



University of Massachusetts Dartmouth
The School for Marine Science and Technology



Technical Memorandum

Westport River Watershed Alliance Cockeast Pond Monitoring Project Summer 2023

To: Deborah Weaver, Executive Director, WRWA
Roberta Carvalho, Science Director, WRWA

From: Roland Samimy, Sr. Research Scientist, Coastal Systems Program, SMAST
Sara Sampieri Horvet, Manager, Coastal Systems Analytical Facility, SMAST

Re: Summary of Water Quality Monitoring Activities in Cockeast Pond undertaken by the Coastal Systems Program, School for Marine Science & Technology at the University of Massachusetts – Dartmouth and the Westport River Watershed Alliance.
Period of Performance: July-August 2023

Date: January 15, 2024

Overview:

Cockeast Pond discharging to the Westport River Estuary (West Branch) is a small, shallow brackish system that is hydraulically connected via a culvert to the Westport River Estuary located at the southern end of the Town of Westport near the Rhode Island border. Cockeast Pond is adjacent to Buzzards Bay, it is a tidal basin with marine waters entering from the Westport River and freshwater entering via direct groundwater and a small surface water inflow. Cockeast Pond is the only salt pond in the Westport River watershed and provides a unique and diverse habitat for numerous species of plants and animals. Cockeast Pond has a relatively small watershed that includes a nine-hole golf course and a number of single family homes that generate nutrient load that may be driving a portion of the nitrogen related impairment being observed in this small coastal salt pond.

The Westport River Watershed Alliance (WRWA), in partnership with the Coastal Systems Program (CSP) at the University of Massachusetts-Dartmouth, School for Marine Science and Technology (SMAST-UMass Dartmouth), has had in place a nutrient related water quality monitoring program for Cockeast Pond for the past seven years to assess the degree to which the habitat of Cockeast Pond may be affected by nutrient concentrations and incoming nitrogen load from the watershed. Water quality monitoring was specifically undertaken to establish baseline water quality conditions to be linked to observed levels of habitat impairment. It is

suspected that the increasing nitrogen loads to Cockeast Pond from activities in the associated watershed are creating adverse impacts to the ecosystem and limit the function and use of this water resource. It should also be noted that the effectiveness of water exchange between the lower Westport River estuary and the pond via the culvert can also have significant effects on nutrient concentrations in the pond and habitat health. Another reason for maintaining the monitoring program in Cockeast pond.

The water quality monitoring project detailed below was designed to extend the previous (2008-2022) collection of baseline nutrient related water quality data that is required to assess the nutrient related health of Cockeast Pond in the Town of Westport. The sampling approach was consistent with previous years to maintain cross comparability of data sets and was undertaken to evaluate the annual variations in the water quality of the pond based on summer sampling only. Summer is the critical management period, as water quality conditions in ponds and estuaries are generally at their lowest point of the year.

Summer 2023 sample collection and analysis was conducted by CSP scientists. The work included water quality sampling at the previously established monitoring site. Monitoring over multiple years is essential for proper assessment, since inter-annual variations in aquatic systems are common (resulting from differences in rainfall, temperature, and light intensity {cloudy versus sunny days}). A low-intensity, long-term program provides a more accurate measurement of typical conditions and the amount of variation in each parameter. It also allows evaluation of changes in pond water quality due to changing activities within the associated watershed. The baseline water quality monitoring assesses the present health of Cockeast Pond and its need for protection/restoration, and also provides the pond characteristics needed to enhance the MEP evaluation of nitrogen mitigation and analysis of the Westport River estuary system.

The Technical Memorandum is organized as follows:

1. Overview of Cockeast Pond water quality monitoring
2. Summary of Sampling Approach
3. Summary of 2023 Water Quality Results for Cockeast Pond Sampling and a comparison to the previous results

Summary of Sampling Approach in Cockeast Pond:

The Westport River Watershed Alliance (WRWA) Pond Water Quality Monitoring Project was continued in the summer of 2023 following the previously developed protocols and sampling locations to ensure comparability. It should be noted that sampling procedures utilized in Cockeast Pond are consistent with water quality sampling undertaken in other Westport Ponds such as Forge Pond and Adamsville Pond making results directly comparable between systems. Moreover, Cockeast Pond samples collected and analyzed in collaboration with CSP-SMAST are comparable to the entirety of the CSP nutrient related water quality database for estuaries and salt ponds of southeastern Massachusetts. The 2023 program included a total of four (2) sampling events in July and August at two stations (CP1, CP2). Samples of the water column were collected at both surface and bottom depths at CP1 and at mid depth at CP2 (Figure 1). The outflow from Cockeast Pond to the Westport River estuary was not sampled during the 2023 season.

