**Old Woman Creek (OWC) NERR Site Water Quality Metadata**

January through December 2019

Latest Update: February 13, 2023

**I. Data Set and Research Descriptors**

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**2)** **Research objectives:**

1. Monthly Grab Sampling Program:

Samples for chemical analysis are taken at least monthly at the four existing datalogger sites within or near the Old Woman Creek State Nature Preserve (SNP) and NERR. Three of the sites are in the estuary proper- one in the upper reaches at Darrow Road (DR) one near the mouth, just south of State Route 6 (WM) and the third site is upstream from the WM site (OL). The final site (BR) is just upstream of the first riffle zone above the estuary in Old Woman Creek proper. The purpose of this part of the nutrient monitoring program is to document the spatial and temporal distribution of nutrient levels as water moves through this Great Lakes estuary.

1. Diel Sampling Program:

At site WM samples are collected at 2-hour intervals over a 26-hour period once a month. The purpose of this part of the monitoring program is to examine temporal changes in nutrient levels in the estuary over the course of a day.

**3) Research methods:**

1. Monthly Sampling

The 2019 chemical monitoring program began on 17 March 2019 at sites BR, DR, OL, and WM. Sampling at all sites ended for the year on 12 December 2019 due to ice cover.

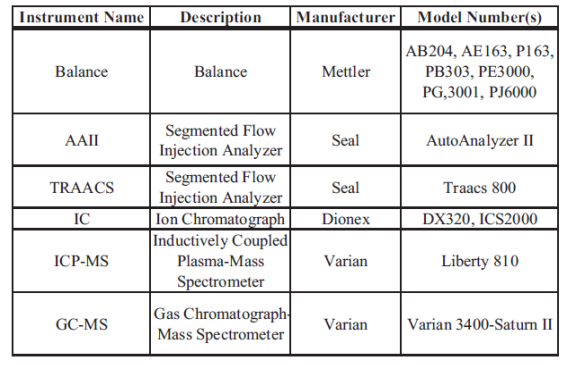
Replicate surface water grab samples for chemical and chlorophyll analysis were collected sequentially at each of the data logger sites. If collected concurrent with logger exchange, the samples were collected immediately prior to exchange to ensure that the samples for chemical analysis were undisturbed. Both samples were normally collected within 30 seconds of each other, except at site DR, where the samples were collected about 2-3 minutes apart (see table below). At DR, samples were collected using a 3-L Van Dorn bottle.

Sample bottles (previously washed in a commercial grade dishwasher with phosphate-free detergent and citric acid rinse aid or with 10% HCl, rinsed six (6) times with distilled water, then allowed to air dry upside down prior to sampling) were rinsed with the sample water three times before the sample was collected for analysis. Temperature, conductivity, dissolved oxygen, and pH values were determined on the samples at time of collection using a field meter that was previously calibrated according to the manufacturer specifications. Sample turbidity was measured in the lab with a Hach 2100AN Turbidimeter. If samples were not to be filtered and analyzed within the next hour or so, they were stored in a refrigerator or in the dark on ice.

All monthly grab samples and diel samples collected through June 2019, were analyzed at the National Center for Water Quality Research (NCWQR) at Heidelberg University in Tiffin, OH (see below). Monthly grab samples and diel samples collected from July through December as well as all chlorophyll a samples collected in 2019 were analyzed in the Old Woman Creek analytical laboratory following NERRS guidance as described in the Old Woman Creek Standard Operating Procedures and Quality Control.

Within 2-3 hours of collection, monthly grab samples through June 2019 were split into unfiltered and filtered subsamples and frozen at -20°C within 1-2 hours. The filter subsample was filtered following NERRS guidance as described in the Old Woman Creek Standard Operating Procedures and Quality Control. Within one to two weeks, samples were transported in a cooler by automobile to the NCWQR. Samples were thawed and analyzed within two days. The NCWQR uses the following equipment as described in the “Quality Assurance Project Plan for The Honey Creek Targeted Watershed Project Assistance Agreement No. WS – 00E39901-0” (D.B. Baker 2009; available at: <https://ncwqr.files.wordpress.com/2017/06/ncwqr-hc-twg-qapp.pdf>).

Table 1: National Center for Water Quality Research laboratory instrumentation.



1. Diel Sampling

An ISCO Model 5800 refrigerated sampler was used to collect water samples at site WM once a month, from March through December 2019 (see table below). The sampler collected a single, 900-ml sample at 2-hour intervals for a 26-hour period. The sampler intake was suspended adjacent to the WM data sonde at a ~0.3 m shallower depth than the sonde sensors. Sampler intake and pump tubing was replaced as needed. Prior to collecting each sample, the ISCO sampler was programmed to rinse the collection line three times. Water temperature, pH, and DO were taken from the associated YSI data logger at owcwmwq and the nearest 15-minute readings.

The sample bottles for the sampler were cleaned using the same protocol outlined above and processing was the same as for the monthly grab samples. Samples were analyzed with the same equipment and following the same protocols as for the Monthly Grab Sampling Program, with all samples through June 2019 analyzed by the NCWQR for all parameters except chlorophyll a.

4) Site location and character:

Old Woman Creek National Estuarine Research Reserve is located on the southern shore of Lake Erie, slightly east of the city of Huron, Ohio (Latitude 41° 23'N; Longitude 82° 33'W). Land use in the Old Woman Creek (OWC) watershed is primarily row crop agriculture (~70%). All residences in the watershed (concentrated in one small village) have septic systems. Salinity in Old Woman Creek is normally 1 ppt or less. Lake Erie water levels and, as a result, Old Woman Creek estuary water levels were much higher than average and at time close to record values during 2019.

The data logger at the State Route 6 (WM) site (Latitude 41° 22' 57” N, Longitude 82° 30'52” W) is very close to the mouth of Old Woman Creek. In this portion of the Reserve, the creek is very shallow but extends over a large surface area. This site frequently experiences influx of Lake Erie waters. The bottom sediments at this site are silty clay. No rooted aquatic vegetation is present directly adjacent to the site, although both emergent and submerged vegetation are present within 3 m of the site. *Phragmites* *australis* was the dominant aquatic macrophyte near this site but has been drowned out due to high water levels. Depth at this site will range from less than 10 cm to nearly 2.0 meter over the course of a year. Deeper water conditions typically occurred when the outlet of the estuary to Lake Erie was “closed” (i.e., no direct surface water exchange) due to development of a barrier beach. Water levels rose above flood level in fall 2015.

