Boston Harbor Water Quality
2013

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EXECUTIVE SUMMARY

Significant improvements to the water quality of Boston Harbor have been observed since the early 1990's. This report provides an overview of water quality conditions in Boston Harbor during 2013. Because the impacts of upstream processes (including infrastructure projects by the MWRA and others) are integrated by the main body of the harbor, this report focuses on this particular region of the harbor.

- N and P concentrations during 2013 were the lowest since concentrations were first measured in 1995. They were much lower than during the years the harbor received the discharges from the Deer Island and/or Nut Island treatment facilities.
- Bottom-water dissolved oxygen DO concentrations during 2013 were the highest since monitoring started in 1994.
- *Enterococcus* counts easily met the State swimming standard, and were among the lowest observed since 1996. River inflows, and water temperatures and salinity in the harbor were approximately average for the period 1994-2013.
- Phytoplankton biomass in the harbor during summer 2013 (and measured as concentrations of chl-a) was lower than all years the harbor received the WWTF discharges. Chl-a concentrations during 2013 were the second highest for the 13 summers since the discharges to the harbor were ended.
- TSS concentrations were the highest, and water transparency the poorest observed since monitoring was started. The causes of these particular changes are not known for certain, but sediment resuspension or shoreline erosion was likely the cause.

Water quality in Boston Harbor has greatly improved during the past 20 years, and apart from the increased TSS and decreased transparency,

1.0 INTRODUCTION

During the past 25 years the MWRA has undertaken a series engineering projects to better collect, treat and dispose of the wastewater discharged from the City of Boston and surrounding communities to the harbor and its tributary rivers. These projects have included the Boston Harbor Project (Fig. 1, Taylor 2010), the combined

Fig. 1. Deer Island wastewater treatment facility with City of Boston in background.

sewer overflow Control Plan (MWRA 2013), the TRAC pretreatment program, and programs to decrease infiltration into the sewer system.

Over the same period MWRA has monitored water quality in Boston Harbor in support of these engineering projects. In this report we document the harbor water quality during 2013. The report focuses on the main body of the harbor, because water quality in this

region integrates the impacts of pollutant inputs from all sources.

This report presents data collected by MWRA at 12 harbor locations (Figure 2). The data were collected as part of MWRA's Boston Harbor Water Quality Monitoring (BHWQM) project. Most of the 12 locations have been sampled weekly or every two weeks since 1994. The sampling and analytical procedures used are described in detail in Rex and Taylor (2000).

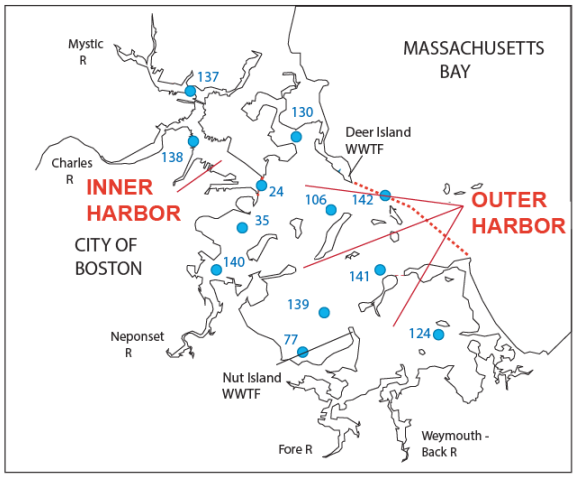

Fig. 2. Boston Harbor showing the 12 sampling locations, and the Inner (IH) and Outer Harbor (OH) regions of the harbor.

All data in the report are averaged for either the harbor as a whole, or for particular regions of the harbor. The horizontal bars at the top of each of the Figures shows the 13 years since the wastewater treatment facility discharges to the harbor were discontinued in September 2000.

2.0 RESULTS

2.1. WATER QUALITY

2.1.1. Amounts and types of nutrients

The harbor's total N (TN) and total P (TP) concentrations in 2013 (18.2 µmol l^{-1} and 1.21 µmol l^{-1}, respectively), were the lowest seen since the discharges to the harbor were ended in 2000 (Figure 3). Total N refers to dissolved inorganic N (DIN) + particulate nitrogen (PN) + dissolved organic N (DON), and DIN refers to NH_4 + NO_{3+2}. Total N: total P concentration ratios during 2013 averaged 15.1:1. They fell within the range seen since the discharges to the harbor were discontinued, but were lower than during the years the harbor received the wastewater treatment facility discharges.

