Pleasant Bay Alliance Water Quality Monitoring Program: Statistical Analysis of 2000-2014 Water Quality Monitoring Data

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Executive Summary

Introduction

Pleasant Bay is an estuarine system located on Cape Cod in the Towns of Orleans, Chatham, Harwich, and Brewster, Massachusetts. The Pleasant Bay Alliance (Alliance) was formed in 1998 to oversee the implementation of a resource management plan for Pleasant Bay developed by the four towns. A key component of the resource management plan has been bay-wide water quality monitoring. Fifteen consecutive years of water quality data have been collected, at the time of this analysis, at sites throughout Pleasant Bay and its sub-embayments. In an effort to better understand these data to guide management planning, the Alliance retained The Cadmus Group, Inc. to update the statistical and trend analysis of monitoring data previously completed in 2010 (The Cadmus Group, 2010) to include results of 2010-2014 sampling.

Methods

Water quality monitoring data from 34 stations in Pleasant Bay over the period 2000 through 2014 were reviewed for analysis of bay-wide trends and station-specific trends. The duration of Pleasant Bay water quality monitoring to date (15 years) and sampling frequency (two times per month during July and August and once in early September) provides a dataset that is well-suited for analysis of long-term trends. Trend analysis was completed for the following parameters:

- Dissolved Inorganic Nitrogen (DIN)
- Total Nitrogen (TN)
- Total Phytopigments
- Salinity
- Bioactive Nitrogen (BioN)
- Phosphate (PO_4)
- Dissolved Oxygen (DO)

Analysis of water quality trends in Pleasant Bay is subject to added complexity because of a major disturbance event that occurred on April 16, 2007, when a large storm created a “break” in the outer barrier beach (Nauset Beach). The formation of this second inlet connecting Pleasant Bay to the Atlantic Ocean has increased the volume of water exchanged with the Atlantic Ocean and thus has the potential to influence water quality in the Bay. Statistical techniques that account for the potential effect of the 2007 break on water quality trends were, therefore, applied for this study.

Most of the water quality parameters included in the trend analysis are related to eutrophication. Eutrophication refers to the enrichment of an ecosystem with nutrients (nitrogen and phosphorus) and the corresponding ecosystem response of nutrient enrichment. Trends in dissolved inorganic nitrogen, bioactive nitrogen, total nitrogen, and phosphate concentrations provide information on whether nutrient enrichment in Pleasant Bay has been stable, increased or decreased over time, while trends in total algal phytopigments and dissolved oxygen provide information on ecosystem responses to changes in nutrient levels. Trends in salinity concentrations were also analyzed. Although salinity is not directly related to eutrophication, salinity is an important physical water quality parameter and salinity trends provide information on changes in the relative amount of freshwater versus ocean water in Pleasant Bay.

Trend analysis results provide insight into whether water quality in Pleasant Bay has been stable, improved, or declined with respect to eutrophication[1]. Trends of decreased nutrient concentrations, decreased total phytopigment concentrations, and increased dissolved oxygen concentrations are indicative of improved conditions because they describe a system with lower nutrient enrichment, less algal growth, and higher oxygen levels for aquatic biota (Figure ES- 1). Conversely, trends of increased nutrient concentrations, increased total phytopigment concentrations, and decreased dissolved oxygen concentrations are indicative of worsened conditions and continued eutrophication.

