

Maryland Shallow Water Monitoring Program – 2021 Continuous Monitoring

Metadata:

Identification_Information:

Citation:

Citation_Information:

Originator: Maryland Department of Natural Resources, Resource Assessment Service (MD DNR RAS)

Publication_Date: 20220419

Title: MD DNR Continuous Water Quality Monitoring Project 2021

Geospatial_Data_Presentation_Form: Spatial dataset

Description:

Abstract:

Water quality was monitored at sixteen Maryland shallow water sites located in Chesapeake Bay and Chesapeake Bay tributaries during 2021. YSI (6600 V2 or EXO2) data loggers sampled seven environmental parameters: water temperature, specific conductance, dissolved oxygen concentration, oxygen percent saturation, pH, turbidity, and fluorescence. Water depth was measured at stations where loggers were deployed at fixed depths. Salinity and chlorophyll were derived from specific conductance and fluorescence, respectively. Each parameter was sampled at 15-minute intervals. The number of days that data were collected at individual stations ranged from one hundred thirty-nine to three hundred sixty-five.

At five stations in which 6600 V2 data loggers were deployed, sondes were exchanged bi-weekly. For eleven stations at which EXO2 data loggers were deployed, sondes were exchanged every two to four weeks because these loggers are equipped with more advanced monitoring technology that allows for longer deployments. Data loggers deployed from November through March were exchanged monthly because less biofouling, which may compromise data integrity, occurs during cold weather months. Data loggers were deployed simultaneously at two depths at station XIE7136.

When data loggers were exchanged, water samples for pigments, suspended solids, and nutrients from select stations were collected for later analyses. At the same time, Secchi disk depth was measured and a Hydrolab (series 4a or 5) or EXO water quality sonde was used to collect discrete water temperature, salinity, dissolved oxygen and pH data. Light attenuation was also measured using a LI-COR instrument.

Purpose:

The Maryland Department of Natural Resources Shallow Water Monitoring program is part of a cooperative effort between the Federal government and State and local governments in the Chesapeake Bay watershed to assess the ambient water quality criteria for dissolved oxygen, chlorophyll, and water clarity in shallow water habitats. The Shallow Water Monitoring Program includes two components, the Water Quality Mapping Project and the Continuous Water Quality

Monitoring Project. Details of the Water Quality Mapping Project are documented in a separate document.

Continuous Water Quality monitoring data describe the 2021 state of sixteen shallow water sites on Chesapeake Bay and associated tributaries using key water quality indicators.

The information is integrated with data from other Bay water quality stations and living resources monitoring projects and used to understand linkages, temporal variation and long-term trends.

Water quality data are used to refine, calibrate and validate Chesapeake Bay ecological models. The models are used to develop and assess water quality criteria with the goal of removing the Chesapeake Bay and its tidal rivers from the U.S. Environmental Protection Agency 303(d) list of impaired waters.

Supplemental_Information:

The target audiences for this information include Resource Managers, Technical/Scientific Users, Government, Educators, Students and General Public.

Data users who desire very detailed information about Water Quality Monitoring data definition, sampling procedures and data processing are encouraged to refer to the documents listed below.

Water Quality Database - Database Design and Data Dictionary Prepared For: U.S. Environmental Protection Agency, Region III, Chesapeake Bay Program Office, January 2004. [https://www.chesapeakebay.net/documents/3676/cbwqdb2004_rb.pdf]. An updated version of the data dictionary is a Chesapeake Bay Program work in progress.

Guide to Using Chesapeake Bay Program Water Quality Monitoring Data, EPA 903-R-12-001, February 2012, CBP/TRS 304-12 [https://www.chesapeakebay.net/documents/3676/wq_data_userguide_10feb12_mod.pdf]

Methods and Quality Assurance for Chesapeake Bay Water Quality Monitoring Programs, May 2017, CBP/TRS-319-17 [<https://www.chesapeakebay.net/documents/CBPMethodsManualMay2017.pdf>]

Quality Assurance Project Plan for the Maryland Department of Natural Resources, Chesapeake Bay Shallow Water Quality Monitoring Program, for the period July 1, 2021 - June 30, 2022 [http://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/SWM_QAPP_2021_2022_Draft_v6.pdf]

Time_Period_of_Content:

Time_Period_Information:

Range_of_Dates/Times:

Beginning_Date: 20210101

Ending_Date: 20211231

Currentness_Reference: Ground condition

Status:

Progress: Complete

Maintenance_and_Update_Frequency: As needed

Spatial_Domain:

Bounding_Coordinates:

West_Bounding_Coordinate: -79.4938

East_Bounding_Coordinate: -75.0405

North_Bounding_Coordinate: 39.7425

South_Bounding_Coordinate: 37.8713

Keywords:

Theme:

Theme_Keyword_Thesaurus:

Global Change Master Directory (GCMD). 2022. GCMD Keywords, Version 13.2
Greenbelt, MD: Earth Science Data and Information System, Earth Science Projects Division,
Goddard Space Flight Center (GSFC) National Aeronautics and Space Administration (NASA).

