

An aerial photograph of the Golden Gate Bridge in San Francisco, California. The bridge's iconic red-orange towers and suspension cables are prominent, spanning the San Francisco Bay. In the background, the city of San Francisco is visible, nestled between the water and rolling hills. The foreground shows a grassy hillside with a winding road. The sky is filled with soft, white clouds.

San Francisco Bay Microplastics: From Comprehensive Data to Scientifically Supported Solutions

Ezra Miller, PhD

Environmental Scientist, San Francisco Estuary Institute

Before I get started...

I am trans! My pronouns are ze/zir/zirs or singular they/them/theirs.
Please do not use she/her pronouns to refer to me.

*“I saw Ezra’s talk at the GETA symposium.
Ze talked about **zir** work on microplastics in the environment.”*



- Non-profit and JPA
- Approx. 60 scientists and technologists
- **Mission:** Provide scientific support and tools for decision-making and communication through collaborative efforts



Science to Inform and Advance Environmental Protection

Performing cutting-edge research and routine environmental monitoring



Communicating and directing future research



Local data support state-wide action



Marine Pollution Bulletin

Volume 109, Issue 1, 15 August 2016, Pages 230-235



Microplastic contamination in the San Francisco Bay, California, USA

Rebecca Sutton ^a, Sherri A. Mason ^b, Shavonne K. Stanek ^{a, 1}, Ellen Willis-Norton ^{a, 2}, Ian F. Wren ^c, Carolynn Box ^d

CONTRACOSTA TIMES NEWS

News ▾ Business ▾ Sports ▾ Entertainment ▾ Lifestyle ▾ Opinion ▾ Obituaries ▾ My To

HOT TOPICS: Scott Walker Emmy winners Tesla Model X Carson vs. Muslims Record heat \$1,300

Home News Breaking News **Story**

Plastic pollution: Billions of pieces of tiny plastic litter found in San Francisco Bay

By Paul Rogers progers@mercurynews.com

California Assembly Passes Historic Law to Remove Plastic Microbeads from Personal Care Products



By Stefanie Spear | May 24, 2014



What are microplastics?



Monitoring environmental microplastics

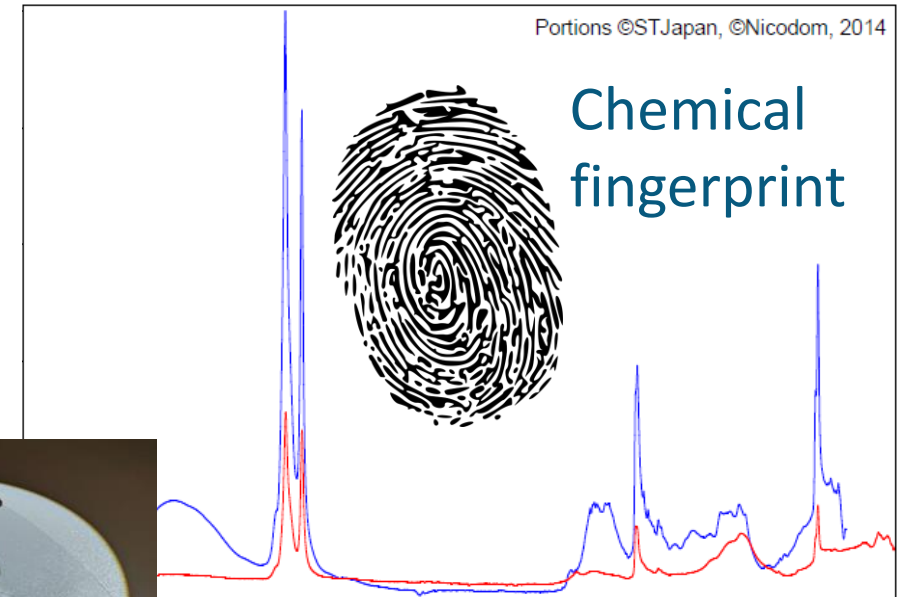
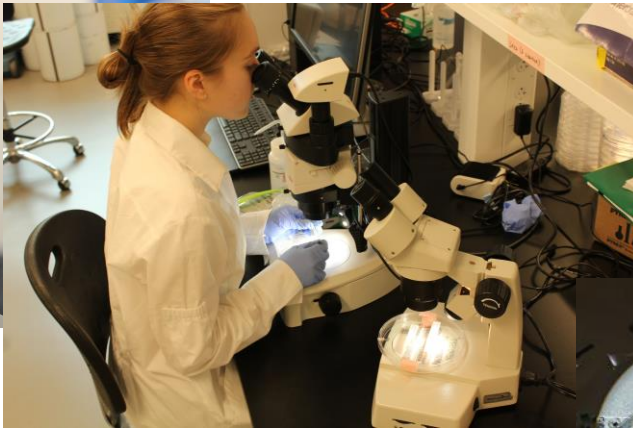
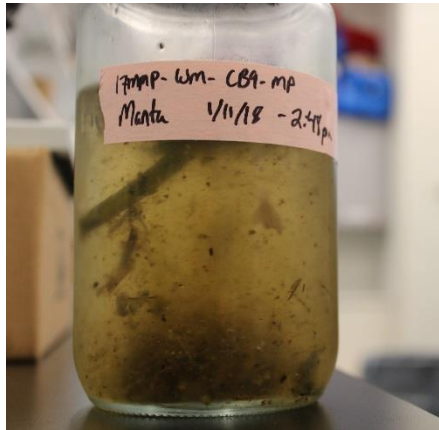
Extract particles
from samples



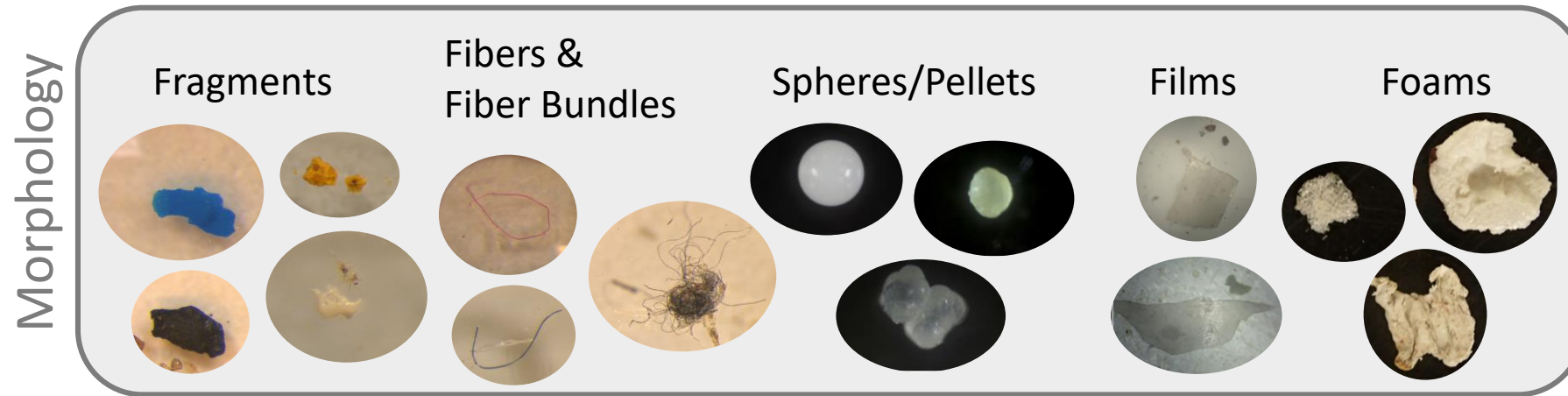
Use visual observation
to classify and count
individual particles that
may be plastic



FTIR / Raman spectroscopy to
confirm plastic identification



Microplastics are extremely diverse!



