The Outer Banks Study – Physio-Chemical Parameters for Water Quality Testing/Professional Development Program for Teachers

Joseph Stringer
Middletown City Schools
Middletown, OH 45044

Timothy Bowman
Middletown City Schools
Middletown, OH 45044, USA

Keith Vinson
Franklin City Schools
Franklin, OH 45005, USA

Catherine Warnecke
Saint Clement Schools
Saint Bernard, OH 45217, USA

Nora Lewis
Wright State University
Dept. of Chemistry
Dayton, OH 45435, USA

William Slattery, PhD
Professor of Earth and Environmental Sciences
Wright State University
Department of Earth and Environmental Sciences
3640 Colonel Glenn Hwy.
Dayton, OH 45435, USA

Suzanne K. Lunsford, Ph.D.
Professor of Chemistry
Wright State University
Department of Chemistry
3640 Colonel Glenn Hwy.
Dayton, OH 45435, USA

ABSTRACT: This manuscript describes the study of the water quality testing being carried out /analyzed during a professional development program held along the Outer Banks of North Carolina for in-service teachers. The professional development participants were engaged to learn different types of water quality equipment. These participants found the advantages of utilizing electrodes and a photometer for reproducible results in examining the environmental impacts of possible industry located around the area sites studied. The water analysis project has allowed the in-service teachers to learn the use of various technology and software needed for real-world problem solving related to industry and how it can impact the waterways.

Keywords: Inquiry-based learning/problem-based technology, interdisciplinary- academia and industry.

INTRODUCTION: There is a significant threat of to human lives due to the possible changes in chemical and biological characteristic of the water, soil and air. Possible contamination of the water can be due to farming (fertilization), industrial pollution and urban sprawl (increased human population). The testing of water quality is of necessity and of great importance due to the aquatic life species that humans eat and to live a healthy life. Thus, the analysis of water quality testing needs to be a high priority to prevent water borne diseases in water. The Outer Banks of North Carolina are ideal for the teaching and sampling of water quality due to having an active industry such as the Potash Corporation. The Potash Company is located along the waterway with an active mining production process, which may be contributing to significant changes of water quality along Morehead City. Potash Corp produces 5.4 million tons of phosphate rock, 1.2 million tons of phosphoric acid, 0.80 million tons of ammonia and 3 million tons of nitrogen solutions (nitric acid, and ammonium nitrate). The uses of phosphate and nitrogen are in liquid and solid fertilizers and

animal feed supplements used in the agriculture. Also, the purified phosphoric acid is used in food and beverages and in metal treatment compounds. The Morehead City waterway is where the Potash Corp products are shipped by barge and this unique setting has brought about the interest to test water quality in this area of industrial setting, Figure 1. Figure 2 illustrates the sites marked for sampling and Figure 3 has the site for sampling along the Shackelford Island (Potash distance from Shackelford island 5.5 km) and Pivers Island (Potash distance from Pivers Island 2.2 km). There will be three different types of techniques to study the water quality and these different instrumentations and kits will provide findings discovered by our participants during a professional development program for teachers in Environmental Science. The instrumentation utilized were LaMotte Water Quality kit the Horiba Water Quality Testing electrodes and the Yellow Springs Instruments Photometer. These physico-chemical parameters for the testing included DO, Salinity, pH, BOD, temperature, nitrate, phosphate, conductivity, total dissolved solids and ORP (Oxidation-Reduction Potential).

Figure 1.
Port of Morehead City; Potash Company, barge/shipping location, adapted from the website: http://www.ssamarine.com/locations/morehead-city-nc/.

