Are the Levels of Toxic Chemicals in Casco Bay Sediments Changing Over Time?

Answer: Generally, the levels of toxic chemicals have declined or remained unchanged over the past decade.

Why Is it Important to Measure the Levels of Toxic Chemicals in Casco Bay Sediments?

The presence of toxic chemicals in the sediments of Casco Bay serves as an indicator of overall contamination of the marine ecosystem. When toxic chemicals are introduced to the Bay via rivers, stormwater runoff, pipes and the atmosphere, many do not readily dissolve or disperse. They can become attached to sediment particles and settle to the bottom where they may take a long time to break down. Even when clean sediments are deposited on top of contaminated deposits, dredging and biological activity can bring them back to the surface. Bottom-dwelling (benthic) animals that are exposed to contaminated sediments can suffer adverse effects. These benthic organisms play an important role in the food chain, recycling organic matter and serving as a food source for groundfish (*e.g.*, flounder, cod, and haddock), lobsters and crabs. By eating benthic organisms that live and feed on contaminated sediments, fish and large crustaceans may experience inhibited growth and reproduction, disease vulnerability and even death. Humans who eat seafood contaminated by toxic chemicals can also be at risk. For example, the presence of dioxins in Casco Bay, largely a byproduct of paper mills, has resulted in elevated concentrations in the liver (tomalley) of lobsters. A public health advisory against eating lobster tomalley has been in effect in Maine since 1992 (Maine DEP 2004). The Maine Department of Health and Human Services has also issued guidelines for the consumption of saltwater fish species contaminated by mercury and organic chemicals.

Key Findings

When scientists first took a close look at the sediments of Casco Bay in 1980, they were surprised to find a wide array of toxic contaminants present, including heavy metals and organic chemicals. In 1991, CBEP commissioned a baseline study to assess sediment contamination levels at 65 sites in the Bay, using state-of-the art analytical methods. Sampling sites were selected based on depth, circulation, sediment type and historical data, *i.e.*, areas where there was a known "dirty history" such as industrial facilities and point discharges. The samples were analyzed for heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and pesticides (Kennicutt *et al.* 1992). In 1994, 28 of the original sites and 5 new sites were analyzed for butyltins, dioxins/furans and coplanar PCBs (Wade *et al.* 1995). In 2000 and 2001, in partnership with EPA's National Coastal Assessment, CBEP resampled the sediments at the original locations. Scientists from Texas A & M University compared the results of the 1991/1994 sampling to the 2000/2001 studies. They concluded that most toxic chemicals have decreased or stayed the same over time, indicating that pollution control strategies are working in Casco Bay (Wade and Sweet 2005).