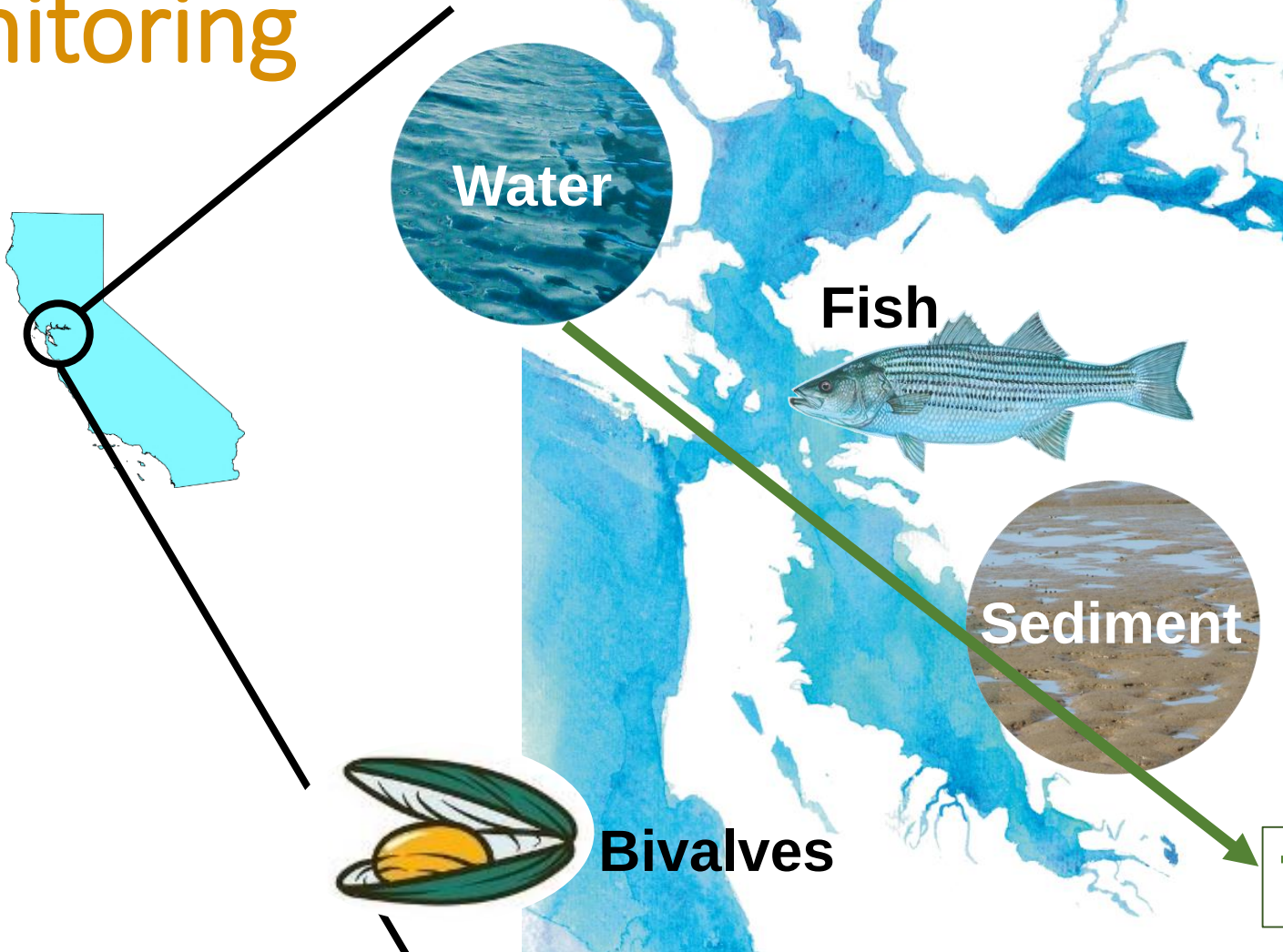
Chemistry

Polymer	Additives	Eco-toxins	Color	Size
PP LDPE HDPE PVC PU OET	Plasticizers Colorants Reinforcements Fillers Flame retardants Stabilizers etc...	PCBs PAHs DDT Heavy metals PBDEs etc...	Red Orange Yellow Brown White Black Grey Blue Green etc...	mm μm nm etc...
PS ABS PMMA POM PBT PC				
PA SAN PEEK PSU PU etc...				



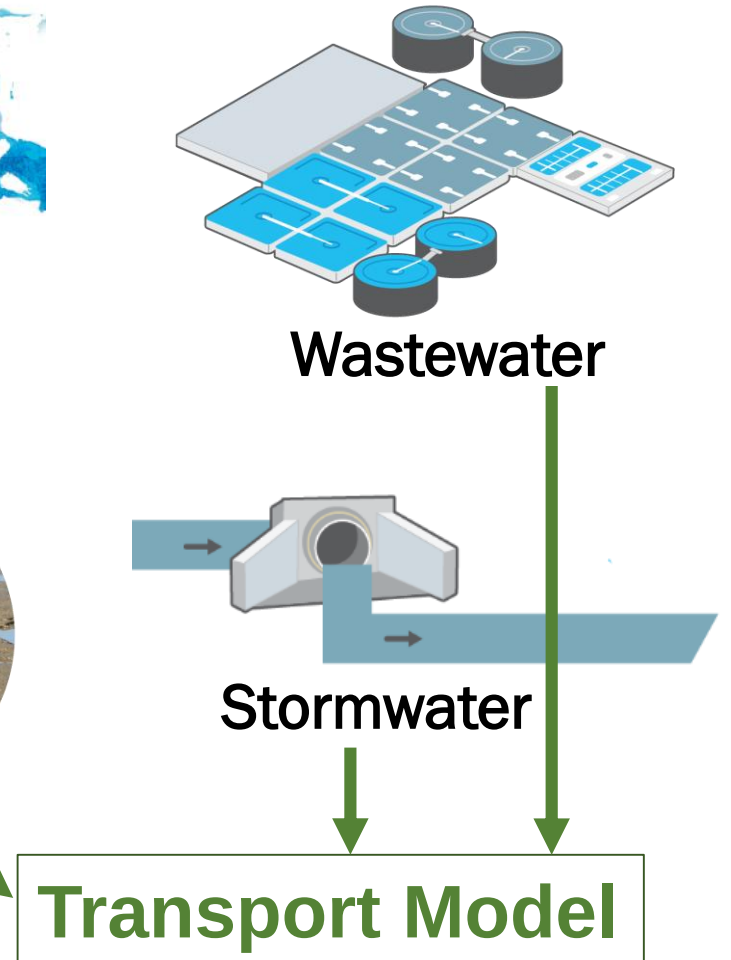
Morphology and chemistry give us clues to source

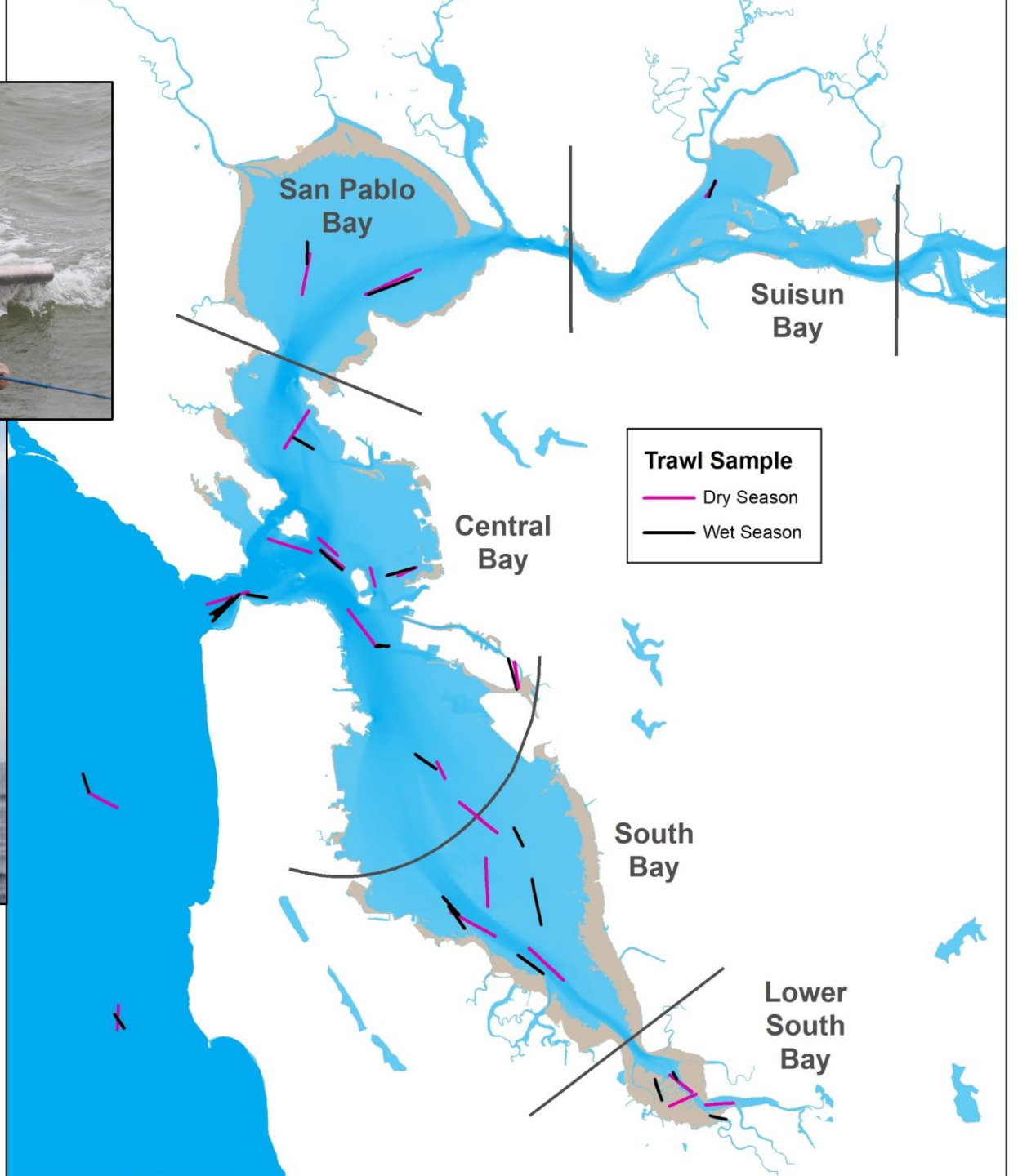
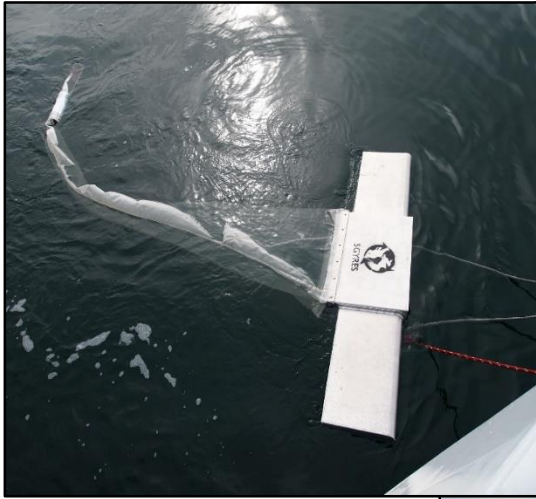
2016-2019 Comprehensive Monitoring