Lowered concentrations of the 3 dissolved N fractions (NH_4, NO_{3+2}, and DON) were responsible for the low total N concentrations during 2013; concentrations of the particulate N (PN) fractions were actually the second highest since the discharges to the harbor were discontinued (Fig. 4).

Both the IH and the OH regions showed the lowered TN concentrations during 2013 (Fig. 5). As in all years since monitoring started in 1995, the IH showed greater TN concentrations in 2013 than did the OH.

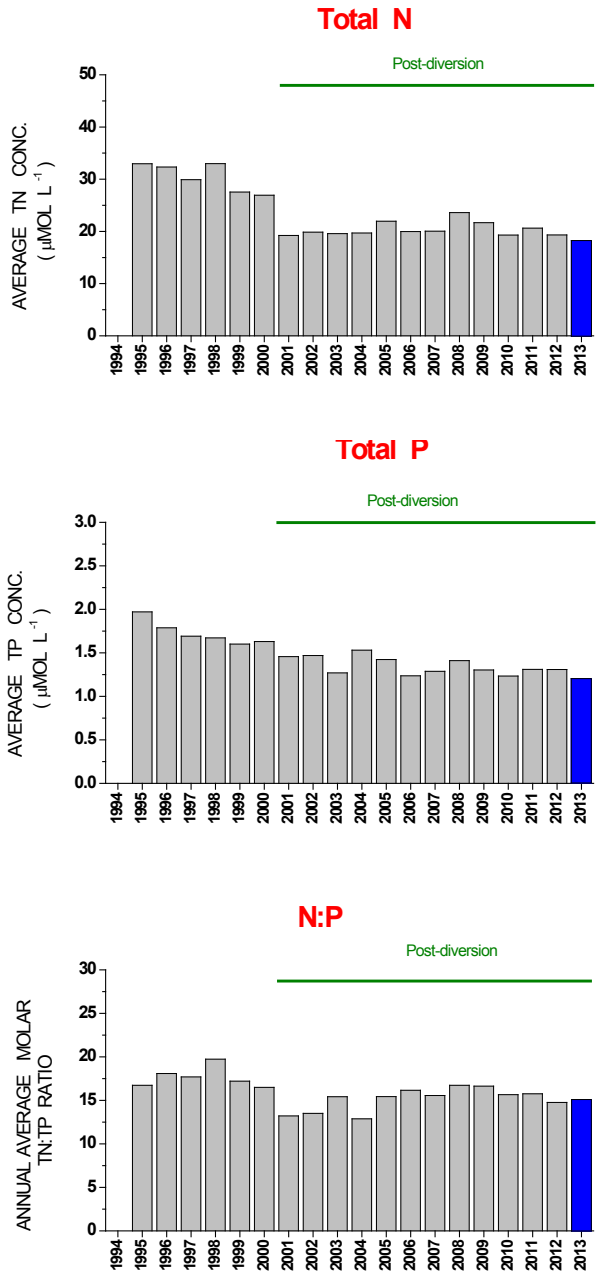

Fig. 3. Annual average TN and TP concentrations and TN:TP concentration ratios, 1995-2013.