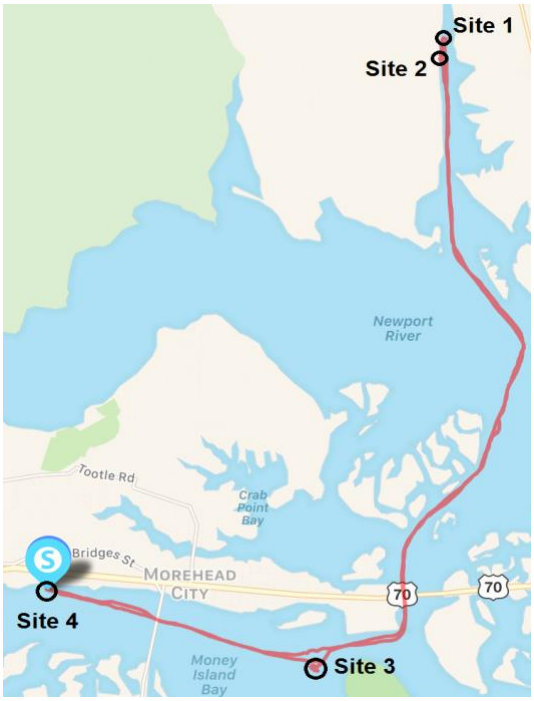


Figure 2.
Site 1: Core Creek Deep (N 34 deg / 47' 59" W 76 deg / 41'14") *Site 2*:Core Creek Bank (N 34 deg / 48' 2" W 76 deg 41'15") *Site 3:* Tar Landing Bay (N 34 deg / 42'35" W 76 deg / 42'30") *Site 4*: Dock at Morehead City (N 34 deg / 43'19" W 76 deg 46'14"), adapted from google maps.

Figure 3.
Site 1: Pivers Island (N 34 deg / 43' 0.77" W 76 deg / 40' 20.26") *Site 2*: Shackleford Island (N 34 deg / 41' 10.51" W 76 deg / 38' 33.70"), adapted from google maps.

EXPERIMENTAL

Apparatus

The LaMotte Water Kits were utilized to approximate the range of water quality results and the Yellow Springs Instruments (YSI) 9300 Photometer was utilized to provide accurate readings of the water quality. The YSI 9300 photometer has direct reading of concentrations, waterproof rating for field tests, and provides multiple parameters for testing. The Horiba U-50 was utilized to provide on-site measurements in seconds (features speed) in pH, DO, salinity, temperature, conductivity, turbidity, total dissolved solids and ORP readings at various depths in the ocean water and brackish water located along the Outer Banks of North Carolina.

RESULTS/DISCUSSION:

The participating in-service teachers were required to learn the process of how to calculate the WQI (Water Quality Index) with various types of equipment integrated. The different types of equipment utilized were the LaMotte Water Kit with the Horiba electrodes (on-site readings) plus the YSI 9300 Photometer. The main areas of the focus study were the following sites labeled in Figure 2, and 3. As shown in Table 1a, 1b, 1c, the calculated WQI readings for the sites measured had an overall good water quality. The WQI for the Shackelford Island is 73.08 which demonstrates good water quality (Table 1d) and Pivers Island (Table 1e) had average water quality, thus we are noticing differences along the different sites for phosphates and nitrates overall.

Table 1a. Core Creek

Test Parameter	Q-Value	Weighing Factor	Total Quality Index
DO	83	0.27	22.41
Fecal Coliform, BOD	65	0.25	16.25
Nitrates	98	0.16	15.68
Phosphates	97	0.16	15.52
pH	85	0.17	14.45
Total WQI			**84.31**

Table 1b. Tar Landing Bay

Test Parameter	Q-Value	Weighing Factor	Total Quality Index
DO	100	0.27	27
Fecal Coliform, BOD	65	0.25	16.25
Nitrates	97.5	0.16	15.6
Phosphates	92	0.16	14.72
pH	85	0.17	14.45
Total WQI			**88.02**

Table 1c. Dock at Morehead City

Test Parameter	Q-Value	Weighing Factor	Total Quality Index
DO	99	0.27	26.73
Fecal Coliform, BOD	65	.25	16.25
Nitrates	98	0.16	15.68
Phosphates	96	0.16	15.36
pH	85	0.17	14.45
Total WQI			**88.47**

Table 1d. Shackleford Island

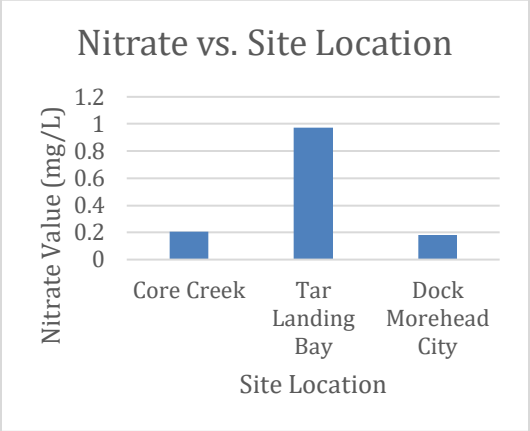
Test Parameter	Q-Value	Weighing Factor	Total Quality Index
DO	43	0.27	11.61
Fecal Coliform, BOD	65	.25	16.25
Nitrates	95	0.16	15.20
Phosphates	92	0.16	14.72
pH	90	0.17	15.3
Total WQI			**73.08**

