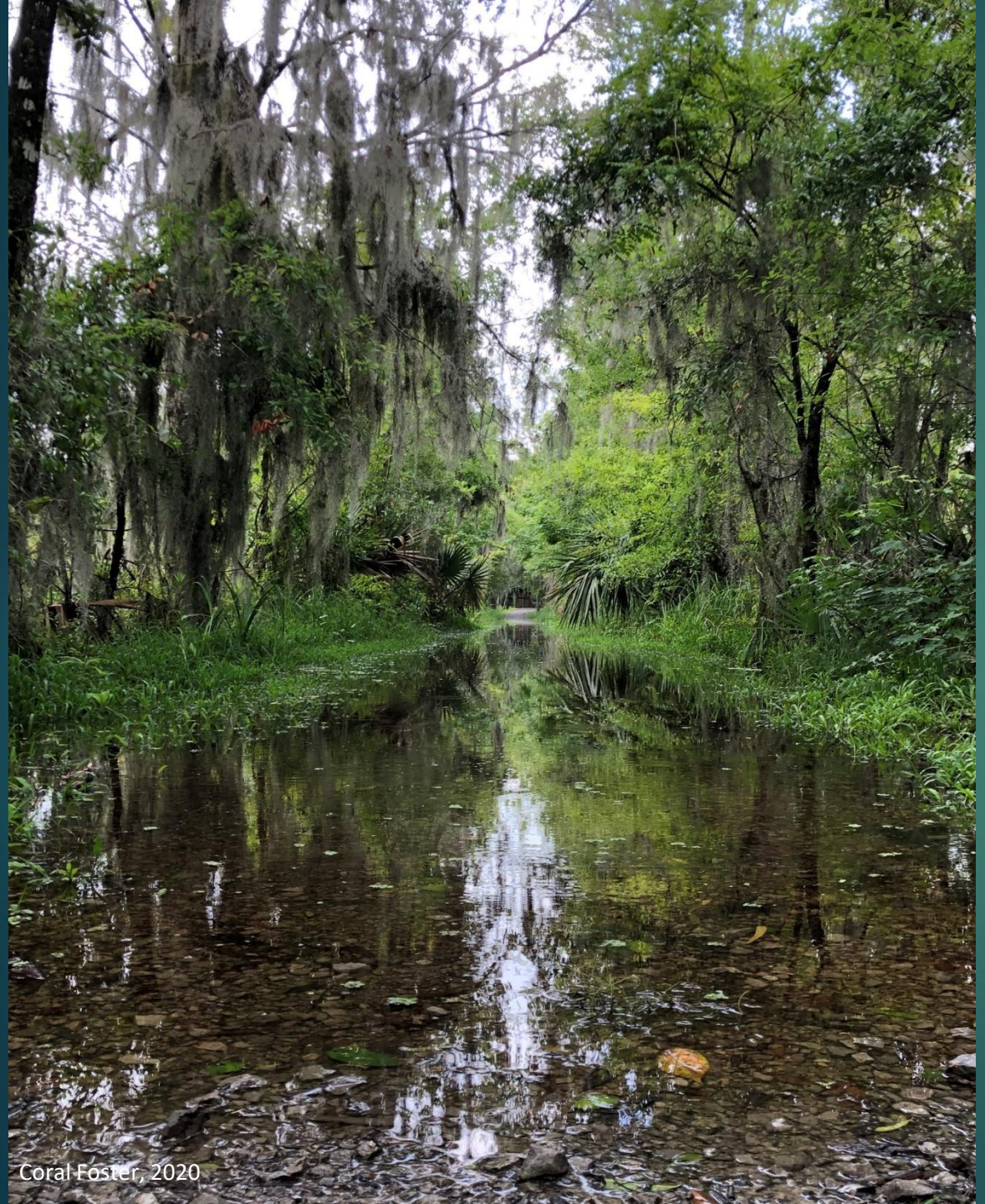


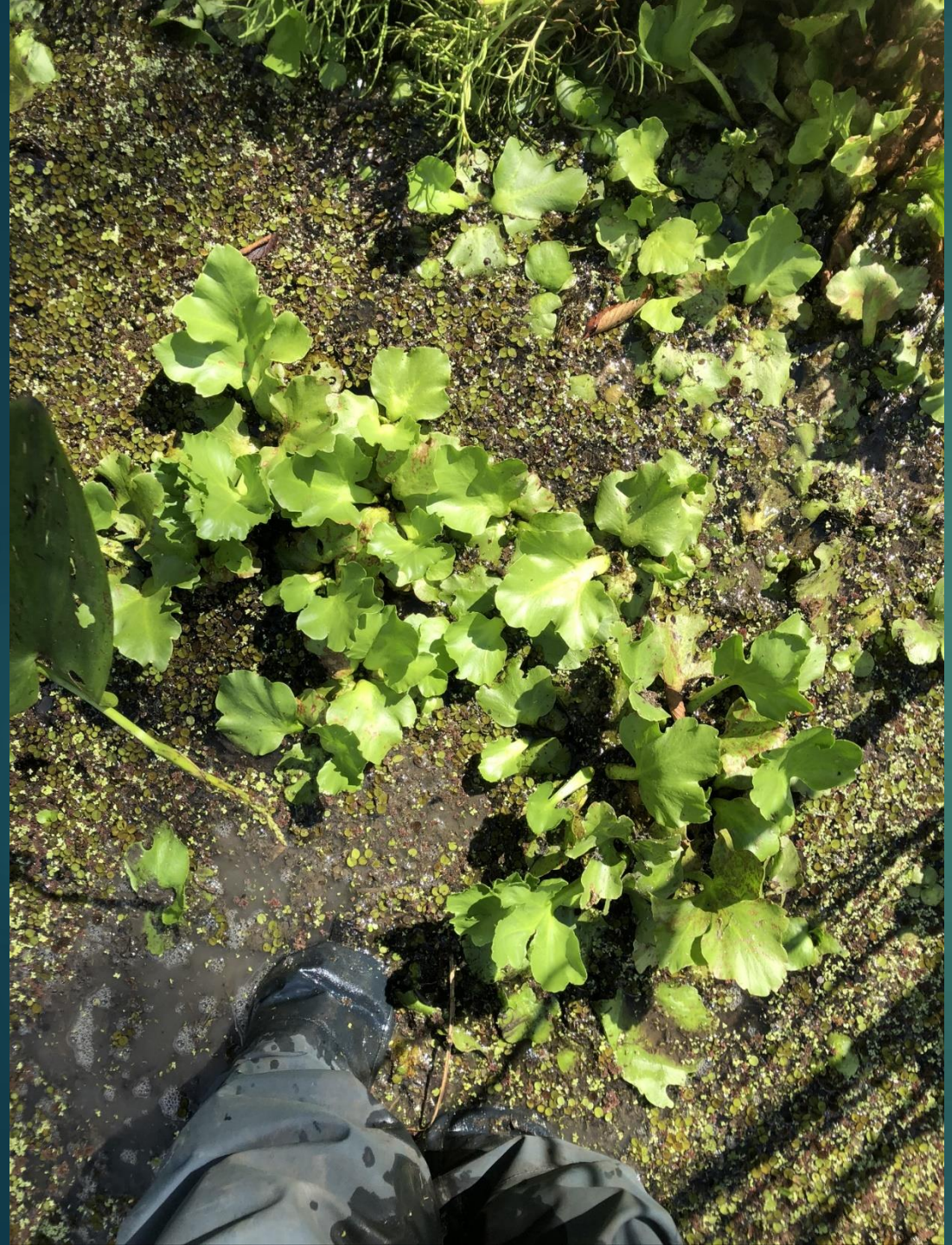
Coral Foster, 2020

Microplastics and Plants: Breakthrough or Disaster?

MASTER'S THESIS RESEARCH

NICHOLLS STATE UNIVERSITY

Lexi Woods
Environmental Specialist
Upper Colorado River Authority



Overview

Plastics – they're everywhere?!

Chemical properties & degradation

Microplastics

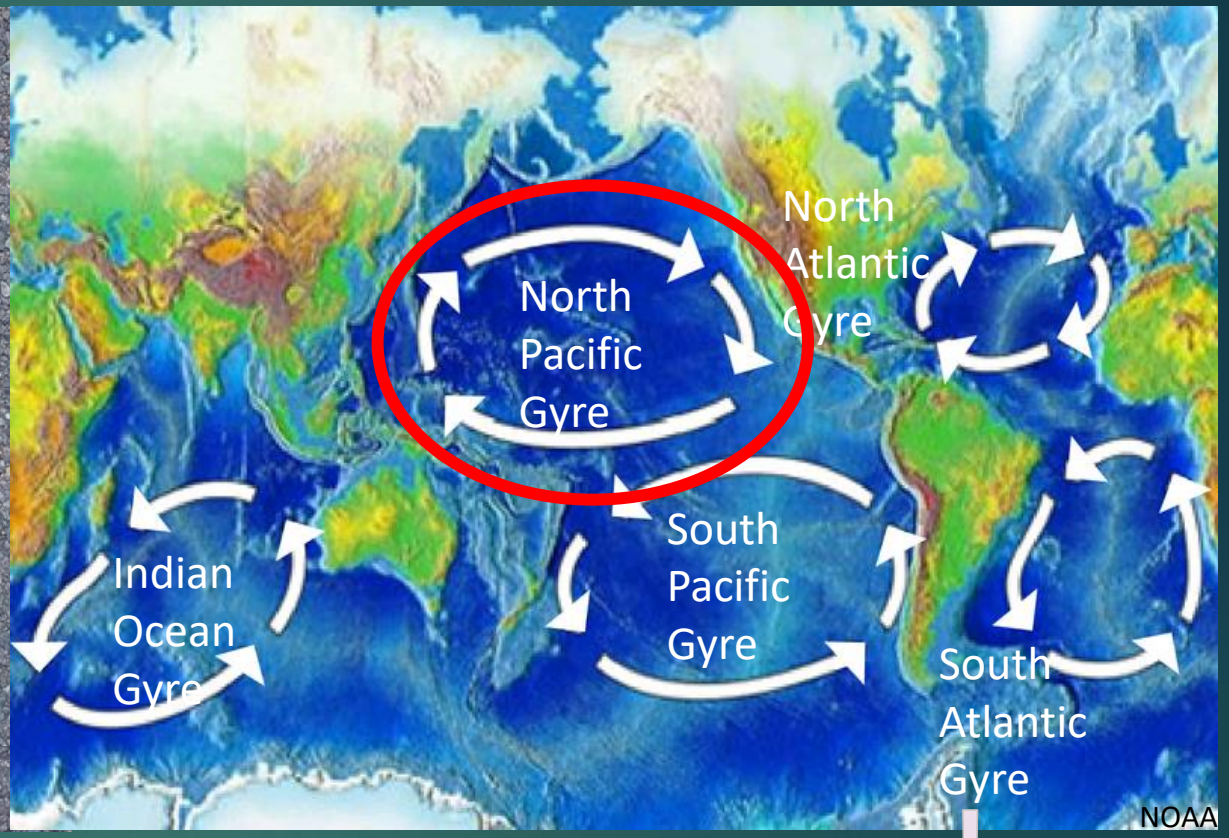
Fauna, vegetation, and biofilms.

