CHAPTER 4.6 CHESAPEAKE BAY ASSESSMENT

(Note: The Federal-Interstate Chesapeake Bay Program, which is responsible for developing water quality standards and assessment protocols for Bay waters, is described in more detail in Chapter 7.7.)

Assessment of Aquatic Life Use in Chesapeake Bay and Its Tidal Tributaries

Summary

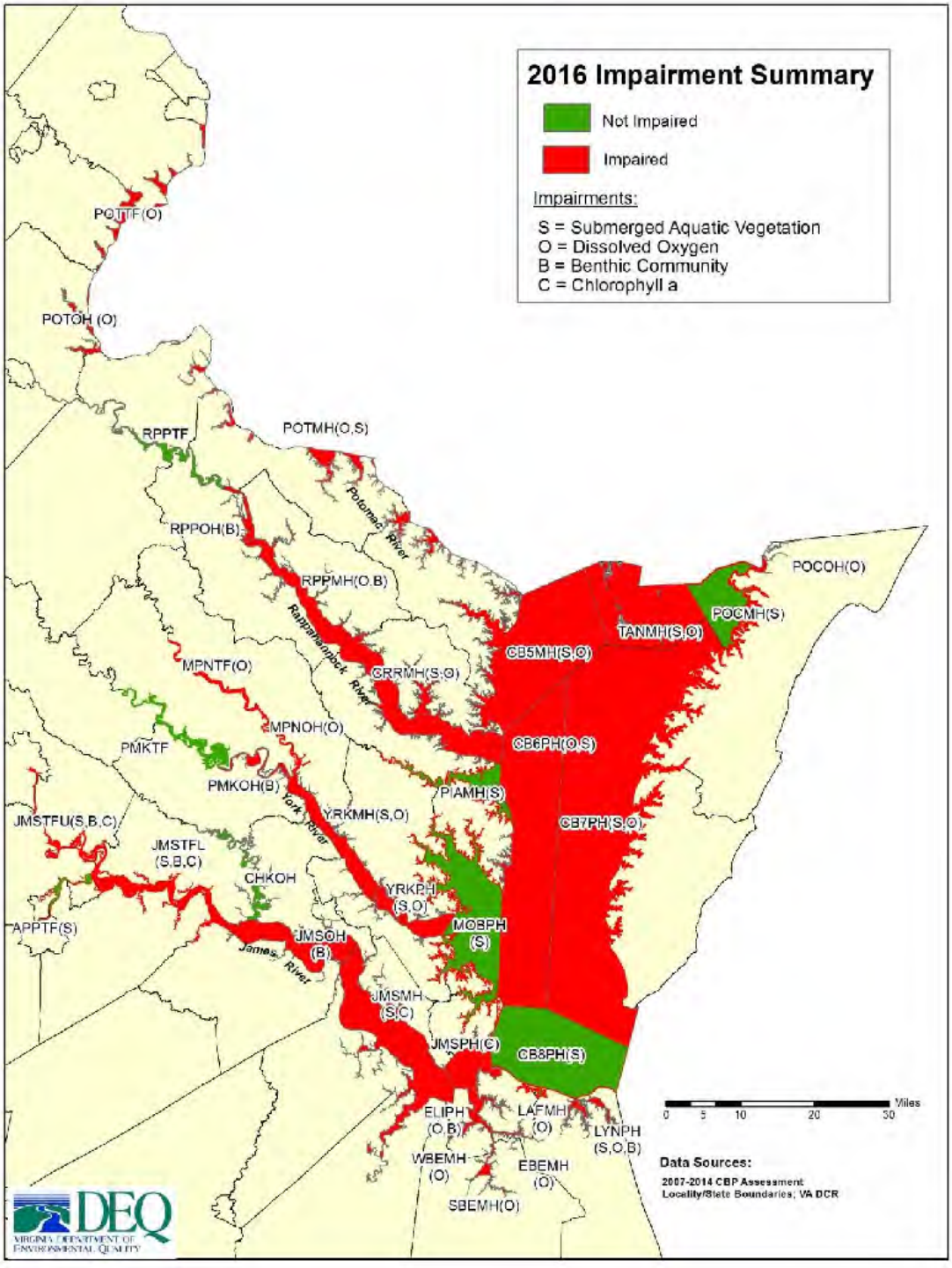
The 2016 assessment reveals promising findings for aquatic life use attainment in Virginia's Chesapeake Bay waters. While hypoxia continues to be problematic in both shallow and deeper areas, particularly during the summer months, the number of tributary segments failing assessed dissolved oxygen (DO) criteria during summer months was lower relative to the number reported in the 2014 assessment. For the first time since the adoption of the Bay DO standards, no evidence of chronic hypoxia was found in the James River and Rappahannock River segments for the Open Water sub-use, and the Deep Channel sub-use is met in mainstem segment CB5MH. Chlorophyll standards were fully attained in the oligohaline portion of the James for the first time, though they were not met in the rest of the estuary. Additionally, approximately 47% of the total state-wide submerged aquatic vegetation (SAV) acres goal was attained, up from 46% reported in the 2014 assessment. It is anticipated that progress in Bay aquatic life use attainment will continue to as the Bay Total Maximum Daily Load (TMDL) and Virginia's Watershed Implementation Plan are implemented.

Figure 4.6-1 summarizes the current aquatic life use status for the Bay-specific criteria detailed in 9AVAC25-260-185 (note it does not reflect other impairments such as pH, fish tissue contaminants, or other aquatic life criteria).

The tidal fresh segments of the Mattaponi (MPNTF) and Pamunkey (PMKTF) meet all assessed Bay criteria. However, these areas remain classified as impaired in the Assessment Database (ADB) because short-term criteria established for dissolved oxygen (7-day mean, 1-day mean, and instantaneous minimum) have not been assessed. There are some data available to assess these criteria, but the Chesapeake Bay Program has not yet developed the appropriate assessment protocols. Segments which were over-listed by the EPA in 1999 for dissolved oxygen and currently meet all assessed criteria are assumed to be impaired until all dissolved oxygen criteria for all appropriate designated uses are assessed and determined to be meeting.

The following sections describe in further detail 1) aquatic life sub-uses and criteria, 2) 2016 aquatic life use assessment results and 3) future assessment refinements.

Figure 4.6-1 Impairment status of the Bay aquatic life use.



Chesapeake Bay and Tidal Tributaries Aquatic Life Uses and Criteria

The Chesapeake Bay aquatic life sub-uses described below reflect the different aquatic living resource communities living in the different areas of the Bay. Impairment of any of these sub-categories of aquatic life use is also considered an impairment of the overall aquatic life use. The overall aquatic life use also exists as a distinct designated use (i.e. distinct from the sub-uses) and is assessed with other protocols including benthic Indices of Biological Integrity (IBI), ammonia criteria, and toxicity bioassays.

Designated Uses

Migratory Fish Spawning and Nursery (MSN) Designated Use

This use exists in waters in the Chesapeake Bay and its tidal tributaries that protect the survival, growth and propagation of the early life stages of a balanced, indigenous population of anadromous, semi-anadromous, catadromous and tidal-fresh resident fish species inhabiting spawning and nursery grounds. Figure 4.6-2 illustrates this designated use and detailed geographic descriptions are in *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum Chesapeake Bay Program Office, Annapolis, Maryland*. The designated use extends from the beginning of tidal waters to the downriver end of spawning and nursery habitats, as determined through a composite of all targeted anadromous and semi-anadromous fish species' spawning and nursery habitats. The designated use extends horizontally from the shoreline of the body of water to the adjacent shoreline, and extends down through the water column to the bottom water-sediment interface. This use applies February 1 through May 31 and exists concurrently with the open-water use.

Shallow-Water Submerged Aquatic Vegetation (SWSAV) Designated Use

This use exists in waters in the Chesapeake Bay and its tidal tributaries that support the survival, growth and propagation of submerged aquatic vegetation (rooted, underwater bay grasses). Figure 4.6-2 illustrates this designated use and detailed geographic descriptions are in *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum Chesapeake Bay Program Office, Annapolis, Maryland*. This use applies April 1 through October 31 in tidal-fresh, oligohaline and mesohaline Chesapeake Bay Program segments, and March 1 through November 30 in polyhaline Chesapeake Bay Program segments and exists concurrently with the open-water use.