URL (GCMD Keyword Forum Page):

[<https://forum.earthdata.nasa.gov/app.php/tag/GCMD+Keywords>]

Theme_Keyword: Earth Science > Biosphere > Ecosystems > Marine Ecosystems > Estuary

Theme_Keyword: Earth Science > Biosphere > Ecosystems > Freshwater Ecosystems >
Rivers/Streams

Theme_Keyword: Earth Science > Biosphere > Ecological Dynamics > Ecosystem
Functions > Nutrient Cycling

Theme_Keyword: Earth Science > Biosphere > Ecological Dynamics > Ecosystem
Functions > Primary Production

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Surface Water > Surface
Water Features > Rivers/Streams

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Surface Water > Surface
Water Processes/Measurements > Water Depth

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water
Chemistry > Water Characteristics > Chlorophyll Concentrations

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water
Chemistry > Water Characteristics > Conductivity

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water
Chemistry > Water Characteristics > Light Transmission

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water
Chemistry > Water Characteristics > Nitrogen Compounds

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water
Chemistry > Gases > Dissolved Oxygen

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water
Chemistry > Water Characteristics > Nutrients

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water
Chemistry > Water Characteristics > pH

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water
Chemistry > Water Characteristics > Phosphorous Compounds

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water Chemistry > Solids > Suspended Solids

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water Chemistry > Water Characteristics > Turbidity

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water Chemistry > Water Characteristics > Water Temperature

Theme_Keyword: Earth Science > Terrestrial Hydrosphere > Water Quality/Water Chemistry > Water Characteristics > Saline Concentration

Theme_Keyword: Earth Science > Salinity/Density > Pycnocline

Place:

Place_Keyword_Thesaurus: Producer Defined

Place_Keyword: United States

Place_Keyword: Maryland

Place_Keyword: Chesapeake Bay Watershed

Place_Keyword: Chesapeake Bay

Place_Keyword: Anne Arundel County

Place_Keyword: Baltimore City

Place_Keyword: Baltimore County

Place_Keyword: Charles County

Place_Keyword: Dorchester County

Place_Keyword: Harford County

Place_Keyword: Prince George's County

Place_Keyword: Somerset County

Place_Keyword: St. Mary's County

Place_Keyword: Back River

Place_Keyword: Bush River

Place_Keyword: Patapsco River

Place_Keyword: Patuxent River

Place_Keyword: Potomac River

Place_Keyword: Susquehanna River

Place_Keyword: Tangier Sound

Place_Keyword: Wicomico River

Temporal:

Temporal_Keyword_Thesaurus: USGS Thesaurus

Temporal_Keyword: autumn

Temporal_Keyword: spring (season)

Temporal_Keyword: summer

Temporal_Keyword: winter

Access_Constraints: None

Use_Constraints: Acknowledgement of the MD Department of Natural Resources, Resource Assessment Service as a data source would be appreciated in products developed from these data. Please use the following citation: Maryland Department of Natural Resources, Resource Assessment Service. Eyes on the Bay. URL: [<http://www.eyesonthebay.net>].

Point_of_Contact:

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Browse_Graphic:

Browse_Graphic_File_Name:

[https://eyesonthebay.dnr.maryland.gov/contmon/stn_map/Cmon_stns_2021.jpg]

Browse_Graphic_File_Description: Map of sixteen 2021 Continuous Monitoring Stations.

Browse_Graphic_File_Type: JPG

Data_Set_Credit:

Maryland Department of Natural Resources (MDDNR) Resource Assessment Service (RAS) staff collected the majority of samples and processed the data. The Nutrient Analytical Services Laboratory (NASL) at the Chesapeake Biological Laboratory (University of Maryland Center for Environmental Science) analyzed the nutrient, chlorophyll and suspended solids samples.

The project was made possible with funding provided by The State of Maryland, the United States Environmental Protection Agency Chesapeake Bay Program, the National Oceanic and Atmospheric Administration Chesapeake Bay Office and National Estuarine Research Reserve System program, the Oyster Recovery Partnership, the National Aquarium in Baltimore, Maryland Environmental Service, and the National Marine Sanctuary Foundation.

Data_Quality_Information:

Attribute_Accuracy:

Attribute_Accuracy_Report:

Quality Assurance/Quality Control: MDDNR followed specific procedures to ensure that the Shallow Water Quality Monitoring Program project design was properly implemented and managed with sufficient accuracy, precision and detection limits. Accuracy (closeness to the true value) of collected data was controlled and assured by the proper use, calibration and maintenance of both field and laboratory equipment for the measurement of physical and chemical parameters.

The YSI 6600 V2 sondes were configured with the following probes:
6560(conductivity/temperature); 6561(flat glass pH) or 6579(tall pH); 6136(turbidity);
6150(ROX dissolved oxygen); 6025(fluorescence/chlorophyll).

The YSI EXO2 sondes were configured with the following probes: 599870-
01(conductivity/temperature) or 599827 (wiped conductivity/temperature); 599702(unguarded

pH); 599101-01(turbidity); 599100-01(optical dissolved oxygen); 599103-01(total algal chlorophyll and phycoerythrin).

Resolution, range and accuracy specifications for the YSI sondes and probes may be obtained from the manufacturer. [<https://www.ysi.com/customer-support>]

In March 2015, all remaining Series 4a instruments equipped with Standard Clark Polarographic Dissolved Oxygen Sensors were replaced with Series 5 instruments equipped with optical dissolved oxygen sensors (Luminescent Dissolved Oxygen Sensor - LDO). Calibration logs for each instrument list specific replacement dates. Sensors for temperature, specific conductance, pH and depth are identical for Series 4a and 5 instruments.