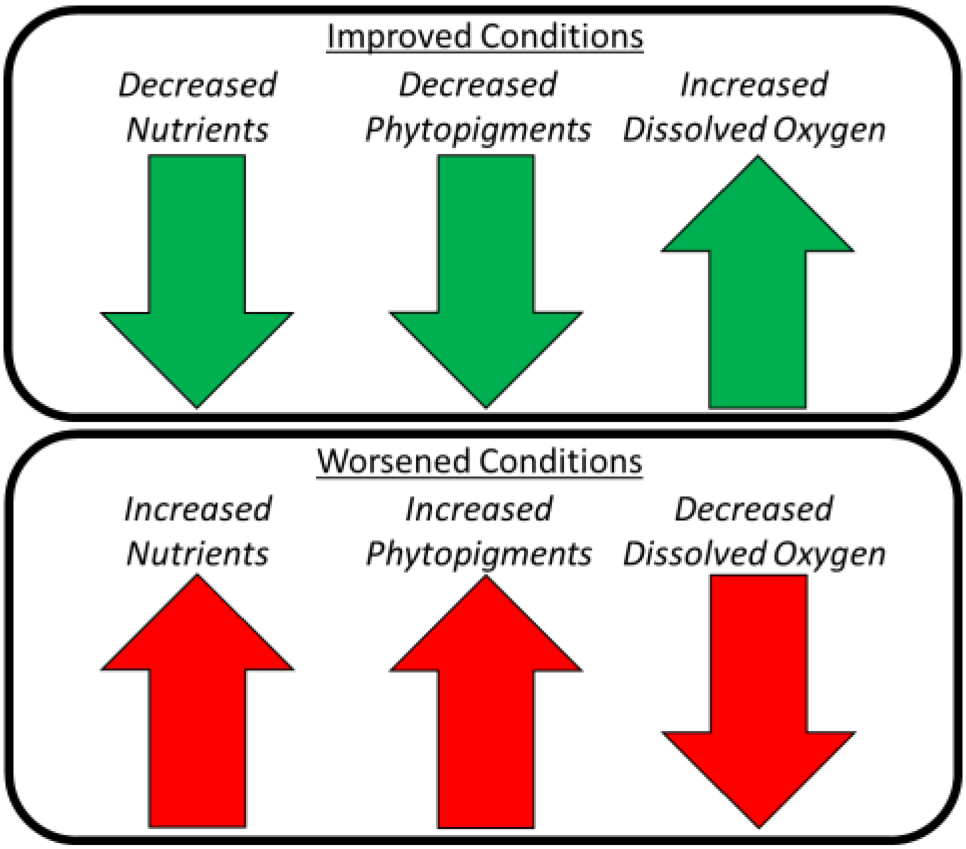

Figure ES- 1. Summary of trends in nutrients (dissolved organic nitrogen, bioactive nitrogen, etc.), total phytopigments, and dissolved oxygen concentrations associated with improved (top) and worsened (bottom) conditions in Pleasant Bay.

[1] While eutrophication-related parameters are important indicators of Pleasant Bay water quality, additional parameters are used to assess overall water quality (pathogens, metals, toxics, etc.). These additional parameters were not analyzed as part of this study.

Station-Specific Results

Twenty Pleasant Bay water quality monitoring stations had sufficient data for station-specific trend analysis (fourteen stations had large data gaps that preclude meaningful analysis of trends). Station-specific trend analysis involved fitting individual trendlines to sample data for each water quality parameter at each monitoring station and determining the statistical significance of trendlines. Statistical significance is based on the estimated likelihood that the trendline slope is due to random variation in sample data instead of a true change over time. A significance level of 5% was used for this study, which corresponds to a 5% likelihood of mischaracterizing a trendline as statistically significant even though no true trend exists. Results of “no statistically significant trend” do not necessarily mean that the water quality parameter did not change over the study period. Trends may not be detected as statistically significant because of insufficient sample data. Trend analysis results are summarized for each station-parameter pair in Table ES- 1.

Station-specific trend analysis results demonstrate that Pleasant Bay is a highly variable and complex system. Varied conditions throughout the Bay are reflected in differences in the direction and presence of trends among monitoring stations for each water quality parameter. None of the seven parameters analyzed have consistent trends across all twenty monitoring stations. Total nitrogen trends, for example, are increasing at four stations, decreasing at nine stations, and are not statistically different at seven stations over the period studied.

The complexity of water quality relationships in Pleasant Bay is reflected in the lack of consistent trends between parameters at a given station. None of the twenty stations included in trend analysis show improvements across all six eutrophication-related parameters and none show worsened conditions across all six parameters. Seven stations (Big Bay-SW, Paw Wah Pond, Namequoit-South, Meetinghouse Pond, Pochet Mouth, Namequoit River Mid, and River at Rattles Dock) have improving trends in bioactive nitrogen and/or total nitrogen, no significant trend or an improving trend in phosphate, and improving total phytopigment trends. Three of these seven also have trends of improved dissolved oxygen concentrations (Big Bay-SW, Namequoit-South, and River at Rattles Dock). Of the twenty stations included in trend analysis, these seven have results that are most in line with improvements in nutrient enrichment and ecosystem responses. However, the lack of dissolved inorganic nitrogen trends and consistent dissolved oxygen improvements preclude definitive statements on an overall decline in eutrophication at these stations. One station (Little Quanset Pond) has trends of increasing dissolved inorganic nitrogen, bioactive nitrogen, and total nitrogen concentrations and decreasing dissolved oxygen. While these trends are consistent with continued nutrient enrichment and declining ecosystem conditions, no significant trend was found for phosphate and total phytopigments at Little Quanset Pond.

