Maryland Shallow Water Monitoring Program – 2019 DATAFLOW

Metadata:

Identification_Information:
Citation:
Citation_Information:
Originator: Maryland Department of Natural Resources, Resource Assessment Service (MD DNR RAS)
Publication_Date: 20200408
Title: MD DNR Water Quality Mapping Project 2019
Geospatial_Data_Presentation_Form: Spatial dataset

Description:
Abstract:
This record describes one year of an on-going water quality monitoring project. Mapping surveys were performed monthly from April through October 2019.

A total of forty-two mapping cruises were conducted on the Chesapeake Bay. The spatial extent of water quality was measured on waters of Chesapeake Bay segments CB4MH and CB5MH.

Monthly CB4MH central, northern and southern survey data and CB5MH central and eastern survey data were aggregated to map Chesapeake Bay segments CB4MH and CB5MH water quality. Northern, southern and eastern surveys were conducted using shallow-draft small boats. Data for central segments CB4MH and CB5MH were collected using a larger vessel. Due to logistical issues, the five monthly surveys regularly occurred on different days.

St. Jerome Creek lies north of the mouth of the Potomac River. Segment CB5MH eastern survey data were acquired using a small boat and used to create maps of St. Jerome Creek each month.

Small boat water quality mapping was conducted using DATAFLOW, a compact, self-contained surface water quality mapping system. The small boats operated at planing speeds of up to 45 km/hr (24.3 kts). Measurements were made approximately every four seconds, or 50 meters (164 feet). Seven water quality parameters were measured: water temperature, salinity (calculated from conductivity), conductivity, dissolved oxygen, turbidity, fluorescence and pH.

Larger vessel water quality mapping sonde data acquisition was accomplished by flowing Chesapeake Bay water from 0.5 m depth across sonde sensors in a YSI(tm) flow-cell and merging the sonde file with the vessel navigation log file. Typical large vessel cruising speed was 28 km/hr (15 kts). Measurements were made approximately every four seconds, or 17

meters (56 feet). Seven water quality parameters were measured: water temperature, salinity, conductivity, dissolved oxygen, turbidity, fluorescence and pH.

Additional water quality measurements were made at fifteen calibration stations and included: Secchi disk depth, photosynthetic active radiation, and HydroLab water temperature, pH, dissolved oxygen, specific conductance, and salinity. Five sites were sampled during each of the CB4MH northern and southern surveys. Measurements were made at three CB5MH eastern survey sites and at two CB5MH Western sites. Water Quality Mapping calibration samples were not collected during segment CB4MH and CB5MH central surveys.

Water quality calibration chlorophyll a and total suspended solids "grab" water samples were also collected at the calibration stations during each monthly mapping small-boat survey. The "grab" samples were collected, after stopping the boat, at 0.5 m depth and filtered, when possible, on site.

Laboratory analyses were performed on calibration "grab" sample water. Concentrations of chlorophyll a and total suspended solids were determined for all stations.

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.

Water quality mapping provides data on variability and patchiness that are valuable in assessing water quality criteria, and in determining attainment of those criteria. For example, spatial information on turbidity can be correlated to the spatial coverage of living resources such as Submerged Aquatic Vegetation (SAV). This information can be used to determine and assess water clarity criteria necessary to support SAV growth, address the progress of meeting SAV restoration goals, and better target specific locations for future SAV restoration.

Spatially-intensive data can also help pinpoint localized areas of water quality concern, such as areas of low dissolved oxygen that can cause fish kills, and their possible links to nearby land uses or point sources.

Water quality maps can capture localized areas of algae blooms, high turbidity, or low dissolved oxygen that may adversely affect living resources in shallow water habitats and spawning areas.

Spatial data can also be aggregated across watershed units to aid in the evaluation of entire systems. Water quality mapping data are 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 list of impaired waters.

Supplemental_Information:
The target audiences for these data 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 documents listed below.

