SoCal
SETAC News

Society of Environmental Toxicology and Chemistry
Southern California Chapter

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FEATURE ARTICLE

DDT in the So Cal Bight – Let Sleeping Dogs Lie?

By Keith Maruya[1], Allan Chartrand [2], and Dan Schlenk[3]

Pt. Vicente Lighthouse, Palos Verdes, CA

If you live in southern California, chances are you have heard about the insecticide DDT, produced between 1947-82 at the Montrose Chemical plant a few miles south of downtown Los Angeles. If you follow the recent history of coastal environmental quality, you probably know that up until ca. 1970, several hundred tons of DDT were co-discharged with treated wastewater effluent into the ocean off Palos Verdes, just around the corner from the LA/Long Beach Harbor complex. What you may not know is that many thousands of industrial waste barrels, some with 0.5 – 2% DDT, were disposed of offshore and allowed to sink to depths up to 1000 m between the mainland and Santa Catalina island (Figure. 1). The history of this deep barrel dumping practice (1947-61) was documented by co-author Chartrand, and the discovery of dozens of these waste remnants by a team led by David Valentine of UCSB, was recently covered in a feature article by Los Angeles Times reporter Rosanna Xia ("A toxic secret lurks in deep sea"; 10/25/20).

DDT, formulated to combat insect-vectored disease and applied worldwide since WWII, is a technical mixture of organochlorine compounds composed of at least 80% dichlorodiphenyltrichloroethane (Figure 2).

Dicofol (hydroxylated DDT), Tris-(4-chlorophenyl)methane and its

Figure. 1. DDT was discharged inshore ("PV") and disposed of in deeper waters ("I" and "II") between the mainland and Catalina.

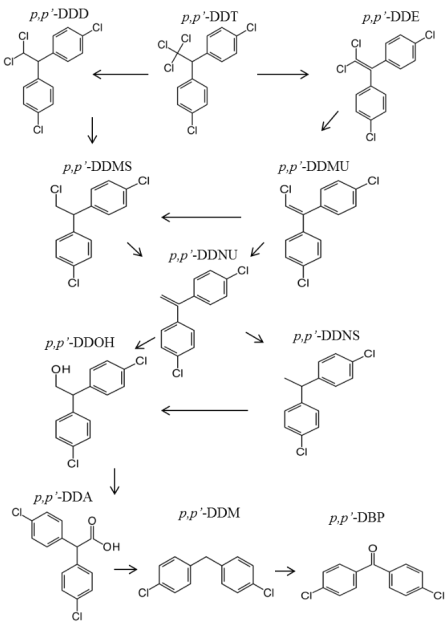

Figure. 2. DDT (p,p' isomer) and its breakdown products.

President's Corner

Nick Hayman

Welcome to 2021 SoCal SETAC! As we begin a new year, I am hopeful that this year will not be as challenging as the last. However, despite those challenges, SoCal SETAC still had a great year. As we wrapped up 2020, our Chapter was well represented in the first fully virtual North America SETAC annual meeting in November, SciCon2. I was impressed with how engaging the meeting still was, despite being 100% virtual. There were several excellent keynote presentations, including a fascinating presentation on wildlife photography and its power in galvanizing communities to protect our critical ecosystems. It really drove

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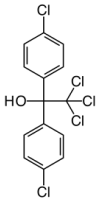
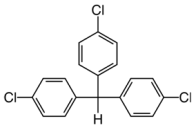
hydroxylated analog Tris(4-chlorophenyl)methanol (collectively referred to as "Tris") are produced from and/or are structurally related to DDT (Figure 3). These chemicals are insoluble in water and resistant to breakdown, so when introduced to aquatic systems, they partition to suspended and bed sediment, and accumulate in lipid-rich tissues (Figure 4). Over time, they are subject to chemical and/or microbially-mediated transformation, creating a mixture of lower chlorinated metabolites, such as DDE, DDD, DDMU and DDNU and DBP (Figure. 2). During the peak buildup of DDT in the southern California Bight (ca. 1970), residues accumulated to levels with devastating effects on fish eating wildlife, as evidenced by the decimation of California brown pelican, bald eagle, peregrine falcon and other avian species populations in the region, due to reproductive impairment. Along with similar evidence from other regions, these effects led to the banning of DDT use in the U.S. in 1972.

