The 2013 Chesapeake Bay summer *Dead Zone*

Summer volume of the Chesapeake Bay's "Dead Zone" in 2013 is near average and provides less habitat for the Bay's fish, crabs and oysters in which to live, thrive and reproduce.

SUMMARY: The volume of the "Dead Zone" in Chesapeake Bay in summer of 2013 was 22.1 percent of the Bay volume. This represents an increase above the near record low "Dead Zone" volume (second best year on record) observed in 2012 (16.5%). Defined by oxygen levels less than 2 milligrams of oxygen per liter of water (mg/L), these low oxygen (or hypoxic) waters cannot support fish, crabs and oysters, which has led to the popular use of the term, "Dead Zone". With oxygen levels well below a 5 milligram/liter goal, "Dead Zone" waters represent a loss of habitat during a time when spawning occurs, oyster spat are setting and young fish and crabs are rapidly growing. In the "Dead Zone", these activities are absent.

The 2013 Chesapeake Bay "Dead Zone" volume slightly above the 29-year (1985-2013) average of 21.9%. Over this period, the summer "Dead Zone" volume has ranged from 15.3% (1985) to 33.1% (2011). Modeled projections of hypoxic volume released earlier this year are based on estimated nutrient loadings to the Bay from its tributaries during the winter and spring. The 2013 model results predicted a "Dead Zone" volume slightly lower than the long-term average, but the actual volume was within the probable range. The higher observed volume than projected may be due to higher nutrient loadings to the Bay during late spring/early summer rains.

INTRODUCTION: In Chesapeake Bay, most animals require oxygen concentrations of at least 5 milligrams per liter (parts per million) to live, thrive and reproduce. During the summer in Chesapeake Bay, the lack of strong winds that help entrain oxygen and mix waters, the warm water temperatures, natural stratification (layering), rapid algae growth from nutrient enriched waters and bacterial decomposition of dead algae in the deeper waters of the Bay can reduce oxygen levels to 2 parts per million (ppm) or lower - oxygen levels too low to support fish, crabs and oysters. Waters with oxygen levels are below 2 ppm are termed "hypoxic".

BACKGROUND During the summer (June through August), staff from the Maryland Department of Natural Resources and Virginia Department of Environmental Quality record data and collect samples twice each month from a network of Chesapeake Bay sites. These data have been used to help define the amount of water in the the Bay where oxygen levels are too low to support fish, crabs and oysters. This fluctuating, deep layer of hypoxic water is popularly called the Bay's "Dead Zone".

The size of the "Dead Zone" represents a significant loss of living space (habitat) for the Bay's animals. The 2013 hypoxic volume was slightly greater than the 29-year average, but annual surveys show that this volume varies widely (Figure 1). The 2013 "Dead Zone" (**22.1%**) was substantially larger than that observed in 2012 (**16.7%**) which was the 2nd *smallest* reported hypoxic volume. In contrast, both the 2012 and 2013 "Dead Zone" volumes were much smaller than the very high "Dead Zone" volume observed in 2011 (**27.7%**) which was "relieved" by passage of Hurricane Irene which abruptly mixed and aerated the Bay's deep waters in late August.

SUMMER 2013 RESULTS: Data collected during this summer's bi-weekly sampling trips were used in a modified NOAA-Chesapeake Bay Office INTERPOLATOR model to calculate the hypoxic volume of the Bay for each sampling period. From early June through late August 2013, the volume of the Bay's "Dead Zone" fluctuated above and below the long-term average dashed line in ***Figure 2***.

Figure 1.