Results for the remaining twelve stations (Outer Ryder's Cove, Inner Ryders Cove, Crow’s Pond, Muddy Creek, Muddy Creek-Upper, Big Bay-NE, Round Cove, Quanset Pond, Namequoit-North, Arey’s Pond, Kescayogansett Pond, and Pochet Upper) are more variable between parameters. Most show improved total phytopigment concentrations (i.e. decreased levels) but increasing concentrations of at least one nitrogen parameter. For example, Quanset Pond (PBA-10) has trends of increased dissolved inorganic nitrogen, bioactive nitrogen, and total nitrogen but decreased total phytopigment concentrations and no significant trend in dissolved oxygen. Such inconsistencies illustrate the potential influence of factors, in addition to nutrient levels, on algal growth and dissolved oxygen concentrations (e.g., pH, light, water clarity, or tidal flushing).

Table ES- 1. Results of station-specific trend analysis. The direction of statistically significant trends is indicated by the arrow direction (▲, ▲, ▲ = increase; ▼, ▼, ▼ = decrease). Arrow colors describe whether the trend is associated with improved or worsened conditions (green = improved; red = worsened). Station-parameter pairs with no significant trend are symbolized with a black square (■). Salinity trends are not associated with improved or worsened conditions because they are not directly related to eutrophication.

Station	DIN	BioN	TN	PO4	Pigment	DO	Salinity
Outer Ryder's Cove (CM-13)	▲	■	▲	▲	▼	▲	■
Inner Ryders Cove (PBA-3)	▲	■	■	■	▼	▲	▲
Crow's Pond (PBA-4)	■	▼	▼	▲	▼	▲	▲
Muddy Creek (PBA-5)	▲	■	■	■	■	■	▲
Muddy Creek-Upper (PBA-5A)	▼	■	■	■	▲	■	▲
Big Bay-SW (PBA-6)	■	■	▼	▼	▼	▲	▲
Big Bay-NE (PBA-8)	▲	■	▲	▼	▼	■	■
Round Cove (PBA-9)	▲	▼	▼	■	▼	▼	■
Quanset Pond (PBA-10)	▲	▲	▲	▼	▼	■	■
Paw Wah Pond (PBA-11)	■	▼	▼	■	▼	■	▲
Namequoit-South (PBA-12)	■	▼	▼	▼	▼	▲	▲
Namequoit-North (PBA-13)	▲	■	■	■	▼	■	■
Arey's Pond (PBA-14)	■	■	■	■	▼	▼	■
Kescayogansett Pond (PBA-15)	■	▼	▼	▲	▼	■	■
Meetinghouse Pond (PBA-16)	■	▼	■	■	▼	■	■
Pochet Mouth (WMO-3)	■	▼	▼	■	▼	■	■
Pochet Upper (WMO-5)	■	■	■	▲	▼	▲	■
Namequoit River Mid (WMO-6)	■	▼	▼	■	▼	■	■
River at Rattles Dock (WMO-10)	■	▼	▼	■	▼	▲	▲
Little Quanset Pond (WMO-12)	▲	▲	▲	■	■	▼	▲

DIN = Dissolved Inorganic Nitrogen, BioN = Bioactive Nitrogen; TN = Total Nitrogen
PO4 = Phosphate; Pigment = Total Phytopigments; DO = Dissolved Oxygen

Bay-Wide Results

Bay-wide trend analysis involved pooling sample data from all 34 Pleasant Bay monitoring stations and fitting a trendline for each water quality parameter. All seven water quality parameters tested demonstrated statistically significant trends. Trends for six of the seven parameters (the exception was salinity) were best characterized with a trendline that changed following the 2007 Nauset Beach break. Bay-wide trend results are summarized below and in Table ES- 2.