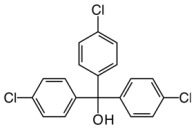


Dicofol

(a)



4,4',4''-TCPM



4,4',4''-TCPMOH

(b)

Figure 3. (a) p,p'-Kelthane (2,2,2-Trichloro-1,1-bis(4-chlorophenyl)-ethanol, dicofol); (b) Tris-(4-chlorophenyl)methane (TCPM) and methanol (TCPMOH).

Identification of regional contamination led to (in the early 1970s) regulation of discharged waste from Montrose and Los Angeles County Sanitation Districts wastewater utilities. Since that time, a slew of monitoring, research and restoration/recovery efforts lead us to believe we are well on the road to recovery. Among the evidence supporting such resilience are the recovery of impacted bird populations; a slow but steady decline in DDT residues in sediment, commercially and recreationally important marine fish, and seabird eggs; and the relatively healthy condition of benthic communities across inshore and shelf habitats. On the other hand, the report of elevated DDT levels in deep basin fish (up to 25 ppm) in the late 1980s has not been revisited, and maximum DDT levels in sediment near the waste barrels (up to 250 ppm) were reported as 40 times that found in sediment off Palos Verdes. DDT and Tris residues remain among the most abundant classes of persistent organic pollutants (POPs) in seabird eggs and marine mammals frequenting the Bight, with many organochlorine residues still unidentified. As its impact on the health of apex marine predators remains uncertain, DDT continues to be of interest to investigators of chronic disease in, e.g., sea lions along the California coast.

With the recent discovery of dozens of DDT waste barrels, some clearly breached, the $64,000 question arises *"So What"? Will this "deep barrel" source cause new, unforeseen or additional environmental effects?*

A starting point in answering this question would be to consider the approach applied to the former EPA Superfund Site off Palos Verdes that received the DDT-tainted wastewater discharge. In contrast to the designated barrel dumping sites in the San Pedro Basin, the PV site lies on the narrow shelf in 50-90 m. After EPA evaluated the effectiveness of sediment capping as a remedial option (ca. 2010), it is presumed (because no final decision or report has been released) that those in charge have settled on a monitoring approach, aka Monitored Natural Attenuation (MNA). Since the benefits of taking further (including more aggressive) remedial action is not expected to improve environmental quality to a measurable extent, continued periodic monitoring to show that DDT concentrations in the water column, sediment and wildlife are not increasing would show that MNA is a cost-effective response to the contamination that remains. More costly and technically challenging alternatives to MNA include capping and dredging/removal of contaminated sediment.

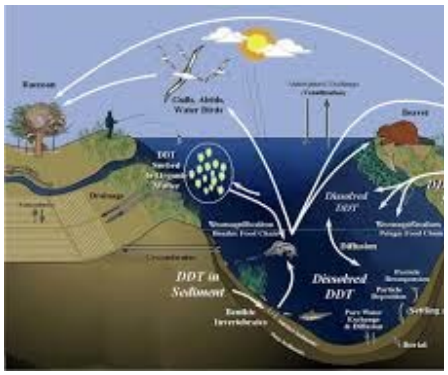


Figure 4. DDT and other persistent organochlorine chemicals bind to sediments, accumulate in aquatic biota, and can affect wildlife health. Transformation processes in situ reduces hydrophobicity and accumulative potential while increasing mobility and transport of DDT. (courtesy of Springer Link).