Ocean & Bay Monitoring

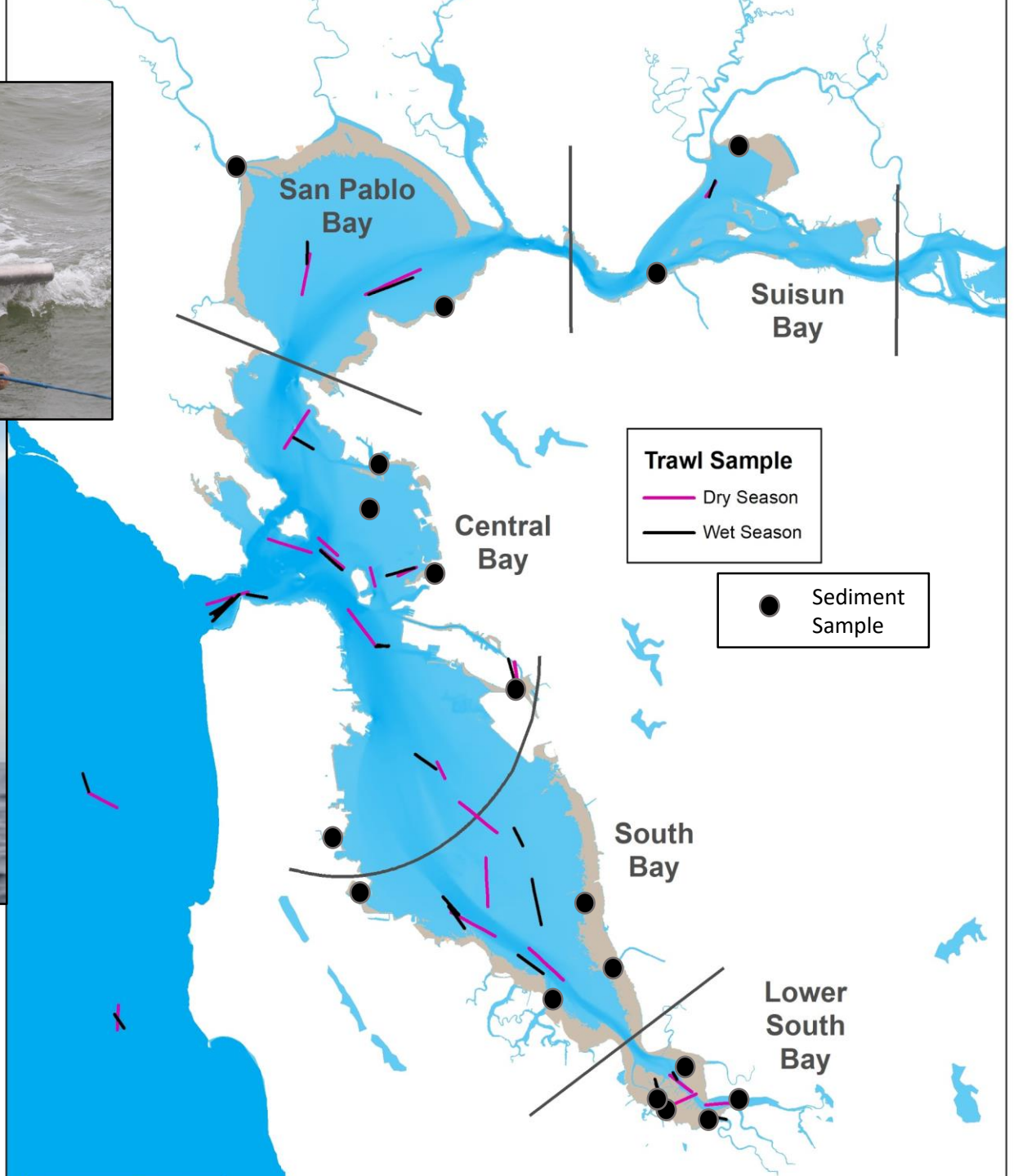
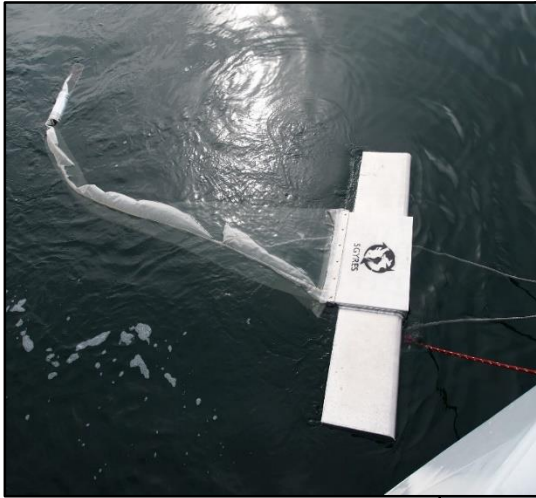
Pollution Pathways



