

Contingency Plan Report Fourth Quarter 2014

Ambient Monitoring

MWRA gathers data from the outfall location in Massachusetts Bay on various thresholds in its Deer Island outfall discharge permit. This report shows relevant ambient monitoring results that became available in the October-December 2014 time period for sediment contamination, sediment biodiversity, sediment enrichment, dissolved oxygen (DO), DO depletion rate, chlorophyll, and nuisance algae. There were two contingency plan threshold exceedances for sediment biodiversity. There was a contingency plan threshold exceedance for the nuisance alga *Phaeocystis*, which was reported last quarter based on a partial data set for summer 2014; the same exceedance is reported again this quarter because we now have results from the full summer data set.

SEDIMENT CONTAMINATION - 2014

Sediment contamination levels at the outfall site in 2014 were well below the thresholds.

The sediment contamination thresholds would indicate any unexpected accumulation of toxic contaminants in soft sediments near the outfall. Contaminant levels are compared to sediment guidelines issued by the National Oceanic and Atmospheric Administration (NOAA). These NOAA “Effects Range-Medium” (ER-M) levels indicate toxic contaminant concentrations above which adverse effects on marine life are often detected. Baseline sediment contamination levels are all well below the ER-M levels for all contaminants.

In 2014, contaminant levels were within or below the baseline (pre-discharge) range. This continues the pattern consistently seen since the outfall went on-line: little to no change in sediment contaminant levels at sites potentially affected by the discharge.

PARAMETER		Baseline Range	Warning Level Threshold	2014 Value
Polycyclic Aromatic Hydrocarbons (PAHs) (ng/g dry weight)	acenaphthene	22.7 - 43.5	500	28.3
	acenaphthylene	30.3 - 43.1	640	11.1
	anthracene	101 - 159	1100	77.3
	benz(a)anthracene	206 - 302	1600	176
	benzo(a)pyrene	204 - 298	1600	182
	chrysene	164 - 296	2800	172
	dibenzo(a,h)anthracene	27.8 - 38.3	260	26.7
	fluoranthene	422 - 621	5100	389
	fluorene	35.5 - 66.6	540	32.5
	naphthalene	53.6 - 103	2100	31.6
	phenanthrene	273 - 431	1500	247
	pyrene	412 - 579	2600	362
	sum high molecular weight PAH	2790 - 3850	9600	2440
	sum low molecular weight PAH	1390 - 1630	3160	814
	total PAH	4180 - 5400	44792	3260
Other Organic Contaminants (ng/g dry weight)	p,p'-DDE	0.386 - 1.00	27	0.374
	total DDT	2.51 - 5.69	46.1	0.794
	total PCB	10.2 - 20.2	180	7.17

	PARAMETER	Baseline Range	Warning Level Threshold	2014 Value
Metals (µg/g dry weight)	cadmium	0.0727 - 0.185	9.6	0.109
	chromium	59.2 - 79.9	370	47.6
	copper	19.1 - 25.2	270	22.9
	lead	41.1 - 46.3	218	32.7
	mercury	0.159 - 0.353	0.71	0.123
	nickel	15.7 - 17.2	51.6	8.46
	silver	0.335 - 0.485	3.7	0.173
	zinc	49.5 - 57.5	410	41.5

SEDIMENT BIODIVERSITY - 2014
DIVERSITY

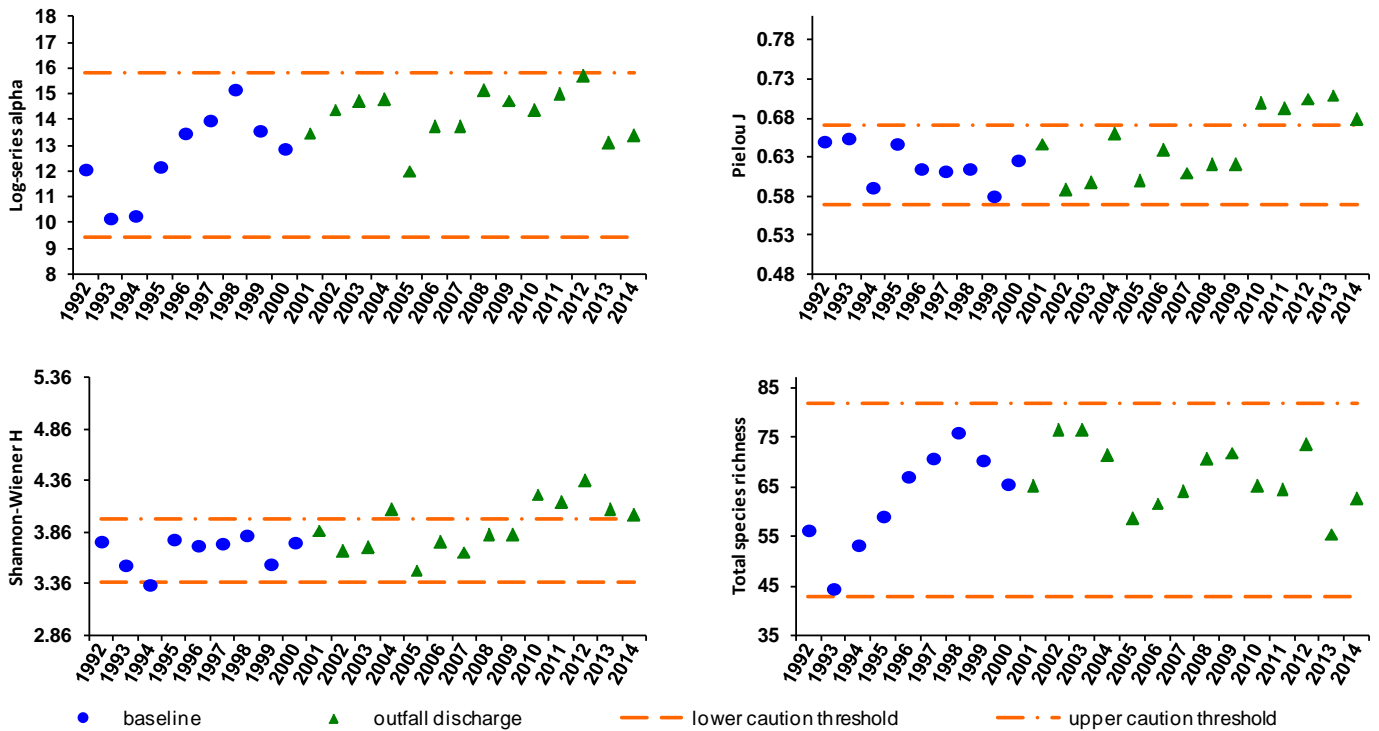
The annual survey of sediment-dwelling communities in August 2014 showed that two measures of [benthic diversity](#) exceeded their thresholds. Diversity indices Shannon-Wiener H' and Pielou's J', were slightly higher (more diverse) than their upper thresholds, triggering notification under the Contingency Plan (see http://www.mwra.state.ma.us/harbor/pdf/20141205_amx.pdf). MWRA samples the animals that live in the mud near the outfall every summer and measures the numbers and kinds of animals living there. These measurements are used in four indicators of biodiversity. In 2014, as in [2010](#), [2011](#), [2012](#), and [2013](#) two of those four measures were slightly higher than the upper diversity threshold (there are upper and lower thresholds corresponding to the 97.5th percentile and 2.5th percentile of the baseline mean.) That is, the community was more diverse than in baseline, before the outfall came on-line.