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

Methods and Quality Assurance for Chesapeake Bay Water Quality Monitoring Programs. Chesapeake Bay Program, 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, 2019 - June 30, 2020 [http://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/SWM_QAPP_2019_2020_Draft_v3.pdf].

Water Quality Database - Database Design and Data Dictionary, Prepared For: U.S. Environmental Protection Agency, Region III, Chesapeake Bay Program Office, January 2004. [http://archive.chesapeakebay.net/pubs/cbwqdb2004_RB.PDF]. An updated version of the data dictionary is a Chesapeake Bay Program work in progress.

Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20190410
Ending_Date: 20191024
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). 2020. GCMD Keywords, Version 9.1 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://earthdata.nasa.gov/gcmd-forum]

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>OCEANS>SALINITY/DENSITY>PYCNOCLINE

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>GASES>DISSOLVED OXYGEN

Theme_Keyword: EARTH SCIENCE>TERRESTRIAL HYDROSPHERE>WATER QUALITY/WATER CHEMISTRY>WATER CHARACTERISTICS>EUTROPHICATION

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>pH

Theme_Keyword: EARTH SCIENCE>TERRESTRIAL HYDROSPHERE>WATER QUALITY/WATER CHEMISTRY>WATER CHARACTERISTICS>SALINE CONCENTRATION

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

Place:

Place_Keyword_Thesaurus: Common geographic areas

Place_Keyword: United States

Place_Keyword: Maryland

Place_Keyword: Anne Arundel County

Place_Keyword: Calvert County

Place_Keyword: Dorchester County

Place_Keyword: Lower Chesapeake Bay
Place_Keyword: Queen Anne's County
Place_Keyword: Saint Mary's County
Place_Keyword: Talbot County
Place_Keyword: Upper Chesapeake Bay
Temporal:
Temporal_Keyword_Thesaurus: USGS Thesaurus
Temporal_Keyword: summer
Temporal_Keyword: spring (season)
Temporal_Keyword: autumn
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:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Mark Trice
Contact_Position: Program Chief, Water Quality Informatics, Tidewater Ecosystem Assessment
Contact_Address:
Address_Type: Mailing and Physical Address
Address: Tawes State Office Building, 580 Taylor Avenue, D2
City: Annapolis
State_or_Province: MD
Postal_Code: 21401
Country: USA
Contact_Voice_Telephone: 410.260.8630
Contact_Electronic_Mail_Address: mark.trice_nospam_@maryland.gov[Remove _nospam_ for valid email address]

Browse_Graphic:
Browse_Graphic_File_Name: MDDNR Water Quality Mapping Monitoring Project 2019 Station Map [http://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/metadata/MdDNR_DFlowStns2019.pdf].
Browse_Graphic_File_Description: Overview map of fifteen 2019 DATAFLOW calibration station sites located in Chesapeake Bay Segments CB4MH and CB5MH.
Browse_Graphic_File_Type: PDF
Data_Set_Credit:
Survey and calibration data were collected by MD DNR Resource Assessment Service (RAS) Annapolis Field Office staff.

The Nutrient Analytical Services Laboratory (NASL) at the Chesapeake Biological Laboratory (University of Maryland) analyzed chlorophyll and suspended solids samples.

The project was made possible with funding provided by the State of Maryland and the United States Environmental Protection Agency Chesapeake Bay Program.

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
QUALITY ASSURANCE/QUALITY CONTROL

Maryland Department of Natural Resources followed specific procedures to ensure that the DATAFLOW component of 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 used for the measurement of physical and chemical parameters.

YSI 6600 V2 sondes were configured with the following probes: 6025 (chlorophyll); 6136 (turbidity); 6560 (spCond & temperature); 6561(pH); and 6150ROX (dissolved oxygen) during 2019. Resolution, range and accuracy specifications for the sonde and probes may be obtained from the manufacturer [https://www.ysi.com/search?k=6600+AND+probes].