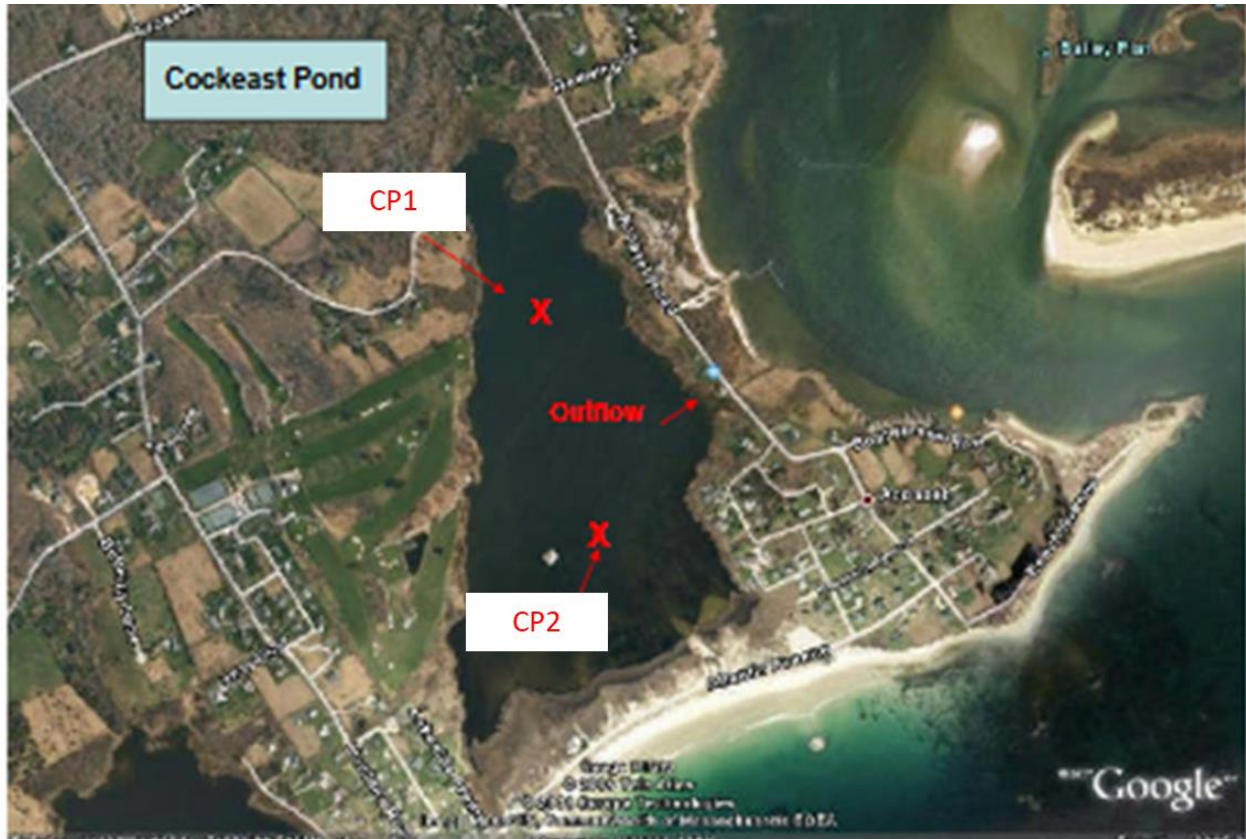


Figure 1 – Aerial photograph of Cockeest Pond depicting the 2 locations at which nutrient samples were collected in 2023. Samples were not collected at the outflow.

