

## Indicator: Toxic Contaminants in the Great Bay and Hampton-Seabrook Estuaries

### Question

How much toxic contamination is in shellfish tissue and how has it changed over time?

### Short Answer

Most concentrations of measured metals and organic chemicals in blue mussel tissue from 1991-2014 are declining or not changing. Mercury and PCB levels remain high enough to merit continued concern. Many new contaminants have been introduced to the estuary, such as pharmaceuticals, perfluorinated compounds and brominated flame retardants, and they are not being consistently monitored.

### PREP Goal

Zero percent of sampling stations in the two estuaries have shellfish tissue concentrations that exceed levels of concern and no increasing trends for any contaminants (from the PREP Comprehensive Conservation and Management Plan, PREP 2010).

### Why This Matters

Toxic and persistent contaminants such as PCBs (polychlorinated biphenyls), mercury, and DDT (dichloro-diphenyltrichloroethane) can accumulate in the tissue of filter-feeding mussels, clams, oysters and other marine biota and seafood. Tracking contamination in mussel tissue offers insight into changes in contaminant levels in our estuarine and coastal ecosystems.

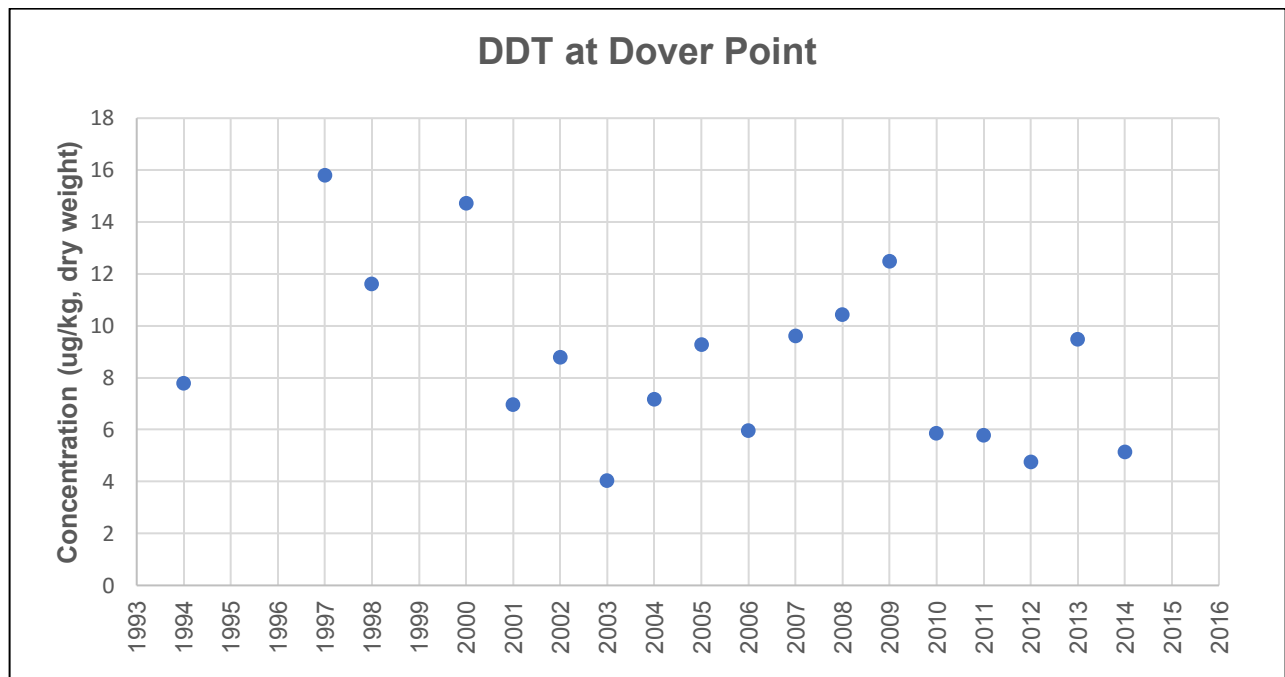


Figure TC-1. Concentrations of DDT in mussel tissue at Dover Point. The most recent national median for the Mussel Watch program was 30ug/kg. The 85th percentile was 130ug/kg. Data Source: Gulfwatch Program (LeBlanc et al. 2009).

### Explanation (from 2018 State of Our Estuaries Report)

The Gulfwatch Program uses blue mussels (*Mytilus edulis*) to better understand trends in the accumulation of toxic and persistent contaminants, including metals, pesticides, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). The use of many of these contaminants has been banned or is limited, so

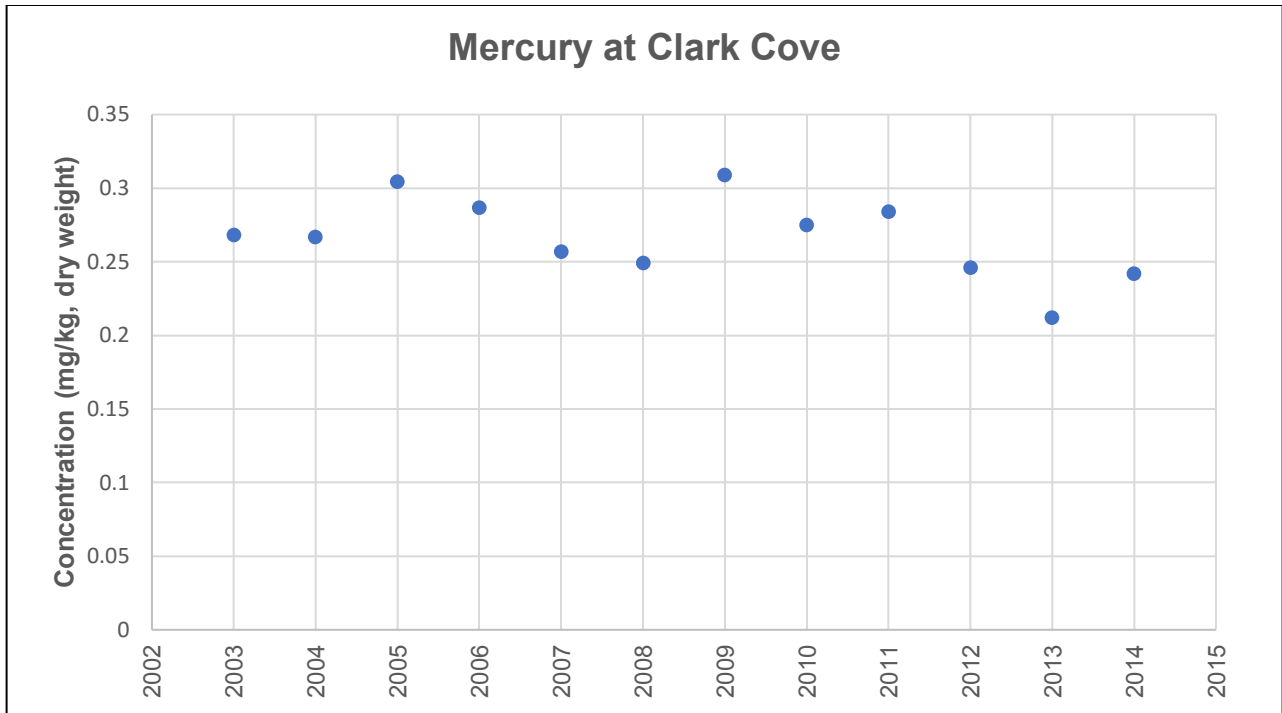


Figure TC-2. Concentrations of Mercury in mussel tissue at Clark Cove, Portsmouth Harbor. The most recent national median for the Mussel Watch program was 0.7mg/kg. The 85th percentile was 0.13mg/kg. Data Source: Gulfwatch Program (LeBlanc et al. 2009).

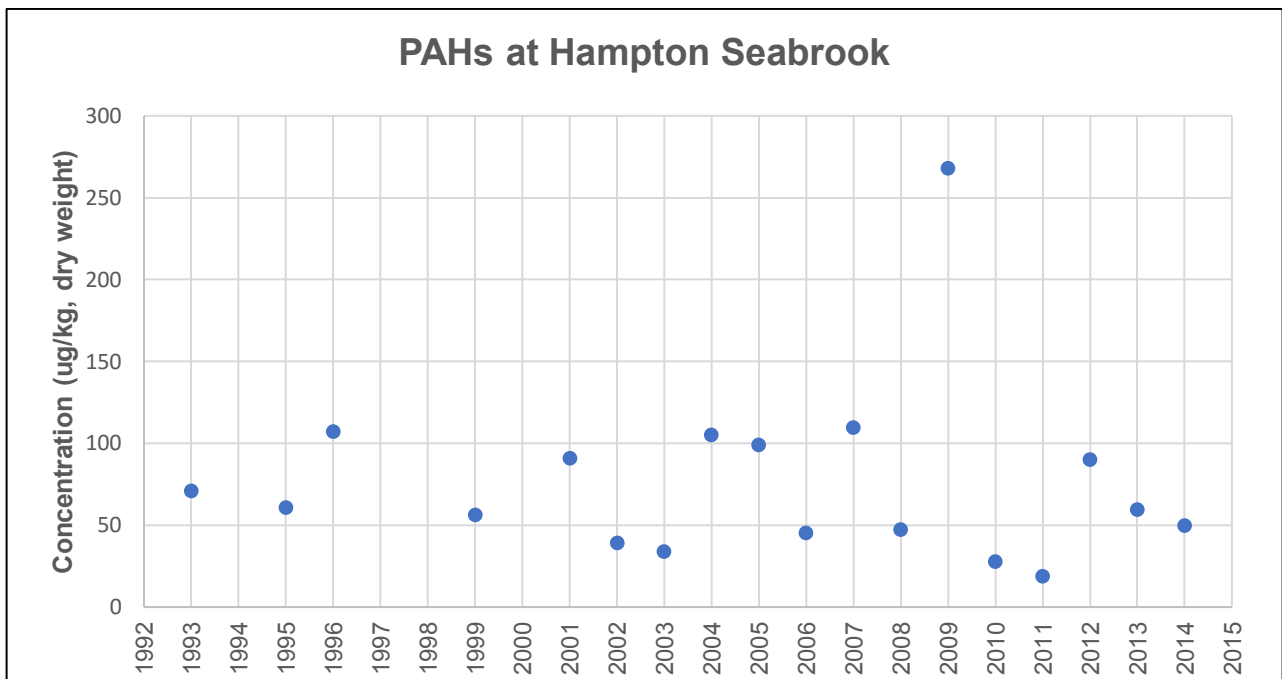


Figure TC-3. Concentration of PAHs at Hampton-Seabrook Harbor. In 2008, the national median for the Mussel Watch program was 250 ug/kg. The 85th percentile was 1250 ug/kg. Data Source: Gulfwatch Program (LeBlanc et al. 2009).

trends are expected to be stable or decreasing. At Dover Point, concentrations of DDT, an insecticide banned in the U.S. in 1972, are relatively low and gradually decreasing (Figure TC-1). Inputs of mercury, a heavy metal, have been reduced since the 1990s due to regulatory action taken on coal-fired power plants, medical waste and municipal incinerators, but mercury continues to be deposited through wet and dry atmospheric deposition (NEIWPCC 2007). At most sites, including Clark Cove in Portsmouth Harbor, mercury levels in shellfish have been fairly stable since 2003 (Figure TC-2), these levels are similar to those seen in other estuaries located close to urban centers (Sunderland et al. 2012). PAHs, which mostly come from oils spills, the burning of fossil fuels and some driveway sealants, have been stable across all stations, including Hampton-Seabrook. Only one value was above the national median level of 250 ug/kg (Figure TC-3). Other data collected at that time indicate a possible fuel spill (PREP 2009). Trend lines are not shown as there were no statistically significant results.

PAHs, DDT and mercury at these three stations—Dover Point, Clark Cove and Hampton-Seabrook— are generally representative of the trends in the more comprehensive dataset, which includes over 120 different specific contaminants. Even measuring these 120 contaminants, however, does not provide a comprehensive picture of the level of toxic contamination in our estuaries. Many new contaminants have been introduced to the estuary, such as pharmaceuticals, perfluorinated compounds and brominated flame retardants, and they are not being consistently monitored.

#### Methods and Data Sources

Each blue mussel tissue sample consisted of either four measurements from replicate subsamples and/or a composite sample from samples collected at four distinct areas at the sample site. Trends were evaluated at the three benchmark sites in the estuary: MECC (Clark Cove, Portsmouth Harbor), NHDP (Dover Point) and NHHS (Hampton-Seabrook Harbor). In 2008, the Gulfwatch program changed the sample design from collecting four replicates at each station to collecting three replicates plus one composite of the three replicates. Funding limitations in recent years only allowed for the analysis of composite samples and replicate samples at select sites. The averages from all results (replicates and composites) for each parameter were regressed against the year of collection using a linear model. Linear coefficients with a probability of <0.05 of being different from zero were considered statistically significant.

For details on data collection and lab analysis, see Wood (2015) at: <http://scholars.unh.edu/prep/357/>

#### Data Sources

Originally conducted by the Gulf of Maine Council on the Marine Environment from 1993 to 2011, the Gulfwatch Program examined trends in the water quality of the Gulf of Maine by monitoring toxic contaminant concentrations in the tissues of shellfish. In 2012, after the Gulfwatch program was discontinued, PREP and partners such as NOAA, NHDES and the UNH Jackson Estuarine Laboratory have worked to continue this program in the Piscataqua Region. For this report, data are only presented up to 2014. It is anticipated that data from 2015 and future years will be included in the 2023 State of Our Estuaries Report.

#### Additional Results (Beyond the Data Reported in the SOOE)

Table TC-1 indicates that of the 39 indicators (13 at each of three stations), 19 fell in the “no significant trend” category, 19 were in the “decreasing” category and only one was categorized as “increasing” (cadmium at Hampton Harbor). Compared with the last report (reporting on data through 2011, as opposed to 2014), 9 indicators were added to the “decreasing” category, changed from “no significant trend,” and one indicator (iron at Hampton Harbor) went from “increasing” to “no significant trend”. At Clark Cove, PCBs went from “decreasing” to “no significant trend” due to three years of elevated results. No indicators were added to the “increasing” category.

Figures TC-4 through TC-42 show individual plots of all 39 indicators.

### References Cited

LeBlanc LA, Krahforst C, Aube J, Roach S, Brun G, Harding G, Hennigar P, Page D, Jones SH, Shaw S, Stahlnecker J, Schwartz J, Taylor D, Thorpe B, Wells P. 2009. Eighteenth Year of the Gulf of Maine Environmental Monitoring Program. *PREP Publications*. 385. <http://scholars.unh.edu/prep/385>

NEIWPC. 2007. Northeast regional mercury TMDL. [https://www.des.nh.gov/organization/divisions/water/wmb/tmdl/documents/mercury\\_final.pdf](https://www.des.nh.gov/organization/divisions/water/wmb/tmdl/documents/mercury_final.pdf)

PREP. 2009. State of Our Estuaries 2009. *PREP Publications*. 260. <http://scholars.unh.edu/prep/260>

PREP 2010. Piscataqua Region Comprehensive Conservation and Management Plan, Piscataqua Region Estuaries Partnership: D.B.Truslow Associates, Mettee Planning Consultants, 2010, Durham, NH. <http://scholars.unh.edu/prep/22/>. Accessed 14 September 2017.

Sunderland EM, Amirbahman A, Burgess NM, Dalziel J, Harding G, Jones SH, Kamai EH, Karagas MR, Shi X, Chen CY. 2012. Mercury sources and fate in the Gulf of Maine. *Environmental Research*. 119: 27 - 41.

