Per- and Polyfluoroalkyl Substances (PFAS) in San Francisco Bay Fish

MEETING SUMMARY • February 4, 2022

ORGANIZING PARTNERS

CLEAN WATER ACTION | CLEAN WATER FUND

California Indian Environmental Alliance

SFEI San Francisco Estuary Institute

with assistance from Green Science Policy Institute and The Water Foundation

FUNDED BY The Gordon and Betty Moore Foundation • Rose Foundation for Communities and the Environment • Satterberg Foundation

CO-HOSTS Dr. Rebecca Sutton, Senior Scientist at the San Francisco Estuary Institute

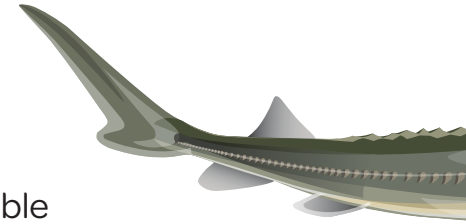
Andria Ventura, California Legislative and Policy Director at Clean Water Action

Sherri Norris, Executive Director of California Indian Environmental Alliance (Osage Nation)

PRESENTATIONS AVAILABLE AT https://www.sfei.org/projects/PFASBayFish and https://www.cleanwateraction.org/features/tackling-californias-pfas-problem

Goals of Today's Meeting and Land Acknowledgment

The virtual forum began with introductions from the co-hosts, who represent diverse perspectives on PFAS in San Francisco Bay fish including science, policy/regulation, and adversely impacted communities. With early findings showing detection of PFAS in various Bay matrices, this forum was conceived to discuss PFAS sources, concentrations of PFAS in the Bay, and the negative impacts on Bay Area communities. The meeting was not recorded to ensure all participants felt comfortable vocalizing their honest sentiments.



Developed by Bay Area indigenous groups, Ms. Norris gave a land acknowledgement as a step towards restored justice for the original peoples of the San Francisco Bay.

Fishing near Vallejo. Photo by Joe Clark, All Positives Possible • https://www.allpositivesp.org/

Session 1. Setting the Stage: PFAS and Perspectives from Bay Fishing Communities

Reducing Harm from PFAS for Healthier People and Environment

Dr. Arlene Blum • Founder and Executive Director, Green Science Policy Institute

Dr. Arlene Blum presented a general overview of the uses and harms of PFAS, highlighting its place as one of six chemical classes of concern encountered significantly in our daily lives (sixclasses.org). Due to their unique chemistry, PFAS are widely used across consumer products and in firefighting foams, with known contamination from industrial production sites, military areas, and airports. The most well-known chemicals in the class are perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). They are known multi-organ toxicants that have been banned in the US. However, due to their persistence, the legacy of their past use remains in humans and the environment. Continued development and production of similar emerging PFAS as replacements results in exposure to contaminants suspected to be as toxic as PFOS and PFOA.

Dr. Blum spotlighted the importance of minimizing harms, particularly by choosing safer alternatives, and the preferable approach to reducing use in specific sources like consumer products to prevent their introduction into the environment. Several industries or innovative companies have begun to remove PFAS from products including food packaging, carpets, and shoes. In addition, many states,

including California, are leading change by imposing regulations on PFAS in several products such as paper-based food packaging, carpet, and firefighting foams. For more information on PFAS including up-to-date science and alternatives, please visit PFAScentral.org.

Perspectives of Historically Disadvantaged, High Risk, Long-Term Exposed African American Communities

Lonnie Mason • Executive Director, First Generation Environmental Health & Economic Development • www.firstgenerationehed.org

Dominique Brooks • Executive Director, Healing Impacted Communities • www.healcommunity.site

LaDonna Williams • Programs Director, All Positives Possible • www.allpositivesp.org/

William Ware • Graduate Student at UC Santa Cruz and Fish Biologist at FISHBIO

This series of speakers highlighted the undue burden of environmental pollution on Bay Area frontline Black communities. All stressed the complex impacts from multiple contamination sources and types, other social impacts such as lack of access to healthy foods, and the need for clear communication and engagement with local communities by agencies and decision-makers.