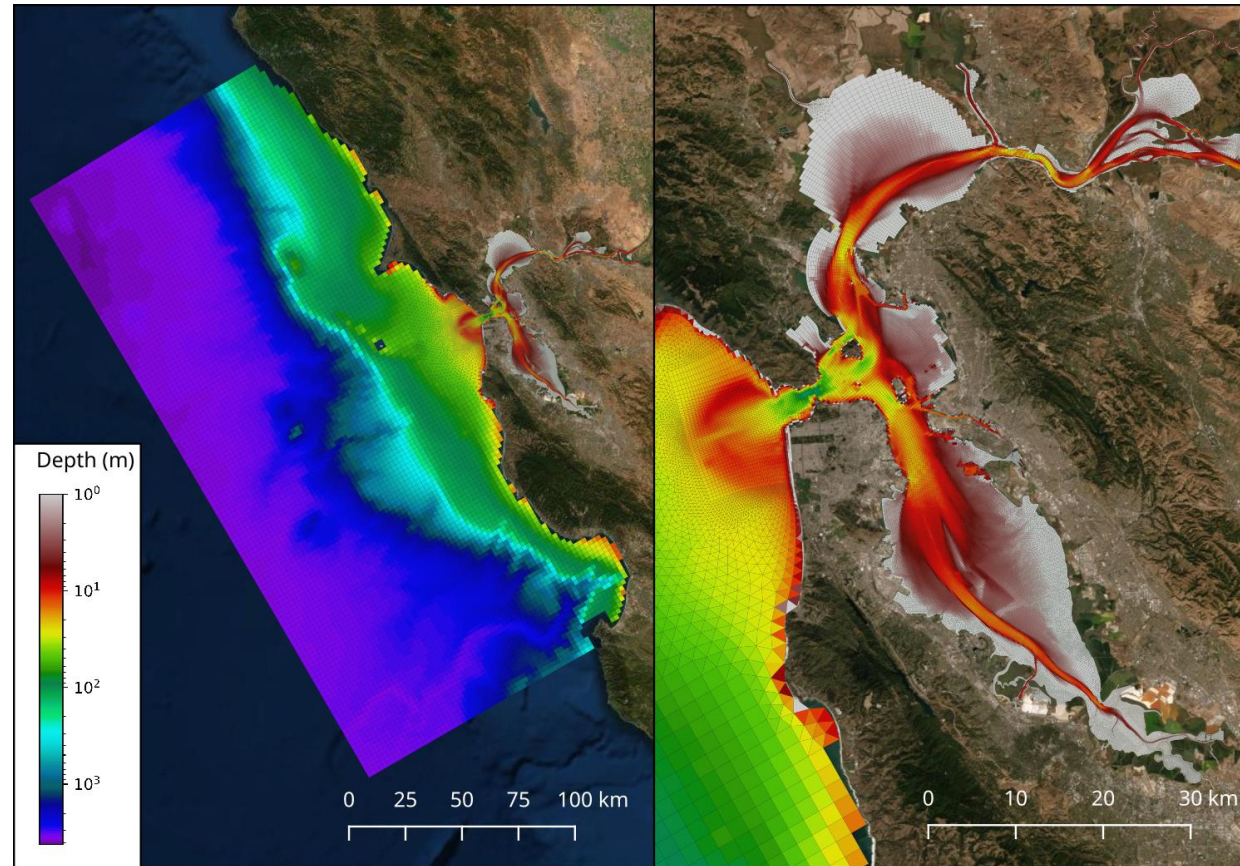
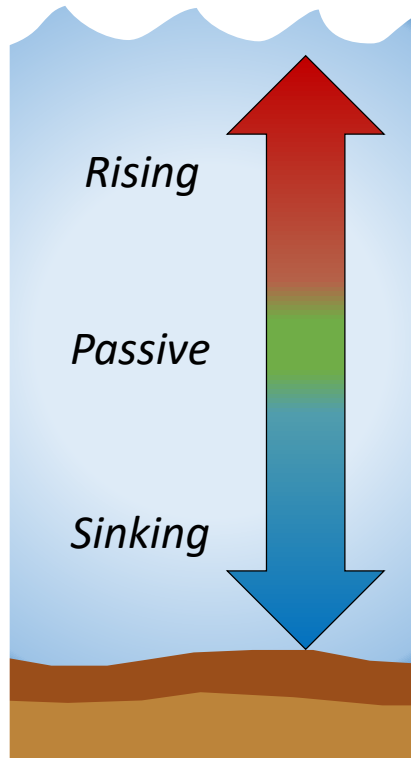


Manta trawls = most widely used method to sample surface water

Limitation: fibers and small particles can escape through 335 μm mesh net



Monitoring Data → Transport Model



Particle Tracking: Currents + Particle Buoyancy



RED: Rising, 5mm/s

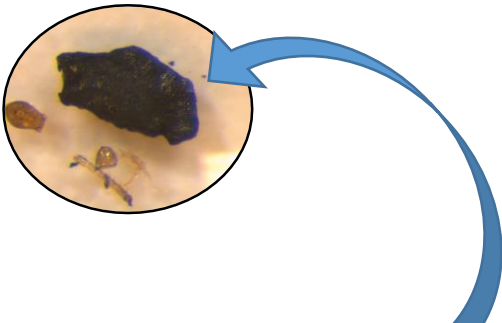
GREEN: Passive

BLUE: Sinking, 5mm/s

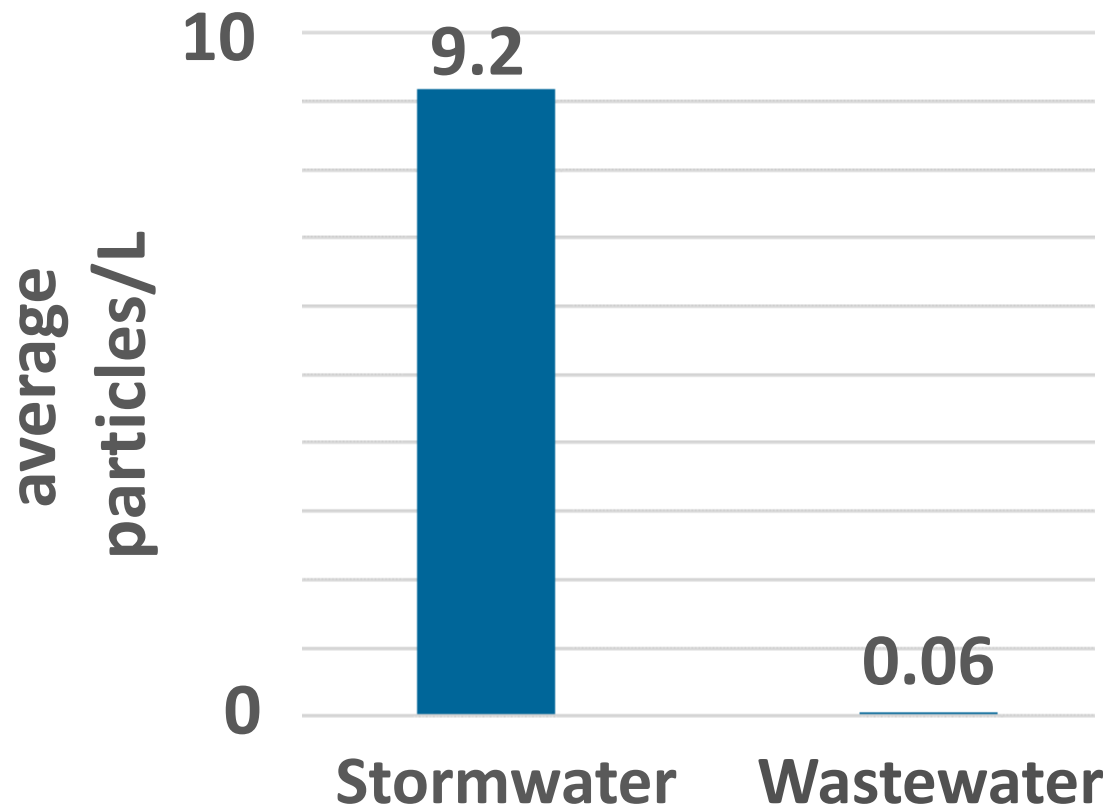
Pathways: Stormwater

Sampled 11% of total runoff to SF Bay

- 47% of particles were black rubbery fragments, likely from tires



What are the loads to SF Bay?



× annual volumes discharged
and
× fraction confirmed plastic
=

Wastewater 17 billion

Stormwater 7 trillion

estimated microplastics discharged to SF Bay annually

**Stormwater load is 300 times greater
than the wastewater
load to the Bay**

HOUSE ISSUES THREATS, TRUMP RAGES

As Democrats signal a possible White House subpoena, president lashes out at them and the whistleblower.

By Eli Stokols, Chris Mozerian and Sarah D. Wire

WASHINGTON — President Trump on Wednesday raged over House Democrats' accelerating impeachment inquiry, leveling several false claims, ducking questions and publicly venting an anger that's been percolating for a week behind closed West Wing doors.

Trump's outburst came amid an intensifying showdown with Capitol Hill as House Democrats said they would issue a subpoena to the White House on Friday if the Trump administration did not voluntarily turn over records related to a July 25 phone call with Ukraine's president.

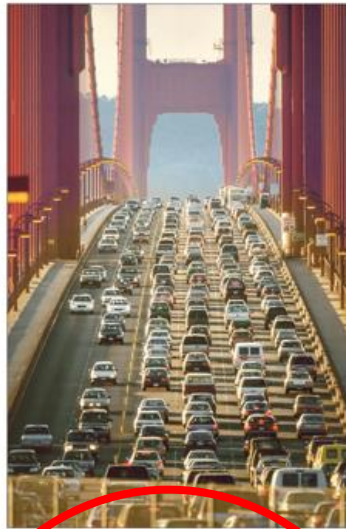
Later during public appearances at the White House, Trump repeated his claim that the whistleblower is a "spy" and vowed to "get out" who that person was.

Added whether the whistleblower's identity should be protected, Trump told reporters in the Oval Office, "I don't care."

Earlier, Trump's assistant, Ivanka Trump, said Democrats had "wasted" everyone's time and energy by "not responding in real time to House Speaker Nancy Pelosi's hearing news conference."