Wood, MA. 2015. Shellfish Tissue Monitoring in Piscataqua Region Estuaries 2014. *PREP Publications*. 357. <http://scholars.unh.edu/prep/357>

**Table TC-1: Trends in contaminant concentrations in mussel tissue in Clark Cove, Portsmouth Harbor ("MECC"), Dover Point ("NHDP") and Hampton Harbor ("NHHS"), 1993-2014.**

Station	Parameter	Period	Trend
MECC (Portsmouth Harbor)	ALUMINUM	1993 - 2014	No significant trend
	CADMIUM	1993 - 2014	No significant trend
	CHROMIUM	1993 - 2014	<b>Decreasing</b>
	COPPER	1993 - 2014	No significant trend
	IRON	1993 - 2014	No significant trend
	LEAD	1993 - 2014	<b>Decreasing</b>
	MERCURY	2003 - 2014	No significant trend
	NICKEL	1993 - 2014	<b>Decreasing</b>
	SILVER	2003 - 2014	<b>Decreasing</b>
	ZINC	1993 - 2014	No significant trend
	DDT, TOTAL	1993 - 2014	<b>Decreasing</b>
	PAH, TOTAL	1993 - 2014	No significant trend
	PCB, TOTAL	1993 - 2014	No significant trend
	NHDP Dover Point	ALUMINUM	1994 - 2014
CADMIUM		1994 - 2014	<b>Decreasing</b>
CHROMIUM		1994 - 2014	<b>Decreasing</b>
COPPER		1994 - 2014	No significant trend
IRON		1994 - 2014	<b>Decreasing</b>
LEAD		1994 - 2014	<b>Decreasing</b>
MERCURY		2003 - 2014	No significant trend
NICKEL		1994 - 2014	<b>Decreasing</b>
SILVER		2003 - 2014	<b>Decreasing</b>
ZINC		1993 - 2014	<b>Decreasing</b>
DDT, TOTAL		1993 - 2014	No significant trend
PAH, TOTAL		1993 - 2014	No significant trend
PCB, TOTAL		1993 - 2014	No significant trend
NHHS (Hampton Harbor)		ALUMINUM	1993 - 2014
	CADMIUM	1993 - 2014	<b>Increasing</b>
	CHROMIUM	1993 - 2014	<b>Decreasing</b>
	COPPER	1993 - 2014	No significant trend
	IRON	1993 - 2014	No significant trend
	LEAD	1993 - 2014	<b>Decreasing</b>
	MERCURY	2003 - 2014	No significant trend
	NICKEL	1993 - 2014	<b>Decreasing</b>
	SILVER	2003 - 2014	<b>Decreasing</b>
	ZINC	1993 - 2014	<b>Decreasing</b>
	DDT, TOTAL	1993 - 2014	<b>Decreasing</b>
	PAH, TOTAL	1993 - 2014	No significant trend
	PCB, TOTAL	1993 - 2014	<b>Decreasing</b>

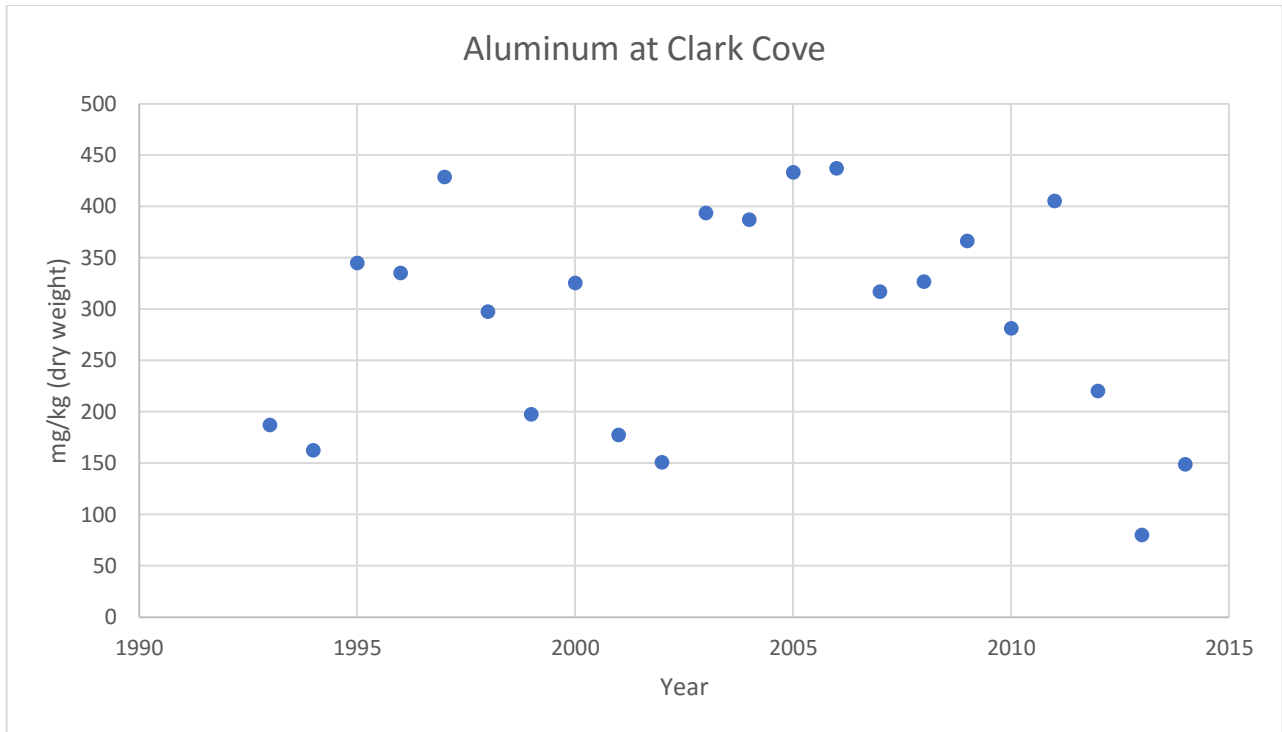


Figure TC-4: Aluminum concentrations in mussel tissue at Clark Cove, Portsmouth Harbor.

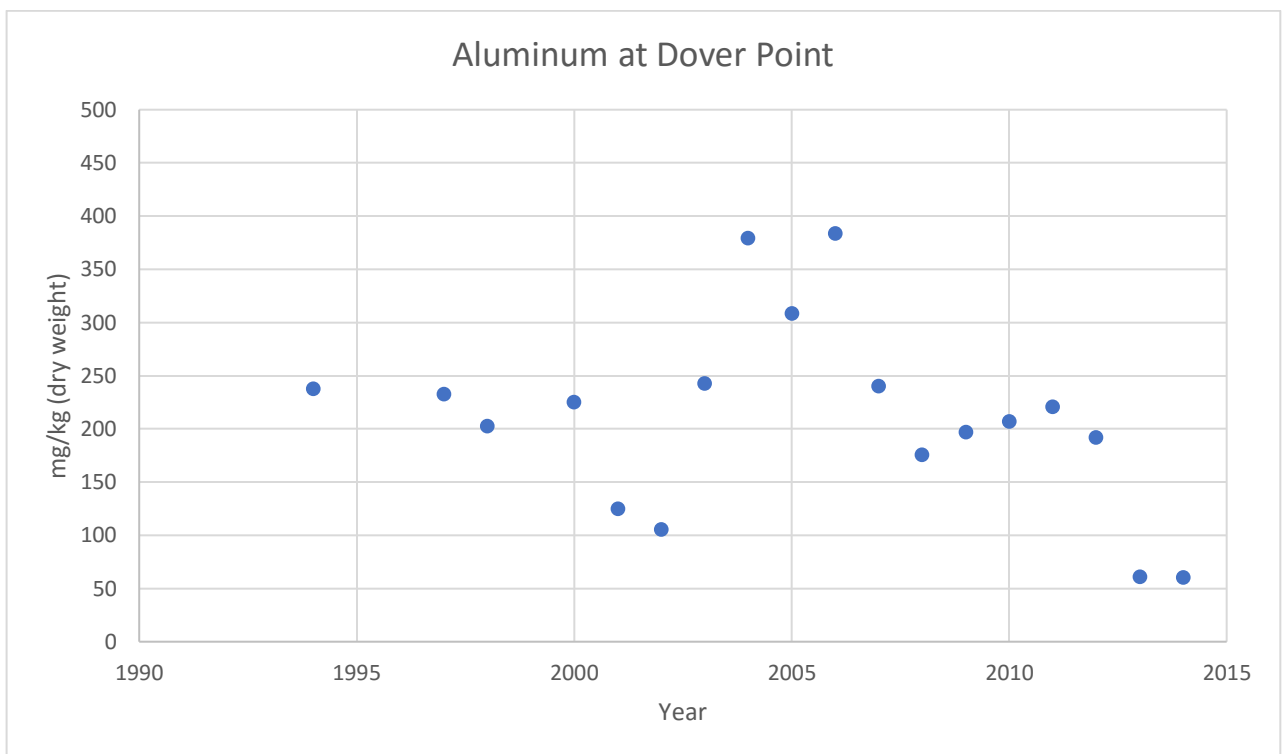


Figure TC-5: Aluminum concentrations in mussel tissue at the Dover Point station.

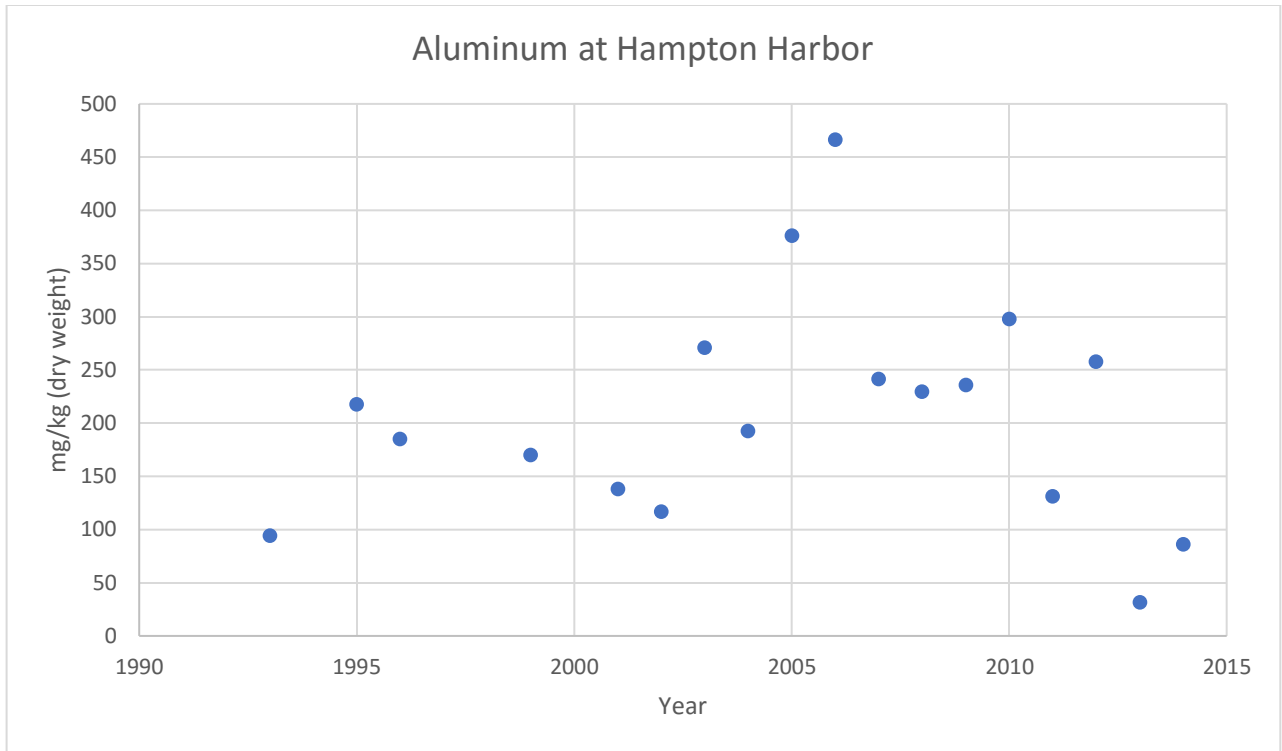


Figure TC-6: Aluminum concentrations in mussel tissue at the Hampton Harbor station.

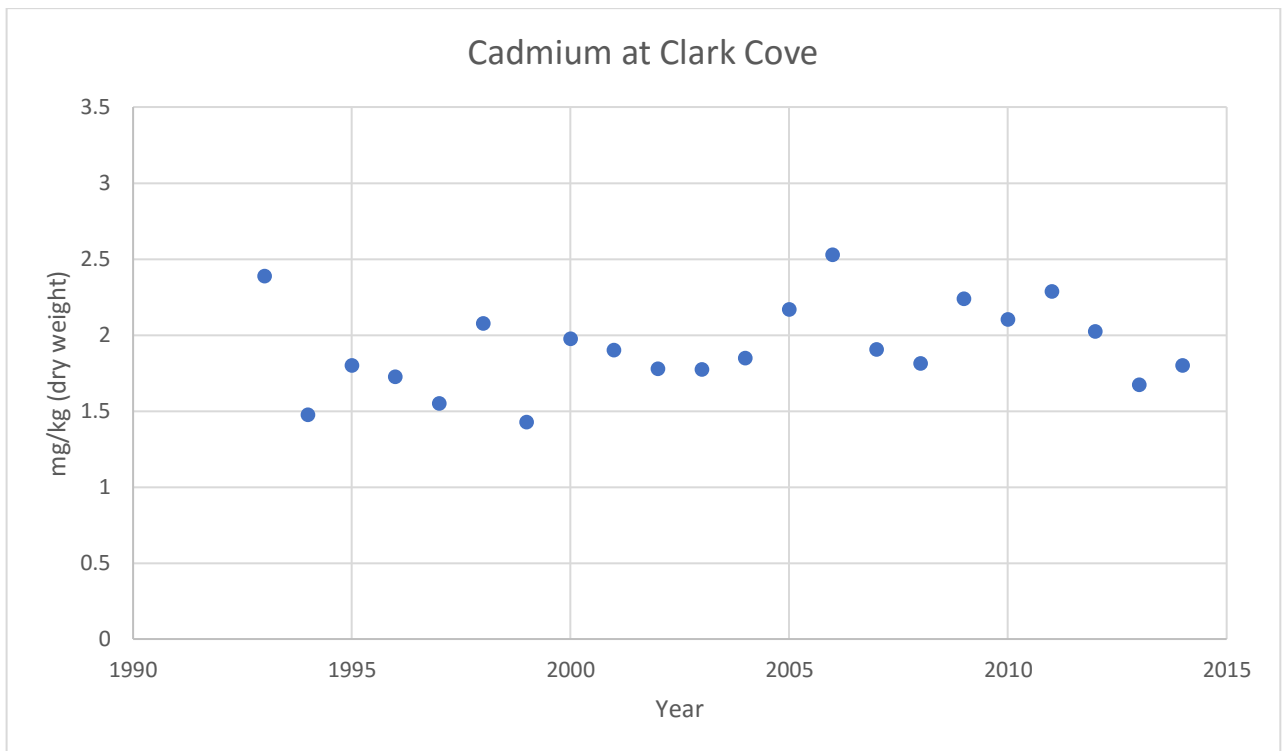
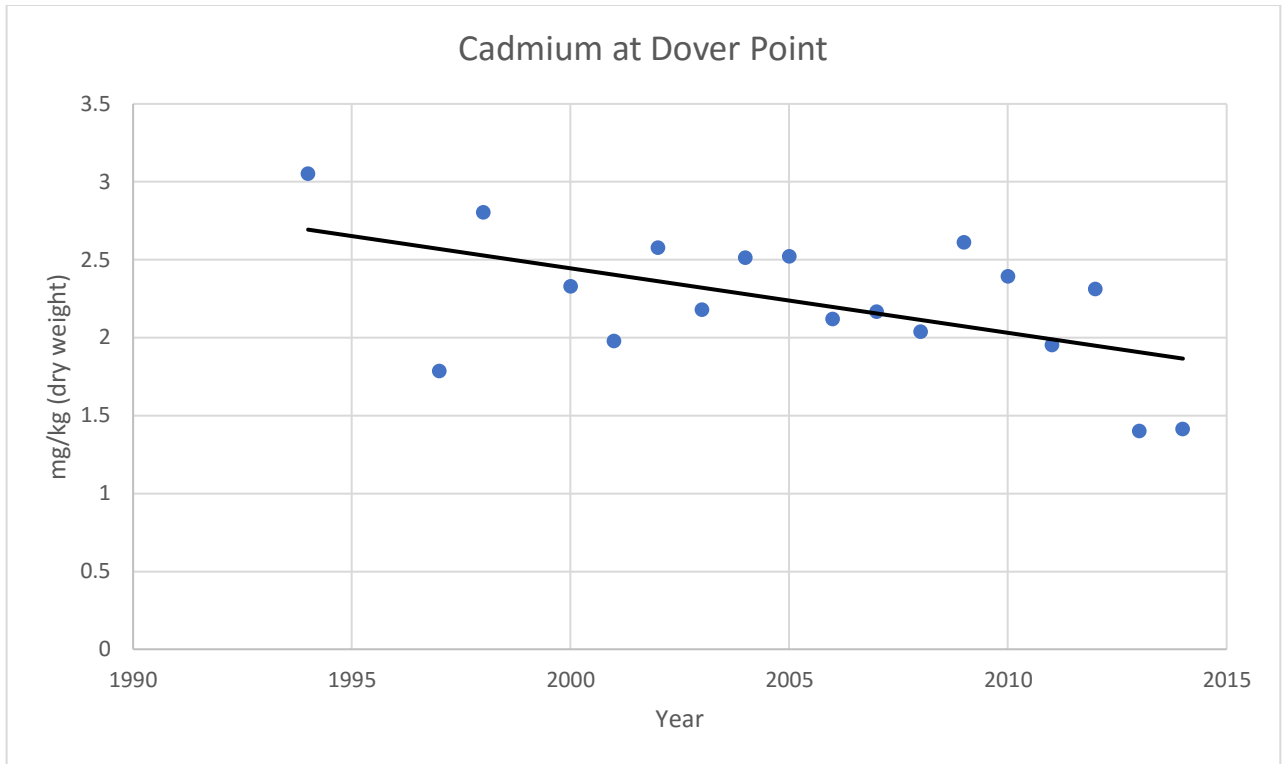
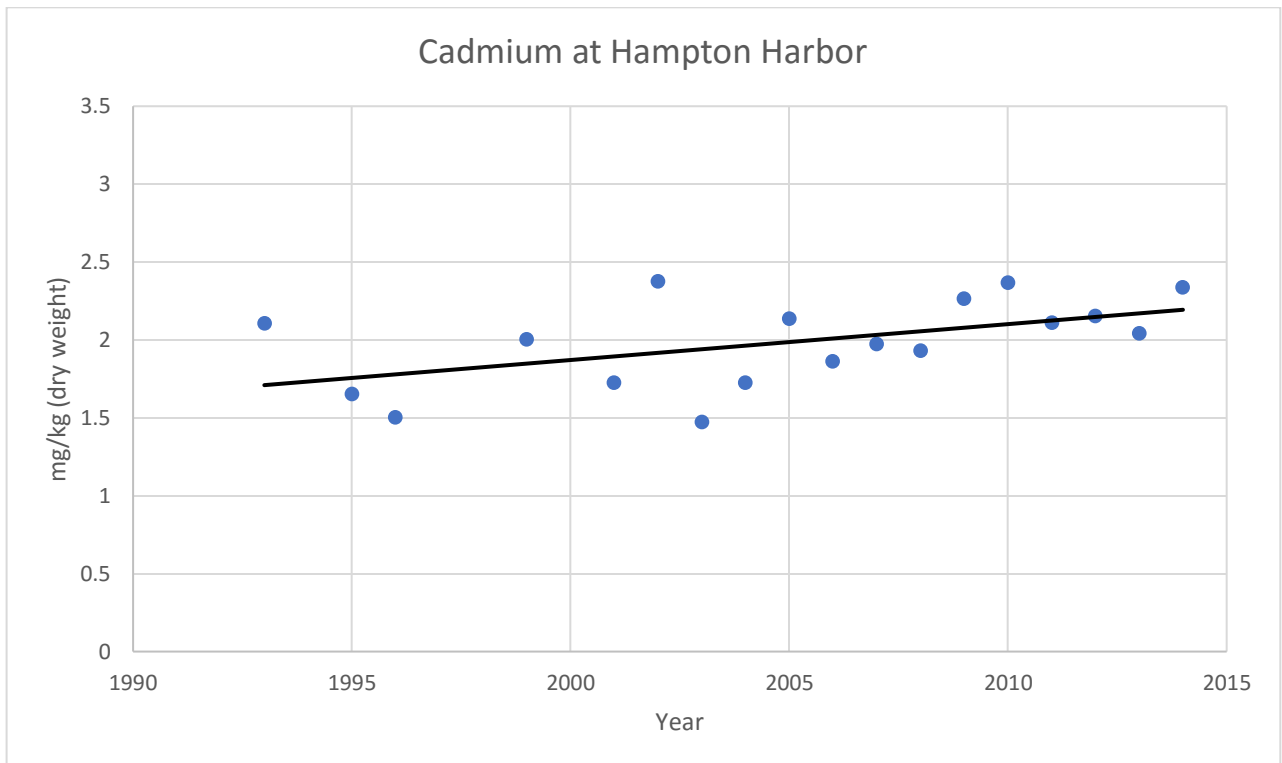


Figure TC-7: Cadmium concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor.