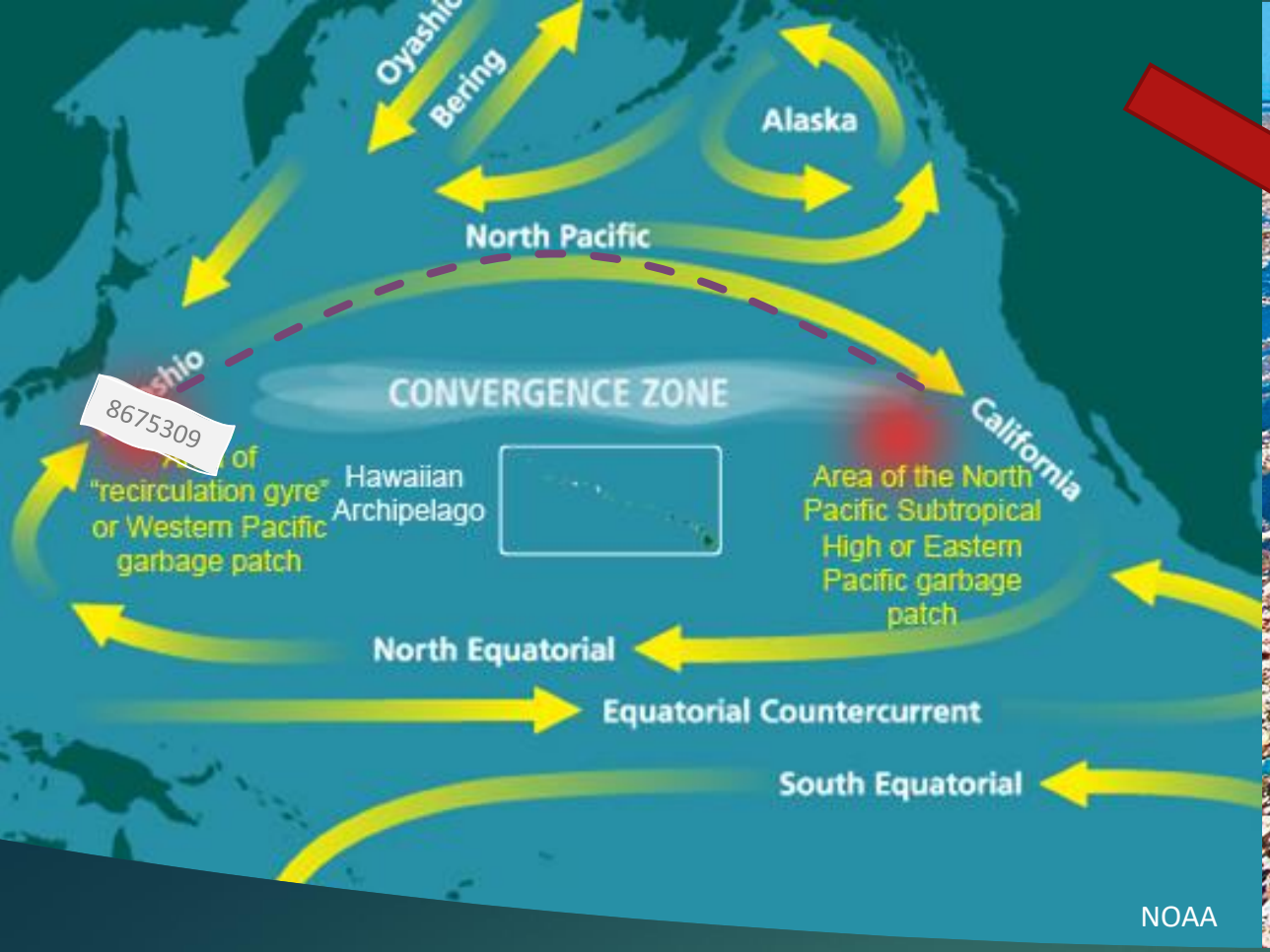
Oh my!

Wetlands: the secret superheroes

Mesocosm 1
Plants vs. Microplastics
FIGHT!