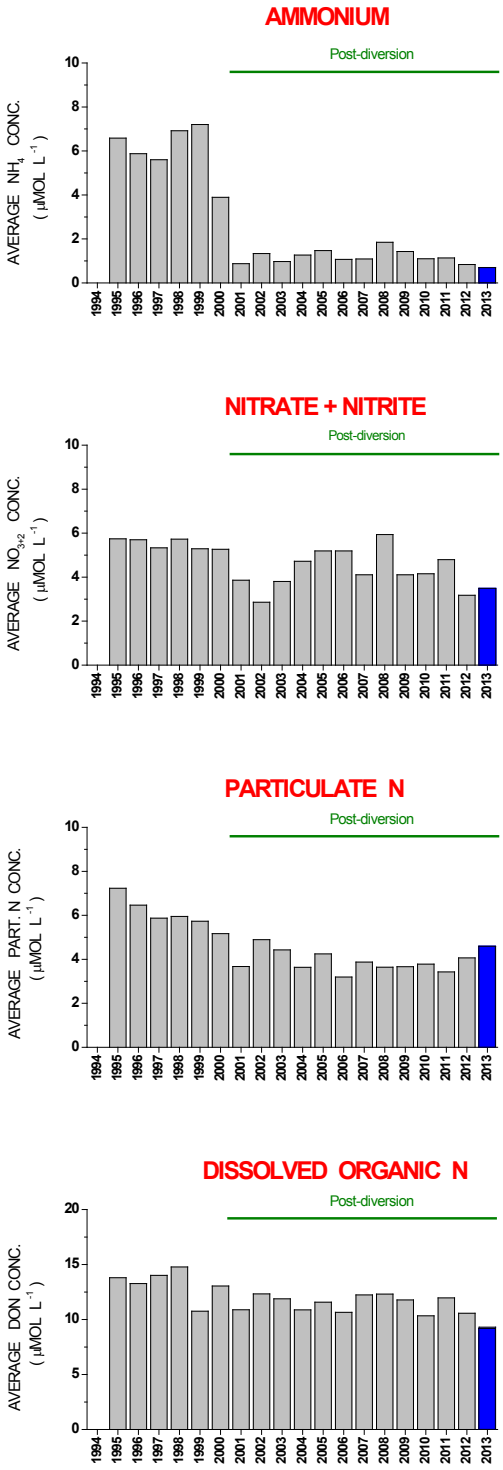

Fig. 4. Annual average concentrations of the four fractions making up total N (TN), 1995-2013

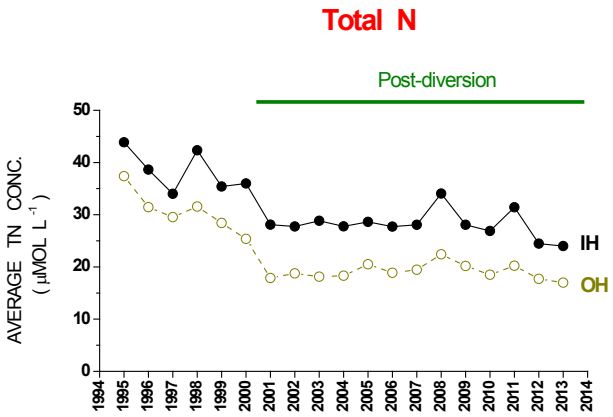

Fig. 5. Annual average TN concentrations in the Inner Harbor and Outer harbor, 1995-2013

2.1.2. *Amounts of phytoplankton*

Summer phytoplankton biomass (measured as chlorophyll a) averaged 5.4 µg l^{-1} in 2013 (Fig. 6). 2013 chlorophyll concentrations were again lower than during all years the harbor received wastewater discharges, but was relatively high compared to the other 12 years after the discharges to the harbor were discontinued. Elevated concentrations in both the IH and the OH regions were responsible for the elevated 2013 concentrations (Fig. 7).

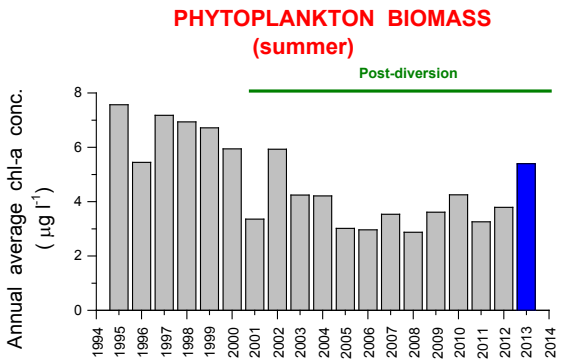

Fig. 6. Summer average phytoplankton biomass measured as chl-a, 1995-2013. Summer = J, J, A, S.

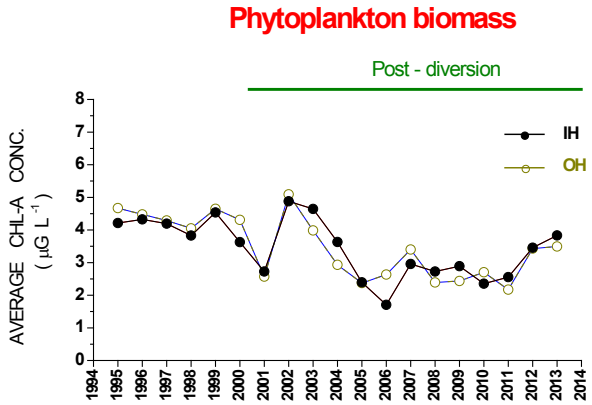

Fig. 7. Comparison of summer chl-a in the IH and OH, 1995-2013

2.1.3. *Bottom-water DO*

Minimum monthly average bottom-water DO concentrations in 2013 (7.6 mg l^{-1}) were the highest since 1994 (Fig. 8). The harbor appears to have shown a gradual increase in bottom-water since 1994, and the elevated 2013 concentrations were a continuation of this trend. Both in the IH and the OH, the minimum monthly DO concentrations in 2013 easily met the State Std of 6 mg l^{-1} (Fig. 9).

