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Contingency Plan Report
Fourth Quarter 2002

Ambient Monitoring

MWRA gathers data from the outfall location in Massachusetts Bay on various thresholds outlined in its Deer Island outfall discharge permit. This report shows relevant ambient monitoring results that became available in the fourth quarter of 2002.

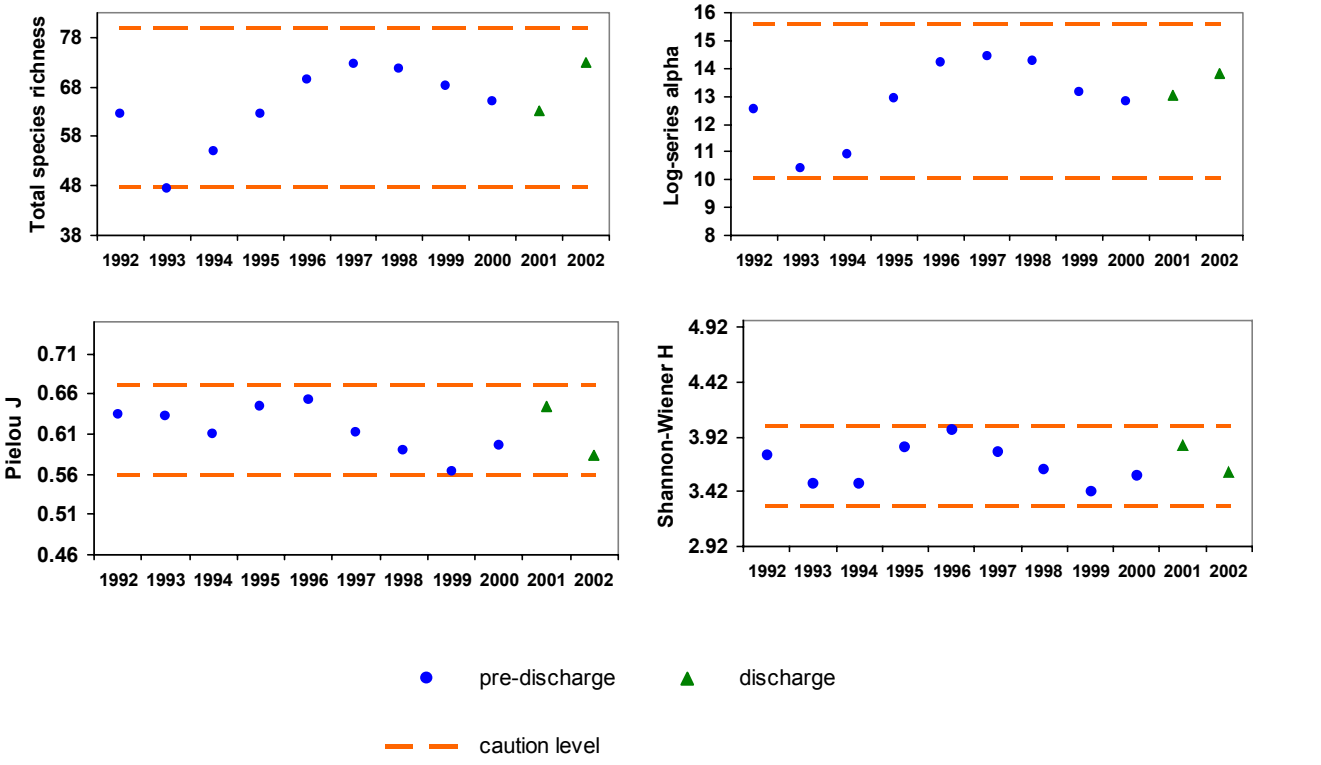
SEDIMENT BIODIVERSITY

One way to track the status of a marine ecosystem is to measure the diversity of the organisms in the communities that comprise the ecosystem, such as the soft-sediment communities (benthic infauna) in the sediment. The benthic diversity thresholds are intended to indicate whether there is a change from baseline conditions (either toward more or less diversity) now that the outfall is discharging. Of the dozens of statistical measures of diversity that have been developed by researchers over the past few decades, four are tracked within the MWRA monitoring program to show possible changes in diversity.

Two of these indices, total number of species per sample and Fisher's log-series alpha, are measures of species richness (how many species are present). Both measures track species richness while total species per sample is easy to describe to a general audience, Fisher's Log-series alpha has a theoretical grounding favored by some researchers. The other two diversity indices tracked by MWRA's monitoring are among those most commonly used by ecologists in many environments. Pielou's *J'* is a measure of how evenly individuals are distributed among species in a community. Samples where most species have about the same number of individuals have high evenness, while samples where most of the individuals belong to one or a few species have low evenness. Finally, Shannon-Wiener *H'* is a diversity measure that is sensitive both to species richness and to species evenness in a community.

For each diversity measure, these graphs show the annual average for all sediment samples collected within seven kilometers of the outfall discharge. The extreme winter storms of December 1992 caused 24-foot seas in the vicinity of the outfall, moving sediments and burying some areas under inches of sand, mud, or gravel even though the ocean is about 100 feet deep in the area. This physical disturbance was the cause of the decline seen in the two richness indices between 1992 and 1993. The communities recovered rapidly, and by the late 1990s appeared to be showing a several-year cycle in species richness (data from farfield stations also show this apparent trend).