The data logger at site OL (Latitude 41° 22’ 54” N, Longitude 82° 30’50” W) is in the lower reaches of the estuary. This site is not in direct sight of the mouth, so northerly winds and resulting seiche activities are less noticeable at this site but can occur. The bottom sediments are silty clay. This site is located near the northern tip of a *Nelumbo* *lutea* bed, and during many years these plants are within 3 m of the site. This site varied in depth from 20 cm to more than a meter during the year. Again, deeper water typically occurred when the estuary outlet was closed or during a significant rain event.

The data logger at site DR (Latitude 41° 21’54”N, Longitude 82° 30’ 17”W) is at the southern boundary of the reserve. The logger trap is suspended from one of the supports on the north side of the Darrow Road bridge. At this site, the creek is relatively narrow. Although water direction and flow are influenced at this site by changes in Lake Erie water levels, this site does not have direct contact with Lake Erie waters. The bottom sediments at this site are silty clay. No rooted aquatic vegetation is present near or upstream from this site. Depth at this site ranges from about 20 cm up to over 1 m.

The data logger at site BR (Latitude 41° 20’56” N, Longitude 82° 30’44”W) is located in the lower portion of the creek proper. Just upstream from the data logger, Berlin Road crosses Old Woman Creek. The site is just upstream of the first riffle area above the estuary. Unlike the other three sites, Lake Erie water levels have no impact on this site. The bottom of the creek at this site is a combination of rocks interspersed with clay-silt that has been washed in from upstream. There are no aquatic macrophytes at or near this site, but there can be algal growth on the bottom rocks during much of the year. Depth during base flow conditions was about 50 cm but could rise to 2.5 m during storm flow.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Station Code | SWMP Status | Station Name | Location | Active Dates | Reason Decommissioned | Notes |
| owcbrnut | P | Berlin Road | 41.3483, 82.5139 | 03/2002 - current | NA | NA |
| owcdrnut | P | Darrow Road | 41.3650, 82.5047 | 08/2007 – current | NA | NA |
| owcsunut |  | Route 2 | 41.3672, 82.5072 | 03/2002 – 08/2007 | Bridge repair work and access | No longer in service, replaced with owcdrnut |
| owcolnut | P | Lower Estuary | 41.3817, 82.5144 | 4/2002 – current | NA | NA |
| owcwmnut | P | Route 6 | 41.3825, 82.5144 | 3/2002 – current | NA | NA |

