



University of Massachusetts Dartmouth
The School for Marine Science and Technology



Technical Memorandum

Westport River Watershed Alliance Cockeast Pond Monitoring Project Summer 2011

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Re: Summary of Water Quality Monitoring Activities in Cockeast Pond, as undertaken by the Coastal Systems Program, School for Marine Science & Technology at the University of Massachusetts – Dartmouth.
Period of Performance: June 28 through September 2011

Date: April 30, 2012

Overview: Originally established for Forge Pond and Adamsville Pond as well as Cockeast Pond, the 2011 water quality monitoring project detailed below was set up to extend the previous (2008, 2009 and 2010) collection of baseline nutrient related water quality data required for assessing the nutrient related health of Cockeast Pond in the Town of Westport. Sampling was undertaken to allow evaluation of the annual variation in water quality in Cockeast Pond based on summer sampling only, as summer is the critical management period for this ecosystem.

The proposed 2011 sampling effort was, as in the past, a joint effort between WRWA and S Mast, with technical assistance, sample collection and analysis by the Coastal Systems Program within the School for Marine Science and Technology (S Mast), University of Massachusetts, Dartmouth. The work included sampling previously established sampling sites in Cockeast Pond because multi-year sampling is essential to determine inter-annual variations in physical characteristics and nutrient levels resulting from differences in rainfall, temperature, and light intensity (cloudy versus sunny days). Distributing the effort over several years provides a more accurate measurement of typical conditions and the amount of inter-annual variation in each parameter. The baseline water quality monitoring supports assessment of the present

health of Cockeyeast Pond and its need for protection/restoration, and also provides continuing pond information needed to enhance the MEP analysis of the Westport River estuary system.

The Technical Memorandum is organized as follows:

1. Overview
2. Summary of Sampling Approach in Cockeyeast Pond
3. Results of Sampling Measurements in Cockeyeast Pond
 - Summary of 2011 Water Quality Results for Cockeyeast Pond Sampling
 - Comparison with 2008, 2009 and 2010 results
4. Trophic Status of Cockeyeast Pond 2011
 - Comparison with 2009 and 2010 results

Summary of Sampling Approach in Cockeyeast Pond:

The Westport River Watershed Alliance (WRWA) Pond Water Quality Monitoring Project was continued for Cockeyeast Pond in the summer of 2011 following the previously developed protocols and sampling locations of 2008, 2009 and 2010. The 2011 program included a total of four (4) sampling events, once per month in June, July, August and September.

As in previous years, there were 2 sampling stations, one each in the upper and lower basins: Station 1 in the lower basin and Station 2 in the upper basin (Figure 1). Samples in the north basin (Station 2) were collected at mid-depth in June and at surface and bottom depths in July, August and September. Samples in the south basin (Station 1) were collected only in June at mid-depth (Table 1).

Station ID	Sample Depth	Sample Date
1	Mid	6/28/2011
2	Mid	6/28/2011
2	Surf & Bot	7/19/2011
2	Surf & Bot	8/17/2011
2	Surf & Bot	9/21/2011

Table 1 – nutrient samples were collected.

Sampling depths and dates when

Samples for the assessment of nutrient related water quality were collected at each sampling station and transported to SMAST in dark coolers, on ice. Sample bottles were cleaned and acid leached prior to use. Chemical assays were performed by the Coastal Systems Analytical Facility at SMAST1. All samples were analyzed for ammonium (NH₄), nitrate+nitrite (NO₃+NO₂), dissolved organic nitrogen (DON), particulate organic nitrogen (PON), orthophosphate (PO₄), particulate organic carbon (POC), Total Phosphorus (TP), Chlorophyll a, Pheophytin a, pH and alkalinity. A total of 8 samples were collected from Cockeyeast Pond in 2011. In addition, one Field Duplicate was collected on each sampling date.



Figure 1 – Aerial photograph of Cockeast Pond depicting the 2 sampling locations at which nutrient samples were collected.

Summary of Water Quality Results for Cockeast Pond Sampling:

Samples were collected at 2 sites within the pond, one at either end, on either side of the outflow channel. Water samples collected in 2011 generally showed moderate levels of total nitrogen for a freshwater pond (1.0 to 1.1 mg TN/L). Similar to prior years, TN was primarily comprised of dissolved organic nitrogen (~ 0.6-0.7 mg/L), making up about 61% of the TN, while dissolved inorganic nitrogen, primarily nitrite and nitrate (NO_x), were found at only very low levels (~ 0.02-0.04 mg/L), around 2-3% of the TN (Table 2). Throughout the entire Cockeast Pond system average DON concentrations were again much higher than average DIN concentrations. While nitrogen likely enters the pond as DIN primarily through groundwater seepage, uptake of DIN and conversion to organic forms by phytoplankton and rooted plants associated with the pond is rapid in summer. At the same time DON is released by grazing and upon senescence and decay plus entry of DON from terrestrial sources such as vegetation and soils. DON is not easily utilized by plants or microorganisms, and thus tends to remain in the water column for long periods.