Procedures used to control and assure the accuracy of field measurements included: calibration of field instruments, verification of calibration results, equipment maintenance, and collection of filter blanks. Most of the details of how data acquired with YSI sondes were quality assured and quality controlled are described in process description elements in the Lineage portion of this metadata record. Water quality calibration-station laboratory analytical results were used to crosscheck sonde data for accuracy.

PAR sensors were returned to LI-COR prior to the field season for factory calibration.

Daily quality control checks (including the running of blanks and standards) were used to control and assure laboratory analytical accuracy.

Accuracy of Chesapeake Biological Laboratory, Nutrient Analytical Services Laboratory (CBL NASL) 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 established 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. Analytical results were compared using appropriate statistical tests to determine if results differed significantly among labs. If a difference occurred, discussions began regarding techniques and potential methods changes to resolve discrepancies.

OTHER ATTRIBUTE ACCURACY INFORMATION

The 2019 segments CB4MH and CB5MH mainstem surveys usually conducted using RV Kerhin, a larger vessel. RV Rachel Carson served as the mainstem sampling platform in October 2019. Air bubbles created when the larger vessels arrived and departed from mainstem fixed calibration stations, regularly caused the turbidity sensor to return elevated results. Changes in vessel speed frequently co-varied with elevated turbidity readings. During quality assurance, turbidity results suspected to have been caused by air bubbles were flagged. Flagged results were retained but not published.

April 2019: Comments in the sonde file created during the April segment CB5MH mainstem survey noted that a subset of turbidity results were considered suspect due to the rough ride between stations. Pollen was observed on the water surface when station XFE5373 calibration samples were collected.

August 2019: RV Kerhin stopped at Sandy Point during the segment CB5MH mainstem survey to collect a passenger and sonde results comments suggested increased turbidity readings beginning at 13:53 were related to disturbed bottom waters. Opportunistic phytoplankton samples were collected at stations XGF5025 and XFE5373 and two other locations on the cruise track. Sixty segment CB4 mainstem survey turbidity results, beginning at 13:58, were suspected to be related to bottom disturbances and censored.

October 2019: Due to logistical issues, GPS coordinates collected during the October CB5HM and CB4MH mainstem surveys on RV Rachel Carson were acquired using a Garmin GPSMAP® 64st handheld device.

There were no known attribute accuracy issues during May, June, July and September 2019.

Logical_Consistency_Report:

April 2019: The segment CB4 North survey cruise track was altered in order to search for a missing data sonde in Harris Creek.

May 2019: A detour was made from the CB4 North survey cruise track to service Harris Creek water quality vertical profiler equipment.

June 2019: During the segment CB4 South survey, a dead dolphin was found and reported at 09:31. The survey track was altered to investigate another suspected dolphin mortality.

August 2019: The cruise track of the segment CB4 mainstem survey was altered to pick up additional personnel at Sandy Point State Park.

October 2019: Due to logistical issues, GPS coordinates collected during the October CB5HM and CB4MH mainstem surveys on RV Rachel Carson were acquired using a Garmin GPSMAP® 64st handheld device.

There were no known logical consistency issues during sampling conducted during July and September 2019.

Completeness_Report:

The DATAFLOW project dataset includes mapping and calibration data acquired during monthly sampling runs, between April and October.

Sampling-event, water-quality-calibration, pigment and suspended solids data from fifteen stations are included in the dataset. Five calibration samples were collected during each of the monthly sampling runs: CB4MH North and CB4MH South. Calibration samples were collected at two stations on the CB5MH West run and at three stations on the CB5MH East run.

Sampling runs CB4MH mainstem and CB5MH mainstem were conducted using a larger vessel in the central portions of Chesapeake Bay segments CB4MH and CB5MH respectively. Mainstem sampling project calibration samples were collected during the CB4MH mainstem and CB5MH mainstem surveys. DATAFLOW calibration samples were deemed duplicative and were not collected.

Collection of a full suite of nutrient samples ceased on most Water Quality Mapping Surveys in 2010. Nutrient sampling on Corsica River surveys continued through 2016 and were discontinued in 2017.

