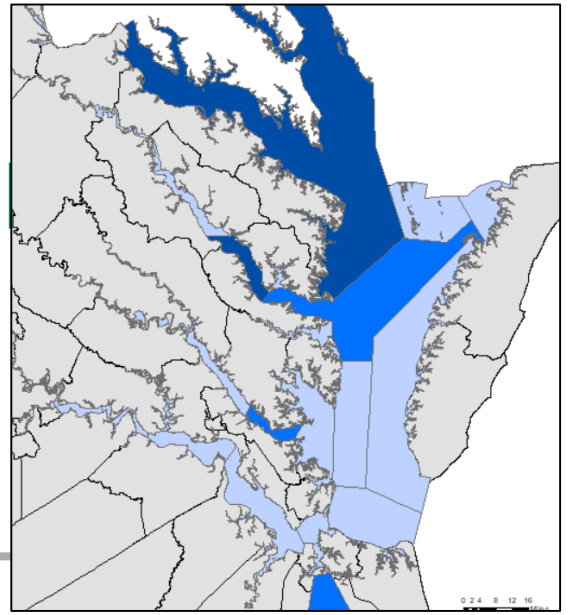
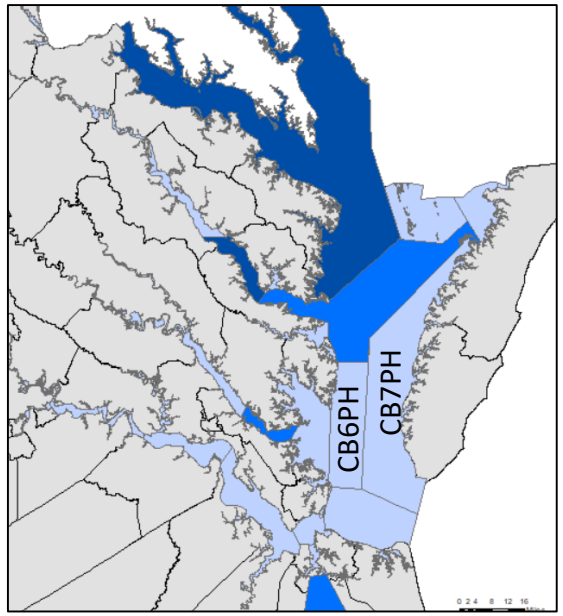
Proposed Boundary Extension of the Deep Water Sub-use in Virginia's Mainstem Chesapeake Bay



Tish Robertson
Virginia DEQ-Office of Ecology
Criteria Assessment Protocols Workgroup
November 16, 2022

Background

- CB6PH and CB7PH are the largest segments by area and volume in Virginia's portion of the Chesapeake Bay.