Trump dismissed his attempt to portray the whistleblower as a fake during a news conference in the White House. East Room allegations are president of Finland, "I have a lot of respect for Trump, AK."

Impeachment history lessons
Since President Andrew Johnson was impeached in 1868, each inquiry has had its unique circumstances. BACK STORY, A1



The Golden Gate Bridge, a state symbol, is also a source of tire rubber that pollutes the sea.

Cars pollute the sea too, with tire rubber

California's waters are awash in microplastics, and automobiles may be the primary source

By ROSANNA XIA

BERKELEY — Driving is not just an air pollution and climate change problem — turns out, it just might be the largest contributor of microplastics in California coastal waters.

That is one of many new findings, released Wednesday, from the most comprehensive study to date on microplastics in California. Roughly 7 million pieces of microplastics, much of it tire particles left behind on streets, into San Francisco Bay each year — an amount 200 times greater than what comes from microfibers washing off polyester clothes, microbeads from beauty products and the many other plastics washing down our sinks, sewers and storm drains.

These tiny plastics, invisible to the naked eye, have been vilified for polluting water and wildlife but are notoriously difficult to study. They're everywhere and seemingly come from everywhere. They wash into the ocean in all different shapes and sizes, many covered with dyes and chemicals. Researchers at the state, the nation and the world haven't even agreed on how exactly to measure or sample or study them.

It is a team of researchers, led by the San Francisco Estuary Institute and the U.S. Environmental Protection Agency, that has taken the lead in creating a national research group focused on reducing plastic pollution, and set off to create an inventory of ways to identify all the ways these different microplastics were getting into San Francisco Bay. They analyzed hundreds of samples of fish, sediment, surface water, wastewater and stormwater runoff and tried to trace the origins of all these plastics.

Mark C. Meyer heads the state's Ocean Protection Council and was a key figure in the study. (See Microplastics, A1)

L.A. vows to void 2 million court citations and warrants

Officials say the move will benefit the poor and homeless, who often go to jail over minor offenses.

By MARK FRIEDMAN AND RICHARD WINTON

In a stroke more designed to ease the challenges facing the region's poor and homeless people, Los Angeles officials said Wednesday that they were voiding nearly 2 million minor citations and warrants that had kept people trapped in the court system.

The announcement is designed to fix a system that has led to many people being repeatedly ticketed and arrested for minor infractions, leading to growing fines and warrants. For homeless people, that has created roadblocks to accessing housing and services.

Nationally, big cities have been trying to move away from citations and infractions that according to critics "tied people into the system" and kept them from the streets into jail cells. Until now in Los Angeles, eliminating citations

had been done on a limited basis.

A Times data analysis in 2018 found a persistent cycle of homeless arrests. Los Angeles has more than a dozen "quality-of-life" laws — restricting sleeping on the sidewalk, living in a car or low-level drug possession, for example — that police usually enforce with a citation. The tickets typically start out at less than \$200, but often top \$500 once court fees are added. Tickets pile up, and people go to jail.

In a joint announcement Wednesday, Los Angeles City Atty. Mike Feuer, Los Angeles County Dist. Atty. Jackie Lacey and LAPD Chief Michel Moore said they wanted to "undo" the court system.

The plan will save the courts money, they said, and help the LAPD focus on getting the worst criminals off the streets instead of having officers spend crucial time on minor infractions involving homeless people.

"We're taking action with our law enforcement partners today," Feuer said in a combined statement. "No focus on the most important public safety issues, but on the least important."

A test-optional route into UC?

Regents debate lifting SAT requirement to even the playing field, a move that could set the bar nationwide.

By TESSA WATKINS

Half a century ago, the University of California placed a national promise on its flag: to provide the college admission process when it began receiving all applicants to the test, test and report scores.

Now the UC system, by its own size and influence as the nation's premier public research university, is again poised to play an outsize role in the future of standardized testing in America as its leaders consider whether to drop both the SAT and ACT as an admissions requirement.

Although the standardized tests are predictive of college performance, par-

ticularly at selective universities, they are increasingly seen as an unnecessary barrier to students who don't test well or don't have the means to access or pay for private test preparation. Decades of research has shown that scores are strongly influenced by family income, parents' education and race.

The burning question is how UC officials will move to address the clearly documented flaws of the test. If they choose to throw out the SAT and the ACT, another popular test, will they find a better replacement?

"Whatever we do will be a national precedent," UC President Janet Napolitano said at a recent Board of Regents meeting. "And we want to get it right."

The decision will be a "monumental" one, UC's status is likely to heavily influence other universities and the testing industry itself, said Jay Rosner, an admissions test expert with the Princeton Review Proce-

(See Tests, A1)

Sports: Sharks' Kane suspended for 3 games. C1

Business: Nestle, Dreyer's cutting hundreds of jobs in Bay Area. C2

Local: BART general manager's with a second route across the bay. B1

Nation: E.A.-Dallas officer found guilty of murder. A3

Plastic tide: 7 trillion bits wash into bay every year

New study reveals that storm drains are the largest source of the toxic confetti



A crab fisherman checks his trap while cleaning a storm drain in San Francisco on Monday. A three-year scientific study found trillions of "microplastics" pieces are flowing into San Francisco Bay, threatening the ecosystem.

By Paul Rogers

San Francisco — Every year, 7 trillion tiny pieces of plastic, roughly equal to millions of plastic bottles, are washed down storm drains and into the bay.

That's the finding of a new study by the University of California, San Francisco, and the University of California, Berkeley, which is the most comprehensive scientific study yet on the subject.

The findings question the long-held belief that the Bay Area's 400 sewage treatment plants every year are the main source of plastic pollution.

The study found that the Bay Area's 400 sewage treatment plants every year are the main source of plastic pollution.

The study found that the Bay Area's 400 sewage treatment plants every year are the main source of plastic pollution.

(See Plastic, A1)

IMPEACHMENT INQUIRY

Pompeo, House chairmen clash

Secretary of State rejects Democrats' demands to interview State Department officials

By Nicholas Fandos and Lara Jakes

WASHINGTON — The Trump administration and the leaders of the House impeachment inquiry into President Donald Trump clashed Tuesday over demands to interview State Department officials who are witnesses in the growing investigation, trading accusations of overreach and obstruction.

Secretary of State Mike Pompeo pushed back in a letter Tuesday morning on a demand from three House committees for American diplomats to sit this week for depositions on Capitol Hill, saying the effort amounted to "an act of intimidation" and did not allow enough time for the State Department to properly respond.

The chairmen of the House Intelligence, Foreign Affairs and Judiciary committees said they would hold the depositions on Oct. 10.

(See Impeachment, A1)



Secretary of State Mike Pompeo told lawmakers that a demand for American diplomats to sit for depositions this week amounted to "an act of intimidation."

PLAY-BY-PLAY MAN

For announcer, A's playoffs part of growing up

Oakland-born Vasquez says that he used to bleed green and gold

By Chuck Heston

ESPN play-by-play man Matt Vasquez was barely 5 years old when he uttered a curse word in front of his dad for the first time — and the Oakland A's made him do it. Sort of.

