Maryland Shallow Water Monitoring Program – 2017 DATAFLOW

Metadata:

Identification_Information:
Citation:
Citation_Information:
Originator: Maryland Department of Natural Resources, Resource Assessment Service (MD DNR RAS)
Publication_Date: 20180630
Title: MD DNR Water Quality Mapping Project 2017
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 2017.

A total of thirty-five mapping cruises were conducted on the Chesapeake Bay. The spatial extent of water quality was measured on waters of Chesapeake Bay segments CB2OH and CB4MH.

An Eastern and Western survey were required to map the extent of Chesapeake Bay segment CB2OH each month. Each month, surveys were conducted on the same day. Results collected during two surveys were combined.

Monthly central, Northern and Southern survey data were aggregated to map Chesapeake Bay segment CB4MH water quality. Northern and Southern surveys were conducted on the same day, using shallow-draft small boats. Additional results were acquired in central segment CB4MH using a larger vessel. Due to logistical issues, the monthly central CB4MH larger vessel surveys occurred on different days than the Northern and Southern small boat surveys. Central, Northern and Southern results were aggregated for each of the months sampled.

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 Bay water from 0.5m 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 twenty-one calibration stations and included: Secchi disk depth, photosynthetic active radiation, and HydroLab water temperature, pH, dissolved oxygen, specific conductance, and salinity measurements were made each station. Five sites were sampled during each of the CB2OH Eastern, CB2OH Western and CB4MH Northern surveys. Samples were collected at six CB4MH Southern survey sites. Water Quality Mapping calibration samples were not collected during segment CB4MH central surveys.

Water quality calibration chlorophyll a and total suspended solids "grab" water samples were collected at five 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.

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].

Quality Assurance Project Plan for the Maryland Department of Natural Resources, Chesapeake Bay Shallow Water Quality Monitoring Program, for the period July 1, 2017 - June 30, 2018.
[http://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/SWM_QAPP_2017_2018_Draft_v6.pdf].

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].

Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: 20170412
Ending_Date: 20171031
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). 2018. GCMD Keywords, Version 8.6. Greenbelt, MD: Global Change Data Center, Science and Exploration Directorate, 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>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>GASES>DISSOLVED OXYGEN

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

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: Baltimore County

Place_Keyword: Calvert County

Place_Keyword: Dorchester County

Place_Keyword: Harford County

Place_Keyword: Kent County

Place_Keyword: Lower Chesapeake Bay

Place_Keyword: Queen Anne'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: None
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 2017 Station Map [http://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/metadata/MdDNR_DFlowStns2017.pdf].
Browse_Graphic_File_Description:
Overview map of twenty-one 2017 DATAFLOW calibration station sites located in Chesapeake Bay Segments CB2OH and CB4MH.

The station XEE3591 sampling location was replaced by a new site: station XEE3691, located 205 meters north. Calibration samples were collected at station XEE3591 during monthly surveys in April-September 2017. Calibration samples were collected at station XEE3691 in October 2017.
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

MD DNR 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 2017. 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

July 2017: Elevated CB4MH_M (central) survey turbidity readings beginning near 08:46 and 09:10 may have been related to a possible algal bloom.

There were no known attribute accuracy issues during April, May, June, August, September and October 2017.

Logical_Consistency_Report:

May 2017: The track of the Chesapeake Bay segment CB4MH_S survey was modified between 08:53 and 09:22 to increase spatial coverage.

September 2017: The CB2OH_W survey cruise track was altered due to an Aberdeen Proving Ground waters closure. A data gap, due to poor electrical connectivity, in CB2OH_E survey sonde results, occurred between 10:39 and 11:14.

October 2017: The CB2OH_W survey cruise track was altered due to an Aberdeen Proving Ground waters closure. A CB4MH_N sonde data gap from 07:45 to 07:57 was caused by a hardware power failure. The CB4MH_M survey navigation data logging interval was 30 seconds instead of the usual 4 seconds.

There were no known logical consistency issues during sampling conducted during April, June, July, and August 2017.

Completeness_Report:

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 twenty-one stations are included in the dataset. Five calibration samples were collected during each of the monthly sampling runs: CB2OH_E, CB2OH_W, CB4MH_M, CB4MH_N and CB4MH_S.

Sampling run CB4MH_M was conducted on a larger vessel in the central portion of Chesapeake Bay segment CB4MH.

The station XEE3591 sampling location was replaced by a new site: station XEE3691, located 205 meters north. Calibration samples were collected at station XEE3591 during monthly surveys in April-September 2017. Calibration samples were collected at station XEE3691 in October 2017.

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 2017 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 2017: LI-COR samples were not collected at stations XJH4239, XIG6373, XEE3591 due to dangerous sea conditions. The CB4MH_N sonde data had gaps from 07:40 - 08:13 and 09:54 - 10:01. The gaps were related to DATAFLOW pump issues. DATAFLOW computer issues resulted in CB2OH_W data gaps from 08:45 - 09:22 and 09:25 - 09:58. The CB2OH_W calibration station XIG7901 sample was collected at 08:58. Sonde data collected during CB4MH_N survey were post-processed to remove corrupt parameter values. Corrections to the sonde record set included removal of extra special characters from fields and rearrangement of displaced data to appropriate field. Similarly, the CB2OH_W sonde data also required removal of extra special characters from fields and rearrangement of displaced data to appropriate fields.