Open-Water (OW) Aquatic Life Designated Use

This use exists in waters in the Chesapeake Bay and its tidal tributaries that protect the survival, growth and propagation of a balanced, indigenous population of aquatic life inhabiting open water habitats. Figure 4.6-2 illustrates this designated use and detailed geographic descriptions are in *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum Chesapeake Bay Program Office, Annapolis, Maryland*. This designated use applies year-round but the vertical boundaries change seasonally. October 1 - May 31: the open-water aquatic life use extends horizontally from the shoreline at mean low water, to the adjacent shoreline, and extending through the water column to the bottom water-sediment interface. June 1 - September 30: if a pycnocline (i.e. a physical inhibition of mixing due to a rapid change of density in the water column with depth) is present, the open-water sub-use extends down into the water column only as far as the upper boundary of the pycnocline; otherwise, it extends to the water-sediment interface. This designated use is concurrent with the migratory fish spawning and nursery and Shallow-Water submerged aquatic vegetation uses in areas where these uses apply.

Deep-Water (DW) Aquatic Life Designated Use

This use exists in waters in the Chesapeake Bay and its tidal tributaries that protect the survival and growth of a balanced, indigenous population of aquatic life inhabiting deep-water habitats. Figure 4.6-2 illustrates this designated use and detailed geographic descriptions are in *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum Chesapeake Bay Program Office, Annapolis, Maryland.* This designated use applies to the tidally influenced waters located between the upper and lower boundaries of the pycnocline where, in combination with bottom bathymetry and water circulation patterns, a pycnocline is present and presents a barrier to oxygen replenishment of deeper waters. In some areas, the deep-water sub-use extends from the upper boundary of the pycnocline down to the bottom water-sediment interface. This use applies June 1 through September 30.

Deep-Channel (DC) Seasonal Refuge Designated Use

This use exists in waters in the Chesapeake Bay and its tidal tributaries that protect the survival of a balanced, indigenous population of benthic infauna and epifauna inhabiting deep-channel habitats. Figure 4.6-2 illustrates this designated use and detailed geographic descriptions are in *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability 2004 Addendum Chesapeake Bay Program Office, Annapolis, Maryland.* This designated use applies to the tidally influenced waters at depths greater than the lower boundary of the pycnocline in areas where, in combination with bottom bathymetry and water circulation patterns, the pycnocline presents a barrier to oxygen replenishment of deeper waters. This use applies June 1 through September 30.

Applicable Criteria

Dissolved oxygen criteria protecting the described uses are shown in Table 4.6-1. The methodology for assessing monitoring data against these criteria involves spatial interpolation of fixed site monitoring results to create a 3-D picture of oxygen conditions in thousands of individual grid cells throughout the Bay. Each individual grid cell is then assessed against the criteria. In this way, the volume of water in attainment is calculated for each data collection cruise, allowing for an assessment of criteria on a spatial scale. To account for natural fluctuations over seasons and years, the individual monthly spatial assessments of a three-year time period are aggregated, allowing for an estimate of the frequency of violations. (Note that this contrasts with the six-year time period used in the assessment of DO for non-Bay waters.) The frequency and spatial extent of violations are combined to create a cumulative frequency diagram (CFD) curve, which is examined against an established reference curve.

The dissolved oxygen assessment is based on stations monitored by DEQ, Old Dominion University, Virginia Institute of Marine Science, municipalities, and citizens groups. Details of the assessment procedure can be found in guidance manuals from EPA and DEQ (*Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll a for the Chesapeake Bay and Its tidal Tributaries, EPA 903-R-03-002, April 2003* ; *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll a for the Chesapeake Bay and Its tidal Tributaries, 2004 Addendum, EPA 904-R-04-005 October 2004*; *Water Quality Assessment Guidance Manual for Y2008: 305(B)/303(D) Integrated Water Quality Report, April, 2007*; and *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll a for the Chesapeake Bay and Its tidal Tributaries, 2007 Addendum, EPA 903-R-07-003 July 2007*).

Criteria specific to the Shallow-Water submerged aquatic vegetation use (SWSAV) are shown in Table 4.6-2. The criterion of “SAV Acres” was assessed in every segment. The criterion for “Water Clarity Acres” was assessed where data were available (Rappahannock, York and James River systems). The SAV Acres criterion is met by having aquatic vegetation present as measured by annual aerial photography. The Water Clarity Acres criterion is met by having sufficient water clarity present to support the potential for aquatic vegetation to grow (i.e. regardless of whether the submerged aquatic vegetation is actually present). This criterion was created because the water may be clear enough to support

submerged aquatic vegetation, but it may take several years for the areas to re-populate with grasses. A detailed description of the assessment methodology can found in *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll a for the Chesapeake Bay and Its tidal Tributaries, 2018 Technical Support for Criteria Assessment Protocols Addendum, EPA 903-R-08-001 September 2008.*

The chlorophyll *a* criteria assessed are shown in Table 4.6-3. There are separate criteria applicable to each segment and season, and a spatial-temporal assessment is conducted using a cumulative frequency diagram (see *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll a for the Chesapeake Bay and Its tidal Tributaries, 2018 Technical Support for Criteria Assessment Protocols Addendum, EPA 903-R-08-001, EPA 903-R-08-001 September 2008*). If either one of the criteria (i.e. spring or summer season) is found to be failing, then the segment is assessed as failing the chlorophyll *a* standard.

Spatial Assessment Units

A general overview of the CBP segmentation scheme that is used for assessment of designated uses is shown in Figure 4.6-3. Not every designated use exists in each segment or necessarily throughout the full extent of the segments in which they exist. Details of where each designated use occurs within each of these CBP segments can be found in *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability, 2004 Addendum*, *October 2004, EPA 903-R-04-006* and *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity, and Chlorophyll a for the Chesapeake Bay and Its tidal Tributaries, 2010 Technical Support for Criteria Assessment Protocols Addendum, EPA 903-R-10-002 May 2010*.

Figure 4.6-2 Conceptualized illustration of location of the five Chesapeake Bay tidal water designated use zones.