Procedures used to control and assure the accuracy of field measurements consisted of calibration of field instruments, verification of calibrations, equipment maintenance, and collection of filter blanks. Details of how data acquired with YSI sondes were quality assured and quality controlled may be found in the process description elements in the Lineage portion of this metadata record.

Water quality laboratory analysis results were used to calibrate and cross-check sonde data for accuracy. Daily quality control checks (including the running of blanks and standards) were used to control and assure laboratory accuracy.

Accuracy of Chesapeake Biological Laboratory, Nutrient Analytical Services Laboratory (CBL NASL) laboratory results was also assessed through DNR's participation in the Chesapeake Bay Coordinated Split Sample Program (CSSP), a split sampling program in which five laboratories involved in Chesapeake Bay monitoring analyze the coordinated split samples. CSSP was initiated in June 1989 to establish a measure of comparability between sampling and analytical operations for water quality monitoring throughout the Chesapeake Bay and its tributaries. DNR followed the protocols in the Chesapeake Bay Coordinated Split Sample Program Implementation Guidelines (EPA 1991) and its revisions. Split samples were collected quarterly. Results were analyzed by appropriate statistical methods to determine if results differed significantly among labs. If a difference occurred, discussions began regarding techniques and potential method changes to resolve discrepancies.

Additionally, CBL NASL participated two times per year in the United States Geologic Survey (USGS) reference sample program.

Logical_Consistency_Report:

Two of the attributes in the water quality data set are PARAMETER and MEASUREVALUE. In cases where PARAMETER value is "SIGMA_T" and the MEASUREVALUE in the record is a negative number, the number should be considered unreliable. SIGMA_T values are not measured. SIGMA_T values are derived.

During 2021, at all but one station, water quality monitoring sondes were deployed at a single depth. At the Aquarium East station (XIE7136) sondes were deployed concurrently at two depths: one meter from the surface and 0.3-0.4 meters above the bottom.

Values in the 'LAYER' column of sonde data files may be used to determine the depth at which a sonde was deployed. Sonde data from all 2021 sites, except XIE7136, list a value of 'BS' ('below surface') in the LAYER column. Depth values for stations with a LAYER value of 'BS' will vary depending on the method of sonde deployment at that station. For station XIE7136, a LAYER column value of 'B' indicates the sonde was deployed 0.3 meters above the bottom and a LAYER column value of 'S' indicates the sonde was deployed 1 meter below the surface.

Beginning in 2013, data collection was discontinued at station XIE4741 (Masonville Cove) and a new station, XIE4742 (Masonville Cove Pier), was deployed approximately 160 meters west of station XIE4741. Also, beginning in 2019, station XEF3551 (Gooses – Surface) was transitioned into NOAA's Chesapeake Bay Interpretive Buoy System (CBIBS). In 2021, the bottom sonde at station XEF3551 was also transitioned into NOAA's CBIBS. Data collected at that surface and bottom station are available through NOAA's CBIBS website [<https://buoybay.noaa.gov/>] and deployment information is no longer covered in this metadata record.

In the 2021 sonde data, there are numerous instances of turbidity measurements with negative values. The turbidity probe accuracy is plus or minus 5 Nephelometric Turbidity Units/Formazin Nephelometric Units (NTU/FNU). In cases where turbidity probe post-deployment calibration values were within acceptable limits, negative values greater than or equal to -5.0 NTU/FNU are reported.

During 2021, it was not always possible, for logistical reasons, to replace sondes at all sites every two weeks for stations: WXT0013 (Iron Pot Landing), XIE4742 (Masonville Cove Pier), MTI0015 (Mataponi), XKH2949 (Havre de Grace), and XHF0460 (Sandy Point - South Beach), or every two to four weeks for stations: LMN0028 (Little Monie Creek), PXT0455 (Jug Bay), XAI8482 (Daugherty Creek), XBF7904 (St. Georges Creek), XCH3277 (Karen Noonan Center), XCI0132 (Deal Island), XDA8236 (Mallows Bay Buoy), XIE7135 (Aquarium West), XIE7136 (Aquarium East – Surface and Bottom), XIF7918 (Riverside), and XJG7035 (Otter Point Creek).

The sonde at station XIE4742 was not exchanged on 17-Jun-2021 and 1-Jul-2021 because the United States Fish and Wildlife Service enforced a no entry policy into areas surrounding the monitoring site due to a pair of nesting eagles. This policy precluded DNR field personnel from servicing this station.

The sonde at station XBF7904 was not exchanged on 9-Aug-2021.

The sonde at station XHF0460 was not exchanged on 29-Jun-2021, 28-Jul-2021, 11-Aug-2021, 2-Sep-2021, 16-Sep-2021, 6-Oct-2021, and 3-Nov-2021.

The sonde at station XKH2949 was not exchanged on 30-Jun-2021, 29-Jul-2021, 26-Aug-2021, 22-Sep-2021, and 21-Oct-2021.

A boat lift was installed on the same pier as station LMN0028 on 1-Oct-2021. Construction activities may have impacted turbidity readings on this date.

Construction of a Baltimore Gas and Electric (BGE) transmission line in the Bush River 2.25 miles downstream of station XJG7035 began on 1-Sep-2021. Impacts to water quality data at this station from construction activities are not anticipated.