Contour maps based on 2019 dissolved oxygen, salinity, turbidity, temperature and chlorophyll data acquired during DATAFLOW monthly mapping cruises are available on-line. [http://eyesonthebay.dnr.maryland.gov/sim/DataFlowDataMenu.cfm].

Data users may discover a few interruptions in sonde datasets. These were related to short-term problems with flow, power or sonde operation.

Turbidity data were censored in cases where bottom sediment disturbances were determined to be caused by the sampling vessel or other vessels.

April 2019: The southern portion of the mainstem survey was not conducted due to rough seas.

May 2019: During the CB4MH East survey, the data acquisition laptop battery failed as the boat returned to the dock. Dangerous conditions precluded LI-COR data acquisition at station XBG4203. LI-COR data were not collected at stations XFE5373, XFF2293, XGF1167, XGF5025 and XGF7480 due to hardware failure.

June 2019: LI-COR data were not collected at station XDG2324 because of rough seas.

October 2019: Station XGF5025 LI-COR data not acquired due to sea conditions. Battery failure resulted in data loss during the segment CB4 North survey. Data were also lost because of a hardware connection interruption on the segment CB5 East survey.

There were no known completeness issues during 2019 July, August and September surveys.

Lineage:

Process_Step:
Process_Description:
WATER QUALITY CALIBRATION SAMPLES:

At each calibration station, "grab" water quality samples were collected from the outflow of the DATAFLOW unit.

"Grab" samples were collected at the same time as the Hydrolab surface sample was recorded. Numbered two quart bottles were triple-rinsed and filled with water for chlorophyll and total suspended solids samples.

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

HYDROLAB PROFILE:

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

SECCHI DEPTH:

Secchi disk depth was measured at each calibration station. 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, and the depth at which it was no longer visible was recorded. The Secchi depth reading was taken near the stern of the vessel, and the time at which the reading was taken was noted (to the second) from the Global Positioning System. This facilitated later matching of Secchi depth readings with turbidity probe data.

PAR MEASUREMENT:

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

At each calibration station, down-welling light penetrating the water column (PAR) was measured underwater at several depths to calculate the light attenuation coefficient, Kd. Simultaneous deck and submersed PAR intensity measurements were taken to account for variability in incident surface irradiance due to changes in cloud cover. Data collected using 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).

Deck 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 at 0.25 m intervals until 10% of the 0.1 m reading was reached. If the station depth was greater than 3 m, a reading was taken at 0.1 m and at 0.5 m intervals until 10% of the 0.1 m reading was reached.

SONDE PROBES:

YSI 6600 data sondes equipped with a 6560 conductivity/temperature probe, a 6136 turbidity probe, a 6025 chlorophyll probe, a 6561 pH probe and a 6150ROX (Optical) dissolved oxygen probe were maintained and calibrated before and after each deployment in accordance with YSI recommendations [http://www.ysi.com/resource-library.php].

SMALL BOAT SURVEYS:

DATAFLOW is a compact, self-contained surface water quality mapping system, suitable for use in a small boat operating at planing speeds of about 25 knots. The system collects water through a pipe ("ram") deployed on the transom of the vessel, pumps it through an array of water quality sensors, and then discharges the water overboard. Orientation of the sonde vertically, with probes upward, ensures that no air bubbles are conveyed to the sensors, preventing errors that might be caused by such bubbles.

Water quality instrumentation consisted of a YSI 6600 Sonde equipped with a flow-through chamber. The system was configured with conductivity/temperature, turbidity, chlorophyll, pH and dissolved oxygen probes.

Positioning and depth instrumentation consisted of a Raymarine A70D Chartplotter/Sounder. The data logger matched the position data with water quality sensor data for each observation. The Raymarine A70D GPS transmitted NMEA data to a Panasonic ToughBook(tm). A DATAFLOW/LabVIEW program was used to merge position and depth data with data collected by the logger and create an output file.