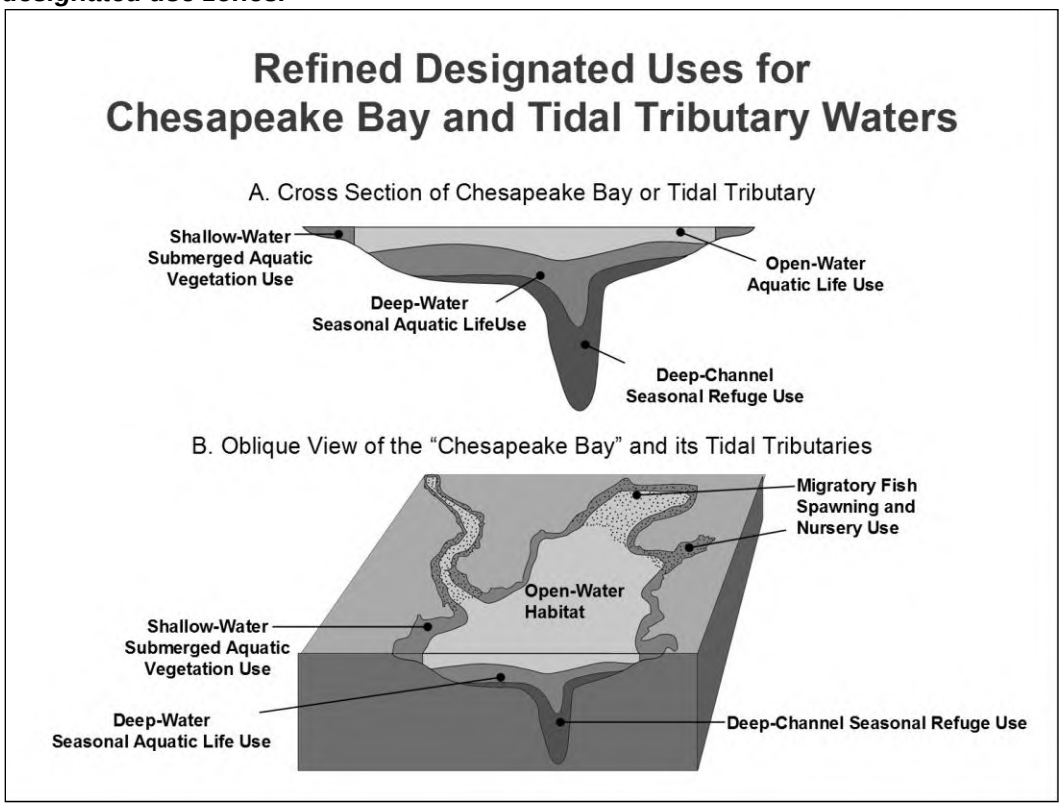


Table 4.6-1 Chesapeake Bay dissolved oxygen criteria

Designated Use	Criteria Concentration/Duration	Protection Provided	Temporal Application
Migratory fish spawning and nursery use	7-day mean $\geq$ 6 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Survival/growth of larval/juvenile tidal-fresh resident fish; protective of threatened/endangered species.	February 1 - May 31
	Instantaneous minimum $\geq$ 5 mg liter^{-1}	Survival and growth of larval/juvenile migratory fish; protective of threatened/endangered species.	
	Open-water fish and shellfish designated use criteria apply		June 1 - January 31
Shallow-Water bay grass use	Open-water fish and shellfish designated use criteria apply		Year-round
Open-water fish and shellfish use[1]	30-day mean $\geq$ 5.5 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Growth of tidal-fresh juvenile and adult fish; protective of threatened/endangered species.	Year-round
	30-day mean $\geq$ 5 mg liter^{-1} (tidal habitats with >0.5 ppt salinity)	Growth of larval, juvenile and adult fish and shellfish; protective of threatened/endangered species.	
	7-day mean $\geq$ 4 mg liter^{-1}	Survival of open-water fish larvae.	
	Instantaneous minimum $\geq$ 3.2 mg liter^{-1}	Survival of threatened/endangered sturgeon species.[2]	
Deep-water seasonal fish and shellfish use	30-day mean $\geq$ 3 mg liter^{-1}	Survival and recruitment of bay anchovy eggs and larvae.	June 1 - September 30
	1-day mean $\geq$ 2.3 mg liter^{-1}	Survival of open-water juvenile and adult fish.	
	Instantaneous minimum $\geq$ 1.7 mg liter^{-1}	Survival of bay anchovy eggs and larvae.	
	Open-water fish and shellfish designated-use criteria apply		October 1 - May 31
Deep-channel seasonal refuge use	Instantaneous minimum $\geq$ 1 mg liter^{-1}	Survival of bottom-dwelling worms and clams.	June 1 - September 30
	Open-water fish and shellfish designated use criteria apply		October 1 - May 31

[1] Special criteria for the Mattaponi and Pamunkey rivers are 30 day mean > 4.0 mg/l ;Instantaneous minimum > 3.2 mg/l at temperatures < 29^{o}C; Instantaneous minimum > 4.3 mg/l at temperatures > 29^{o}C.

[2] At temperatures considered stressful to shortnose sturgeon (> 29^{o}C), dissolved oxygen concentrations above an instantaneous minimum of 4.3 mg liter^{-1} will protect survival of this listed sturgeon species.

Table 4.6-2 Summary of Chesapeake Bay water clarity criteria for application to Shallow-Water SAV designated use habitats. Chesapeake Bay program segments are shown in Figure 4.6-2.

Chesapeake Bay Program Segment	SAV Acres[1]	Percent light-through-water[2]	Water Clarity Acres[1]	Temporal Application
CB5MH	7,633	22%	14,514	April 1 - October 31
CB6PH	1,267	22%	3,168	March 1 - November 30
CB7PH	15,107	22%	34,085	March 1 - November 30
CB8PH	11	22%	28	March 1 - November 30
POTTF	2,093	13%	5,233	April 1 - October 31
POTOH	1,503	13%	3,758	April 1 - October 31
POTMH	4,250	22%	10,625	April 1 - October 31
RPPTF	66	13%	165	April 1 - October 31
RPPOH	4	13	10	April 1 - October 31
RPPMH	1700	22%	5000	April 1 - October 31
CRRMH	768	22%	1,920	April 1 - October 31
PIAMH	3,479	22%	8,014	April 1 - October 31
MPNTF	85	13%	213	April 1 - October 31
MPNOH	-	-	-	-
PMKTF	187	13%	468	April 1 - October 31
PMKOH	-	-	-	-
YRKMH	239	22%	598	April 1 - October 31
YRKPH	2,793	22%	6,982	March 1 - November 30
MOBPH	15,901	22%	33,990	March 1 - November 30
JMSTF2	200	13%	500	April 1 - October 31
JMSTF1	1000	13%	2500	April 1 - October 31
APPTF	379	13%	948	April 1 - October 31
JMSOH	15	13%	38	April 1 - October 31
CHKOH	535	13%	1,338	April 1 - October 31
JMSMH	200	22%	500	April 1 - October 31
JMSPH	300	22%	750	March 1 - November 30
LYNPH	107	22%	268	March 1 - November 30
POCOH	-	-	-	-
POCMH	4,066	22%	9,368	April 1 - October 31
TANMH	13,579	22%	22,064	April 1 - October 31

1 = The assessment period for SAV and water clarity acres is the single best year in the most recent three consecutive years. When three consecutive years of data are not available, a minimum of three years within a six-year data assessment window is used.

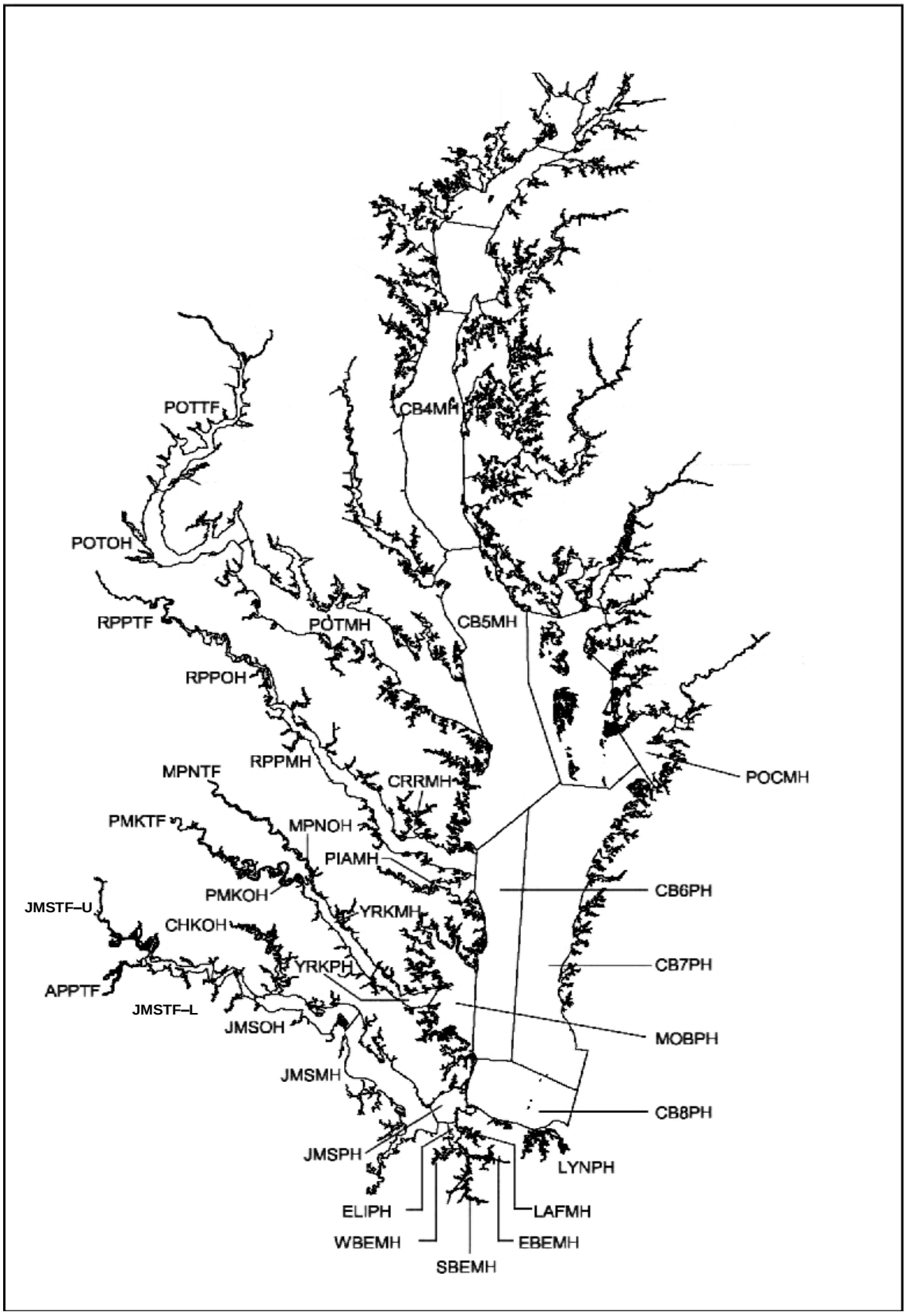
2 = Percent Light through Water = $100e^{(-KdZ)}$ where K_d is water column light attenuation coefficient and can be measured directly or converted from a measured secchi depth where K_d = 1.45/secchi depth. Z = depth at location of measurement of K_d.