Lonnie Mason began by presenting on the Bayview-Hunters Point neighborhood, a historically predominantly black community in the southeast corner of San Francisco significantly affected by environmental issues. The development of a US Naval shipyard in the community during World War II brought many Black Americans to the Bay. However, the subsequent development of the shipyard, an eventual Superfund site including the Naval Radiological Defense Laboratory, coupled with industrial and public utilities sites has left the environment contaminated with PFAS and a variety of other pollutants.

Dominique Brooks highlighted similar issues in the East Bay, specifically the Bayo Vista neighborhood in Rodeo, CA. She first provided an overview of the PFAS sources and pathways that lead to community contamination and then the multiple industrial pollution sources affecting the Black community of Bayo Vista. These include the Phillips 66 Refinery, NuStar Energy Company[1], a local wastewater treatment plant, as well as freeways and a railroad. This is in keeping with cited reports demonstrating that Black fenceline communities "face cumulative impacts from multiple routes of exposure to hazards, leading to increased health burdens," and that these communities also bear heavier burdens of PFAS contamination. Ms. Brooks also highlighted that these increasing adverse environmental issues are impacting the generational legacy of fishing within the Black communities of the Bay. With many neighborhoods considered food deserts, local Black communities see fishing as a primary food source as well as a part of family tradition, hobby, and source of mental well-being.

LaDonna Williams recognized the important work required to actively engage and include the Black communities of the Bay in discussions of fish contamination. Fishing is a cultural family tradition that began in the South and continues for those who came to the Bay Area. The focus must be on communication and information access for the average community resident that does not know about PFAS. Systemic issues, especially racism and redlining, have greatly affected Black American communities, and chemicals like PFAS further add to that burden. Impacts include the mental

1 Editor's note: A fire at NuStar exacerbated local impacts in Oct. 2019, when local residents were advised to shelter in place and PFAS-containing firefighting foam was released into the environment. See: https://www.kqed.org/news/11780224/shelter-in-place-order-issued-for-rodeo-crockett-following-fire-at-nustar-energy-facility and https://abc7news.com/contra-costa-county-rodeo-fire-nsutar-refinery/5622706/

health effects experienced by those who rely on subsistence fishing and know they are eating toxic fish. Thus, it is important for Black communities to be acknowledged for their unique environmental exposures and be included in environmental programs and any other government or regulatory agency efforts to begin to move forward in a more fair and equitable manner.

All the speakers noted the importance of agencies working with the community to provide further information regarding PFAS and other contaminants (including historical and long-term exposure issues related to fish), ways to help at present, and actions moving forward to tackle these problems. William Ware further highlighted these points in his presentation by illustrating how collaborative research between fishing community groups and fishers can increase the communication and planning needed to better understand and reduce how fish contaminants harm people.

PFAS Measured in Biomonitoring California's Asian/Pacific Islander Community Exposures (ACE) Project

Duyen Kauffman • Health Program Specialist, Biomonitoring California Environmental Health Investigations Branch, California Dept. of Public Health

Duyen Kauffman described Biomonitoring California's Asian/Pacific Islander Community Exposures (ACE) Project. This was a community-based study to biomonitor (monitor contaminants in human biological samples) Asian populations for various heavy metals, as well as 32 PFAS, in order to better understand chemical exposures and consider ways to reduce these exposures. The study analyzed samples from 100 Chinese residents, primarily in San Francisco (ACE 1) and 100 Vietnamese residents, primarily in San Jose (ACE 2). Nineteen of the 32 PFAS measured were detected in at least 1 participant, 11 PFAS in at least half of the study population, and 5 PFAS in over 98% of participants. The detected concentrations were generally higher than comparable national surveys, with general trends of levels being higher in males, older people, and those born outside of the US.

The ACE Project highlighted the importance of having bilingual and bi-cultural staff throughout the project, working closely with community partners on outreach efforts and materials, providing financial incentives for participation, and proactive attention to addressing community concerns, such as cultural beliefs about giving blood. Moving forward, program staff will explore potential exposure routes of PFAS by analyzing questionnaire data collected from study participants, in order to inform and refine educational materials and public messaging on reducing chemical exposures.

Panel Discussion for Session 1

The panelists and meeting participants discussed the mental health impacts of learning about contaminants impacting their lived environments, both at an individual and community level. Some expressed feeling upset, anxious, afraid, and depressed, especially as clusters of health issues emerge within communities and worries mount over potential linkages to exposure to contaminants like PFAS. There continues to be considerable shock within communities when local residents learn of PFAS, further impacting the tradition of fishing as they once knew it.