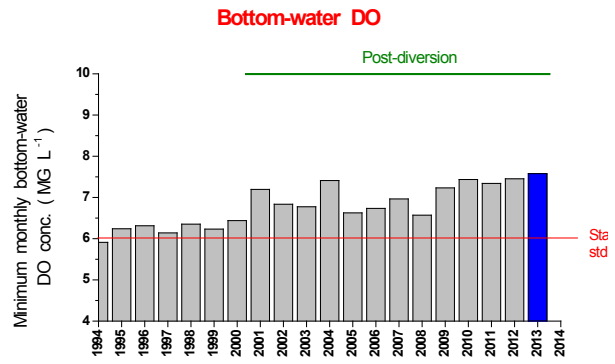

Fig. 8. Minimum monthly harbor-wide average bottom-water DO concentrations, 1994-2013

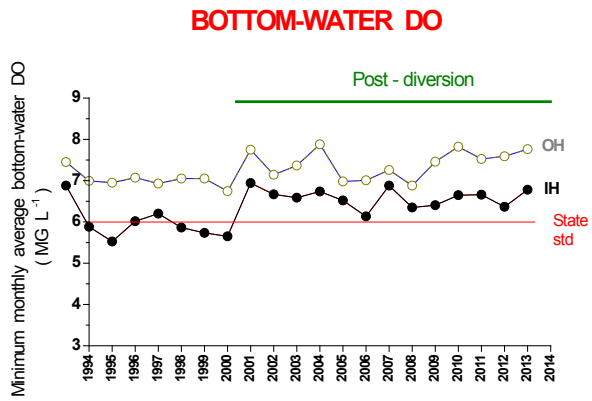

Fig. 9. Minimum monthly average bottom-water DO concentrations observed in the bottom-waters of the IH and OH

2.1.4. Suspended particulate material

2013 TSS concentrations were by far the highest observed since 1996 (Fig. 10). PC concentrations, a measure of the organic content of the TSS, were also elevated, but concentrations were the highest since the not to the same extent as TSS. PC