The water quality monitoring buoy at station XDA8236 was found 500 feet downstream of the listed station location on 16-Sep-2021. The move is hypothesized to have been caused by strong currents associated with the remnants of Hurricane Ida, which impacted the region on 1-Sep-2021. The buoy was moved back to the listed station location on 16-Sep-2021.

Completeness_Report:

2021 Data from sixteen continuous monitoring stations are available on-line.
[<https://eyesonthebay.dnr.maryland.gov/contmon/ContMon.cfm>]

The 2021 Continuous Monitoring project dataset includes twelve months of sonde records from the continuous monitoring stations: WXT0013 (Iron Pot Landing), PXT0455 (Jug Bay), MTI0015 (Mataponi), LMN0028 (Little Monie Creek), XIE4742 (Masonville Cove Pier), XJG7035 (Otter Point Creek), XIE7135 (Aquarium West), and XIE7136 (Aquarium East – Surface and Bottom).

Sondes were deployed ten months at station: XDA8236 (Mallows Bay Buoy).

Sonde data were collected for eight months at stations: XCH3277 (Karen Noonan Center) and XCI0132 (Deal Island).

Deployments at stations: XBF7904 (St Georges Creek), XHF0460 (Sandy Point - South Beach), XIF7918 (Riverside), XKH2949 (Havre de Grace), and XAI8482 (Daugherty Creek) lasted six months.

In 2021, the full suite of nutrient samples was not collected at any stations. A sub-set of nutrients (Volatile Suspended Solids, Ammonium, Orthophosphate, Nitrite plus Nitrate, Total Dissolved Nitrogen (TDN), and Total Dissolved Phosphorus (TDP)) were collected at stations: XJG7035 (Otter Point Creek), PXT0455 (Jug Bay), MTI0015 (Mataponi), WXT0013 (Iron Pot Landing), LMN0028 (Little Monie Creek), and XDA8236 (Mallows Bay Buoy). Total Suspended Solids, chlorophyll, and pheophytin were collected at all stations except stations XIE7135 (Aquarium West) and XIE7136 (Aquarium East - Bottom and Surface). No samples were collected by DNR at these two stations.

The user may discover a few interruptions in sonde datasets. In most cases, these interruptions were related to short-term problems with sonde operation.

There were gaps in the sonde data for the following reasons.

Station XAI8482 (Daugherty Creek) was not deployed until 23-Jun-2021 due to pending site approval from property managers.

Station XKH2949 (Havre de Grace) was not deployed until 16-Jun-2021 due to personnel constraints associated with the COVID-19 pandemic.

Station XBF7904 (St Georges Creek) was not deployed until 8-Jun-2021 due to personnel constraints associated with the COVID-19 pandemic.

Station XHF0460 (Sandy Point - South Beach) was not deployed until 15-Jun-2021 due to personnel constraints associated with the COVID-19 pandemic.

Station XIF7918 (Riverside) was not deployed until 17-Jun-2021 due to personnel constraints associated with the COVID-19 pandemic.

Station XDA8236 (Mallows Bay Buoy) was not deployed until 30-Mar-2021 and was removed from service on 20-Dec-2021 due to concerns about ice and low temperature. Station XDA8236 is also missing data from 30-Apr-2021 to 4-May-2021 and from 16-Sep-2021 to 29-Sep-2021 due to equipment malfunctions.

Station XJG7035 (Otter Point Creek) was not deployed between 4-Feb-2021 and 10-Mar-2021 due to concerns about ice and low temperatures.

Station XIE7136 (Aquarium East – Surface) is missing data from 15-Feb-2021 to 2-Mar-2021, 23-Apr-2021 to 5-May-2021, 6-May-2021 to 19-May-2021, 3-Jun-2021 to 17-Jun-2021, 4-Jul-2021 to 15-Jul-2021, and from 31-Jul-2021 to 26-Aug-2021 due to equipment malfunctions.

Station XIE7136 (Aquarium East – Bottom) is missing data from 10-May-2021 to 19-May-2021 and from 6-Jun-2021 to 17-Jun-2021 due to equipment malfunctions.

Station PXT0455 (Jug Bay) is missing data from 7-Mar-2021 to 24-Mar-2021 due to a sonde power failure.

Station XIE4742 (Masonville Cove Pier) is missing data from 1-Jan-2021 to 5-Jan-2021, 2-Mar-2021 to 6-Apr-2021, and from 2-Nov-2021 to 9-Dec-2021 due to equipment malfunctions.

On a few occasions, due to extreme low tide conditions, sondes were not submerged. These data are not included in the published dataset.

All other missing sonde attribute values were removed during the quality control process because the data were determined to be unreliable.

Lineage:

Process_Step:

Process_Description:

SONDE CALIBRATION and POST-CALIBRATION

The Yellow Springs Instrument (YSI) 6600 V2 and EXO2 data sondes were maintained and calibrated before and after each deployment in accordance with YSI recommendations. [<https://www.y.si.com/customer-support>]

FIELD MEASUREMENTS AND SAMPLING

SONDES:

The continuous monitoring sensors at the sites recorded seven water quality parameters every 15 minutes. Data were uploaded to DNR's web site [<http://www.eyesonthebay.net>] shortly after retrieval.