Participants also noted an issue regarding public health recommendations to limit consumption of Bay fish species to just the fish fillets in local fishing. Many noted the cultural practices of specific groups where every part of the fish is used, suggesting the need for more thorough analysis of fish to assess potential PFAS exposure.

Session 2. State and Regional PFAS Monitoring

PFAS Site Investigation in Drinking Water and Groundwater

Wendy Linck • Senior Engineering Geologist, State Water Resources Control Board

Wendy Linck presented the current California efforts to examine PFAS, spotlighting the state-wide PFAS investigative orders. The focus of these orders is to identify the sources and pathways for PFAS entering the environment. Leveraging the studies and knowledge garnered from other states' PFAS projects, California has targeted particular industries for PFAS monitoring including airports, refineries, bulk field terminals, landfills, chrome platers, military sites, and wastewater treatment plants (WWTPs). Available data to date indicates the highest concentrations of PFAS are in soil, groundwater, and stormwater at airports, refineries, and bulk field terminals, where aqueous film forming foam (AFFF) has been used to fight fires. Landfills and related leachates can be significant sources, while stormwater originating from chrome plating facilities appears to be of moderate concern. Generally, concentrations in WWTP influent, effluent, and biosolids have been relatively low.

Looking forward, this effort will assess PFAS in drinking water wells in communities with septic systems, and at surface water intakes along several major rivers in California, to help inform further monitoring and improve understanding of sources of PFAS across the state. These overall efforts may also help in the development of a California-derived maximum contaminant level (MCL) for PFOA and PFOS. The US EPA is also moving forward with its own PFAS roadmap including the development of MCLs for PFOA and PFOS, development of wastewater effluent limitations guidance, and sampling in California's public and small water system. For more information on state-wide efforts, please visit www.waterboards.ca.gov/pfas/; for national efforts, please visit https://www.epa.gov/pfas.

Looking for Sources of PFAS in Bay Area Wastewater

Dr. Lorien Fono • Executive Director, Bay Area Clean Water Agencies

Miguel Mendez • Associate Environmental Scientist, San Francisco Estuary Institute

Dr. Lorien Fono and Miguel Mendez discussed the two-phase study of PFAS in Bay Area publicly owned treatment works (POTWs), which emerged as a part of the statewide investigative orders to analyze PFAS in California's wastewater. This study leverages the work of the San Francisco Bay Regional Monitoring Program (RMP) to help gain further insights on PFAS fate and transport in the Bay.

Phase 1 of the project examined wastewater influent (raw sewage), effluent (treated wastewater), and biosolids (digested sludge) from 12 representative municipal POTWs. Analysis of 40 PFAS at these municipal POTWs yielded comparable concentrations for the sum of PFAS, with median concentrations of 27 ng/L in influent, 58 ng/L in effluent, and

EBMUD Wastewater Treatment Plant • Imagery courtesy of Google Earth

178 ng/g in biosolids. These results are generally lower than preliminary statewide median concentrations for influent (66 ng/L) and effluent (115 ng/L).

A particular strength of this project is an effort to assess the presence of PFAS precursors,[2] including many of the PFAS in commercial use that cannot be quantified via standard analytical methods. Precursors in influent and biosolids were assessed by converting oxidizable PFAS to persistent PFAS end-products prior to analysis (Total Oxidizable Precursors or TOP method). The TOP method PFAS concentrations were significantly higher across matrices studied, with median concentrations of 231 ng/L in influent and 594 ng/g in biosolids. The precursors in influent can be converted to PFAS end-products during wastewater treatment, which explains the higher levels of target PFAS observed in effluent relative to influent. Levels in biosolids were detectable, though lower than concentrations found in common consumer products like food packaging (>580 ng/g) and household dust (22,000 ng/g).

Phase 2 will build on the findings of Phase 1, focusing on the identification of sources of PFAS within the Bay sewershed including sampling of specific businesses and industries known to contain PFAS. The study will also examine the importance of residential flows as sources of PFAS. Sampling will be conducted this year with a final report expected in Fall 2023.