Nutrient samples collected at each sampling station were assayed at the Coastal Systems Program Analytical Facility at SMAST. All samples were analyzed for ammonium (NH_4), nitrate+nitrite (NO_3+NO_2), dissolved organic nitrogen (DON), particulate organic nitrogen (PON), ortho-phosphate (PO_4), particulate organic carbon (POC), total phosphorus (TP), Chlorophyll-*a*, and Pheophytin-*a*. Over the 2023 season, a total of 12 samples were collected from Cockeest Pond including 4 field duplicates for QA purposes.

Summary of 2023 Water Quality Results Cockeest Pond:

Total nitrogen levels showed water column enrichment in Cockeest Pond (1.14 mg/L). Although the dominant forms of nitrogen entering streams and ponds is typically nitrate and ammonium (DIN), organic forms of nitrogen (DON, PON) dominated the water column nitrogen. This results from the transformation of inorganic forms of nitrogen to organic forms by aquatic plants, algae and phytoplankton.

DON was the dominant form of nitrogen in Cockeest Pond. The average DON concentration in the water column across the sampling dates was 0.66 mg/L, approximately 58% of the TN pool (Table 1). The remaining nitrogen pool, PON, was comprised primarily of phytoplankton and some organic detritus and boosted the organic nitrogen pool in Cockeest Pond to 99.1% of the TN.

The dominance of organic nitrogen is fairly typical of freshwater systems. Dissolved organic nitrogen, a by-product of the decomposition of plant material, enters from the upland stream and pond sediments and is not readily available to plants or bacteria. It tends to remain in the water

column until transported out in outflowing water. In contrast, the inorganic nitrogen released during plant decay (or that enters in groundwater, surface water, or rainfall) is readily available to algae, phytoplankton and plants. It is rapidly taken up and converted to organic nitrogen within streams, ponds and estuaries. The PON level within the pond is primarily a result of this uptake and growth by phytoplankton. The predominance of organic forms within Cockeyeast Pond indicates that these transformations are occurring. For informed management of nutrient related impairment of Cockeyeast Pond, a coupled land-use / pond analysis such as that prepared by the MEP for the Westport River and a multitude of other systems in southeastern Massachusetts is needed for definitive evaluation of nutrient sources, total load to the pond, and the rate of water turnover (flushing/exchange) within Cockeyeast pond.

While nitrogen is critical in determining the health of down gradient estuaries and is an important nutrient in pond productivity, phosphorus appears to be the immediate nutrient causing eutrophic conditions in fully freshwater ponds. The ratio of N/P can be used as an approximate gauge of the relative importance of N and P to the nutrient related health of an aquatic system. While this is a more robust analysis in salt water compared to freshwater systems, generally N/P ratios less than 16 indicate that the nutrient to manage is nitrogen. In salt ponds such as Cockeyeast Pond (with a salinity ranging around 10-14 ppt), the molar ratio DIN/DIP (dissolved inorganic N and P) is sometimes used for the evaluation. However, the concentrations of the nutrients also need to be taken into account. In Cockeyeast Pond both the DIN and DIP levels are very low. Therefore, it appears from this preliminary analysis that both nitrogen and phosphorus inputs will result in increased phytoplankton growth.

Comparison of 2023 Data with Previously Collected Water Quality Results:

TN values have been variable in Cockeyeast Pond over the sampling years, but are showing an increase. Over this 16 year period, 2014 had the lowest TN concentration (0.71 mg/L) while 2016 had the highest TN concentration (1.68 mg/L) (Figure 2). For all 16 years, DON dominates all other forms of N with DIN making up a very small fraction of TN (Figure 3).