**5) Coded variable definitions**

owcwmnut = Old Woman Creek State Route 6 nutrients

owcolnut = Old Woman Creek Lower Estuary nutrients

owcdrnut = Old Woman Creek Darrow Road nutrients

owbrnut = Old Woman Creek Berlin Road nutrients

monthly grab sample program = 1

diel grab sample program = 2

replicates = 1 or 2

**6) Data collection period**

1. Monthly Sampling

Sampling at all sites began on 17 March 2019 and ended on 12 December 2019. Specific deployment dates and times (EST) are listed below. The two grab samples were collected sequentially within 1-3 minutes of each other.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Site | Rep | Date Time (EST) | Air Temp (°C) | Cloud Cover (%) | Precipitation (past 72 hr) | Wind Direction | Wind Speed | Algae / Flotsam present? | Ice present? |
| owcbrnut | 1 | 03/27/2019 09:50 | 4 | CCL | PDR | NNE | WS1 | N | N |
| owcbrnut | 2 | 03/27/2019 09:51 | 4 | CCL | PDR | NNE | WS1 | N | N |
| owcbrnut | 1 | 04/17/2019 09:50 | 7.4 | COC | PHR | NE | WS1 | N | N |
| owcbrnut | 2 | 04/17/2019 09:51 | 7.4 | COC | PHR | NE | WS1 | N | N |
| owcbrnut | 1 | 05/15/2019 08:29 | 18.9 | CCL | PLR | WSW | WS1 | N | N |
| owcbrnut | 2 | 05/15/2019 08:31 | 18.9 | CCL | PLR | WSW | WS1 | N | N |
| owcbrnut | 1 | 06/11/2019 08:12 | 18.4 | CSP | PHR | W | WS1 | N | N |
| owcbrnut | 2 | 06/11/2019 08:14 | 18.4 | CSP | PHR | W | WS1 | N | N |
| owcbrnut | 1 | 07/09/2019 08:46 | 23 | CCL | PNP | E | WS1 | N | N |
| owcbrnut | 2 | 07/09/2019 08:48 | 23 | CCL | PNP | E | WS1 | N | N |
| owcbrnut | 1 | 08/07/2019 09:17 | 19 | COC | PHR | SSW | WS1 | N | N |
| owcbrnut | 2 | 08/07/2019 09:21 | 19 | COC | PHR | SSW | WS1 | N | N |
| owcbrnut | 1 | 09/03/2019 07:29 | 19 | CSP | PHR | SSW | WS1 | N | N |
| owcbrnut | 2 | 09/03/2019 07:30 | 19 | CSP | PHR | SSW | WS1 | N | N |
| owcbrnut | 1 | 10/02/2019 07:30 | 22.2 | CSP | PDR | SSW | WS1 | N | N |
| owcbrnut | 2 | 10/02/2019 07:31 | 22.2 | CSP | PDR | SSW | WS1 | N | N |
| owcbrnut | 1 | 10/29/2019 08:30 | 12.7 | CPB | PDR | SW | WS0 | N | N |
| owcbrnut | 2 | 10/29/2019 08:31 | 12.7 | CPB | PDR | SW | WS0 | N | N |
| owcbrnut | 1 | 11/12/2019 09:58 | -4.5 | CPB | PSR | WNW | WS1 | N | N |
| owcbrnut | 2 | 11/12/2019 09:59 | -4.5 | CPB | PSR | WNW | WS1 | N | N |
| owcbrnut | 1 | 12/02/2019 09:02 | 1.8 | COC | PFQ | NW | WS1 | N | N |
| owcbrnut | 2 | 12/02/2019 09:03 | 1.8 | COC | PFQ | NW | WS1 | N | N |
| owcdrnut | 1 | 03/27/2019 10:09 | 4 | CCL | PDR | NNE | WS1 | N | N |
| owcdrnut | 2 | 03/27/2019 10:17 | 4 | CCL | PDR | NNE | WS1 | N | N |
| owcdrnut | 1 | 04/17/2019 10:03 | 7.4 | COC | PHR | NE | WS1 | N | N |
| owcdrnut | 2 | 04/17/2019 10:12 | 7.4 | COC | PHR | NE | WS1 | N | N |
| owcdrnut | 1 | 05/15/2019 08:55 | 18.9 | CCL | PLR | WSW | WS1 | N | N |
| owcdrnut | 2 | 05/15/2019 09:05 | 18.9 | CCL | PLR | WSW | WS1 | N | N |
| owcdrnut | 1 | 06/11/2019 08:28 | 18.4 | CSP | PHR | W | WS1 | N | N |
| owcdrnut | 2 | 06/11/2019 08:35 | 18.4 | CSP | PHR | W | WS1 | N | N |
| owcdrnut | 1 | 07/09/2019 09:21 | 23 | CCL | PNP | E | WS1 | N | N |
| owcdrnut | 2 | 07/09/2019 09:24 | 23 | CCL | PNP | E | WS1 | N | N |
| owcdrnut | 1 | 08/07/2019 09:35 | 19 | COC | PHR | SSW | WS1 | N | N |
| owcdrnut | 2 | 08/07/2019 09:40 | 19 | COC | PHR | SSW | WS1 | N | N |
| owcdrnut | 1 | 09/03/2019 07:47 | 19 | CSP | PHR | SSW | WS1 | N | N |
| owcdrnut | 2 | 09/03/2019 07:52 | 19 | CSP | PHR | SSW | WS1 | N | N |
| owcdrnut | 1 | 10/02/2019 07:43 | 22.2 | CSP | PDR | SSW | WS1 | N | N |
| owcdrnut | 2 | 10/02/2019 07:49 | 22.2 | CSP | PDR | SSW | WS1 | N | N |
| owcdrnut | 1 | 10/29/2019 09:00 | 12.7 | CPB | PDR | SW | WS0 | N | N |
| owcdrnut | 2 | 10/29/2019 09:07 | 12.7 | CPB | PDR | SW | WS0 | N | N |
| owcdrnut | 1 | 11/12/2019 10:23 | -4.5 | CPB | PSR | WNW | WS1 | N | N |
| owcdrnut | 2 | 11/12/2019 10:33 | -4.5 | CPB | PSR | WNW | WS1 | N | N |
| owcdrnut | 1 | 12/02/2019 09:20 | 1.8 | COC | PFQ | NW | WS1 | N | N |
| owcdrnut | 2 | 12/02/2019 09:29 | 1.8 | COC | PFQ | NW | WS1 | N | N |
| owcolnut | 1 | 03/27/2019 11:06 | 4 | CCL | PDR | NNE | WS1 | N | N |
| owcolnut | 2 | 03/27/2019 11:10 | 4 | CCL | PDR | NNE | WS1 | N | N |
| owcolnut | 1 | 04/17/2019 08:51 | 7.4 | COC | PHR | NE | WS1 | N | N |
| owcolnut | 2 | 04/17/2019 08:55 | 7.4 | COC | PHR | NE | WS1 | N | N |
| owcolnut | 1 | 05/15/2019 09:53 | 18.9 | CCL | PLR | WSW | WS1 | N | N |
| owcolnut | 2 | 05/15/2019 09:54 | 18.9 | CCL | PLR | WSW | WS1 | N | N |
| owcolnut | 1 | 06/11/2019 09:01 | 18.4 | CSP | PHR | W | WS1 | N | N |
| owcolnut | 2 | 06/11/2019 09:06 | 18.4 | CSP | PHR | W | WS1 | N | N |
| owcolnut | 1 | 07/09/2019 10:45 | 23 | CCL | PNP | E | WS1 | N | N |
| owcolnut | 2 | 07/09/2019 10:47 | 23 | CCL | PNP | E | WS1 | N | N |
| owcolnut | 1 | 08/07/2019 10:01 | 19 | COC | PHR | SSW | WS1 | N | N |
| owcolnut | 2 | 08/07/2019 10:03 | 19 | COC | PHR | SSW | WS1 | N | N |
| owcolnut | 1 | 09/03/2019 08:11 | 19 | CSP | PHR | SSW | WS1 | N | N |
| owcolnut | 2 | 09/03/2019 08:13 | 19 | CSP | PHR | SSW | WS1 | N | N |
| owcolnut | 1 | 10/02/2019 08:09 | 22.2 | CSP | PDR | SSW | WS1 | N | N |
| owcolnut | 2 | 10/02/2019 08:11 | 22.2 | CSP | PDR | SSW | WS1 | N | N |
| owcolnut | 1 | 10/29/2019 09:23 | 12.7 | CPB | PDR | SW | WS0 | N | N |
| owcolnut | 2 | 10/29/2019 09:26 | 12.7 | CPB | PDR | SW | WS0 | N | N |
| owcolnut | 1 | 11/12/2019 11:15 | -4.5 | CPB | PSR | WNW | WS1 | N | N |
| owcolnut | 2 | 11/12/2019 11:16 | -4.5 | CPB | PSR | WNW | WS1 | N | N |
| owcolnut | 1 | 12/02/2019 09:53 | 1.8 | COC | PFQ | NW | WS1 | N | N |
| owcolnut | 2 | 12/02/2019 10:00 | 1.8 | COC | PFQ | NW | WS1 | N | N |
| owcwmnut | 1 | 03/27/2019 11:24 | 4 | CCL | PDR | NNE | WS1 | N | N |
| owcwmnut | 2 | 03/27/2019 11:26 | 4 | CCL | PDR | NNE | WS1 | N | N |
| owcwmnut | 1 | 04/17/2019 08:59 | 7.4 | COC | PHR | NE | WS1 | N | N |
| owcwmnut | 2 | 04/17/2019 09:02 | 7.4 | COC | PHR | NE | WS1 | N | N |
| owcwmnut | 1 | 05/15/2019 10:20 | 18.9 | CCL | PLR | WSW | WS1 | N | N |
| owcwmnut | 2 | 05/15/2019 10:24 | 18.9 | CCL | PLR | WSW | WS1 | N | N |
| owcwmnut | 1 | 06/11/2019 09:13 | 18.4 | CSP | PHR | W | WS1 | N | N |
| owcwmnut | 2 | 06/11/2019 09:16 | 18.4 | CSP | PHR | W | WS1 | N | N |
| owcwmnut | 1 | 07/09/2019 10:52 | 23 | CCL | PNP | E | WS1 | N | N |
| owcwmnut | 2 | 07/09/2019 10:54 | 23 | CCL | PNP | E | WS1 | N | N |
| owcwmnut | 1 | 08/07/2019 10:12 | 19 | COC | PHR | SSW | WS1 | N | N |
| owcwmnut | 2 | 08/07/2019 10:14 | 19 | COC | PHR | SSW | WS1 | N | N |
| owcwmnut | 1 | 09/03/2019 08:20 | 19 | CSP | PHR | SSW | WS1 | N | N |
| owcwmnut | 2 | 09/03/2019 08:21 | 19 | CSP | PHR | SSW | WS1 | N | N |
| owcwmnut | 1 | 10/02/2019 08:16 | 22.2 | CSP | PDR | SSW | WS1 | N | N |
| owcwmnut | 2 | 10/02/2019 08:18 | 22.2 | CSP | PDR | SSW | WS1 | N | N |
| owcwmnut | 1 | 10/29/2019 09:33 | 12.7 | CPB | PDR | SW | WS0 | N | N |
| owcwmnut | 2 | 10/29/2019 09:35 | 12.7 | CPB | PDR | SW | WS0 | N | N |
| owcwmnut | 1 | 11/12/2019 11:37 | -4.5 | CPB | PSR | WNW | WS1 | N | N |
| owcwmnut | 2 | 11/12/2019 11:38 | -4.5 | CPB | PSR | WNW | WS1 | N | N |
| owcwmnut | 1 | 12/02/2019 10:03 | 1.8 | COC | PFQ | NW | WS1 | N | N |
| owcwmnut | 2 | 12/02/2019 10:05 | 1.8 | COC | PFQ | NW | WS1 | N | N |