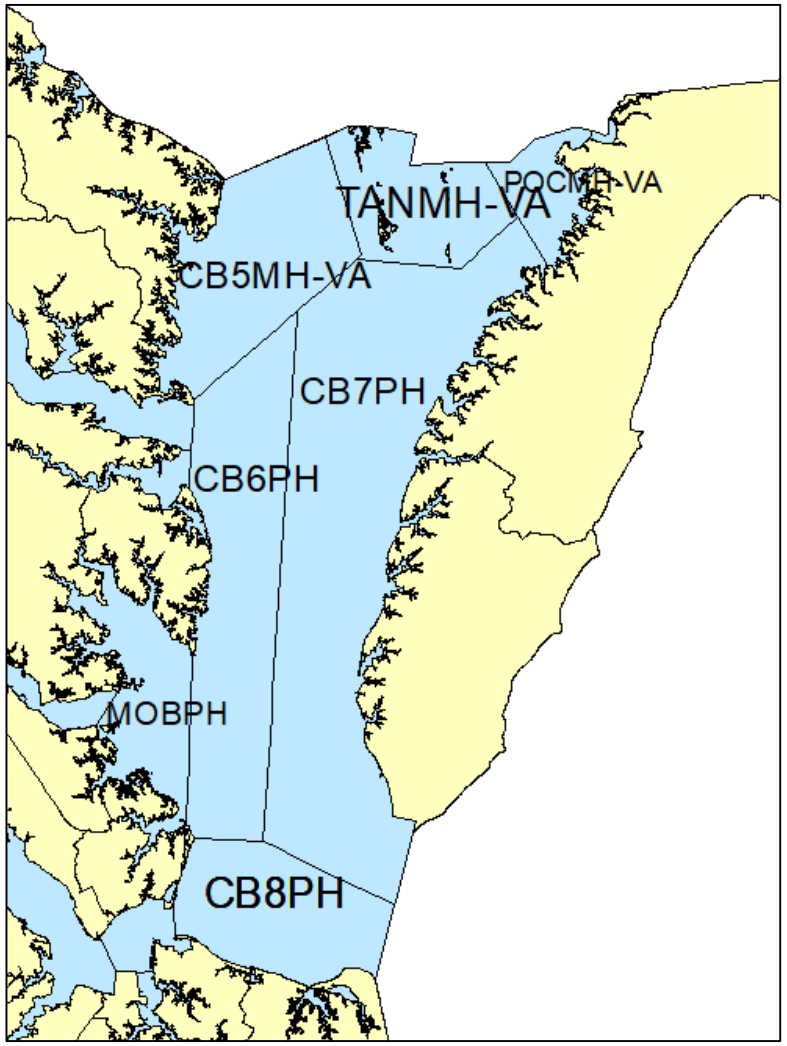


- CB6PH is frequently in non-attainment of the Open Water 30-day Mean DO criterion.

- CB7PH has never attained the Open Water 30-day Mean criterion.

DEQ

Assessment Results for VA Mainstem Segments



Assessment Period	CB5MH-VA	CB6PH	CB7PH	CB8PH
1985-1987	1	0	0	1
1986-1988	1	0	0	1
1987-1989	1	0	0	0
1988-1990	1	0	0	0
1989-1991	1	0	0	0
1990-1992	1	0	0	1
1991-1993	1	0	0	1
1992-1994	1	0	0	1
1993-1995	1	0	0	1
1994-1996	1	0	0	1
1995-1997	1	0	0	1
1996-1998	1	0	0	1
1997-1999	1	1	0	1
1998-2000	1	0	0	1
1999-2001	1	1	0	1
2000-2002	1	1	0	1
2001-2003	1	1	0	1
2002-2004	1	0	0	1
2003-2005	1	0	0	1
2004-2006	1	1	0	1
2005-2007	1	1	0	1
2006-2008	1	1	0	1
2007-2009	1	1	0	1
2008-2010	1	0	0	1
2009-2011	1	0	0	1
2010-2012	1	0	0	1
2011-2013	0	0	0	1
2012-2014	1	1	0	1
2013-2015	1	1	0	1
2014-2016	1	1	0	1
2015-2017	1	1	0	1
2016-2018	1	1	0	1
2017-2019	1	1	0	1
2018-2020	0	0	0	1

