

# Seals as Sentinels Research

## Brominated Flame Retardants in the NW Atlantic Marine Food Web

### Abstract

Seven species of teleost fishes comprising major prey of northwest Atlantic harbor seals were analyzed for polybrominated diphenyl ethers (PBDEs). PBDE concentrations in whole fish samples (n=87) were compared with those measured previously in harbor seal blubber to evaluate the transfer of PBDEs from prey to predator.



Hexabromocyclododecane (HBCD) concentrations were measured in three fish species to provide an initial estimation of HBCD contamination in this ecosystem. HBCD was detected in 87% of the fish samples at concentrations ranging from 2.4 to 38.1 ng/g, lw (overall mean  $17.2 \pm 10.2$  ng/g, lw).  $\Sigma$ PBDE concentrations in fish ranged from 17.9 to 94 ng/g, lw (overall mean  $62 \pm 34$  ng/g, lw).  $\Sigma$ PBDE concentrations in the harbor seals were two orders of magnitude higher than levels in the fish. Biomagnification factors (BMFs) from fish to seals averaged from 17 to 76, indicating that tetra- to hexa-BDEs are highly biomagnified in this marine food web. BDE-47 was the dominant congener in all samples, suggesting exposure to the penta-BDE mixture. The presence of higher brominated congeners including BDE-209 at measurable levels in fish and seal tissue, along with the very high biomagnification of BDE-153, as well as -155, and -154, suggests recent exposure to the octa- and deca-BDE formulations in this US coastal marine food web, as well as the additional contribution of BDE-209 debromination in fish to the loading of persistent PBDEs in the seals. This is the first study to report the occurrence of BDE-209 and other higher BDEs in commercially important marine fishes from the northwest Atlantic. Shaw et al. (2009) *Science of the Total Environment* 407: 3323–3329.

### Background

This study is the first to show that the brominated flame retardants PBDEs and HBCDs have contaminated top predators in the northwest Atlantic marine food web. These compounds leach out of consumer products such as furniture foam, textiles, electronics, and plastic casings for TVs and computers and are found at high levels in dust in homes and offices. PBDEs and HBCDs enter estuarine and coastal food webs from diffuse sources including households, industries, wastewater treatment plants and landfills.

Whereas earlier studies have rarely measured the fully brominated Deca-BDE (BDE-209) in marine food webs, this study measured BDE-209 and other highly brominated BDEs in seven species of marine fish that are known harbor seal prey (silver hake, red/white hake, herring, flounder, plaice, alewife, and mackerel). Levels in the fish were compared with those measured in our previous study of PBDEs in harbor seal tissues (Shaw et al. 2008 *Chemosphere*). The findings have implications for human health, since many of these same fish are consumed by people.

### Findings

PBDE concentrations in (whole) fish tissues were comparable to those reported in marine fish from Europe. HBCD concentrations were two- to four-fold lower than, reflecting different usage patterns of these BFRs.

The dominant PBDE congeners in fish and seals (BDE-47, -99 and -100) are suggestive of exposure to the Penta-BDE commercial mixture. These congeners, along with the hexa-BDEs, are considered to be the most persistent, bioaccumulative, and toxic PBDEs.

Tetra- through hexa-BDEs (especially BDE-153) were highly biomagnified from fish to seals, indicating the potential for accumulation of high levels of these persistent PBDEs in top predator species.

Deca-BDE (-209) was detected at similar levels in blubber of the seals and their fish prey (1 - 8 ppb lipid),

indicating that Deca-BDE bioaccumulates but does not biomagnify from fish to seals (BMF<1). However, it is plausible that BDE-209 may preferentially migrate to blood-perfused tissues such as liver; thus, the levels detected in blubber may underestimate actual body burdens of Deca-BDE in these seals.

We found an enrichment of congeners that are markers of BDE-209 debromination (metabolic breakdown) in both fish and seals, indicating that BDE-209 debromination may be occurring in wild marine fishes and may be an additional source of more persistent and toxic BDEs in the seals.

BDE-209 and other highly brominated BDEs have a short half-life in mammals (days to months), thus the presence of these congeners in fish and seal tissues suggests recent exposure to the octa- and deca-BDE commercial mixtures.

The potential for BDE-209 accumulation/ debromination in marine ecosystems is of concern, as Deca-BDE has only begun to be regulated and large amounts are still in use. Moreover, because BDE-209 is strongly particle-associated, marine sediments constitute a vast reservoir for ongoing exposure to Deca-BDE and its breakdown products, posing an increasing health risk to marine species.

#### **Publications resulting from this research:**

Shaw, S. D., Berger, M. L., Brenner, D., Kannan, K., Lohmann, N., P\_cke, O. (2009). Bioaccumulation of polybrominated diphenyl ethers and hexabromocyclododecane in the northwest Atlantic marine food web. *Science of the Total Environment* 407: 3323–3329.

Shaw, S. D., Brenner, D., Berger, M. L., Fang, F., Hong, C.-S., Addink, R., Hilker, D.(2008). Bioaccumulation of polybrominated diphenyl ethers in harbor seals from the northwest Atlantic. *Chemosphere* 73: 1773-1780.

Shaw, S. D., Berger, M. L., Brenner, D., Lohmann, N., P\_cke, O. (2008). [Bioaccumulation of polybrominated diphenyl ethers and hexabromocyclododecane in the northwest Atlantic marine food web.](#) *Organohalogen Compounds* 70: 841-845.

Shaw, S.D., Brenner, D., Berger, M.L., Fang, F., Hong, C-S., Storm, R., Hilker, D., O'Keefe, P. (2007). [Polybrominated diphenyl ethers \(PBDEs\) in harbor seals from the northwestern Atlantic. Are seals debrominating DecaBDE?](#) *Organohalogen Compounds*69:829-832.