At all sites the seven water quality parameters measured continuously were: water temperature, specific conductance (used to derive salinity values), dissolved oxygen, oxygen percent saturation, turbidity (NTU/FNU), fluorescence (used to estimate chlorophyll a), and pH. Sondes deployed at fixed depths also measured water depth.

Five monitoring stations were equipped with a YSI 6600 V2 sonde. These stations were: WXT0013 (Iron Pot Landing), XIE4742 (Masonville Cove Pier), MTI0015 (Mataponi), XKH2949 (Havre de Grace), and XHF0460 (Sandy Point - South Beach). The following eleven stations were equipped with a YSI EXO2 sonde: LMN0028 (Little Monie Creek), XIE7135 (Aquarium West), XIE7136 (Aquarium East – Surface and Bottom), XIF7918 (Riverside), XBF7904 (St. George's Creek), XCH3277 (Karen Noonan Center), XCI0132 (Deal Island), XAI8482 (Daugherty Creek), XDA8236 (Mallows Bay Buoy), PXT0455 (Jug Bay), and XJG7035 (Otter Point Creek). Both types of sonde logged data onto an internal memory, where it was stored until retrieval. Eight stations were equipped with cellular telemetry units, which allowed data to be transmitted hourly to a server computer at DNR. Most sondes were deployed inside vertically-oriented PVC pipes with several two-inch holes drilled along their length to allow for water exchange. Depending on location, these sondes were either suspended from a float 1.0 meters below surface or fixed 0.3 meters or 0.5 meters above bottom resting on a stop bolt. Some EXO2 sondes were deployed inside a crabpot-like structure that rested on the bottom and suspended the instrument 0.3 meters off bottom in a horizontal PVC tube tethered to a pier with a cable.

Sondes at the following stations were deployed at a fixed depth of 0.3 meters above the bottom: LMN0028 (Little Monie Creek), MTI0015 (Mataponi), PXT0455 (Jug Bay), WXT0013 (Iron Pot Landing), XJG7035 (Otter Point Creek), XKH2949 (Havre de Grace), XIE7136 (Aquarium East - Bottom), XCH3277 (Karen Noonan Center), XCI0132 (Deal Island), and XAI8482 (Daugherty Creek).

Sondes at station XBF7904 (St Georges Creek) were deployed at a fixed depth of 0.5 meters above the bottom.

Sondes at stations XIE7135 (Aquarium West), XIE7136 (Aquarium East – Surface), XIF7918 (Riverside), XHF0460 (Sandy Point - South Beach), XIE4742 (Masonville Cove Pier) and XDA8236 (Mallows Bay Buoy) were deployed suspended from buoys or floats at a depth of 1.0 meter below the surface.

Note that sondes were deployed concurrently at two depths at station: XIE7136.

WATER QUALITY CALIBRATION SAMPLES:

Every time sondes were exchanged at each Continuous Monitoring station, "grab" water quality samples were collected at 1.0 meter depth, or at deployment depth for stations deployed at a fixed depth above the bottom, using a horizontal "Alpha" water sampler. At the time the water was collected, a Hydrolab or EXO sonde measurement was taken at 1.0 meter or at deployment depth. Note that no samples were collected by DNR at stations XIE7135 and XIE7136.

Numbered two-quart bottles were triple-rinsed and filled with water for "whole" and "filtered" nutrient and chlorophyll samples. (As noted previously, full suites of nutrient samples were not collected at all stations).

Nutrient, pigment and suspended-solid water samples were filtered on station or shortly thereafter. Sample waters and filters were placed on ice immediately after filtration.

Particulate samples included: Chlorophyll, Pheophytin, Particulate Carbon, Particulate Nitrogen (PN), Particulate Phosphorus (PP), Total Suspended Solids (TSS) and Volatile Suspended Solids (VSS).

Filtrate collected from TSS/VSS or PP/PIP filtrations was used for dissolved nutrient samples. Total Dissolved Nitrogen (TDN) and Total Dissolved Phosphorus (TDP), Nitrite plus Nitrate, Ammonium, and Orthophosphate.

HYDROLAB/EXO PROFILE:

The first reading of the Hydrolab or EXO water column profile at each station was recorded at the same time the water quality "grab" sample was collected. After the 1.0 meter depth record was logged, the sonde was lowered to the bottom. A reading was taken at 0.3 meters above the bottom. The sonde was raised and measurements were recorded at 0.5 meter or 1.0 meter increments until it reached the surface. (In cases where station depth was greater than 3 meters, the sonde was raised in 1 meter increments).

SECCHI DEPTH:

Secchi disk depth was measured each time sondes were exchanged. Readings with the Secchi disk were made in-situ without the aid of sunglasses. The Secchi disk was lowered into the water, on the shady side of the boat or pier. The depth at which the disk was no longer visible was recorded. The time at which the reading was taken was noted. This facilitated later matching of Secchi depth readings with transmissometer and turbidity data.

PAR MEASUREMENT:

Underwater Photosynthetically Active Radiation (PAR, 400-700nm)

When meters were exchanged at a site, down-welling light penetrating the water column (PAR) was measured underwater at several depths to calculate the light attenuation coefficient, Kd. Simultaneous surface and submersed PAR intensity measurements were taken to account for variability in incident surface irradiance due to changes in cloud cover. Data collected from this procedure were used to estimate the depth of the photic zone.