As was stated in the 2010 report, actions to increase nitrogen retention within Cockeast Pond would focus on increasing the deposition of particulate nitrogen, as transformation of inorganic nitrogen to organic forms is basically "complete" and almost all of the nitrogen in pond waters is in organic forms. It is common for watersheds with high nitrogen loading to have 50% or more of the nitrogen in their freshwater streams as nitrate, similarly in these watershed almost all of the nitrogen within the groundwater aquifer is as nitrate. It appears that at present Cockeast Pond is very efficient at transforming inorganic nitrogen to organic forms.

Comparison of 2011 Data with 2008, 2009 and 2010 Data

In Cockeyeast Pond, TN has been variable at Cockeyeast 1, based upon the data it is not possible to determine a significant trend in the time-series, as TN was approximately 1.2 mg/L in 2008, 0.8 in 2009, 1.1 mg/L in 2010, and decreasing slightly to 1.0 mg/L in 2011 (Figure 2, Table 2 and 2010 Tech Memo). At Cockeyeast 2 TN levels showed a similar pattern, but again with no discernable trend with TN in 2008 averaging 1.2 mg/L, 0.9 mg/L in 2009, 1.1 mg/L in 2010 and 1.1 mg/L in 2011. At both stations, 2011 TN levels were almost exactly the average of the previous 3 years. It is important to note that the 2009 TN data was only a single sample, while 2008, 2010 and 2011 values are means of several samplings. This may be the cause of the apparent low in 2009 and indicates that for this system multiple samples should be collected each year. As for 2011, DON is the dominant N form in all years, with only a small contribution by DIN. PON represents a moderate proportion of the TN pool, indicating the potential for nitrogen deposition to the sediments (Figure 2). TP has varied from about 0.014-0.118 mg/L with no clear trend over the 4 years of sampling (Table 2 and 2009 and 2010 Tech Memos).

Annual rainfall data (New Bedford) from 2008-2011 show a general decrease over this period from 59.5 inches in 2008 to 56.4 inches in 2009 to 46.1 inches in 2010 with an increase to 52.0 inches in 2011 (Northeast Regional Climate Center). This pattern does not seem to correlate with the variable levels of TN in Cockeyeast Pond (Figure 4). Prior to the sampling period in each of the 3 years, rainfall amounts (New Bedford, Jan-July) were approximately 28 inches in 2008, 31 inches in 2009, about 30 inches in 2010 and 26 inches in 2011 (Northeast Regional Climate Center). It is not clear whether or not rainfall had a major influence on the differences between N levels during the 4 sampling years.