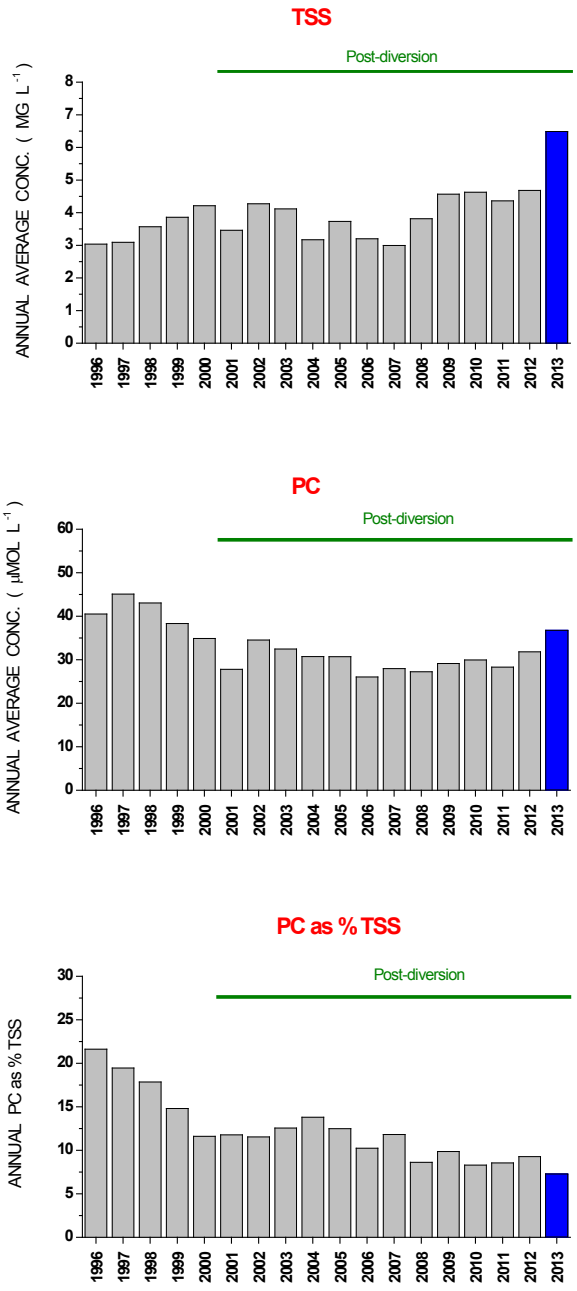

Fig. 10. TSS, PC and PC as % TSS, 1996-2013

discharges to the harbor were discontinued, but lower than during years the harbor received wastewater discharges. PC expressed as percent of TSS was the lowest observed during the study. The elevated

2013 TSS concentrations were evident both in the IH and the OH (Fig. 11).

2.1.5. Transparency

Transparency in the harbor was the poorest since 1996, but still relatively high for a coastal bay or estuary (Fig. 12). Harbor attenuation coefficients in 2013 averaged 0.62 m^{-1}. Note, the attenuation coefficients, as reported, are reciprocal values, so the higher the value, the more rapid the light attenuation as it passes through the water.

2.1.6. Pathogen indicator counts

Enterococcus counts in 2013 were low, and averaged 3 colonies 100 ml^{-1} (Fig. 13). Counts in the IH were higher than in the OH, as has been the case in all years since 1995. 2013 counts in the IH were the third lowest since 1995 (Fig. 14). Counts in the IH tend to vary more year to year than in the OH.