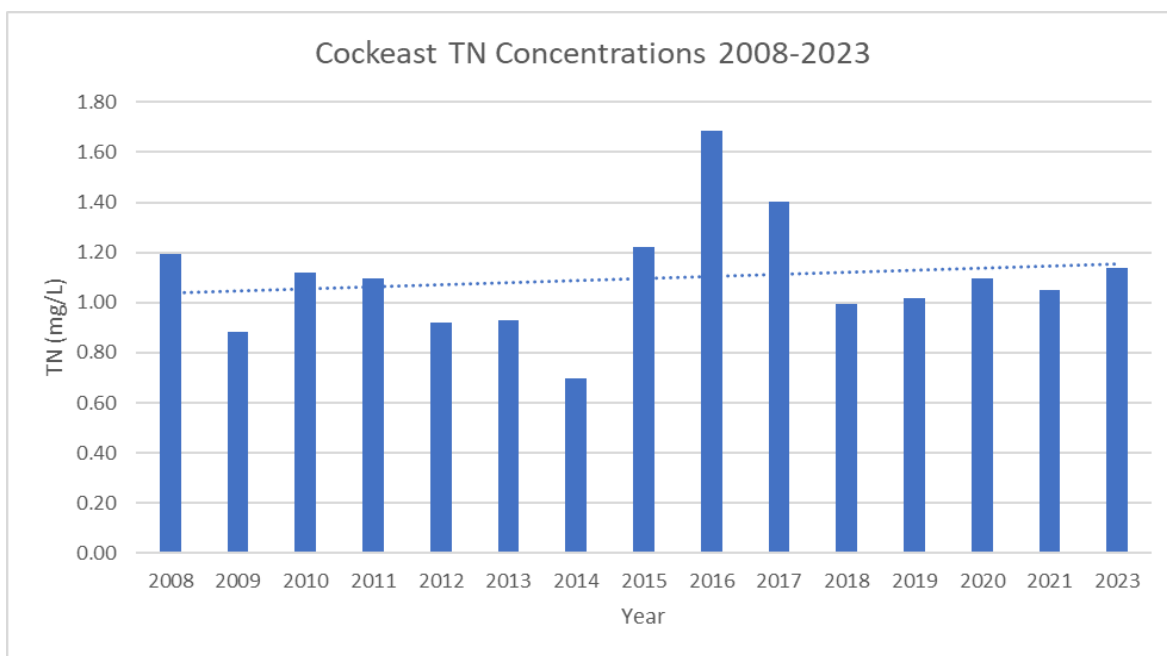


Figure 2. Comparison of summer water column Nitrogen concentrations from 2008-2023. No samples were collected in 2022.