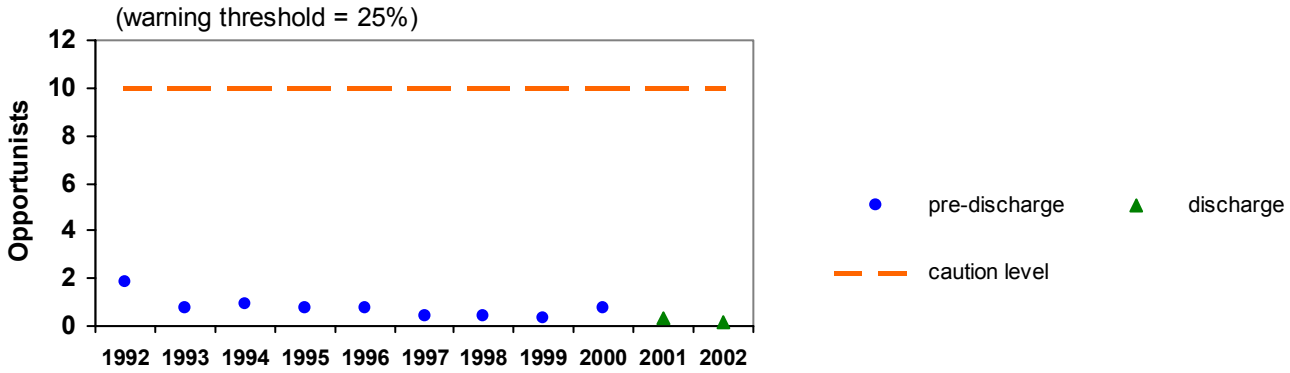
The annual survey of post-discharge monitoring in 2002 showed that the benthic diversity was normal at the outfall site and did not exceed any of the thresholds.



Another measure of possible pollution impact on sediments in the vicinity of the outfall is the presence of pollution-tolerant or opportunistic species. These are species that can build up to high population levels in response to, for example, increased deposition of organic matter. In their selection of an outfall location in 1988, EPA modeled the deposition of organic matter and determined that with a secondary discharge, impacts would be minimal.

Based on a review of the species found in Boston Harbor, Massachusetts Bay, and Cape Cod Bay sediments during baseline sampling, several species have been identified as opportunists: *Capitella* spp. *and Capitella capitata* complex, *Polydora cornuta*, *Streblospio benedicti*, *Ampelisca abdita*, *Ampelisca vadorum*, *Ampelisca macrocephala*, and *Mulinia lateralis*. The *Ampelisca* species were included in the list because they are tolerant to moderate levels of organic enrichment, even though they cannot tolerate high levels. For example, the appearance of large populations of *Ampelisca* in Harbor sediments in the mid-1990s was one of the early signals of the Harbor's recovery.

The Contingency Plan thresholds for percent opportunists were set well below levels seen in Boston Harbor throughout the 1990s. The annual sampling in 2002 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.



SEDIMENT CONTAMINATION

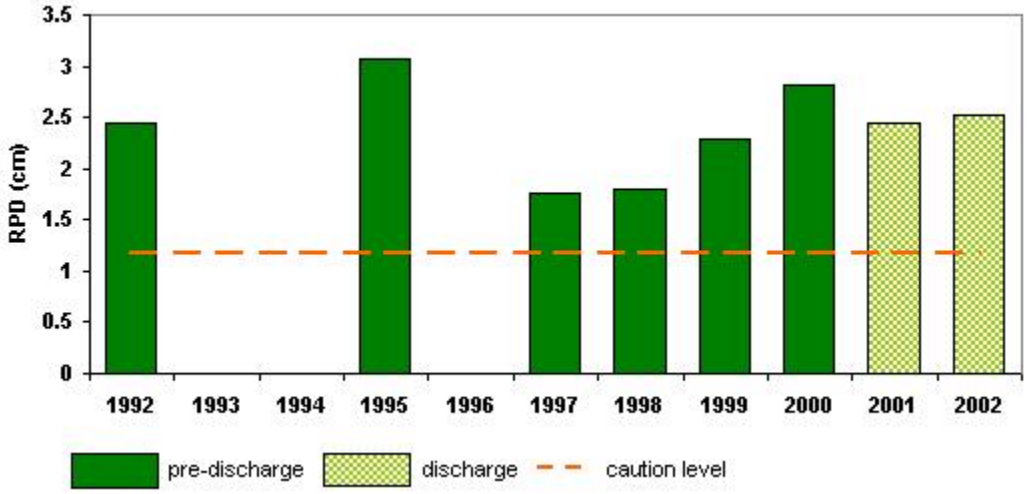
The sediment contamination thresholds will indicate any unexpected accumulation of toxic contaminants in soft sediments near the outfall. Contaminant levels measured each year are compared to sediment guidelines issued by the National Oceanic and Atmospheric Administration (NOAA). These NOAA “ERL-M” levels indicate toxic contaminant concentrations above which adverse effects on marine life are often detected. Baseline sediment contamination levels are all well below the ERL-M levels for all contaminants, with only low molecular weight polycyclic aromatic hydrocarbons (LMWPAH) reaching to more than half the threshold value. The annual post-discharge monitoring showed that sediment contamination levels at the outfall site in 2002 were well below the thresholds. Metals (except for lead) and pesticides were similar to previous years. Lead was higher than baseline at two stations, but the nearfield average was well below the threshold. PAHs were elevated over previous years because of one sample which appeared to contain coal tar. All the other stations, and the other replicates from that station (FF10), had PAH values similar to previous years. Occasional spikes in high molecular weight PAHs in single samples were observed during baseline at other stations. Pieces of furnace slag and partially burned coal have been identified in core samples by USGS researchers working in the area.