1 = OW 30Day Mean Criterion attained
0 = OW 30Day Mean Criterion NOT attained

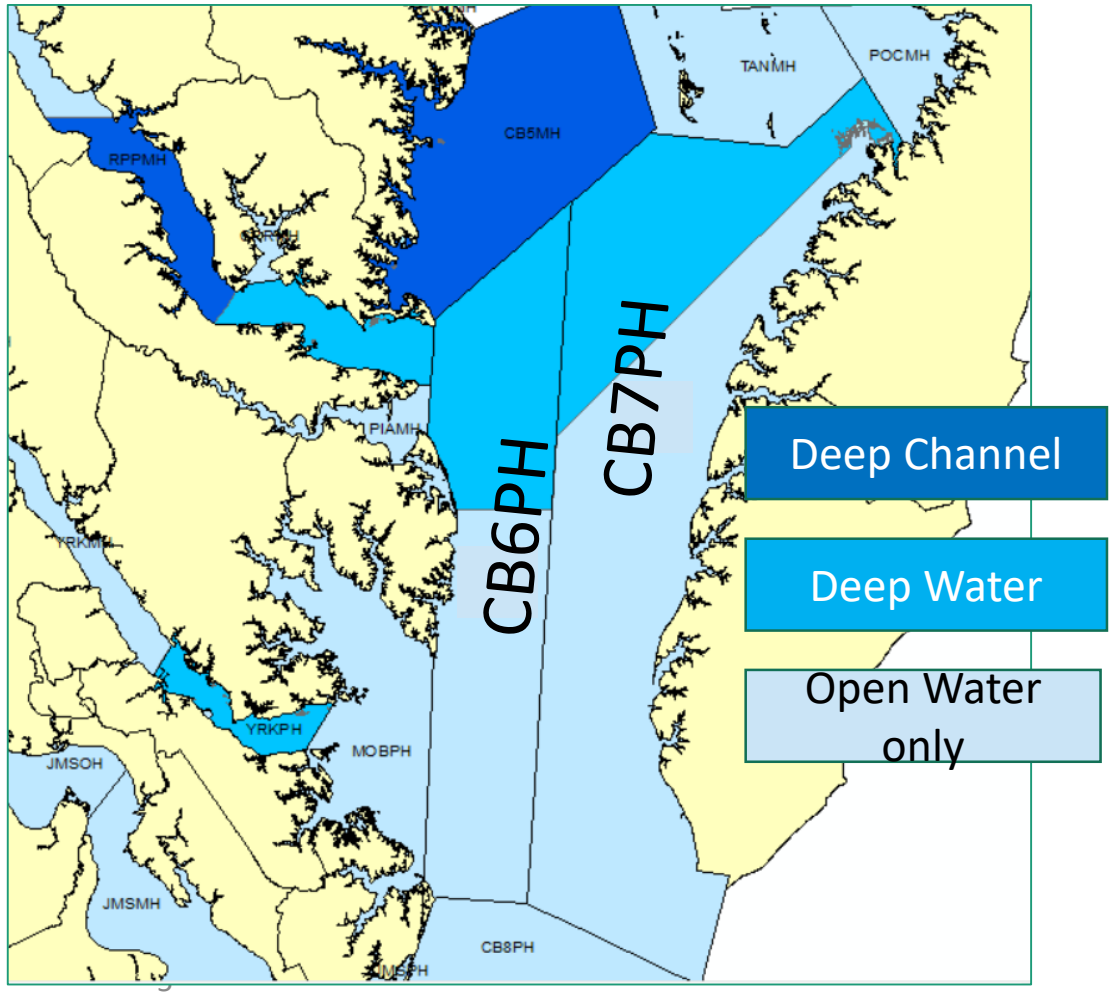
Modeled Assessment Results of 30-Day Mean Criteria Attainment for VA Mainstem Segments Under WIP3 + Climate Change

Open Water 30-Day Mean Criterion attainment* for mainstem segments predicted by the Partnership's Phase 6 suite of models, assuming WIP III nutrient loadings and climate change.

CB Segment	2025 Climate Change 2025 Land Use	2035 Climate Change 2035 Land Use	2045 Climate Change 2045 Land Use	2055 Climate Change 2055 Land Use
CB1TF	0.00%	0.00%	0.00%	0.00%
CB2OH	0.00%	0.00%	0.00%	0.00%
CB3MH	0.00%	0.00%	0.00%	0.00%
CB4MH	0.00%	0.00%	0.00%	0.00%
CB5MH-MD	0.00%	0.00%	0.00%	0.00%
CB5MH-VA	0.00%	0.00%	0.00%	0.00%
CB6PH	0.4%	0.8%	1.1%	1.4%
CB7PH	1.1%	1.9%	2.9%	4.1%
CB8PH	0.00%	0.00%	0.00%	0.00%