Other measures of the sediment animal community health — including the other two diversity indices, sediment oxygenation, sediment quality, and the abundance of animals — showed no indication that excessive sediment enrichment was occurring, or that there has been a decline in sediment community health. The two other diversity parameters calculated for August 2014 samples, log-series alpha and total species richness, were within their threshold ranges. The number of opportunistic animals remains extremely low. The six opportunistic taxa made up less than 1% of the animals collected from nearfield sediments (the Caution Level is 10%). Therefore, all indications so far are that the increased diversity is a normal fluctuation of the sediment animal community.

Given the strong year-to-year similarity normally observed in infaunal communities during MWRA's monitoring, it is not surprising that similar exceedances in the same parameters were observed in the 2014 monitoring as were seen in the past four years.

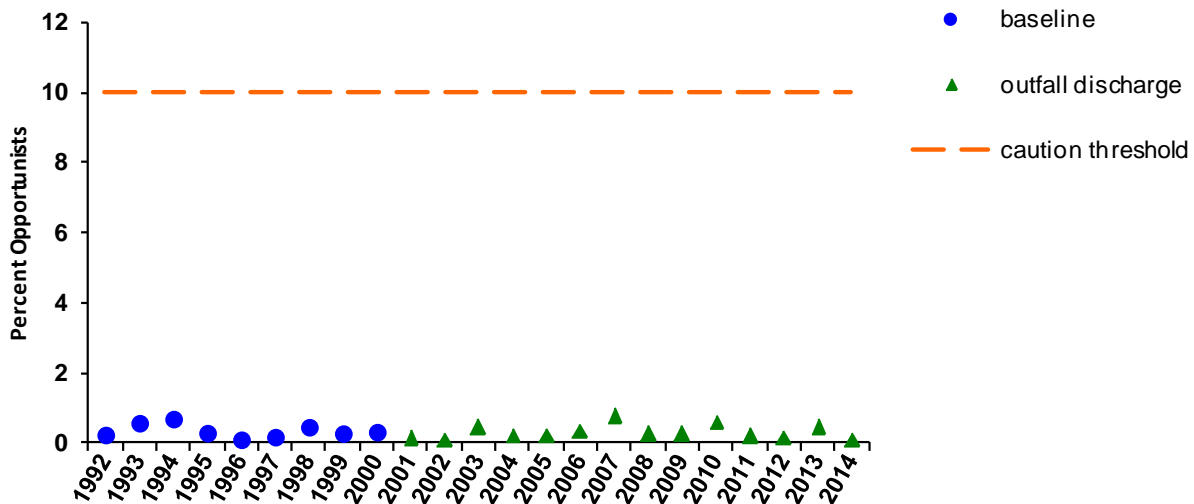
For each diversity measure, the graphs below show the annual average for sediment samples collected within seven kilometers of the outfall discharge since 1992. For comparability across all sampled years, the results shown for 1992-2003, and 2011-2014 are from the current eleven monitoring stations (which are a subset of the stations sampled 1992-2003), reflecting the modified design that began in 2011, while data from 2004 through 2010 are the averages for the odd- or even-year stations sampled then, as not all of the 11 nearfield stations currently sampled were sampled in those years.

The threshold levels varied slightly through the monitoring period because of the differing station sets; for simplicity only the current thresholds are shown. (Although it appears that there was an exceedance of the Shannon-Weiner H' threshold in 2004, the threshold in effect at that time was slightly higher, so there was no exceedance.) The previous reports are at <http://www.mwra.state.ma.us/harbor/html/archive.htm#cpqamb>.