The system was equipped with an inline flow meter. Although the flow rate did not affect sensor readings, decreased flow was an indication of either a partial blockage or an interruption of water flow to the instrument. Flow data were used in the field as a diagnostic tool to ensure that the system was working properly and, later, as a quality assurance tool to verify that water flow was uninterrupted. A boat horn was wired to the flow meter. If the flow-rate fell below 3.0 L/s, the horn sounded and warned operators that a problem needed to be corrected.

Cruise tracks varied depending on the water body being mapped. In general, a square-wave pattern was followed by alternately sampling shallow shoreline areas, and open, deeper waters while traveling up and down river. Alternative cruise paths were followed if water body size, shape impediments, or obstructions dictated otherwise. Cruise patterns were selected to obtain representative coverage of shallow water habitats and open waters so that segment-wide criteria could be assessed as accurately as possible. Navigational issues and placement of representative calibration sites also determined ultimate cruise tracks.

LARGE VESSEL SURVEYS:

Maryland Department of Natural Resources has used large vessels to collect monthly water quality samples at fixed Chesapeake Bay mainstem stations since 1984. When the water quality mapping program began surveying Chesapeake Bay segment CB4MH in 2017, it was decided that DATAFLOW sonde data could be collected as the mainstem survey sampling vessel proceeded from station to station.

The larger survey vessels are built with through-hull fittings (sea-cocks) located 0.5m below the waterline. The fittings are means of safely controlling the flow of water from outside the vessel hull into the vessel. At the beginning of each survey, the DATAFLOW sonde was activated. Bay water was flowed from the sea-cock across the DATAFLOW sonde sensors in the YSI Flow-cell. A vessel navigation log file was started and vessel coordinate and speed values were acquired from the vessel geographic positioning system. At the end of the survey, the navigation file was copied and uploaded to a data server. After sonde post-calibration, the sonde file was copied and uploaded to a data server.

A larger vessel served as survey platforms during the 2019 water quality mapping season, RV Kerhin. Vessel length was 49 feet. A program named GPSU was used to log navigation data from a Simrad HS70 GPS compass, and depth readings from a Furuno FCV 1100 L echo sounder.

Process_Date: Unknown
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Kristen Heyer
Contact_Position: Manager, Water Quality Monitoring
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: 410.990.4600
Contact_Electronic_Mail_Address: kristen.heyer_nospam_@maryland.gov[Remove _nospam_ for valid email address]

Process_Step:
Process_Description:
SONDE FILE AND NAVIGATION FILE MERGE:

The output of the DATAFLOW/LabVIEW system used on small boat surveys contains merged time, coordinate and sonde results. When the large vessels were used, the LabVIEW

component was not used and additional post-processing work was required to merge navigation log files with the sonde files into a single file.

The process was complicated because the navigation log file and the water quality data sonde files were each started at different times and configured with different time increments. While some navigation and sonde records aligned at precisely the same hour:minute:second timestamp, other navigation and sonde record timestamps were close but differed by one or more seconds.

In order to align the sonde timestamps with the navigation timestamps, time offset expressions were used. For example if the sonde and navigation timestamps were 1 second off, a 1 second timestamp offset was used to align the records. Offset values were documented. Often, timestamps matched and no adjustment was required. In other instances, 1, 2 or 3 second adjustments were employed to align the navigation and sonde data. During a survey lasting approximately 7 hours, a 3 second time offset was considered to be sufficiently geographically-precise for the purposes of the project.

Each month, the raw large vessel navigation log file, the raw water quality sonde data file and timestamp bridge file were referenced in a Microsoft Access(tm) database. The bridge timestamp file contained one second interval time records from 06:00:00 through 23:59:59.

Database queries were used to populate a table that joined navigation records with timestamp bridge records, and a table that joined water quality sonde records with timestamp bridge records. Then, a final query was used to join the navigation and sonde tables and the result set was saved as a Microsoft Excel(tm) workbook.

