

2010 Mussel Watch California Pilot Study: Compounds of Emerging Concern

Introduction

The California Department of Toxic Substance Control (2007) estimated more than 85,000 chemicals are currently used in the United States and an additional 2,000 new chemicals are introduced annually. Many of these compounds lack adequate toxicological studies that evaluate their impacts on wildlife and human health. Sometimes, short-term exposure data are available for a chemical, but long-term effects of the chemical are unknown. Many laboratory studies have not tested the effects of chemicals at environmentally relevant concentrations. Scientists are beginning to identify what compounds are of concern and how are they impacting the coastal environment.

It has been well documented that many California coastal environments are contaminated with anthropogenic chemicals, which may have deleterious effects on aquatic organisms. In addition to legacy organic contaminants and trace metals, a number of studies have identified compounds of emerging concern (CECs) in marine and estuarine environments. CECs can be naturally or synthetically occurring hormones, personal care products, pharmaceutical compounds, industrial compounds, or current use biocides. Some CECs have been in use for a long time but they are considered to be of “emerging concern” because recent advances in analytical techniques have enabled accurate detection of the previously undetectable chemicals. Scientists are now finding CECs in recycled water, coastal environments, and in the tissue of aquatic animals. Studies have found that some CECs are biologically active at low concentrations and can interfere with natural hormone processes in organisms (endocrine disrupting compounds).

The presence of CECs in California coastal waters is understudied and the impacts CECs are having on marine life are not well understood. To gain a better understanding of the presence of CECs in California coastal waters, NOAA partnered with the State Water Board, San Francisco Estuary Institute, United States Geological Survey, and SCCWRP in a 2010 pilot project (CEC Pilot Project) that measured CECs in bivalves using established NMW stations. The primary goal of the CEC Pilot Project was to expand the relevancy and utility of the NMW program by determining the occurrence of CECs in California and using the information to identify compounds for inclusion in future nation-wide Mussel Watch surveys, as well as, to suggest compounds of particular concern in California waters that may require further investigation.

Specific Aims

Resident mussels were sampled for the CEC Pilot Project from December 2009 to May 2010.

CEC concentrations and frequency of CEC detection were measured in resident mussels from up to 68 stations. Legacy organic contaminants and trace metals were measured in mussels from up to 23 stations. Over 160 CECs were measured in mussels including: 86 pharmaceutical and personal care products (e.g. DEET, ibuprofen, triclosan), 54 industrial and commercial CECs (e.g. 4-nonylphenol, bisphenol-A, PBDE-47, perfluorinated compounds), and 27 current use pesticides (e.g. chlorpyrifos, dacthal, permethrin).

The study established relationships between land use (agriculture, low development, mixed development, or urban) and CEC occurrence, as well as relationships between CEC occurrence and proximity to discharges of treated municipal wastewater effluent or storm water runoff. Passive sampling devices (PSDs) were also used in this study as an alternative means of detecting CECs in the environment. PSDs have the ability to accumulate water soluble and insoluble compounds and can be utilized in environmental conditions where mussels do not thrive.

Results

Results from the CEC Pilot Study indicated polybrominated diphenyl ethers (PBDEs-flame retardants), alkylphenols (fuel, detergent, and fragrance additives), and pharmaceutical and personal care products were detected most frequently in mussel tissue. CECs typically enter the marine environment in treated municipal wastewater or stormwater runoff and can accumulate in the tissue of mussels. CECs were detected more frequently and had higher concentrations at stations influenced by stormwater and treated municipal wastewater discharges. Land use data indicated that urban land use stations generally had higher concentrations and detection frequencies of many CECs (perfluorinated compounds, alkylphenols, and PBDEs). Pharmaceutical and personal care products were present in all land uses, including agriculture. Current use pesticides were highest at agricultural areas, followed by urban land use areas. There were positive relationships between bioaccumulation of CECs and legacy organic contaminants in mussel tissue and PSDs. The composition of chemicals varied slightly between the two methods. PBDEs, plasticizers, and galaxolide (additive in fragrances) were the most frequently detected CECs in PSDs. The similarities between CEC accumulation by PSDs and in bivalve tissue demonstrated that PSDs can be used as an effective means for assessing water quality in environments where mussel populations cannot or do not grow.

Conclusions

The results from the CEC Pilot Project established a need to monitor certain CECs (PBDEs, perfluorinated compounds, alkylphenols, and the antibiotic lomefloxacin) in coastal ecosystems, particularly in heavily urbanized regions. Studies like the CEC Pilot Project can help regulators identify locations (e.g. stormwater management zones) where certain compounds are of particular concern, and regulators can shape monitoring and remediation efforts accordingly.

Analytical advances have expanded the number of compounds that can be monitored, particularly in tissue; however, there is still a need to improve and standardize analytical techniques for new chemicals and analytically challenging compounds. New monitoring techniques should be developed to assess how wildlife are responding to: CECs, changes in chemical compositions in the environment, and mixtures of CECs. These techniques would be valuable for assessing potential risks to human health and could be adapted to further environmental monitoring efforts.

PSDs are effective monitoring tools for assessing bioaccumulation of CECs. PSDs are cost effective and even though they are not as ecologically relevant as biosentinels, they can be deployed in environments where bivalves do not grow; this greatly expands the regions that can be monitored for CECs.

The collaboration among local, state, and federal agencies for the CEC Pilot Study enabled resources to be pooled and maximized, which ultimately resulted in the ability to expand the scope of the project. Future collaborations would be beneficial to all stakeholders to reach the common goal of gaining a better understanding of CECs in California coastal waters.

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