	contaminant	range over baseline	threshold	2002 value
PAHs (ng/g dry weight)				
	acenaphthene	23-41.3	500	46
	acenaphthylene	38.3-58.4	640	83
	anthracene	114.1-171	1100	264
	benz(a)anthracene	221.4-302	1600	362
	benzo(a)pyrene	223.6-287	1600	300
	chrysene	217.3-288	2800	362
	dibenzo(a,h)anthracene	30.5-42	260	59
	fluoranthene	465-592	5100	821
	fluorene	37.9-60.9	540	75
	naphthalene	53.5-83.2	2100	103
	phenanthrene	296.4-405	1500	630
	pyrene	440.3-540	2600	847
	sum HMWPAH	2986.4-3754	9600	4816
	sum LMWPAH	1420.1-2004	3160	2138
	total PAH	4482.5-5726	44792	6954
Other organic contam. (ng/g)				
	p,p'-DDE	0.28-1.25	27	0.6
	total DDT	2.59-5.27	46.1	2.3
	total PCB	10.4-28.6	180	18
Metals (ug/g dry weight)				
	cadmium	0.09-0.23	9.6	0.09
	chromium	61.9-86.8	370	79
	copper	19.2-27.6	270	25
	lead	42.9-47.2	218	68
	mercury	0.2-0.29	0.71	0.20
	nickel	15.5-18.5	51.6	17
	silver	0.47-0.71	3.7	0.49
	zinc	56.6-69.7	410	64

SEDIMENT ENRICHMENT

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.)

The 2002 annual post-discharge monitoring showed that the RPD depth was normal at the outfall site and did not exceed the threshold (did not fall below the minimum RPD threshold.)



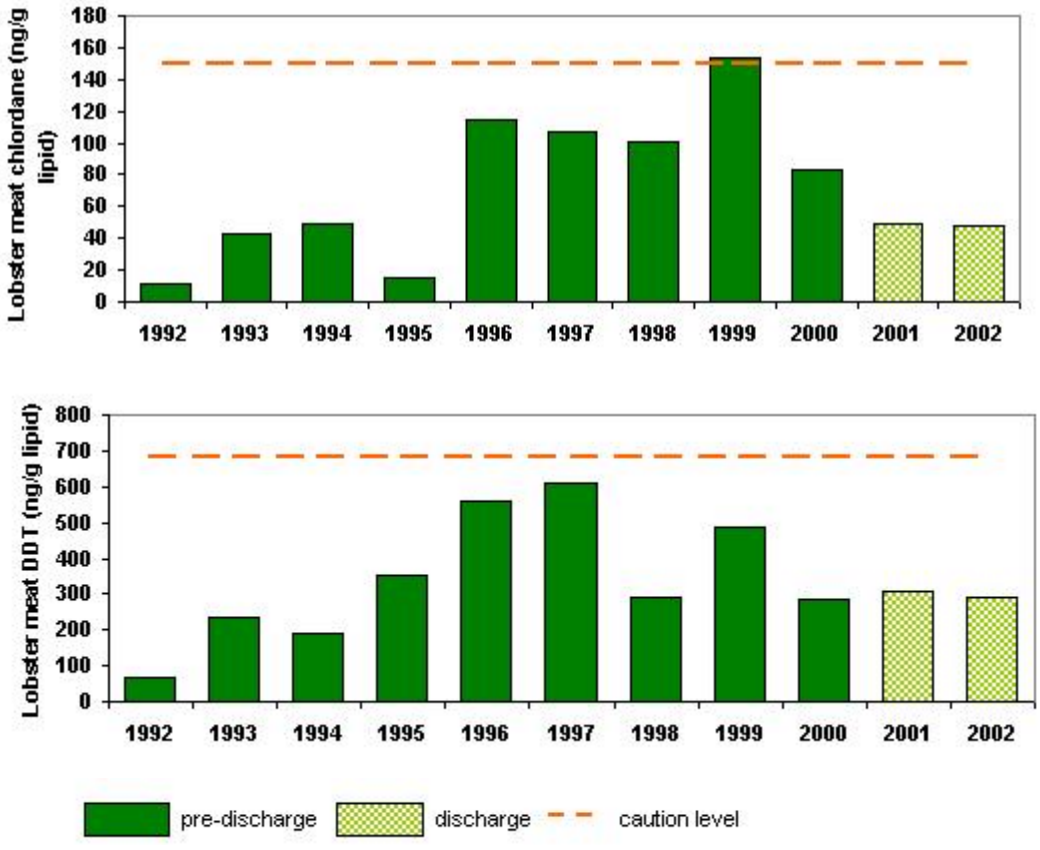
FISH AND SHELLFISH TISSUE CONTAMINATION

Contaminants are measured in three species of seafood: flounder, lobster, and mussels. FDA Action Limits exist for mercury and PCBs in flounder, lobster, and mussels; for these measurements, caution and warning thresholds are set at 50% and 80% of the FDA limits. The threshold for lead in mussels is based on EPA risk assessment of lead in drinking water. Other fish/shellfish tissue contamination thresholds are based on change from baseline conditions at the outfall site.

Data available this quarter include tissue contamination in lobster, which were sampled at the outfall site in October 2002 and in mussels, which were deployed in cages at the outfall site in June-August 2002**.**

LOBSTER

Lobster meat contamination remained low, below threshold values, and similar to other years.