- *Dissolved Inorganic Nitrogen*: Concentrations of dissolved inorganic nitrogen show a significant increasing trend from 2000 to the 2007 Nauset Beach break. The increasing trend has continued after the break.
- *Bioactive Nitrogen*: Bioactive nitrogen concentrations show a significant decreasing trend from 2000 to the 2007 Nauset Beach break. Since the break, bioactive nitrogen concentrations are increasing (i.e., the pre-break trend has reversed).
- *Total Nitrogen*: Concentrations of total nitrogen show a significant decreasing trend from 2000 to the 2007 Nauset Beach break. Since the break, there is no significant trend in total nitrogen concentrations.
- *Phosphate*: Concentrations of phosphate show a significant increasing trend from 2000 to the 2007 Nauset Beach break. Since the break, there is no significant trend in phosphate concentrations.
- *Total Phytopigments*: Total phytopigment concentrations show no significant trend from 2000 to the 2007 Nauset Beach break. Since the break, total phytopigment concentrations have been decreasing.
- *Dissolved Oxygen*: No significant trend in dissolved oxygen concentrations is apparent from 2000 to the 2007 Nauset Beach break. Since the break, dissolved oxygen concentrations have been increasing.
- *Salinity*: The salinity trend was best characterized as a "step-change" type trend, with a statistically significant increase in salinity concentrations after the 2007 break relative to pre-break concentrations.

Table ES- 2. Results of bay-wide trend analysis. The direction of statistically significant trends is indicated by the arrow direction (▲, ▲, ▲ = increase; ▼, ▼, ▼ = decrease). Arrow colors are used to convey whether the trend is associated with improved or worsened conditions (green = improved; red = worsened). Station-parameter pairs with no significant trend are symbolized with a black square (■). The salinity trend was characterized as a step-change type trend, with a statistically significant increase in salinity concentrations after the 2007 break, and is not associated with improved or worsened conditions because it is not directly related to eutrophication.

Parameter	Pre-Break Trend	Post-Break Trend
Dissolved Inorganic Nitrogen	▲	▲
Bioactive Nitrogen	▼	▲
Total Nitrogen	▼	■
Phosphate	▲	■
Total Phytopigments	■	▼
Dissolved Oxygen	■	▲
Salinity	■	▲

Like the station-specific trend analysis results, bay-wide trend analysis results reflect the complexity of relationships between nutrient enrichment and ecosystem responses. Pre-break trends show a system with increased trends in two nutrient parameters (dissolved inorganic nitrogen and phosphate), decreased trends in two nutrient parameters (bioactive nitrogen and total nitrogen), and no significant trends in response parameters (total phytopigments and dissolved oxygen). Since the break, trends of increased dissolved inorganic nitrogen and bioactive nitrogen suggest continued nutrient enrichment but trends of decreased total phytopigments and increased dissolved oxygen indicate that any increase in nutrient enrichment has not translated to worsening ecosystem conditions. Analysis of other physical factors affecting algal growth and dissolved oxygen (pH, light, water clarity, tidal flushing, etc.) may provide insight into why response parameters have improved despite increased nutrient levels.

Discussion and Conclusions

Trend analysis results underscore the variability of conditions and complexity of water quality relationships throughout Pleasant Bay. Varied conditions throughout the Bay are reflected in differences in the direction and presence of trends among monitoring stations, while the lack of consistent trends between parameters reflects the complexity of relationships between nutrient inputs, nutrient cycling, and ecosystem responses to nutrient enrichment. Overall, trend analysis results do not show that eutrophication has improved or worsened at any one location or bay-wide. However, some stations have trends in individual parameters that suggest increased or decreased nutrient loading and these can be reviewed in conjunction with information on recent restoration efforts to gauge their effectiveness or to highlight areas as future restoration priorities. Furthermore, the presence of opposing trends in nutrient and response parameters (e.g., increasing nutrient concentrations but decreasing total phytopigment concentrations) merits further investigation of nutrient inputs, nutrient cycling, and ecosystem responses to changing nutrient levels in Pleasant Bay.

