PBDES IN THE SAN FRANCISCO BAY FOOD WEB

Introduction

Some of the highest concentrations of polybrominated diphenyl ethers (PBDES) in the world have been observed in San Francisco Bay wildlife and humans (She et al. 2002, 2003). These results and the pervasive use of these compounds prompted the Regional Monitoring Program for Water Quality in the San Francisco Bay (RMP) to focus significant resources in understanding the occurrence of PBDES in Bay biota, sediment and water beginning in 2002. This report focuses on data for a variety of biota that reside in San Francisco Bay, including deployed and resident bioucles, sport fish, and tern and common eider.

In part as a result of the widely detected presence of PBDES in the environment, the major manufacturer, Great Lakes Chemical Company (now Chemtura Corporation) of two of the three PBDE formulations (Penta and Octa) ceased production of these compounds at the end of 2002. The California legislature banned Penta and Octa in 2006. Also in 2006, the USEPA issued a significant new use rule on these compounds, requiring that any use proposed in the future be reviewed for safety.

The Deca formulation is scheduled to be phased out in 2013. The long-term and ongoing monitoring of PBDES undertaken by the RMP allows us to observe whether these actions have resulted in reduced contamination of the Bay.

Conclusions

Although concentrations in Atlantic Bay media such as sediment and water have shown no noticeable temporal trends over the ten-year monitoring period, concentrations in biota have declined dramatically, suggesting that management actions in sediments by regulatory controls have reduced pollutant concentrations in the food web. Investigation of potential contamination “hot spots” in the margins surrounding the Bay may prove useful in understanding the specific exposure pathways leading to PBDE declines in wildlife.

Materials and Methods

Concentrations of water (Figure 1) and sediment (Figures 2 and 3) have remained largely constant over the last ten years with an interdecadal range of total PBDES (the sum of measurable congeners) from 65 to 603 pg/L (median 154 pg/L) in water and 1 to 9 (median 3.0) ng/g dry weight over the last ten years (Figure 2). Trends in concentrations observed were at Wheeler Island in Suisun Bay, an area that is upstream in the Delta.

Figure 1

Concentrations of PBDEs in water in San Francisco Bay (pg/L)

Figure 2

Concentrations of PBDEs in sediment in San Francisco Bay (pg/g dry weight)

Concentrations of BDE-47 in Water (pg/L)

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

Figure 3

Concentrations of BDE-47 in sediment in San Francisco Bay (pg/g dry weight)

Bivalves

Concentrations of total PBDES were mostly between 6.2 and 62 ng/g (interdecile range) with a median across the monitored period of 20 ng/g. Resident bivalves located in San Francisco Bay, including deployed and resident bivalves, sport fish, and tern and common eider.

Figure 4

Concentrations of BDE-47 in Bivalves (ng/g dry)

Bird Eggs

Concentrations of PBDES in common eider eggs have also decreased over the ten-year period (Figure 5). Major congeners observed were BDE-47, 99, and 100. The highest concentrations were observed at Wheeler Island in Suisun Bay, an area that is relatively undisturbed and may be influenced by activities nearby and upstream in the Delta. She et al. (2008) reported the world’s highest concentrations of PBDES in birds: 63,000 ng/g lipid in Frateron’s tern eggs from the South Bay. Samples of tern eggs collected in 2009 in the same region suggest a dramatic decline, with concentrations ranging from 670 to 2,400 ng/g lipid. In addition, recent work sponsored by the RMP suggests that these concentrations are well below thresholds that may cause effects to piping and hatching success (Rutten et al. 2011).

Figure 5

Concentrations of Total PBDES in Common Eider Eggs (ng/g dry)

Sport Fish

Although PBDES have been monitored in a variety of fish over the last decade, including white croaker, anchovy, sturgeon, and jacks, the RMP has focused its long-term trend comparisons on chinook salmon (Cyanogaster aggregata). Annual average concentrations of PBDES in this species ranged from 15 to 88 pg/g wet weight, with a nearly two-fold decline between earlier measurements (2001-2006) and those made in 2009 (Figure 6). Some of the concentrations of any species of sport fish monitored exceeded the recently developed human health advisory tissue level of 500 pg/g for the consumption of white fish (Waring and Brodsky 2011). Bioucles were preserved, processed using long chain technique, and analyzed by gas chromatography-mass spectrometry. Inorganic and polybrominated diphenyl ether (PBDE) congeners were quantified (Zeile et al. 2009).

Figure 6


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