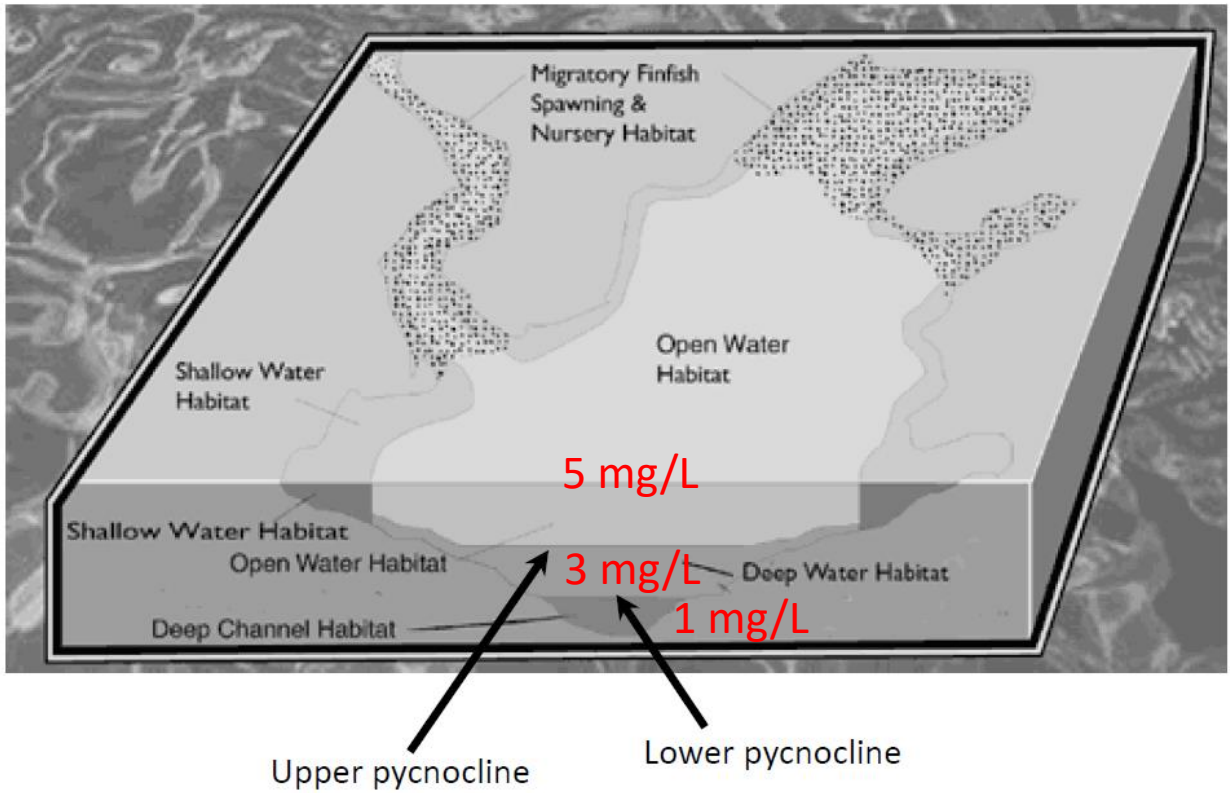
DEQ

What makes CB6PH and CB7PH so different from their mainstem neighbors?



- The upper portions of CB6PH and CB7PH are designated for Open Water and Deep Water uses.
- The rest is designated only for the Open Water use.
- Use designations determine which DO criteria apply where and when.