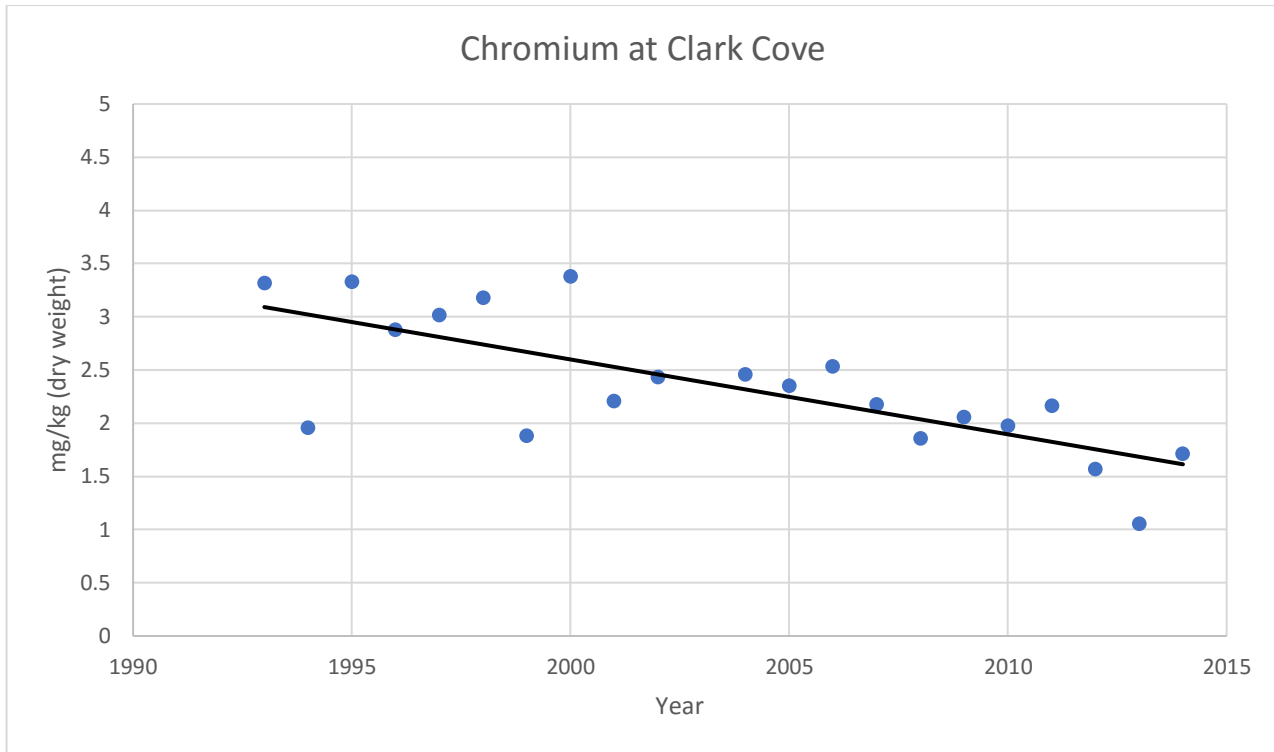


**Figure TC-8: Cadmium concentrations in mussel tissue at the Dover Point station. Trendline indicates statistically significant trend.**

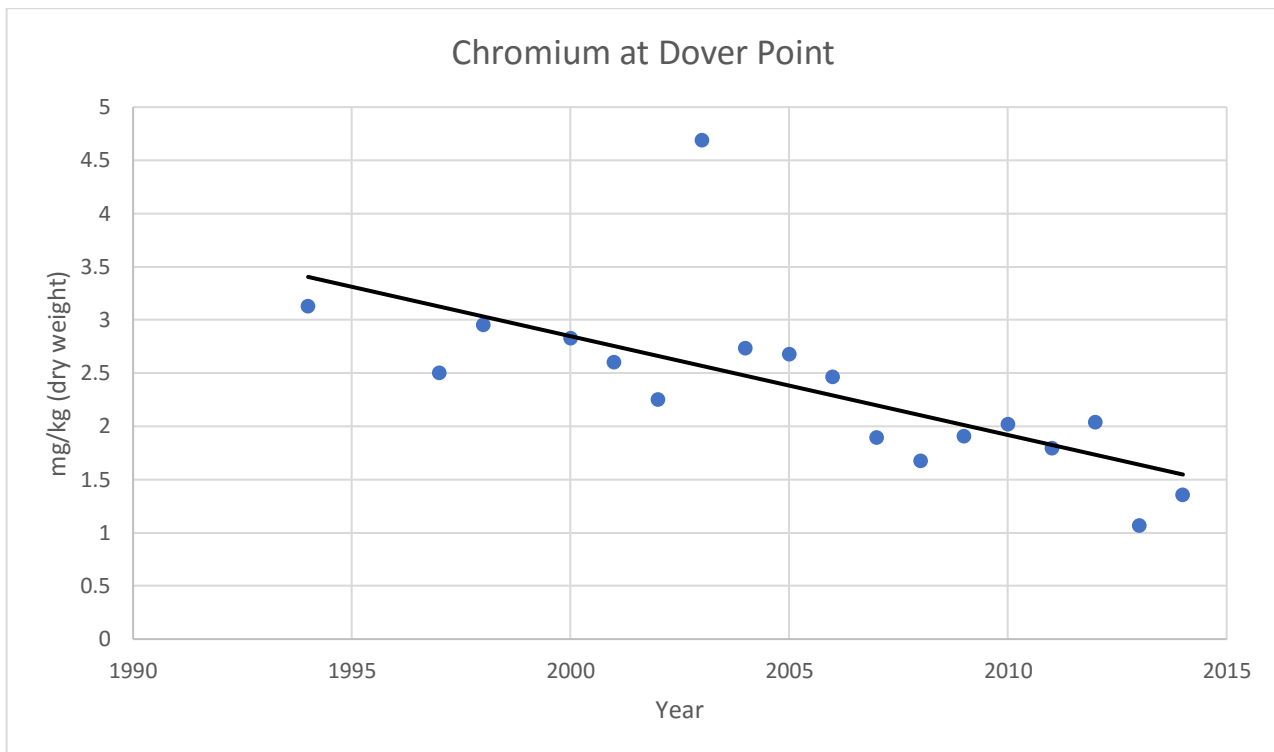


**Figure TC-9: Cadmium concentrations in mussel tissue at the Hampton Harbor station. Trendline indicates statistically significant trend.**

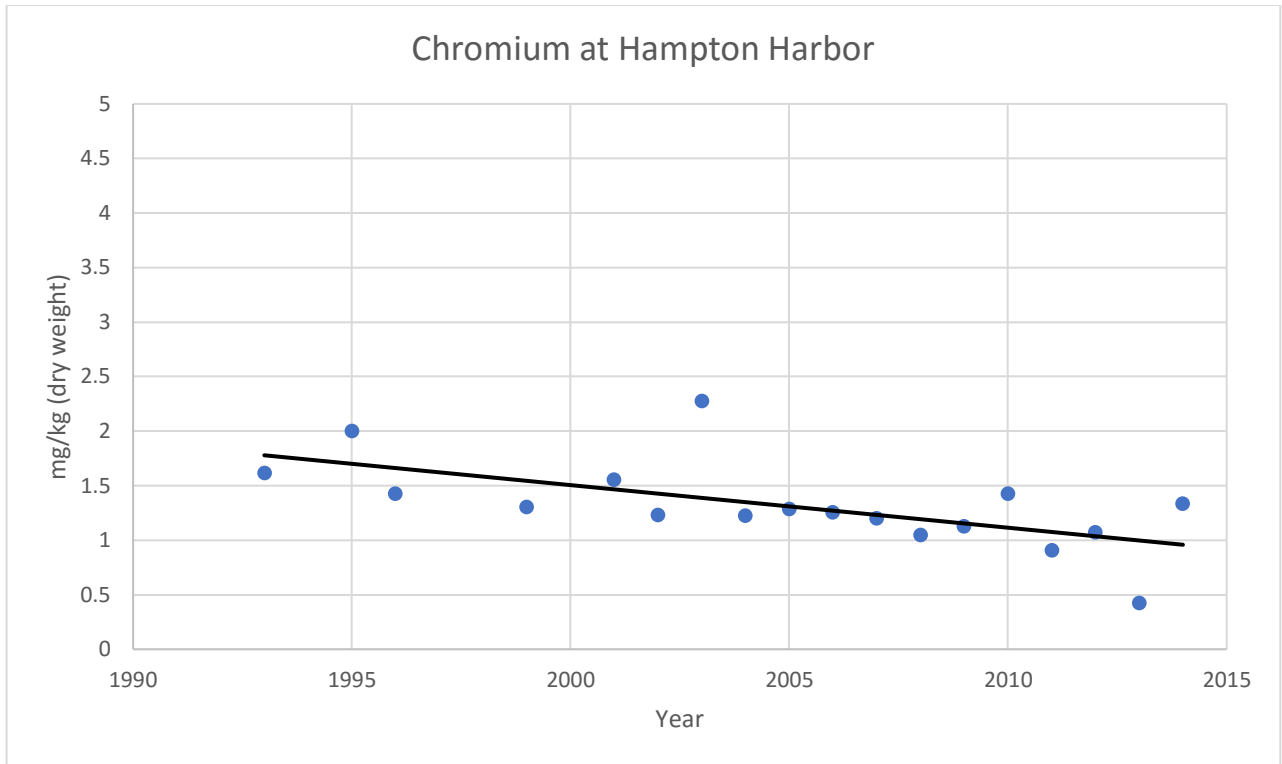




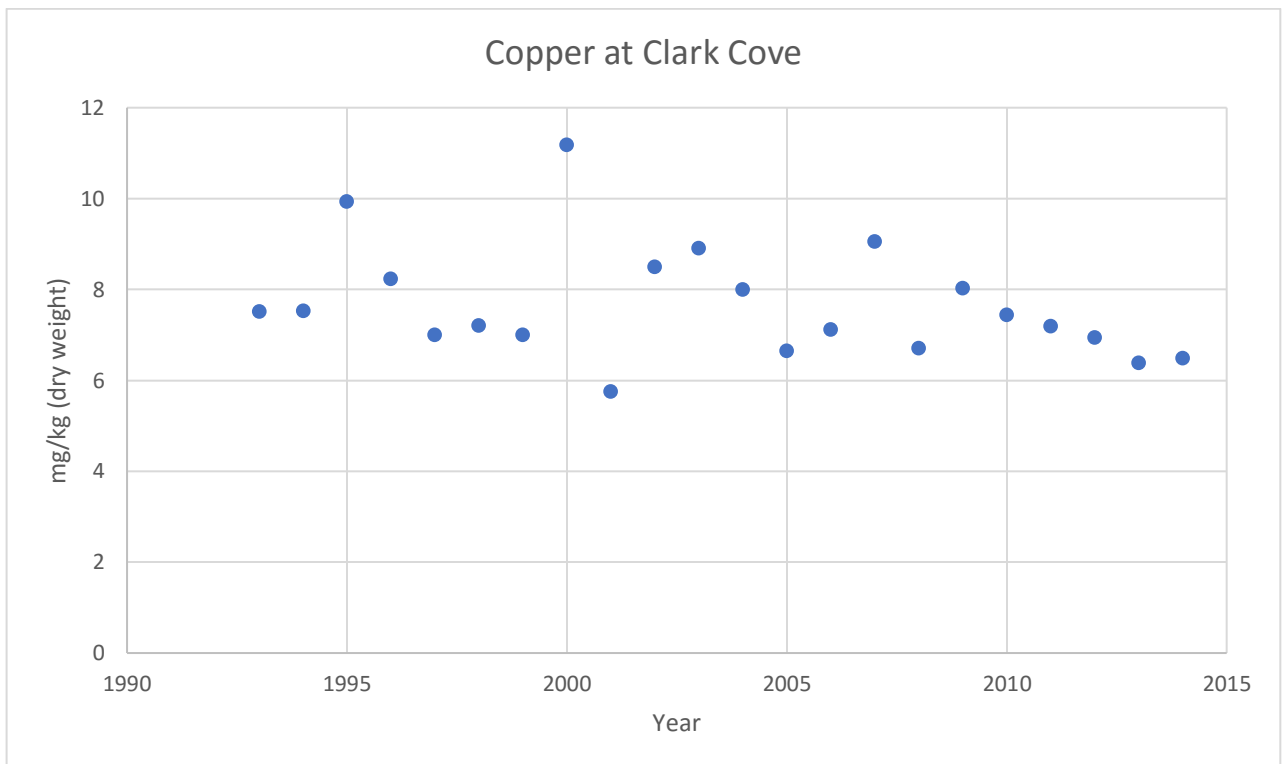
**Figure TC-10: Chromium concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor. Trendline indicates statistically significant trend.**



**Figure TC-11: Chromium concentrations in mussel tissue at the Dover Point station. Trendline indicates statistically significant trend.**



**Figure TC-12: Chromium concentrations in mussel tissue at the Hampton Harbor station. Trendline indicates statistically significant trend.**



**Figure TC-13: Copper concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor.**

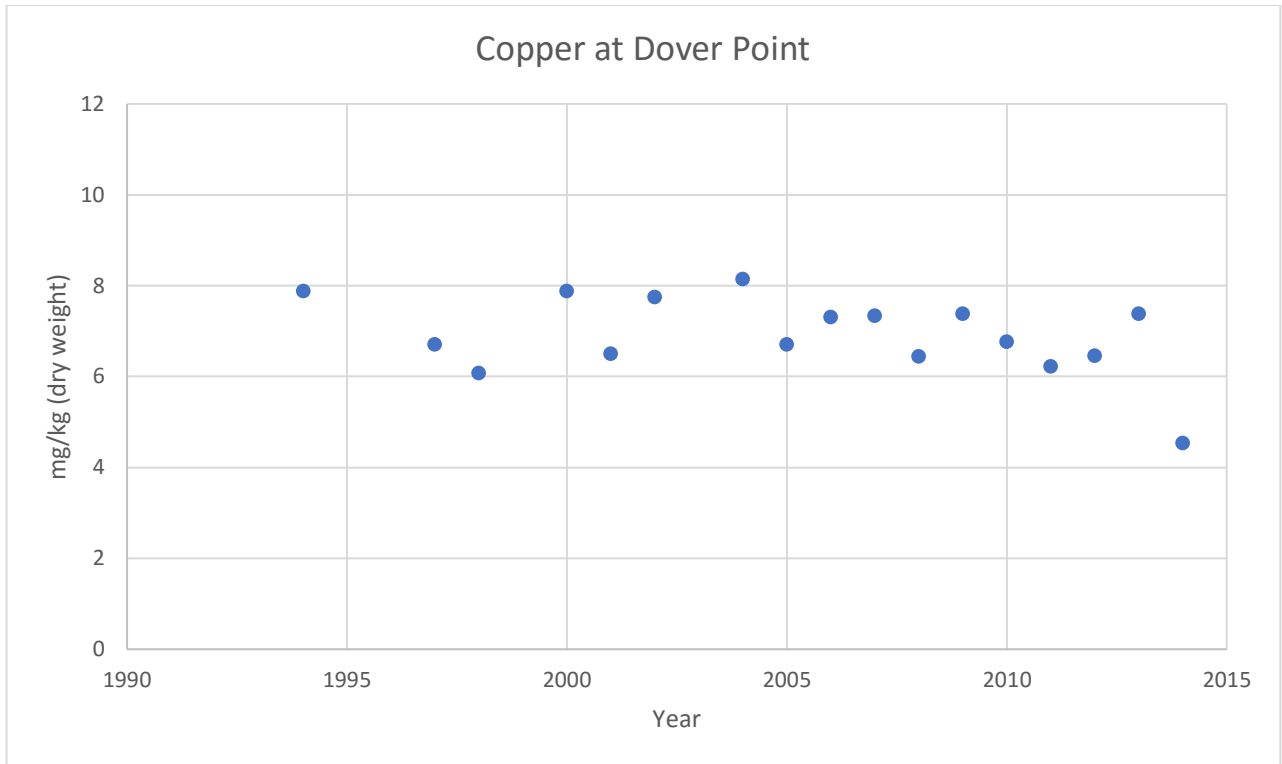


Figure TC-14: Copper concentrations in mussel tissue at the Dover Point station.

