

FEATURE ARTICLE

Per- and polyfluoroalkyl substances (PFAS): Overview and Recent California Actions

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Per- and polyfluoroalkyl substances (PFAS) are a large family of chemicals (>4,000 compounds currently) that have a wide variety of chemical and physical properties¹. PFAS are distinguished by having at least one carbon atom with fluorine atoms attached at all bonding sites. The chemical and physical stability of PFAS make them useful in many applications (including aqueous firefighting foams [AFFF], additives to household items/textiles for water/stain repellent and fire-resistant properties, see a more complete list [here](#)). Decades of widespread use in combination with their environmental persistence have resulted in their ubiquitous presence across the globe and in the blood of >99% of Americans². Due to mandatory and voluntary phase-outs of long chain PFAS with well-documented human health effects (i.e. perfluorooctanesulfonic acid [PFOS] and perfluorooctanoic acid [PFOA]), manufacturers are using new short-chain PFAS (e.g. GenX and PFHxS) as replacements. This is a chemical “whack-a-mole” situation; as soon as we start getting a handle on some of the PFAS, others just keep popping up.

There are several characteristics of these chemicals that make PFAS unique compared to ‘traditional’ organic contaminants. The first characteristic is the carbon-fluorine bonds (the strongest bond in chemistry!) which make PFAS particularly recalcitrant in the environment and resistant to

biodegradation. While many PFAS will transform into perfluoroalkyl acids (PFAAs) such as PFOS and PFOA in the environment, they degrade on geologic timescales and still retain toxic properties. Thus, it is important to measure and control not only the toxic PFAAs, but also those PFAS that eventually degrade into PFAAs (“PFAA Precursors”). In order to effectively monitor this growing class of chemicals, some researchers and regulators are using surrogate methods to characterize PFAS, such as total fluorine analysis, or non-targeted chemical analysis to understand the full PFAS load in environmental media. Additionally, because PFAS are amphiphilic (possess both hydrophilic and hydrophobic structures), they are relatively mobile in water, presenting significant challenges for water agencies. Finally, these compounds tend to bind to blood proteins instead of distributing in fatty tissues, rendering our traditional tools to characterize fate in biological systems (such as log K_{ow}) not particularly useful.

As with many areas of PFAS research, there is a lot of uncertainty about the risk of PFAS to organisms. Research has focused on a small number of PFAAs (e.g. PFOS and PFOA), leaving significant data gaps for the rest of the class. PFAS have generally shown relatively low toxicity to aquatic organisms using traditional chronic endpoints (e.g. survival, growth, etc.)³. To better understand the toxicity of PFAS, in vitro and in silico models are being used to develop adverse outcome pathways, as well as sensitive sub-organismal endpoints. In animals, long-chained PFAAs bioaccumulate more than short-chained PFAAs, and perfluoroalkane sulfonates (e.g. PFOS)

President's Corner



Erika Holland, CSU Long Beach

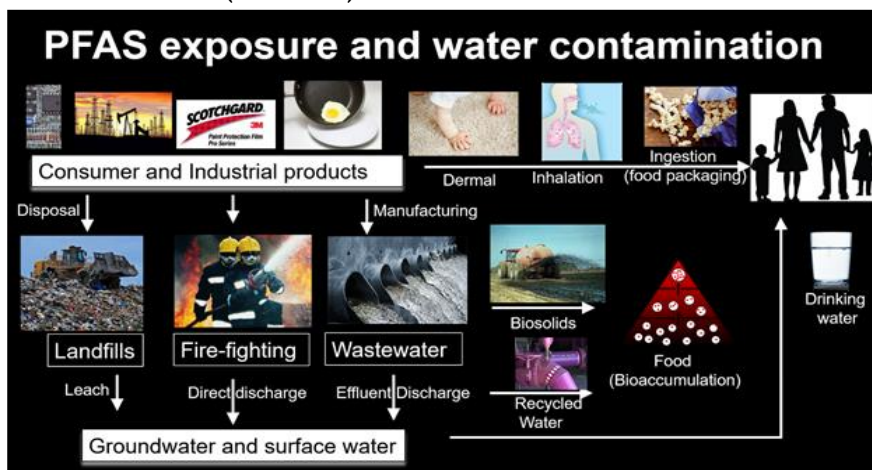
Hello SoCal SETAC, I wanted to start by saying that I hope our entire membership and their families are safe and staying healthy during this interesting time. Also, thanks for your understanding regarding the Officers and Board's decision to cancel the 2020 annual meeting that was to be held at the Crowne Plaza in Ventura, CA. on April 26-27th. Turns out we made the right decision but it did not come easily. We were so looking forward to catching up with research in the community, networking with old and new acquaintances, and supporting our great student body in their career advancement. Again, thank you for your understanding, hopefully, these