OPPORTUNISTS

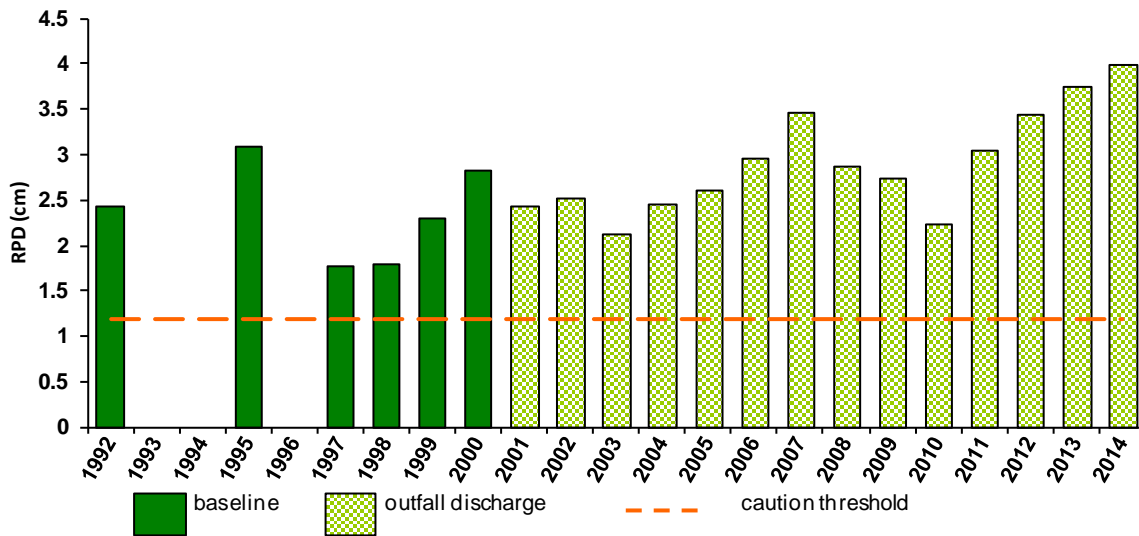
The annual sampling in 2014 showed that the numbers of [opportunistic benthic organisms](#) remain normal at the outfall site and did not exceed the caution threshold of 10% of the total population. The warning threshold is 25% of the total population.



The graph shows the annual average for sediment samples collected within seven kilometers of the outfall discharge since 1992, calculated in the same manner as for the diversity thresholds. This enables us to better compare the threshold results across years. Earlier reports are at <http://www.mwra.state.ma.us/harbor/html/archive.htm#cpqamb>.

SEDIMENT ENRICHMENT - 2014

The 2014 annual sediment monitoring showed that the redox potential discontinuity (RPD) depth was the deepest yet observed at the outfall site and did not exceed the threshold (did not fall below the minimum RPD threshold; see explanation below).



The depth of the oxygenated layer in marine sediment is a measure of ecosystem health. A diverse bottom-dwelling community includes organisms that mix water and oxygen down into the sediment. In an over-enriched environment, organic material deposited on the sediment surface can use up the available oxygen and smother the bottom-dwelling community. Such areas, including some areas of Boston Harbor, have a thin or nonexistent oxygenated layer. The thickness of the oxygenated layer is called the redox potential discontinuity (RPD) depth. In MWRA’s monitoring program, the RPD depth is estimated from sediment-profile images, cross-sections of the upper several centimeters of the sediment taken with a special mud-penetrating prism and camera. The threshold for RPD is half the mean measured in the baseline period (that is, if the thickness of the oxygenated layer fell to less than half the thickness measured pre-discharge, a caution threshold would be exceeded.)

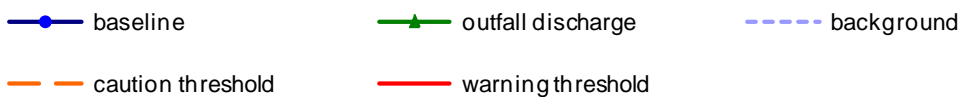
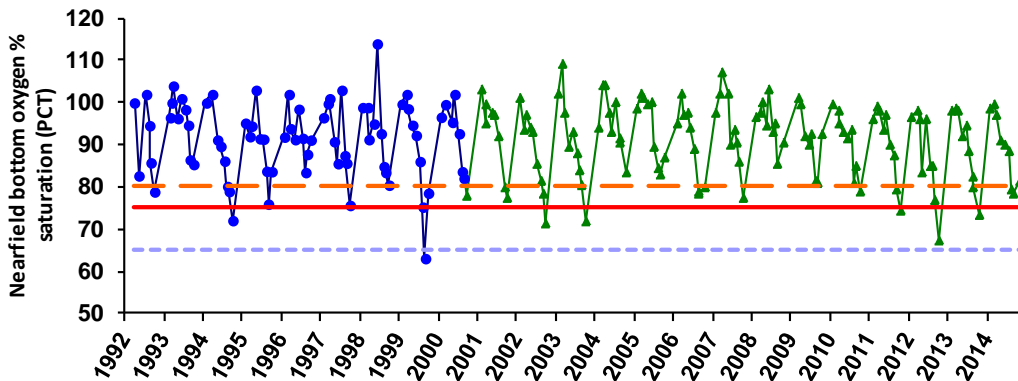
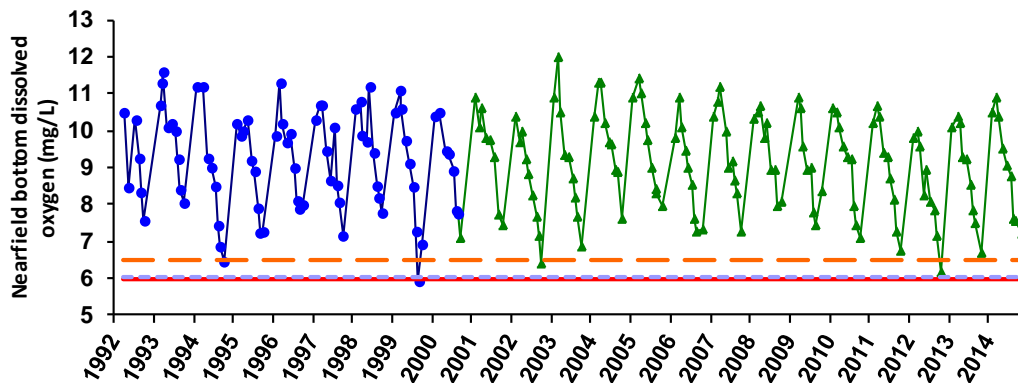
DISSOLVED OXYGEN (DO) – October 2014