Phase 1 data are available at https://geotracker.waterboards.ca.gov/map/pfas_map and PFAS Fact Sheet San Francisco Bay Region Phase I Study Results

Regional Water Board Perspectives on PFAS Sources and Management Approaches

Dr. Thomas Mumley • Interim Executive Officer, San Francisco Bay Regional Water Quality Control Board

Dr. Thomas Mumley talked about the San Francisco Bay Management and Monitoring Strategy, focusing on understanding PFAS in the Bay, particularly sources and loadings (e.g., annual discharges). The strategy hones in on identification and management of tractable sources. With bioaccumulation in fish being a primary concern, a bioaccumulation conceptual model for PFAS was presented, noting the potential for PFAS transport, fate, accumulation in fish, and human exposure.

There are several challenges moving forward with PFAS management including the continued development and use of PFAS globally, the potential for undesirable regulatory consequences, and high costs with limited benefits from water treatment. Still, increased management of PFAS, particularly source controls, is needed moving forward.

Panel Discussion for Session 2

Discussion focused on how to best engage both the state and community together, with several noting the need for more staff, and resources for further studies and public outreach. Organizations and agencies will continue to do the best with what is available, though there is a need for continued engagement across stakeholders. This includes outreach to other states and to national efforts to effectively tackle the issues of PFAS contamination. Participants noted a willingness from the State and Regional Water Boards to take action to control sources of PFAS.

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2 A PFAS precursor is a chemical within the PFAS family that transforms in the environment into a persistent PFAS end product such as PFOS or PFOA. While the carbon-fluorine bonds in PFAS are generally considered practically indestructible, some individual PFAS may serve as precursors to other PFAS, meaning they convert to another type of PFAS that is truly persistent.

Session 3. PFAS in Bay Fish and Beyond

Cultural Importance of Fishing for Local Native American Communities

Valentin Lopez • Chairman of the Amah Mutsun Tribal Band, President of the Amah Mutsun Land Trust

Sherri Norris • Executive Director, California Indian Environmental Alliance (Osage Nation)

Page Hingst • Brownfields 128(a) Tribal Response Manager for the Santee Sioux Nation of Nebraska and member of the Tribal PFAS Working Group

Mark Junke • Tribal Response Coordinator for the Sac & Fox Nation of Missouri in Kansas and Nebraska and member of the Tribal PFAS Working Group

Sherri Norris and Valentin Lopez discussed the history of indigenous peoples in the Bay Area and California. They spotlighted the impact of colonization on the indigenous community and the overall state of the environment in California. Though stewardship and overall care of the environment is central to indigenous sacred traditions across the US, the historical impacts from colonization on local first peoples, and the modern changes to the natural environment, have led to a significant loss of knowledge about environmental management, especially as related to sustainable and safe fishing. Many indigenous communities, however, continue to contribute traditional knowledge to restore the aquatic environment, including restoration of habitat for different aquatic species (such as salmon and clams) and implementing cultural traditions of caring for the environment.

Page Hingst and Mark Junker highlighted their work as a part of the Tribal PFAS Working Group, aimed at engaging with tribal communities to understand the harmful impacts of PFAS across tribal lands in the US. According to a study by the Environmental Working Group, there are a significant number of known and potential PFAS contamination sites, occurring on nearly 7% of studied tribal lands. The Tribal PFAS Working Group aims to fill the gap of communication needed to understand PFAS and potential contamination and advocate for an increased role for Native American communities in studies related to PFAS. Further information on the group can be found at: https://www7.nau.edu/itep/main/ntwc/Issues/PFAS

PFAS in San Francisco Bay Fish

Dr. Jay Davis • Program Director and Senior Scientist, San Francisco Estuary Institute

Dr. Jay Davis described the Regional Monitoring Program's efforts in fish monitoring in the Bay and its contributions to development of the San Francisco Bay fish consumption advisory. The advice for the Bay is driven by concern for exposure to mercury and polychlorinated biphenyls (PCBs) from Bay fish.

PFAS monitoring began in 2009 with the most recent round of sampling of five species (largemouth bass, striped bass, shiner surfperch, white sturgeon, and white croaker) taking place in 2019 at six sites across the Bay (Suisun Bay, Central Bay, Oakland Harbor, Redwood City Harbor, Coyote Creek, and Artesian Slough). The latest effort found PFAS in 14 out of 16 Bay fish samples, with largemouth and striped bass showing the highest average concentration of PFOS (9 and 7.5 ppb wet weight, respectively), followed by shiner surfperch (3.8 ppb wet weight). The limited dataset suggests that levels are higher in the South Bay, which could be due to the greater influence of WWTP effluent compared to the rest of the Bay. The long-term dataset is relatively limited. The earliest data from

2009 were of limited value due to insensitive analytical methods. However, data obtained using more sensitive methods in 2014 and 2019 suggest that PFAS are persisting in fish in San Francisco Bay.