1. Diel Sampling

For the following dates and times (EST) in 2019, samples were collected at site WM at two-hour intervals over a 26-hour time period.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Station Code | Start Date (mm/dd/yyy) | Start Time (EST) | End  Date | End Time |
| owcwmnut | 04/03/2019 | 4:00:00 | 04/04/2019 | 6:00:00 |
| owcwmnut | 04/28/2019 | 4:00:00 | 04/29/2019 | 6:00:00 |
| owcwmnut | 05/29/2019 | 4:00:00 | 05/30/2019 | 6:00:00 |
| owcwmnut | 06/26/2018 | 4:00:00 | 06/27/2019 | 6:00:00 |
| owcwmnut | 07/16/2018 | 4:00:00 | 07/17/2019 | 6:00:00 |
| owcwmnut | 08/13/2018 | 4:00:00 | 08/14/2019 | 6:00:00 |
| owcwmnut | 09/09/2018 | 4:00:00 | 09/10/2019 | 6:00:00 |
| owcwmnut | 10/07/2018 | 4:00:00 | 10/08/2019 | 6:00:00 |
| owcwmnut | 11/06/2018 | 4:00:00 | 11/07/2019 | 6:00:00 |
| owcwmnut | 12/03/2019 | 4:00:00 | 12/04/2019 | 6:00:00 |

7) Associated researchers and projects:

As part of the SWMP long-term monitoring program, OWC NERR also monitors 15-minute meteorological and water quality data which may be correlated with this nutrient/pigment dataset. Water quality data sondes are deployed at each of the nutrient sampling sites. These sondes measure and record water temperature, specific conductivity, dissolved oxygen, pH, turbidity, and depth at 15-minute intervals throughout the sampling period (approximately March – December). A meteorological tower is located on reserve property within 1 km of the DR, OL, and WM nutrient collection sites and within 5 km of the BR nutrient collection site. Air temperature, humidity, barometric pressure, wind speed and direction, precipitation, and photosynthetically active radiation data are collected at 15-minute intervals throughout the year. These data are available at [www.nerrsdata.org](http://www.nerrsdata.org). Microwave radar water level sensors (Waterlog Nile Series) are located at the DR and adjacent to the WM sites; sensors collect water depth data every 15 minutes under ice-free conditions. Data are available upon request from the Research Coordinator.

A more comprehensive set of chemical parameters are determined for each surface water grab and diel sample collected for this sampling program. Samples for phytoplankton determination are collected at the same time as surface water grab samples at the DR site and within 100 m of the WM site. This enhanced data set is available from the research coordinator at Old Woman Creek NERR.

From May 2015 to present, three samples a day are collected from the owcbrnut and owcwmnut sites using an autosampler programmed to collect samples at 04:00, 12:00, and 20:00. The samples are transported to the NCWQR weekly (usually Monday mornings) for analysis. Up to three samples per day are analyzed depending on weather (1 sample during base flow; 2-3 samples during storm events). These data are available from the OWC NERR Research Coordinator or from <https://ncwqr.org/monitoring/>. Starting June 2019, the analyses of samples mentioned above were done at OWC NERR. The sampling regiment also changed slightly following the schedule below:

For storm events (at least 10 per year):

owcbrnut x3 per day @ 04:00, 12:00, and 20:00

owcwmnut x1 per day @ 12:00

Non-storm regular sampling:

owcbrnut x1 per day @ 12:00

owcwmnut x1 per week @ 12:00 on Mondays

The chemical data have been incorporated into several research projects and publications related to plankton eukaryotic microorganisms, the breakdown of selected organic contaminants, of *Phragmites* control on non-target communities, biomonitoring study of the aquatic vegetation of the estuary, nutrient cycling, nutrient assimilation, and nutrient and sediment loading reduction through agricultural conservation practices. The data are also used to produce an annual watershed health report card for the Old Woman Creek watershed.

**8) Distribution**

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data.  The NERRS retains the right to be fully credited for having collected and process the data.  Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used.  The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement.  The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons.  The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

Requested citation format:

NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: [www.nerrsdata.org](http://www.nerrsdata.org); *accessed* 12 October 2020.

NERR nutrient data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal investigators and contact persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page [www.nerrsdata.org](http://cfcdmo.baruch.sc.edu/). Data are available in comma separated version format.

**II. Physical Structure Descriptors**

**9) Entry verification**

All field data are recorded by hand on a field datasheet during sample collection. All laboratory chemical analysis data are recorded by hand on a laboratory datasheet; field measurements of water temperature, pH, and dissolved oxygen are transcribed to that datasheet. Any anomalies observed in the field or in the lab are also recorded on their respective datasheets. Duplicate readings are visually inspected to identify any outliers, which would suggest either testing or contamination problems. The datasheets are kept on file at the Old Woman Creek Visitor Center. For samples processed at the NCWQR (monthly grab: Jan.-Jun. 2019; diel: Jan.- Jun. 2019), data were transcribed from instrument print-outs onto laboratory datasheets. For samples processed at OWC NERR (monthly grab: Jun.-Dec. 2019; diel: Jun.- Dec. 2019), values were written onto laboratory datasheets.