Table 1e. Pivers Island

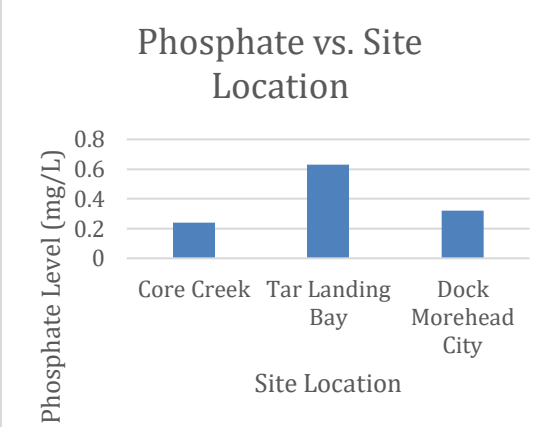
Test Parameter	Q-Value	Weighing Factor	Total Quality Index
DO	43	0.27	11.61
Fecal Coliform, BOD	65	.25	16.25
Nitrates	95	0.16	15.20
Phosphates	37	0.16	5.92
pH	67.5	0.17	11.48
Total WQI			**60.46**

The findings of the main differences in water quality in the higher phosphates and higher nitrates may be due to the Potash site location. Graph 1 illustrates elevated levels of nitrate and Graph 2 illustrates elevated levels of phosphates in the Tar Landing Bay, which is located closer than any of other testing sites (Tar Landing bay located 1.3 km from Potash). Our students have realized that tracking sources of pollutants can be more difficult than measuring the water quality for possible pollutants. Possible changes in the water quality can be from point sources and nonpoint sources and the primary pollutants are oxygen consuming wastes, nutrients, suspended sediments (TDS-Total Dissolved Solids), and toxins (metals –Cd, Pb). The weather of rain versus drought has an effect on the nonpoint sources of pollution which are carried by rainfall, runoff and ground water seepage thus nonpoint varies with weather patterns thus our students needed larger sample size over an extended period of time. The use of the YSI 9300 Photometer has assisted with

comparing the different sites for nitrate and phosphate in more detail compared to LaMotte Kit (samples were analyzed by color-not digital reading). Notably the Tar Landing Bay area has the higher nitrate and phosphate (Graph 1 and Graph 2) readings than the Core Creek and Dock at Morehead City. The use of the YSI 9300 has been more accurate where the readings are recorded in the decimal place not just an approximate reading as with the LaMotte water kits (LaMotte kits students had to ball park the range of nitrates and phosphates by visual analysis of color change in the ppm concentration range).

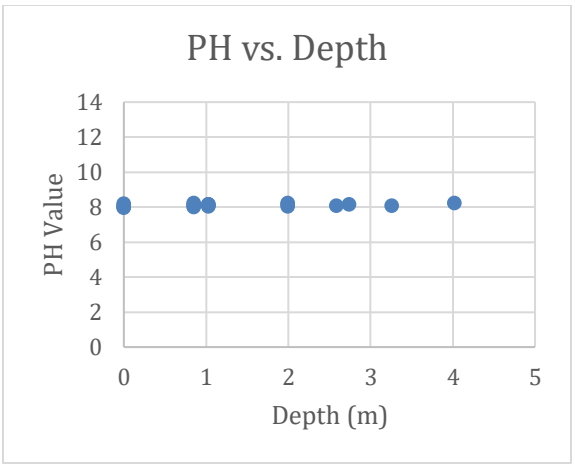


Graph 1. Nitrate Levels at: Core Creek, Tar Landing Bay, and Morehead City.



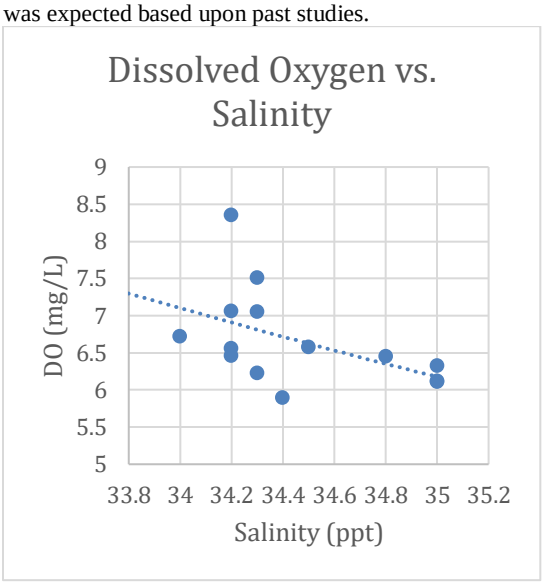
Graph 2. Phosphate Levels at: Core Creek, Tar Landing Bay, and Morehead City.