Measurements of dissolved oxygen (DO) concentration (mg/L) and percent saturation in autumn 2014 did not fall below background levels used designated as the lower-limit thresholds and thus did not trigger an exceedance. The comparisons for these parameters are unusual in that there is no threshold exceedance unless the survey mean is below both the threshold value (caution or warning) and the background value. The background values are calculated from data gathered during the baseline period (summers of 1992 through 1999).

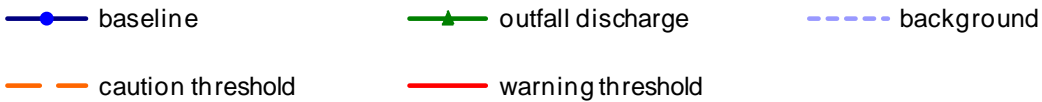
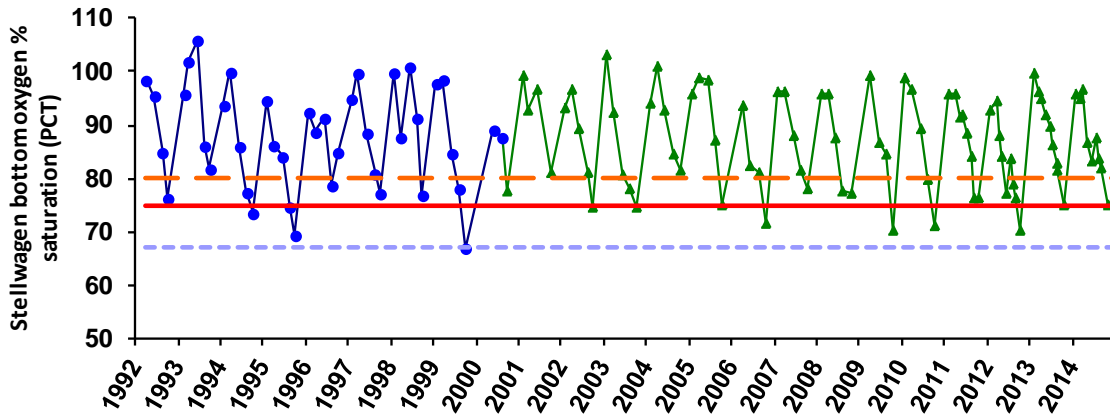
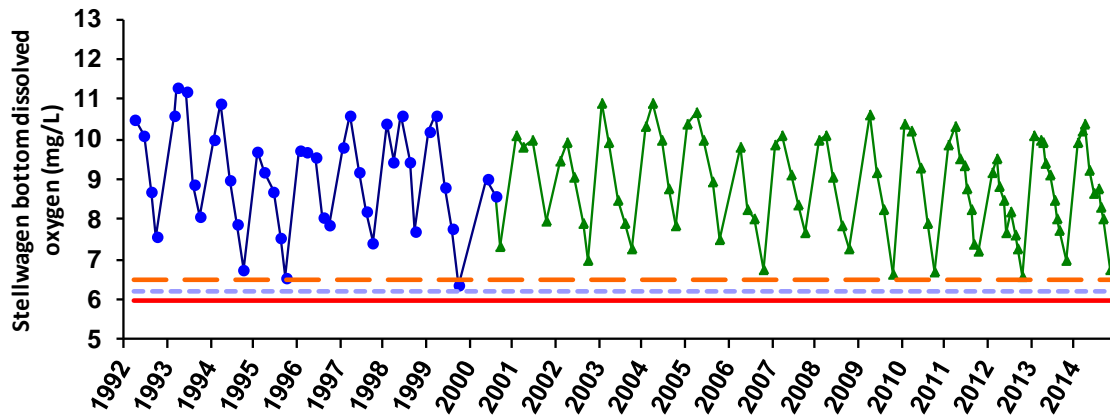
The current reporting period for [dissolved oxygen thresholds](#) is October 2014. During this period there was one survey. The graphs below show the natural annual fluctuation of DO and percent saturation, which is typically lowest in early autumn. The 1992-2010 data shown are a subset of all data reflecting the modified design that began in 2011, *i.e.* nine surveys per year, and one station rather than four in Stellwagen Basin. This enables us to better compare the threshold results across years. The previous reports are at <http://www.mwra.state.ma.us/harbor/html/archive.htm#cpqamb>.

Nearfield oxygen levels in October 2014 were somewhat higher than in the previous five years. Stellwagen Basin oxygen levels were similar to the same time period last year and above threshold levels.