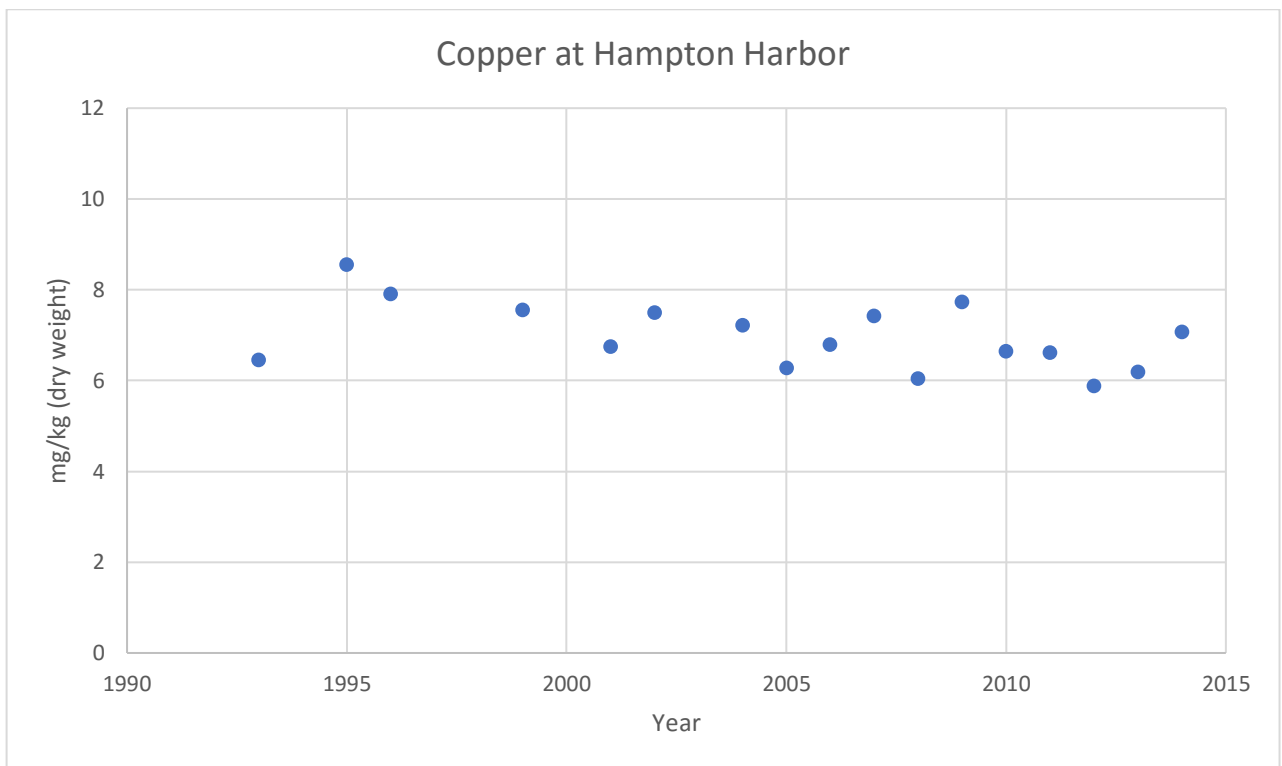


Figure TC-15: Copper concentrations in mussel tissue at the Hampton Harbor station.

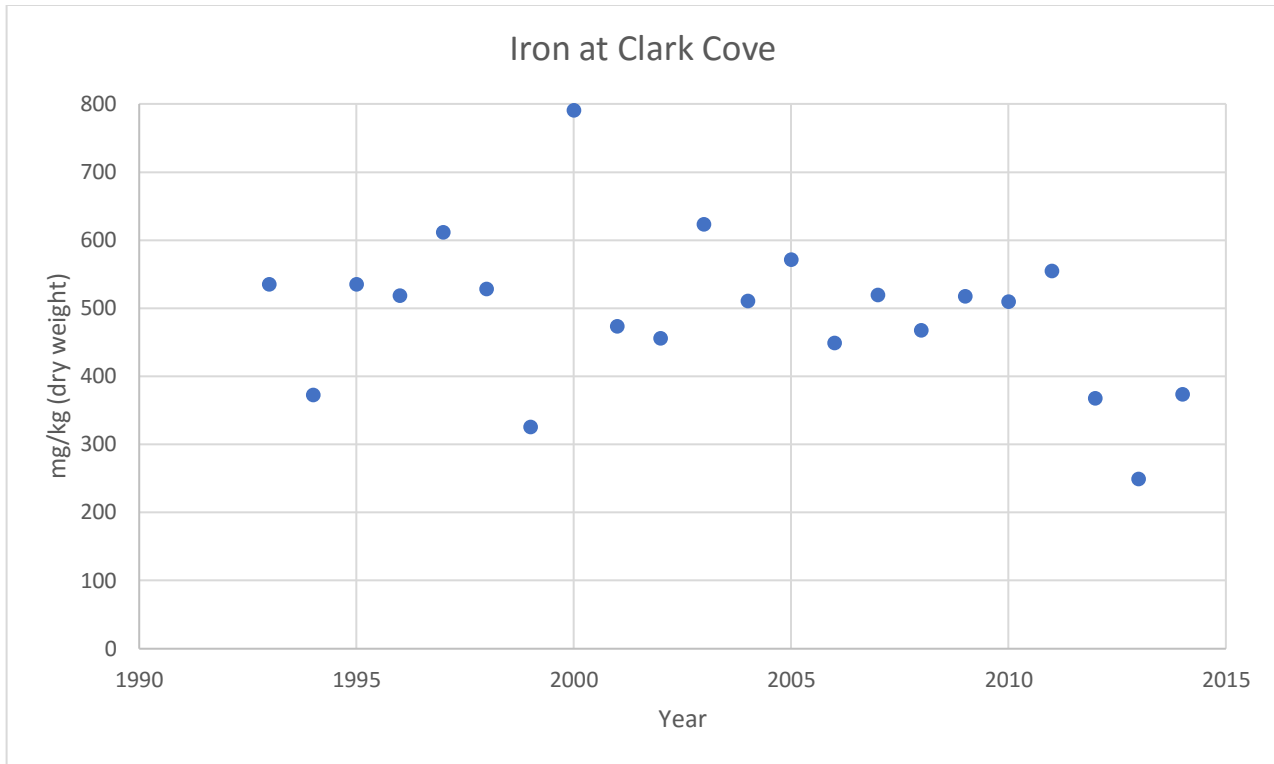


Figure TC-16: Iron concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor.

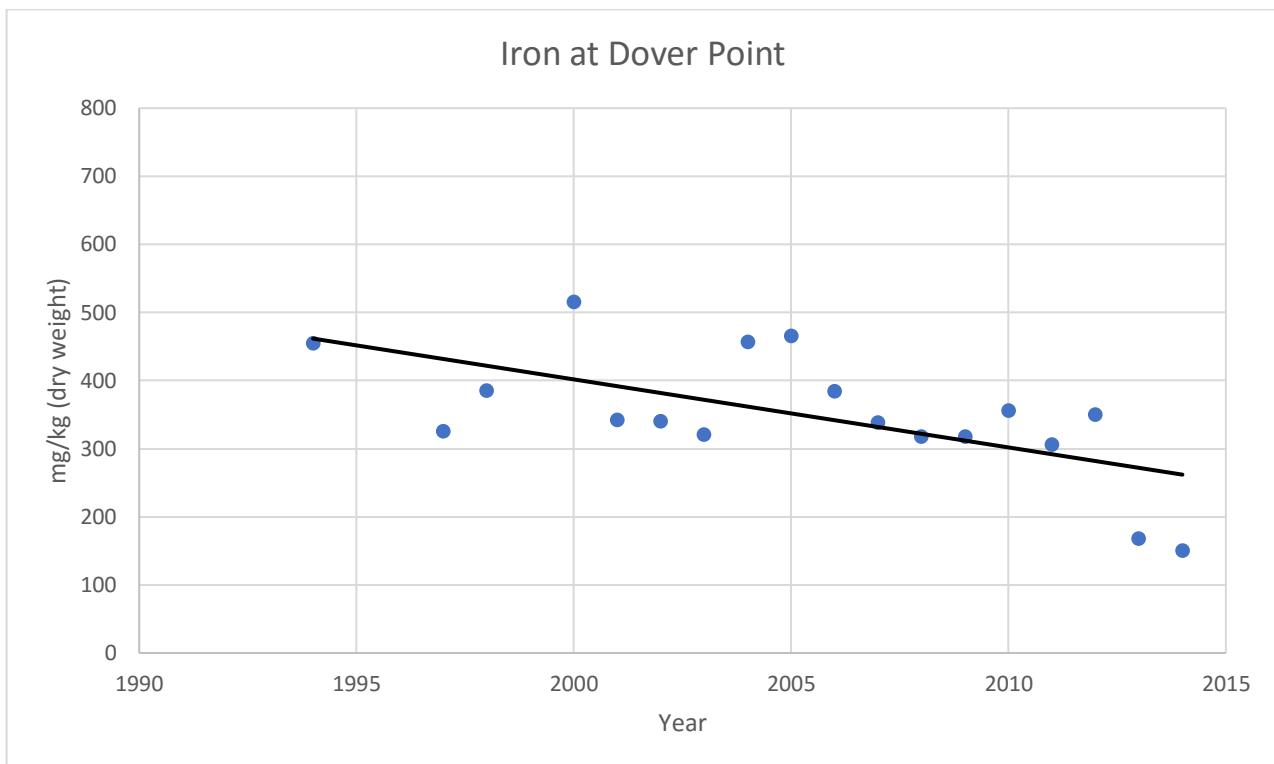


Figure TC-17: Iron concentrations in mussel tissue at the Dover Point station. Trendline indicates statistically significant trend.

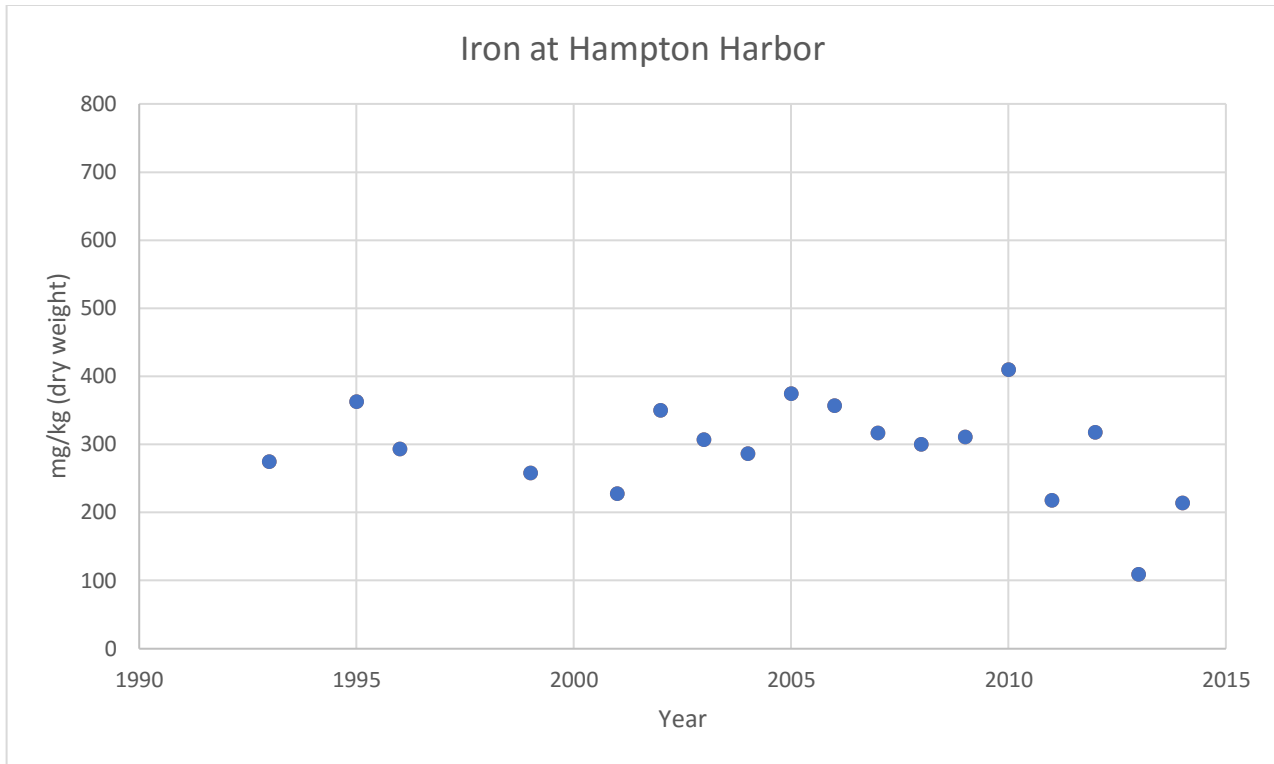


Figure TC-18: Iron concentrations in mussel tissue at the Hampton Harbor station.

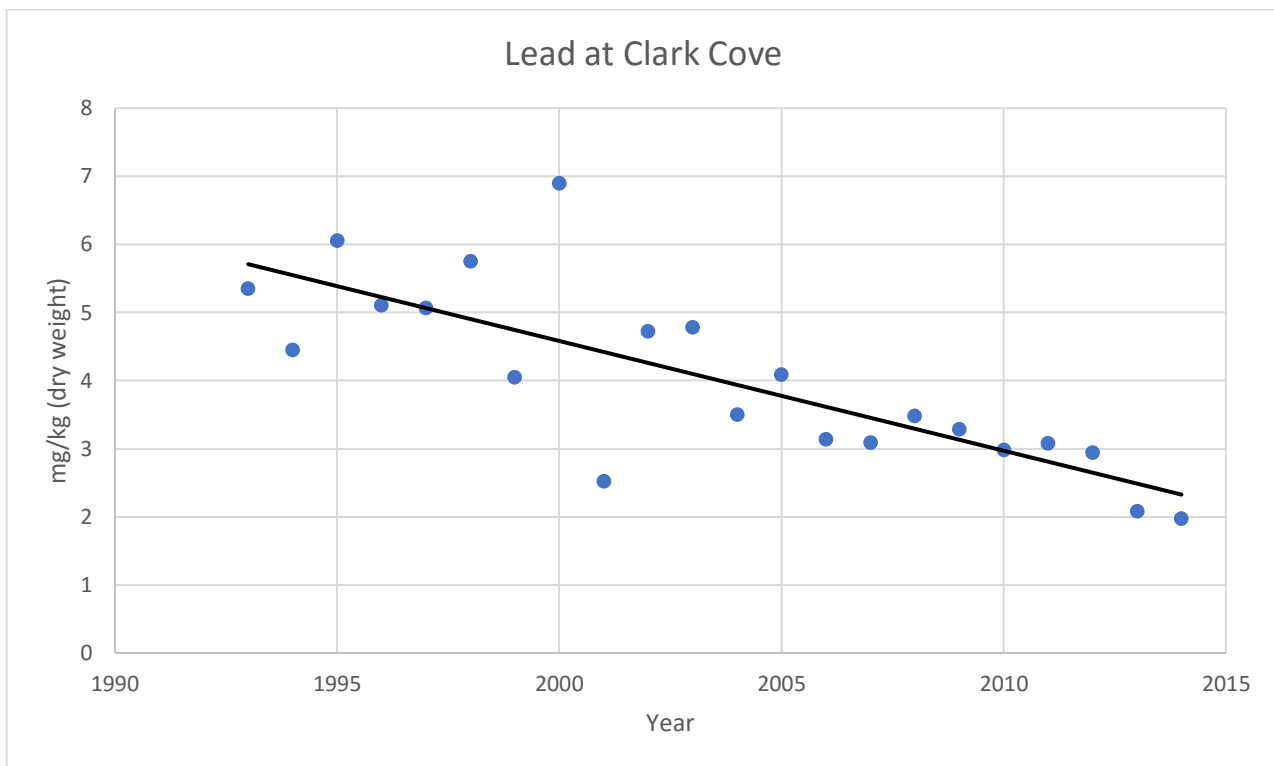


Figure TC-19: Lead concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor. Trendline indicates statistically significant trend.

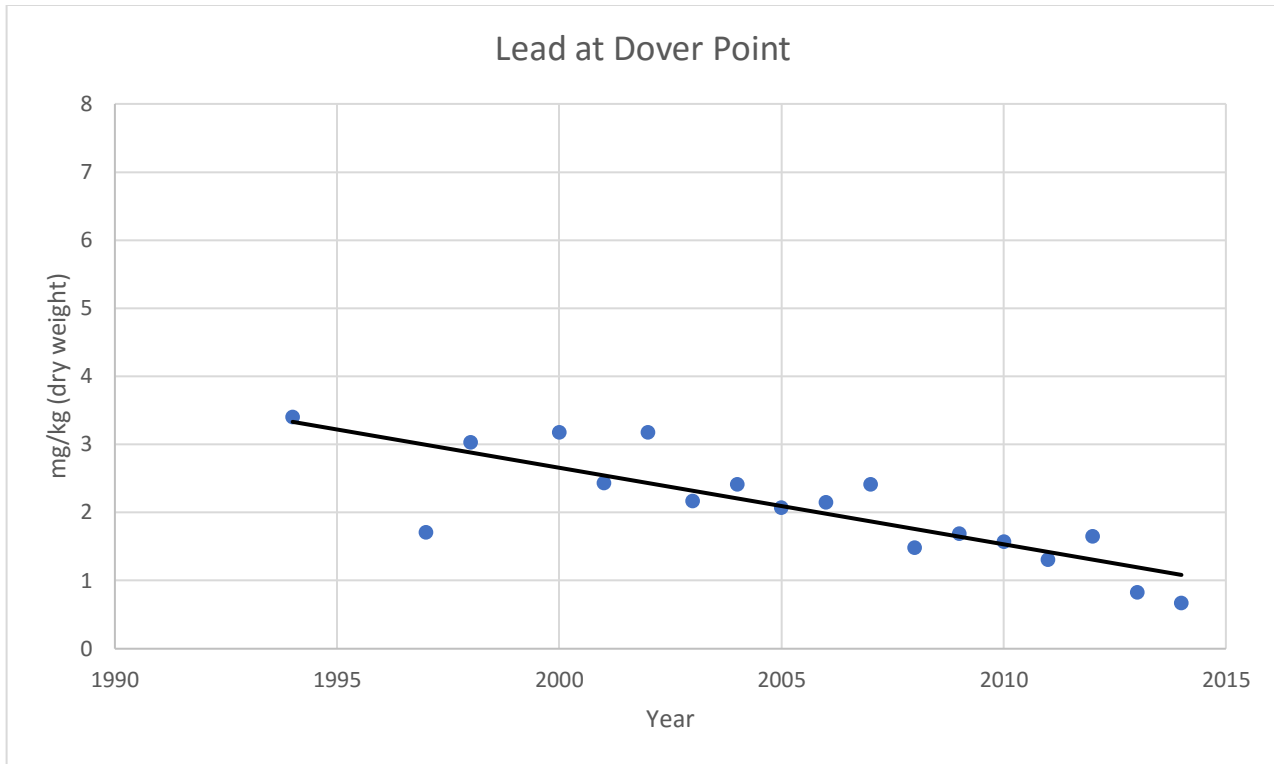


Figure TC-20: Lead concentrations in mussel tissue at the Dover Point station. Trendline indicates statistically significant trend.