Table 4.6-3 Chlorophyll a criteria for application to open-water designated use habitats in the James River.

Designated Use	Chlorophyll *a* (ug/l)	Chesapeake Bay Program Segment (1)	Temporal Application
Open-Water	10	JMSTFU (James Tidal Fresh Upper)	March 1 - May 31
	15	JMSTFL (James Tidal Fresh Lower)	
	15	JMSOH (James Oligohaline)	
	12	JMSMH (James Mesohaline)	
	12	JMSPH (James Polyhaline)	
	15	JMSTFU (James Tidal Fresh Upper)	July 1 - September 30
	23	JMSTFL (James Tidal Fresh Lower)	
	22	JMSOH (James Oligohaline)	
	10	JMSMH (James Mesohaline)	
	10	JMSPH (James Polyhaline)	

1) See Figure 4.6-3 for locations of these segments.

Figure 4.6-3 Chesapeake Bay dissolved oxygen and water clarity assessment segmentation.



Aquatic Life Assessment Results

Open-Water Designated Assessment

Figure 4.6-4 shows attainment of the 30-day mean criterion for dissolved oxygen (DO) in the Open-Water designated use. Overall summer exceedence rates in impaired segments are not substantially different for this reporting period compared to the last one, but more segments met the criteria during both summer and rest-of-the-year months during the 2012-2014 period than the 2010-2012 period. Segments that currently meet the 30-day mean criterion and failed it previously: the lower tidal fresh and oligohaline segments of the James (JMSTFL and JMSOH), the oligohaline segment of the Pamunkey (PMKOH), Mobjack Bay (MOBPH), and all segments of the Rappahannock River (RPPTF, RPPOH, and RPPMH). Only the oligohaline portion of the Potomac embayments (POTOH) and mainstem segment CB5MH met the 30-Day mean criteria for the last reporting period while failing it for the current one. Attainment of the assessed criteria is achieved in about 22% of the mainstem Bay (i.e. Mobjack Bay, segment CB8PH, and the mesohaline portion of Pocomoke Sound (POCMH)).

The highest DO violation rates occurred in the Southern and Eastern branches of the Elizabeth River—summertime exceedence rates of 44.3% and 40.9%, respectively. Hypoxia during the non-summer months was found in the Lynnhaven River (LYNPH) and both segments of the York River (YRKMH and YRKPH).

Figure 4.6-5 shows an evaluation of chlorophyll-*a* in the James River. All segments failed to meet both spring *and* summer chlorophyll-*a* criteria, except for the oligohaline segment (which attained both).

Deep-Water Aquatic Life Designated Use Assessment

Figure 4.6-5 shows attainment of the 30-day mean criterion for dissolved oxygen in the Deep-Water aquatic life designated use. Much of the designated use was attained--a major departure from what has been observed in the past. Exceedence rates ranged from 0.33% in mainstem segment (CB5MH) to 4.3% in the Southern Branch of the Elizabeth (SBEMH).

Deep-Channel Designated Use Assessment

Figure 4.6-6 shows attainment status of the instantaneous criterion for dissolved oxygen (see inset box). This use exists only in relatively small areas of the Rappahannock mesohaline segment (RPPMH), mainstem Bay segment CB5PH, and the Potomac mesohaline embayments (POTMH). For this assessment, there were only enough data available to assess the first two segments. **For the first time since the Bay criteria were adopted, the Deep Channel sub-use is fully attained in segment CB5MH**.

Shallow-Water Designated Use Assessment

Figure 4.6-7 shows an evaluation of the Shallow-Water submerged aquatic vegetation (SWSAV) designated use. This designated use is attained if there are sufficient acres of submerged aquatic vegetation mapped by annual aerial surveys or if the water is sufficiently clear (i.e. has sufficient "water clarity" acres) so that SAV regrowth is possible. This is because lack of SAV growth may have non-pollutant causes such as insufficient propagule availability, herbivory by turtles and waterfowl, or habitat disruption by cow-nosed rays.

Full attainment of the SWSAV use is present in areas of each of the major estuaries (James, York, Rappahannock and Potomac), but the majority of segments continue to fail SAV acreage goals. As found in previous reporting periods, only nine segments met their respective goals: the Chickahominy (CHKOH), the middle and lower James (JMSOH and JMSPH, respectively), tidal fresh portions of the Mattaponi and Pamunkey (MPNTF and PMKTF), and tidal fresh and oligohaline portions of the Rappahannock and Potomac embayments (RPPTF, RPPOH, POTTF, and POTOH).

The Bay tributaries historically have had relatively little SAV habitat in comparison to the mainstem Bay, where the largest shortfall of vegetation occurs. The open Bay areas with larger shoals had a combined percentage shortfall of 57% (32,0170 acres) for segments CB5MH, TANMH, POCMH, CB7PH, and MOBPH. Forty-six percent (47%) of the overall sum of segment-specific SAV acreage goals was achieved. This means 41,434 acres of SAV needs to be restored before the SWSAV designated use will be met throughout the Bay and tributaries. Alternatively, sufficient water clarity must be present to potentially support this many acres of submerged aquatic vegetation.

Figure 4.6-4 Attainment of the Open-Water designated use (dissolved oxygen criteria).