2017 MURDER TRIAL

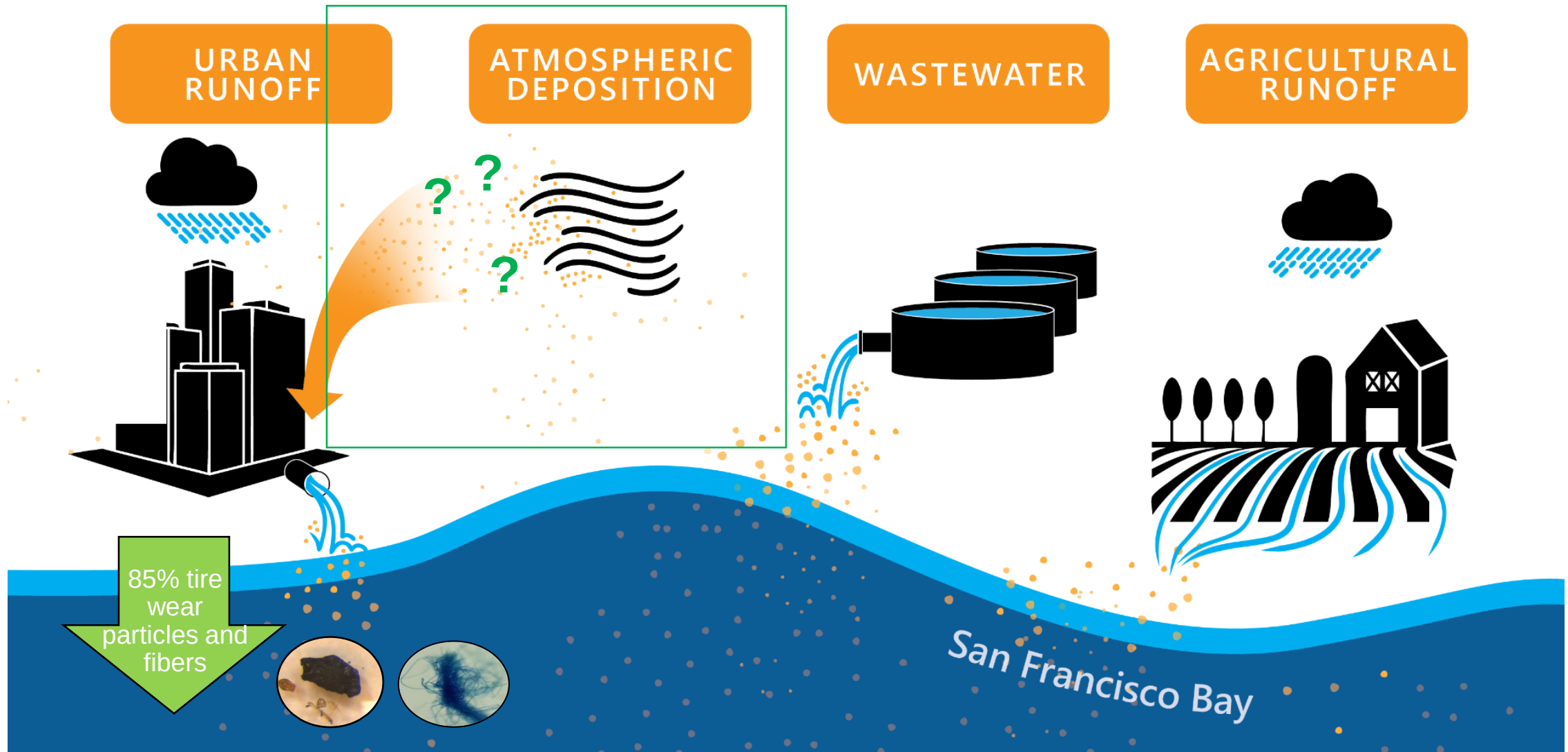
Excusal of black jurors ruled legal

What's Next?

Understanding Urban Runoff



Fibers: Air is a major transport pathway. Major outdoor sources are still unclear.



Tires chemical leaching can cause acute toxicity



Tire ingredient
6PPD

Ozone in air



6PPD-quinone
in urban runoff



Coho salmon fish kills



Chemical ingredients are an important part of microplastic transport and exposure

Linking science to solutions



CA Department of Toxic Substance Control Proposed Regulations



-  Hazardous Waste ▾
-  Site Mitigation ▾
-  Safer Consumer Products ▾
-  Chemistry ▾
-  Get Involved ▾
-  Laws & Regulations ▾
-  About DTSC ▾
-  Search

News Release

T - 07 - 22

Meredith Williams, Director

FOR IMMEDIATE RELEASE

May 23, 2022

Contact: Sanford (Sandy) Nax

(916) 416-4309

Sanford.Nax@dtsc.ca.gov

California Proposes Requiring Tiremakers to Consider Safer Alternative to Chemical
that Kills Coho Salmon

Legislative focus on microplastics

California Senate Bill 1422 (2018): Microplastics in Drinking Water

- Develop plans for measuring microplastic particles in drinking water by 2021

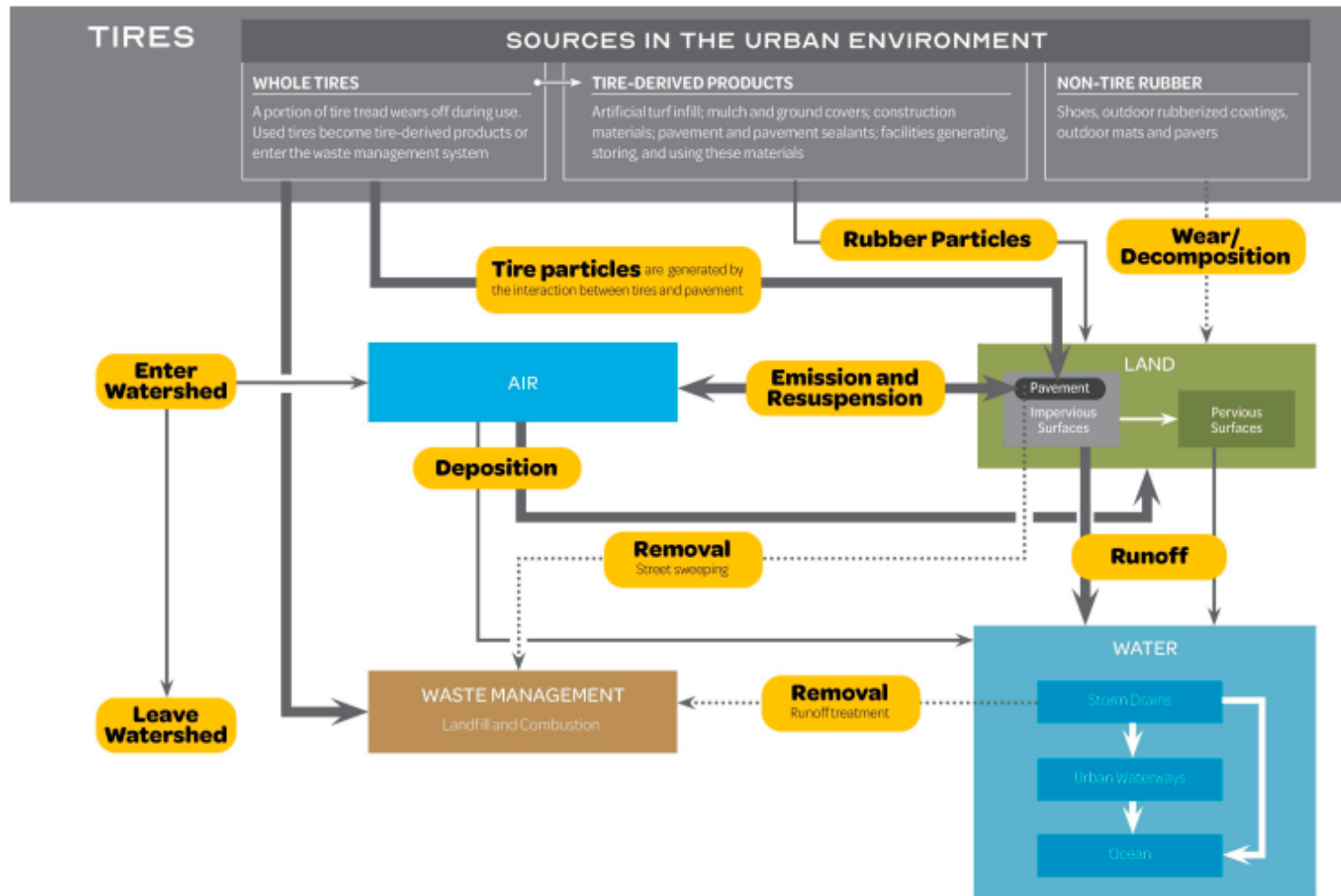
California Senate Bill 1263 (2018): Statewide Microplastics Strategy

By 2026

- Develop risk assessment framework
- Develop standardized methods
- Establish baseline occurrence data
- Investigate sources and pathways
- Recommend source reduction strategies



Stormwater Conceptual Models (2021)