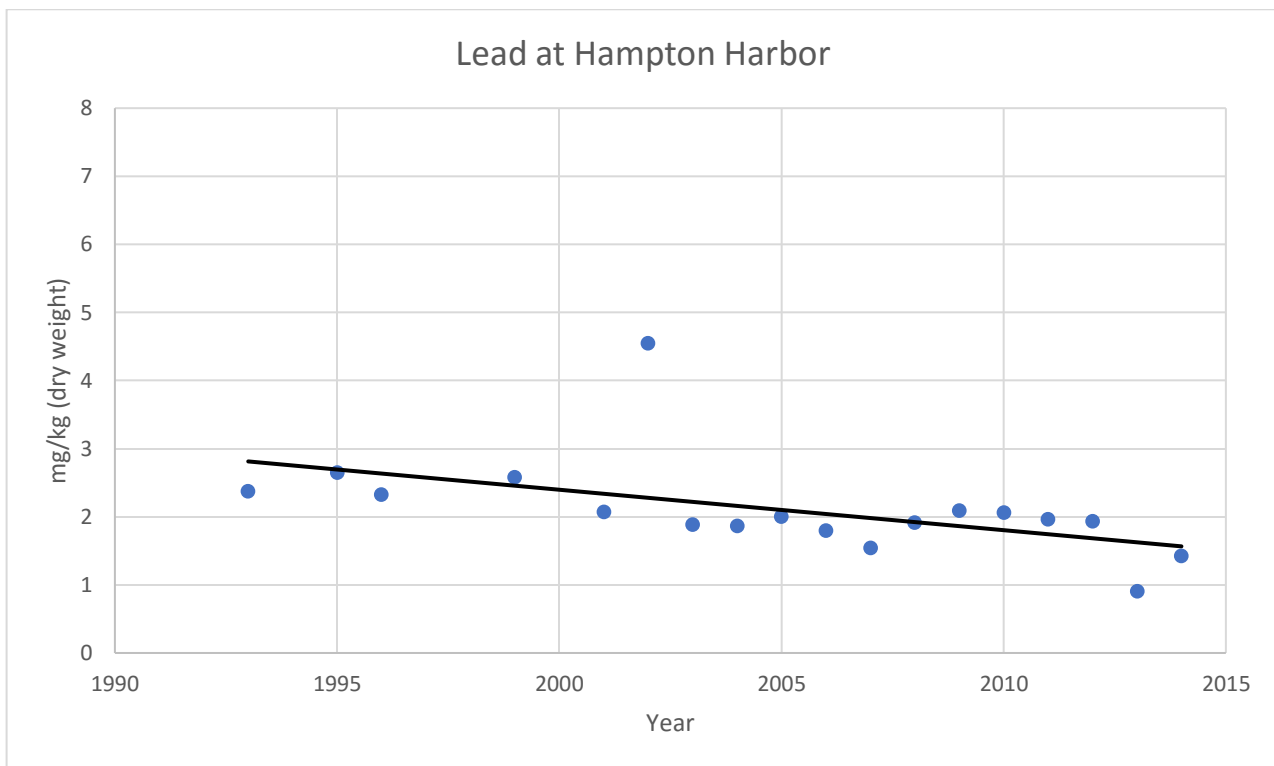


Figure TC-21: Lead concentrations in mussel tissue at the Hampton Harbor station. Trendline indicates statistically significant trend.

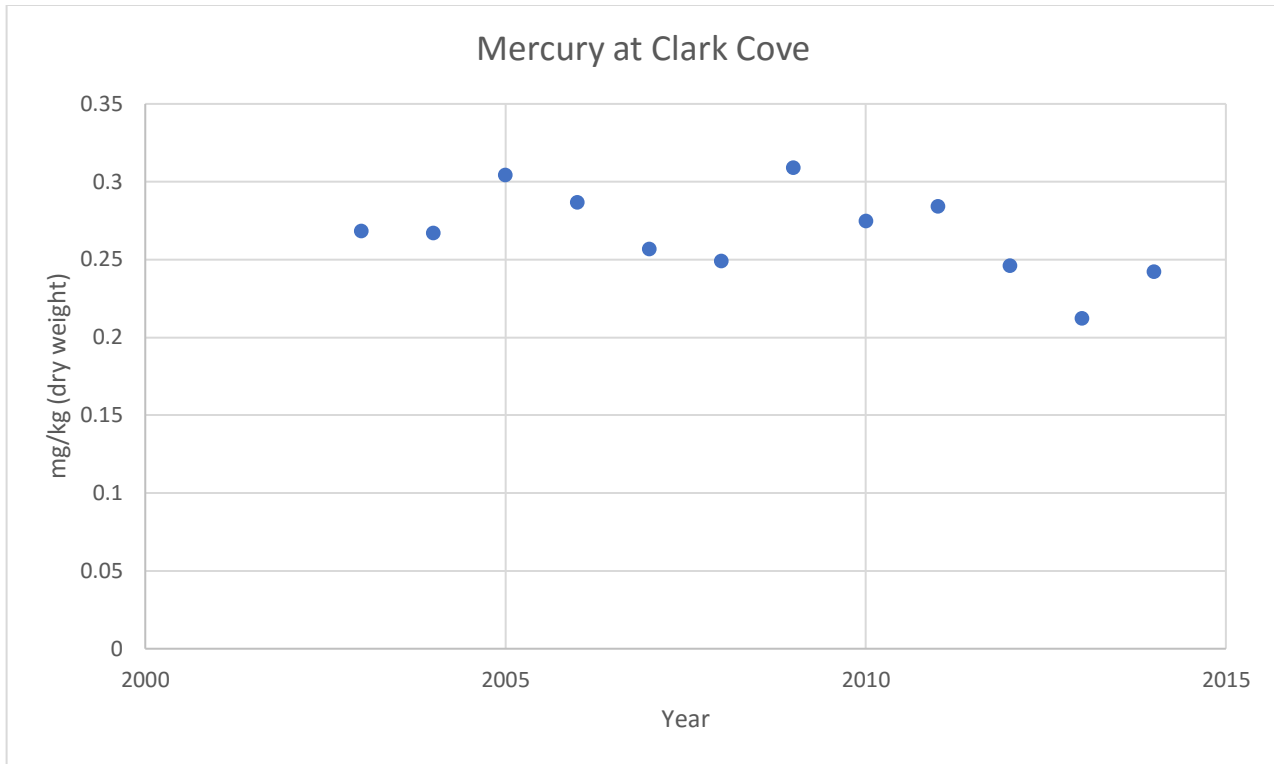


Figure TC-22: Mercury concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor.

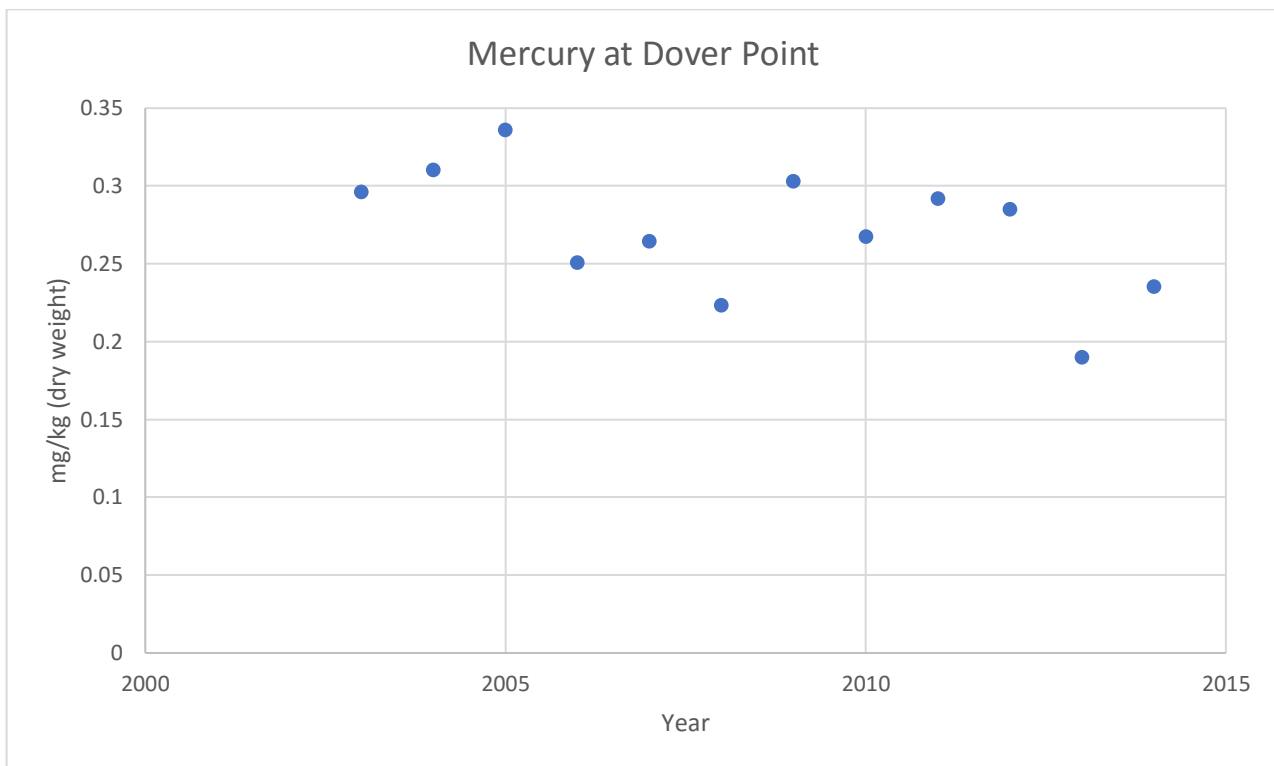


Figure TC-23: Mercury concentrations in mussel tissue at the Dover Point station.

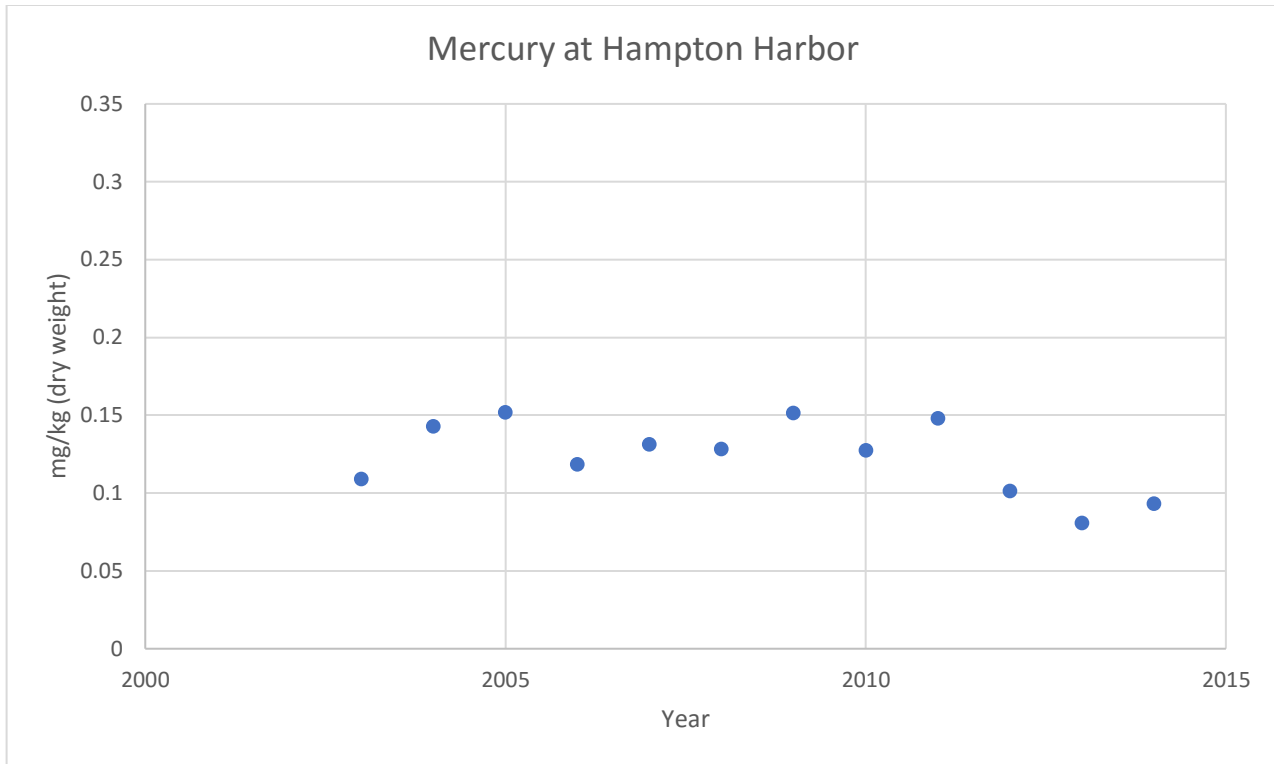


Figure TC-24: Mercury concentrations in mussel tissue at the Hampton Harbor station.

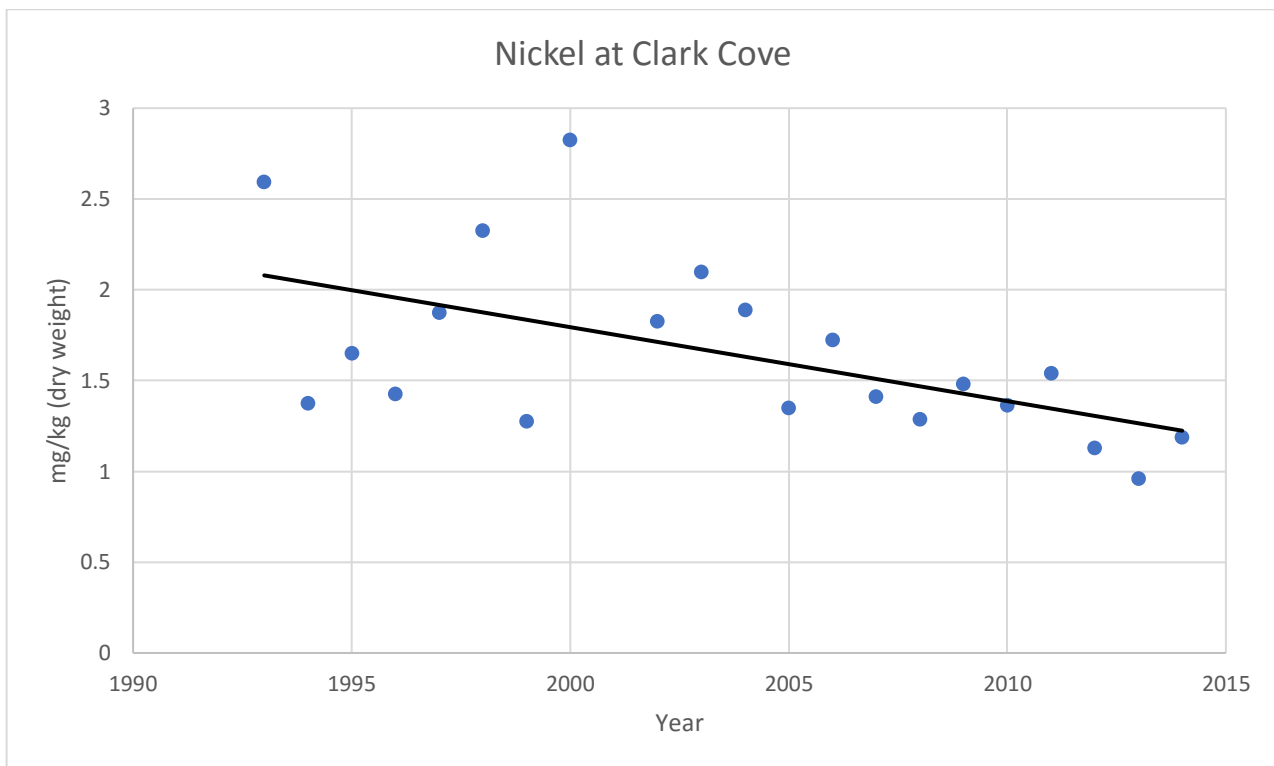


Figure TC-25: Nickel concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor. Trendline indicates statistically significant trend.