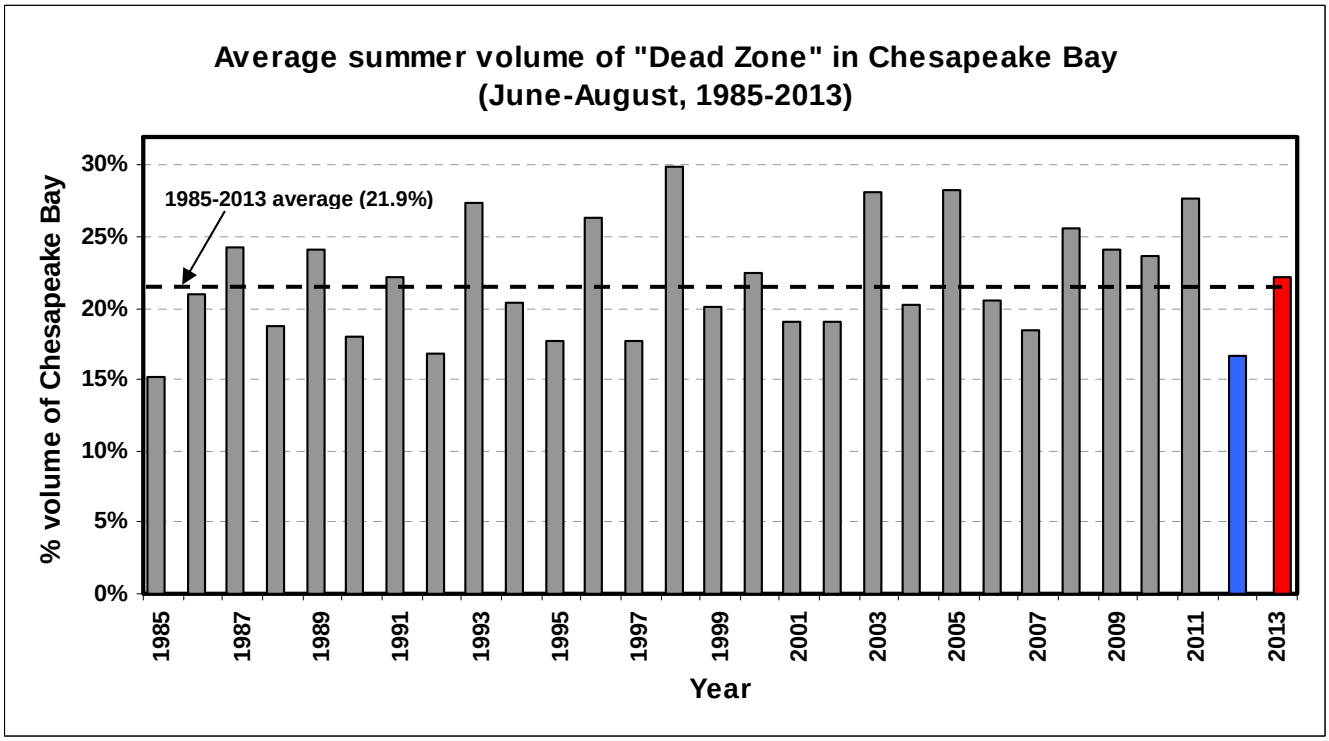
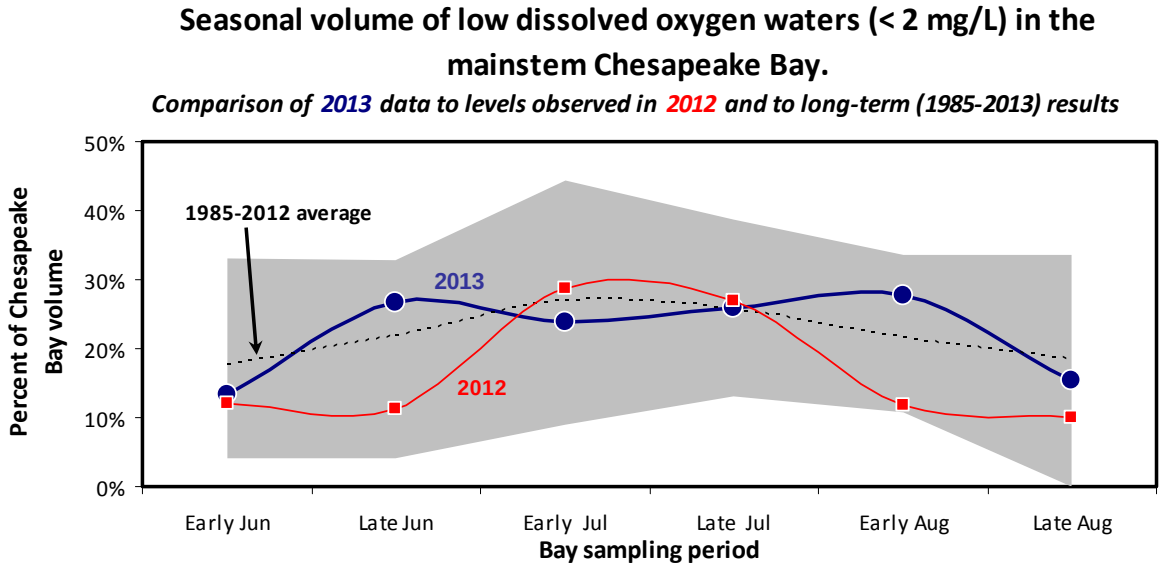
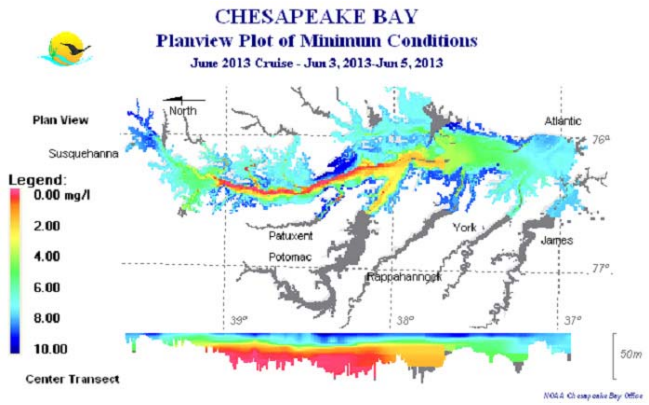