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FEATURE ARTICLE (continued)



From: Farahnak, S., and Coffin, S. California Water Board's Actions on Per- and Polyfluoroalkyl Substances (PFAS). September, 2019. GRA's Second Annual Western Groundwater Congress 2019. Presentation

bioaccumulate more than perfluoroalkyl carboxylates (e.g. PFOA), however in plants the opposite of both are true.³ Finally, there is evidence of biomagnification of these compounds in high-level, air-breathing organisms (e.g. birds, mammals, etc.).³

Similarly, reliable human toxicological information is only available for a small subset of PFAS compounds. Human health effects of PFOS and PFOA have been relatively well investigated through human, animal, and in vitro/mechanistic studies⁴. Despite no longer being manufactured or intentionally added to consumer products in the U.S., PFOS and PFOA are still found widely in blood serum of the general U.S. population, due to their relatively long half-lives in humans (2-8 yrs), persistence in the environment, bioaccumulation potential, and their ability to be formed through the breakdown of other PFAS still widely used.⁵ Exposure to PFOS and PFOA results in a variety of toxic health effects in humans, including developmental effects, cancer, liver damage, immunosuppression, thyroid effects, and more.⁶ Of these endpoints, the pancreas and liver are especially sensitive to the development of tumors, with cancer thresholds of 0.1 ng/L (PFOA) and 0.4 ng/L (PFOS) in drinking water.⁷ The toxicity of other PFAS chemicals are being evaluated for these, and other

human health outcomes by the National Toxicology Program, US EPA, California Office of Environmental Health and Hazard Assessment (OEHHA), and other agencies.⁸ Thorough human, animal, and in-vitro testing for 4,000+ PFAS chemicals is a near-impossible task, and many agencies are applying 21st-century tools to predict their toxicities.⁹

California has taken swift steps to characterize and address PFAS contamination in the State. Starting in March 2019, the State Water Resources Control Board (State Water Board) initiated an investigation of PFAS in groundwater, soils, and public water system source wells, starting with identifying the likeliest sources of PFAS contamination based on known uses, and prioritizing monitoring accordingly.¹⁰ In March 2019, one-time regulatory orders were sent to 30 commercial airports and 196 municipal solid waste landfills to monitor groundwater, soil, and leachates. Commercial airports are known to use PFAS as aqueous film-forming foam (AFFF) to extinguish chemical-based fires, and landfills receive products laden with PFAS such as carpets, non-stick pans, textiles (to name a few). Additionally, 192 public water systems received orders to monitor on a quarterly basis in wells adjacent to airports, landfills, or in wells that had prior detections. In October 2019, 271 Chrome

Plating Facilities received monitoring orders.

In response to concerns regarding PFAS in water, the California Legislature passed Assembly Bill 756, which (effective January 1st, 2020) provides broad authority for the State Water Board to monitor PFAS in drinking water supplies and requires extended notification requirements to consumers and additional mitigation actions above threshold levels.¹¹ In response to a re-evaluation of human health effects by OEHHA, the State Water Board lowered 'response levels' (levels that trigger responses by local water systems) for PFOS and PFOA in February, 2020 to 40 and 10 ng/liter, respectively.¹² Similar responses are required when a water system detects PFOS and PFOA above the US EPA's Lifetime Health Advisory level of 70 ng/L (combined PFOS and PFOA). As OEHHA develops health-based guidance levels for additional PFAS, the State Water Board will respond accordingly.

