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Water Resources: Contaminants of Emerging Concern

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1.3.0 Contaminants of Emerging Concern

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Overview

Contaminants of emerging concern (CECs) encompass a vast number of compounds that are largely unregulated in the U.S. and abroad, and have limited or no monitoring data available for environmental media (e.g., air, water, sediment, and biota). A wide variety of pharmaceuticals, flame retardants, contemporary use pesticides, and even food additives are considered CECs. Many of these compounds have likely been present in aquatic ecosystems for decades, but were not previously detectable using available chemical methods. However, recent advances in analysis have allowed for the detection of many CECs in coastal habitats around the world. Previous studies of CEC occurrence and fate in Santa Monica Bay and other coastal areas, summarized in the 2010 State of the Bay Report, identified the widespread occurrence of some CECs and the potential for exposure of coastal fish and manifestation of adverse effects. However, these studies also identified many knowledge gaps that limit our ability to make decisions on managing CECs that are based on sound science. In the last 5 years, steps have been taken by California agencies to fill these knowledge gaps and develop new strategies for CEC management and regulation.

Several recent regional and statewide studies have been conducted that add significantly to our understanding of CEC contamination in southern California and suggest directions for future management efforts. The 2008 Southern California Bight Regional Monitoring Program analyzed sediments from bays and estuaries for polybrominated diphenyl ether (PBDE) flame retardants and pyrethroid pesticides. In 2009-10, the Mussel Watch California Pilot Study was conducted to determine the extent and magnitude of more than 150 CECs in mussels (*Mytilus* spp.), low trophic level sentinels for contaminant exposure, at 68 sites along the California coast. Water column concentrations of CECs were also measured at selected sites using **passive sampling technology**. The Stormwater Monitoring Coalition (SMC) has also conducted chemical analyses of water from perennial streams in southern California coastal watersheds.

Passive sampling devices (PSDs) are simple, low cost alternatives to conventional methods for the extraction and chemical analysis of water or sediment that rely on diffusive mass transport and/or preferential sorption to concentrate chemicals of interest.

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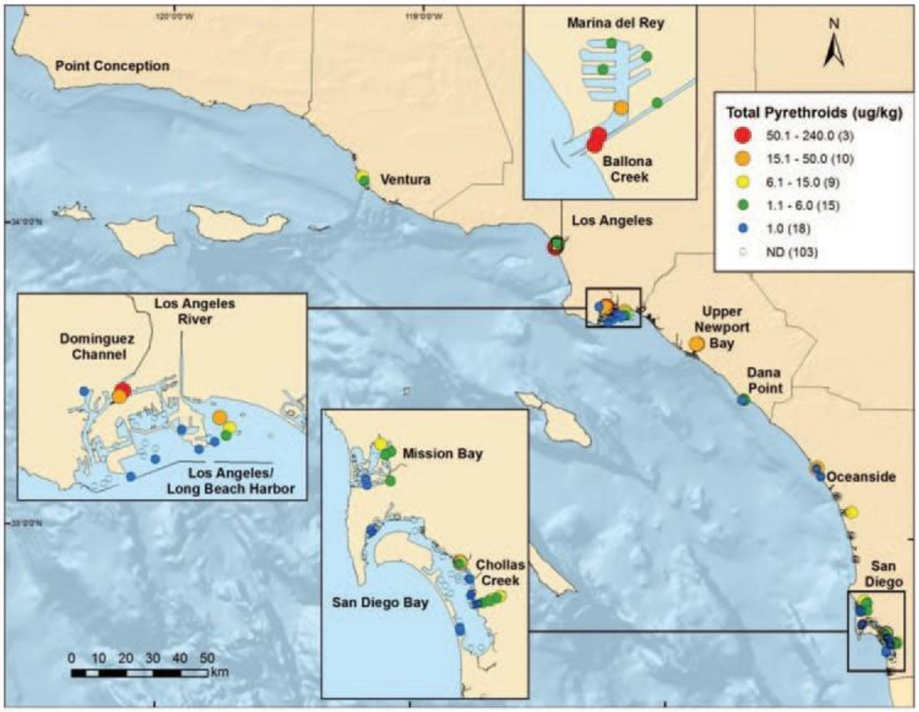
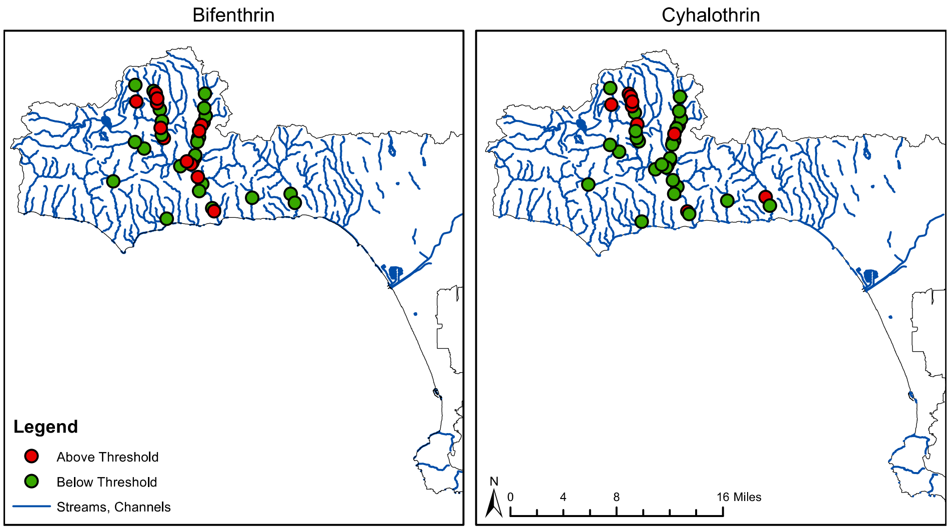
Figure 1.3 -1. Geographical distribution of pyrethroid pesticide concentrations in sediments from embayments of the Southern California Bight in 2008. Concentrations shown are the sum of 8 individual pyrethroids. *Source: Lao et al. 2012.*