The Reserve staff enter the data recorded on field datasheets into an Excel workbook designated for that sampling year. The Reserve staff enter the data recorded on the laboratory datasheets into Excel workbooks designated for each site that include all years of data collected for each site. Parameters measured in ppb (ug/L) are converted to ppm (mg/L) in the Excel workbook, except for Chlorophyll a. A different Reserve staff member checks the field and laboratory data. Field and laboratory workbooks are saved to the Research Coordinator’s computer and a central Ohio Department of Natural Resources Division of Wildlife server, which is regularly backed up through the State of Ohio’s Information Technology Department. The Research Coordinator and SWMP Coordinator are responsible for the data QA/QC and for the nutrient analysis QA/QC.

Nutrient data are entered into a Microsoft Excel worksheet and processed using the NutrientQAQC Excel macro. The NutrientQAQC macro sets up the data worksheet, metadata worksheets, and MDL worksheet; adds chosen parameters and facilitates data entry; allows the user to set the number of significant figures to be reported for each parameter and rounds using banker’s rounding rules; allows the user to input MDL values and then automatically flags/codes measured values below MDL and inserts the MDL; calculates parameters chosen by the user and automatically flags/codes for component values below MDL, negative calculated values, and missing data; allows the user to apply QAQC flags and codes to the data; produces summary statistics; graphs selected parameters for review; and exports the resulting data file to the CDMO for tertiary QAQC and assimilation into the CDMO’s authoritative online database.

**10) Parameter titles and variable names by data category**

Required NOAA/NERRS System-wide Monitoring Program nutrient parameters are denoted by an asterisk “\*”.

*Data Category Parameter Variable Unit of*

*Name Measure*

Phosphorus: \*Orthophosphate PO4F mg/l as P

(Soluble Reactive Phosphorus, SRP)

Total Phosphorus TP mg/l as P

Nitrogen: \*Nitrite + Nitrate, Filtered NO23F mg/l as N

\*Nitrite, Filtered NO2F mg/l as N

\*Nitrate, Filtered NO3F mg/l as N

\*Ammonium, Filtered NH4F mg/l as N

Dissolved Inorganic Nitrogen DIN mg/l as N

Plant Pigments: \*Chlorophyll a CHLA\_N μg/l

Field Parameters: Water Temperature WTEM\_N ºC

pH PH\_N pH

Dissolved Oxygen DO\_N mg/L

Specific Conductivity SCON\_N µS/cm

Turbidity TURB\_N NTU

Air Temperature ATEM\_N ºC

Notes:

1. Time is coded based on a 2400 clock and is referenced to Standard Time.
2. Reserves have the option of measuring either NO2 and NO3 or they may substitute NO23 for individual analyses if they can show that NO2 is a minor component relative to NO3.

**11)** **Measured and calculated laboratory parameters**

**a. Parameters measured directly**

Phosphorus Species: PO4F, TP

Nitrogen Species: NH4F, NO2F, NO3F (Jan-Jun), NO23F (Jul-Dec)

Other: CHLA\_N

**b. Calculated variables**

Nitrogen Species: NO23F = NO2F+ NO3F (Jan-Jun)

NO3F = NO23F-NO2F (Jul-Dec)

DIN = NO23F + NH4F

**12)**  **Limits of detection**

The Minimum Detection Limits (MDL), the lowest concentration of a parameter that an analytical procedure can reliably detect, have been established by the NCWQR and the Old Woman Creek Analytical Laboratory. The MDL is determined as 3 times the standard deviation of a minimum of 7 replicates of a single low concentration sample. The table below presents the MDL’s for the 2019 analytical period. These values are reviewed and revised annually.

*Old Woman Creek MDLs*

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Start Date | End Date | MDL (µg/L) |
| CHLA\_N | 2013 |  | 0.086 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Analyte | Start Date | End Date | Date verified | MDL (mg/L) |
| Total Phosphorus (TP) | 6/14/2019 | 12/31/2019 | 6/27/2019 | 0.002 |
| Orthophosphate (PO4F) | 6/14/2019 | 12/31/2019 | 4/12/2019 | 0.0001 |
| Nitrate+Nitrite (NO23F) | 6/14/2019 | 12/31/2019 | 6/6/2019 | 0.010 |
| Nitrite (NO2F) | 6/14/2019 | 12/31/2019 | 6/13/2019 | 0.0001 |
| Ammonia (NH4F) | 6/14/2019 | 12/31/2019 | 5/30/2019 | 0.002 |

*National Center for Water Quality Research MDLs*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Analyte | Start Date | End Date | Date verified | MDL (mg/L) |
| Total Phosphorus (TP) | 1/1/2019 | 6/13/2019 | Jan 2019 | 0.001 |
| Orthophosphate (PO4F) | 1/1/2019 | 6/13/2019 | Jan 2019 | 0.001 |
| Nitrate (NO3F) | 1/1/2019 | 6/13/2019 | Jan 2019 | 0.04 |
| Nitrite (NO2F) | 1/1/2019 | 6/13/2019 | Jan 2019 | 0.01 |
| Ammonia (NH4F) | 1/1/2019 | 6/13/2019 | Jan 2019 | 0.01 |

**13) Laboratory methods**

Upon returning to the laboratory, each bottle was shaken and a ~30 ml sub-sample was removed for turbidity determination using a laboratory meter. For samples analyzed at NCWQR, a 200-ml sub-sample was removed and frozen immediately for total phosphorus and total Kjeldahl Nitrogen analysis. Samples for filtered chemical and chlorophyll analysis were filtered as quickly as possible using an aspirator/vacuum system as described below. Samples analyzed at OWC NERR were processed in a similar manner with a raw 50-ml sub samples taken for total phosphorus. The remainder was then filtered using an aspirator/vacuum system as described below.

**Samples for chlorophyll analysis:** A sample of known volume (for chlorophyll analysis) was filtered through a Gelman 47 mm diameter A/E filter (1 micron). The filter was then removed, folded, cut into small pieces, and then placed into 10 ml aqueous acetone (90% acetone, 10% saturated magnesium carbonate solution) in a 100-ml glass-stoppered bottle and stored in the freezer in the dark until analysis was conducted one week later. The procedure for chlorophyll analysis is described in Standard Methods for the Analysis of Water and Wastewater, 19th Edn. (1995) (Standard Methods) under “Spectrophotometric Determination of Chlorophyll”, page 10-18.