When interpreting trend analysis results, note that trends do not explicitly depict water quality as "good" or "bad". Such classifications are typically made by evaluating whether sample data are above or below a numeric target. Trend analysis instead describes the relationship between water quality and time during the period of analysis, specifically whether concentrations have increased or decreased. Targets for water quality parameters analyzed in this study include dissolved oxygen concentrations above 6 milligrams per liter, total phytopigment concentrations below 5 micrograms per liter, and bioactive nitrogen concentrations between 0.098 and 0.405 milligrams per liter (bioactive nitrogen targets vary by station). Although trend analysis results show improved conditions for some parameters in portions of Pleasant Bay, sample data show that numeric targets were consistently not achieved in recent years. For example, the Namequoit-South station (PBA-12) has improving trends in five of the six eutrophication-related parameters analyzed (the exception is dissolved inorganic nitrogen) but 80% of samples collected in 2014 (eight of ten samples) do not meet the dissolved oxygen target. Such results illustrate continued effort is needed to restore the Pleasant Bay ecosystem and why trend analysis results should be one of several pieces of information used to guide restoration planning.

The trend analysis results presented in this report are <u>not</u> intended to be used to draw conclusions on the role of the 2007 break as a driver of water quality change in Pleasant Bay. Trend analysis showed a significant post-break change for some station-parameter pairs and for all parameters in the bay-wide analysis. In some cases, the post-break change is consistent with the expected effect of the break (e.g., the increase in bay-wide salinity concentrations following the break, possibly due to increased exchange of open ocean water). However, increased or decreased concentrations in samples collected after the 2007 break alone do not supply definitive evidence that the break caused a change in a water quality parameter. Analysis of other potential drivers of change (e.g., trends in nutrient loads from Pleasant Bay tributaries) are needed in order to determine the influence of the 2007 break and such analyses were beyond the scope of this study. Finally, trend analysis results are also not intended to be used for prediction of future conditions. Pleasant Bay is a dynamic system, and conditions in future years may drastically differ from the conditions that contributed to observed trends from 2000-2014. Continued monitoring is needed to characterize water quality in the coming years and additional sample data may allow for the identification of trends not detected in the 2000-2014 dataset.

Appendix C. Exceedances of Targets and Thresholds

The following tables present the percent of samples exceeding thresholds/targets for bioactive nitrogen, dissolved oxygen, and total phytopigments by year. Bioactive nitrogen thresholds were established by the Massachusetts Estuaries Program (MEP) to support the development of the 2007 Pleasant Bay TMDL (Howes et al. 2006). The dissolved oxygen target is the Massachusetts water quality standard for coastal waters. The total phytopigment target is a guidance value established by the National Oceanic and Atmospheric Administration (NOAA).