Laysan Albatross and Plastic

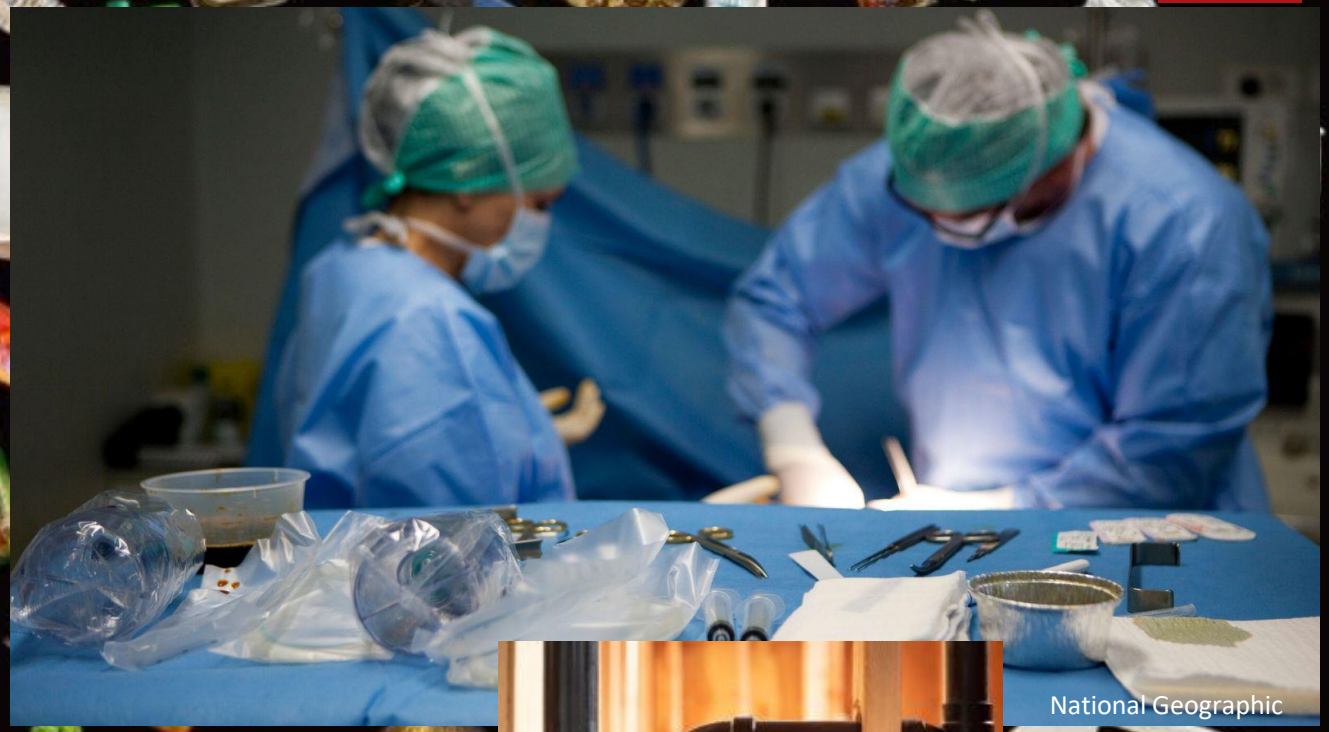




Great Pacific Garbage Patch

Plastic Application

ThermoFisher Scientific


National Geographic


Commercial Industry Supply

National Geographic

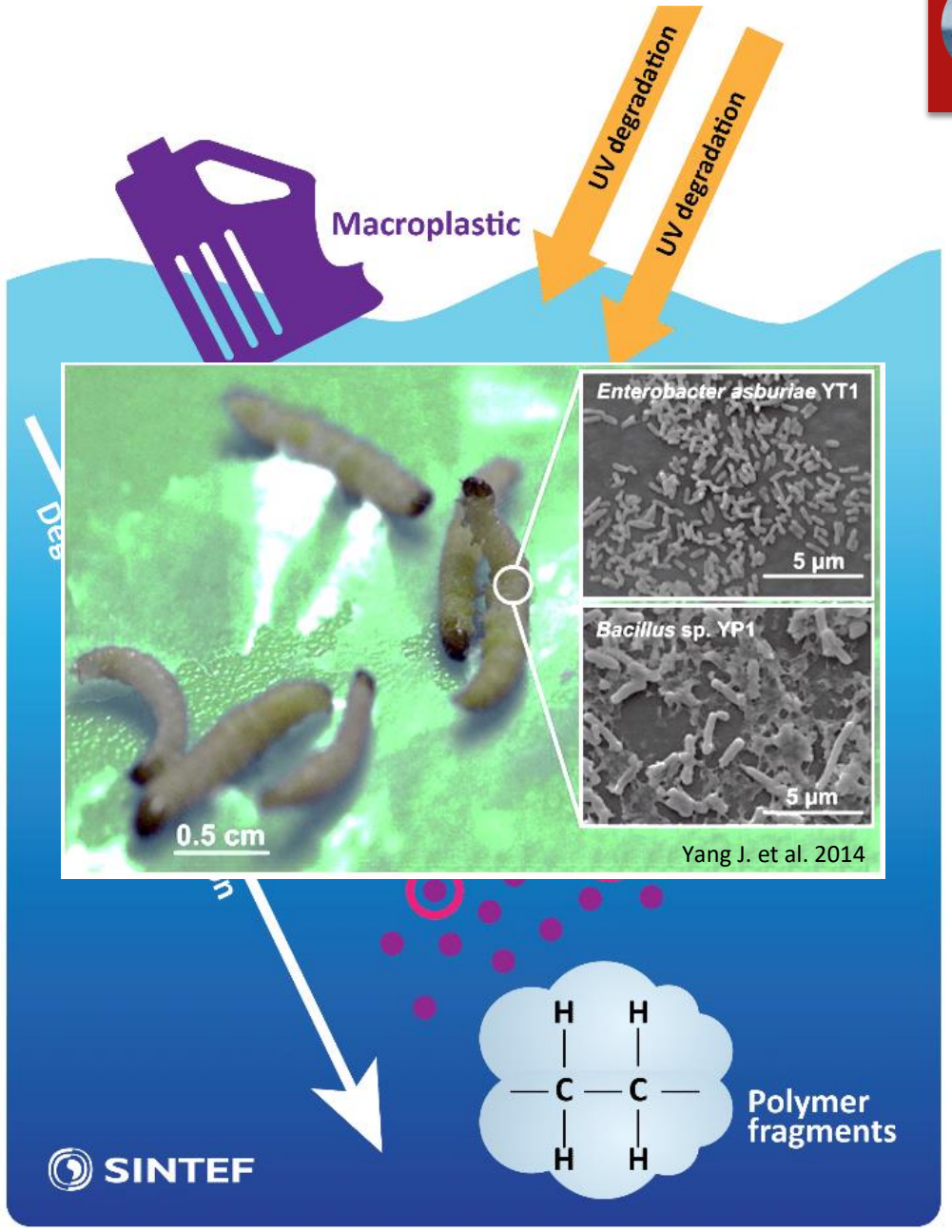
Degradation

Abiotic

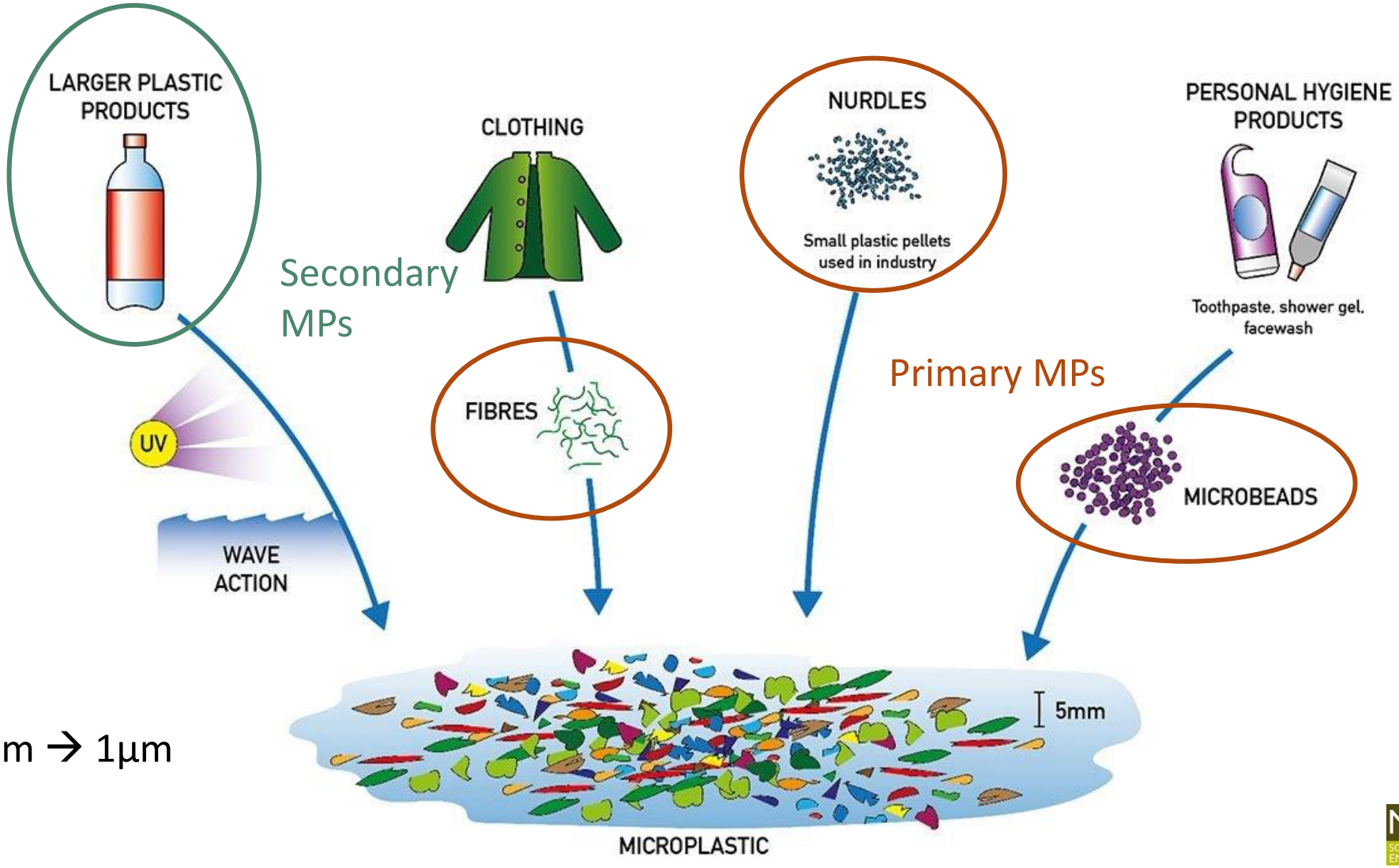
- UV light
- Temperature
- Water
- Atmospheric Gases

Biotic

- Insects
- Microorganisms
- Fungi



Plastic to Microplastic (MP)



Sized: 5mm → 1µm

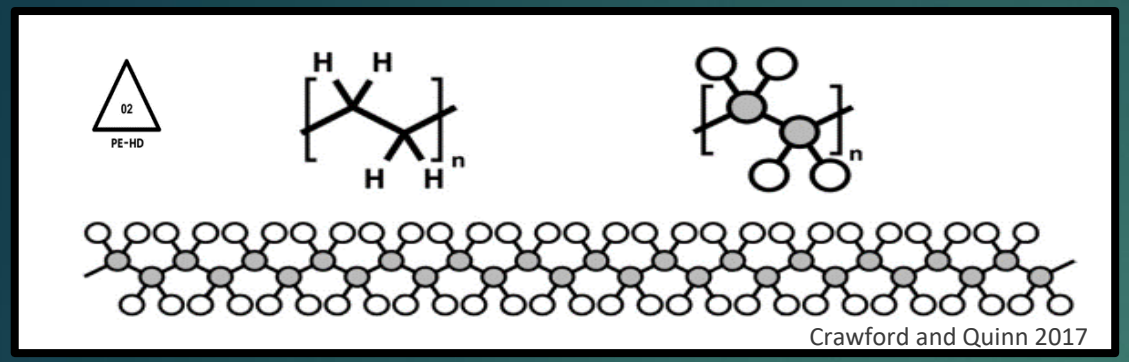
§307.3, Definitions and Abbreviations

Proposed changes to §307.3 include the addition of a definition for "Pre-production plastic." The intent behind this definition is to differentiate pre-production plastic, or primary plastic manufactured for a variety of uses, from secondary plastic, such as degraded particles, bottles, containers, packaging, or bags. Proposed changes also include a definition and acronym for "Bioaccumulation factor," and the addition of an acronym for "municipal utility district." The definition for "method detection limit" has also been amended to match the current federal definition in 40 CFR Part 136. Other revisions are editorial and proposed to improve overall clarity.