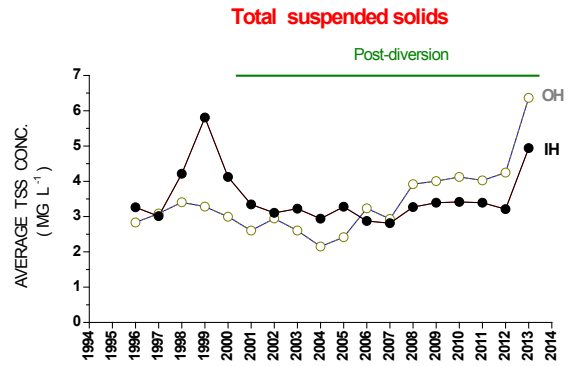

Fig. 11. Comparison of annual average TSS concentrations in the IH and OH

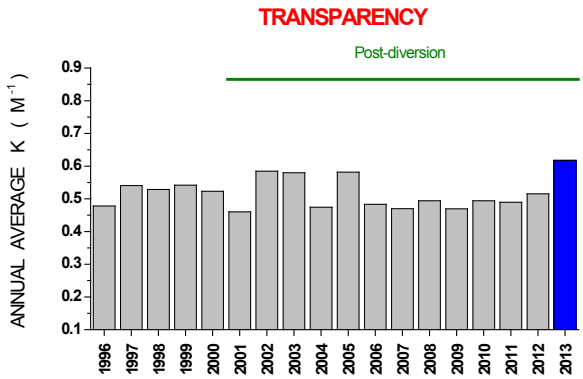

Fig. 12. Annual average attenuation coefficients, 1997-2013

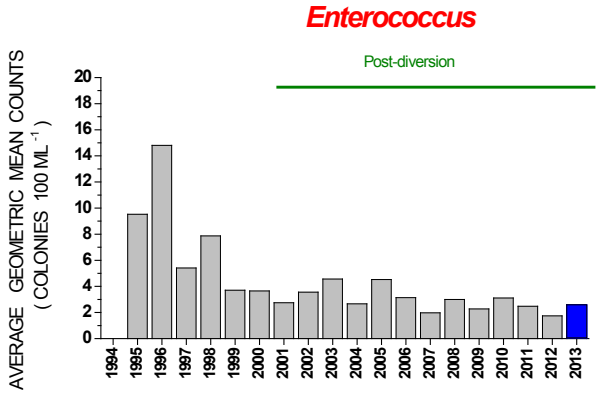

Fig. 13. Average of the geometric mean *Enterococcus* counts by year, 1995-2013

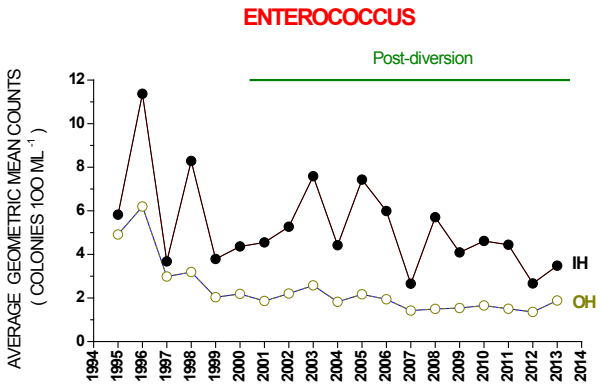

Fig. 14. Average geometric mean *Enterococcus* counts in the IH and OH

3.0. 2013 PHYSICAL CONDITIONS

River flows during 2013 averaged 2.04 x10^6 m^3 d^{-1}, approximately average for the past 24 years (Fig. 15). Salinity averaged 30.1 psu, again approximately average for the period 1994-2013 (Fig. 16). Salinity in the IH in 2013 was lower than in the OH, as has been the case in all years since 1994.

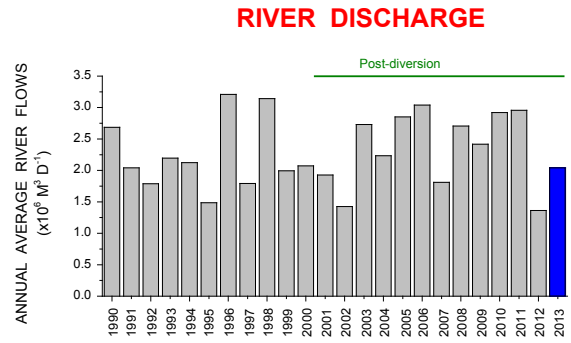

Fig. 15. Annual average river inflows into Boston Harbor. Data are sum of discharges from Charles, Mystic, Neponset and Weymouth-Weir rivers (data from USGS).

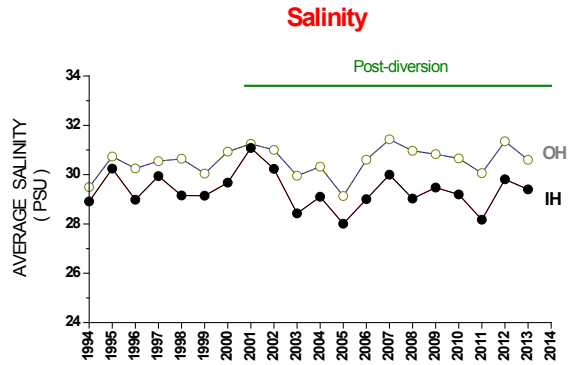

Fig. 16. Comparison of annual average salinity in the IH and OH, 1994-2013

During all months except for October during 2013, the monthly average water temperatures fell within the range seen during other years since the discharges to the harbor were discontinued (Fig. 17).

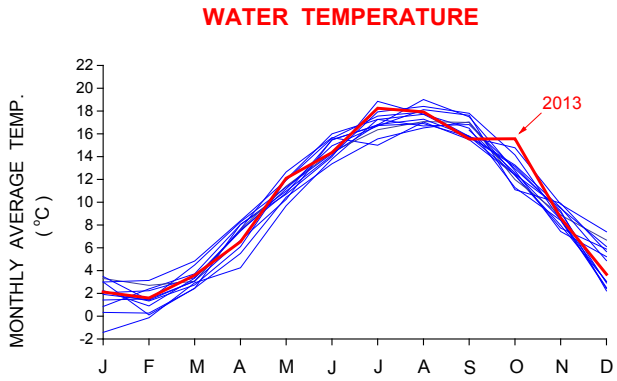

Fig. 17. Average water temperatures by month of year. Blues lines show data for 2001-2012.

4.0. REFERENCES

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Rex A., Taylor D.I., 2000. Combined Work/Quality Assurance Project Plan (CW/QAPP) for Water Quality Monitoring and Combined Sewer Overflow Receiving Water Monitoring in Boston Harbor and Its Tributary Rivers. Boston: Massachusetts Water Resources Authority. Report 2000-ms-67. 48 p.

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