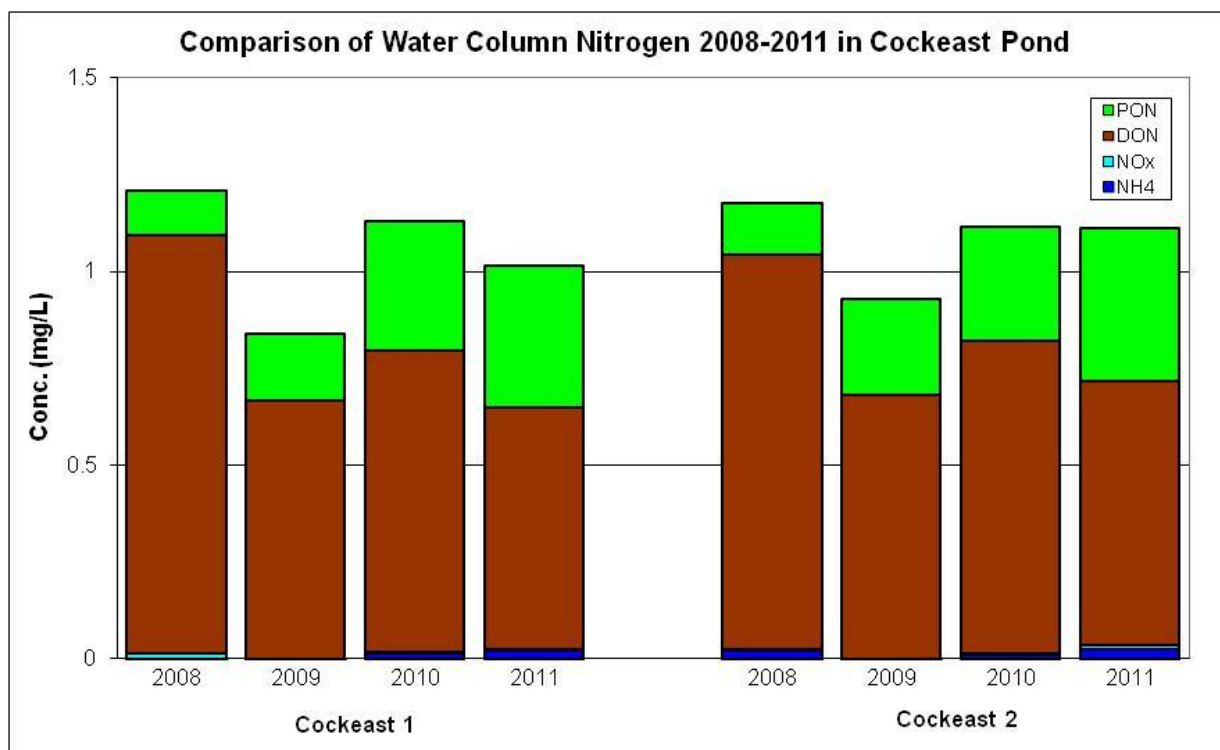


Figure 2. Comparison of water column average nitrogen in Cockeyeast Pond, 2008-2011. Values (mg/L) are means of 4 monthly samples June-September in 2008, a September sample in 2009, 3 monthly samples August-September in 2010, and all 2011 samplings (Table 2).

Pond Trophic Status:

Based upon the summer 2011 survey results it is possible to conduct a basic assessment of the nutrient related health of Cockeast Pond. The assessment uses Total Phosphorus, Chlorophyll a pigment levels and water clarity (Secchi depth), all of which are interrelated parameters that focus on nutrient enrichment. The index of choice is the Carlson Trophic State Index, which is based upon comparisons to a large number of U.S. lakes and ponds (Table 4)¹. The data used in the index was the average over the sampling period from the mixed layer of each pond. While the Index needs to be used with other biotic indicators, it does provide a general assessment tool where calculated index levels are correlated with different Trophic States:

- TSI >50: Eutrophic (highly nutrient enriched)
- TSI 40-50: Mesotrophic (moderately nutrient enriched)
- TSI <40: Oligotrophic (low level of nutrient enrichment)

It appears that Cockeast Pond is consistently showing clear signs of nutrient enrichment or eutrophication (Table 4). Eutrophic conditions are those that exist under high nutrient inputs and are typified by algal and phytoplankton blooms, low water clarity and sometimes low oxygen in bottom waters. Nutrient enrichment can be seen in the poor water clarity. Cockeast Pond showed an average secchi depth of less than 1 meter in 2011 (Table 4), oligotrophic ponds in s.e. Massachusetts have Secchi depths of up to 6 meters. This poor water clarity is related to elevated levels of phytoplankton and associated particulates in the water column resulting from the nutrient "fertilization" of the pond waters. The "cloudiness" of the water column is primarily caused by phytoplankton growth, measured by Chlorophyll a concentrations which averaged 7.7 ug/L (6.7 ug/L at Cockeast and 8.7 ug/L at Cockeast 2; Table 2). Phosphorus is the nutrient primarily responsible for phytoplankton growth in freshwater lakes and ponds. TP levels in Cockeast Pond in 2011 are high with average concentrations at 47.2 ug/L (0.047 mg/L in Cockeast 1 and 0.048 mg/L in Cockeast 2; Table 2). These concentrations correlate with the high levels of Chlorophyll-a and pheophytin-a and resulting low water clarity. These 3 indicators together yield the high TSI values in Table 4 and the resulting "Eutrophic" designation for Cockeast Pond for 2011.

In comparing the 2009 and 2010 Trophic States with 2011, Cockeast Pond appears to be significantly enriched. Both 2010 and 2011 results indicate Eutrophic conditions, while the single sample in 2009 showed Meso/Eutrophic conditions. However, as was noted above and in last year's Tech Memo, because of the single sampling in 2009 the resulting Meso/Eutrophic classification for 2009 is not significantly different from the 2010 and 2011 results which are based upon multiple samplings.

Recommendations:

Because of its continuing Eutrophic status and because of the need to build a solid long-term data set from which to evaluate future changes in trophic status, monitoring of Cockeast Pond and other of Westport's ponds should be maintained to support on-going and future management efforts. From the sampling to date, it is clear that 3-4 sampling events are required per year for establishing an accurate baseline for Cockeast Pond.