May 2017: Sonde data collected during the CB4MH_N survey were post-processed to remove corrupt parameter values. During the CB2OH_W survey, a power failure resulted in a sonde data gap between 09:06 and 09:16.

June 2017: Elevated CB4MH_M turbidity readings were censored, due to suspected water column disturbance related to the survey vessel arrival on and departure from calibration stations. There were two short-term data gaps, related to sonde hardware, during the CB2OH_W survey.

July 2017: Due to suspected water column disturbance, related to the survey vessel arrival on and departure from calibration stations, elevated CB4MH_M turbidity readings were censored. Vessel speed was not logged during the CB4MH_M survey due to vessel network issues.

August 2017: LI-COR Samples were not collected at stations XJG1795, XIG7748, XIG4800 and XIF3760 due to equipment issues. A CB4MH_S survey sonde-data gap between 09:27 and 10:57 was caused by operator error. During the CB2OH_W survey the DATAFLOW pump became clogged with submerged aquatic vegetation resulting in a brief sonde data gap beginning at 09:56. Later in the CB2OH_W survey, at 10:32 the DATAFLOW pump failed. A replacement pump was flowing by 10:45. Depth results between 11:07 to 12:00 were sporadic, during the CB2OH_E survey, due to the transducer being hit by a submerged log.

September 2017: Calibration samples were not collected at the following stations: XIG6373, XIG5528 and XIG2853. LI-COR Samples were not collected at XIG7901, XJG1795, XIG7748 and XIG4800 due to unsafe conditions. A loose electrical connection caused a CB2OH_E sonde data gap between 10:39 and 11:14. At 11:17 the remainder of the CB2OH_E survey was scrubbed due to very rough weather conditions. Elevated CB4MH_M turbidity readings were censored, due to a suspected water column disturbance related to the survey vessel arrival on and departure from calibration stations.

October 2017: A dozen sonde records beginning at 08:08, on the CB4MH_S survey, were censored due to a suspected power surge. The CB4MH_M survey navigation data logging interval was 30 seconds instead of the usual 4 seconds.

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-meter depth. The sonde was then 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 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-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.

SONDE CALIBRATION and POST-CALIBRATION:

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 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.

Two larger vessels served as survey platforms during the 2017 water quality mapping season, RV Kerhin and RV Rachel Carson. Vessel lengths were, respectively, 49 and 81 feet. RV Kerhin used a program named GPSU to log navigation data from a Simrad HS70 GPS compass, and depth readings from a Furuno FCV 1100 L echo sounder. RV Rachel Carson used a program named Electronic Nautical Chart to log navigation data from a Northstar 952X Differential GPS.

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:
DATAFLOW RAW FILE CLEAN UP:

Hardware issues with a subset of 2017 surveys made extra processing steps necessary. Data in the April CB2OH_W, April CB4MH_N and May CB4MH_N -survey data files were affected. Characters, in addition to standard numeric values, populated parameter values in multiple fields. No pattern was discerned in the way the anomalous strings were distributed throughout in the text file. All values in each field in each row of the three data files were reviewed. All anomalous strings in fields were edited to remove extra symbols if possible or deleted. In cases where strings in fields appeared to have shifted to other fields, the values were evaluated in the context of preceding and subsequent values. In cases where values clearly appeared to be consistent with preceding and following data field values, the values in question were realigned to the appropriate field. Coordinate values were plotted Using ArcGIS Desktop. Records with coordinates that were inconsistent with preceding and following cruise track values were deleted. Copies of the unedited, raw files were retained. Finally, the edited files were processed with other survey files using the Excel(tm) macro described under the heading: DATAFLOW FILE POST-PROCESSING.

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 time stamps 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. Chesapeake Bay Segment CB4MH extends roughly 85 km from North to South. 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. 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 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) values were determined to be "bad" were documented with error codes and comments. Unreliable data were masked. No data were discarded. All DATAFLOW data for each mapping cruise, both "good" and "bad", 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. 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: CB2OH, CB4MH, 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 thirty-five year 2017 DATAFLOW mapping cruises.

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

The entity Light_Attenuation_Data is comprised of the attributes: Depth, Details, EventId, HUC8, LowerPycnocline, Method, Parameter, Program, Project, SampleDate, SampleReplicateType, SampleTime, Source, Station, TotalDepth, Unit, and UpperPycnocline.

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 Sonde_Data is comprised of the attributes: Sample_Date, Sample_Time, Water_Body, 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, Lab, Latitude, Layer, Longitude, LowerPycnocline, MeasureValue, Method, MonitoringStation, 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:
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].

Quality Assurance Project Plan for the Maryland Department of Natural Resources, Chesapeake Bay Shallow Water Quality Monitoring Program, for the period July 1, 2017 - June 30, 2018.
[http://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/SWM_QAPP_2017_2018_Draft_v6.pdf].

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].

Distribution_Information:
Distributor:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Mike Mallonee
Contact_Position: Water Quality Database 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: 11.9
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: 20180718
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