The RMP's next steps include expanded PFAS monitoring in 2024, involving monitoring of more species at more sites across the Bay, creating a dataset similar in scope to the datasets for mercury and PCBs. In addition, Dr. Davis highlighted a need to increase the focus on serving populations with high fish consumption to better understand the impacts of fish contamination on Bay Area communities. There is also potential for community-guided monitoring in the Bay by the California State Water Board's Surface Water Ambient Monitoring Program in the next few years.

For more information, please see Technical Report on 2019 RMP Sport Fish Monitoring

and access to San Francisco Bay RMP data on fish at https://cd3.sfei.org/

The OEHHA Fish Advisory Program

Dr. Wesley Smith • Staff Toxicologist, California Office of Environmental Health Hazard Assessment (OEHHA)

Dr. Wesley Smith gave an overview of OEHHA's Fish Advisory Program, which develops guidelines recommending the amount of fish caught in state waters that can be eaten per week. These advisories are based on the best available science, professional judgment, and consideration of cultural practices, regulations, local fishing pressure, and environmental justice.

Guidelines are published for two population groups: the sensitive population (women ages 18-49, children ages 1-17) and the general population (women >50 and men >18 years of age). There are currently about 135 total advisories in California, driven by six contaminants (mercury, PCBs, selenium, dieldrin, DDTs, and polybrominated diphenyl ethers [PBDEs]); 132 are site-specific, focusing on particular aquatic environments within California, while three statewide advisories are for general fishing across either the coast, lakes and reservoirs, as well as for migratory fish that travel across water bodies. Advisory signs are often posted near fishing sites and are available in a variety of languages, with brochures, fact sheets, and technical reports also available for review.

Advisories are developed through a multi-step process. Fish samples are collected and analyzed at a certified laboratory, and much of the data is made publicly available on the California Environmental Data Exchange Network (CEDEN). Data that meet identified criteria are then reviewed, analyzed, and interpreted before a final dataset is confirmed and used to calculate a tissue concentration for each chemical in each fish species within a water body. These concentrations are compared to OEHHA's Advisory Tissue Levels (ATLs) for the studied chemical, which indicate a number of recommended servings that would be considered health protective based on the range of contaminant concentrations. ATLs are developed using risk assessment equations for cancer and non-cancer endpoints. Multiple chemical exposure methodology is also used when contaminants with similar adverse effects are found in fish, which may result in a decrease of servings per week compared to if the fish were contaminated by only one substance. A final report and poster are developed and posted at www.oehha.ca.gov/fish/advisories.

PFAS and New Jersey Fish Consumption Advisories

Dr. Sandra Goodrow • *Research Scientist, New Jersey Department of Environmental Protection*

Dr. Sandra Goodrow discussed the development of fish consumption advisories in New Jersey, particularly as it related to PFAS.

Fish consumption advisories are based on health effects relevant to both the general population and high-risk populations. The State of New Jersey develops statewide, region-wide, and water body-specific consumption advisories for fish harvested from NJ waters based on upon data collected through special surveys or research projects conducted by the New Jersey Department of Environmental Protection (NJDEP) Division of Science and Research (DSR) and other agencies. The New Jersey Routine Monitoring Program samples one of five distinct regions for contaminants every year, with the whole state sampled every 5 years.

An initial PFAS investigation was conducted to understand the transport and fate of PFAS in the environment, selecting 11 sites in close proximity to potential sources. The study detected 13 PFAS in fish tissue, sediment, and surface waters, with PFOS found most notably across fish species. Concentrations were highest in white perch, largemouth bass, bluegill sunfish, and common carp.