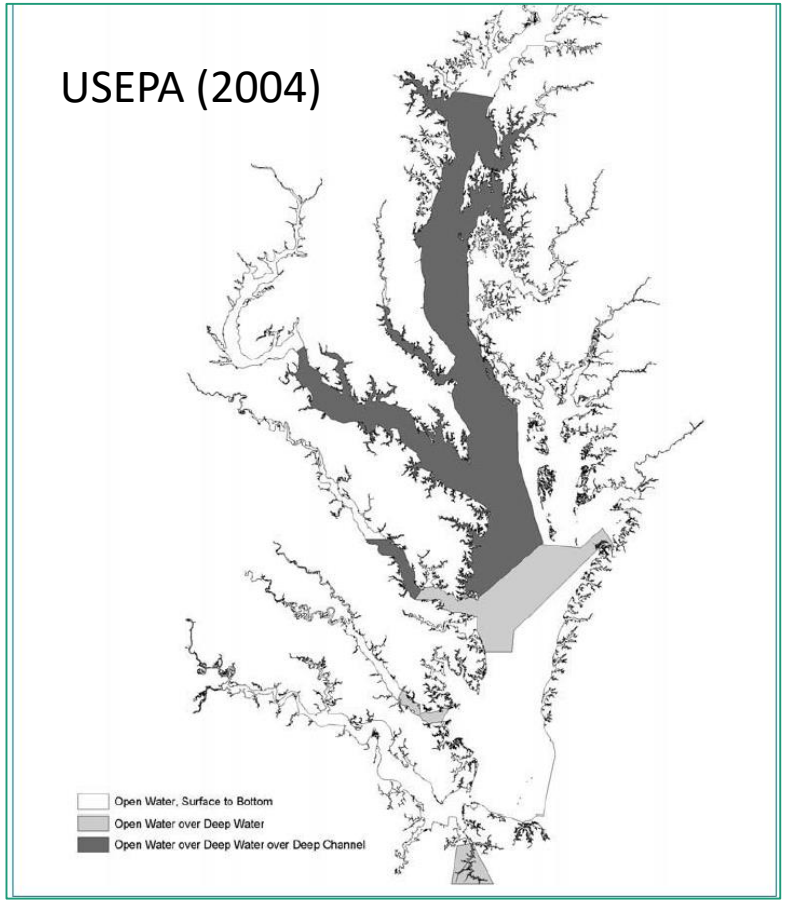
DEQ



"If a pycnocline is present but other physical circulation patterns (such as influx of oxygen rich oceanic bottom waters) provide for oxygen replenishment of deeper waters, the **open-water fish and shellfish designated use** extends down into the water column to the bottom water sediment interface." - *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability (2003)*

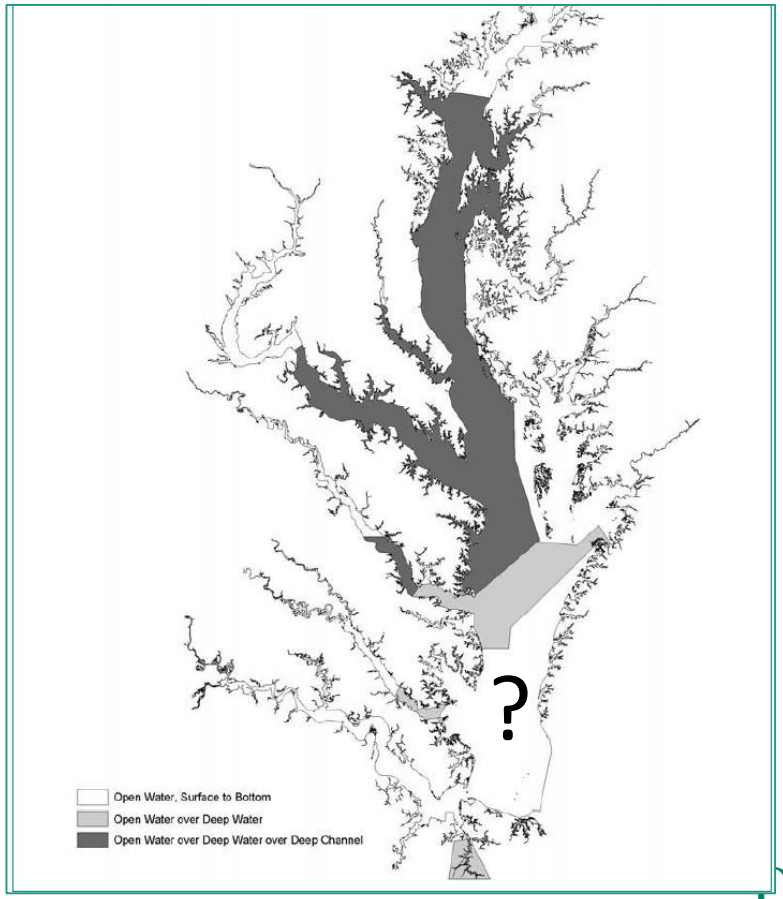
"Tidally influenced waters located…in areas where the measured pycnocline, in combination with bottom bathymetry and water circulation patterns, presents a barrier to oxygen replenishment of deeper waters. In some areas where a lower boundary of the pycnocline is not calculated, the **deep water designated use** extends from the measured depth of the upper boundary of the pycnocline down through the water column to the bottom sediment-water interface." – *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability (2003)*