A series of steps were executed on Excel(tm) workbook worksheets that selected a subset of the record set generated using the Access(tm) database. The first worksheet served to document the raw, merged navigation-bridge-sonde records set. The second, based on a copy of the first, used sorting to select sonde and navigation data time stamps that matched exactly. The third worksheet, also based on a copy of the first, prepared records for the fourth worksheet. In the fourth worksheet, sonde values were shifted up one row, in relation to navigation record timestamp values. The number of seconds-shifted (offset) needed to align navigation values and sonde values in worksheet rows, was documented in the fourth worksheet. Finally, the last worksheet, combined water quality sonde and navigation values from the second and fourth worksheet results, including time-shift offset values ranging from 0 seconds to 3 seconds.

At this point, the larger vessel merged time, coordinate and sonde results had been transformed to a stage where they were ready for processes described under the heading: DATAFLOW FILE POST-PROCESSING.

DATAFLOW FILE POST-PROCESSING:

Each file was opened in Microsoft Excel(tm) and renamed using a survey-date naming convention. Rows of data acquired before and after mapping were deleted. Records (if any) were also deleted if they did not have associated GPS values. A macro was executed that

rearranged columns and inserted error-tracking columns and headings. Next, negative values were flagged, and values outside each parameter's normal range were highlighted. The macro also returned a form summarizing exceedances. Finally, mapping cruise event and instrument information were appended to each record.

Flagged values were evaluated for common anomalies, including spikes in fluorescence and turbidity, dips in specific conductance, and unusually 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) values were determined to be erroneous were documented with error codes and comments. Unreliable data were masked. No data were discarded. All DATAFLOW data for each mapping cruise, both valid and erroneous, were retained in an archival file. Only data considered reliable were published in reports.

VERIFICATION AND DATA MANAGEMENT:

At the end of the monitoring season, DNR Tawes Office and Field Office personnel conducted additional data QA/QC procedures. All of the water quality calibration "grab" sample 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 outlying values. In cases where values were not considered to be legitimate, they were masked from the published dataset with the approval of the field staff and the Quality Assurance Officer.

Process_Date: Unknown
Process_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Mark Trice
Contact_Position: Program Chief, Water Quality Informatics, Tidewater Ecosystem Assessment
Contact_Address:
Address_Type: Mailing and Physical Address
Address: Tawes State Office Building, 580 Taylor Avenue, D2
City: Annapolis
State_or_Province: MD
Postal_Code: 21401
Country: USA
Contact_Voice_Telephone: 410.260.8630
Contact_Electronic_Mail_Address: mark.trice_nospam_@maryland.gov[Remove _nospam_ for valid email address]

Process_Step:
Process_Description:
LABORATORY ANALYSIS - CBL

University of Maryland's Chesapeake Biological Laboratory (CBL), Nutrient Analytical Services Laboratory (NASL) analyzed chlorophyll, phaeophytin and total suspended solids.

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 of Analytical Services
Contact_Address:
Address_Type: mailing and physical
Address: Chesapeake Biological Laboratory, Center for Environmental and Estuarine Studies, The University of Maryland System, 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_@umces.edu[Remove _nospam_ for valid email address]

Spatial_Data_Organization_Information:
Indirect_Spatial_Reference: CB4MH, CB5MH, 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 describes water quality data collected during a water-quality mapping project. Project data are an aggregation of data collected during forty-two 2019 DATAFLOW mapping cruises.

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

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

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

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

The entity Sonde_Data is comprised of the attributes: BATT , BATT_A , BOAT_SPEED , BOAT_SPEED_A , CHLA , CHLA_A , COMMENTS , DO , DO_A , DO_SAT , DO_SAT_A , FLUOR , FLUOR_A , LATITUDE , LONGITUDE , PH , PH_A , PRI_SEG , SALINITY , SALINITY_A , SAMPLE_DATE , SAMPLE_TIME , SONDE , SPCOND , SPCOND_A , STATION , TCHL_PRE_CAL , TCHL_PRE_CAL_A , TOTAL_DEPTH , TOTAL_DEPTH_A , TURB_NTU , TURB_NTU_A , WATER_BODY , WTEMP and WTEMP_A. Sample_Date, SampleTime, Waterbody, Section, Pri_Seg, Sonde, Latitude, Longitude, Total_Depth, Boat_Speed, Batt, Wtemp, Spcond, Salinity, DO_%Sat, Do, Ph, Turb_NTU, Fluor, TChl_Pre_Cal and Comments.