New Jersey has created fish consumption advisory trigger levels for three PFAS: PFOA, PFNA, and PFOS using the Reference Doses previously developed for use in drinking water and ground water standards (available at https://www.nj.gov/dep/dsr/njmainfish.htm). The presentation ended with contrasting examples of locations where PFAS-related fish advisories were posted, including lakes near military bases with established sources of contamination, as well as a remote site (Echo Lake) where an advisory for PFAS was surprisingly needed, though no sources of contamination were identified, and no detectable levels of PFOS were found in water or sediment. The latter example highlights the potential for long-range transport of PFAS in the environment.

Historical Patterns of Exposure, Genetic Variance and Increased Susceptibility

Dr. Raymond Tompkins • Researcher, African American Health Equity Council

Dr. Raymond Tompkins discussed the difference in cultural and social practices relating to studies evaluating the contaminants in fish.

The historical and traditional practice of fishing in the Black community is critical to their identity in the Bay, especially considering the history of neglect experienced by this community. Within the context of developing monitoring studies, there is a need to include community-specific fishing and eating practices to effectively target exposure concerns of affected communities. This includes consideration of actual consumption habits, such as the preparation and amount of fish and shellfish that community members typically eat per meal, as well as the cumulative exposures Black communities experience from multiple sources and to numerous contaminants. Full cooperation and true integration of these communities is essential to appropriately assess the problem and scope and fund future projects, including allocating resources to community groups. Effective science communication is also critical to having a knowledgeable and engaged public that understands the health risks of fishing.

Panel Discussion for Session 3

Due to time constraints, discussion was moved as a part of the next session.

Session 4. Where Do We Go From Here?

Open Discussion, *moderated by* ***Juliet Christian-Smith,*** *Water Foundation*

Meeting participants reflected on the presentations given during the forum, highlighting the need to establish better relationships across different groups, communities, and stakeholders. This meeting demonstrates the dietary, cultural, and spiritual significance of fish and fishing in the Bay. Some discussion addressed the necessity for agencies and powerful stakeholders to make space for those not present within the decision-making process and potential paths for successful inclusion, including building honest and respectful relationships.

Several participants noted the importance of easier access to information about fish contamination, with many appreciative of improved signage of OEHHA Fish Advisories within fishing areas. There was agreement among some participants that establishing a fish consumption advisory for PFAS, or at least PFOS, is also important in educating the public about these chemicals and identifying the magnitude of the problem in the Bay and state surface waters. In addition, the accessibility of meetings like this one can be improved to allow broader participation.

Fishing for herring • Photo by Kelly Moran (SFEI)

Further discussion emerged on the topic of monitoring and its intended strategy, with some expressing frustration with what seems like limited focus on cleaning up the contaminants in the Bay, and the need to recognize the real fishing and cultural practices exercised in the Bay, especially by communities of color.

Although there is ongoing opposition from industry, source reduction is the key to reducing contaminants entering the environment and to better tailor future clean-up efforts. There are a number of past and ongoing efforts at the state level to ban PFAS in certain products to stop pollution and exposure at the source. A growing international movement to "turn off the tap" on PFAS is also important to limit global transport and exposure of PFAS. Some participants noted that at the state level, water and wastewater agencies are organized to obtain funding for PFAS related projects. Funding is also needed for impacted communities to lead their own science and education efforts. Others provided information about state efforts to limit PFAS use. For more information about these, contact aventura@cleanwater.org.

Wrap Up and Next Steps

The meeting hosts thanked all speakers and participants for their contributions to this informative meeting. Fishing has deep roots within multiple disadvantaged communities in the Bay Area, communities that are subject to multiple burdens and stressors and are frustrated at the lack of action. Communities and community-based organizations need meaningful engagement, funding, and a seat at the table. Government agencies and scientists need to improve communications with disadvantaged communities, including listening to their perspectives. Meanwhile, there is a growing urgency to address PFAS in California. Resource limitations are impacting the ability of state agencies to evaluate PFAS contamination and act on it.

The meeting hosts encouraged continued engagement by stakeholders to improve our understanding of PFAS in San Francisco Bay fish, the fishing practices of local tribes and disadvantaged communities, and provide safe and inclusive fishing information and advice for all Bay Area residents. This Forum is intended to be the start of a conversation to move us towards collaborative and inclusive solutions.

Additional resources:

PFAS science in the San Francisco Bay Area

10 Things You Can Do About Toxic PFAS

Fishing for herring near the mouth of Mission Creek in San Francisco • Photo by Kelly Moran (SFEI)