What would such a monitoring program look like? One might start with periodic health assessments of previously impacted fish-eating bird populations, e.g. the California brown pelican, one of the species for which the eggshell thinning effects of DDT was established. Second, the status and trends of DDT contamination in marine mammals frequenting the Bight, would provide value in interpreting the results of past, on-going and future health assessments. Third, periodic monitoring for DDT residues in commercially and recreationally important, regionally

Feature Article (continued)

harvested fish and shellfish should continue, as a high priority, to inform and update consumption advisories as warranted. Fourth, continued assessment of sediment quality throughout the Bight, one of the core elements of the multi-agency Southern California Bight Regional Monitoring Program[4], using a multiple line of evidence approach, would help identify any change in DDT levels. The Bight Monitoring Program last included slope and deep basin habitats in 2008.

Each of these core monitoring components could be complemented by focused investigations clarifying the role of the deep barrel source of DDTs. First, identification and mapping of unknown/poorly characterized DDT hotspots on the seafloor (as suggested by Valentine's team), focused on a depth regime (e.g. < 300 m) accessed by commercial and recreational seafood harvesters. Second, identification of DDT-related compounds unique to deeper (i.e. slope and basin) Bight habitats, using, e.g. non-targeted analysis of archived samples (or extracts thereof) collected previously. This task could be further informed by collaborative interpretation of the independent analyses of such samples by co-author Chartrand and colleagues in the late 1980s, and more recently by Valentine's team. Third, development and application of a molecular "bioscreening" toolbox that would allow for rapid, cost-effective screening of aquatic samples (aqueous, sediment and/or tissue) for potential toxicity. Such a toolbox would consist of molecular assays that screen for a specific sequence of sub-cellular events (aka as "modes of action" or "toxicity pathways") linked to unwanted biological effects (e.g. endocrine modulation leading to impaired reproduction of fish). Lastly, the opportunity exists to update contaminant fate and transport models for POPs that extend beyond the shelf into deeper habitats, using DDT in the Bight as the poster child. Such models would be invaluable to managers in prioritizing future actions that would minimize impacts arising from legacy DDT in the Bight.

In light of the Times article, some would say MNA, even on a regional scale, combined with complementary studies, as described above, would be woefully inadequate and under protective. Others would question the wisdom of spending millions of dollars to further document a decline in DDT concentrations and the status of sentinel wildlife populations that may now be deemed as fully recovered. In broadly outlining a vigilant middle ground course of action, we welcome future discourse on legacy DDTs in the Bight.

The authors thank Eunha Hoh and Robert Risebrough.

1. *Keith Maruya* is an environmental scientist and Past President of SoCal SETAC
2. *Allan Chartrand* is an environmental consultant, and former staff at the Los Angeles Regional Water Quality Control Board
3. *Dan Schlenk* is a professor of environmental toxicology at UC Riverside and Past President of SoCal SETAC

4. The Southern California Bight Regional Monitoring Program is a platform for comprehensive monitoring of coastal aquatic and marine resources in habitats stretching from Point Conception to the International Border with Mexico, an endeavor that has been performed every 5 years since 1994. The Bight program was inaugurated in large part to assess the impacts of discharge from large wastewater outfalls, including the Joint Water Pollution Control Facility (JWPCF) discharging to the coastal ocean at White Point in Palos Verdes. To ensure that the needs and wants of a broad constituency are represented, dozens of participating agencies are engaged in the planning, design, execution and interpretation phases of each 5-year cycle. Program output is centered around a series of technical reports for each element, including the core elements of sediment chemistry, toxicity, and benthic community condition, as well as an integrated synthesis and executive summary (https://www.sccwrp.org/about/research-areas/regional-monitoring/). Although certainly not the only platform available for effecting monitoring of DDT in the Bight, this program uniquely offers a comprehensive (and largely performance-based) quality assurance/quality control (QA/QC) component that assures monitoring data are high quality and comparable in time and space. As part of this ongoing QA/QC effort, analytical protocols for DDT and related contaminants are routinely evaluated and updated, as needed, to meet monitoring performance objectives for each successive 5-year cycle.