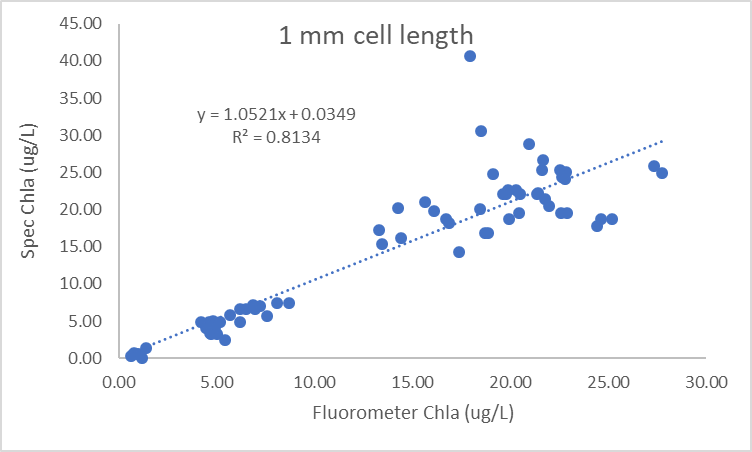


Figure 1: Comparison of spectrophotometric and fluorometric methods for determining chlorophyll-*a* concentrations at Old Woman Creek.

Starting 5/1/19, the OWC analytical lab began measuring chlorophyll-*a* fluorometrically using a Turner Designs Trilogy Fluorometer following EPA approved Method 445.0 rev.1.2. Before 5/1/19, chlorophyll-a concentrations were quantified using a spectrophotometer following EPA Method 446.0 rev 1.2. A comparison of these methods indicated that results were fairly consistent between methods (Figure 1). The main difference between methods 445.0 rev 1.2 and 446.0 rev 1.2 is that the former is designed for chlorophyll-a determination through fluorometry, while the latter is for spectrophotometric chlorophyll-*a* determination. The extraction procedure is similar for both methods. Therefore, chlorophyll-*a* extraction at the OWC analytical lab remained the same before and after the switch to a fluorometer. Briefly, a sample of known volume was filtered through a Gelman 47 mm diameter A/E filter (1 micron). The filter was then removed, folded, cut to remove the filter edge, and placed into 10 ml aqueous acetone (90% acetone, 10% deionized water) in a 100-ml glass-stoppered bottle and stored in the freezer in the dark until analysis was conducted one week later.

**Samples for chemical analysis:** After filtration for chlorophyll analysis, a 200-ml sub-sample of filtrate to be used for chemical analysis was then filtered through a 47-mm diameter membrane filter (0.45 micron) that had been prepared by soaking in distilled water as outlined in Standard Methods. This filtrate was frozen immediately for analysis as were unfiltered samples.

Samples were analyzed by NCWQR for the first portion of the year, January through June 11, 2019. The chemical procedures used by the NCWQR are described in the “Quality Assurance Project Plan for The Honey Creek Targeted Watershed Project Assistance Agreement No. WS – 00E39901-0” (D.B. Baker 2009; available at: <https://ncwqr.files.wordpress.com/2017/06/ncwqr-hc-twg-qapp.pdf>). They are outlined as follows:

NCWQR chemical procedures used from Standard Methods:

**a) Parameter Ammonia:**

Standard Methods Reference: 4500-NH3 Automated Phenate Method,

Traacs, page 4-115

NCWQR SOP – 350 Ammonia N in Water by Automated Colorimetry

Preservation method: frozen

**b) Parameter Nitrite**:

Standard Methods Reference: 4110B Anions by Chromatography,

Ion Chromatography Dioinex DX320 System with Eluent Generator or Dionex ICS2000 with Eluent Generator, page 4-3

NCWQR SOP – 300.1 Anions in Water

Preservation Method: frozen

**c) Parameter Nitrate:**

Standard Methods Reference: 4110B Anions by Chromatography,

Ion Chromatography Dioinex DX320 System with Eluent Generator or Dionex ICS2000 with Eluent Generator, page 4-3

NCWQR SOP – 300.1 Anions in Water

Preservation Method: frozen

**d) Parameter Phosphorus (soluble reactive phosphorus):**

Standard Methods Reference: 4500-P Automated Ascorbic Acid Reduction Method,

Traacs 880, page 4-155

NCWQR SOP – 365.2 Soluble Reactive Phosphorus by Semi-Automated Colorimetry

Preservation method: frozen

**e) Parameter Total Phosphorus**

Standard Methods Reference: 4500-P Persulfate Digestion Method,

Technicon Autoanalyzer II, page 4-158

NCWQR SOP – 365.1 Total Phosphorus

Preservation method: frozen

**f) Parameter Sulfate**

Standard Methods Reference: 4110B Anions by Chromatography,

Ion Chromatography Dioinex DX320 System with Eluent Generator or Dionex ICS2000 with Eluent Generator, page 4-3

NCWQR SOP – 300.1 Anions in Water

Preservation Method: frozen

**g) Parameter Chloride**

Standard Methods Reference: 4110B Anions by Chromatography,

Ion Chromatography Dioinex DX320 System with Eluent Generator or Dionex ICS2000 with Eluent Generator, page 4-3

NCWQR SOP – 300.1 Anions in Water

Preservation Method: frozen

Samples were analyzed by OWC NERR for the second portion of the year, June 12, 2019 through December. The chemical procedures used by OWC NERR are described in the Old Woman Creek Standard Operating Procedures and Quality Control document and are outlined as follows:

**Samples for chemical analysis at Old Woman Creek:** After filtration for chlorophyll analysis, the water used for chemical analysis was then filtered through a 47-mm diameter membrane filter (0.45 micron) that had been prepared by soaking in distilled water as outlined in Standard Methods. The chemical procedures used were from Standard Methods:

**a) Parameter Ammonia:**

Standard Methods Reference: 4500-NH3 Phenate Method, page 4-80

Old Woman Creek SOP- ammonia test

Preservation method: none- tested within 12 hours of collection

**b) Parameter Nitrite**:

Standard Methods Reference: 4500-NO2 Colorimetric Method, page 4-83

Old Woman Creek SOP- nitrite test

Preservation method: none- tested within 12 hours of collection

**c) Parameter Nitrite + Nitrate, Nitrate:**

Standard Methods Reference: 4500-NO3 Cadmium Reduction Method

page 4-87

Old Woman Creek SOP- nitrate test

Preservation method: none- tested within 12 hours of collection

**d) Parameter Phosphorus (soluble reactive phosphorus):**

Standard Methods Reference: 4500-P Ascorbic Acid Method, page 4-153

Old Woman Creek SOP- Soluble reactive phosphorus test

Preservation method: none- tested within 24 hours of collection

**e) Parameter Total Phosphorus**

Standard Methods Reference: 4500-P Persulfate Digestion Method,

880 nm spec, page 4-158

Old Woman Creek SOP – Total phosphorus test

Preservation method: none – tested within 24 hours of collection; 10% HCl added to neutralize pH and prevent speciation of P.