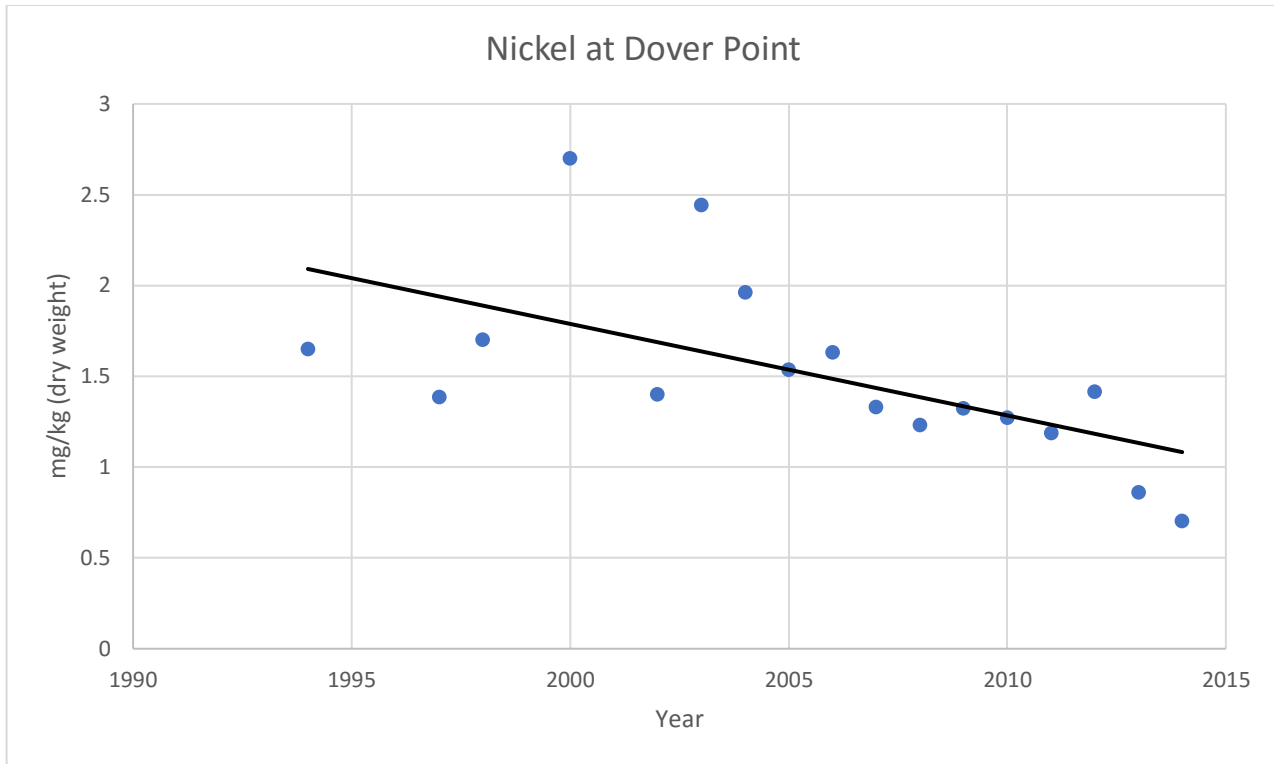


Figure TC-26: Nickel concentrations in mussel tissue at the Dover Point station. Trendline indicates statistically significant trend.

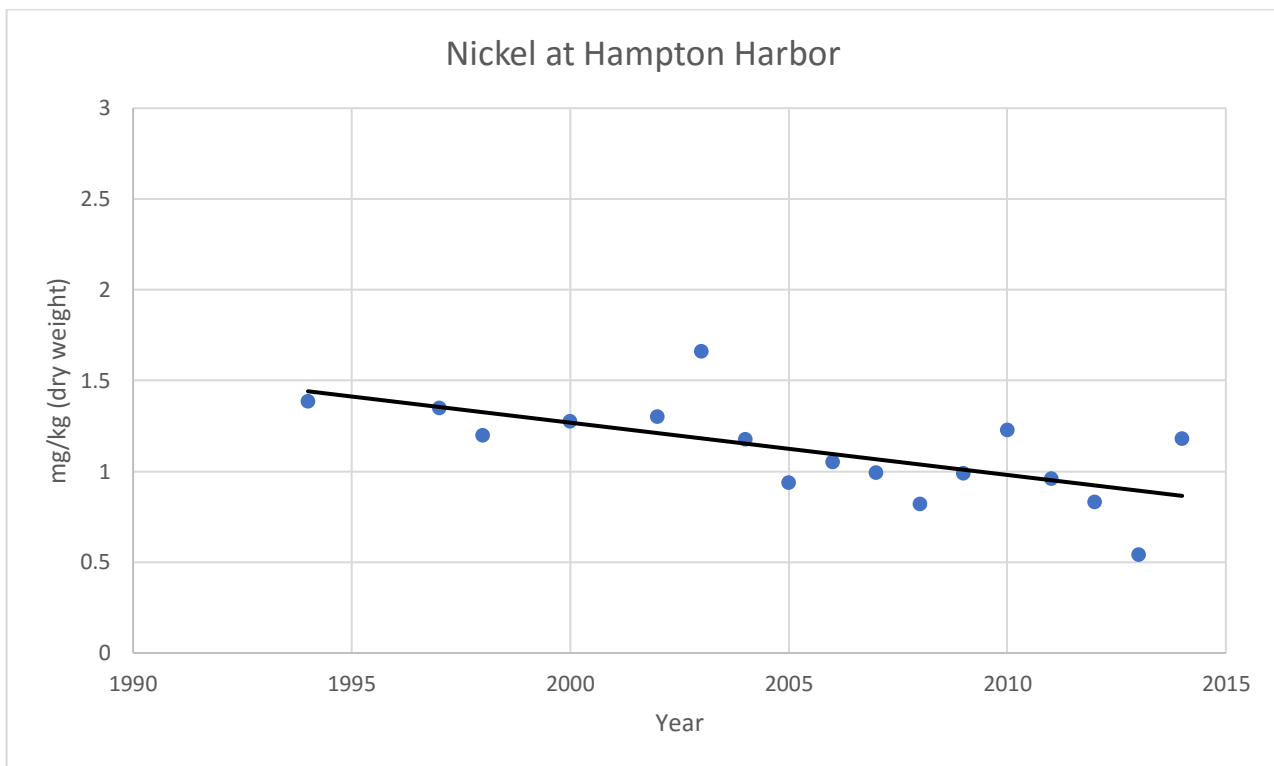
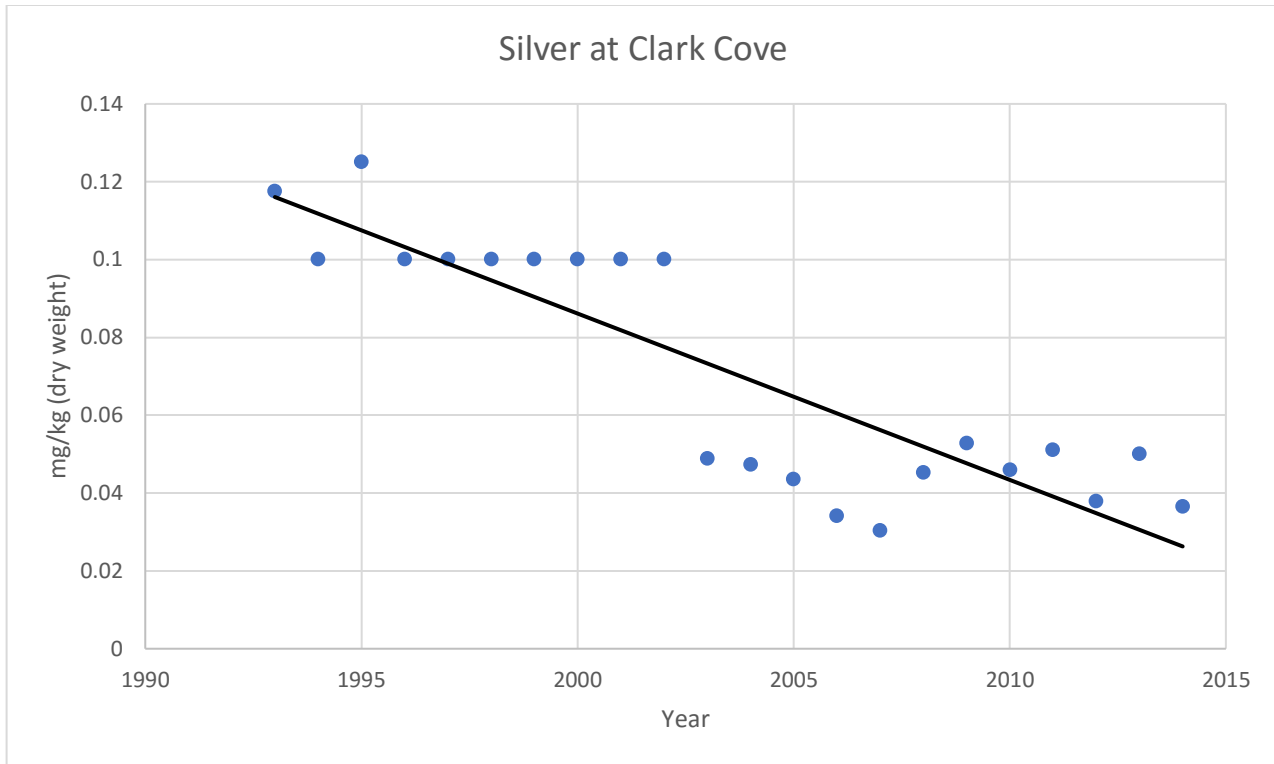
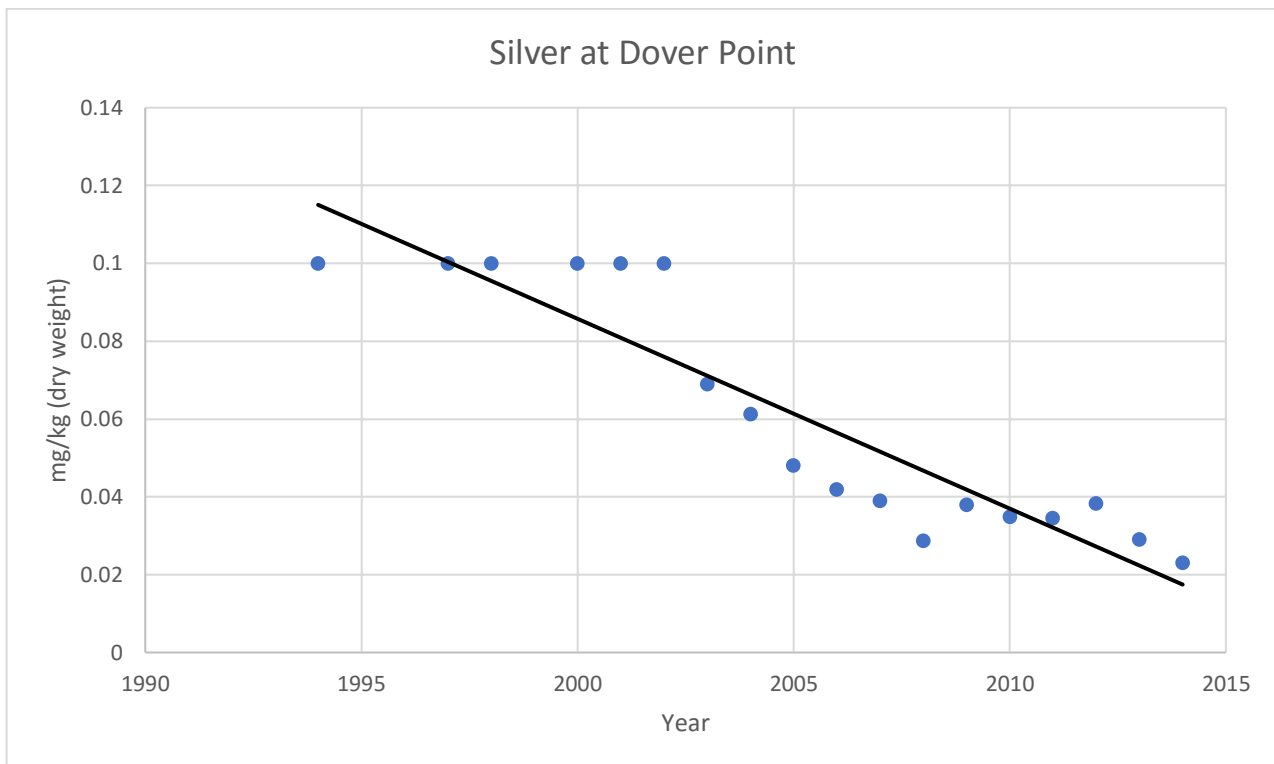


Figure TC-27: Nickel concentrations in mussel tissue at the Hampton Harbor station. Trendline indicates statistically significant trend.



**Figure TC-28: Silver concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor. Trendline indicates statistically significant trend. Multiple 0.1 results are due to minimum detection limits, which were changed in 2003.**



**Figure TC-29: Silver concentrations in mussel tissue at the Dover Point station. Trendline indicates statistically significant trend. Multiple 0.1 results are due to minimum detection limits, which were changed in 2003.**

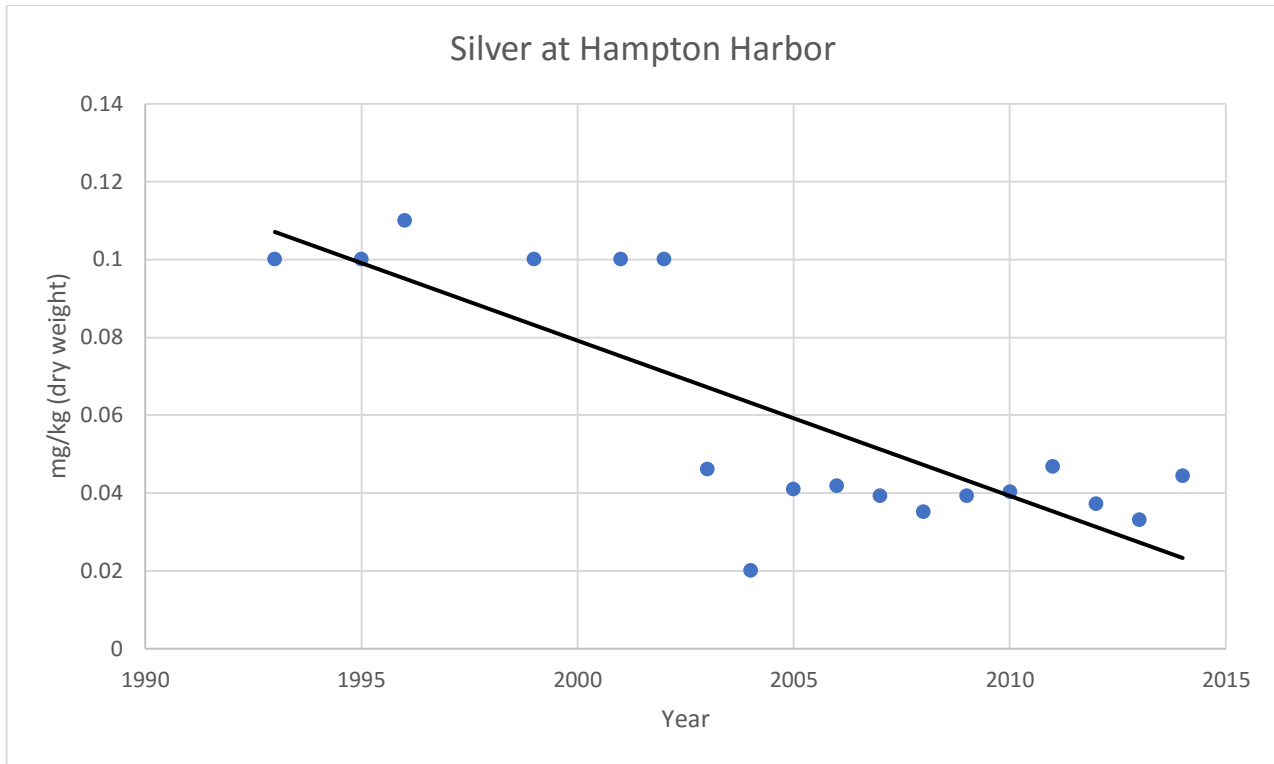


Figure TC-30: Silver concentrations in mussel tissue at the Hampton Harbor station. Trendline indicates statistically significant trend. Multiple 0.1 results are due to minimum detection limits, which were changed in 2003.

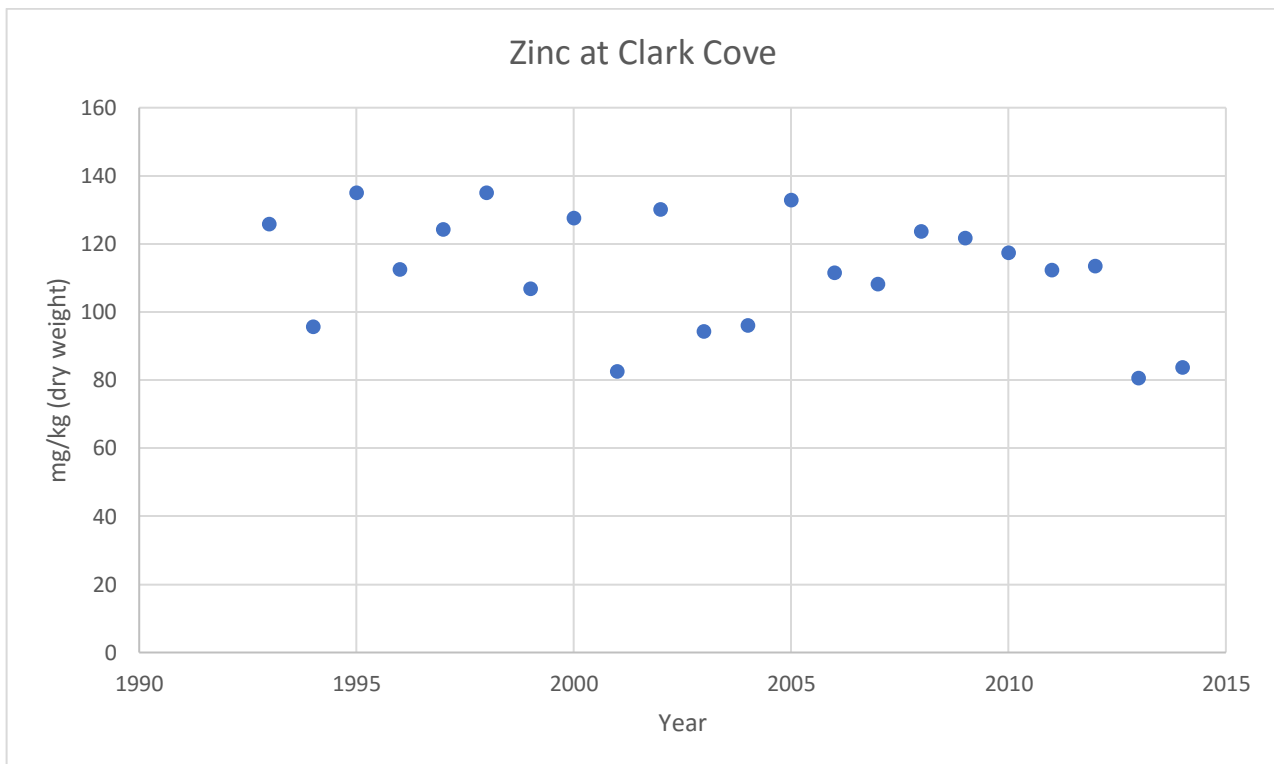


Figure TC-31: Zinc concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor.