PRESIDENT'S CORNER (continued)

home why we do what we do. The poster and platform sessions were illuminating and covered a range of interesting topics. Given my position at the Naval Information Warfare Center Pacific and my scientific interests, I was especially excited about the broad coverage of per- and polyfluoroalkyl substances, including an excellent special session with several of the big names in that field of research. Despite the success of the virtual meeting, I am hopeful that we will be able to gather in person for the 2021 North America SETAC meeting in Portland, not only because I am excited to see everyone in person, but also because Portland is one of my favorite cities to visit.

This Spring brings a couple exciting SoCal SETAC virtual events. First, we are hosting our virtual spring meeting, which is free to all who register, March 9th from 2 - 4 pm. We are thrilled to have three incredible scientists

PRESIDENT'S CORNER (continued)

giving talks on their research in the region. First we have Peter Arth and Adrienne Cibor, from Enthalpy Analytical, giving a talk about toxicity and bioaccumulation of hazardous chemicals from cigarette leachate in marine organisms. We also have Dr. Kari Sant, from the San Diego State University Department of Public Health presenting her lab's work on a the DDT-related contaminant also described in the feature article, tris(4-chlorophenyl)methanol (TCPMOH) and its toxicity to developing zebrafish. Finally, Molly Colvin will discuss several of the novel tools developed at the Naval Information Center Warfare Pacific to assess the transport and toxicity of contaminants in situ. Our hope is that these talks will give students, as well as recent graduates, a sense of the broad environmental toxicology and chemistry positions available in the Southern California region. In addition, we are trying a new networking event after the presentations that will place participants in random breakout rooms for informal conversations, our attempt to mimic the magic of the dinner meeting meal conversations.

Second, we are hosting our 2021 Annual Meeting on Zoom on April 26-28th from 12:30-5 pm each day. Please join us for networking, our standard platform presentations and lightning talks (similar to those we did for our Fall Meeting), replacing poster presentations this year. We are currently planning a session focused on per- and polyfluoroalkyl substances (PFAS) as well impacts of wildfires on Southern California ecosystems. We are still working on the final details for the meeting, but look for a call for abstracts and meeting registration information coming out in mid-March.

In closing, I would like to give my heartfelt thanks to all of our board members and the officers. We truly have an incredible group that is working tirelessly to support our virtual events and make sure we have quality events for the SoCal SETAC community! It is going to be a great Spring for SoCal SETAC and we look forward to working with all of you and "seeing" at our virtual events. If you have questions or want to be more involved, please do not hesitate to reach out to me, our officer, or our Board.

Join us for the SoCal SETAC Spring Virtual Meeting: Professionals in our Community

When: Friday, March 9th, 2 – 4 PM PST

Where: Anywhere (on Zoom)

Cost: Free

Come join us for the first hour to hear from four professionals in our community: Ms. Adrienne Cibor and Mr. Peter Arth from Enthalpy Analytical, Ms. Molly Colvin from the Naval Information Warfare Center Pacific, and Dr. Kari Sant from the San Diego State University Public Health Department.

During the second hour, we will recreate the magic of our dinner meetings with small breakout room discussion groups to informally network with others in the SoCal SETAC community. We look forward to seeing you there!

Please register on the SoCal SETAC website:

Website link: https://www.socal-setac.org/spring2021meeting

MEET THE BOARD

Leslie Nanninga

City of San Diego

Leslie at the start of the Tongariro Alpine Crossing in New Zealand.

Hello! I'm excited to serve as your newest SoCal SETAC board member representing the public sector. I've been involved with SETAC throughout my professional career and I'm thrilled to take on a more active role. I am the supervising Toxicologist at the City of San Diego where I manage marine, freshwater, and sediment toxicity testing in support of our compliance permits.