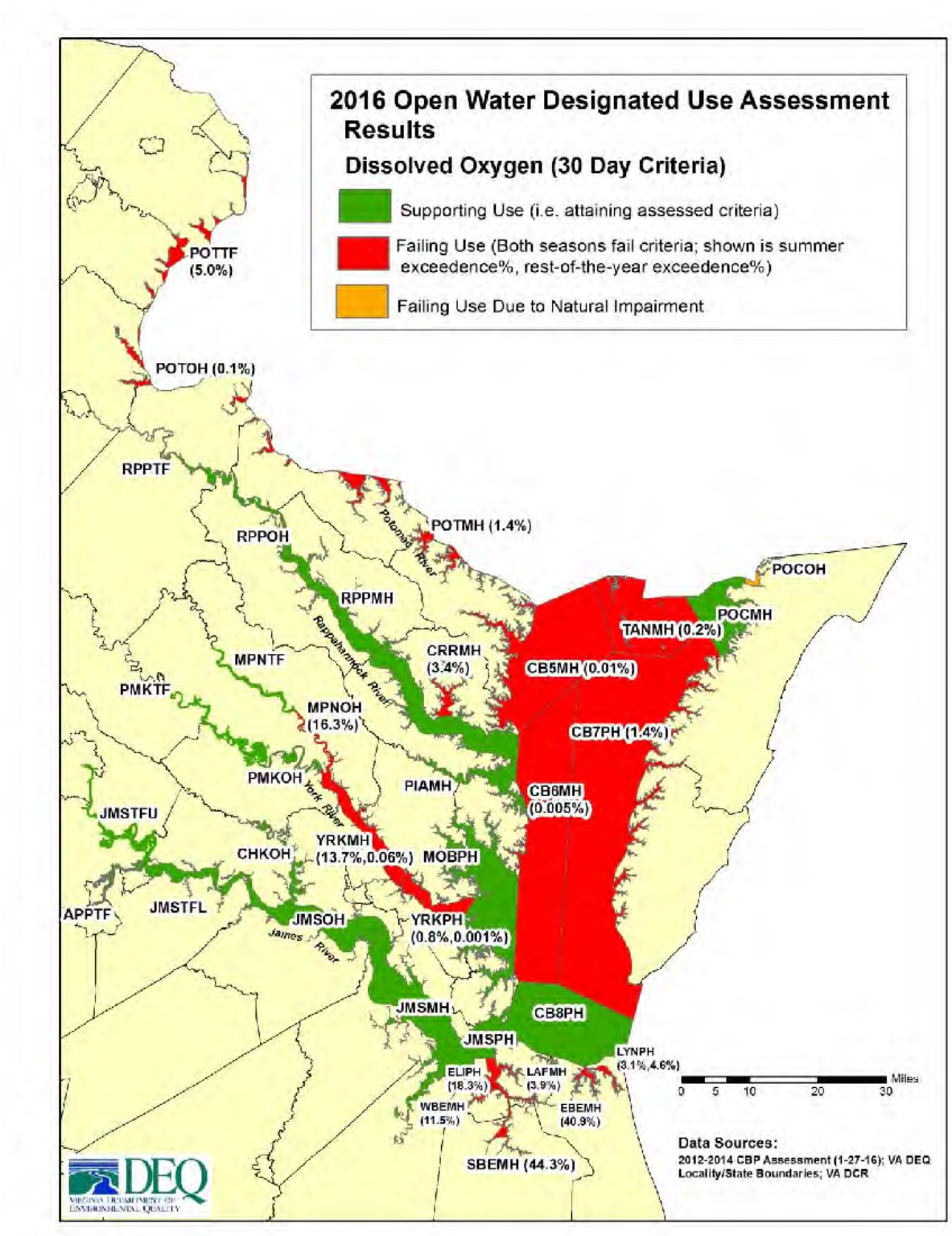


Figure 4.6-5 Attainment of the Open-Water designated use (chlorophyll criteria). The chlorophyll criteria only apply to the James River segments.

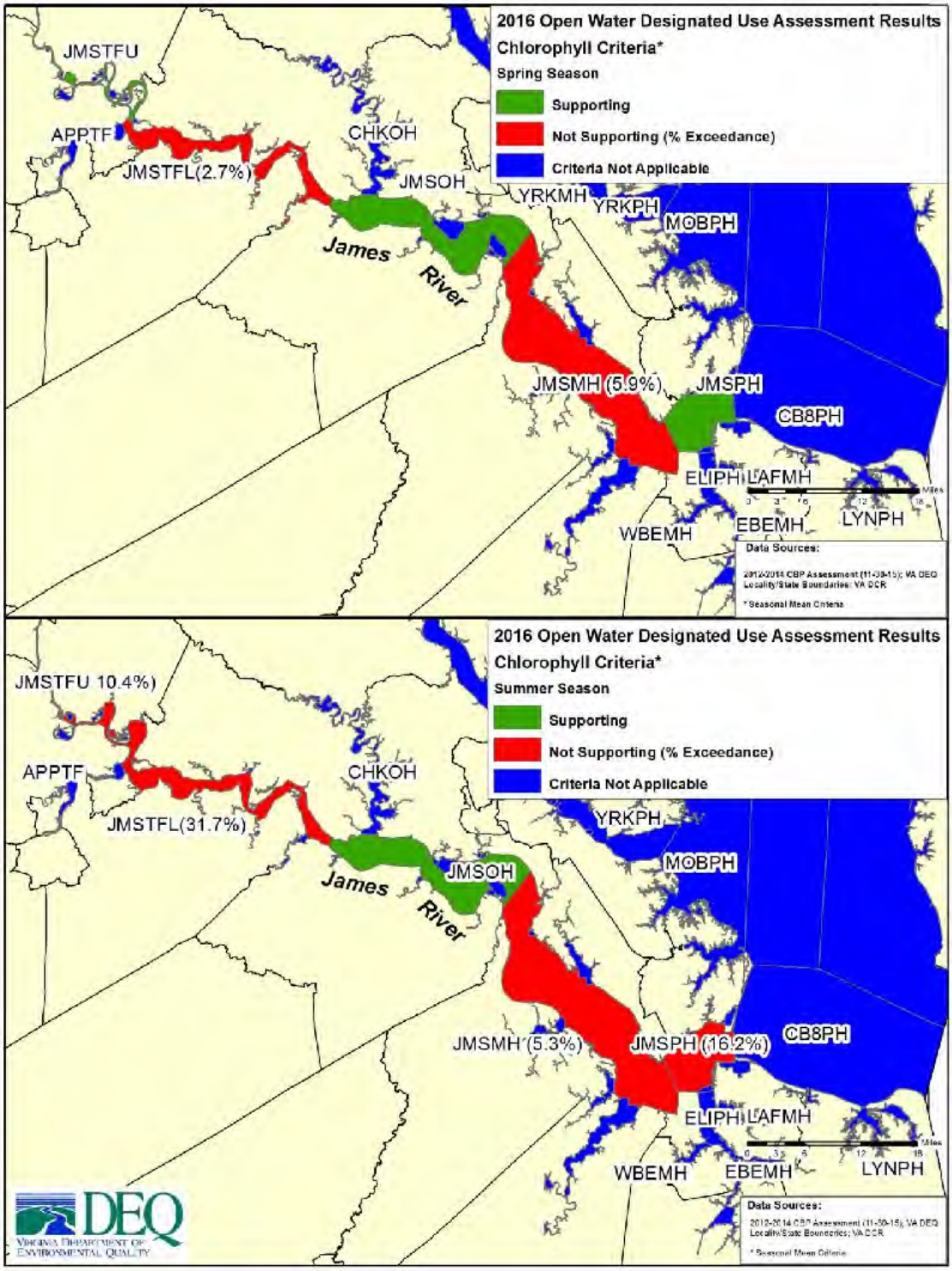


Figure 4.6-6 Attainment of the Deep-Water and Deep-Channel designated use (dissolved oxygen criteria).