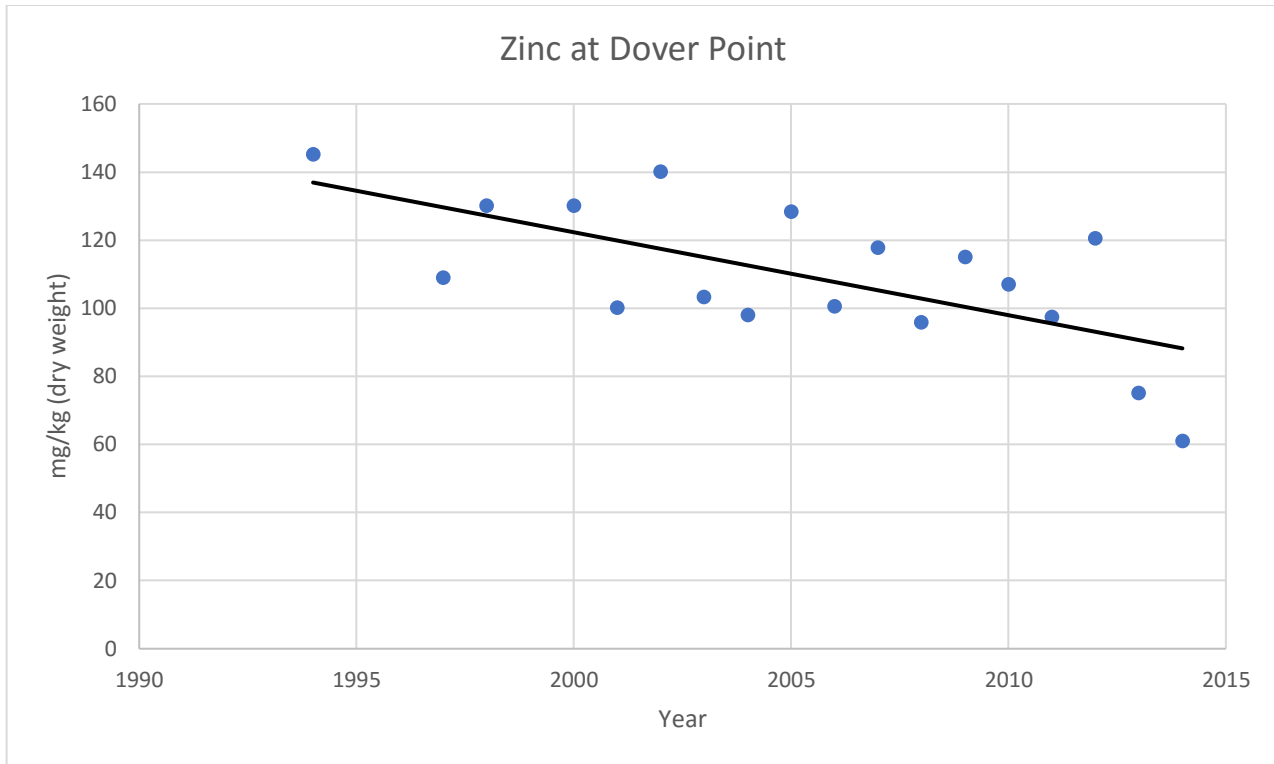


Figure TC-32: Zinc concentrations in mussel tissue at the Dover Point station. Trendline indicates statistically significant trend.

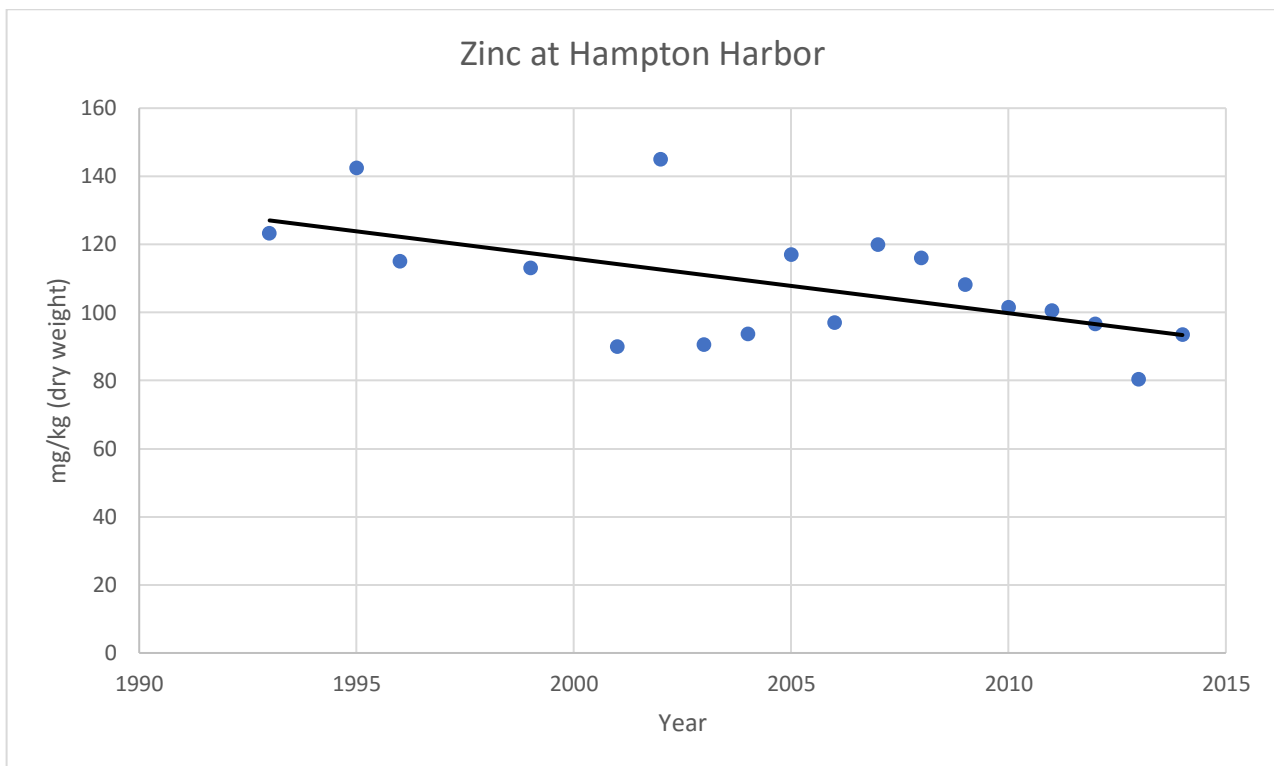


Figure TC-33: Zinc concentrations in mussel tissue at the Hampton Harbor station. Trendline indicates statistically significant trend.

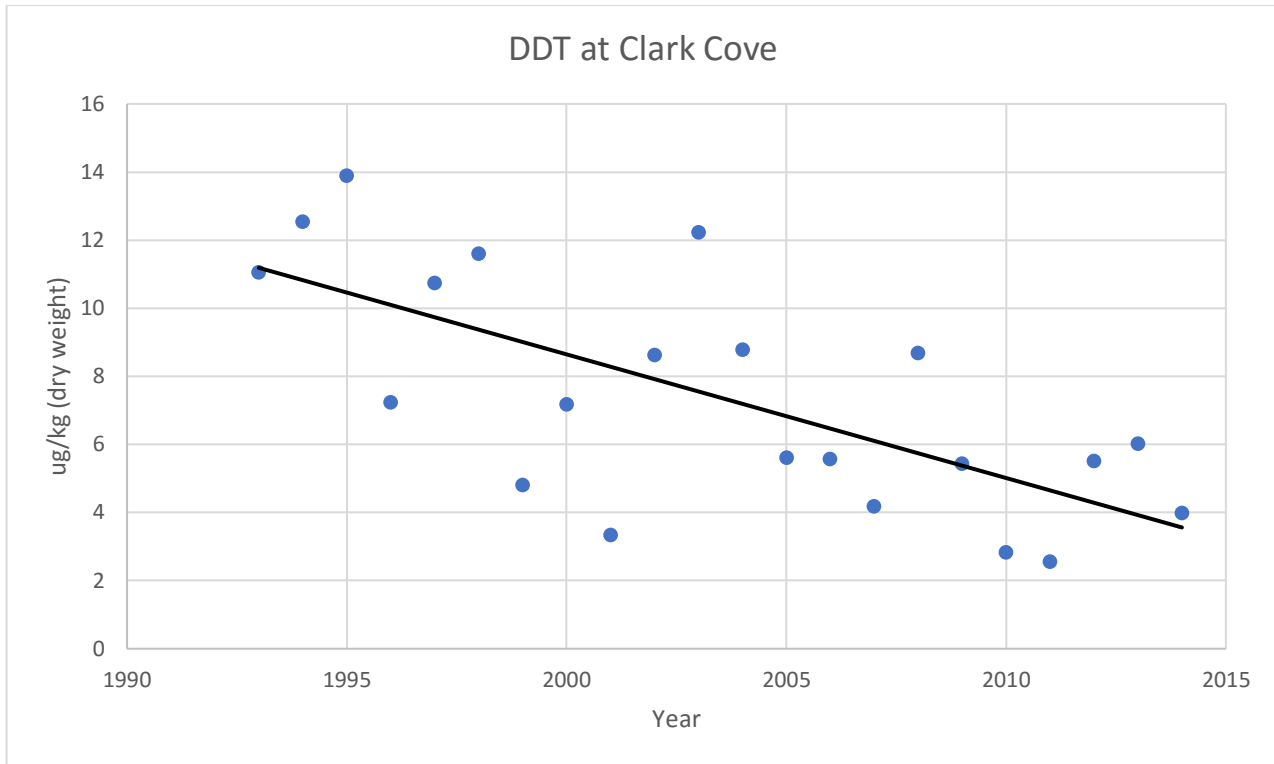


Figure TC-34: Total DDT concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor. Trendline indicates statistically significant trend.

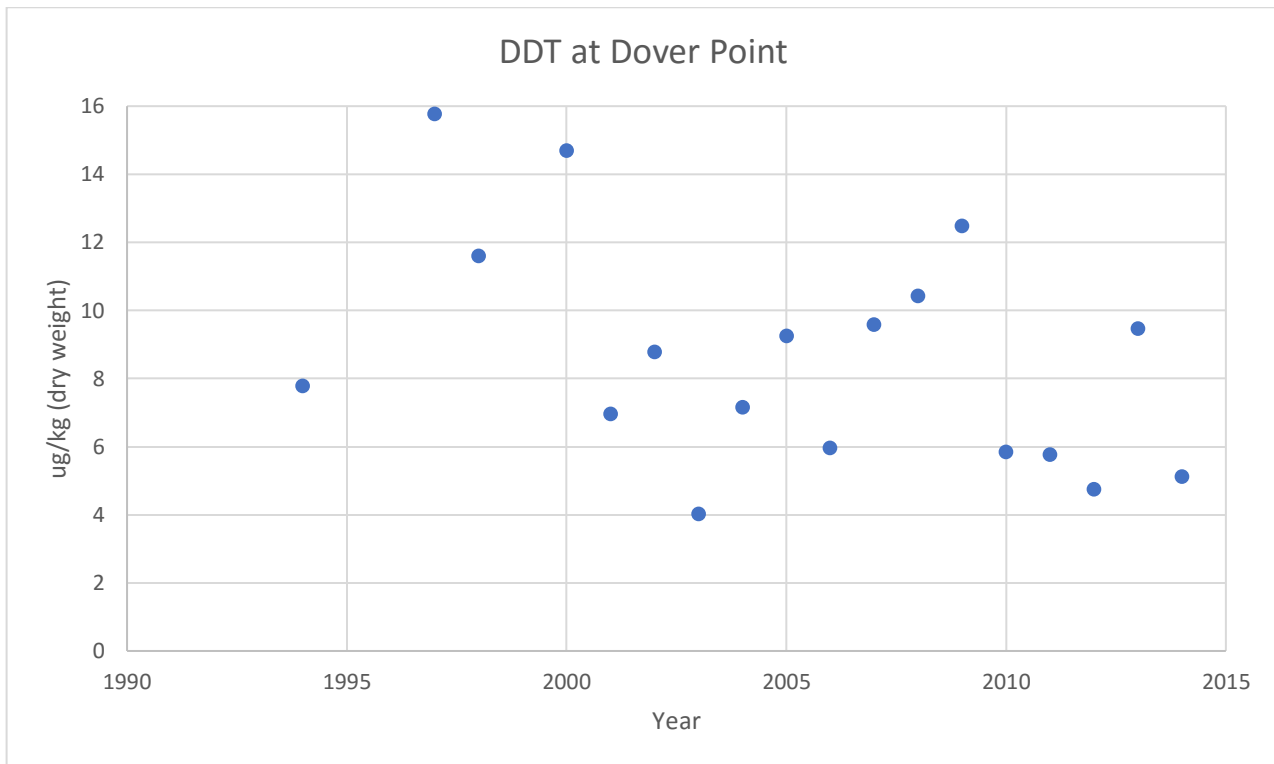


Figure TC-35: Total DDT concentrations in mussel tissue at the Dover Point station.

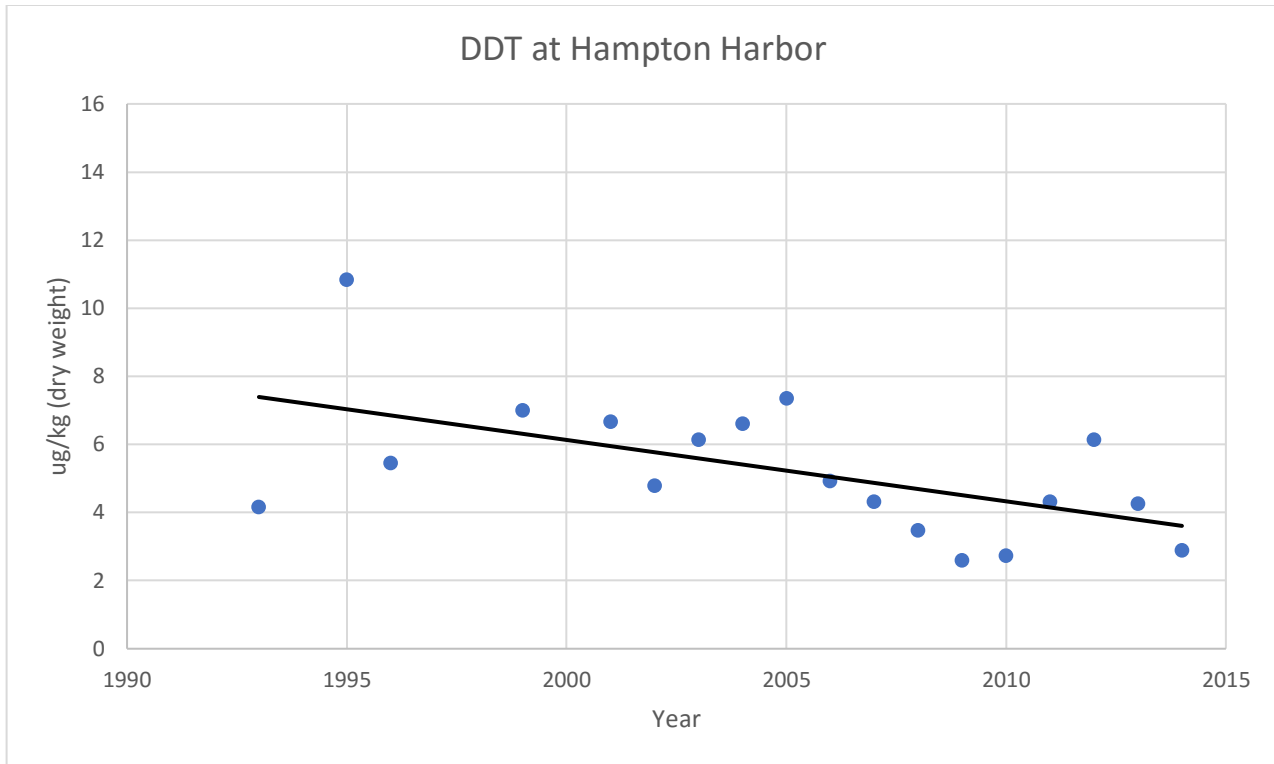


Figure TC-36: Total DDT concentrations in mussel tissue at the Hampton Harbor station. Trendline indicates statistically significant trend.