USEPA (2004)



DEQ

Is the nonattainment of Open Water DO criteria in CB6PH and CB7PH due to stratification in the lower portions of these segments?



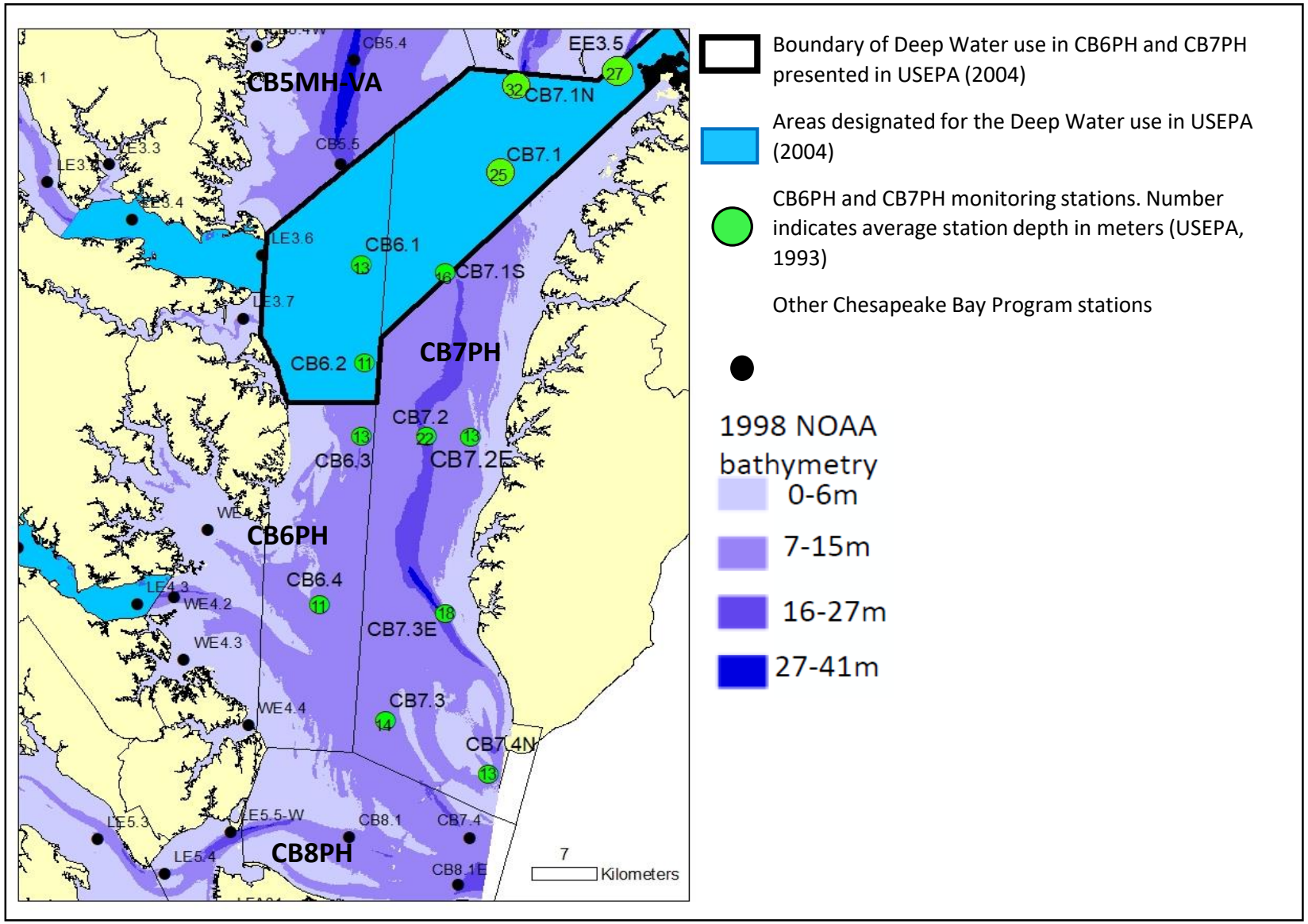
Features of Deep Water Habitat

- Deep bathymetry
- Stratification (persistent pycnocline)
- Hypoxia within and below the pycnocline

"Tidally influenced waters located…in areas where the **measured pycnocline, in combination with bottom bathymetry and water circulation patterns, presents a barrier to oxygen replenishment** of deeper