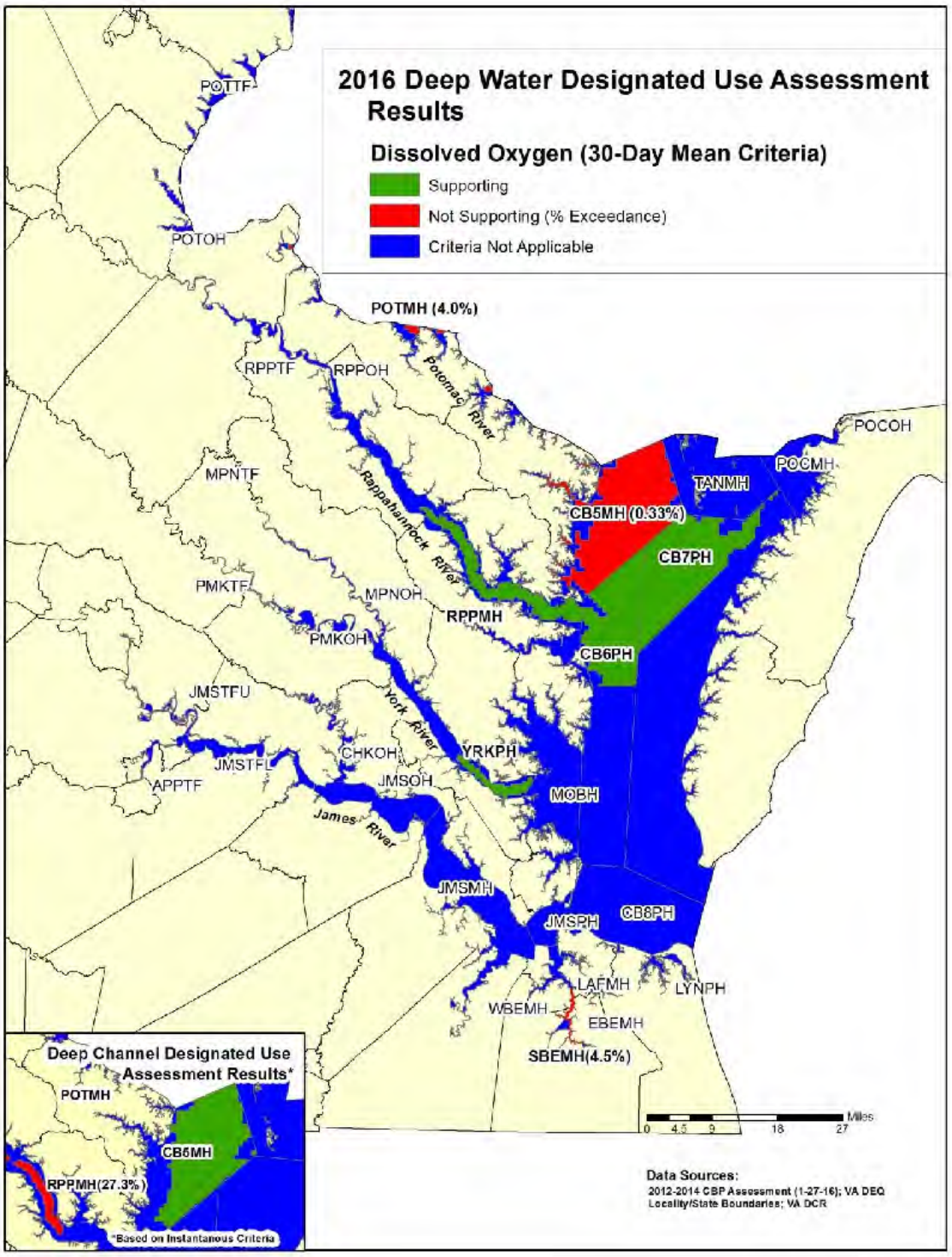
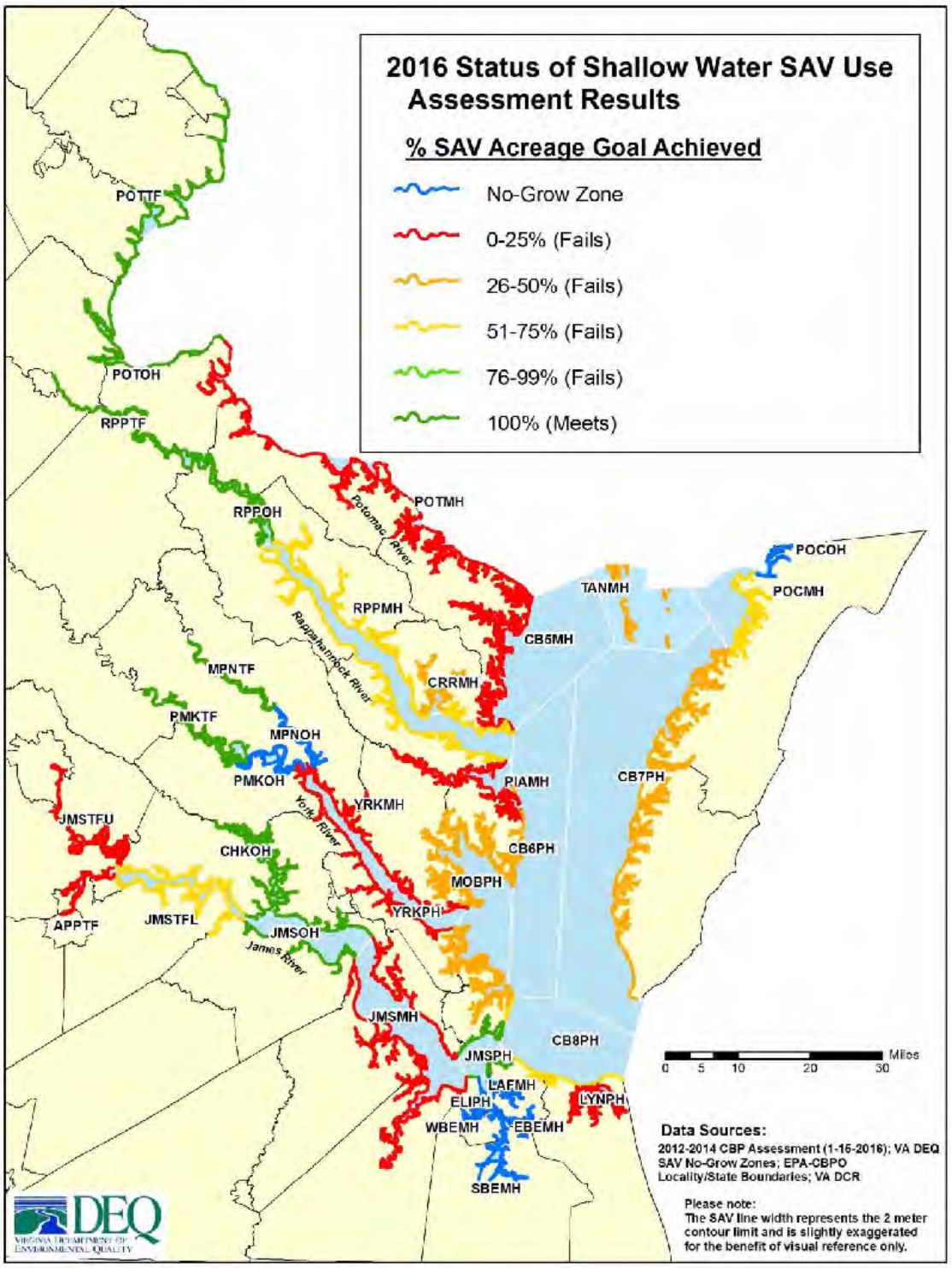


Figure 4.6-7 Attainment of the Shallow-Water SAV designated use (SAV acres and water clarity acres criteria).