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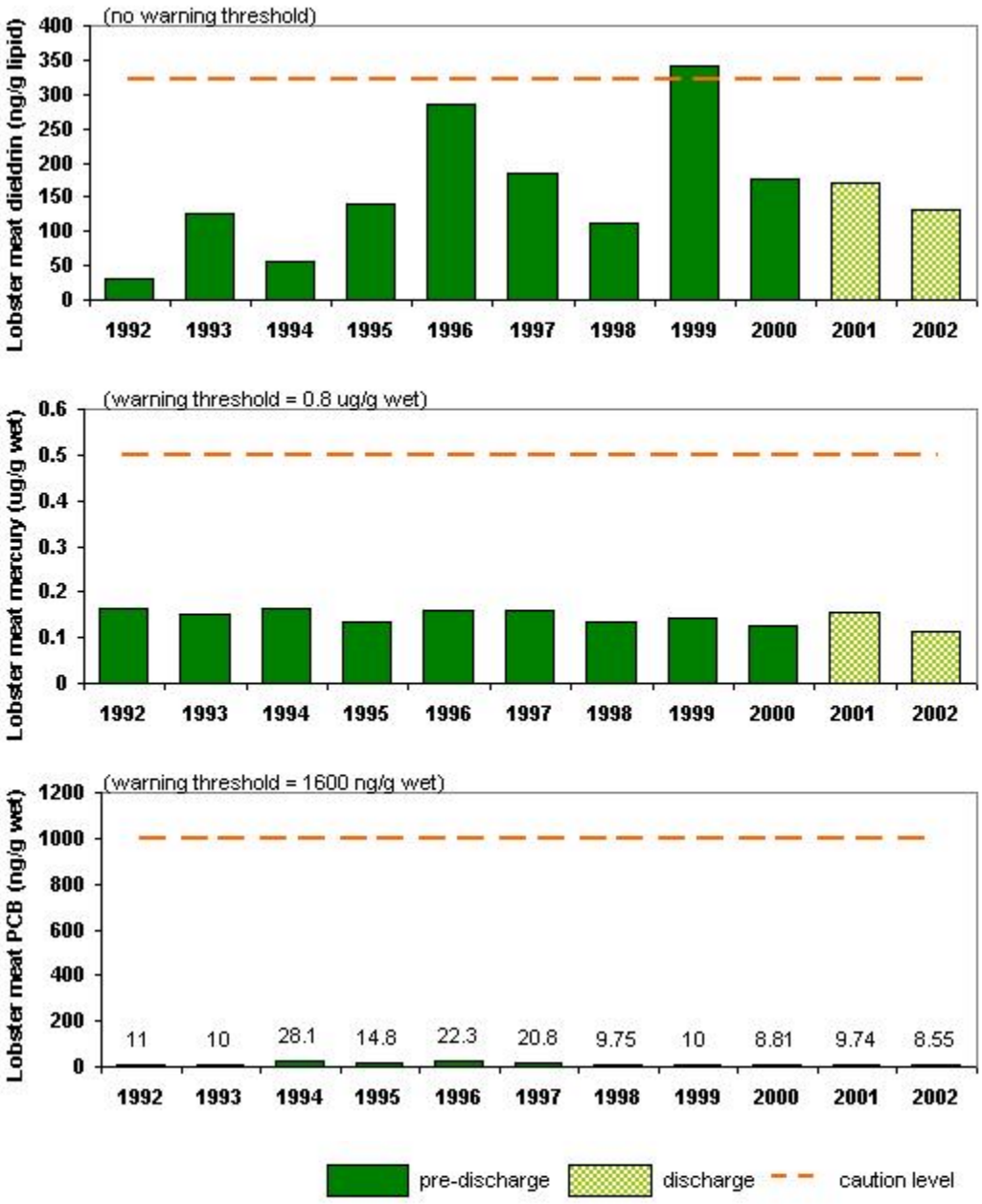
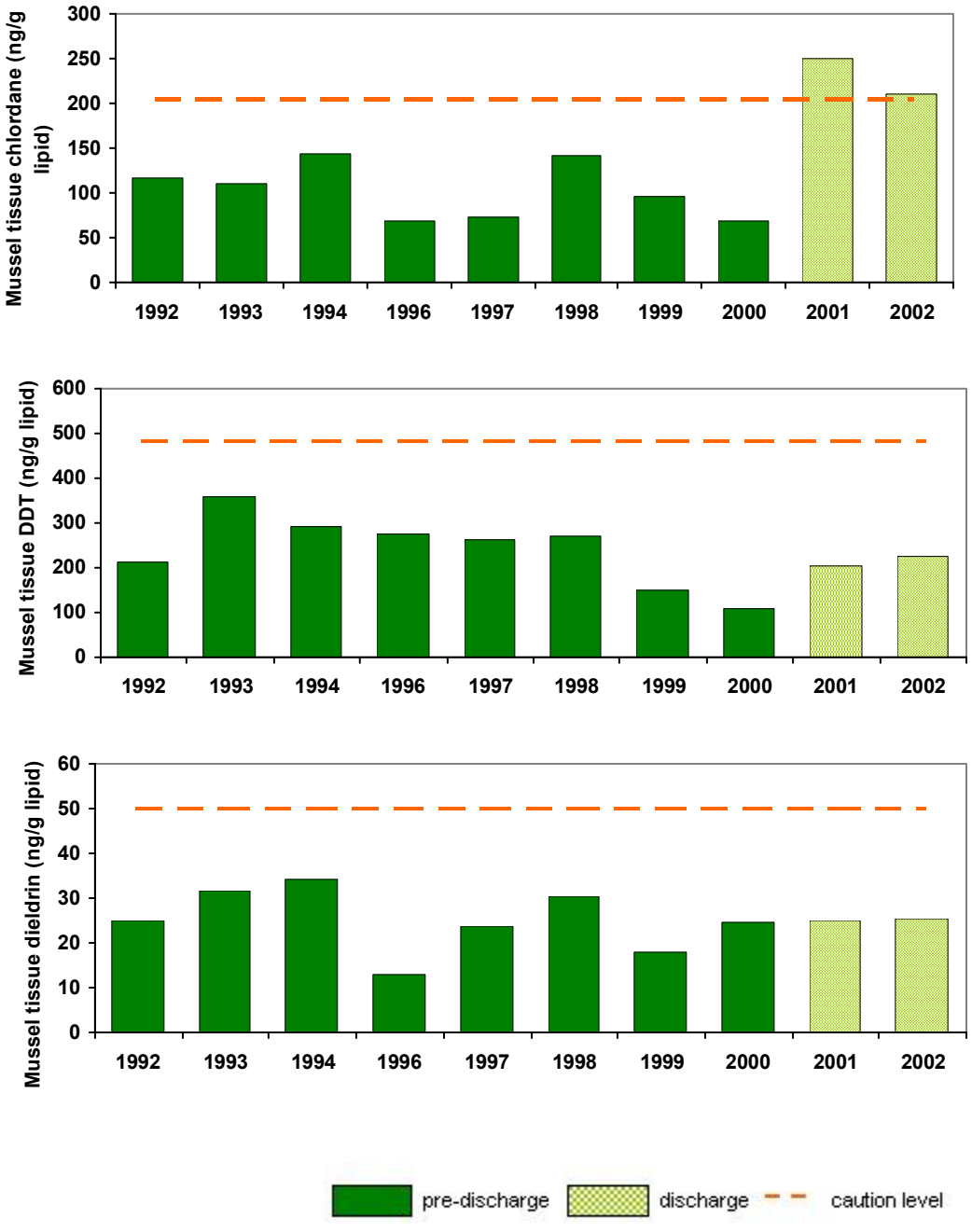
Lobster tissue contaminant levels (continued)