Monitoring results are available on the State Water Board's webpage.¹³ In December 2019, the State Water Board hosted a collaborative two-day "PFAS Datathon" event to analyze the data. Facilitated by former SoCal SETAC Student Representative and State Water Board employee Scott Coffin, this event garnered over 40 participants from around the State, resulting in the development of several innovative projects aimed at answering key scientific and management questions related to PFAS.¹⁴ The PFAS Datathon will be re-iterated (virtually) in 2020 (date TBD), and all are welcome to participate.¹⁵

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- [3.https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/ER18-1614](https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/ER18-1614)
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PRESIDENT'S CORNER (continued)

types of early decisions will help reduce the virus' impact in the long run.

Along those lines, we have decided to delay the annual meeting for an entire year given the high amount of uncertainty of the virus' trajectory. The Crowne Plaza has been very generous by allowing us to delay our meeting to an available date that might best fit our needs. We decided it was fate when they told us that April 24th and 25th of 2021 were still available, which is exactly a year past what we had planned in 2020. We also thought the entire year would allow us more time to plan a great meeting for 2021 given these setbacks. We will keep the special sessions focused on the same topics, namely PFAS compounds and the impact of wildfires on surrounding ecosystems. This will give us even more to cover, especially as the new PFAS regulations roll out in 2020.

To offset the lack of an annual meeting in 2020 the Officers and Board are currently planning several additional networking events to help our members connect for the rest of the year. We know that a big part of our annual meeting is for networking, which is especially true for students who will soon be entering the workforce. The advice and connections they build through our members are invaluable and we wanted to provide a small event to help them continue to build those relationships. So, coming up in June we are going to host a small online event "Chat with an Expert" where students can connect with more senior members from different job sectors. The informal event will take place via Zoom and will provide students a chance to meet the membership and get insights into different careers while providing our experts with a chance to share their knowledge and career trajectory. We are also currently planning a larger Fall get-together that will substitute for the normal Fall dinner meeting. As of right now, we are hoping this will take place in person. This will provide a great opportunity to catch up before the North America SETAC meeting in November, which will proceed as planned in Texas. While all the details are still in the works, we plan on having a strong student focus to allow them to show off their great research and practice for the larger North American meeting. Stay tuned for more details on these events as we move into summer!

Finally, I will say we were lucky enough to squeeze our Spring Dinner meeting in right before everything started to close. Here, members joined us on March 12th at Leucadia Pizza in Encinitas, CA. We were lucky to be joined by two guest speakers, Dr. Rich Gersberg, San Diego State University (SDSU) and Dr. Goran Bozinovic CEO of Boz Life Science Research and Teaching Institute (also part of

SDSU and UCSD). They presented two unique aspects of toxicology in SoCal, namely the presence of illicit compounds in SoCal waters (Gersberg) and new aspects of research and professional development in upcoming water quality leaders (Bozinovic). The dinner meeting attendees were overwhelmingly enthusiastic about the presentation of these diverse aspects of toxicology and we cannot thank them enough for coming out to share their interesting work. Check out a synopsis of their work as well as some pictures from the event in this newsletter. I am also excited about the feature article in this newsletter, a timely piece on PFAS written by Scott Coffin, a previous SoCal Board member, and our newsletter editor, Nick Hayman. They brought together diverse aspects of the new California regulations providing a nice overview for the year to come.

Hopefully, we will see everyone soon, but in the meantime, stay safe and healthy.

Erika

Save the Dates!



2021 SoCal SETAC Annual Meeting

When: April 24-25th, 2021

Where: Crowne Plaza Ventura Beach

Stay tuned for more updates as we get closer to the meeting!

"Chat with an Expert" Event

When: June 2nd, 2020; 2-4 PM PDT

Where: Your living room (on Zoom)

Student/Recent Graduate event to discover possible careers in the SoCal Area. Follow the below link for more information!

<https://www.socal-setac.org/virtual-networking>

MEET THE BOARD

Mary Woo

California State University Channel Islands



Mary with her husband, Simon, in Hong Kong.