¹ <http://www.epa.gov/bioiweb1/aquatic/carlson.html>

ACKNOWLEDGMENTS

The Coastal Systems Program Technical Team would like to again thank the Westport River Watershed Alliance for its continued commitment to advancing environmental stewardship in southeastern Massachusetts and its proactive attitude in seeking quantitative assessment of aquatic systems in need of protection or restoration. The meshing of advocacy with science over the long term is the required driver for timely, cost effective management of coastal systems for the benefit of present residents and future generations. WRWA's continued efforts are fundamental to achieving these ends. As in the past, the assistance of Gay Gillespie, Roberta Carvalho and Betsy White is much appreciated, as are the efforts of the new Executive Director, Matt Patrick. We also gratefully acknowledge the support of the Town of Westport and its Massachusetts Estuaries Project Committee, as they continue to examine the variety of nitrogen management alternatives (including using restoration of freshwater habitats) for the overall restoration of the Westport River Estuary.

Sample ID	Date	NH4 (mg/L)	NOx (mg/L)	DIN (mg/L)	DON (mg/L)	TDN (mg/L)	TON (mg/L)	TN (mg/L)	POC (mg/L)	PON (mg/L)	PO4 (mg/L)	TP (mg/L)	Chl a Pigments (ug/L)
COCKEAST POND 1	6/28/2011	0.022	0.002	0.024	0.606	0.629	0.984	1.007	2.890	0.378	<0.003	0.047	6.80
COCKEAST POND 1	6/28/2011	0.022	0.002	0.024	0.645	0.670	1.002	1.026	2.807	0.356	<0.003	0.047	6.66
Average		0.022	0.002	0.024	0.626	0.649	0.993	1.017	2.848	0.367	<0.003	0.047	6.73
COCKEAST POND 2	6/28/2011	0.023	0.002	0.025	0.664	0.690	1.040	1.066	3.147	0.376	0.003	0.110	6.32
COCKEAST POND 2	7/19/2011	0.010	0.014	0.024	0.750	0.774	1.122	1.146	2.860	0.372	<0.003	0.050	4.50
COCKEAST POND 2	7/19/2011	0.007	0.013	0.020	0.653	0.674	1.135	1.155	4.112	0.482	<0.003	0.050	5.31
COCKEAST POND 2	7/19/2011	0.016	0.006	0.022	0.704	0.726	1.197	1.219	4.073	0.493	<0.003	0.047	4.99
COCKEAST POND 2	8/17/2011	0.068	0.004	0.071	0.683	0.754	1.109	1.180	3.260	0.426	<0.003	0.011	12.01
COCKEAST POND 2	8/17/2011	0.065	0.011	0.076	0.637	0.714	1.099	1.175	3.431	0.461	<0.003	0.045	12.51
COCKEAST POND 2	8/17/2011	0.065	0.010	0.075	0.651	0.726	1.106	1.181	3.428	0.455	<0.003	0.052	14.53
COCKEAST POND 2	9/21/2011	0.001	0.024	0.025	0.721	0.746	0.973	0.997	1.992	0.252	<0.003	0.031	8.90
COCKEAST POND 2	9/21/2011	0.001	0.013	0.014	0.670	0.684	0.995	1.009	2.567	0.325	<0.003	0.032	9.16
COCKEAST POND 2	9/21/2011	<0.001	0.010	0.010	0.656	0.666	0.993	1.003	2.653	0.337	<0.003	0.047	9.18
Average		0.026	0.011	0.036	0.679	0.715	1.077	1.113	3.152	0.398	<0.003	0.048	8.74

Table 2. Summary of nutrient concentrations for samples collected in Cockeast Pond at two open water. Nutrient concentrations are in milligrams/liter, Chlorophyll pigments are in micrograms/liter.

TSI	Secchi Depth (m)	Epilimnion Total P (ug/L)	Epilimnion Chlorophyll a (ug/L)	Trophic State
0	63.98	0.75	0.04	Oligo trophic
10	32.00	1.5	0.12	Oligo trophic
20	16.00	3	0.34	Oligo trophic
30	7.99	6	0.94	Oligo trophic
40	3.99	12	2.6	Mesotrophic
50	2.01	24	6.4	Eutrophic
60	1.01	48	20	Eutrophic
70	0.49	96	56	Eutrophic
80	0.24	192	154	Eutrophic
90	0.12	384	427	Eutrophic
100	0.06	768	1183	Eutrophic

Table 3. The Carlson Trophic Status Index (TSI) scores for Secchi Depth, Total Phosphorus and Chlorophyll a.

Pond	Secchi (m)	Secchi TSI	Chl a (ug/L)	Chl a TSI	TP (ug/L)	TP TSI	2011 Trophic State	2010 Trophic State	2009 Trophic State
Cockeast	0.88	61.8	7.7	50.6	47.2	59.7	Eutrophic	Eutrophic	Meso/Eutrophic

Table 4. Assessment of 2011 Trophic State of Cockeast Pond within the Town of Westport, based upon average values of summer surveys, and comparison with historical Trophic State assessments.