The equipment used was manufactured by LI-COR, Inc. and consisted of a LI-192SA, flat cosine Underwater Quantum Sensor, a LI-190SA air (deck) reference sensor and a Data Logger (LI-1000 or LI-1400).

Surface and underwater readings were recorded simultaneously. Readings were allowed to stabilize before being recorded. If the station depth was less than 3 meters, readings were taken at 0.1 meter and then at 0.25 meter intervals, until 10% of the 0.1 meter reading was reached. If the station depth was greater than 3 meters, a reading was taken at 0.1 meter and at 0.5 meter intervals until 10% of the 0.1 meter reading was reached.

PAR readings had also been collected at 15-minute intervals during deployment dates at station XBM8828 (Public Landing) between 2005 and 2012. All 2013 readings were considered invalid, however, due to equipment failure and the PAR sensor has not been deployed since 2013.

SONDE DATA CHECKS

At stations that utilized 6600 V2 data loggers, the continuous monitoring sondes were retrieved, calibrated and replaced bi-weekly during deployment. At eleven stations, data loggers equipped with more advanced monitoring technology that allows for longer deployments were exchanged every two to four weeks. Data loggers deployed from November to March were exchanged monthly because less biofouling, which may compromise data integrity, occurs during cold weather months. At each deployment, sondes were replaced with clean, recalibrated units and data from the data loggers were downloaded to a computer.

In the field, before an instrument was replaced, field staff allowed both the new (freshly calibrated) sonde and the old (deployed) sonde to log two readings (fifteen minutes apart at most stations) side by side at the same depth. At all of the stations, for one of the simultaneous readings, data were recorded from a discrete instrument (a Hydrolab or EXO sonde). This three-way comparison assured that the "new" and "old" sondes were both reading each parameter within a certain tolerance. The Hydrolab or EXO reading was used as a "double-check," and since it was a discrete reading, it allowed staff to watch the display and note whether the parameters were fluctuating or stable.

EcoWatch(TM) software (a YSI product) was used to calibrate the YSI 6600 V2 instruments, as well as to upload and view data collected. KOR(TM) software (a YSI product) was used to calibrate the EXO2 instruments, as well as to upload and view data collected. Data downloaded from the sonde were subjected to quality assurance/quality control checks to ensure that values outside the range of possibility were not displayed on the DNR web site [<http://www.eyesonthebay.net>].

Data were evaluated using both three-way in-situ comparison results and data from sonde calibrations. The comparison tolerances were as follows for both pre- and post-calibration and in-situ comparisons: Temperature (deg C) +- 0.2; Specific Conductance (uM/cm) +- 5%; Dissolved Oxygen (mg/l) +- 0.5 mg/l; pH +- 0.2; Turbidity (NTU/FNU) +- 5% or 5.0 NTU/FNU (whichever is greater); Chlorophyll (ug/l) +- 5% or 5.0 ug/l (whichever is greater).

Excessive drift between pre- and post- calibration values of sonde probes, variance from in-situ measurements or probe failures caused data to be flagged. When post-calibration drift exceeded the limits stated above in both the post-calibration and the in-situ comparables, suspect data were masked within the data set with an error code (see Quality Assurance Project Plan for list of error codes).

SONDE FILE POST-PROCESSING:

Each "raw" .csv file of sonde data was post-processed using an Excel(TM) macro. The file was opened and renamed. Rows of data acquired before and after deployment were deleted. Records (if any) were also deleted if instrument error codes indicated erroneous data. The macro rearranged columns and inserted error-tracking columns and headings. Macro statements flagged negative values, missing values and highlighted values outside each parameter's normal range. The macro also returned a report summarizing range exceedances. Event and instrument information was appended to each record.

Flagged values were evaluated. Common anomalies included spikes in fluorescence and turbidity, dips in specific conductance, and extremely high dissolved oxygen readings. Instrument post-calibration results, in-situ comparisons with Hydrolab, LI-COR readings, historical data from nearby locations, and survey crew remarks were used to determine whether sensor values were acceptable.

In cases where data were determined to be unreliable, the reason(s) were documented with error codes and comments. Unreliable data were masked. No data were discarded. Only data considered reliable were published in reports.

Field biologists and data analysts reviewed continuous monitoring data weekly. If a problem was identified, a field team member was dispatched to replace the instrument as soon as possible.

VERIFICATION AND DATA MANAGEMENT

At the end of the monitoring season, DNR data analysts and field biologists conducted additional data QA/QC procedures. All of the data were plotted and outliers and anomalous values were thoroughly researched. Staff compared unusual values to historic values from the site and values from nearby sites in the Bay. Weather events were considered, event logs were reviewed, and field staff members were consulted regarding possible legitimate causes for the values. In cases where values were not considered legitimate, error codes were assigned. All data were retained in the archive data set. After field staff and the Quality Assurance Officer reviewed error flags, the values were masked within the published dataset.