Growing up in San Diego I constantly spent time in and around water. My love and curiosity of the ocean was originally sparked by my mother's ocean obsession and grew when I took an interest in ocean swimming after getting tired of staring at the bottom of a pool during swim practice. La Jolla cove offered a world class swimming destination and, as a Marine Protected Area, a glimpse into what a patch of protected ocean can and should look like. After spending my high school years chasing Garibaldi and dodging slightly aggressive sea lions, I decided to pursue a degree in Environmental Science at the University of California, San Diego.

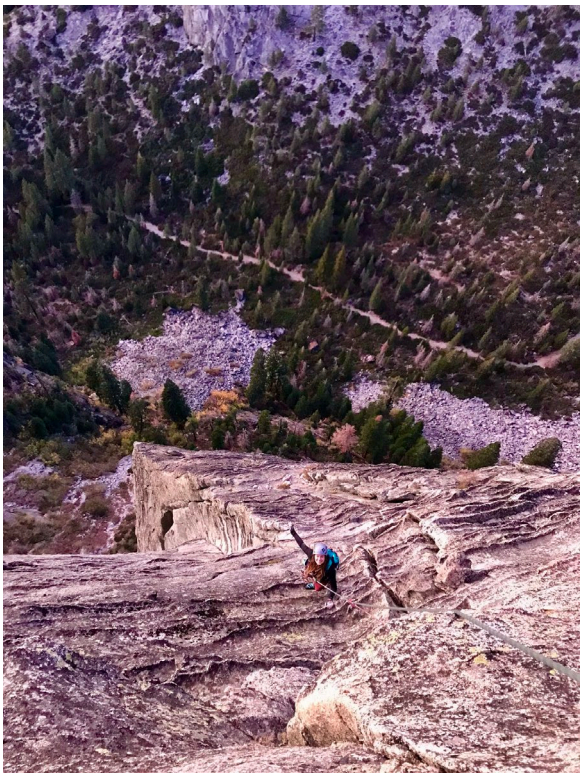
While at UCSD I enrolled in as many marine science courses as possible, eventually picking up a Marine Science minor in addition to my Environmental Science degree. During my senior internship I worked at Scripps Institution of Oceanography in the Ohman Lab assisting a PhD candidate whose work focused on anthropogenic impacts on the marine environment. Over the course of this internship I developed a senior project that explored salinity tolerance and the effects of free amino acids on *Aurelia aurita* (the Moon Jellyfish). Between dragging Secchi discs through Mission Bay and counting microscopic jellyfish polyps by red light I eventually graduated and decided to pursue a career that focused on the intersection of human impacts and the environment.

After graduating, I was hired at Nautilus Environmental (now Enthalpy Analytical) which helped lay the groundwork for my career in environmental toxicology. After a few years I moved on to work for the City of San Diego. My employment at the City has spanned several different positions in different areas ranging from drinking water to marine microbiology and wastewater chemistry.

I finally came to land in the Toxicology laboratory, first as a biologist and now as the supervisor. I currently manage all compliance toxicity testing for the Point Loma Wastewater Treatment Plant and South Bay Water Reclamation Plant. Additionally, my laboratory is involved in the City's recycled water purification program (Pure Water San Diego) which will allow our lab to expand into freshwater and bioanalytical assay testing.

My employment at the City has given me the opportunity to work on numerous diverse projects, both within environmental toxicology and in the broader world of water and wastewater monitoring. This has allowed me to remain actively engaged in the protection and stewardship of the ocean and other waterways while continuing to learn about human impacts on the environment.

Outside of the lab I spend far too much time rock climbing and getting lost in the mountains. Otherwise I enjoy travelling (when that's possible), backpacking, swimming in the ocean, and trying to get my cat to walk on a leash.



Leslie high on the wall at Lover's Leap in Lake Tahoe, California.