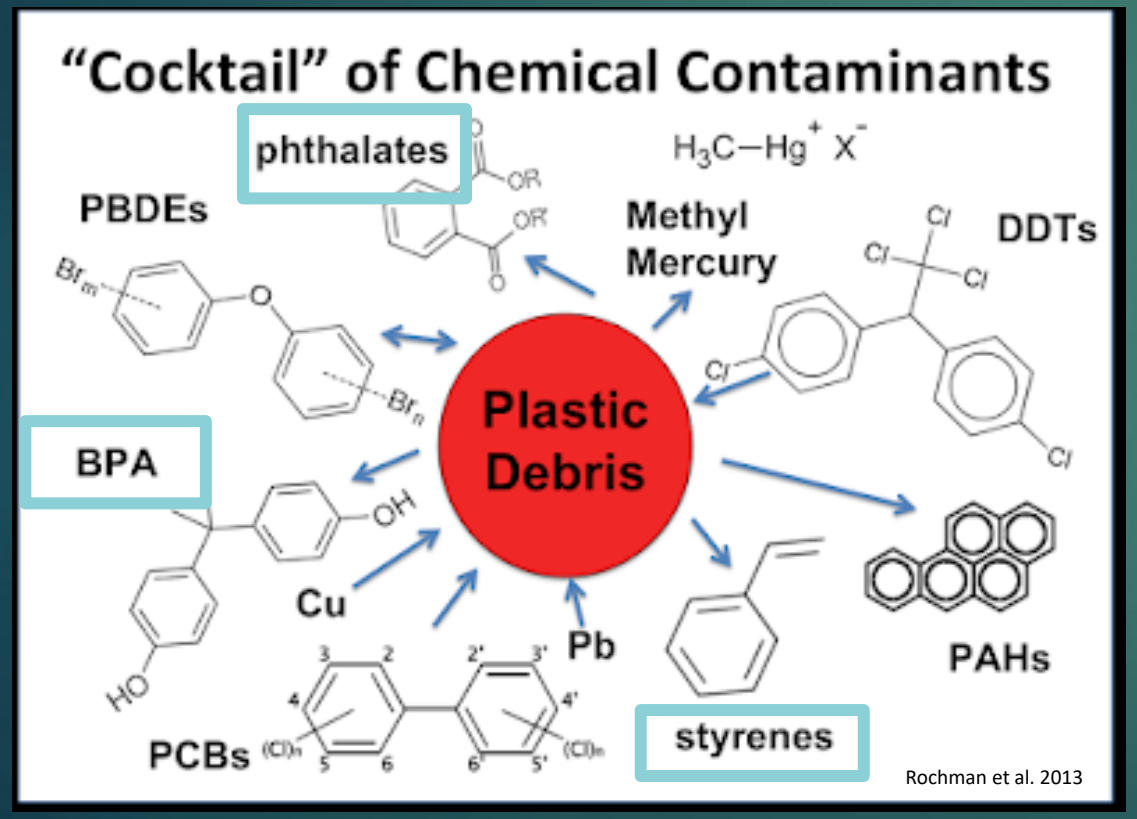
Texas Water Quality Standards

Proposed Changes

Chemical and Structural Toxicity



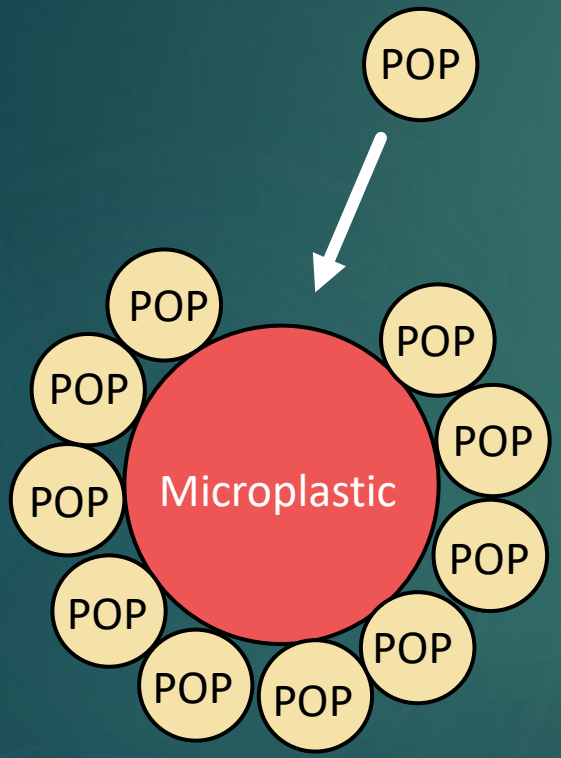
Crawford and Quinn 2017



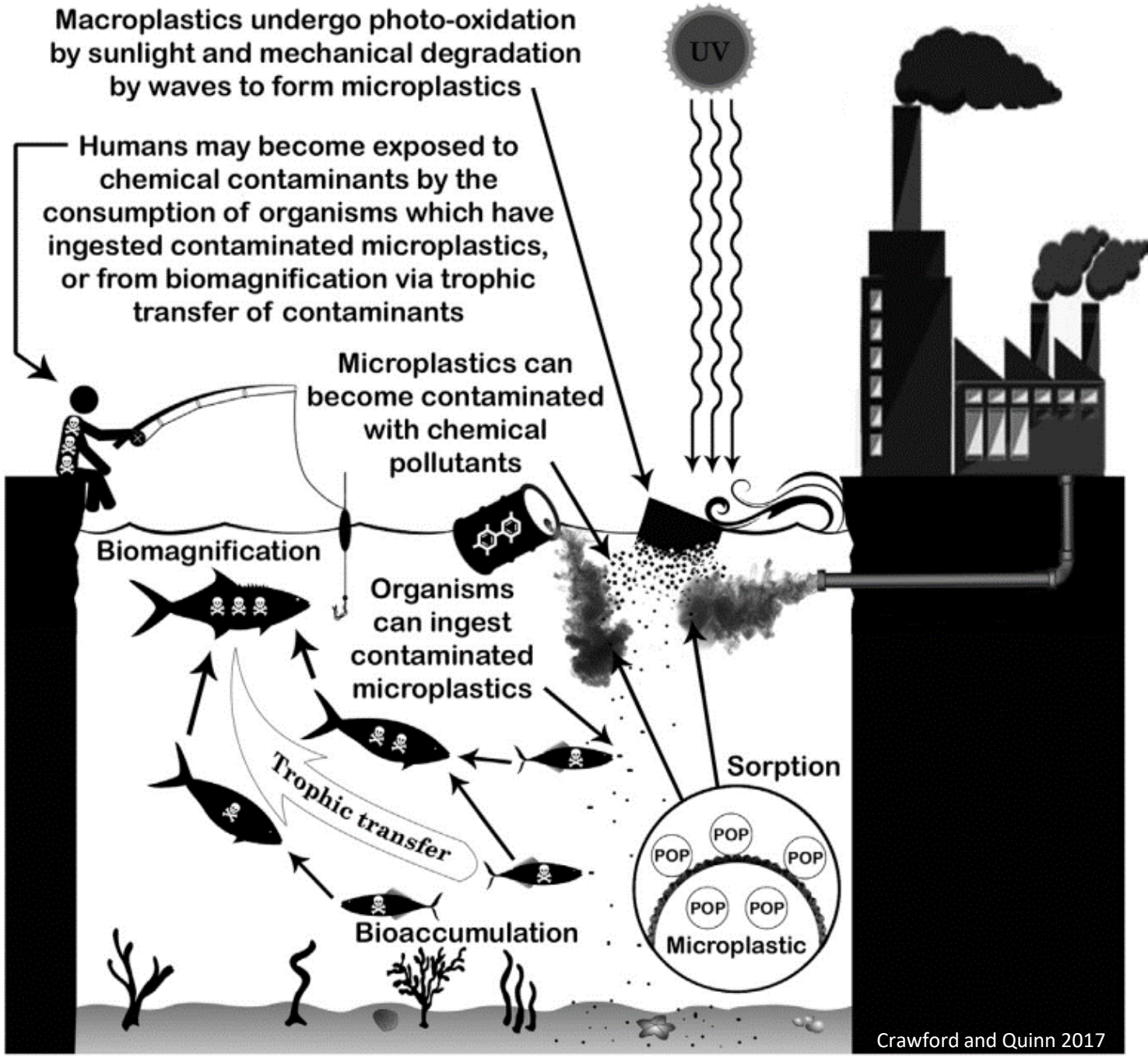
Rochman et al. 2013

- Hydrophobic surface
- Leach out potentially toxic compounds: phthalates, BPA, polystyrene
- MPs attract DDT, PCB, lead

Adverse Effects on Fauna



Persistent Organic Pollutants (POPs)



M. edulis Mussel Toxicity

- Blue Mussel ingest MPs
- MP vehicles→ High pyrene levels
- High pyrene = negative effects
  - Compromised immune system
  - Oxidative stress
  - Neurotoxicity

Environmental Pollution 198 (2015) 211–222

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Pollutants bioavailability and toxicological risk from microplastics to marine mussels

Carlo Giacomo Avio [a], Stefania Gorbi [a], Massimo Milan [b], Maura Benedetti [a], Daniele Fattorini [a], Giuseppe d'Errico [a], Marianna Pauletto [b], Luca Bargelloni [b], Francesco Regoli [a, *]

[a] Dipartimento di Scienze della Vita e dell'Ambiente (DiSVA), Università Politecnica delle Marche, Ancona, Italy
[b] Dipartimento di Biomedicina Comparata e Alimentazione (BCA), Università di Padova, Italy

Ecotoxicological Effects in Fish

- Abundance in feeding types: filter feeders > omnivores > carnivores
- Block intestinal tracts → reduce feeding
- Cause bioaccumulation of POPs like PAHs, PCBs
  - Liver damage


SCIENTIFIC REPORTS

OPEN

SUBJECT AREAS:
ECOPHYSIOLOGY
ECOLOGY
CONSERVATION
ENVIRONMENTAL CHEMISTRY

Received

Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress

Chelsea M. Rochman[1], Eunha Hoh[2], Tomofumi Kurobe[1] & Swee J. Teh[1]

[1]Aquatic Health Program, Department of Anatomy, Physiology and Cell Biology, School of Veterinary Medicine, University of California, Davis, CA 95616, USA, [2]Graduate School of Public Health, San Diego State University, CA 92182, USA.

Japanese Medaka
(*Oryzias latipes*)


Marine Pollution Bulletin 67 (2013) 94–99

Contents lists available at SciVerse ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

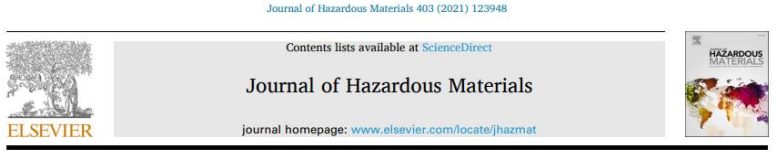
Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel

A.L. Lusher[a], M. McHugh[b], R.C. Thompson[a,*]

[a]School of Marine Science and Engineering, Plymouth University, Drake Circus, Plymouth PL4 8AA, UK
[b]Marine Biological Association of the United Kingdom, The Laboratory, Citadel Hill, Plymouth PL1 2PB, UK

Blue Whiting
(Micromesistius poutassou)

Atlantic Horse Mackerel
(*Trachurus trachurus)*
(+ 8 more species)


Journal of Hazardous Materials 403 (2021) 123948

Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: www.elsevier.com/locate/jhazmat

Species-specific effect of microplastics on fish embryos and observation of toxicity kinetics in larvae

Chaonan Zhang[a], Jun Wang[a,b,d,*], Aiguo Zhou[a,b], Qiao Ye[c], Yongyong Feng[a], Zhenlu Wang[a], Shaodan Wang[a], Guohuan Xu[e,**], Jixing Zou[a,b,***]

[a] Joint Laboratory of Guangdong Province and Hong Kong Region on Marine Bioresource Conservation and Exploitation, College of Marine Sciences, South China Agricultural University, Guangzhou 510642, China
[b] Guangdong Laboratory for Lingnan Modern Agriculture, South China Agricultural University, Guangzhou 510642, China
[c] College of Life Sciences, Huizhou University, Huizhou 516007, Guangdong, China
[d] Guangxi Key Laboratory of Marine Natural Products and Combinatorial Biosynthesis Chemistry, Biophysical and Environmental Science Research Center, Guangxi Academy of Sciences, Nanning 530007, China
[e] State Key Laboratory of Applied Microbiology Southern China, Guangdong Provincial Key Laboratory of Microbial Culture Collection and Application, Guangdong Institute of Microbiology, Guangdong Academy of Sciences, Guangzhou 510070, China

Bighead Carp
(Aristichthys nobilis)

Hybrid Snakehead
(*Channa maculata×Channa argus*)

Indian Major Carp
(Cirrhinus mrigala)

MPs Found in Humans

- MPs in waste → intake of PP packaged beverages
- Plasticenta
  - 12 MPs in human placentas