MUSSELS

Bioaccumulation data are available this quarter from mussels in cages recovered in August 2002. As in 2001, mussel tissue levels of chlordane and PAH slightly exceeded thresholds (see http://www.mwra.state.ma.us/harbor/pdf/20021213amx.pdf), while levels of other contaminants were similar to those measured in the baseline period. These results are similar to those observed in the 2001 mussel study, and support the conclusions drawn by MWRA's evaluation of that exceedance. That evaluation (http://www.mwra.state.ma.us/harbor/enquad/pdf/2002-05.pdf) concluded that the concentrations of PAHs and chlordane seen in mussels in 2001 were to be expected given current understanding of bioaccumulation processes, and that they were low and represented no threat to mussel health.



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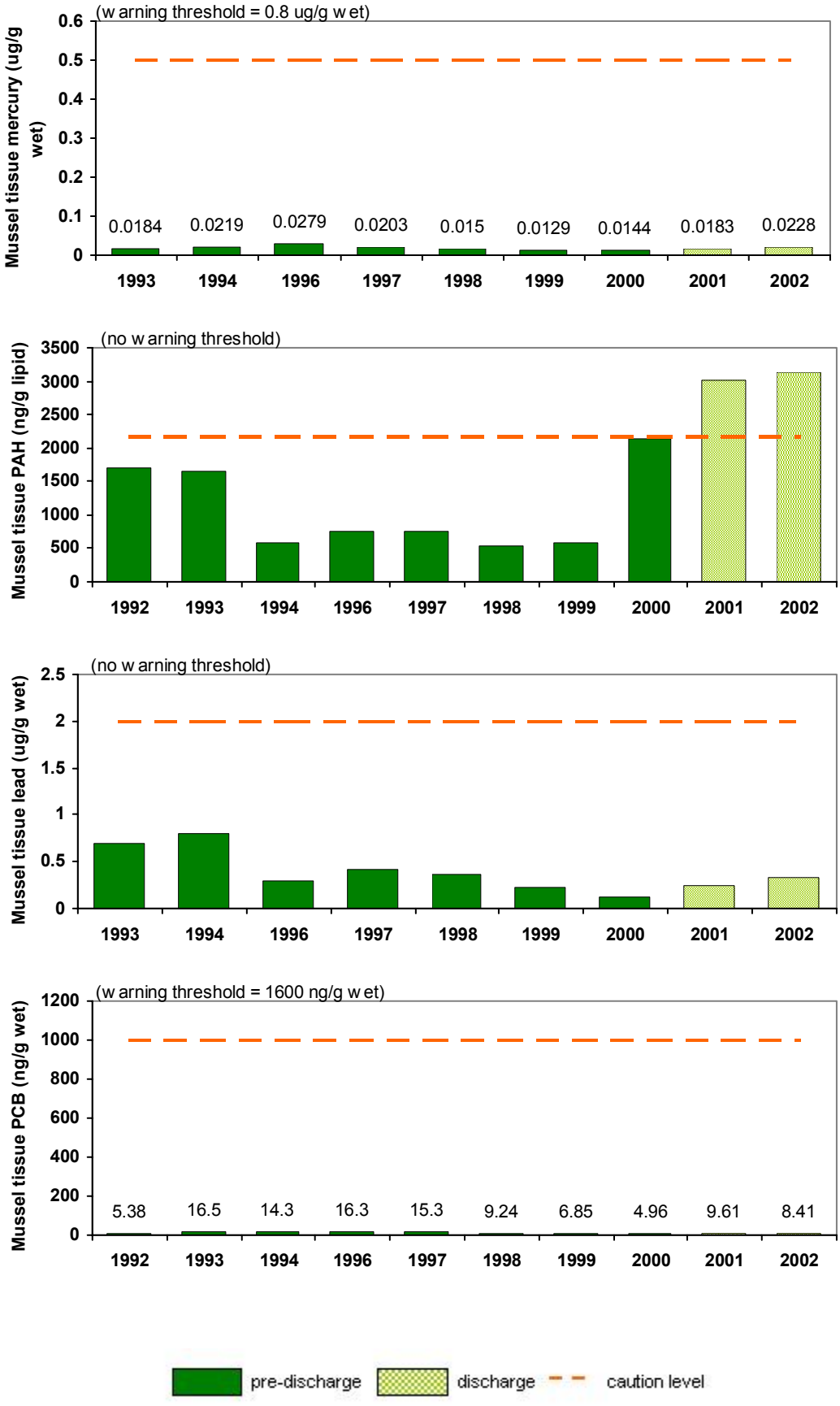
Mussel tissue contaminant levels (continued)