Tires



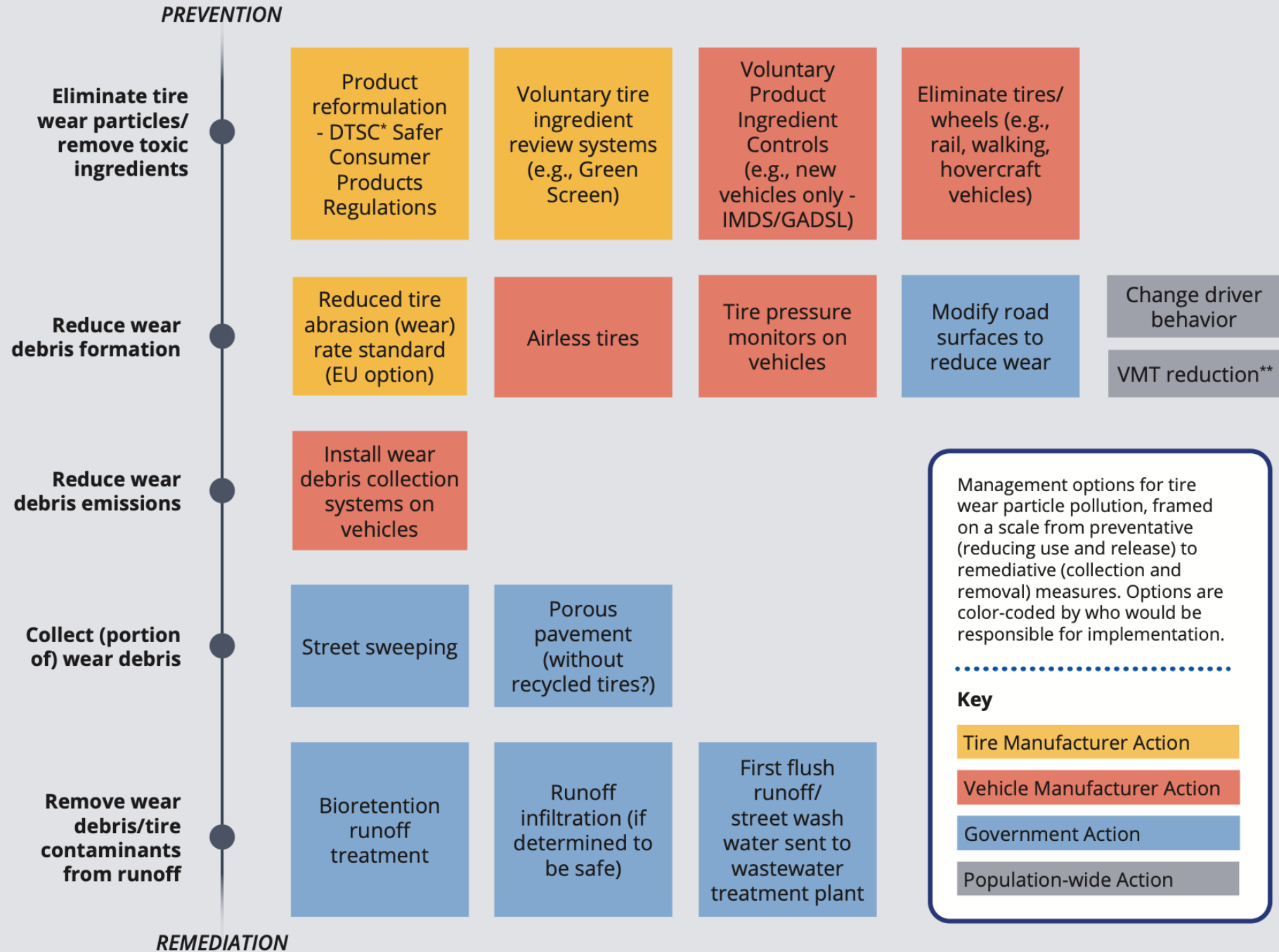
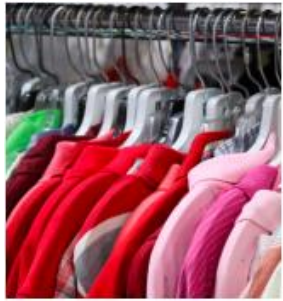
Cigarette butts & cellulose acetate fibers



Fibers (other than cellulose acetate)



Single-use plastic foodware



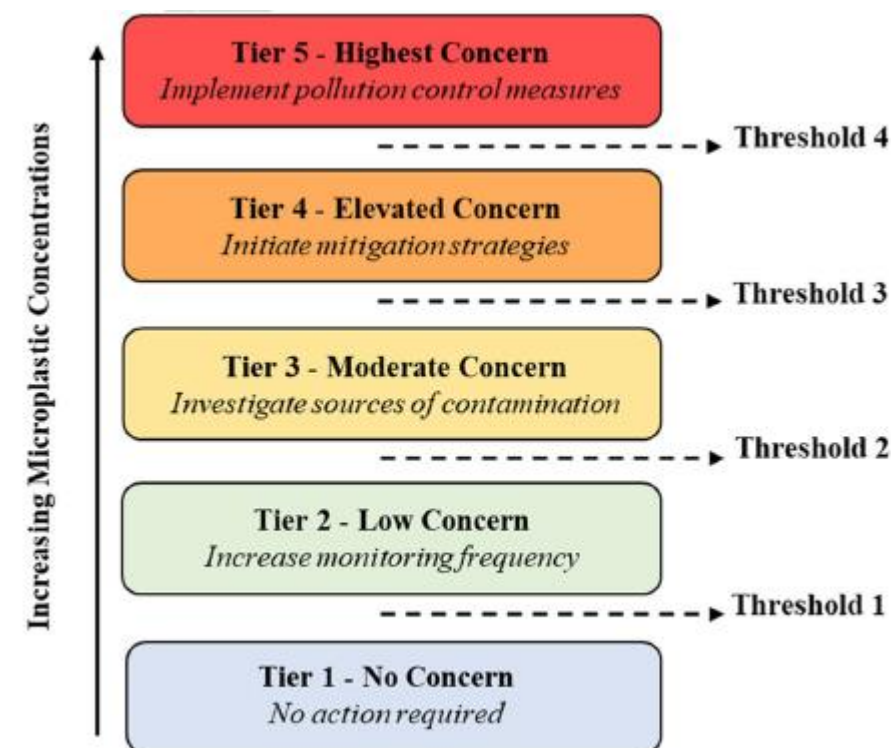
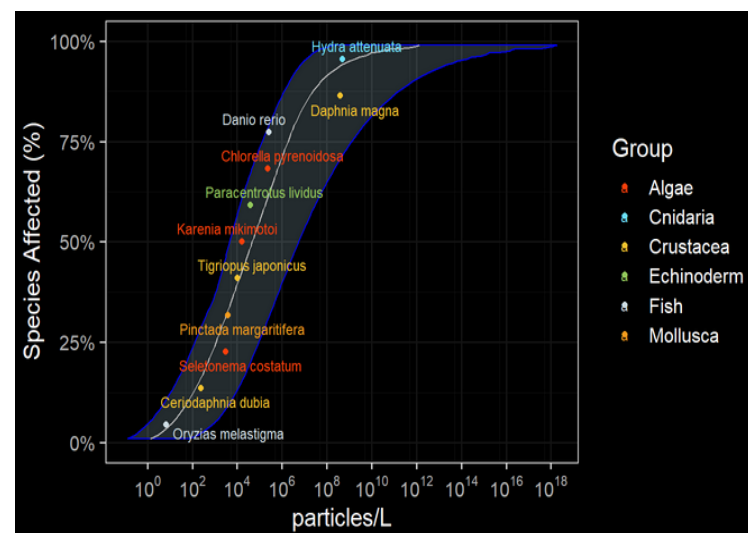


Health Effects Workshop (2020-2021)

- Experts convened to assess current literature and develop a risk framework and approach for developing thresholds



