



Long-term monitoring using resident and caged mussels in Boston Harbor yield similar spatial and temporal trends in chemical contamination

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ABSTRACT

Measurements of chemical contaminants in caged (transplanted) and resident mussel populations have become a routine tool for monitoring and assessing the status and trends of coastal water quality. However, few long-term data sets are available to assess the comparability and efficacy of these two monitoring approaches. Three long-term independent data sets exist for Boston Harbor: the National Mussel Watch program has analyzed resident blue mussels (*Mytilus edulis*) from the Boston Harbor/Massachusetts Bay region for over twenty years, the Massachusetts Water Resources Authority has annually deployed caged (transplanted) mussels (*M. edulis*) to assess bioaccumulation potential of sewage effluent discharged under its NPDES permit for over fourteen years, and the GulfWatch program has analyzed resident blue mussel populations for over twelve years. Together, these data provide consistent and comparable information on temporal and spatial changes in chemical contamination in Boston Harbor as steps were taken to reduce contaminant loading. The data also demonstrate the complementary nature of resident and caged (transplanted) mussels for assessing contaminant trends even when the basic approaches and sampling frequency differ. These fifteen-year data sets demonstrate contaminant concentrations in mussels from Boston Harbor are similar and with few exceptions have significantly decreased since the early 1990s. The observed trends also demonstrate broad scale improvements to the quality of Boston Harbor and expand understanding of the response of coastal systems to interventions that reduce the load of chemicals to the ocean.

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1. Introduction

O'Connor and Lauenstein (2006) report that data from annual collections and chemical analyses of bivalves collected from Untied States waters between 1986 and 2003 show the national median concentrations of synthetic organic chemicals, cadmium and high molecular weight polynuclear aromatic hydrocarbon (PAH) have generally decreased. The long-term data from the Mussel Watch program from 1986 through 2005 also reveal national, regional and local trends (Kimbrough et al., 2008). One of the local areas that received significant national attention in the late 1980s is Boston Harbor. Since then the Massachusetts Water Resources Authority (MWRA), the agency responsible for water supply and treatment of sewage for metropolitan Boston has completed several facility upgrades that improve the quality of sewage discharged to this system. These include termination of sewage sludge discharge in

1991, construction and operation of advanced primary treatment facilities since 1995, completing of advanced secondary treatment facilities in 2002, and relocation of the sewage effluent discharge 9.5 miles offshore in Massachusetts Bay (Werme and Hunt, 2006; Rex et al., 2002). Over 95% of the sewage discharged from this outfall receives secondary treatment.

The MWRA has also monitored the waters and sediments of Boston Harbor and Massachusetts Bay for trends in anthropogenic and other chemicals since the early 1990s (Tucker et al., 2006; Maciolek et al., 2006; Taylor, 2005). Several studies have documented major improvements to the water and sediment quality (Hunt et al., 2006, 2005; Bothner and Butman, 2007; Zago et al., 2001; Bothner et al., 1998). One element of this long-term monitoring program is annual measurement of contaminants in the blue mussel *Mytilus edulis*, the same species sampled by the Mussel Watch program in the area. This paper compares nearly 20 years of transplanted and resident Boston Harbor mussels chemical monitoring in those two programs, each with their own sampling sites and protocols. Despite these program differences, downward trends in chemical concentrations of PAH, PCB, DDT, Chlordane, and lead

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attributable to changes in wastewater treatment and other contaminant loading over this period are observed.

2. Background

MWRA deploys the mussels in cages in the water column at strategic locations in Boston Harbor as well as Massachusetts and Cape Cod Bays (Fig. 1). Some of the MWRA stations are in relatively

close proximity (3–4 km separation) to the Mussel Watch stations (Fig. 1) whose sample shoreline locations bay wide; however, some of the Mussel Watch and MWRA stations are separated by geographic features such as land masses or longer distances (>5 km). The MWRA program also has data for mussels collected from several shoreline locations including the southwest portion of Cape Cod Bay near Sandwich, MA, Cape Ann in northern Massachusetts Bay, and recently from Stover's Point in Maine (Fig. 1).