Graph 3 illustrates the effect of pH versus depth for the main sites of Core Creek, Tar Landing Bay and Dock Morehead City. The pH has no change as the depth was increased and as expected the pH was greater than 7 for brackish/ocean water.

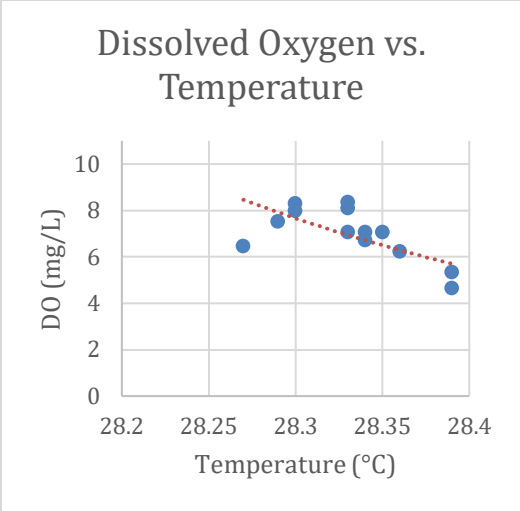


Graph 3. pH versus depth at: Core Creek, Tar Landing Bay, and Morehead City.

In graph 4, it can be noted that as the DO decreases the salinity increases notably by the fit line. This result was expected based upon past studies.

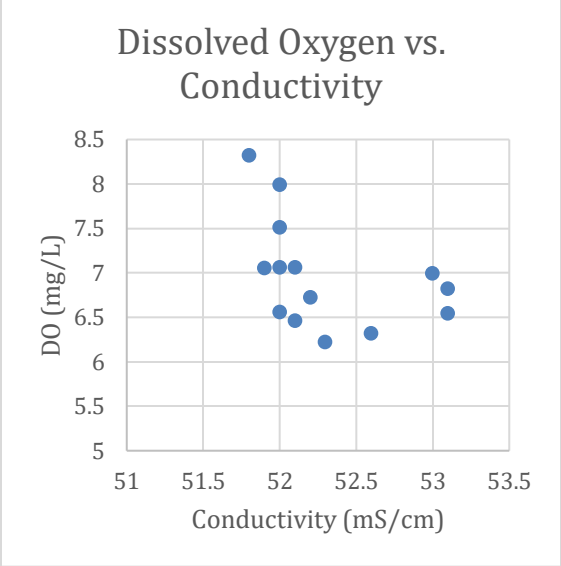


Graph 4. DO versus the Salinity at: Core Creek, Tar Landing Bay and, Morehead City.



Graph 5. DO versus temperature at: Core Creek, Tar Landing Bay, and Morehead City.

The Dissolved oxygen (DO) has been plotted versus temperature and can be seen from the trend that as the DO decreases the temperature increases. The temperature range for this graph is small, however a slight downward trend can be observed.



Graph 6. DO vs. conductivity at: Core Creek, Tar Landing Bay, and Morehead City.

From the readings taken off the research vessel a downward trend was observed when dissolved oxygen was plotted with relationship to conductivity. This is to be expected, for as more particles (metals, minerals) enter the water more ions are present (represented by the higher conductivity) the oxygen has less space to infuse into the water.

CONCLUSION: The data analysis of the water quality has allowed our participating teachers to experience data acquisition by various methods. It was noted by the participants that different data collection yielded inconsistent results such as the LaMotte water kit. The La Motte kit has not been accurate and the students found that the Horiba water quality electrodes provided the most accurate and consistent readings.
The data collection has found the higher nitrates and phosphates may be due to the sites located closest to the Potash dock site. However, it should be noted there may have been some error with our measurements due to lack of sample size and the short duration of the experiments. General trends were observed from the data that was collected, therefore further data including deeper measurements, and a longer study interval should be implemented to see if trends continue with various situations.

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