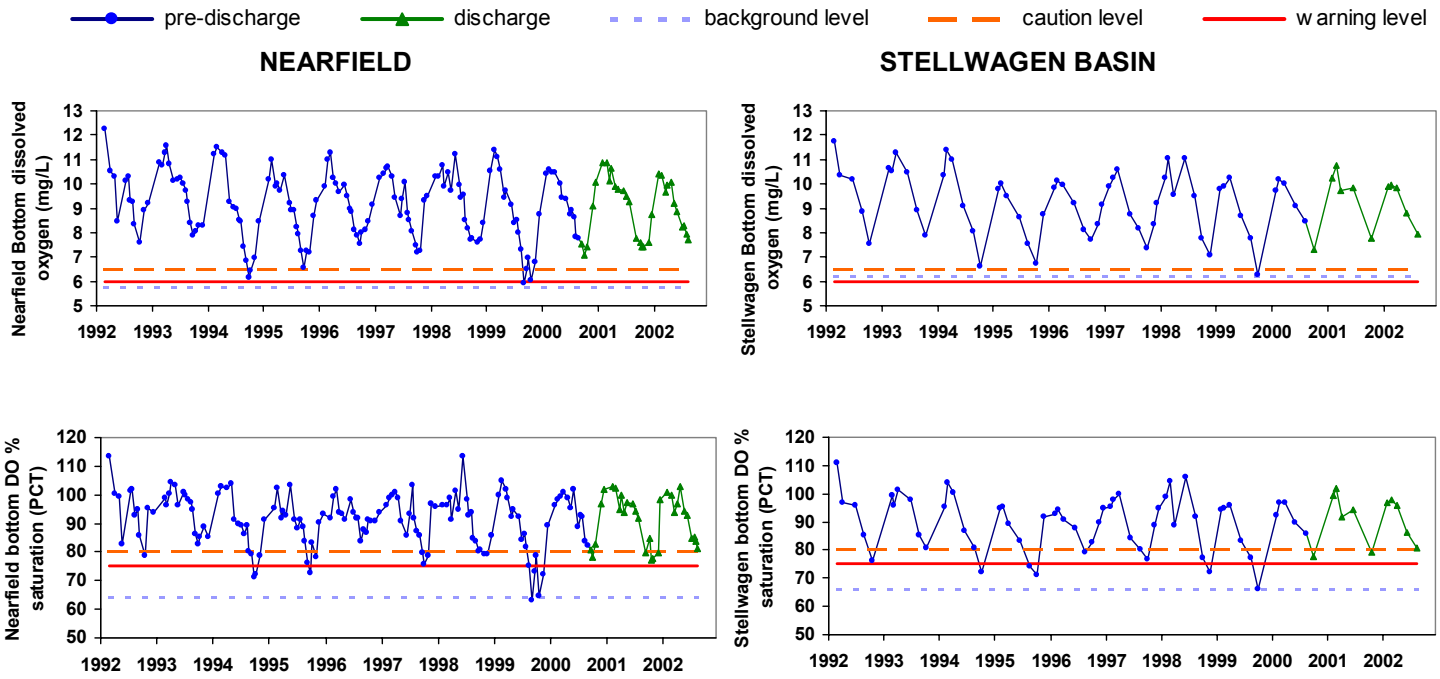
DISSOLVED OXYGEN

The concentration of dissolved oxygen (DO) in the water indicates the balance between production by algae and consumption by aquatic organisms and the decomposition of organic matter. Excessive organic matter may result in oxygen depletion, which may in turn adversely affect the aquatic ecosystem. The amount of oxygen that the water can hold is related to water temperature, salinity, and pressure; thus, the percent saturation of dissolved oxygen is a measure that takes these factors into account. Monitoring locations for which there are DO thresholds include the "nearfield," the group of stations within about three miles from the outfall, and "Stellwagen Basin," a deep area nine miles east of the outfall. Thresholds apply to the part of the year when the water column is stratified, *i.e.* from June - October. The current reporting period for dissolved oxygen thresholds is July-August 2002. During this period there were one farfield survey and five nearfield surveys.