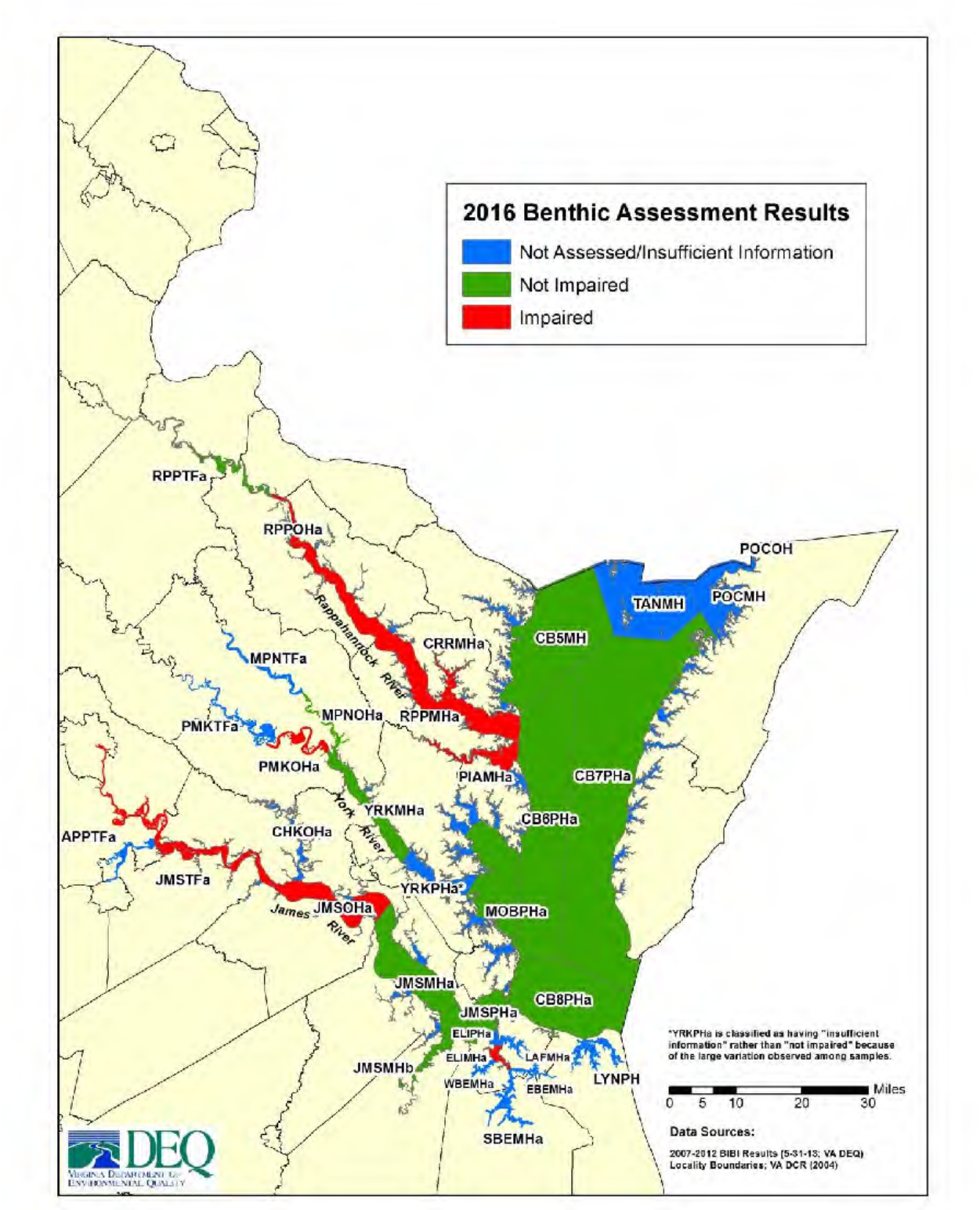
Estuarine Benthic Bioassessment

Support status of the general aquatic life use as indicated by benthic community health throughout Chesapeake Bay and its tidal tributaries was performed in cooperation with EPA Region III, EPA Chesapeake Bay Program, Maryland Department of the Environment, Maryland Department of Natural Resources, and the Virginia Department of Environmental Quality. Technical details of the assessment procedure were previously described in 2006 *303(D) Assessment Methods For Chesapeake Bay Benthos, Final Report Submitted to Virginia Department of Environmental Quality, Roberto J. Llansó, Jon H. Vølstad, Versar Inc., Daniel M. Dauer, Michael F. Lane, Old Dominion University, September 2005*.

Due to lack of technical support for data analysis at the EPA Chesapeake Bay Program Office, the 2016 bioassessment could not be performed. The following results are based on the 2014 reporting period (2007 – 2012).

Figure 4.6-8 shows a map of the benthic assessment results. Approximately 241 square miles of the estuarine aquatic life use is impaired. This represents 13% of the total assessed Bay waters, which is down from 77% reported in 2012. The large difference can be attributed to the assessment of mainstem segment CB7PH, which had previously shown a degraded benthic community and currently does not.

Figure 4.6-8 Estuarine Benthic Biological Assessment.



Chesapeake Bay and Tributaries Aquatic Life Use and Sub-use Impairment Listing

The Integrated Report listing methodology addresses the goals of maintaining continuity with previous methodologies, accurately reflecting the assessment results of new uses and criteria and—more importantly--protecting and restoring aquatic life. The listing methodology for the new aquatic life use sub-categories was developed by a Water Quality Criteria Assessment Workgroup involving EPA Region III, EPA Chesapeake Bay Program, Maryland Department of the Environment, Maryland Department of Natural Resources, and the Virginia Department of Environmental Quality. The workgroup's efforts will continue through future modifications as necessary to assure Bay-wide consistency. The main rules for designated use attainment categorization are:

- Aquatic life use is listed as impaired and having a TMDL (i.e. category 4A) if any aquatic life sub-use (i.e. SWSAV, MSN, OW, DW, DC) is not supported.

- Waters previously listed as impaired by EPA in 1999 for aquatic life use because of low dissolved oxygen but currently meeting assessed criteria will remain in category 4D[1] until all applicable criteria are assessed. All applicable dissolved oxygen criteria must be assessed and attained in order for a DO-related sub-use (i.e. MSN, OW, DW, DC) to be fully supported for these waters. For additional information on un-assessed criteria, see the section on Future Assessment Refinements (page 187).

- The Shallow-Water submerged aquatic vegetation (SWSAV) use is fully supporting if any of the criteria for this use is met. For example, if sufficient water clarity is present (i.e. "Water Clarity Acres" criterion is met), then the SWSAV designated use is supported regardless of the presence or absence of sufficient submerged aquatic vegetation (i.e. "SAV Acres" criterion is not met). This is because there can be many non-pollutant causes for the lack of SAV acres such as lack of propagule availability, herbivory by turtles, waterfowl, etc. or habitat disruption by cow-nosed rays.

[1] A waterbody is assessed as category 4D when a part(s) of a water quality standard is attained for a pollutant with a TMDL, but the remaining criteria for the standard were not assessed due to insufficient information. This only to be applies to dissolved oxygen in tidal waters of the Chesapeake Bay.

Aquatic Life Use Assessment Database Summary for Chesapeake Bay Waters

Figure 4.6-9 presents aquatic life designated use and sub-use support for the Chesapeake Bay and its tidal tributaries as summarized from the Assessment Database. The Deep Water Aquatic Life Use subcategory (DW), Deep Channel Aquatic Life Use subcategory (DC), Shallow Water Aquatic Life Use subcategory (SWSAV), and Aquatic Life Use sizes in this chapter are different than what is presented elsewhere in this chapter. This is due to the complex spatial nature of the Bay uses and limitations of the Assessment Database (ADB). A few of the confounding issues and differences between results in this chapter and area summarizations in other chapters created from ADB are listed below.

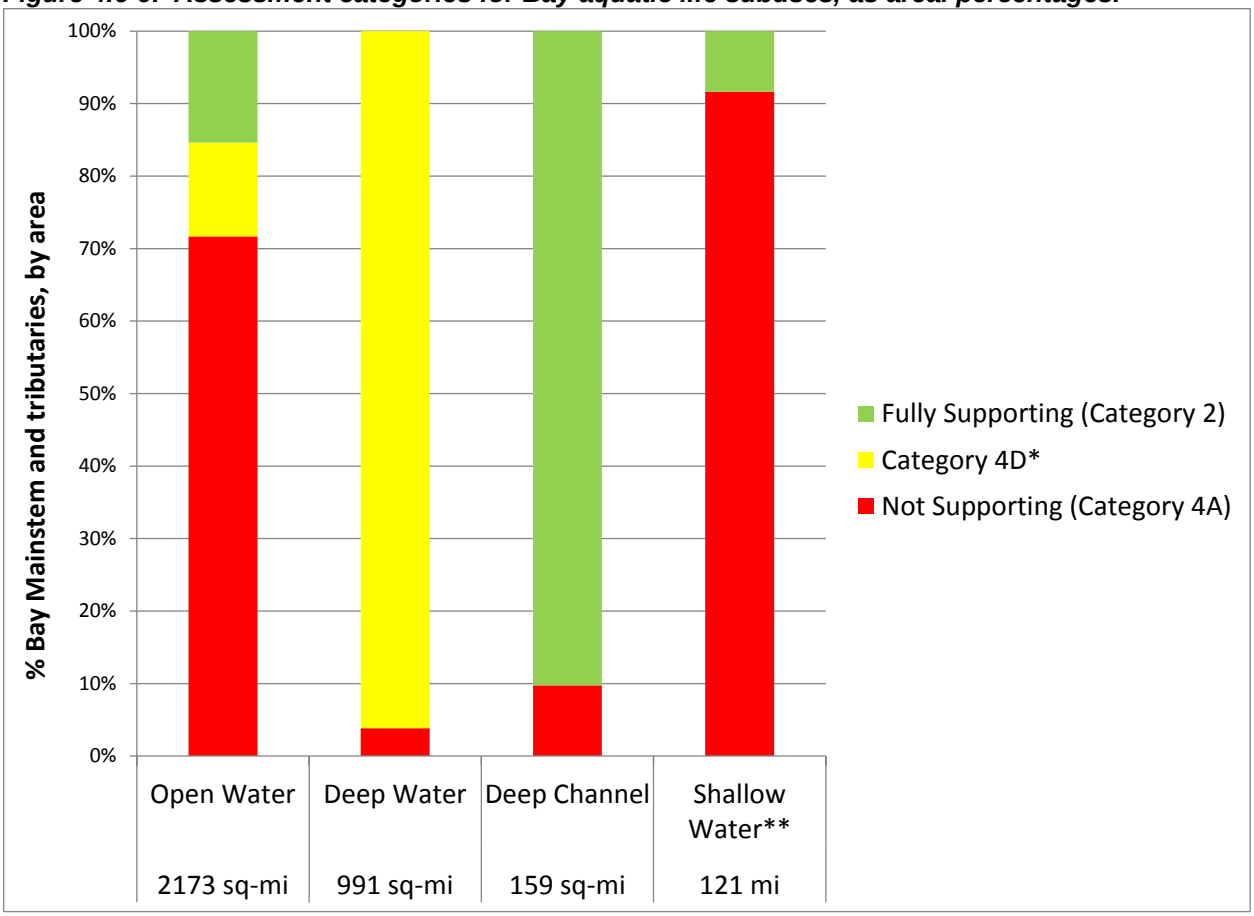
- The area of DW and DC is inaccurate in ADB. Area of DW and DC reported in this chapter vary in square mileage size within assessment units and between reporting periods due to the naturally varying depth of pycnoclines. However, DW and DC area in ADB can only be reported as existing throughout the complete assessment unit.