STUDENT CORNER

Life in Toxicology After Graduation: Advice from Recent Graduates

One of the most stressful decisions students make as they enter their final years of school is what to do after they graduate. Oftentimes, this difficulty is due to a lack of knowledge about the wide range of job opportunities there are out there for environmental chemists and toxicologists. This winter, we interviewed three recent graduates who have all taken different paths since graduation to find out what they have been doing since graduating and ask them for their advice.

Sara Vilet

First, we spoke to Sara Vilet, a 2019 PhD graduate from the University of California Riverside Environmental Toxicology program.

What is your current job?

I am an ORISE Postdoctoral Fellow at the US EPA Great Lakes Toxicology and Ecology Division where I work with both the Office of Research and Development (ORD) and the Endocrine Disruptor Screening Program (EDSP).

What is your favorite thing about your current job?

I love that I get to work across diverse research areas on projects that have direct contributions to the agency. On a given day I typically work on tasks for many different projects, which is so different than my experiences as a PhD student! As a result, I'm able to learn different skills and gain exposure to research I never would have otherwise.

How did SoCal SETAC help prepare you for your job?

My experiences in SoCal SETAC really helped me develop confidence when presenting my work and networking with other scientists. This has been so important, not only my current job, but also when I was interviewing for positions.

What advice would you give to current grad students looking for a similar job after graduation?

Let folks know you are interested! Oftentimes there are positions coming down the pipeline that haven't been posted or widely advertised yet. Something as simple as sending a quick "I'm interested" email can get you on their radar. Try not to be too intimidated by this (I know I was), almost everyone is excited to hear you are interested in their work!

Jordan Alejo

Second, we spoke to Jordan Alejo, who will be graduating in May 2021 with an MPH in Environmental Health from San Diego State University and is a 2021 California Sea Grant State Fellowship recipient!

What is your current job?

I currently work as a laboratory assistant at Enthalpy Analytical (formerly Nautilus Environmental). It is an environmental toxicology laboratory here in San Diego that specializes in whole organism bioassays. I'll be starting a new position with the State Water Resource Board - Division of Water Quality, Sustainable Water Plans, and Policies Unit where I'll be helping do research on science-based policies regarding desalination, constituents of emerging concern, and other things.

What is your favorite thing about your current job?

It's an extremely dynamic environment where there's always something to learn. We do a variety of different tests using different organisms and methods so I'm constantly learning and trying new stuff out.

How did SoCal SETAC help prepare you for your job?

SoCal SETAC actually introduced me to professors that got me into my graduate program and helped me network to learn more about the industry. It's been monumental in learning the different avenues I can pursue within toxicology.

STUDENT CORNER (continued)

What advice would you give to current grad students looking for a similar job after graduation?

Don't be afraid to join organizations like SETAC and take advantage of events, speakers, and networking opportunities. Once you make that first connection, you'll have a plethora of different people and resources to help you along your career journey.

Scott Coffin

Third, we spoke to Scott Coffin, a 2018 graduate of University of California Riverside with a PhD in environmental toxicology.

What is your current job?

Research Scientist III in the Regulatory Development Unit, Division of Drinking Water, State Water Resources Control Board.

What is your favorite thing about your current job?

Serving as a bridge between science and policy/regulations through widespread collaborations and direct funding/oversight of research.

How did SoCal SETAC help prepare you for your job?

Learning about career options directly from the people who are most excited and passionate about the work they do! Also, when I started working, I felt like I had a huge 'leg up' because I had personal relationships with so many people in the field, which made it easier to ask work-related questions to scientists in diverse sectors and increased the potential for collaborations.

How did SoCal SETAC help prepare you for your job?

First- recognize that you've learned a valuable set of skills in graduate school- both technical, and management leadership- and don't be afraid to tout those to potential employers. Second- follow your passion! Employers love scientists who care about what they do, and it makes your work more fulfilling. If you are passionate about the environment and public health, you may consider working for the State of California. California is an international leader in science-informed environmental policies and regulations, so it's quite exciting to be part of!