NEARFIELD

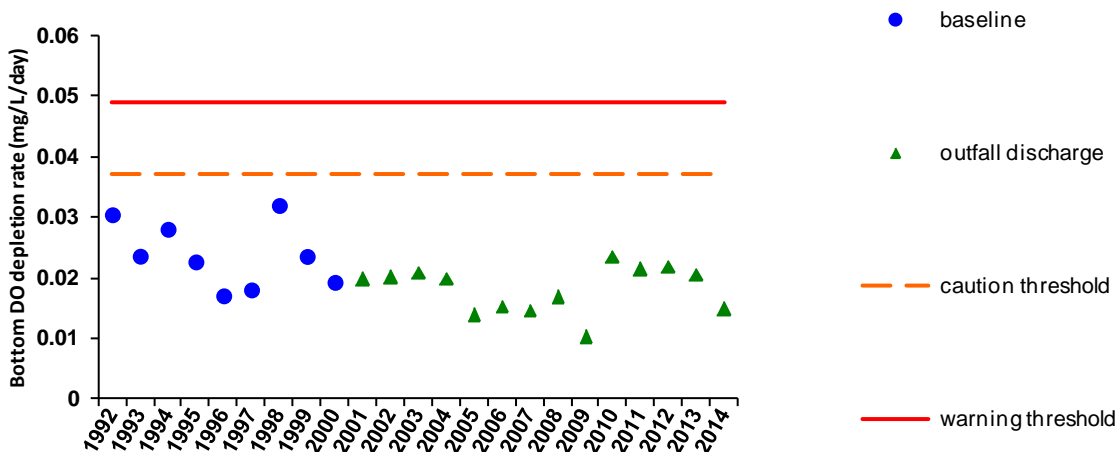


STELLWAGEN BASIN



DO DEPLETION RATE – summer 2014

An additional threshold measure of dissolved oxygen is the rate at which bottom water oxygen is depleted during the stratified summer period. The current reporting period for oxygen depletion rate is summer 2014, defined as June -October. The DO depletion rate for the summer of 2014 was lower than all but three post-discharge years, all pre-discharge years, and well below the threshold.



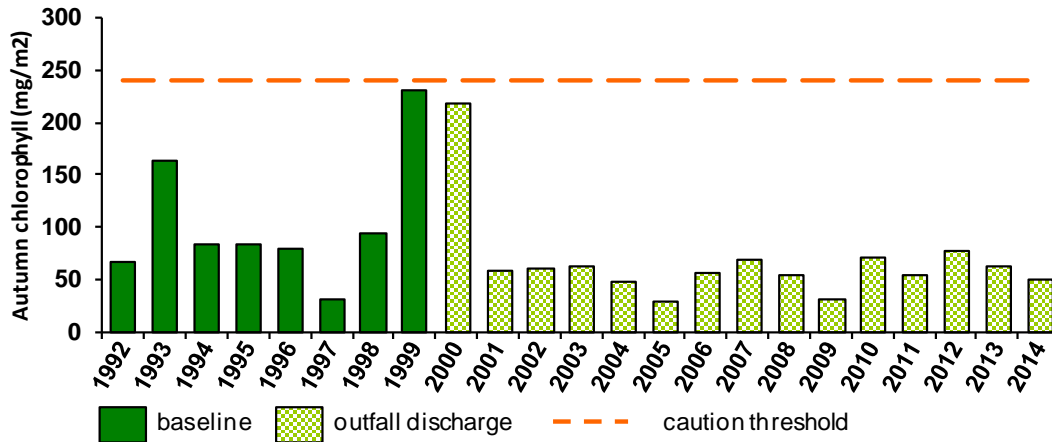
Even if dissolved oxygen concentrations remain healthy, an excessively rapid rate of decrease could signal a future problem. A low rate indicates DO dropped only slowly. The threshold for DO depletion rate is based on a change from the baseline rate; the caution threshold is a rate faster than 1.5 times the baseline mean rate, while the warning threshold is twice the baseline mean rate.

CHLOROPHYLL – September-November 2014 and Annual 2014

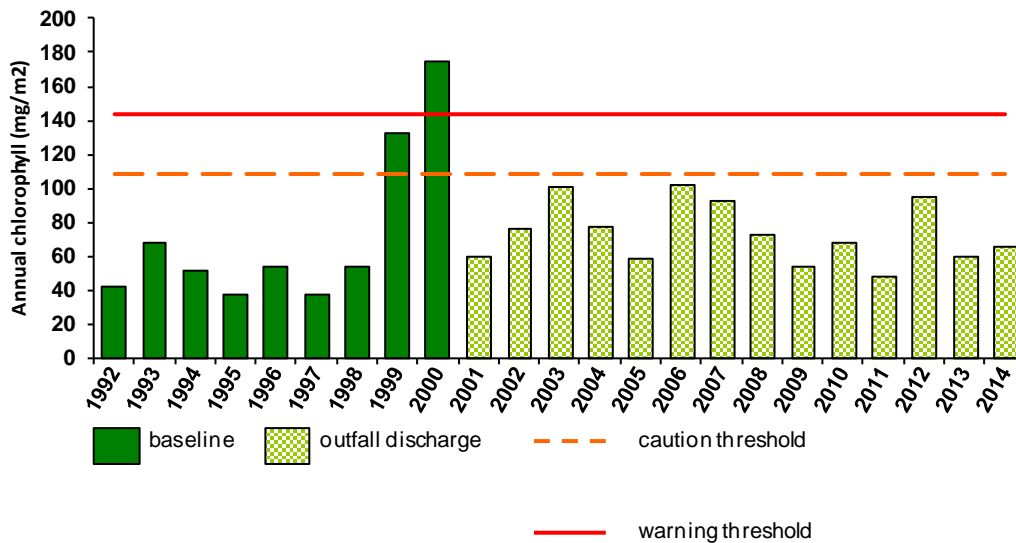
There were no [chlorophyll threshold](#) exceedances for either autumn 2014 or for the entire year. The nearfield mean areal average chlorophyll in autumn 2014 was 50 mg/m², well below the caution level threshold for autumn of 239 mg/m² and in the lower end of the range typical of the pre-discharge period. The 2014 annual average was 66 mg/m², well below the caution and warning thresholds for annual average chlorophyll of 108 and 144 mg/m², respectively. Both autumn and annual results were similar to other years in the pre-diversion and post-diversion periods.