Figure 2.

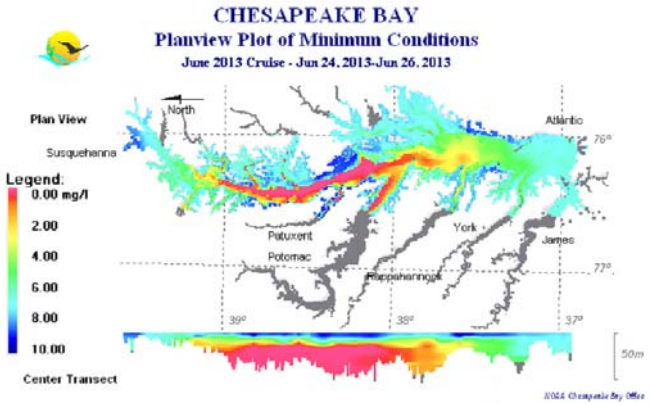


The modified NOAA-Chesapeake Bay Office INTERPOLATOR model that used to calculate the hypoxic volume of the Bay also produces images of oxygen conditions in the Bay - both in plan (representing bottom conditions) and in profile (along the main, deep channels in the Bay). These images show the dynamic seasonal variations in northern and southern limits of the "Dead Zone" and how low oxygen conditions change with depth throughout the summer (***Figures 3a-f***).

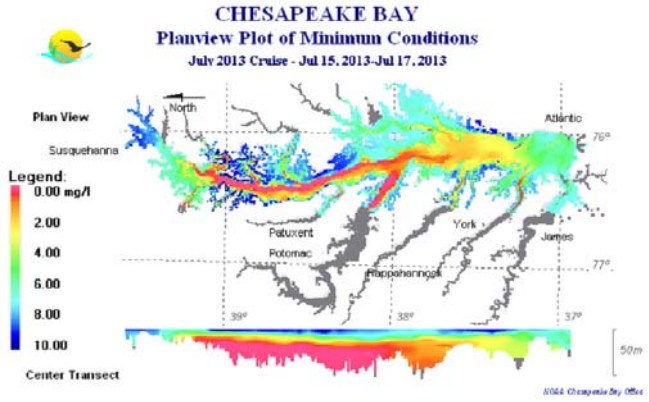
Figure 3 - Approximations of dissolved oxygen conditions in the Maryland-Chesapeake Bay, Summer 2013 (data are based on modified NOAA-Chesapeake Bay Program INTERPOLATOR output)



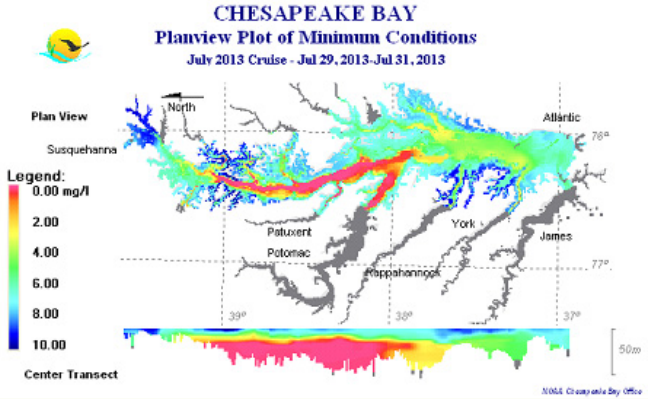
Early June 2013 - Dead Zone in the Bay (oxygen <2 mg/L - orange to red) extends from Baltimore Channel south to Pt. Lookout (Potomac River mouth) with the lowest oxygen levels confined to the Bay's deep central channel