I am honored to introduce myself as a second year SoCal SETAC board member. I am an Environmental Chemist working as a Lecturer at CSU Channel Islands in Camarillo. My two years working as a board member have been a great experience. The level of engagement, dedication and student-centered focus that the board carries is impressive and reflects well in their membership.

From my very first chemistry class in high school I was hooked. It amazed me that the concepts we learned could explain how coolant in our cars works to reduce overheating and how soap magically washes away oil. Plus, who can refuse generating hydrogen gas in a jar and lighting it up with a match! In college at UC Santa Barbara, I found my chemistry classes equally fascinating being able to model the adiabatic heating that warms Santa Ana winds. During my junior year, I became interested in environmental science and the idea of working in the field. This led me to a geology minor and whole new perspective on how to use my chemistry knowledge. After graduating with a BS, I joined the Earth System Science department at UC Irvine to work on a PhD and put my chemistry to use studying earth processes. I had the privilege of working not only in the field, but at sea on UNOLS vessels with remotely operated vehicles. My research developed and tested a method for measuring methane consumption in marine methanotrophs via a carbon-14 tracer. Methanotrophs play a crucial role in regulating climate, intercepting and consuming marine methane before it enters our atmosphere to act as a greenhouse gas. I had the opportunity to join several research cruises that were focused around natural hydrocarbons seeps, a perfect environment to study methanotrophs.

Following graduate school, I explored a number of contract jobs with UC Irvine, NOAA and others. Working with NOAA to collect samples and evaluate the fallout and damage from the 2011 BP Oil Spill again brought me on research vessels and in the field collecting samples. After a few years, I settled down with a small startup company in Camarillo working to design cellulosic biofuel pyrolysis/catalysis techniques.

The idea of using chemistry to develop a carbon neutral energy source was appealing to me. Sadly, after a year, my division shut down and I was back on the job market. I had missed academia having been away for several years and decided to return. Today, I am a Lecturer at CSU Channel Islands in the Chemistry and Environmental Science and Resource Management Programs. I teach a variety of environmental science and chemistry classes and am developing research projects around pollution detection, monitoring, and source tracking. Research on the coastal occurrence of polycyclic aromatic hydrocarbons (PAHs) and microplastics have been my focus thus far. The research projects where I am able to involve community partners (e.g. local water districts) and students to study and improve our effluent/runoff quality have brought about the perfect combination of student and community engagement, environmental monitoring and, of course, chemistry for me. I feel lucky to have found a place where these elements are possible and encouraged.



Mary on the E/V Nautilus processing a sediment core with her colleagues

Learning about environmental monitoring in the southern California Bight from the diverse group of academics, private sector and government associated professionals in the SoCal SETAC chapter fits perfectly with my work at CSU Channels Islands and I look forward to seeing the board and our chapter members at the next SoCal SETAC event.

In my free time I enjoy traveling with my husband and visiting his family in Hong Kong.

STUDENT CORNER

Meet the Board: Amanda Russell



Amanda holds a sea star while leading a tour in Sitka, Alaska

I am honored to be serving on SoCal SETAC's board as a student representative. I am currently finishing my second year in CSULB's Master's program, pursuing a degree in biology in Dr. Erika Holland's environmental toxicology lab. Joining SoCal SETAC has been one of the highlights of my time as a graduate student, and I have enjoyed meeting members of the community and learning more about the field of toxicology.

As a Long Beach native, I was born and raised visiting local beaches and landmarks like the Aquarium of the Pacific and Catalina Island. Some of my earliest memories are snorkeling with garibaldi, kayaking with my grandparents around the harbor, and trying to catch a glimpse of a dolphin at Seal Beach pier. From the very beginning, I have been completely bewitched with the ocean and have been so fortunate to have a family that has continually encouraged and supported my passion for marine life.