The figures below compare chlorophyll data for autumn (September-October), which includes two surveys, and data for the entire year to the corresponding thresholds. The graph includes data since the start of the monitoring program in 1992; however, the seasonal average values for 1992-2010 are calculated using a subset of all results reflecting the current monitoring design, *i.e.* two autumn surveys. This enables us to better compare the threshold results across years. The previous reports are at <http://www.mwra.state.ma.us/harbor/html/archive.htm#cpqamb>.

Autumn



Annual



NUISANCE ALGAE – SUMMER and AUTUMN 2014

There were no threshold exceedances for *Pseudonitzschia* or *Alexandrium*. A previously-reported exceedance for *Phaeocystis* is confirmed based on the full summer data set; there is no *Phaeocystis* exceedance in the autumn.

In the figures below, we compare *Phaeocystis* and *Pseudonitzschia* data to the [nuisance algae thresholds](#) for summer 2014 (May through August), which included four surveys, and autumn 2014 (September – October), which included two surveys. We also compare *Alexandrium* data to the threshold for each sample in August – October 2014. (January – July *Alexandrium* data were reported in earlier quarterly reports.)

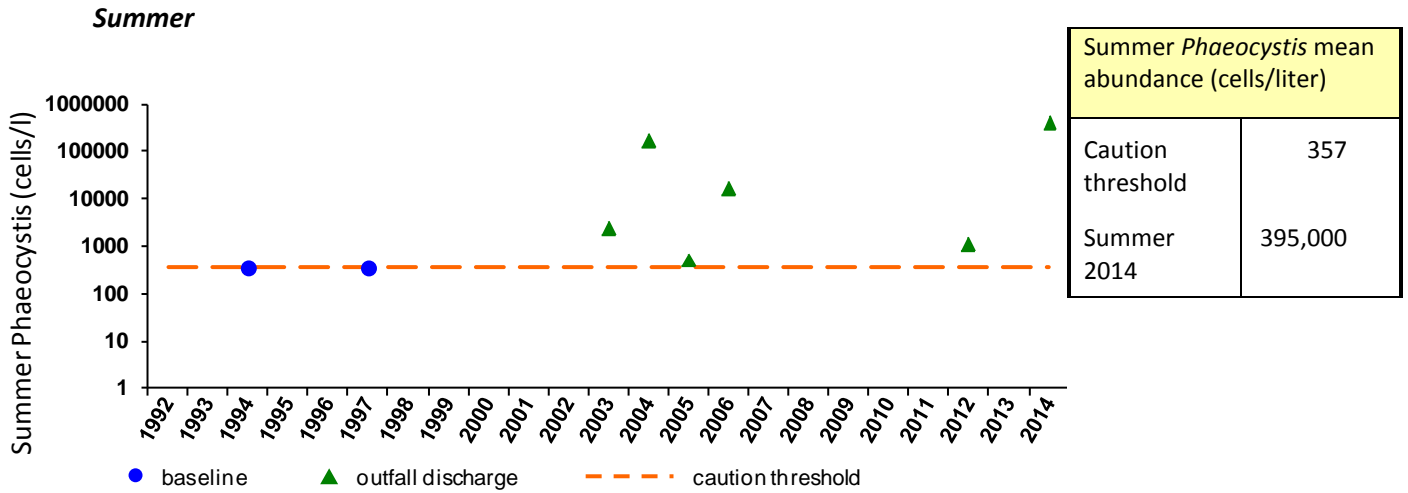
The graphs include data since the start of the monitoring program in 1992; however, the seasonal average values for 1992-2010 are calculated using a subset of all results reflecting the modified design that began in 2011, *i.e.* two rather than four autumn surveys. This enables us to better compare the threshold results across years. The previous reports are at <http://www.mwra.state.ma.us/harbor/html/archive.htm#cpqamb>.