Dissolved oxygen concentration and percent saturation naturally fall below the numerical thresholds on occasion during the baseline period. The state standard, on which the thresholds were based, allows an exception if background conditions are lower, as is the case here; thus, the threshold is not exceeded unless the value falls below the threshold and below background.

Parameter	Location	Caution	Warning	Background
Dissolved Oxygen (mg/L)	Nearfield	6.5	6.0	5.75
	Stellwagen Basin	6.5	6.0	6.2
Percent Oxygen Saturation (%)	Nearfield	80	75	64.3
	Stellwagen Basin	80	75	66.3

Measurements of dissolved oxygen (DO) concentration and percent saturation in summer 2002 did not exceed thresholds. The graphs below include data since the start of the monitoring program in 1992, and reflect the natural fluctuation of DO and percent saturation, which is typically lowest in early fall.



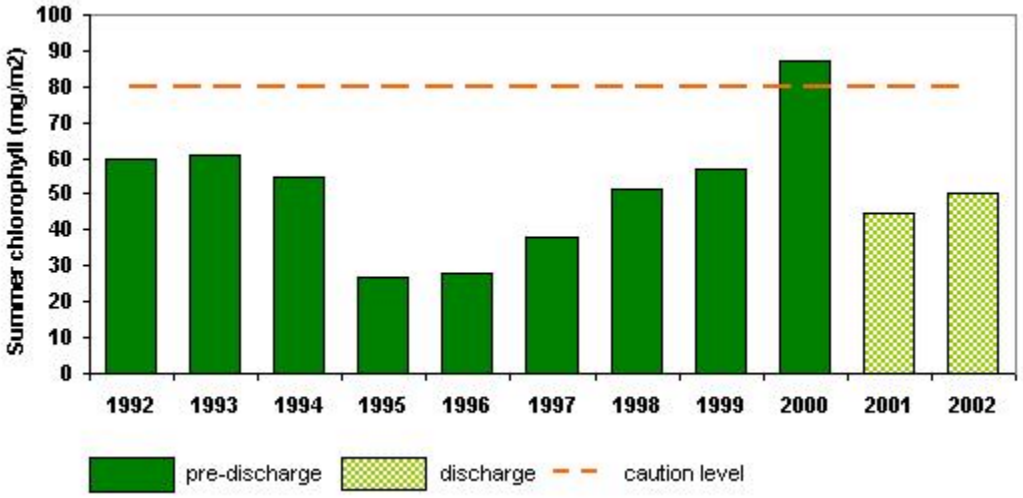
CHLOROPHYLL

Chlorophyll is a measure of the amount of microscopic plants (phytoplankton or algae) in the water. In Massachusetts Bay, production of algae is the basis of the food web. However, excessive growth of algae can lead to undesirable consequences, such as oxygen depletion at depth due to decomposition of organic matter. Effluent from the outfall is rich in nutrients, and therefore could potentially cause excessive algal growth.

There are annual and seasonal chlorophyll thresholds for the "nearfield," the group of stations within about three miles from the outfall which are most likely to be affected by nutrient-rich effluent. Because the levels of chlorophyll in the water naturally vary over the year, there are separate thresholds for different seasons. In most years, Massachusetts Bay experiences a “spring bloom” characterized by high chlorophyll levels as lengthening days provide enough sunlight for algae to grow quickly. Chlorophyll typically drops in summer, as the nutrients in well-lit surface waters are used up. When the weather cools, the surface and bottom waters mix, which usually gives rise to a “fall bloom” as nutrient-rich bottom waters are mixed up into the well-lit surface layers. As the days become short, chlorophyll levels drop again since there is not enough light for algae to grow.

In this report, we compare post-discharge chlorophyll data to the thresholds for summer 2002 (May-August), which included seven nearfield surveys. The graphs include data since the start of the monitoring program in 1992, and reflect the natural fluctuation of chlorophyll described above. The caution level threshold for summer is 80 mg/m^2(areal average of nearfield). The nearfield mean areal average in summer 2002 was 50 mg/m^2, within the baseline range and below the summer threshold of 80 mg/m^2.