Results from these studies confirm that a wide variety of CECs are present in the water, sediments, and biota of the Bight, including Santa Monica Bay. Pyrethroids, a group of current-use pesticides with high toxicity to some aquatic life, were detected in 34% of southern California embayments (Lao et al. 2012), with the highest concentrations present at the mouth of Ballona Creek Estuary (Figure 1.3-1). They make up the dominant cause of sediment toxicity in that body of water (Greenstein et al. 2014). Pyrethroids are also present in streams throughout our coastal watersheds; therefore, streams are a likely source of these insecticides in embayments. Monitoring by the SMC found 12% of streams in the Santa Monica Bay watershed contained potentially toxic concentrations of the pyrethroid, cyhalothrin, while 27% of streams in the Los Angeles River Watershed contained elevated concentrations of bifenthrin (Figure 1.3-2). Residues of CECs in mussel tissue indicated that marine life are exposed to a wide variety of CECs along the coast of California, with the greatest exposure occurring near urban centers and especially near areas receiving stormwater input (Dodder et al. 2013). Of the different CECs detected, pharmaceuticals and personal care products (PPCPs) were most prevalent (30 compounds detected). Other types of CECs present in mussels included alkylphenol surfactants, flame retardants (PBDEs), current-use pesticides, and perfluorinated compounds. Water column measurements also detected the presence of CECs (e.g., chlorinated phosphate flame retardants) that did not accumulate in mussels. Most CECs found in these studies were at relatively low concentrations compared to legacy contaminants such as DDTs and PCBs (Figure 1.3-3).

Figure 1.3-2. Occurrence of the pyrethroid insecticides bifenthrin and cyhalothrin in streams throughout southern California coastal watersheds in 2008-13. *Data Source: The Stormwater Monitoring Coalition.*



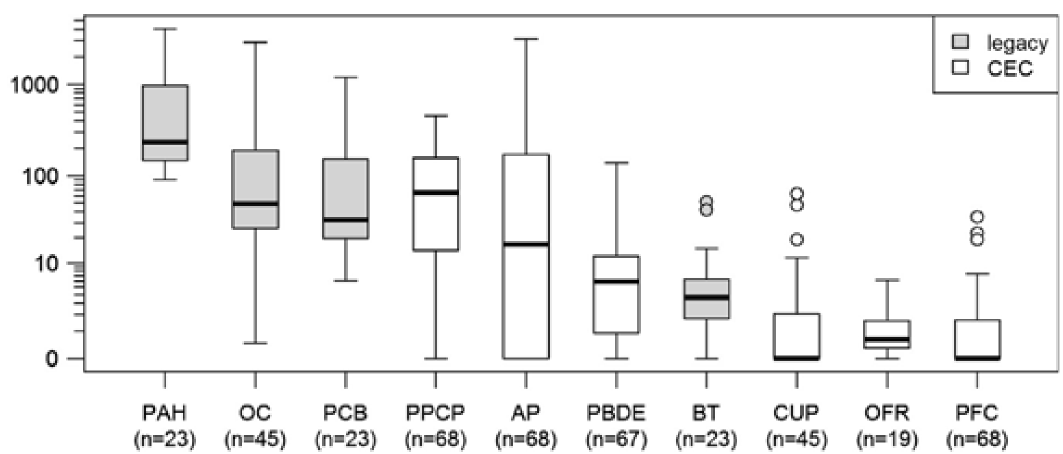
The large number of CECs discharged into aquatic systems, combined with the limited information on thresholds of concern, presents a challenge for monitoring and regulating these compounds. California has begun to take action to address the issue. An expert panel convened by the State Water Resources Control Board (SWRCB) reviewed the potential sources, fate and effects of CECs, and provided guidance for monitoring the State's receiving waters (Anderson et al. 2012). The panel identified 16 CECs for initial monitoring in wastewater effluents, freshwater, estuarine, and marine habitats based on existing occurrence and toxicity data (Table 1.3-1). The panel also determined that the monitoring and regulatory paradigm based on chemical-specific water quality criteria is not feasible for CECs (see Sidebar 1.3 for more on how CECs are monitored). Instead, the panel recommended the use of a comprehensive monitoring framework that integrates biological testing and chemical analysis in a tiered approach (Figure 1.3-4). Routine monitoring (Tier I) would include the use of cell-based (*in vitro*) bioassays in addition to