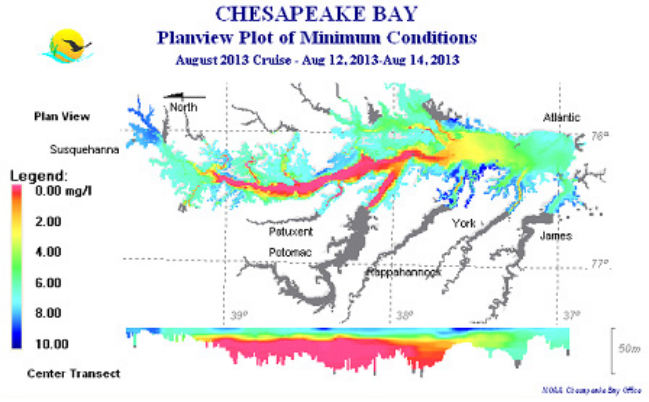
Late June 2013 - The Dead Zone expands south into Virginia's upper Bay, widens south of the Bay Bridge south and extends into the lower Potomac. Lowest oxygen levels (pink color) intensify.



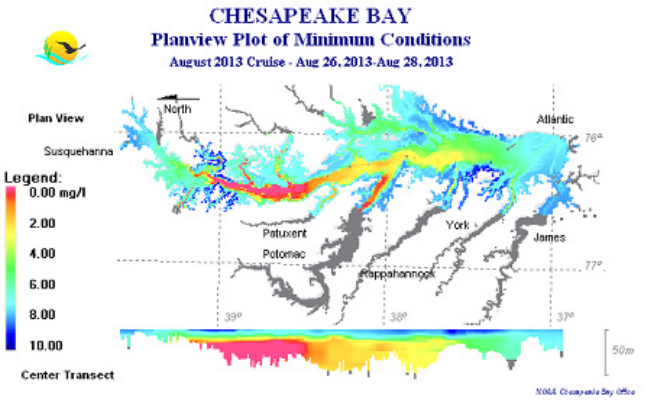
Early July 2013 - The Dead Zone extends to north to Tolchester, sinks in mid-Bay, and narrows throughout the Bay but widens in the lower Potomac.



Late July 2013 - North end of Dead Zone retreats southward to Rock Hall and out of the Virginia Bay, but extends into the lower Patuxent River channel



Early August 2013 - Southern end of Dead Zone extends into Virginia Bay and intensifies in Maryland mid-Bay.



Late August 2013 - Dead Zone in the Bay dramatically retreats to between Baltimore Channel and Choptank entrance and from the Patuxent River

As described earlier, the summer's average volume of the "Dead Zone" ranked 16th out of the 29 years - slightly above the 29-year average (***Figure 1***). These field results are similar to and within the confidence limits of the 2013 summer oxygen forecast released in June by the University of Maryland-NOAA EcoCheck partnership with researchers from the University of Michigan (http://ian.umces.edu/ecocheck/forecast/chesapeake-bay/2013/). Based on winter through May estimates of nutrient levels and freshwater flow into Chesapeake Bay along with estimates of summer wind conditions, estimates of the volume of the summer hypoxic ("Dead Zone") volume are developed along with confidence limits (95% probability). The observed summer 2013 hypoxic volume of **4.7** cubic kilometers (km^3) was above the predicted summer forecast (**4.5 km^3**), but within the predicted 95% confidence interval (**4.1** to **4.8 km^3**). The observed July 2013 hypoxic volume of **5.3 km^3** was below the predicted volume forecast (**6.1 km^3**) but, again, was within the predicted 95% confidence interval (**2.0** to **8.5 km^3**).

EXPECTATIONS: Given the annual variability in the size of the Bay's "Dead Zone", will we see a reduction in the size of "Dead Zone"? Will there be more habitat that Bay's fish, crabs and oysters be able to use? Implementation of required Watershed Implementation Plan (WIP) efforts to restore Chesapeake Bay are planned over the next decade throughout the Bay watershed that include efforts to reduce nutrient loadings to the Bay. These plans include scheduled implementation of nutrient reduction strategies (e.g., upgrades to wastewater treatment plants, additional stormwater management controls, implementation of agriculture management practices like cover crops, and reductions in atmospheric deposition from cars and trucks) that should result in an overall decline in the size of the Chesapeake Bay's "Dead Zone" to minimal levels..

For more information about DNR's Chesapeake Bay monitoring program or results, check out:
- Real-time Maryland Tidal Water Quality Conditions: *www.eyesonthebay.net Twitter:@eyesonthebay*
- Restoring the Chesapeake Bay: Maryland's Actions & Progress: *www.baystat.maryland.gov/*, and
- What You Can Do to Help the Bay: *www.baystat.maryland.gov/what_you_can_do.html*