**14) Field and laboratory QA/QC programs**

1. **Precision**

**Field variability**- For the SWMP Monitoring program, two replicate samples are collected at all four of the data logger sites. These samples are collected consecutively and represent true replicates.

**Laboratory variability-** Refer to “Quality Assurance Project Plan for The Honey Creek Targeted Watershed Project Assistance Agreement No. WS – 00E39901-0” (D.B. Baker 2009; available at: <https://ncwqr.files.wordpress.com/2017/06/ncwqr-hc-twg-qapp.pdf>). Also refer to the Old Woman Creek Standard Operating Procedures and Quality Control document.

**Inter-organizational splits-** OWC NERR did not participate in an inter-organizational split program with any other lab.

1. **Accuracy**

**Sample spikes and standards** - Refer to “Quality Assurance Project Plan for The Honey Creek Targeted Watershed Project Assistance Agreement No. WS – 00E39901-0” (D.B. Baker 2009; available at: <https://ncwqr.files.wordpress.com/2017/06/ncwqr-hc-twg-qapp.pdf>). Also refer to the Old Woman Creek Standard Operating Procedures and Quality Control document.

**Standard reference material analysis** – none in 2019

**Cross calibration exercises**- Old Woman Creek NERR did not participate in any cross-calibration exercises with other labs during 2019.

**15) QAQC flag definitions –**

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter’s associated flag column (header preceded by an F\_). QAQC flags are applied to the nutrient data during secondary QAQC to indicate data that are out of sensor range low (-4), rejected due to QAQC checks (-3), missing (-2), optional and were not collected (-1), suspect (1), and that have been corrected (5). All remaining data are flagged as having passed initial QAQC checks (0) when the data are uploaded and assimilated into the CDMO ODIS as provisional plus data. The historical data flag (4) is used to indicate data that were submitted to the CDMO prior to the initiation of secondary QAQC flags and codes (and the use of the automated primary QAQC system for WQ and MET data). This flag is only present in historical data that are exported from the CDMO ODIS.

-4 Outside Low Sensor Range

-3 Data Rejected due to QAQC

-2 Missing Data

-1 Optional SWMP Supported Parameter

0 Data Passed Initial QAQC Checks

1 Suspect Data

4 Historical Data: Pre-Auto QAQC

5 Corrected Data

**16) QAQC code definitions** –

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the sample or sample collection, sensor errors document common sensor or parameter specific problems, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point. However, a record flag column (F\_Record) in the nutrient data allows multiple comment codes to be applied to the entire data record.

General errors

GCM Calculated value could not be determined due to missing data

GCR Calculated value could not be determined due to rejected data

GDM Data missing or sample never collected

GQD Data rejected due to QA/QC checks

GQS Data suspect due to QA/QC checks

GSM See metadata

Sensor errors

SBL Value below minimum limit of method detection

SCB Calculated value could not be determined due to a below MDL component

SCC Calculation with this component resulted in a negative value

SNV Calculated value is negative

SRD Replicate values differ substantially

SUL Value above upper limit of method detection

Parameter Comments

CAB Algal bloom

CDR Sample diluted and rerun

CHB Sample held beyond specified holding time

CIP Ice present in sample vicinity

CIF Flotsam present in sample vicinity

CLE Sample collected later/earlier than scheduled

CRE Significant rain event

CSM See metadata

CUS Lab analysis from unpreserved sample

Record comments

CAB Algal bloom

CHB Sample held beyond specified holding time

CIP Ice present in sample vicinity

CIF Flotsam present in sample vicinity

CLE Sample collected later/earlier than scheduled

CRE Significant rain event

CSM See metadata

CUS Lab analysis from unpreserved sample

*Cloud cover*

CCL clear (0-10%)

CSP scattered to partly cloudy (10-50%)

CPB partly to broken (50-90%)

COC overcast (>90%)

CFY foggy

CHY hazy

CCC cloud (no percentage)

*Precipitation*

PNP none

PDR drizzle

PLR light rain

PHR heavy rain

PSQ squally

PFQ frozen precipitation (sleet/snow/freezing rain)

PSR mixed rain and snow

*Tide stage*

TSE ebb tide

TSF flood tide

TSH high tide

TSL low tide

*Wave height*

WH0 0 to <0.1 meters

WH1 0.1 to 0.3 meters

WH2 0.3 to 0.6 meters

WH3 0.6 to > 1.0 meters

WH4 1.0 to 1.3 meters

WH5 1.3 or greater meters

*Wind direction*

N from the north

NNE from the north northeast

NE from the northeast

ENE from the east northeast

E from the east

ESE from the east southeast

SE from the southeast

SSE from the south southeast

S from the south

SSW from the south southwest

SW from the southwest

WSW from the west southwest

W from the west

WNW from the west northwest

NW from the northwest

NNW from the north northwest

*Wind speed*

WS0 0 to 1 knot

WS1 > 1 to 10 knots

WS2 > 10 to 20 knots

WS3 > 20 to 30 knots

WS4 > 30 to 40 knots

WS5 > 40 knots

17) Other remarks/notes

Data may be missing due to problems with sample collection or processing. Laboratories in the NERRS System submit data that are censored at a lower detection rate limit, called the Method Detection Limit or MDL. MDLs for specific parameters are listed in the Laboratory Methods and Detection Limits Section (Section II, Part 12) of this document. Concentrations that are less than this limit are censored with the use of a QAQC flag and code, and the reported value is the method detection limit itself rather than a measured value. For example, if the measured concentration of NO23F was 0.0005 mg/l as N (MDL=0.0008), the reported value would be 0.0008 and would be flagged as out of sensor range low (-4) and coded SBL. In addition, if any of the components used to calculate a variable are below the MDL, the calculated variable is removed and flagged/coded -4 SCB. If a calculated value is negative, it is rejected and all measured components are marked suspect. If additional information on MDL’s or missing, suspect, or rejected data is needed, contact the Research Coordinator at the reserve submitting the data.

Note: The way below MDL values are handled in the NERRS SWMP dataset was changed in November of 2011.  Previously, below MDL data from 2007-2010 were also flagged/coded, but either reported as the measured value or a blank cell.  Any 2007-2011 nutrient/pigment data downloaded from the CDMO prior to November of 2011 will reflect this difference.

An important distinction regarding analysis of NO23 & NO3 must be made, in that samples analyzed at OWC NERR were done using a cadmium column, which provided results as NO23 making NO3 a calculated value starting with the July 2019 samples and through the end of 2019. The NCWQR analyzed NO3 directly, therefore all NO23 values January 2019 – June 2019 are calculated. Please see section 13. “Laboratory Methods” for more information.

