2019 Chesapeake Bay Dead Zone Report
November 2019

Hypoxia Background

The "Dead Zone" of the Chesapeake Bay refers to a volume of hypoxic water that is characterized by dissolved oxygen concentrations less than 2 mg/L, which is too low for aquatic organisms such as fish and blue crabs to thrive. The Chesapeake Bay experiences hypoxic conditions every year, with the severity varying from year to year, depending on nutrient and freshwater inputs, wind, and temperature. Multiple metrics are used to relate the severity of hypoxia between different years:

- ***Maximum Daily Hypoxic Volume*** (km^3): The maximum volume of Chesapeake Bay water experiencing hypoxic conditions on any given day[a]
- ***Average Summer Hypoxic Volume*** (km^3): The average volume of hypoxic water from June through September
- ***Hypoxic Duration*** (days): The number of days in a given year between the first and last day of hypoxic conditions exceeding 2 km^3 in volume
- ***Total Annual Hypoxic Volume*** (km^3 days): The total amount of hypoxia in the Bay for a given year, calculated by summing the hypoxic volume on each day

2019 Chesapeake Bay Hypoxia Score

The Virginia Institute of Marine Science[b] and Anchor QEA operate a real-time three-dimensional hypoxia forecast computer model that predicts daily dissolved oxygen concentrations throughout the Bay (www.vims.edu/hypoxia). The metrics listed above were estimated for 2019 from this forecast model; for reference, the same statistics have also been generated for historical years (**1985-2018**).

In 2019:

- **Maximum daily hypoxic volume was greater than 79% of historical years**
- **Summer average hypoxic volume was greater than 74% of historical years**
- **Duration of hypoxia was greater than 82% of historical years**
- **Total annual hypoxic volume was greater than 74% of historical years**

Springtime inflows from the Susquehanna River were high in 2019, resulting in the prediction that 2019 would be the 4th largest July hypoxic volume in the last 20 years.[c] However, summer winds and temperatures also play large roles in the severity of hypoxia. Through mid-July 2019, total annual hypoxic volume was on the high end of 2014 to 2018 (**Figure 1**). Weak winds and high temperatures from the end of June to mid-August allowed hypoxia to increase to higher levels.[d] This is different from 2018, when strong winds reduced the amount of mid-summer hypoxia. In 2019, hypoxia decreased quickly in late August and early September (Hurricane Dorian) as winds increased; however, hypoxia returned with the high temperatures in late September and early October until strong winds mixed the Bay water and ended hypoxia in the mainstem of the Bay for the year. Overall, the total amount of hypoxia in 2019 was estimated to be on the high end of the normal range for 1985 to 2018, and higher than in the recent past (**Table 1**). As in 2018, hypoxia also lasted longer than in other recent years.

Even with environmental conditions that favor severe hypoxia (high riverine input to the Bay and light winds), the total amount of hypoxia in 2019 was within the normal range, suggesting nutrient reductions since the 1980s have helped improve water quality in the Bay.

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[a] 1 km^3 equals about 400,000 Olympic-sized swimming pools of water
[b] Contact Marjorie Friedrichs (marjy@vims.edu) for more information
[c] 2019 springtime forecast: http://scavia.seas.umich.edu/wp-content/uploads/2019/06/2019-Chesapeake-Bay-forecast.pdf
[d] Very high hypoxia was also estimated from cruise-based data. See https://news.maryland.gov/dnr/2019/08/02/july-2019-hypoxia-report/
[e] These estimates are based on computer models that continue to be improved; therefore past estimates may be updated as improvements are made

Table 1. Severity of hypoxia estimated by the forecast model. (For more detailed information, see www.vims.edu/hypoxia.) Note that 2019 values were within the historically normal range (except for maximum daily hypoxic volume) but were higher than recent years (2014 to 2018). Percents (%) represent the percent of the Bay that was hypoxic based on the volume of the Bay in the forecast model

Year	Maximum Daily Hypoxic Volume (km^3)	Average Summer Hypoxic Volume (km^3)	Hypoxic Duration (days)	Total Annual Hypoxic Volume (summed over each day; km^3 days)
Historical*	6.8 to 12.6	2.8 to 6.6	93 to 143	411 to 951
2014	7.7 (10%)	4.9 (6%)	115	625
2015	9.9 (13%)	4.6 6%)	98	588
2016	10.7 (14%)	5.1 (7%)	101	664
2017	9.9 (13%)	5.3 (7%)	92	657
2018	10.4 (13%)	4.8 (6%)	123	645
2019	13.1 (17%)	6.3 (8%)	136	826

*Historical values are based on a model simulation of 1985 to 2018. Values in the range on Table 1 can be considered relatively normal, based on the 1985 to 2018 modeled values. The range is the median plus and minus one standard deviation. The median is the value where half the historical yearly values are lower and half are higher. The standard deviation represents the year to year variability.

Figure 1. Hypoxic volumes for 2014 to 2019 and wind speed for 2018 and 2019. Note the low wind speed and large amount of hypoxia in summer 2019 compared to high wind speed in July 2018 and the corresponding decrease in hypoxia from July into August 2018.