Science of the Total Environment 767 (2021) 144345

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

You are what you eat: Microplastics in the feces of young men living in Beijing

Na Zhang, Yi Bin Li, Hai Rong He, Jian Fen Zhang, Guan Sheng Ma *

Department of Nutrition and Food Hygiene, School of Public Health, Peking University, 38 Xue Yuan Road, Hai Dian District, Beijing 100191, China
Laboratory of Toxicological Research and Risk Assessment for Food Safety, Peking University, 38 Xue Yuan Road, Hai Dian District, Beijing 100191, China

Environment International 146 (2021) 106274

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

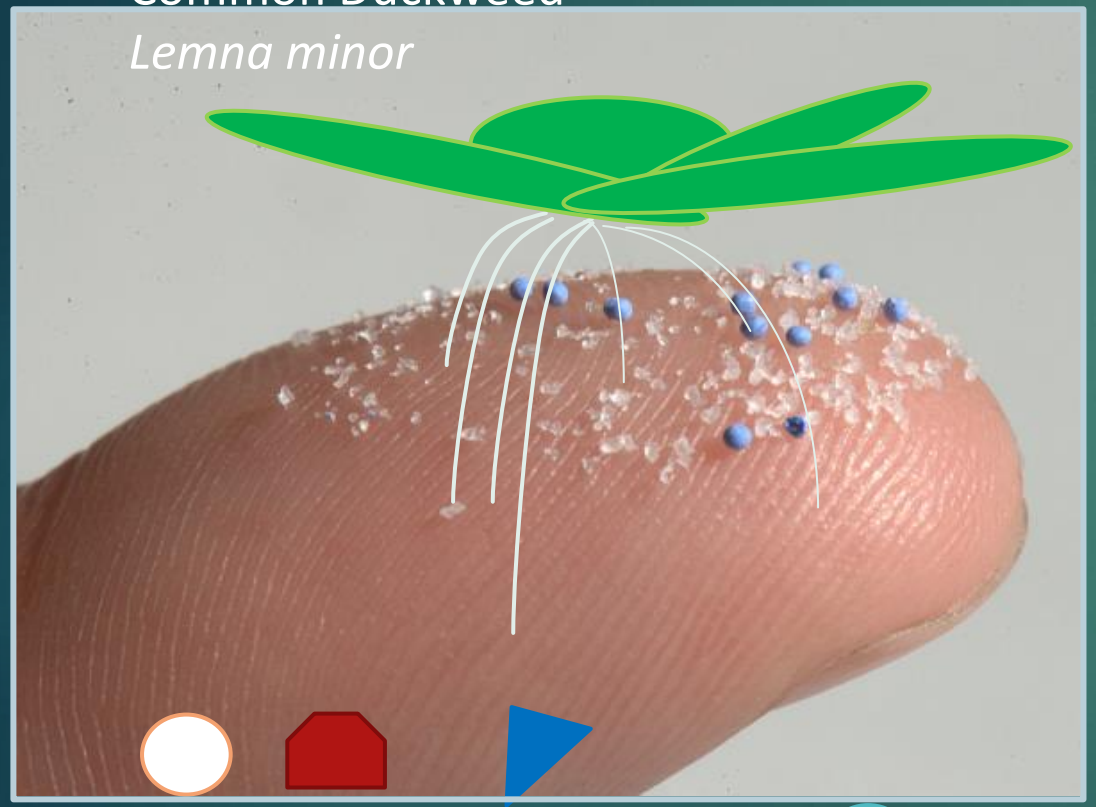
Plasticenta: First evidence of microplastics in human placenta

Antonio Ragusa [a], Alessandro Svelato [a,*], Criselda Santacroce [b], Piera Catalano [b], Valentina Notarstefano [c], Oliana Carnevali [c], Fabrizio Papa [b], Mauro Ciro Antonio Rongioletti [b], Federico Baiocco [a], Simonetta Draghi [a], Elisabetta D'Amore [a], Denise Rinaldo [d], Maria Matta [e], Elisabetta Giorgini [c]

[a] *Department of Obstetrics and Gynecology, San Giovanni Calibita Fatebenefratelli Hospital, Isola Tiberina, Via di Ponte Quattro Capi, 39, 00186 Rome, Italy*
[b] *Department of Pathological Anatomy, San Giovanni Calibita Fatebenefratelli Hospital, Isola Tiberina, Via di Ponte Quattro Capi, 39, 00186 Roma, Italy*
[c] *Department of Life and Environmental Sciences, Università Politecnica delle Marche, via Brecce Bianche, 60131 Ancona, Italy*
[d] *Department of Obstetrics and Gynecology, ASST Bergamo Est, Bolognini Hospital, Seriate, Via Paderno, 21, 24068 Bergamo, Italy*
[e] *Harvey Medical and Surgery Course, University of Pavia, Corso Strada Nuova 65, 27100 Pavia, Italy*

Vegetation Impacts

Common Duckweed
Lemna minor



LIMNOLOGY AND OCEANOGRAPHY
Letters

ASLO

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Limnology and Oceanography Letters 2019

doi: 10.1002/lol2.10118

SPECIAL ISSUE-LETTER

Plastic particles adsorb to the roots of freshwater vascular plant *Spirodela polyrhiza* but do not impair growth

*Lena C. Dovidat,[1] Bregje W. Brinkmann,[2] Martina G. Vijver,[2] Thijs Bosker[1,2]**
[1]Leiden University College, Leiden University, The Hague, The Netherlands; [2]Institute of Environmental Sciences, Leiden University, Leiden, The Netherlands

Science of the Total Environment 689 (2019) 413–421

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

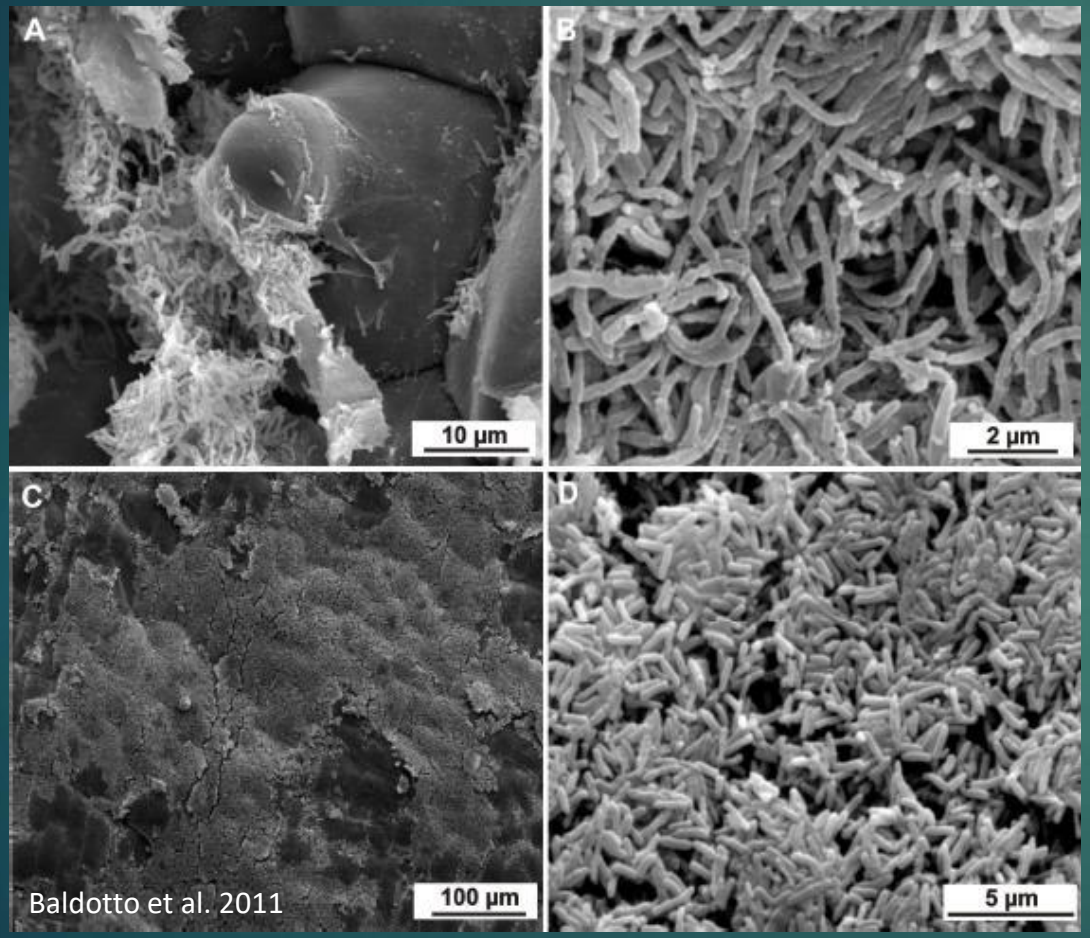
ELSEVIER

Polyethylene microplastics adhere to *Lemna minor* (L.), yet have no effects on plant growth or feeding by *Gammarus duebeni* (Lilj.)

Alicia Mateos-Cárdenas [a,c,*], David T. Scott [a,c], Gulzara Seitmaganbetova [a,c], Frank N.A.M. van Pelt [b,c], John O'Halloran [a,c], Marcel A.K. Jansen [a,c]

[a] School of Biological, Earth and Environmental Sciences, University College Cork, North Mall, Cork City, Ireland
[b] Department of Pharmacology and Therapeutics, Western Gateway Building, University College Cork, Western Road, Cork City, Ireland
[c] Environmental Research Institute, Lee Road, Cork City, Ireland

Biofilms - Adsorption Culprit?