Sidebar 1.3: Monitoring Wastewater for CECs

One of the key data gaps in assessing the environmental risk of CECs to coastal ecosystems is the lack of information on the types and amounts of chemicals being discharged. The Los Angeles Regional Water Quality Control Board has begun requiring monitoring for selected CECs in the NPDES discharge permits for the major municipal wastewater discharges into Santa Monica Bay, and is sponsoring studies on the occurrence of CECs in local watersheds. The City of Los Angeles' Hyperion Treatment Plant began monitoring its effluent in 2012. Once a year, a 24-hour composite sample of the final effluent discharged into the Bay through Hyperion's 5-mile outfall is analyzed for over 30 CECs, including most of those recommended by the SWRCB Expert Panel. In addition to the SWRCB recommended compounds, the effluent samples are being analyzed for a wide variety of other pharmaceuticals and personal care products, including antibiotics, pain relievers, sedatives, and cholesterol-lowering agents. Annual CEC monitoring is also underway for effluent from the Sanitation Districts of Los Angeles County's Joint Water Pollution Control Plant (JWPCP), which is discharged into waters offshore of the Palos Verdes Peninsula. The results from these monitoring efforts will improve our understanding of the sources and loads of CECs into Santa Monica Bay and provide a foundation for improving monitoring programs in the future.

targeted chemical analyses to screen for CECs in aquatic environments. The cell assays would complement the chemical analyses by accounting for the joint effects (including synergism and antagonism) of contaminant mixtures. These tests will provide the necessary sensitivity without the need to analyze for every CEC of potential concern. Follow-up studies (Tier II) that include more detailed biological testing and additional chemical analyses (e.g., additional compounds, non-targeted analysis) would be used to determine the level of concern and need for management actions when screening thresholds are exceeded. Elements of the CEC monitoring framework are currently being tested in pilot studies conducted by local sanitation districts, the SMC, and the Bight Regional Monitoring Program. Screening thresholds will be determined in subsequent phases of the program, utilizing data from previous studies and ecological risk models.

Figure 1.3-3. Mussel (Mytilus spp.) tissue concentration box plots for multiple contaminant classes of samples collected at 68 sites along the California coast in 2009-10. Rectangle, horizontal bar and error bars represent the interquartile range (IQR), median, minimum and 1.5 times the IQR, respectively. Concentrations greater than 1.5 times the IQR are shown as individual circles. PAH-polycyclic aromatic hydrocarbons; OC-organochlorine pesticides; PCB-polychlorinated biphenyls; BT-butyltins; PPCP-pharmaceuticals and personal care products; AP-alkylphenols/alkylphenol ethoxylates; PBDE-polybrominated diphenyl ethers; CUP-current-use pesticides; OFR-other non-PBDE flame retardants; PFC-perfluorinated chemicals. *From Dodder et al. 2013*