PHAEOCYSTIS

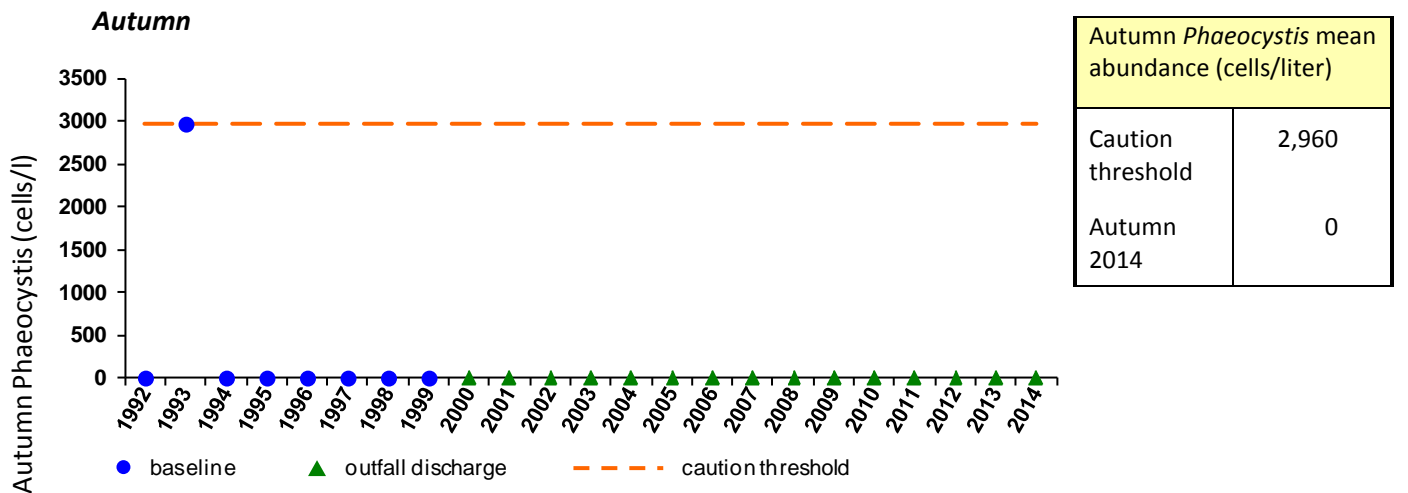
All eight samples collected in the nearfield on May 9, 2014 contained *Phaeocystis*, with the highest abundances found in samples collected at depth, indicating a senescent bloom with colonies settling out of the water column. Two of the eight samples collected in the nearfield on June 14, 2014, both collected at depth, contained *Phaeocystis*, both at low abundances, an apparent remnant of the earlier bloom. No *Phaeocystis* was observed during the subsequent July and August surveys, which are included in the Contingency Plan summer seasonal threshold. Nevertheless, due to the high counts in May, the mean for summer 2014 was 395,000 cells/L, which is above the Caution Level threshold of 357 cells/L that triggered a notification (see http://www.mwra.state.ma.us/harbor/pdf/20140905_amx.pdf) under the Contingency Plan.

Investigations by MWRA suggest it is likely that exceptionally cold ocean temperatures in late spring of 2014 delayed the onset of the typical large spring *Phaeocystis* bloom, extending it into May when it already showed signs of abating. If this is so, the threshold exceedance is not an indication of a summertime bloom of *Phaeocystis*, but rather a shift in the timing of the spring bloom extending it into early summer where the threshold levels (determined from baseline conditions) are much lower. MWRA presented this evaluation to regulators and their Outfall Monitoring Science Advisory Panel (OMSAP) in September 2014. OMSAP concurred with this evaluation,

and requested MWRA evaluate and suggest alternative thresholds that might be less sensitive to temporal shifts in bloom dynamics.



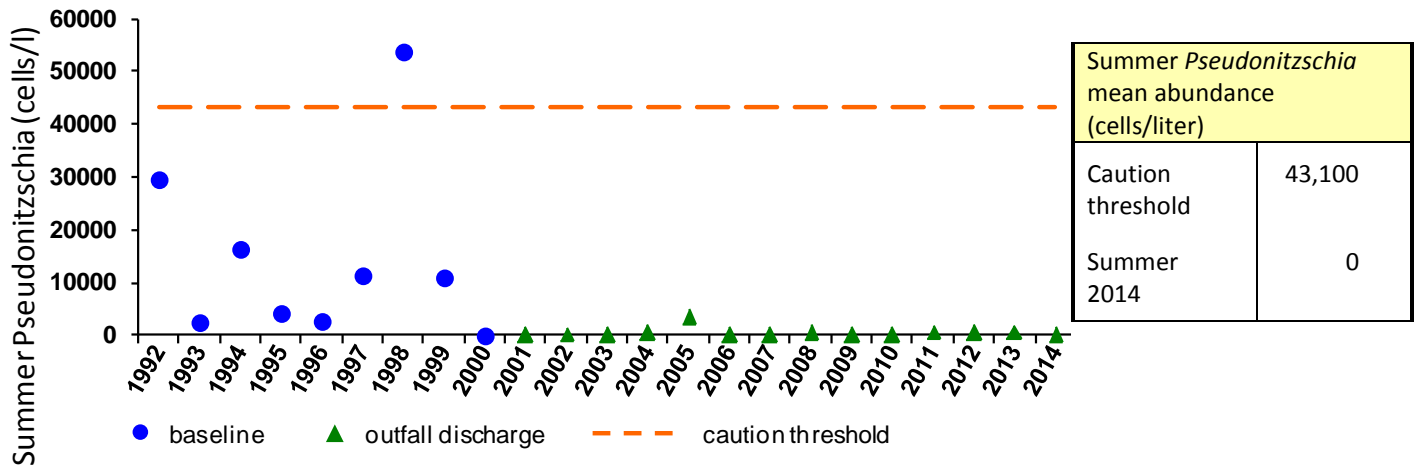
Note logarithmic scale. Years with no data point had zero summer average *Phaeocystis*.



