2021 Maryland Department of Natural Resources Methods for Calculating Chesapeake Bay Hypoxic and Anoxic Volumes

Adequate levels of dissolved oxygen in bay waters are critical for a healthy estuarine habitat. Water with a low concentration of dissolved oxygen is termed hypoxic. Water with dissolved oxygen levels near zero are referred to as anoxic. Hypoxic conditions can be stressful to marine life; and fish, crabs and oysters cannot survive under anoxic conditions. Together, hypoxic and anoxic waters create a region often referred to as the "dead zone" within the Chesapeake Bay due to the greatly reduced number of estuarine species that inhabit this area. Each year, as one measure of bay health, DNR monitors the extent of the dead zone within the Chesapeake Bay by reporting estimates of hypoxic and anoxic water volumes calculated from data collected during bi-monthly water quality monitoring cruises.

DNR computes hypoxia estimates using the Chesapeake Bay interpolator program that was originally developed by the NOAA Chesapeake Bay Office (reference below). The interpolator program uses data from the bay water quality monitoring cruises to calculate dissolved oxygen concentrations throughout the bay using known bay area and bathymetry, and converts those concentrations into estimates of hypoxic volume. For reporting purposes, DNR defines hypoxia as dissolved oxygen concentrations less than 2 mg/L. Dissolved oxygen concentrations less than 0.2 mg/L are defined as anoxic conditions.

For each interpolator run, the sample date at station CB3.2 (located near Swan Point, Rock Hall, MD) determines the date range used for data input. A window of +/- 7 days around the sample date at station CB3.2 defines each interpolation period. Data from 56 long-term monitoring stations (including stations in the bay mainstem and tributaries of both Maryland and Virginia) are examined, and data from any of these 56 stations that were collected within the interpolation period are used for program input. Although data from up to 56 stations may be included in an interpolator run, it is more likely that a subset of these stations is used in each hypoxic volume estimate due to the logistical realities of accessing and sampling all 56 stations within the 15 day window.

Monitoring cruises typically occur twice per month during June, July and August, and once per month during the rest of the year, although this schedule has varied through the years. Generally, a cruise that occurs between day 1-15 of a month produces an "early" hypoxia estimate for the month. Cruises that occur after day 15 of the month produce "late" monthly estimates. If only one cruise occurs in a month, the hypoxic volume estimate is reported in either the "early" or "late" time period, but not both. DNR reports hypoxia estimates for each monitoring cruise that takes place during June through September, the months when low oxygen is most likely to occur in the bay, and computes a seasonal summary for the months of May-September at the end of each summer.

The Maryland Department of Natural Resources, Resource Assessment Service monitors water quality throughout Maryland's tidal and non-tidal waters to assess the health of habitats for living resources such as fish, crabs, oysters and underwater grasses. Monitoring also measures pollutants such as nutrients (nitrogen and phosphorus) and sediment, and guides management actions for restoration of habitats and improved fisheries stocks. Data are used in a variety of assessments, including report cards, environmental models, regulatory analyses, academic research, and forecasts. For hypoxia, monitoring data is used to create, calibrate and improve models that estimate and forecast hypoxia on daily, weekly and seasonal periods.

Reference: Bahner, Lowell. "User Guide for the Chesapeake Bay and Tidal Tributary Interpolator." Software: VOL3D, Version 4.6. NOAA Chesapeake Bay Office, Annapolis, MD, August 2006.