**Sample hold times for 2019:** Samples are held at -20°C. NERRS SOP allows nutrient samples to be held for up to 28 days (CHLA for 30) at -20°C, plus allows for up to 5 days for collecting, processing, and shipping samples. Samples held beyond that time are flagged suspect and coded CHB.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Date Analyzed** | | | | | |
| **Sample Descriptor** | **PO4F** | **TP** | **NH4F** | **NO2F** | **NO(2)3F** | **CHLA\_N, PHEA** |
| 3/27/2019, all grab samples | 4/2/2019 | 4/4/2019 | 4/2/2019 | 4/4/2019 | 4/4/2019 | 4/18/2019 |
| 4/17/2019, all grab samples | 4/23/2019 | 4/23/2019 | 4/23/2019 | 4/23/2019 | 4/23/2019 | 4/26/2019 |
| 5/15/2019, all grab samples | 5/21/2019 | 5/23/2019 | 5/21/2019 | 5/23/2019 | 5/23/2019 | 5/31/2019 |
| 6/11/2019, all grab samples | 6/20/2019 | 6/18/2019 | 6/18/2019 | 6/20/2019 | 6/20/2019 | 6/20/2019 |
| 7/9/2019, all grab samples | 7/9/2019 | 7/9/2019 | 7/11/2019 | 7/11/2019 | 7/11/2019 | 7/16/2019 |
| 8/7/2019, all grab samples | 8/7/2019 | 8/7/2019 | 8/8/2019 | 8/8/2019 | 8/8/2019 | 8/14/2019 |
| 9/3/2019, all grab samples | 9/4/2019 | 9/4/2019 | 9/4/2019 | 9/4/2019 | 9/4/2019 | 9/10/2019 |
| 10/2/2019, all grab samples | 10/2/2019 | 10/2/2019 | 10/3/2019 | 10/3/2019 | 10/3/2019 | 10/23/2019 |
| 10/29/2019, all diel samples | 10/29/2019 | 10/29/2019 | 10/30/2019 | 10/30/2019 | 10/30/2019 | 11/6/2019 |
| 11/12/2019, all grab samples | 11/13/2019 | 11/13/2019 | 11/14/2019 | 11/14/2019 | 11/14/2019 | 11/27/2019 |
| 12/2/2019, all grab samples | 12/2/2019 | 12/2/2019 | 12/3/2019 | 12/3/2019 | 12/3/2019 | 12/19/2019 |
| 4/3-4/2019 all diel samples | 4/9/2019 | 4/11/2019 | 4/19/2019 | 4/11/2019 | 4/19/2019 | 4/11/2019 |
| 4/28-29/2019 all diel samples | 5/7/2019 | 5/9/2019 | 5/7/2019 | 5/9/2019 | 5/9/2019 | 5/6/2019 |
| 5/29-30/2019 all diel samples | 6/4/2019 | 6/6/2019 | 6/4/2019 | 6/6/2019 | 6/6/2019 | 6/6/2019 |
| 6/26-27/2019 all diel samples | 6/27/2019 | 6/27/2019 | 7/26/2019 | 6/27/2019 | 7/26/2019 | 7/8/2019 |
| 7/16-17/2019 all diel samples | 7/17/2019 | 7/17/2019 | 7/18/2019 | 7/18/2019 | 7/18/2019 | 7/24/2019 |
| 8/13-14/2019 all diel samples | 8/15/2019 | 8/15/2019 | 8/15/2019 | 8/16/2019 | 8/16/2019 | 8/22/2019 |
| 9/9-10/2019 all diel samples | 9/10/2019 | 9/10/2019 | 9/11/2019 | 9/11/2019 | 9/11/2019 | 9/18/2019 |
| 10/7-8/2019 all diel samples | 10/8/2019 | 10/8/2019 | 10/9/2019 | 10/10/2019 | 10/10/2019 | 10/23/2019 |
| 11/6-7/2019 all diel samples | 11/7/2019 | 11/7/2019 | 11/8/2019 | 11/8/2019 | 11/8/2019 | 11/13/2019 |
| 12/3-4/2019 all diel samples | 12/4/2019 | 12/4/2019 | 12/5/2019 | 12/5/2019 | 12/5/2019 | 12/19/2019 |

\*sample held longer than allowed by NERRS protocols

Barrier Beach Status and Water Exchange

The water quality of the OL and WM sites at OWC are influenced by whether the barrier beach is open (i.e., surface exchange is occurring between the estuary and the lake). When the barrier is open, wind-driven surface water exchange and larger, seiche events usually result in cycles of water inflow from the lake and outflow to the lake that can be detected in the water quality data. This is evident in less stable values throughout the diel cycles. The change from closed to open can be rapid and dramatic, usually because of precipitation. The transition from open to closed is gradual and usually marked by a gradual increase in water depth and specific conductivity. The Oberlin Beach Association is a private beach association whose property contains a portion of the barrier beach. During 2019, the association used a mini excavator to open the barrier beach three times as documented by the dates below:

Changes to mouth status, Jan. 1, 2019 – Dec. 31, 2019

Jan. 01 – May. 8: **open** (closed Jan. 10-12; frozen some dates in Jan-Feb)

May 09 – May 23: closed

May 24 – Jul. 07: **open** (opened manually by private beach association)

Jul. 08 – Aug. 02: closed

Aug. 03 – Aug. 09: **open** (opened manually by private beach association)

Aug. 10 – Oct. 17: closed

Oct. 18 – Nov. 07: **open** (opened manually by private beach association)

Nov. 08 – Dec 14: closed

Dec. 15 – Dec. 24: **open**

Dec. 25 – Dec. 29: closed

Dec. 30 – Dec. 31: **open**

Chlorophyll a

MDLs were not recalculated for chlorophyll *a* in 2019. Chlorophyll *a* values for the first portion of the year through April samples at all sites were analyzed using the Spectrophotometer, while the remaining samples (beginning with May 2019 samples) were ran using the Turner Designs Trilogy Fluorometer. Please see section 13. “Laboratory Methods” for more information.

Diel Data

Water temperature, DO, and pH measured by the owcwmwq field sonde are included with the diel nutrient data.

Missing nutrient parameter data (with existing CHLA data) occurred when sample collection coincided with samples collected every day at 04:00, 12:00, and 20:00 as part of a separate study. Only the 12:00 sample was run by the NCWQR during base flow conditions, resulting in some of the 04:00 and 20:00 samples not being analyzed.