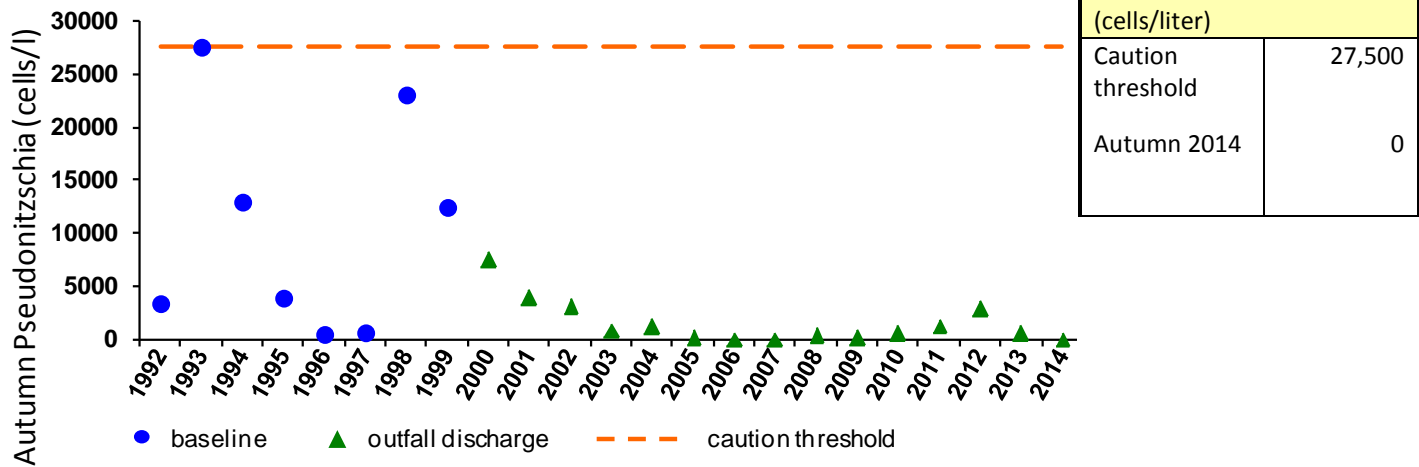
PSEUDONITZSCHIA

Pseudonitzschia was not observed in the summer and autumn of 2014.

Summer



Autumn



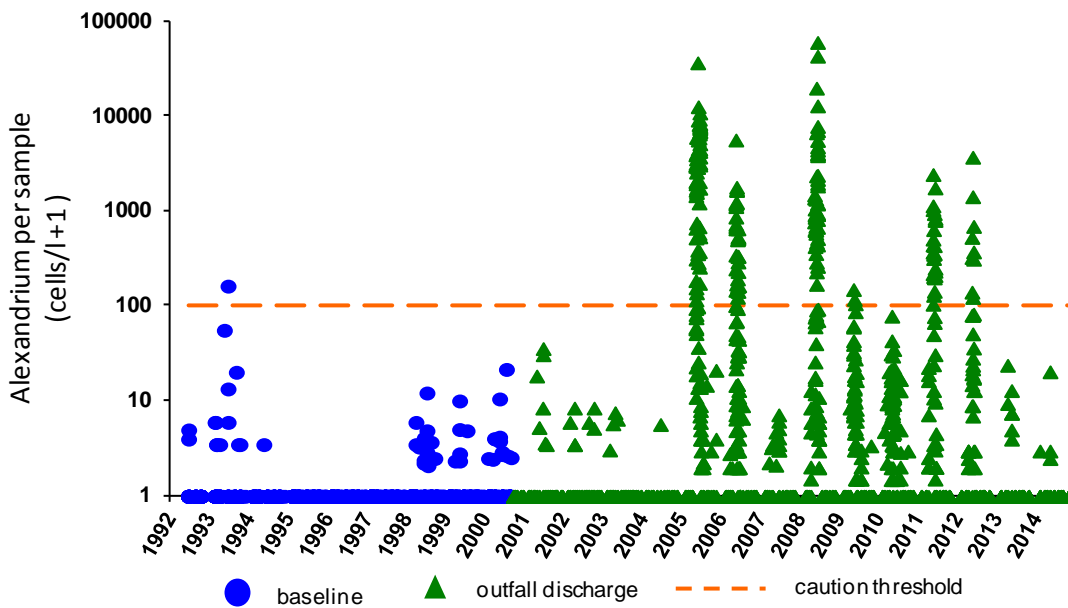
ALEXANDRIUM

The [nuisance algae](#) *Alexandrium* (“red tide”) can cause paralytic shellfish poisoning (PSP) in Massachusetts Bay. MWRA measures *Alexandrium* abundance in its monitoring program, and also checks state fisheries agency observations of shellfish PSP toxicity to keep track of the course of Gulf of Maine *Alexandrium* blooms, which are known to typically be the source for *Alexandrium* in Massachusetts Bay.

As reported previously, in 2014 *Alexandrium* was almost entirely absent from Massachusetts Bay. Final data have been received for surveys in July through October. In the May-June time period when *Alexandrium* has historically bloomed in Massachusetts Bay, in 2014 the levels remained very low. During July through October, we observed no *Alexandrium*. The figure below shows *Alexandrium* in the nearfield since 1992. The bottom figure shows the same data but includes just February through October 2014; during this period there were nine routine surveys. Note logarithmic scale for graphs.

Alexandrium abundances from MWRA’s water quality monitoring surveys are consistent with the results of regional monitoring in 2014 for the paralytic shellfish poisoning (PSP) toxicity that *Alexandrium* causes. Shellfish beds in western Maine, coastal New Hampshire, and in Massachusetts north of Gloucester all developed toxicity in late May and early June, and were closed by state regulators. Moderately high counts of *Alexandrium* were observed in coastal and offshore waters north of Cape Ann at about the same time. Detectable PSP toxicity did not extend south of Cape Ann (Gloucester) into Massachusetts Bay, though, consistent with cell counts from MWRA’s monitoring. By late June, toxicity and cell counts were declining in North Shore shellfish and water samples.

Results through July were reported in previous quarterly reports; this report focuses on results for August through October.



August-October <i>Alexandrium</i> per-sample abundance (cells/liter)	
Caution threshold	100
August- October 2014	0*
* maximum of all samples collected between August 1 and October 31, 2014	