Process_Date: Unknown

Process_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Kristen Heyer

Contact_Position: Program Manager, Water Quality Monitoring, DNR

Contact_Address:

Address_Type: mailing and physical

Address: 1919 Lincoln Drive
City: Annapolis
State_or_Province: Maryland
Postal_Code: 21401
Country: USA
Contact_Voice_Telephone: 410 263-3369
Contact_Electronic_Mail_Address: Kristen.Heyer_nospam_@maryland.gov[Remove_nospam_ for valid email address]

Process_Step:

Process_Description:

LABORATORY ANALYSIS - CBL

University of Maryland Center for Environmental Science's Chesapeake Biological Laboratory (CBL), Nutrient Analytical Services Laboratory analyzed total dissolved nitrogen, particulate nitrogen, nitrite, nitrite + nitrate, ammonium, total dissolved phosphorus, particulate phosphorus, particulate inorganic phosphorus, orthophosphate, dissolved organic carbon, particulate carbon, total suspended solids, volatile suspended solids, chlorophyll, and pheophytin.

Note that in 2021, the full suite of nutrients was not collected at any stations. A subset of nutrients (Volatile Suspended Solids, Ammonium, Orthophosphate, Nitrite plus Nitrate, Total Dissolved Nitrogen, and Total Dissolved Phosphorus) was collected at stations XJG7035 (Otter Point Creek), PXT0455 (Jug Bay), MTI0015 (Mataponi), WXT0013 (Iron Pot Landing), LMN0028 (Little Monie Creek), and XDA8236 (Mallows Bay Buoy). Total Suspended Solids, chlorophyll, and pheophytin were collected at all stations except stations XIE7135 (Aquarium West) and XIE7136 (Aquarium East - Bottom and Surface). No samples were collected by DNR at these two stations.

During the years 2008-2011, Shallow Water Monitoring silicate samples were collected and analyzed at four Maryland Coastal Bays stations: XDM4486 (Bishopville Prong), XDN6921 (Grey's Creek), NPC0012 (Newport Creek) and XBM8828 (Public Landing). Beginning in 2012, silicate samples were no longer collected at these four Coastal Bays stations.

Further information about laboratory analytical procedures may be obtained from the "Process_Contact".

Process_Date: Unknown

Process_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Jerry Frank

Contact_Position: Manager, Nutrient Analytical Services Laboratory

Contact_Address:

Address_Type: mailing and physical

Address: Chesapeake Biological Laboratory, 146 Williams St; P.O. Box 38

City: Solomons

State_or_Province: Maryland

Postal_Code: 20688

Country: USA

Contact_Voice_Telephone: 410 326-7252

Contact_Electronic_Mail_Address: frank_nospam_@cbl.umces.edu[Remove _nospam_ for valid email address]

Spatial_Data_Organization_Information:

Indirect_Spatial_Reference: Back River, Bush River, Chesapeake Bay, Patapsco River, Patuxent River, Potomac River, Susquehanna River, Tangier Sound, Wicomico River, Maryland, USA

Direct_Spatial_Reference_Method: Point

Spatial_Reference_Information:

Horizontal_Coordinate_System_Definition:

Geographic:

Latitude_Resolution: 0.0001

Longitude_Resolution: 0.0001

Geographic_Coordinate_Units: Decimal degrees

Geodetic_Model:

Horizontal_Datum_Name: North American Datum of 1983

Ellipsoid_Name: Geodetic Reference System 80

Semi-major_Axis: 6378137

Denominator_of_Flattening_Ratio: 298.257

Entity_and_Attribute_Information:

Overview_Description:

Entity_and_Attribute_Overview:

This metadata record is a description of a continuous monitoring project. Project data are an aggregation of data collected at sixteen Maryland stations during 2021.

The data are contained in six related entities (tables): Station_Information, Monitoring_Event_Data, Water_Quality_Data, Light_Attenuation_Data, Optical_Density_Data, and CMON_DATA. Each table contains attributes (fields).

The entity Station_Information is comprised of the attributes: Station, StationDescription, CBSeg2003, CBSeg2003Description, CBSegmentShed2009, CBSegmentShed2009Description, HUC8, HUC12, FIPS, State, CountyCity, USGSGage, FallLine, Latitude, Longitude, UTMX, UTM Y and LLDatum.

The entity Monitoring_Event_Data is comprised of the attributes: HUC8, HUC12, FIPS, CBSeg2003, SegmentShed2009, MonitoringStation, EventId, Cruise, Program, Project, Agency, Source, Station, SampleDate, SampleTime, TotalDepth, UpperPycnocline, LowerPycnocline, FieldActivityEventType, FieldActivityRemark, WindSpeed, WindDirection, PrecipType, TideStage, WaveHeight, CloudCover, Pressure, GaugeHeight, FlowStage, Details, Latitude, Longitude, and TierLevel.

The entity *Water_Quality_Data* is comprised of the attributes: HUC8, HUC12, FIPS, CBSeg2003, SegmentShed2009, MonitoringStation, EventId, Cruise, Program, Project, Agency, Source, Station, SampleDate, SampleTime, TotalDepth, UpperPycnocline, LowerPycnocline, Depth, Layer, SampleType, SampleReplicateType, Parameter, Qualifier, MeasureValue, Unit, Method, Lab, Problem, PrecisionPC, BiasPC, Details, Latitude, Longitude, and TierLevel.

The entity *Light_Attenuation_Data* is comprised of the attributes: HUC8, HUC12, FIPS, CBSeg2003, SegmentShed2009, MonitoringStation, EventId, Cruise, Program, Project, Agency, Source, Station, SampleDate, SampleTime, TotalDepth, UpperPycnocline, LowerPycnocline, Depth, Layer, SampleType, SampleReplicateType, Parameter, Qualifier, MeasureValue, Unit, Method, Lab, Problem, PrecisionPC, BiasPC, Details, Latitude, Longitude, and TierLevel.