With two teachers for parents (my mom teaching 2nd grade, and my dad teaching automotive mechanics at a

community college), education has always been a priority in my life. After high school, I attended UCLA, where I was exposed to scientific research and able to assist several graduate students and professors. I did my best to maximize my exposure to several different fields, topics, and experiences in order to better develop my own personal goals and interests. This included joining a study abroad program in Fiji through Broadreach College, where I developed a personal research project related to shark conservation. After spending a month scuba diving with dozens of bull sharks, and some time for solo travel, I returned to UCLA confident that I wanted to build a career related to marine conservation and strengthening our communities' connection with the ocean. My work with several different research labs on campus, including projects related to molecular ecology, wetland management, and geography, made it clear that there were many different ways for me to both encourage my love of the outdoors and improve public education and involvement. Each decision and project helped me to better understand how to move closer to a career in protecting our environment.

After graduating with a B.S. in Environmental Science and a minor in Conservation Biology, I accepted a paid internship with the National Park Service as a fisheries technician in Yellowstone National Park. My summer spent in this amazing place was my first time in that part of our country, and I couldn't get enough of the backpacking, fishing, and wild elk. I gained experience with field work in the backcountry and in difficult conditions, and loved every day of it. For the following summer, I decided to explore the world of eco-tourism in Southeast Alaska as a tour guide. I had the privilege to share whales, sea otters, bears, and the Alaskan rainforest with guests every day. I couldn't believe that it was my job to share all my knowledge and excitement with them, while in one of our country's most beautiful locations! But as the days got colder, it was time to return to Southern California for winter. As I settled back into Long Beach, I began to work for Catalina Sea Ranch, the first shellfish farm in U.S. federal waters, as a biologist. Here, I primarily worked on research projects investigating the cryopreservation of shellfish larvae, the development of biomarkers for selective breeding, biotoxin testing, and the cultivation of giant kelp for commercial purposes. I then worked as a teacher for Long Beach Marine Institute on Catalina Island. I was able to lead activities like kayaking, snorkeling, and hiking, occasionally for students who had never swam in the ocean at all before. I am continually encouraged by the widespread excitement and fascination that comes with exploring our ocean. Having the ability to pursue many different opportunities and jobs related to the environment helped me conclude that a graduate degree would be a vital and necessary step in my career.

My current research is focused on understanding the impact of pollutants and restoration design on oyster health within an oyster restoration site at Upper Newport Bay, CA.

STUDENT CORNER (continued)



Amanda samples sediment and oyster tissue for contaminant analysis at an oyster restoration site at Upper Newport Bay, CA

My project takes a molecular approach in order to understand and identify sub-lethal stress levels to get a picture of the oysters' overall health. Joining Dr. Holland's lab was my first introduction into the field of toxicology, and it has opened my eyes to the connections between my love of the ocean, my interest in community relationships, and my desire for conservation and protection. Learning about the incredible work being done throughout SoCal and around the world has inspired me to continue working to understand the impact that humans can have on the environment, and vice versa. As a board member for SoCal SETAC, I am excited to help bring this connection and inspiration to undergraduate and graduate students across Southern California, and to help voice their interests and concerns. I would love to hear from fellow students about what they have enjoyed about being a member of SoCal SETAC, or what they would like to experience in the future. I look forward to continuing to meet SETAC members and supporting students in toxicology!

Have you checked out the revamped Student Resources Page on the SoCal SETAC Website?

During these unprecedented times, we have built this page to help students find resource to continue to learn and engage with community and prepare for the next step. Check it out and please email vrenick@ocsd.com if you have any additional resources or tips to share!

<https://www.socal-setac.org/student-resources>

Spring Dinner Meeting Recap

Nick Hayman, SoCal SETAC Vice President



Our speakers Dr. Rick Gersberg (left) and Dr. Goran Bozinovic (right) with SoCal SETAC Past President Chris Stransky

Seven days before Governor Newsom declared a stay-at-home order for the State, we held a wonderful Spring Dinner Meeting at Leucadia Pizzeria in Encinitas, CA. After enjoying so much needed catching up with each other over sizzling pizza, we had the pleasure to listen to presentations from Dr. Rick Gersberg (SDSU, School of Public Health) and Dr. Goran Bozinovic (Boz Institute). I would like to give an extra shout to both of them who stepped up to give presentations after an unforeseen circumstance resulting in a last-minute need for speakers. Thank you, Rick and Goran!