SoCal SETAC Annual Meeting

Held Jointly with Desert Southwest SETAC

When: Monday April 26th – Wednesday April 28th

Time: 12:30 to 5:00 PM

Where: Anywhere (on Zoom)

Cost: Free (for members)

Join us for our virtual SoCal SETAC annual meeting. This year's annual meeting will include PFAS, wildfire and general sessions. In addition to the sessions, we will have lightning round talks, to replace the poster session, networking events, and fun & games.

Look out for the call for abstracts in mid-March!

Registration coming soon on the SoCal SETAC website: https://www.socal-setac.org/2021-annual-meeting

Have you checked out the 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

CALENDAR OF EVENTS

March 2021

March 5 - 11

California Water Environmental Association, P3S Conference
https://www.setac.org/events/EventDetails.aspx?id=1391275 | (*virtual)*

March 15 - 25

36th Annual WateReuse Symposium
https://watereuse.org/news-events/conferences/ | (*virtual)*

March 16 - April 6

SETAC Seminar Series: Microplastics in Humans and the Environment
https://www.shellfish.org/annual-meeting | (*virtual)*

March 22 - 25

National Shellfisheries Association
https://www.shellfish.org/annual-meeting

April 2021

April 19 - 23

12th National Monitoring Conference
https://www.nalms.org/2021nmc/ | (*virtual)*

April 26 - 28

SoCal SETAC Annual 2021 Meeting
https://www.socal-setac.org/2021-annual-meeting | (*virtual)*

May 2021

May 2 - 6

SETAC Europe 31st Annual Meeting
https://europe2021.setac.org/ | (*virtual)*

May 7

Southern California Academy of Sciences
https://scas.nhm.org/annual-meeting/ | (*virtual)*

May 12 - 25

Society of Toxicology (SOT) Annual Meeting
https://www.toxicology.org/events/am/AM2021/program-overview.asp (*virtual)*

May 23 - 26

Nontarget Analysis for Environmental Assessment- SETAC Focused Topic Meeting
https://www.setac.org/events/EventDetails.aspx?id=1238564 | (*Durham, North Carolina)*

May 23 - 27

Society of Freshwater Science Meeting
https://freshwater-science.org/annual-meeting-info | (*virtual)*

May 25 - 27

US Symposium on Harmful Algae
http://ushabs.com/ | (*virtual)*

June 2021

June 13 - 16

American Water Works Association (AWWA) Annual Meeting
https://www.awwa.org/ace | (*San Diego, CA*)

June 14 - 17

2021 Western Dredging Association (WEDA) Dredging Summit and Expo
https://dredging-expo.com/ | (*Virtual*)

June 27 - 30

SETAC Africa 10th Biennial Conference
https://www.setac.org/events/EventDetails.aspx?id=1393015&group= | (*Kampala*)

June 29 - 30

California Water Boards Water Data Science Symposium
https://www.waterboards.ca.gov/resources/data_databases/wq_science_symposium.html | (*Virtual*)

August 2021

August 16 - 19

XVI Brazilian Ecotoxicology Meeting- ECOTOX 2020
https://www.setac.org/events/EventDetails.aspx?id=1342519 | (*Gramado*)

September 2021

September 26 - 29

SETAC Latin America 14th Biennial Meeting
https://www.setac.org/events/EventDetails.aspx?id=1393019&group= | (*Valdivia*)

October 2021

October 19 - 20

Living Shorelines Tech Transfer Workshop
https://estuaries.org/livingshorelines/2021-living-shorelines-tech-transfer-workshop/ | (*Cape May, NJ*)

October 25 - 27

California Stormwater Quality Association Annual Meeting
Recovery and Resilience: Achieving Sustainable Stormwater Management
https://www.casqa.org/events/annual-conference | (*Virtual*)

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