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

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

Maps created by interpolating the dissolved oxygen, turbidity, chlorophyll a, salinity and temperature data acquired during monthly mapping cruises show spatial distribution of water quality parameter values on the day of the survey. The maps may be viewed and downloaded from [http://eyesonthebay.dnr.maryland.gov/sim/DataflowDataMenu.cfm].

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

Methods and Quality Assurance for Chesapeake Bay Water Quality Monitoring Programs. Chesapeake Bay Program, 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, 2019 - June 30, 2020 [http://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/SWM_QAPP_2019_2020_Draft_v3.pdf].

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

Distribution_Information:
Distributor:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Mike Mallonee
Contact_Position: Water Quality Data Manager
Contact_Address:
Address_Type: Mailing and Physical
Address: 410 Severn Avenue, Suite 109
City: Annapolis
State_or_Province: Maryland
Postal_Code: 21403
Country: USA
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 nor any of their employees, contractors, or subcontractors make any warranty, expressed or implied, nor assume 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: Light_Attenuation_Data, Monitoring_Event_Data, Optical_Density, Station_Information, and Water_Quality_Data.
File_Decompression_Technique: No compression applied
Transfer_Size: 0.7
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: Data are available via the Chesapeake Bay Programs CIMS data hub. Select Water Quality Database (1984-Present). Access the data by following web site (see Network Resource Name) instructions.
Fees: None

Distribution_Information:
Distributor:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Mark Trice
Contact_Position: Program Chief, Water Quality Informatics, Tidewater Ecosystem Assessment
Contact_Address:
Address_Type: Mailing and Physical Address
Address: Tawes State Office Building, 580 Taylor Avenue, D2
City: Annapolis
State_or_Province: MD
Postal_Code: 21401
Country: USA
Contact_Voice_Telephone: 410.260.8630
Contact_Electronic_Mail_Address: mark.trice_nospam_@maryland.gov[Remove _nospam_ for valid email address]
Resource_Description: Downloadable data
Distribution_Liability: None of the Maryland Department of Natural Resources partners, nor any of their employees, contractors, or subcontractors, make any warranty, expressed or implied, nor assume 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 Maryland Department of Natural Resources.

Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: ASCII (ASCII file, formatted for text attributes, declared "ASCII" format)
Format_Information_Content: Water quality mapping sonde data
File_Decompression_Technique: No compression applied
Transfer_Size: 19.9
Digital_Transfer_Option:
Online_Option:
Computer_Contact_Information:
Network_Address:
Network_Resource_Name: [http://eyesonthebay.dnr.maryland.gov/sim/Dataflow.cfm]
Access_Instructions:
Water quality sonde data have been collected during surveys of tributaries to the Maryland portion of the Chesapeake Bay or Segments of the Chesapeake Bay mainstem.

Select a sampling location (Tributary/Waterbody), then choose sampling date(s). Please wait for sampling dates to load after highlighting a waterbody.
Fees: None

Metadata_Reference_Information:
Metadata_Date: 20200420
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Ben Cole
Contact_Address:
Address_Type: Mailing and physical address
Address:
Maryland Department of Natural Resources, D-2
580 Taylor Avenue
City: Annapolis
State_or_Province: MD
Postal_Code: 21401
Contact_Voice_Telephone: (410) 260-8630
Contact_Electronic_Mail_Address: benjamin.cole_nospam_@maryland.gov[Remove _nospam_ for valid email address]
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998