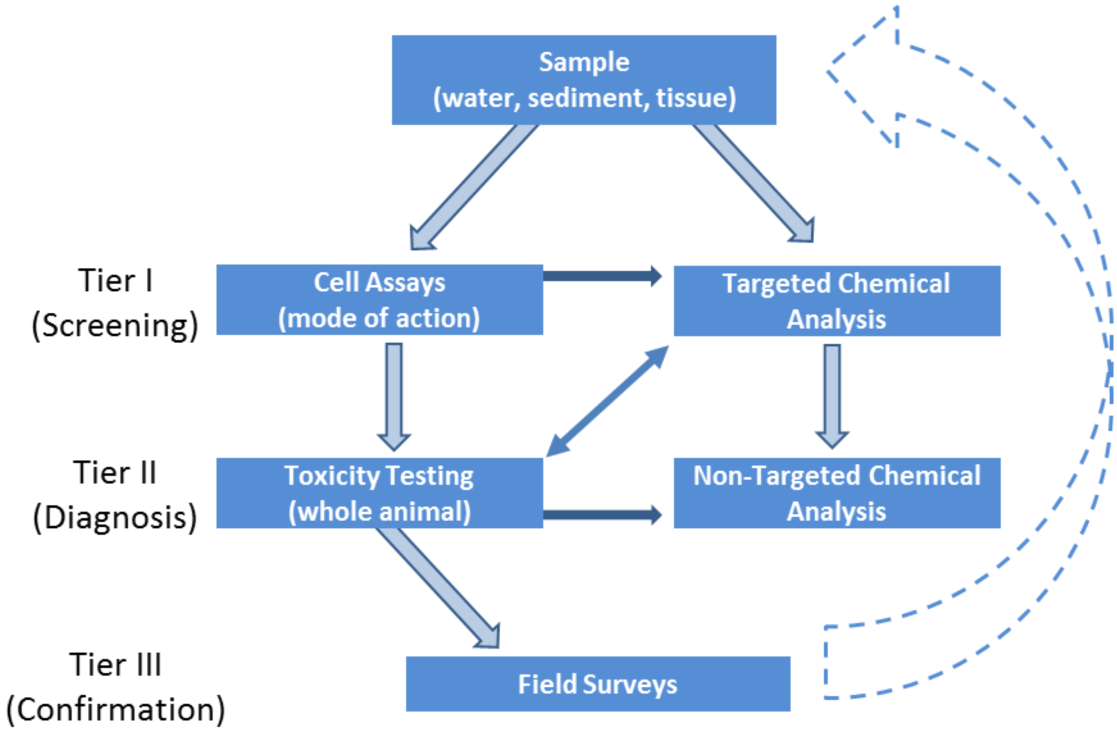
In addition to the SWRCB, other state agencies are developing regulations to reduce sources and inputs of CECs to the environment. The Department of Pesticide Regulation (DPR) promulgated regulations in 2012 to prevent surface water contamination by pesticides used in outdoor urban settings. The Department of Toxic Substances Control (DTSC) has developed Safer Consumer Products Regulations that will require product manufacturers to ask: “Is it necessary?” So far, DTSC has identified three products for which alternatives will be investigated: children’s sleep products containing the flame retardant known as chlorinated tris (TDCPP), cleaning fluids with methylene chloride, and polyurethane foam containing unreacted diisocyanates.

The DTSC process includes four steps:

1. Identify candidate CEC based on hazard traits and evidence of exposure.

2. Identify consumer products containing candidate CECs for which there is a potential exposure that may contribute to or cause significant or widespread adverse impacts.
3. Identify possible alternative product designs or formulations.
4. Implement regulatory responses, including restrictions or prohibitions on sales and end-of-product life stewardship.

Figure 1.3-4. Proposed integrated monitoring framework for CECs in aquatic environments. *Source: SCCWRP*



The intended outcome of the DTSC process is to send a signal to the marketplace before restrictions or prohibitions need to be initiated.

There has been substantial progress in recent years in cataloging the occurrence of CECs in coastal waters, and in developing bioanalytical methods with the high levels of sensitivity needed for environmental monitoring. Future research will focus on developing new technologies for biological effect testing and using these tests to determine CEC thresholds that are protective of water quality. Pilot studies to test the application of California's CEC monitoring strategy are in progress, and are expected to further develop this strategy into monitoring programs that will likely be implemented in discharge permits and new product evaluations. The control and treatment of CECs in waste discharges is a daunting task due to the diversity of CEC types and sources. The challenge facing California's water quality agencies is how to identify and limit the use of problematic CECs before they become a source of environmental degradation and diminish the invaluable benefits provided by the coastal ecosystem.

Table 1.3-1. Contaminants of emerging concern (CECs) recommended for pilot monitoring in wastewater treatment plant effluents and environmental samples (depending on exposure type). *Data Source: Adapted from Anderson et al., 2012.*

Compound	Primary Use	Aqueous Exposure Potential Risk	Sediment Exposure Potential Risk	Bio-accumulation Potential Risk
Bis (2-ethylhexyl) phthalate	Plasticizer for PVC		X	
Bisphenol A	Monomer or epoxy/polycarbonate	X		
Bifenthrin	Pyrethroid insecticide	X	X	
Butylbenzyl phthalate	Plasticizer for PVC		X	
Permethrin	Pyrethroid insecticide	X	X	
Chlorpyrifos	Organophosphate insecticide	X		
Estrone	Steroid hormone	X		
Ibuprofen	Pain reliever	X		
Fipronil	Insecticide	X	X	
17-beta estradiol	Steroid hormone	X		
Galaxolide (HHCB)	Synthetic fragrance	X		
Diclofenac	Non-steroidal anti-inflammatory drug	X		
p-Nonylphenol	Alkylphenol surfactant degradant		X	
PBDE 47 and 99	Brominated flame retardant		X	X
PFOS	Perfluorinated organic chemical		X	X
Triclosan	Antimicrobial	X		

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