*Toxicity of
Microplastics Explorer*

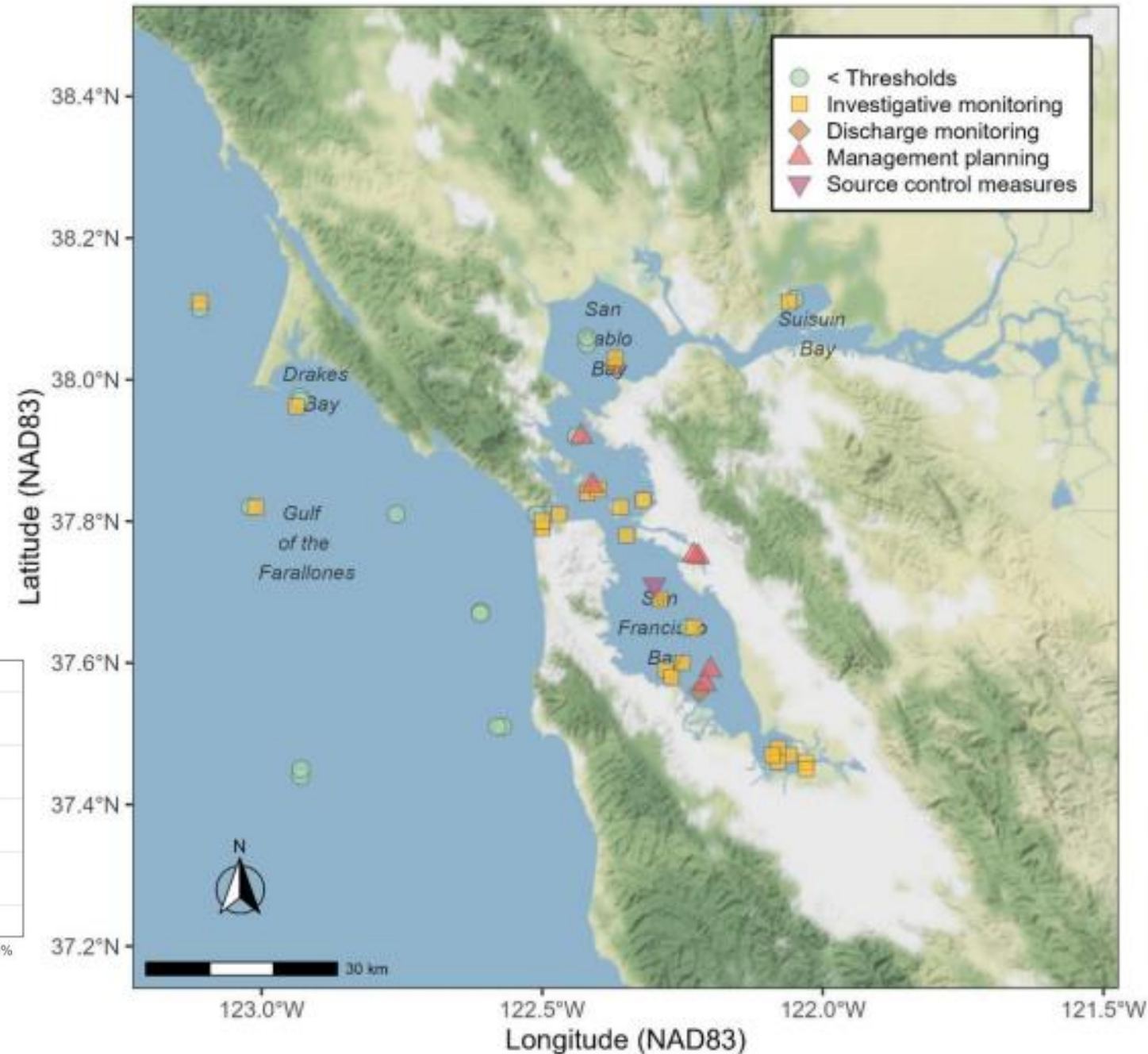
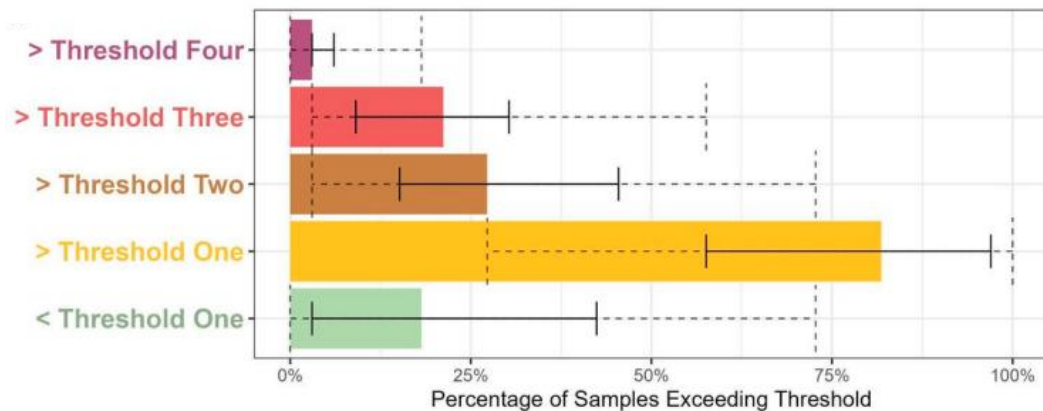


What we know about toxicity to aquatic life



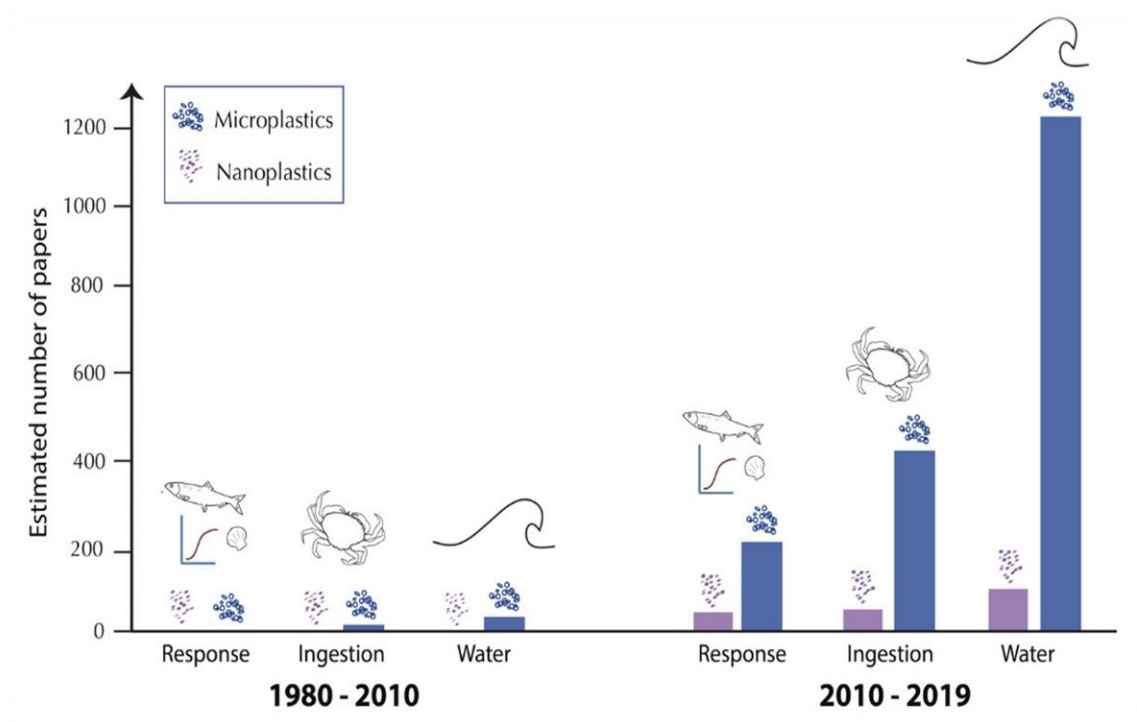
- **Size and shape matter**
 - Aquatic organisms respond more negatively to fibers / fragments than spheres
 - Can affect ingestion, accumulation, translocation within organism (size cut off still uncertain)
- **Polymers across sizes and shapes can cause oxidative stress**
 - Exposure to microplastics → cells often produce reactive oxygen species that can cause structural damage

Microplastics #s in SF Bay indicate cause for concern



We are learning more every day; microplastics research is skyrocketing

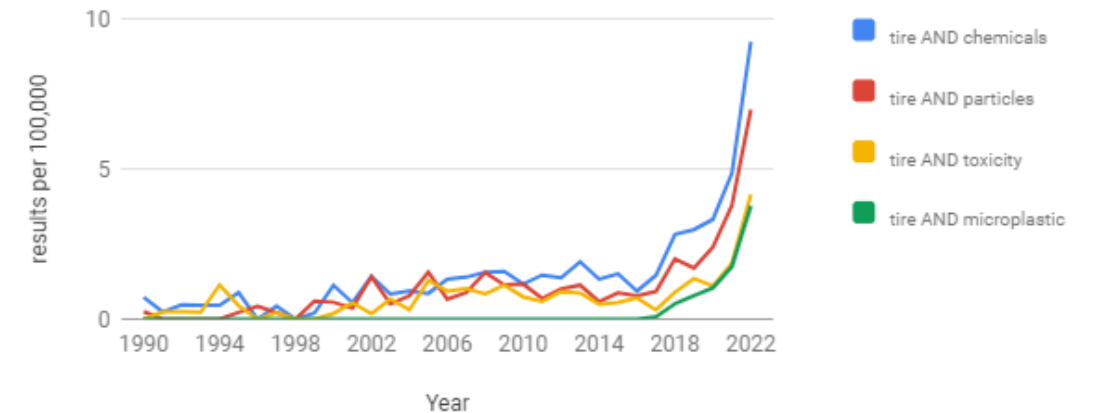
All Particle Types



Granek, Brander, Holland 2020, *Lim Oce Lttrs*

Tire Particles

Results per 100,000 citations in PubMed
proportion for each search by year, 1990 to 2022



Made with PubMed by Year: <http://esperr.github.io/pubmed-by-year>

Thank you to our funders and collaborators!



Questions?

www.sfei.org/projects/microplastics

ezram@sfei.org