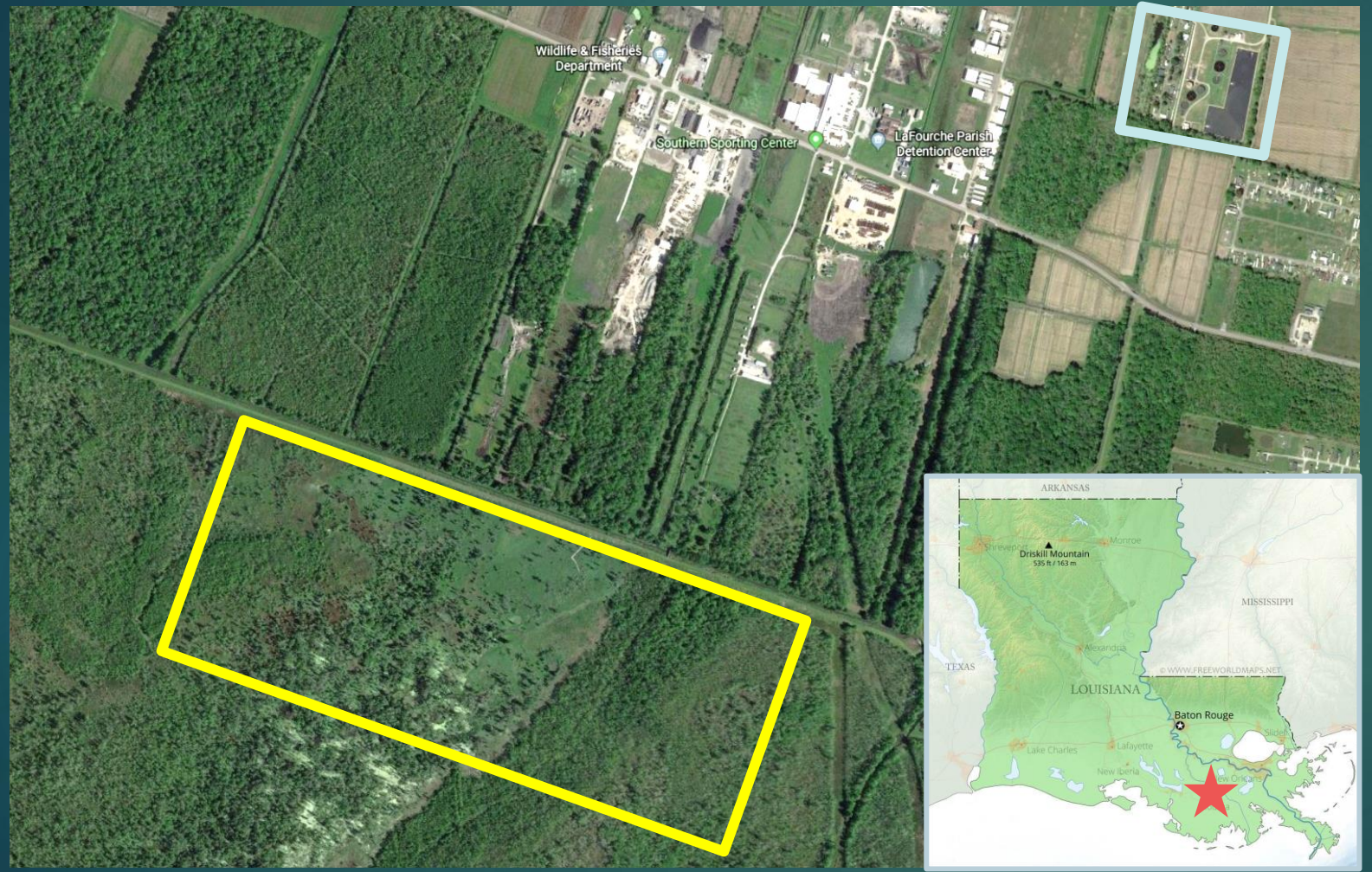
Baldotto et al. 2011

- Mutualistic- vegetation & bacteria
- Filmy matrix:
  - Extrapolymeric substances (EPS)

    aka ‘Sticky blob’
- Biosorption of metals
- Retain MP

Wetlands

Wetlands as Filtration: WWTP



THIBODAUX, LA

Microplastic Retention

Vegetation

Present

Absent

MP Size Class

None

43-250µm (small)

250-500µm (large)