The entity *Optical_Density_Data* is comprised of the attributes: HUC8, HUC12, FIPS, CBSeg2003, SegmentShed2009, MonitoringStation, EventId, Cruise, Program, Project, Agency, Source, Station, SampleDate, SampleTime, TotalDepth, UpperPycnocline, LowerPycnocline, Depth, Layer, SampleType, SampleReplicateType, Parameter, Qualifier, MeasureValue, Unit, Method, Lab, Problem, PrecisionPC, BiasPC, Details, Latitude, Longitude, and TierLevel.

The entity *CMON_DATA* is comprised of the attributes: Sample_date, Sample_Time, DateTime, Station, Layer, SampleDepth_m, Salinity_ppt, pH, DO_mg/L, DO_pctSat, Turb_NTU, Chl_ug/L, T_Fahr, Temp_C.

Entity_and_Attribute_Detail_Citation:

Water Quality Database - Database Design and Data Dictionary Prepared For: U.S. Environmental Protection Agency, Region III, Chesapeake Bay Program Office, January 2004. [https://www.chesapeakebay.net/documents/3676/cbwqdb2004_rb.pdf]

Guide to Using Chesapeake Bay Program Water Quality Monitoring Data, EPA 903-R-12-001, February 2012, CBP/TRS 304-12 [https://www.chesapeakebay.net/documents/3676/wq_data_userguide_10feb12_mod.pdf]

Methods and Quality Assurance for Chesapeake Bay Water Quality Monitoring Programs, May 2017, CBP/TRS-319-17 [<https://www.chesapeakebay.net/documents/CBPMethodsManualMay2017.pdf>]

Quality Assurance Project Plan for the Maryland Department of Natural Resources, Chesapeake Bay Shallow Water Quality Monitoring Program, for the period July 1, 2021 - June 30, 2022. [https://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/SWM_QAPP_2021_2022_Draft_v6.pdf]

Distribution_Information:

Distributor:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Michael Mallonee

Contact_Position: Water Quality Database Manager

Contact_Address:

Address_Type: mailing

Address: 1750 Forest Drive, Suite 130

City: Annapolis

State_or_Province: Maryland

Postal_Code: 21401

Contact_Voice_Telephone: 410-267-5785

Contact_Electronic_Mail_Address: mmallone@_no_spam_chesapeakebay.net[Remove _nospam_ for valid email address]

Resource_Description: Downloadable data

Distribution_Liability: None of the Chesapeake Bay Program partners or any of their employees, contractors, or subcontractors makes any warranty, expressed or implied, nor assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information or data contained within the web site. Reference to any specific commercial products, processes, or services or the use of any trade, firm, or corporation name is for the information and convenience of the public and does not constitute endorsement, recommendation or favoring by the Chesapeake Bay Program partners.

Standard_Order_Process:

Digital_Form:

Digital_Transfer_Information:

Format_Name: ASCII file, formatted for text attributes, declared format

Format_Information_Content: Station Information data, Monitoring Event data, Water Quality Data, Light Attenuation data and Optical Density data

File-Decompression_Technique: No compression applied

Transfer_Size: 2.2

Digital_Transfer_Option:

Online_Option:

Computer_Contact_Information:

Network_Address:

Network_Resource_Name:

[https://www.chesapeakebay.net/what/downloads/cbp_water_quality_database_1984_present]

Access_Instructions: Station Information, Monitoring Event, Water Quality, Light Attenuation and Optical Density data are available through the Chesapeake Bay Program CIMS data hub. Select Water Quality Database (1984-Present). Access the data by following web site (see network resource name) instructions.

Digital_Form:

Digital_Transfer_Information:

Format_Name: ASCII file, formatted for text attributes, declared format

Format_Information_Content: Continuous monitoring sonde data

File-Decompression_Technique: No compression applied

Transfer_Size: 100

Digital_Transfer_Option:

Online_Option:

Computer_Contact_Information:

Network_Address:

Network_Resource_Name:

[<https://eyesonthebay.dnr.maryland.gov/contmon/ContMon.cfm>]

Access_Instructions: CMON data (sonde data) for 2021 are available through the Continuous Monitoring Charts and Data Download page of the Eyes on the Bay website. Access the sonde data by following the web site (see network resource name) instructions. Select station and specify dates. Station record counts range from 13,250 to 35,040. Depending on connection speed, downloads may take a considerable amount of time. Downloading partial record sets will proceed more quickly.

Fees: None

Metadata_Reference_Information:

Metadata_Date: 20220610

Metadata_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Brian Smith

Contact_Address:

Address_Type: Mailing and physical address

Address: MDDNR, 580 Taylor Ave, D-2

City: Annapolis

State_or_Province: MD

Postal_Code: 21401

Contact_Voice_Telephone: (410) 260-8630

Contact_Electronic_Mail_Address: brianr.smith_nospam_@maryland.gov[Remove_nospam_ for valid email address]

Metadata_Standard_Name: Content Standards for Digital Geospatial Metadata

Metadata_Standard_Version: FGDC-STD-001-1998