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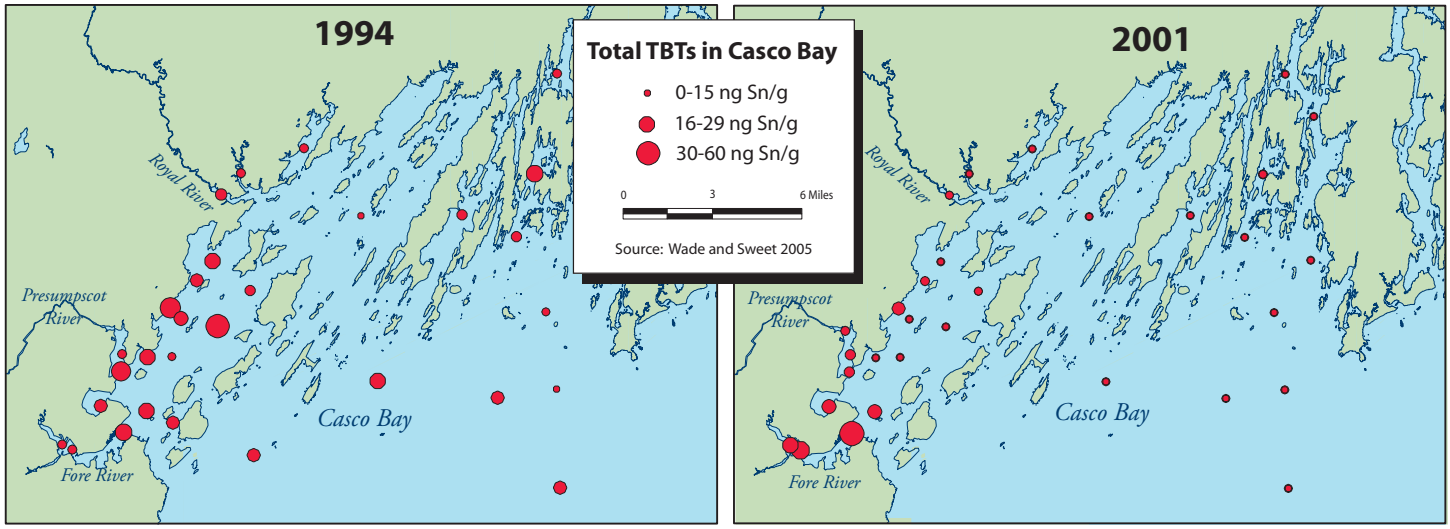
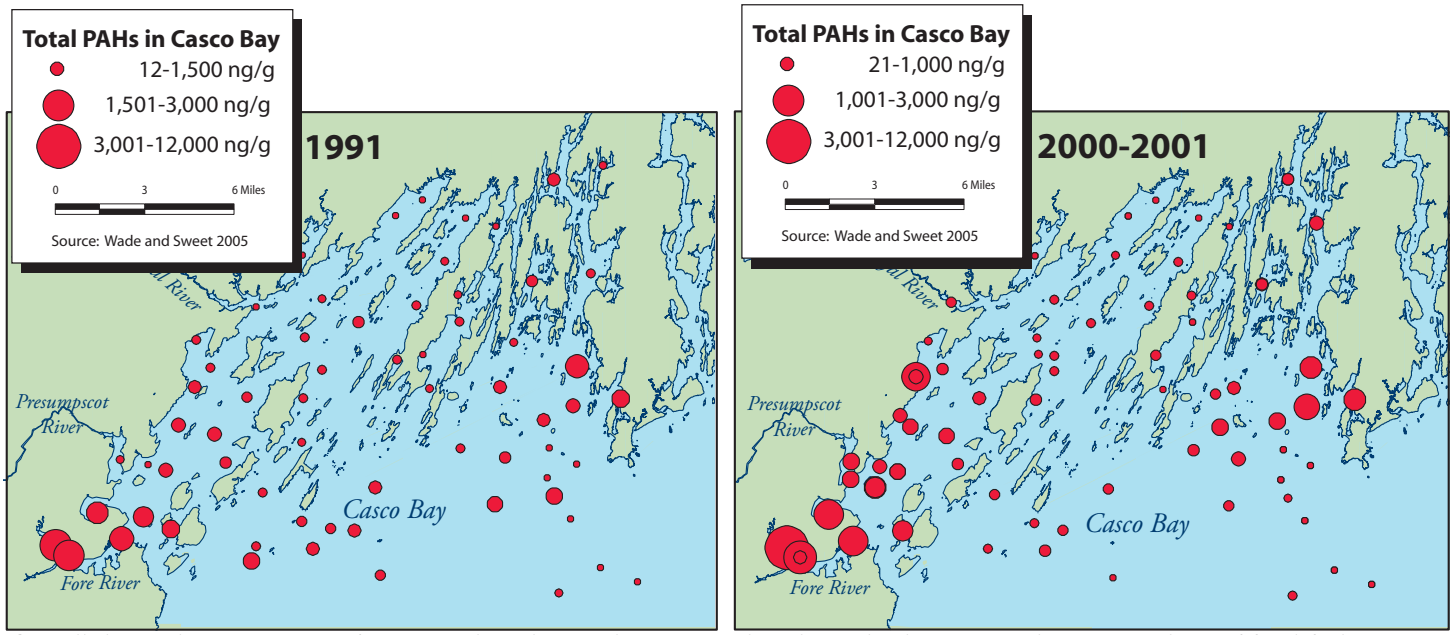
In some heavily polluted areas, such as the flats of the Fore River, mollusks, small crustaceans and other expected benthic species were absent during in a 1989 sampling. Some of the hardy worms that were found had oil on their "feet' (parapodia), probably from petroleum-related contaminants (Doggett 2005).