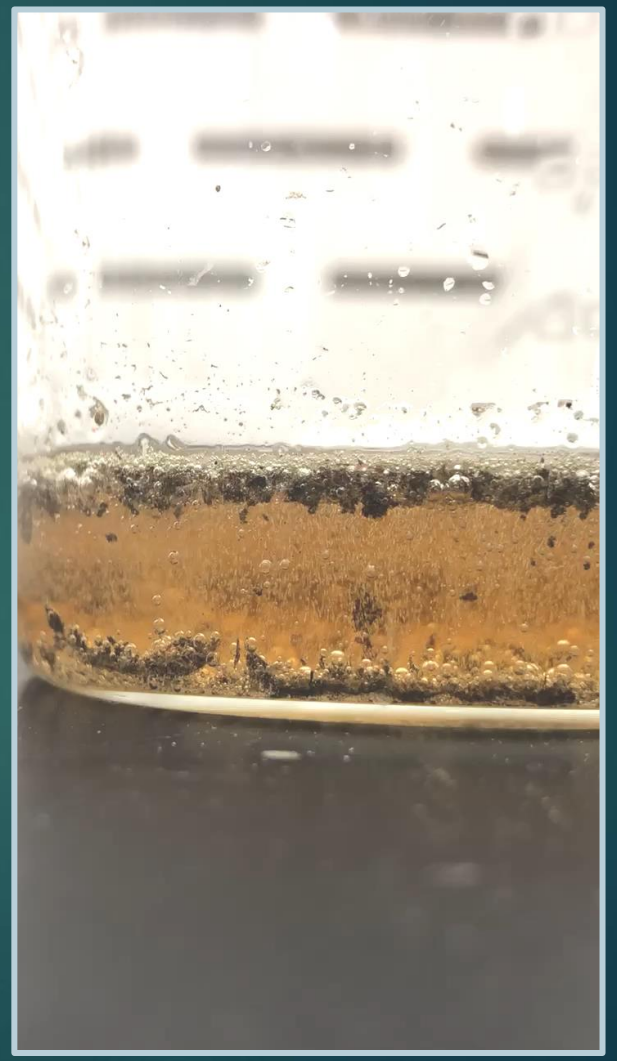
Fertilizer

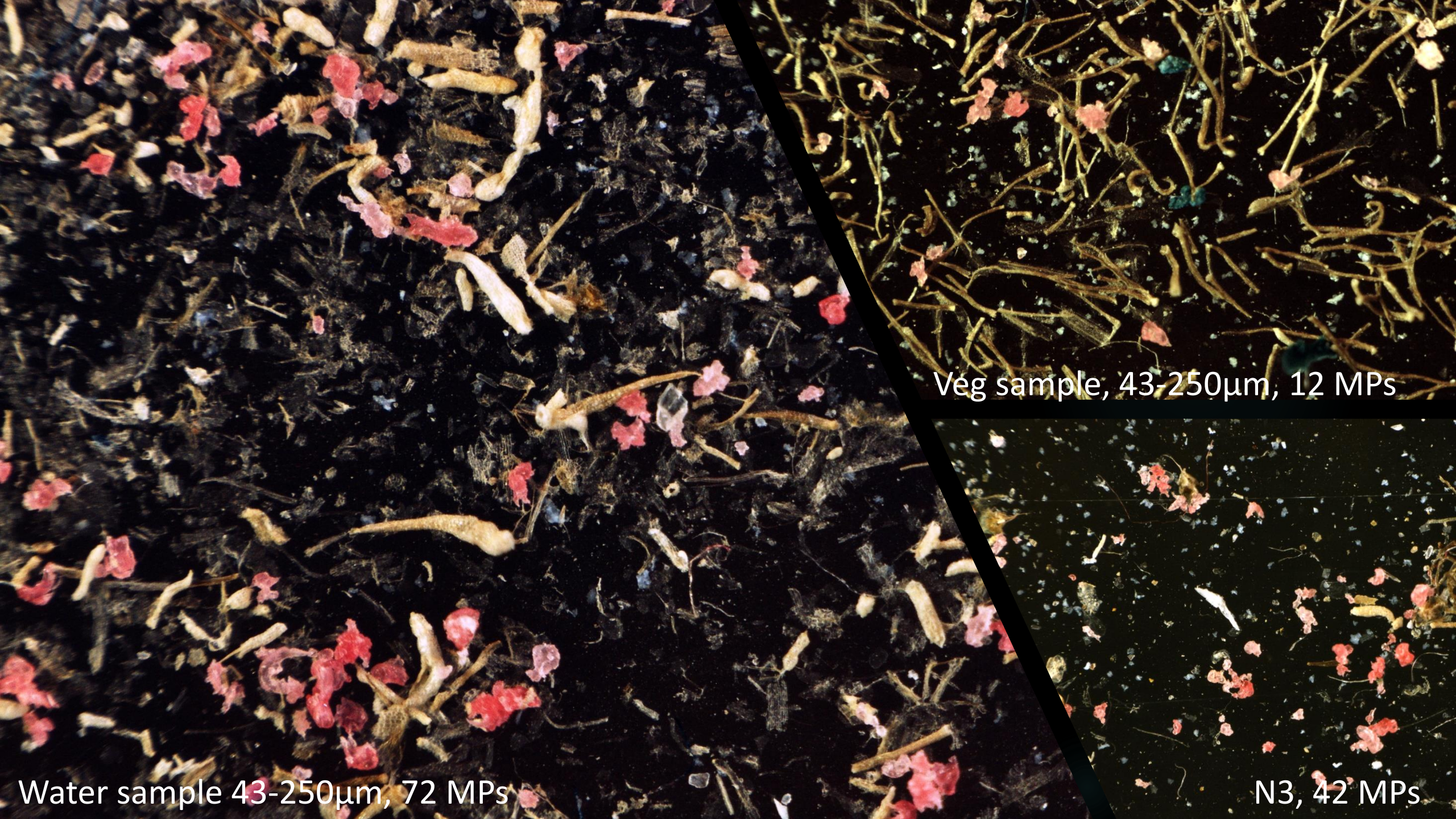
Microplastic Retention

Sample Processing

Density separation protocol

WPO (wet peroxide oxidation) of vegetation sample



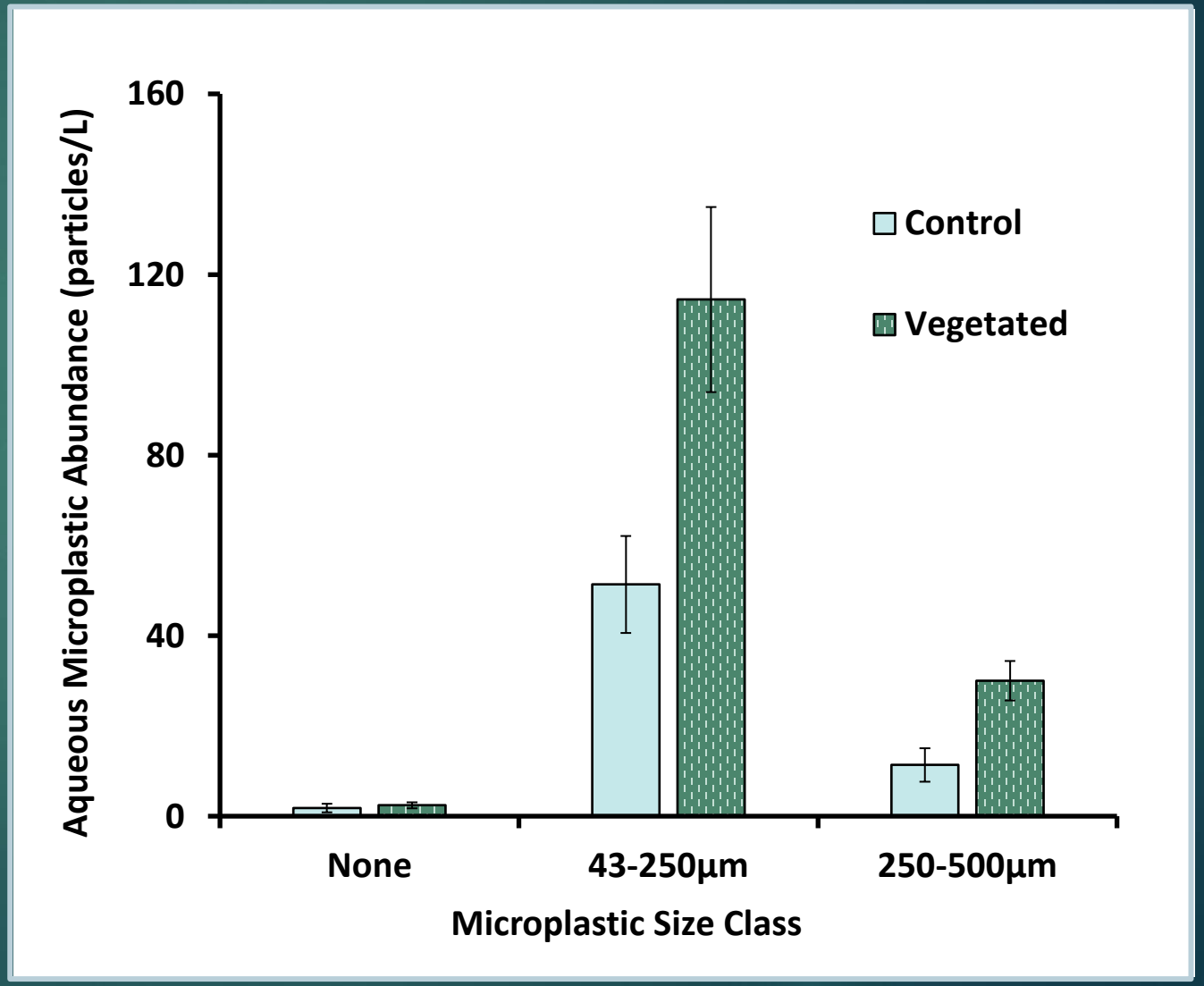

Veg sample, 43-250µm, 12 MPs
Water sample 43-250µm, 72 MPs
N3, 42 MPs

Microplastic Abundance

Vegetated > Control
p=0.0074

Small MPs > Large MPs
p < 0.0001

Vegetation plays a role in aggregation of MPs



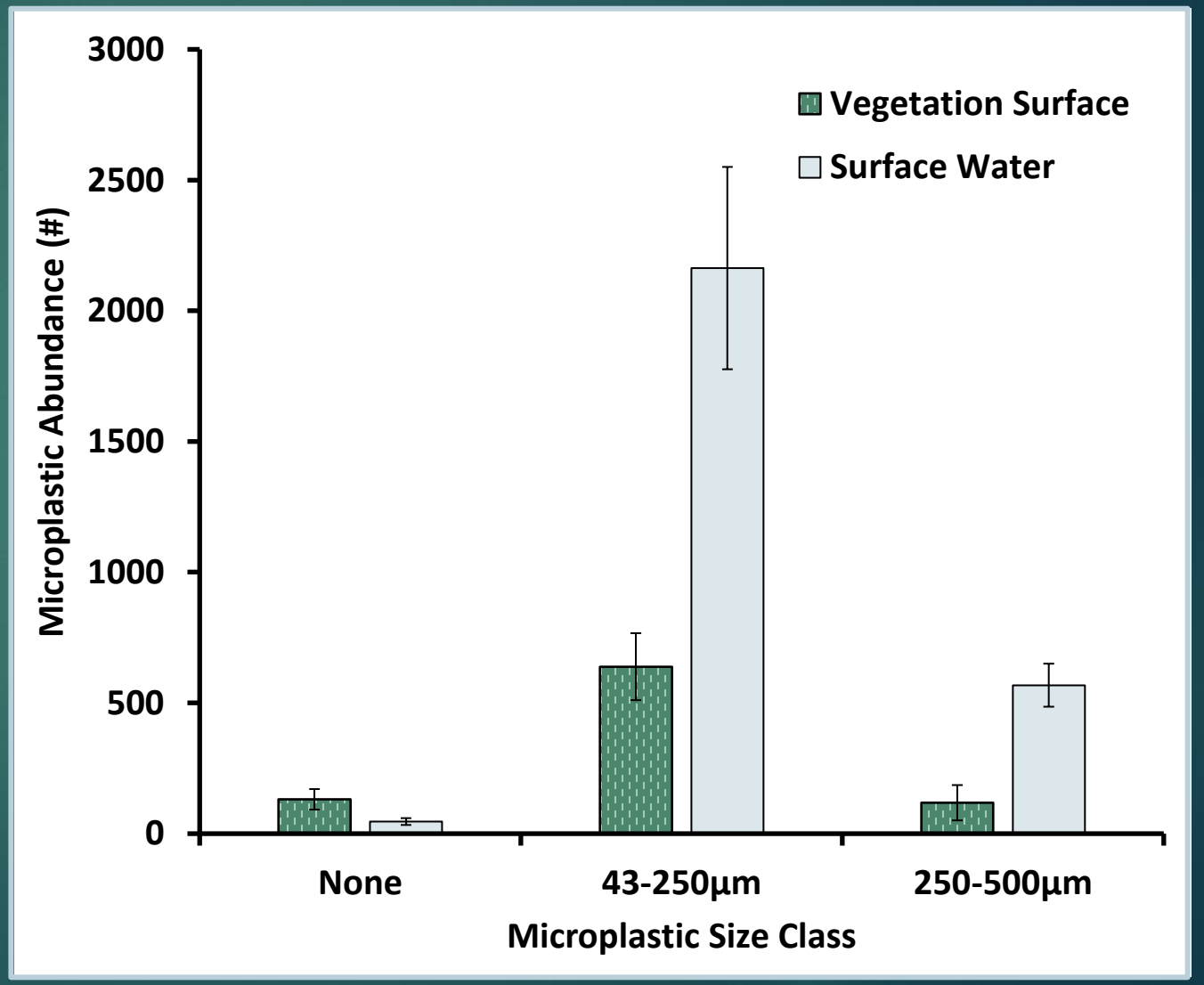
Microplastic Abundance

Surface water > Tissues
$p < 0.0001$

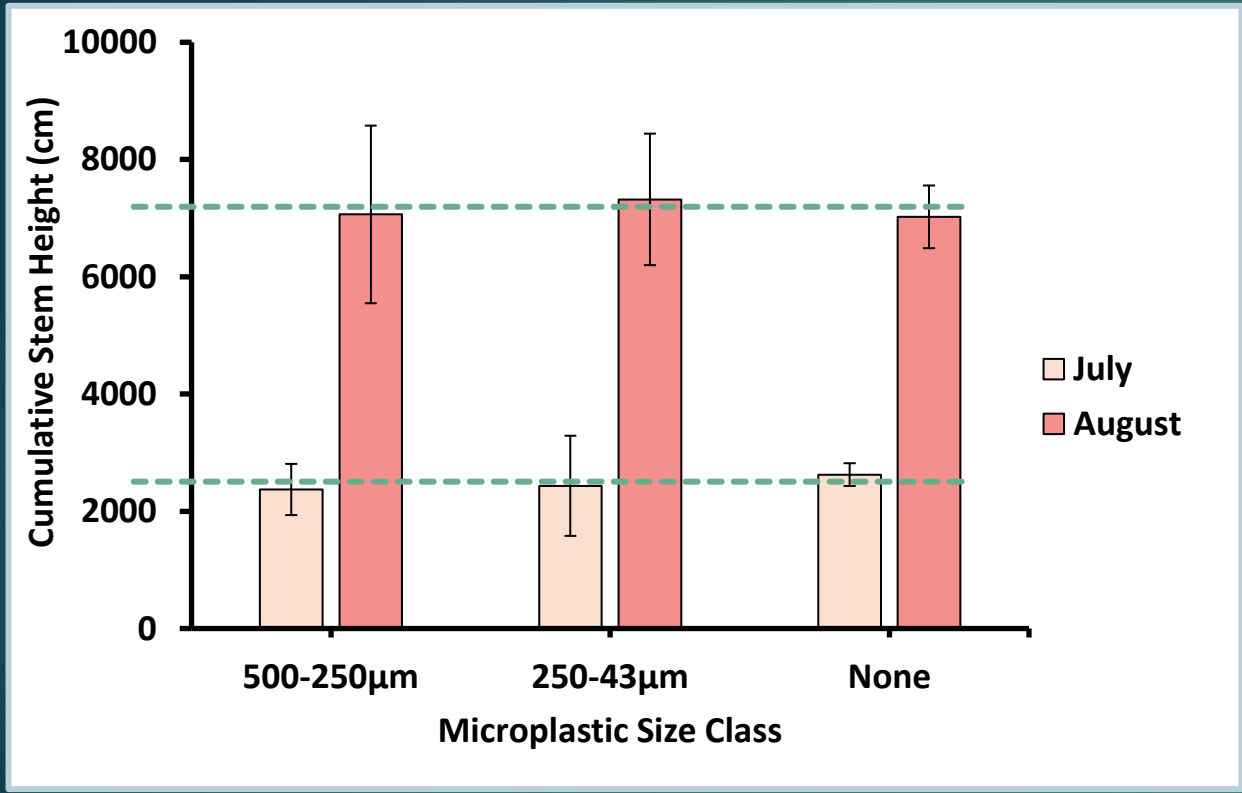
Small MPs > Large MPs
$p = 0.0108$

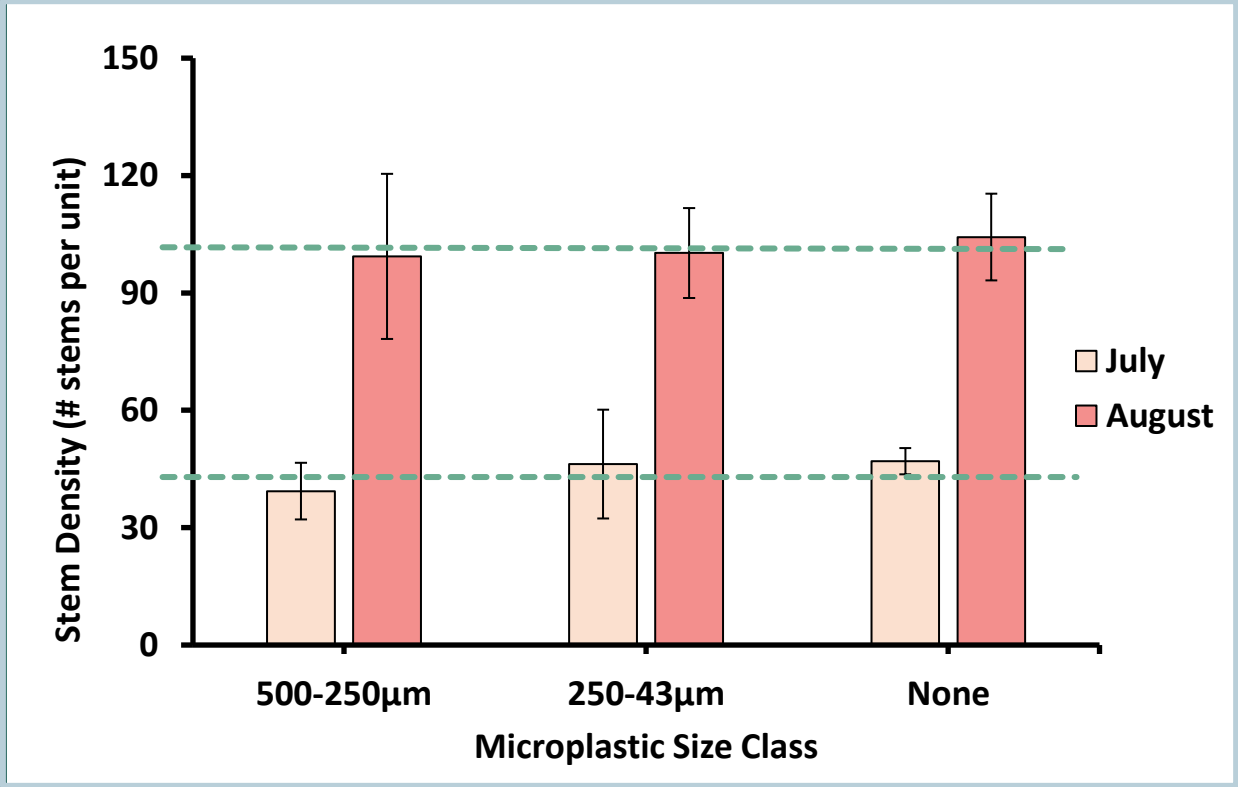
MPs sticking ***around*** more than ***on*** vegetative tissues

…but are the plants okay?



Plant Growth Response



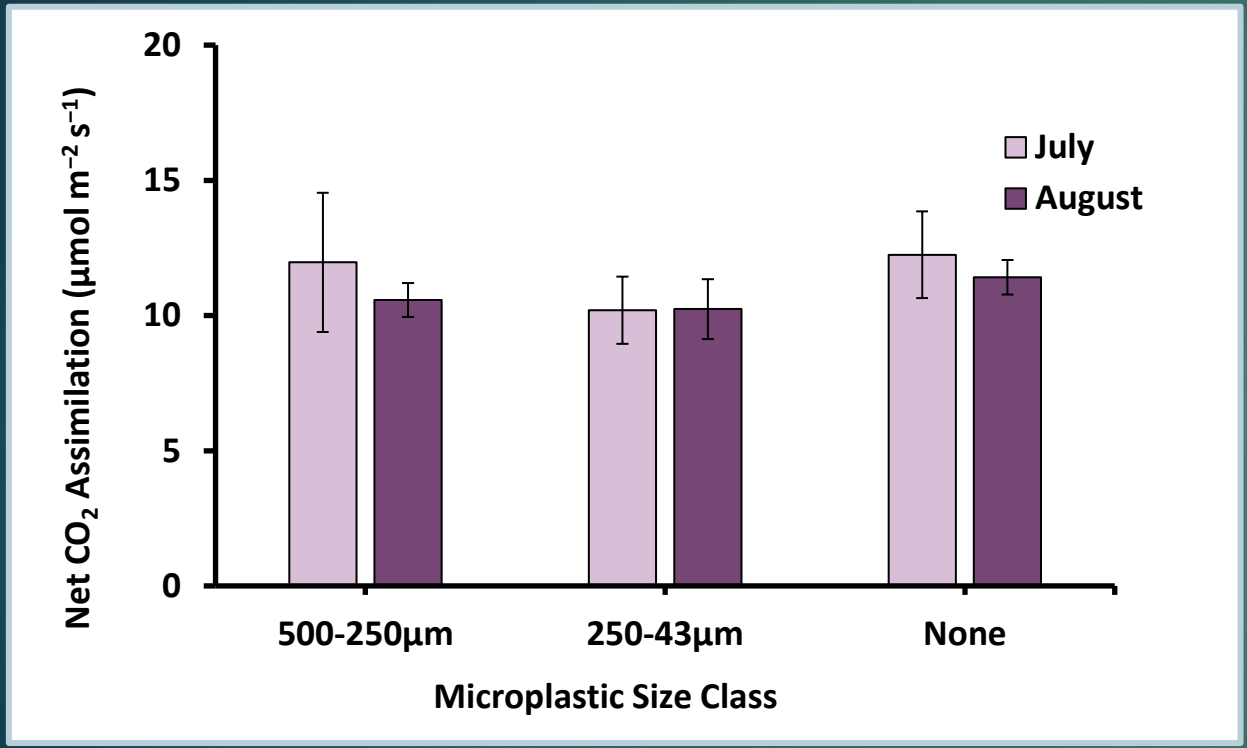


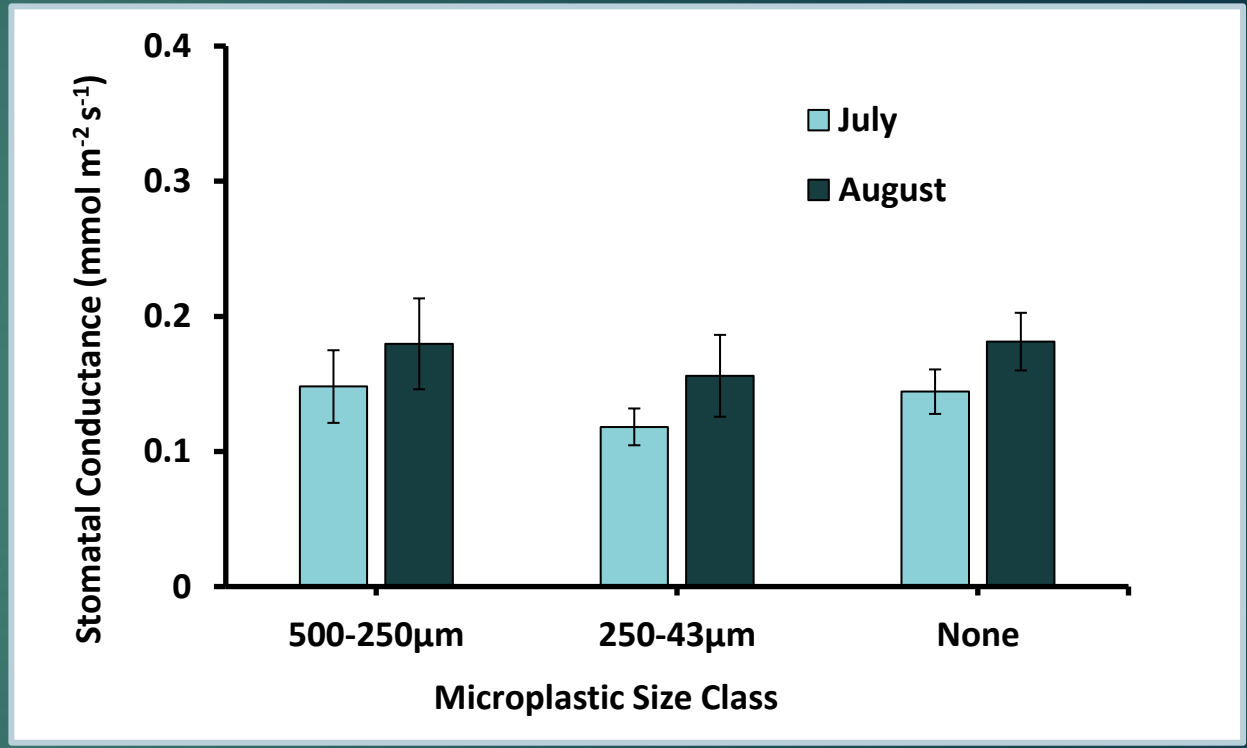
Cumulative stem height increased July → August $p < 0.0010$

Stem density increased July → August $p < 0.0010$

No significant difference between Control, Small, and Large MPs; $p < 0.0010$

Photosynthetic Response





Both parameters: No significance in size class
$p = 0.5775$

Only stomatal conductance increased July → August
$p < 0.05$

Higher temperatures = increase stomatal conductance

Implications for Management

- MPs stick ***around*** plants more than ***on*** them
- Smaller = more abundant
- 43-500um HDPE MPs not inherently toxic

Use wetland vegetation to reduce MPs?

THIBODAUX, LA

Use wetland vegetation to reduce MPs?

- MPs Density change → weathering & biofouling
- Integrated into sediments
- Less time in surface waters = less time available
- Less contaminant transfer

YES!

(Helcoski et al. 2021)

Future Study

- Mesocosm 1 study design + sediment MP abundance
- Additional aquatic vegetation functional types: submergent & floating
- Floating vegetation tissue type: root vs. leaf

- And so many more!

Questions?

Sagittaria “Sally”

Microplastic “Mike”

Email: lexiw@ucratx.org
Phone: 325-655-0565
Thesis copies available upon request