Dr. Gersberg presented data from a fascinating study using sophisticated analytical chemistry techniques to detect stimulant drugs of abuse (e.g. amphetamine, methamphetamine, cocaine, etc.) in Forester Creek in San Diego County. These data not only provided evidence of a continuous contamination in this stream, but were able to provide calculations of per-capita drug use within the population, as well. Interestingly, per-capita use of methamphetamine was among the highest rate ever reported in the U.S. or Europe. It is incredible what we can discover about our communities when looking at our pollution!

Dr. Goran Bozinovic introduced our membership to the Boz Institute, a program he founded that is dedicated to advancing scientific understanding in environmental science while cultivating future scientists and community leaders. We learned about this six to ten-week research immersion program that introduces students to innovative and important research and gives them the skills to pursue environmental science academic interests and careers. Check them out at <https://www.bozoinstitute.com/>!

CALENDAR OF EVENTS

May 2020

May 3-7

[SETAC SciCon: SETAC Europe 30th Annual Meeting](#) | [virtual]

June 2020

June 29 - 30

[2020 California Water Data Science Symposium](#) | [virtual]

July 2020

July 10-13

[Association for Environmental Studies and Sciences Conference 2020](#) | [virtual]

August 2020

August 2-7

[Ecological Society of America 2020 Annual Meeting](#) | Salt Lake City, Utah

August 3-21

[National Environmental Monitoring Conference 2020](#) | [virtual]

August 17-19

[StormCon: The Surface Water Quality Conference & Expo](#) | Seattle, Washington

September 2020

September 13-16

[35th Annual WaterReuse Symposium](#) | *Denver, Colorado*

September 14-16

[California Stormwater Quality Association \(CASQA\) 2020 Annual Conference](#) | *Virtual*

November 2020

November 15-19

[41st Annual NA SETAC Meeting](#) | *Fort Worth, TX*

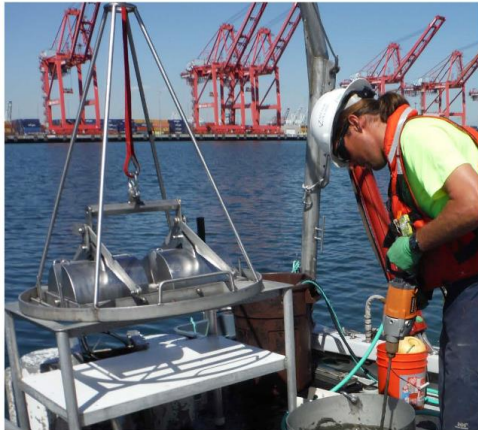
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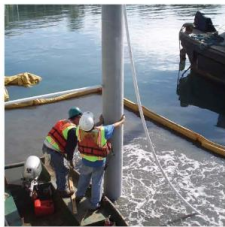
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|----------------------------|-----------------------------|-------------------------------|
| Total Coliform | Organochlorine Pesticides | Unregulated Contaminants |
| Fecal Coliform | Organonitrogen Pesticides | Pharmaceuticals/Hormones |
| Enterococcus | Organophosphorus Pesticides | Emergent Chemicals |
| Streptococcus | Triazine Pesticides | Nitrosamines |
| Heterotrophic Plate Count | Pyrethroid Pesticides | Cyanotoxins |
| Minerals | Neonicotinoid Pesticides | Flame Retardants |
| Nutrients | Carbamate Pesticides | Alkylphenols |
| Trace & Ultra-Trace Metals | Organochlorine Herbicides | PFAS/PFOS/PFOA |
| Hexavalent Chromium | 1,2,3-Trichloropropane | Organotins |
| Radioactivity | 1,4-Dioxane | Alcohols, Glycols & Aldehydes |
| Volatile Organics | Volatile Fatty Acids | Explosives |
| Semivolatile Organics | Geosmin & MIB | Hydrazines (+ UDMH & MMH) |



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Technical excellence

Wood addresses water needs using advanced science, practical approaches and cost-efficient solutions.

- Water resources and supply
- Stormwater
- Infrastructure engineering/design/construction
- Asset management
- Climate change and resilience

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