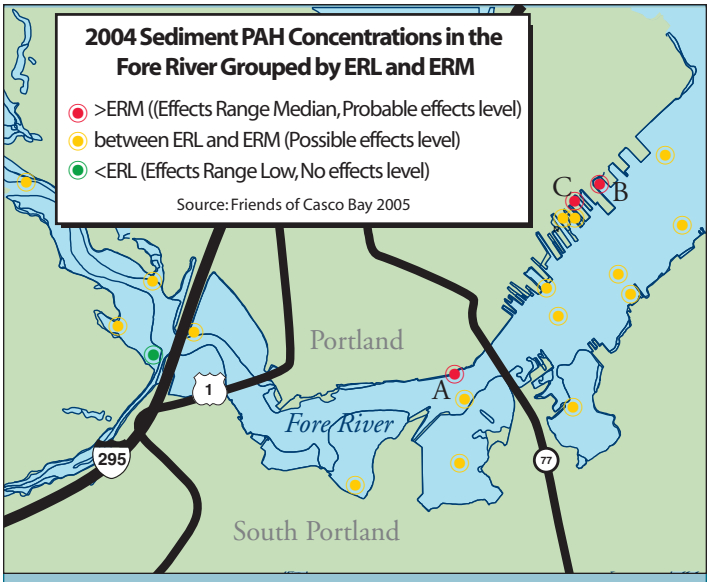
Tributyl tin (TBT) is an ingredient in marine anti-fouling paints. The overall decline of TBT concentrations in the Bay's sediments reflects the effectiveness of the federal and Maine laws which now ban the use of paints with TBT for all uses except for vessels longer than 25 meters or those having aluminum hulls (Maine DEP 1999). The continued use of TBT paints on large commercial vessels may explain the presence of elevated concentrations of TBT in the sediments of inner bay sites.



Overall the total concentration of PAHs in the sediments has remained unchanged. This suggests that increased use of fossil fuels is balanced by environmental controls that lower the PAH inputs to the Bay (Wade and Sweet, 2005).

How Toxic Are Casco Bay Sediments?

The concentrations of metals in Casco Bay are lower than levels known to cause harmful effects to organisms. Even the elevated levels of metals seen in Casco Bay are lower than the highly contaminated sediments in urban areas like Long Island Sound and Boston Harbor. While highly elevated above natural background levels, the PAH concentrations seen in the sediments of the inner part of the Bay were between the levels identified by the National Status and Trends Program as Effects Range Low (possible biological effects) and Effects Range Median (probable biological effects) (Long *et al.*1995). The majority of PAHs detected in the Bay are high molecular weight, combustion related and sequestered in fine particles, which may reduce toxicity. PCB concentrations at almost all sites were below the toxic response threshold. Concentrations of pesticides were low compared to concentrations considered toxic. Butyltins, dioxins/furans, and planar PCBs were not present at toxic concentrations. In general, the highest concentrations of toxic chemicals were found near known sources. For example, elevated butyltin concentrations (a constituent of marine anti-fouling paints) were found near boat anchorages and marinas, while dioxins and furans were found in elevated concentrations downstream of paper mills (Wade and Sweet 2005).



Fore River

In 2004, sediments at 20 sites in Portland Harbor and the Fore River were sampled for toxic chemicals, supported by a Natural Resource Damage Assessment grant and funds from the CBEP. Sites were selected based on the need for future dredging as well as past "dirty history," including the *Julie N* oil spill, industrial uses, proximity to combined sewer overflows (CSOs), and drainage from the Jetport and Maine Mall. Total PAH concentrations at all but one of the sites were elevated beyond the Effects Range Low concentration (possible biological effects), while the Gas Works/China Clay Docks (A) and two sites near large CSOs, the Maine State Pier (B) and the Casco Bay Ferry Terminal (C), exceeded the Effects Range Median concentration (probable biological effects) established by the NOAA Status and Trends program (Long *et al.* 1995). The ratio of low molecular weight PAHs to high molecular weight PAHs can be used as a way to "fingerprint" the likely source of pollution. Low molecular weight PAHs are generally from pre-combustion sources such as oil spills, while high molecular weight PAHs are associated with post-combustion products, entering the marine environment via stormwater runoff and atmospheric deposition. The Casco Bay Ferry Terminal site, for example, had a "fingerprint" suggesting primarily post-combustion sources, likely from the CSO at the site. This sampling study provides valuable baseline data on the current status of the Harbor and Fore River sediments and identifies hot spots which merit further attention (FOCB 2005).

Change in Concentration of Toxic Chemicals From 1991/1994 to 2000/2001 in Casco Bay Sediments

Decreased	Increased	No Overall Change
Cadmium	Silver	Arsenic
Chromium		Copper
Mercury		Lead
Nickel		Zinc
Selenium		
Total pesticides, 4,4-DDE, 4-4-DDD and total DDTs		
Tributyl Tin and Total Butyl Tin		
Total PCBs		
Planar PCB 126		Planar PCB 77
		Dioxins/Furans
Low Molecular Weight PAHs	High Molecular Weight PAHs	Total PAHs

Source: Wade and Sweet 2005

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