SUMMER



NUISANCE ALGAE

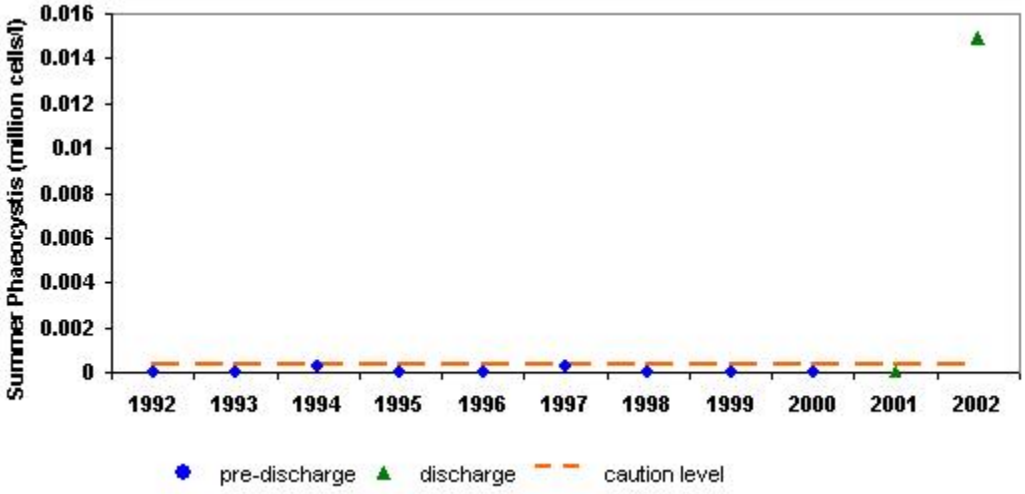
Nuisance algal blooms are less predictable than the normal, beneficial algal blooms which produce oxygen and food for marine life; some nuisance blooms did occur during the baseline monitoring period. There is public concern that effluent nutrients could feed a red tide bloom in the vicinity of the new outfall, or otherwise increase the abundance of nuisance algae. Therefore, the Contingency Plan has thresholds for abundance of *Alexandrium*, *Phaeocystis pouchetii*, and *Pseudonitzschia*, which are triggered if the abundance of any of these becomes unusually high.

In this report, we compare post-discharge nuisance algae data to the thresholds for summer 2002 (May-August), which included 7 nearfield surveys. We also compare the per-sample results for *Alexandrium* in July and August 2002 surveys to the threshold.

PHAEOCYSTIS

Phaeocystis pouchetii blooms usually occur during February to April but can occur at any time. The species is not toxic, but individual cells can aggregate in gelatinous colonies that may be poor food for zooplankton. *Phaeocystis pouchettii* were observed in the nearfield until a survey on May 1, 2002. The May observation was the tail end of a typical, moderate spring bloom of *Phaeocystis*. The very low summer threshold was exceeded for the May-August 2002 time period (see http://www.mwra.state.ma.us/harbor/pdf/20021209amx.pdf.) Despite this summer exceedance, there is no indication that this bloom was at a level of concern. Rather, the 2002 spring bloom of *Phaeocystis* was small and not unusual. It exceeded the summer threshold only because a survey normally carried out in late April was delayed to May 1 because of weather, which put it in the "summer" period as defined by the Contingency Plan. The average abundance for the summer season exceeded the very low summer caution level because the preceding spring bloom, although rapidly declining, was still detectable. The rest of the samples collected during the summer detected no *Phaeocystis*.

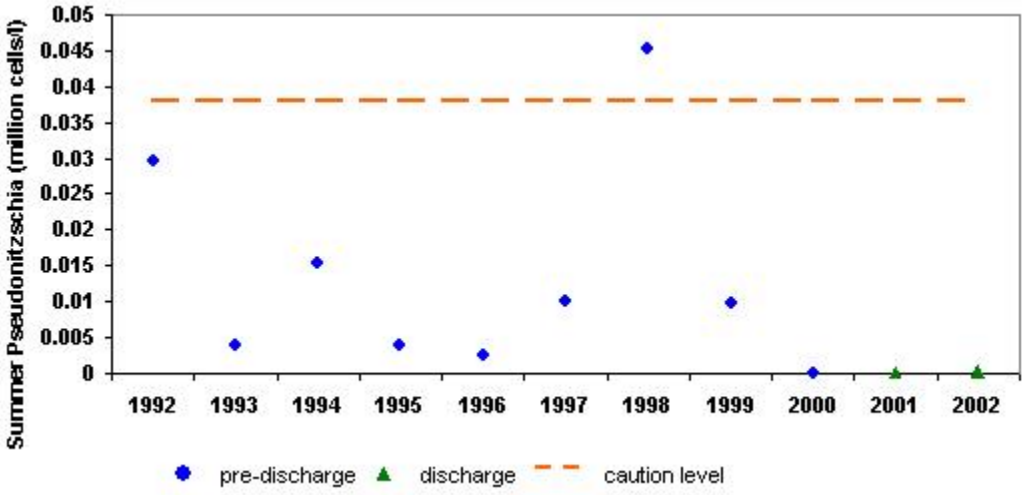
Summer *Phaeocystis* mean abundance (cells/liter)	
caution threshold	334
Summer 2002	14,900



PSEUDONITZSCHIA

Pseudonitzschia multiseries blooms can occur during November to March and produce domoic acid, which can cause a condition known as amnesic shellfish poisoning. The group of algae including the toxic species *Pseudonitzschia multiseries*, the closely related *Pseudonitzschia pungens*, and any unidentified *Pseudonitzschia* species was present only at low abundances in the nearfield in summer 2002, well below the threshold.

Summer *Pseudonitzschia* mean abundance (cells/liter)	
caution threshold	37,900
Summer 2002	191



ALEXANDRIUM

No samples exceeded the threshold of 100 cells/liter during the present reporting period (mid-late summer 2002.) *Alexandrium tamarense* typically may bloom during April to June and can cause paralytic shellfish poisoning, known as PSP or red tide; it has been periodically found in Massachusetts since the 1970s. Toxicity is generally not found in shellfish until much higher cell counts are seen in the overlying waters. In the early summer, historically the time of highest *Alexandrium* counts, *Alexandrium* cells (*Alexandrium tamarense* plus unidentified *Alexandrium* spp.) were observed in a few samples.

Late summer *Alexandrium* per-sample abundance (cells/liter)	
caution threshold	100
July-August 2002*	10

* maximum of all samples collected between July 1, 2002 and August 31, 2002.