- The area of SWSAV use is inaccurate in ADB. The SWSAV designated use exists only within the area defined by the SAV acres criteria. For example, CBP Segment CB5PH has an SAV acres criterion of 7,633 acres (see Table 4.6-2) therefore the area of SWSAV designated use for this segment is 7,633 acres (i.e. 11.9 square miles). However, within ADB the size of SWSAV use within this segment can only be reported as the complete area of the assessment unit (i.e. 215 square miles). The figures reported in this chapter are therefore more accurate.

- Related to the above, the area of impairment for aquatic life use within ADB is often incorrect. For example, segment CB8PH failed the SWSAV use, so the segment also fails the aquatic life use. The area of SWSAV use within this segment is only 11 acres (0.02 square miles), making the accurate area of aquatic life use impairment only 0.02 square miles. However, within ADB the area of aquatic life use can only be reported as the complete area of the assessment unit (48.4 square miles). The figures for impairment area reported in this chapter are more accurate than what appears in ADB.

- This chapter reports only the aquatic life use and sub-use impairments due to dissolved oxygen, water clarity, chlorophyll, and benthic community assessments. Some waters have met all the assessed criteria for these parameters, but may be impaired in ADB for aquatic life due to other parameters (e.g. pH, chloride, bacteria, toxics, etc.). Aquatic life use impairments due to these other parameters are not reported in this chapter.

Figure 4.6-9. Assessment categories for Bay aquatic life subuses, as areal percentages.



* Category 4D applies to waters that meet assessed DO criteria, but which are required to meet all applicable DO criteria before they can be assessed as fully supporting (category 2).

** 47% of the total SAV acreage goal (121 sq-mi) was attained. However, only segments that have met their respective goals are assessed as fully supporting (category 2). The sum of their goals represents 8% of the total SAV acreage goal.

Future Assessment Refinements

This is the sixth report to present assessment of the designated uses in the Chesapeake Bay and its tidal tributaries. Much progress has been made in developing realistic and appropriate designated uses, associated criteria, and assessment protocols for the Chesapeake Bay and its tidal tributaries. Continued refinement for future assessments is summarized below. To ensure consistency throughout the multi-State Chesapeake Bay system, most of these issues will be resolved through the Water Quality Criteria Assessment Workgroup involving EPA Region III, EPA Chesapeake Bay Program, Maryland Department of the Environment, Maryland Department of Natural Resources and the Virginia Department of Environmental Quality.

Assessment of currently un-assessed designated uses and criteria

Of the five aquatic life sub-uses, this chapter reports only on conditions for the Open-Water, Deep- Water, Deep-Channel, and Shallow-Water submerged aquatic vegetation sub-uses. It is anticipated that future reports will assess the remaining aquatic life sub-use of "Migratory and Spawning Fish". Also, only a limited suite of dissolved oxygen criteria for each sub-use were assessed, these being 30-Day average for dissolved oxygen in Open- and Deep-Water uses and the instantaneous minimum for the Deep-Channel use. Many other dissolved oxygen criteria were not assessed (e.g. 7-day, 1-day, and instantaneous minimum criteria). These limitations on assessments of designated uses and criteria are due to the lack of EPA-approved assessment protocols.

Refinements to assessment protocols

While DEQ believes the protocols performed for this assessment are valid, the following issues may be examined in more detail for future assessments:

a. Refinements in spatial interpolation tools.

Part of the assessment protocol involves spatial interpolation of data to create a 3-dimensional depiction of oxygen conditions throughout a waterbody segment. The software used for performing this step in this assessment may be refined and updated to enhance interpolation for future assessments.

b. Refinements in statistical determination of attainment.

Data are assessed after interpolation for criteria exceedences using a reference curve to determine waterbody attainment. The assessment was based on either EPA-published reference curves or used a default 10% reference curve if a published one was not available for a specific aquatic life sub-category (e.g. deep water). It is possible that new reference curves developed by EPA could be adopted into Virginia water quality standards and used in future assessments. Also, there may be future efforts to explicitly incorporate statistical measures of uncertainty into the reference curve attainment process.

Table 4.6-4 shows a summary of the most recent long-trend analysis performed by the Dauer lab at ODU (report available by request). This analysis indicates that nutrient concentrations in the mainstem and many of the tributaries segments are generally improving, while water clarity (as measured by secchi depth) shows a degrading trend overall. Where a significant trend was detected for total suspended solids, it was usually in the "improving" direction. Few discernible trends were detectable in chlorophyll *a,* benthic community integrity, and dissolved oxygen concentrations.

Table 4.6-4 Trend Analysis Results by Bay Segment (1985-2015)

Segment	sTN	bTN	sTP	bTP	sTSS	bTSS	Secchi	Bottom DO	Benthic	Chlorophyll a
APPTF	▼ [1]	▼ [1]	▼ [1]	▼ [1]	▼					
CB5MH					▼	▼				
CB6PH	▼	▼	▼	▼	▼ [2]	▼ [2]	▼			
CB7PH	▼	▼	▼	▼	▼ [2]	▼ [2]	▼			
CB8PH			▼	▼		▼	▼	▲		
CHK0H			▼ [1]	▼		▲	▼			▼
CRRMH		▼ [1]		▼ [1]			▼			
EBEMH	▼	▼	▼	▼	▼	▼	▲		▼	
ELIPH	▼ [1]	▼ [1]	▼ [1]	▼ [1]			▼			
JMSMH		▲	▲	▼ [2]		▲				
JMSOH			▼ [1]						▲	▼
JMSPH	▼ [1]	▼ [1]	▼ [1]	▼ [1]		▼	▼	▲		▲
JMSTF1-UPPER	▼	▼	▼	▼						▼
JMSTF2-LOWER	▼ [1]	▼ [1]	▼ [1]	▼ [1]			▼			
LAFMH	▼		▼		▲	▲				
MOBPH	▼	▼	▼	▼	▼ [2]	▼ [2]	▼	▲		
MPN0H										
MPNTF							▼			▼
PIAMH	▼	▼	▼	▼	▼ [2]	▼ [2]	▼	▲		
PMK0H					▼					
PMKTF		▼			▲		▼	▲		
POCMH	▼	▼	▼	▼	▼ [2]	▼ [2]	▼	▲		
RPPMH		▼ [1]		▼ [1]			▼		▼	▲
RPPOH							▼			▲
RPPTF	▼ [1]	▼ [1]	▼ [1]	▼ [1]	▼			▼		
SBEMH	▼	▼	▼	▼	▼	▼	▲		▲	
WBEMH	▼	▼	▼	▼	▼	▼	▲			▼
YRKMH			▲			▲				▲
YRKPH					▲	▲	▼		▲	

s = Surface b = Bottom TN = total nitrogen TP = Total Phosphorus TSS = Total Suspended Solids DO = Dissolved Oxygen

[1] Trend statistically significant (P<0.01) from method change in 1995 to present.

[2] Trend statistically significant (P<0.01) from method change in 1996 to present.

▲ degrading increasing ▼ degrading decreasing

▲ Improving increasing ▼ Improving decreasing