Site ID	MEP Modeled Restoration Value (mg/L)[5]	Percent of Samples Exceeding MEP Restoration Target for Bioactive Nitrogen														
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CM-13	0.138	84%	44%	100%	75%	93%	36%	25%	30%	60%	60%	30%	100%	100%	70%	60%
CM-14	0.173	100%	67%	100%	100%	100%	50%									
PBA-1	0.102	90%	27%	86%	27%	17%	14%	0%							0%	75%
PBA-2	0.12	90%	13%	86%	20%	0%										
PBA-3	0.19	45%	25%	92%	85%	86%	93%	57%	50%	78%	71%	56%	80%	88%	20%	22%
PBA-4	0.149	80%	38%	100%	90%	69%	57%	50%	60%	20%	50%	75%	40%	100%	30%	0%
PBA-5	0.208	56%	63%	80%	83%	67%	57%	100%	100%	100%	75%	60%	80%	80%	100%	40%
PBA-5A	0.405			83%	100%	86%	100%	100%	100%	100%	100%	100%	60%	100%	100%	75%
PBA-6	0.169	78%	60%	90%	75%	42%	50%					50%	70%	13%	30%	40%
PBA-7	0.153	67%	33%	71%	43%	36%	42%									
PBA-8	0.139	78%	50%	79%	71%	43%	29%	33%	13%	22%	30%	0%	70%	100%	100%	38%
PBA-9	0.207	58%	58%	100%	79%	64%	62%	83%	40%	70%	10%	80%	50%	90%	70%	80%
PBA-10	None															
PBA-11	0.209	33%	36%	57%	75%	50%	43%	58%	0%	13%	30%	10%	10%	40%	60%	40%
PBA-12	0.16	75%	17%	86%	77%	64%	14%	25%	40%	0%	20%	0%	60%	50%	10%	20%
PBA-13	0.172	64%	17%	71%	67%	40%	23%	50%	30%	20%	20%	50%	20%	70%	30%	38%
PBA-14	0.253	58%	42%	85%	79%	100%	93%	83%				70%	30%	100%	80%	60%
PBA-15	0.208	92%	25%	100%	92%	100%	100%	100%	90%	100%	40%	90%	100%	100%	40%	60%
PBA-16	0.262	75%	33%	69%	85%	69%	71%	50%				60%	70%	70%	40%	30%
PBA-17A	0.098											33%	75%	67%	0%	43%
PBA-18	0.112			89%	50%	70%	21%									
PBA-19	0.113			100%	60%	64%	90%								0%	100%
PBA-20	0.118			100%	67%	64%	29%								33%	100%
PBA-21	0.148			70%	58%	8%	14%								0%	20%
WMO-2	0.147		73%	100%	78%	50%										
WMO-3	0.164		50%	63%	67%	50%		33%	40%	0%	0%	20%	0%	100%	0%	0%
WMO-4	0.179		67%	100%	100%	50%										
WMO-5	0.211		67%	75%	83%	33%	83%	67%	40%	60%	60%	60%	80%	100%	40%	80%
WMO-6	0.206		100%	67%	100%	100%		83%	100%	40%	40%	80%	100%	100%	40%	40%
WMO-7	0.188		83%	67%	100%	80%										
WMO-8	0.182		83%	67%	100%	80%									0%	50%
WMO-9	0.196		83%	83%	100%	100%	83%									0%
WMO-10	0.207		67%	73%	100%	100%		100%	100%	100%	40%	70%	90%	100%	60%	80%

[5] From Table VIII-6 in: Howes, Samimy, Schlezinger, Kelley, Ramsey, & Eichner, 2006.

Site ID	Percent of Samples Not Meeting Dissolved Oxygen Standard of 6 mg/L														
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CM-13	35%	6%	29%	33%	29%	42%	42%	70%	100%	100%	40%	20%	100%	20%	60%
CM-14	64%	86%	86%	100%	75%	83%									
PBA-1	20%	0%	0%	0%	0%	0%	0%							0%	25%
PBA-2	20%	13%	29%	20%	20%										
PBA-3	57%	21%	64%	38%	58%	50%	38%	80%	100%	100%	40%	50%	50%	50%	0%
PBA-4	40%	13%	21%	17%	21%	33%	20%	70%	75%	100%	25%	30%	50%	30%	0%
PBA-5	36%	38%	50%	33%	20%	83%	80%	67%	80%	50%	80%	75%	80%	80%	60%
PBA-5A			83%	33%	33%	29%	80%	40%	60%	50%	40%	20%	60%	25%	60%
PBA-6	30%	60%	60%	33%	33%	50%					0%	10%	13%	0%	20%
PBA-7	10%	33%	14%	36%	21%	50%									
PBA-8	50%	9%	7%	7%	13%	21%	17%	10%	50%	80%	0%	0%	75%	0%	38%
PBA-9	25%	8%	42%	7%	14%	38%	75%	25%	100%	100%	30%	30%	80%	60%	60%
PBA-10	58%	83%	100%	64%	64%	79%	92%	100%	100%	100%	90%	40%	100%	100%	80%
PBA-11	58%	91%	93%	67%	83%	79%	75%	100%	100%	90%	60%	60%	100%	70%	80%
PBA-12	58%	83%	86%	71%	50%	86%	75%	80%	100%	100%	30%	30%	100%	80%	80%
PBA-13	67%	100%	100%	60%	90%	71%	83%	60%	100%	100%	80%	70%	100%	90%	100%
PBA-14	75%	92%	100%	79%	86%	86%	100%				75%	80%	90%	80%	90%
PBA-15	80%	92%	100%	83%	100%	92%	90%	75%	88%	100%	90%	75%	100%	60%	90%
PBA-16	42%	67%	67%	75%	92%	86%	71%				88%	100%	100%	70%	80%
PBA-18			0%	0%	0%	43%									
PBA-19			0%	0%	0%	0%								0%	0%
PBA-20			0%	33%	0%	29%								0%	20%
PBA-21			90%	75%	42%	71%								33%	38%
WMO-2		0%	8%	17%	14%										
WMO-3		50%	75%	38%	20%		83%	100%	100%	100%	75%	80%	100%	80%	100%
WMO-4		100%	100%	38%	67%										
WMO-5		100%	100%	50%	67%	100%	83%	100%	100%	100%	100%	80%	100%	100%	100%
WMO-6		100%	100%	67%	53%		100%	75%	100%	100%	40%	80%	100%	80%	100%
WMO-7		100%	100%	61%	50%										
WMO-8		69%	67%	33%	61%									67%	75%
WMO-9		100%	100%	67%	89%	75%									100%
WMO-10					0%		100%	100%	100%	100%	80%	80%	100%	75%	60%
WMO-12		100%	50%	88%	75%						80%	75%	100%	100%	100%