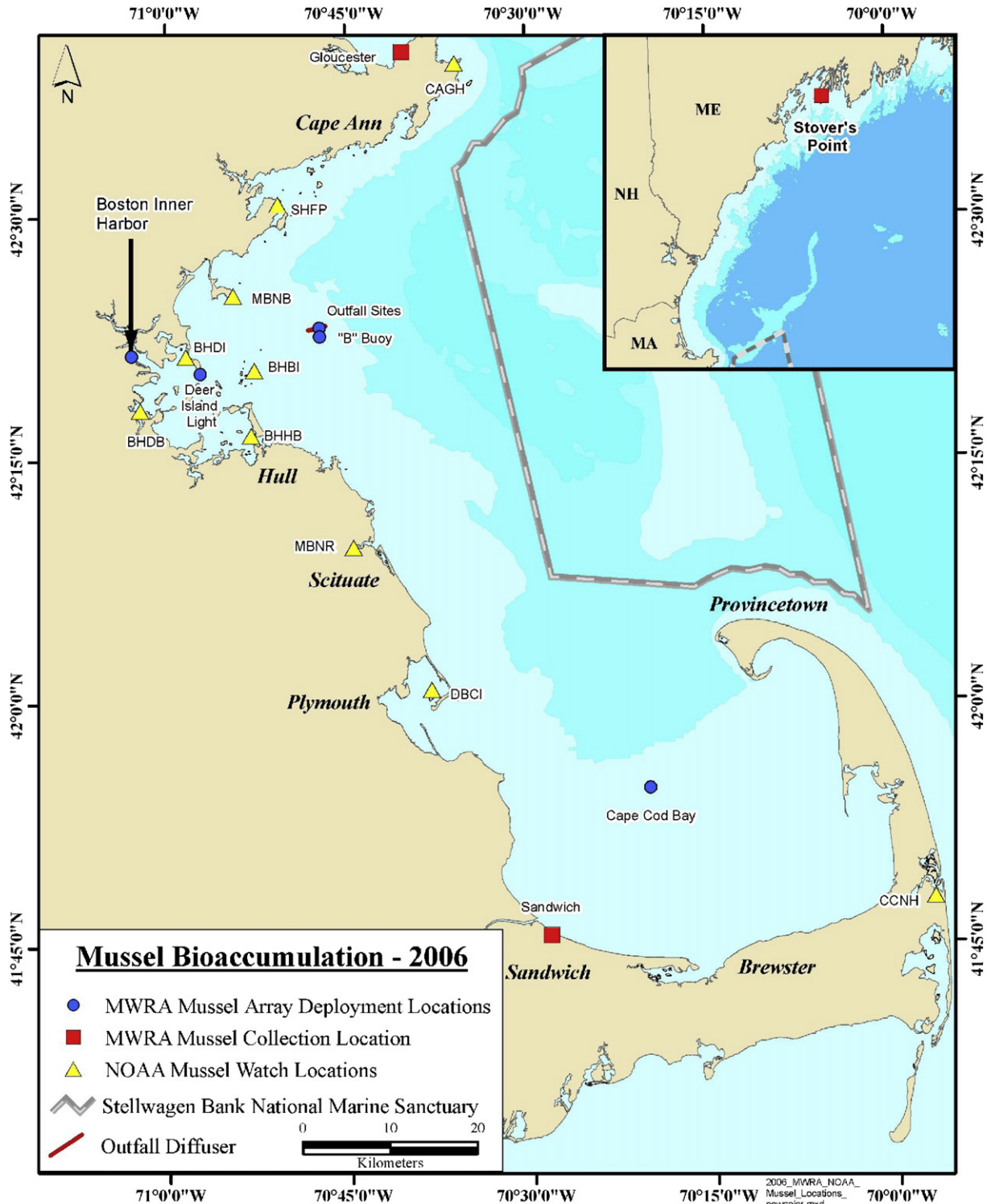


Fig. 1. NOAA Mussel Watch stations and Massachusetts Water Resources Authority caged mussel deployment sites in the Massachusetts Bay and Boston Harbor.

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