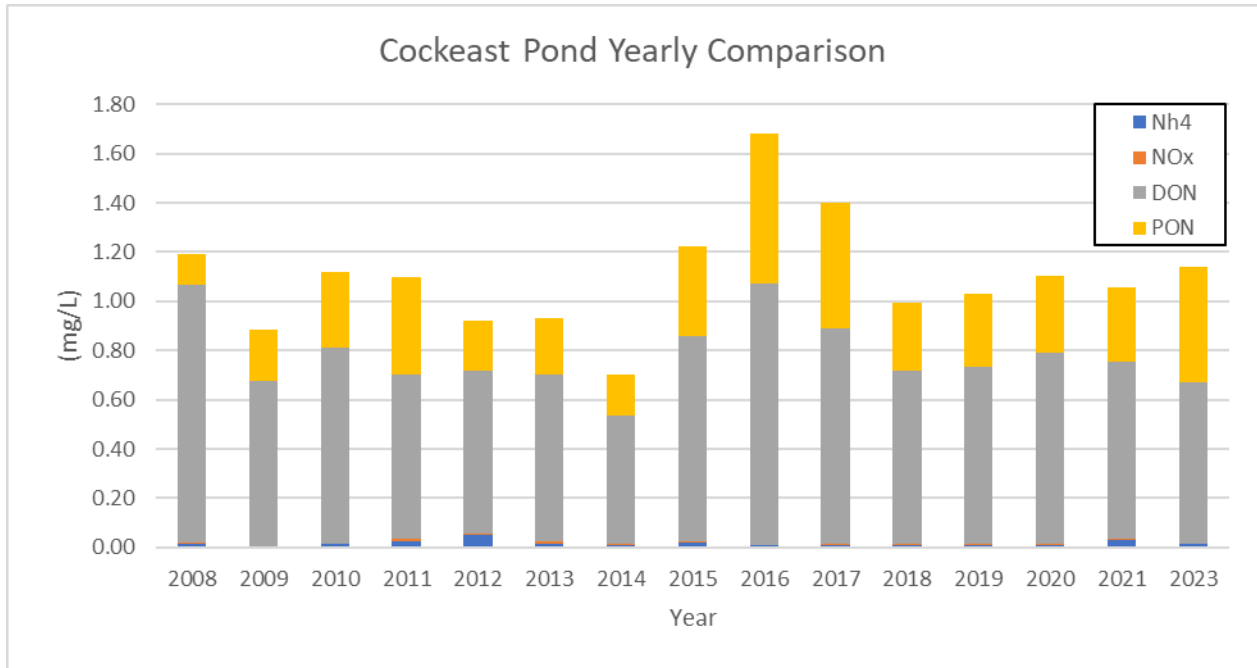


Figure 3. Comparison of summer water column Nitrogen concentrations from 2008-2023. No samples were collected in 2022.

Pond Status:

It appears that Cockeast Pond is continuing to show clear signs of eutrophication. Eutrophic conditions are those that exist under high nutrient inputs and are characterized 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 value of 0.85 meters. A moderately enriched pond would support Secchi depths of 2-4 meters. The “cloudiness” of the water column is mainly caused by phytoplankton growth, measured by total pigment concentrations which were 9.01 ug/L. 10.0 ug/l of CHLA is typically the threshold indicator of eutrophication in a coastal salt pond or estuary.

Recommendations:

Efforts such as reducing nitrogen inflow to the pond and outflow from Cockeast Pond should be encouraged in order to lower nitrogen concentrations both in the pond as well as in the West Branch of the Westport River. In so doing, improving the health of the pond will protect the health of the river herring population, which in turn serves to support numerous bird, fish and mammal species and adds to the support of a healthy Westport River estuary. A comprehensive study of Cockeast Pond will provide the necessary information from which to derive strategic management options and plans.

We recommend that a full sampling schedule (4-6 sampling events) be undertaken in 2024.

This schedule allows for the continuation of tracking the health of Cockeast pond. WRWA should also begin to plan for a management level assessment of the Pond that considers all the collected data and bring it all into context with watershed delineation/land use information and specific biological indicators of habitat health such as detailed water column measurements of dissolved oxygen and CHLA. In addition it is likely that tidal flushing is a primary control on the water quality and habitat health of this small coastal pond and a study of tidal exchange would also be informative in regard to the effectiveness of exchange with lower concentration water from the Westport River.

Additionally, based on the low salinity regime in Cockeast Pond, we would recommend a closer examination of the degree to which N or P limitation may be driving the eutrophication of this coastal pond.

ACKNOWLEDGMENTS

The Coastal Systems Program Technical Team would like to take the opportunity to thank the Westport River Watershed Alliance for its commitment to advancing environmental stewardship in southeastern Massachusetts and its proactive attitude in seeking analyses on aquatic systems in need of protection or restoration. The marriage of advocacy with science helps to ultimately advance the greater good and WRWA is a true champion in that regard. In particular, the assistance of Betsy White is much appreciated. We would also like to acknowledge the support of the interns and lab technicians at the Coastal Systems Program for analyzing the data.

Date	Salinity (ppt)	PO4 (mg/L)	NH4 (mg/L)	NOx (mg/L)	DIN (mg/L)	DON (mg/L)	TDN (mg/L)	POC (mg/L)	PON (mg/L)	TON (mg/L)	TN (mg/L)	TPIG (ug/L)
7/11/2023	14.35	0.001	0.014	0.001	0.015	0.598	0.613	3.49	0.410	1.008	1.023	12.51
7/25/2023	12.98	0.002	0.007	0.002	0.009	0.693	0.702	3.85	0.461	1.154	1.163	9.72
8/16/2023	14.08	0.002	0.013	0.001	0.014	0.606	0.620	2.75	0.432	1.038	1.052	10.05
8/28/2023	14.43	0.005	0.017	0.002	0.019	0.730	0.749	3.69	0.570	1.300	1.319	18.19
AVERAGE	13.96	0.002	0.013	0.001	0.014	0.657	0.671	3.447	0.468	1.125	1.139	12.62

Table 1. Summary of nutrient concentrations for samples collected in Cockeast Pond.