Site ID	Percent of Samples Exceeding NOAA Pigment Guidance of 5 µg/L														
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CM-13	70%	63%	71%	17%	86%	67%	42%	60%	10%	70%	10%	10%	38%	0%	0%
CM-14	90%	71%	71%	57%	71%	50%									
PBA-1	55%	6%	29%	17%	17%	7%	0%							0%	0%
PBA-2	70%	25%	57%	0%	33%										
PBA-3	70%	87%	93%	100%	100%	93%	75%	100%	60%	75%	44%	70%	75%	50%	0%
PBA-4	65%	69%	93%	42%	57%	50%	60%	60%	0%	70%	0%	10%	25%	0%	10%
PBA-5	90%	88%	100%	83%	100%	71%	60%	50%	100%	100%	40%	100%	60%	80%	40%
PBA-5A			100%	71%	86%	86%	83%	80%	100%	100%	80%	80%	100%	100%	100%
PBA-6	80%	70%	100%	75%	92%	100%					50%	100%	25%	50%	20%
PBA-7	58%	36%	86%	31%	50%	75%									
PBA-8	60%	67%	71%	25%	64%	64%	42%	25%	0%	30%	10%	0%	0%	13%	0%
PBA-9	83%	100%	100%	93%	93%	93%	100%	100%	90%	80%	80%	80%	90%	90%	60%
PBA-10	58%	75%	79%	64%	79%	64%	75%	75%	50%	60%	20%	70%	80%	70%	40%
PBA-11	58%	64%	71%	75%	67%	86%	83%	50%	25%	30%	60%	60%	60%	50%	40%
PBA-12	25%	42%	50%	21%	36%	29%	25%	0%	0%	20%	0%	20%	0%	0%	10%
PBA-13	50%	25%	57%	33%	40%	57%	33%	40%	0%	40%	0%	20%	10%	0%	0%
PBA-14	67%	100%	100%	100%	100%	100%	100%				60%	100%	100%	80%	30%
PBA-15	75%	83%	75%	62%	100%	93%	100%	70%	60%	80%	60%	80%	60%	20%	10%
PBA-16	58%	67%	71%	62%	86%	86%	100%				10%	90%	80%	50%	30%
PBA-17A											67%	75%	33%	0%	0%
PBA-18			100%	20%	60%	21%									
PBA-19			40%	20%	25%	30%								0%	0%
PBA-20			100%	17%	64%	71%								0%	10%
PBA-21			40%	0%	17%	21%								0%	0%
WMO-2		67%	80%	60%	67%										
WMO-3		33%	38%	25%	38%		33%	0%	20%	0%	0%	20%	20%	0%	0%
WMO-4		33%	33%	17%	50%										
WMO-5		0%	50%	17%	50%	83%	83%	80%	80%	40%	40%	60%	80%	0%	0%
WMO-6		50%	67%	50%	100%		83%	100%	40%	40%	60%	100%	80%	20%	20%
WMO-7		67%	33%	50%	67%										
WMO-8		67%	50%	50%	83%									0%	0%
WMO-9		67%	50%	83%	100%	83%									0%
WMO-10		83%	55%	67%	100%		100%	88%	80%	30%	10%	80%	80%	20%	0%
WMO-12		50%	67%	17%	33%						0%	50%	40%	40%	20%