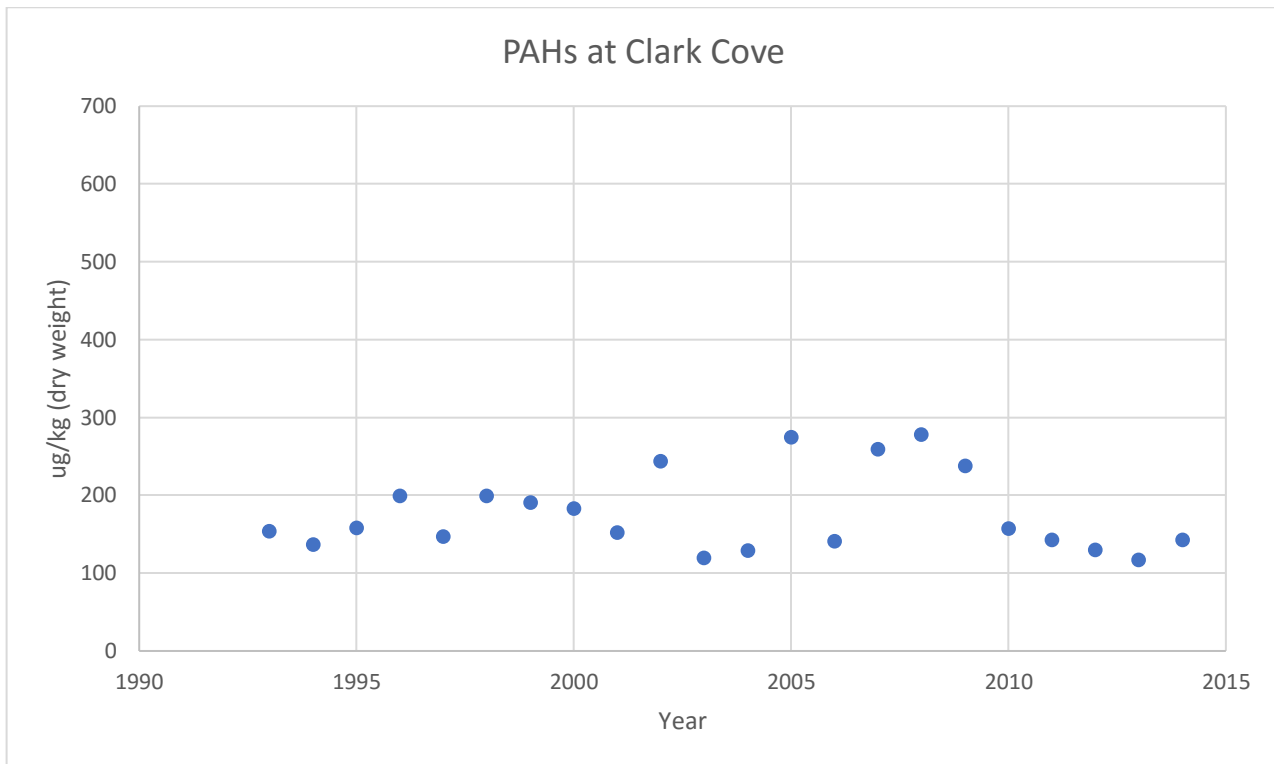


Figure TC-37: Total PAH concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor.

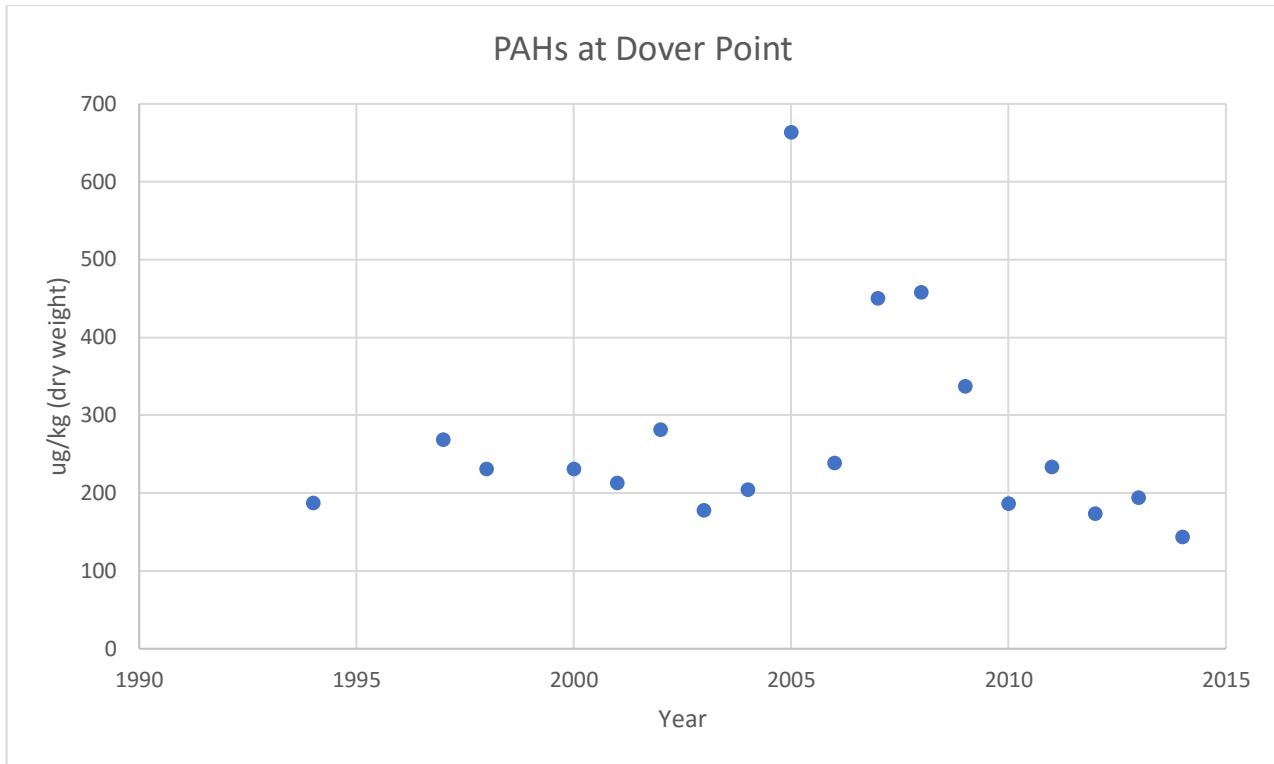


Figure TC-38: Total PAH concentrations in mussel tissue at the Dover Point station.

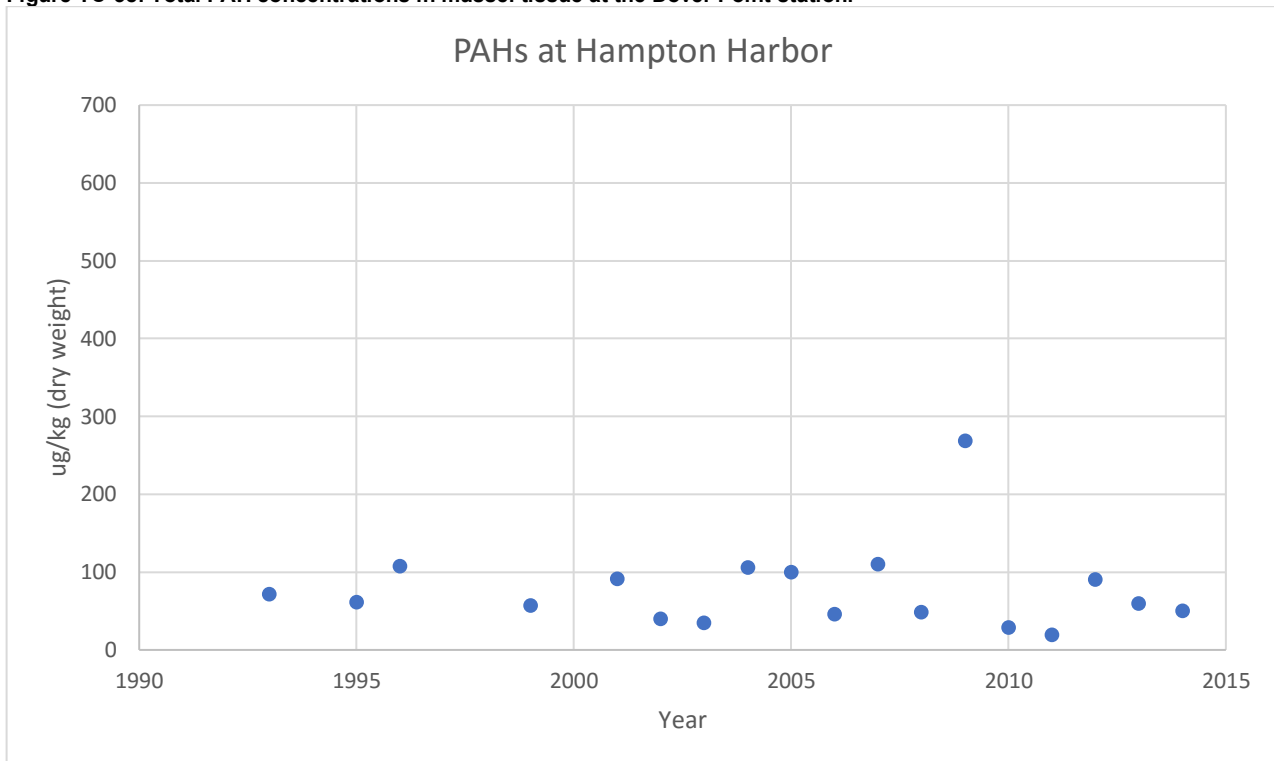


Figure TC-39: Total PAH concentrations in mussel tissue at the Hampton Harbor station.

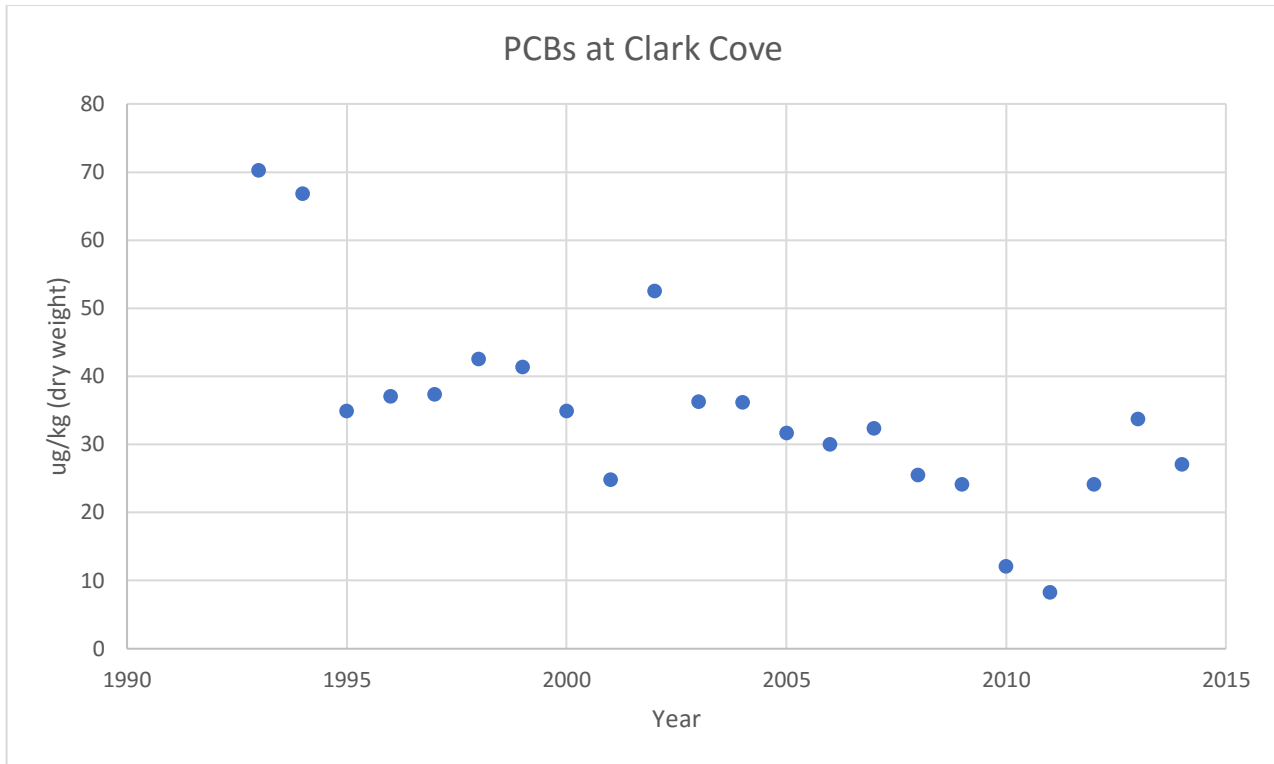


Figure TC-40: Total PCB concentrations in mussel tissue at the Clark Cove station, Portsmouth Harbor.

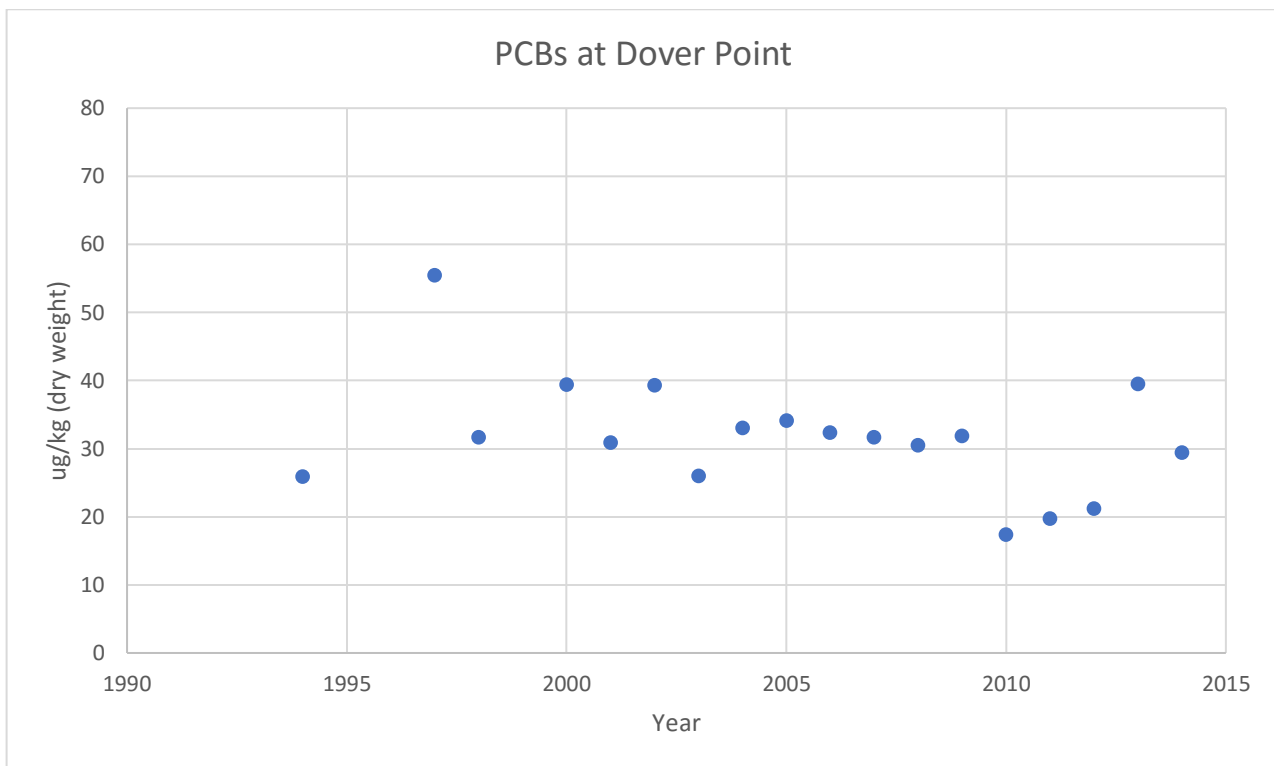


Figure TC-41: Total PCB concentrations in mussel tissue at the Dover Point station.



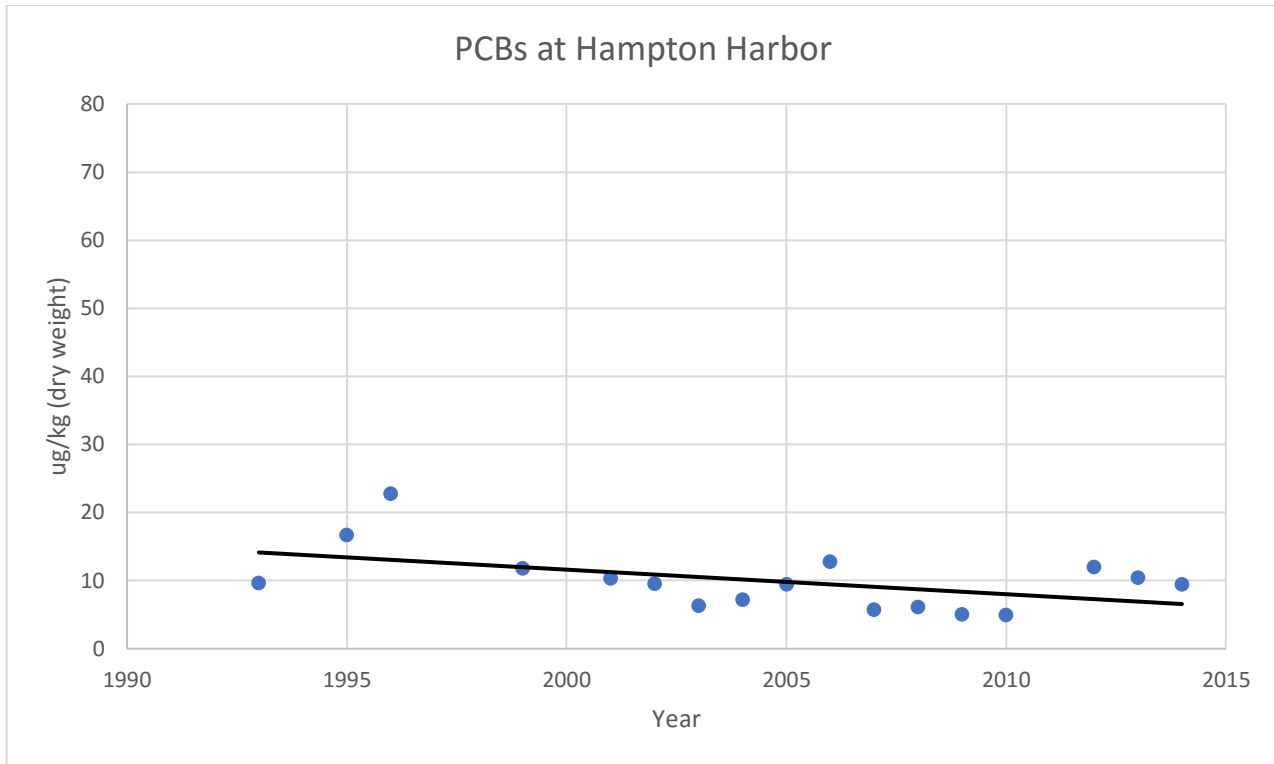


Figure TC-42: Total PCB concentrations in mussel tissue at the Hampton Harbor station. Trendline indicates statistically significant trend.