waters. In some areas where a lower boundary of the pycnocline is not calculated, the **deep water designated use** extends from the measured depth of the upper boundary of the pycnocline down through the water column to the bottom sediment-water interface." – *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability (2003)*

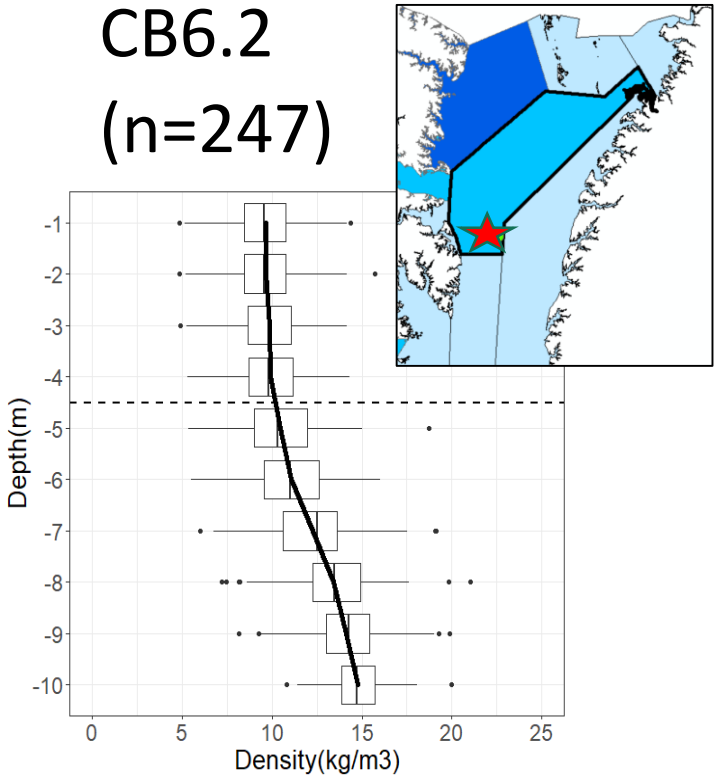
DEQ

The lower portions of CB6PH and CB7PH are sufficiently deep to be considered for the Deep Water use designation.



Stratification

CB6.2
(n=247)

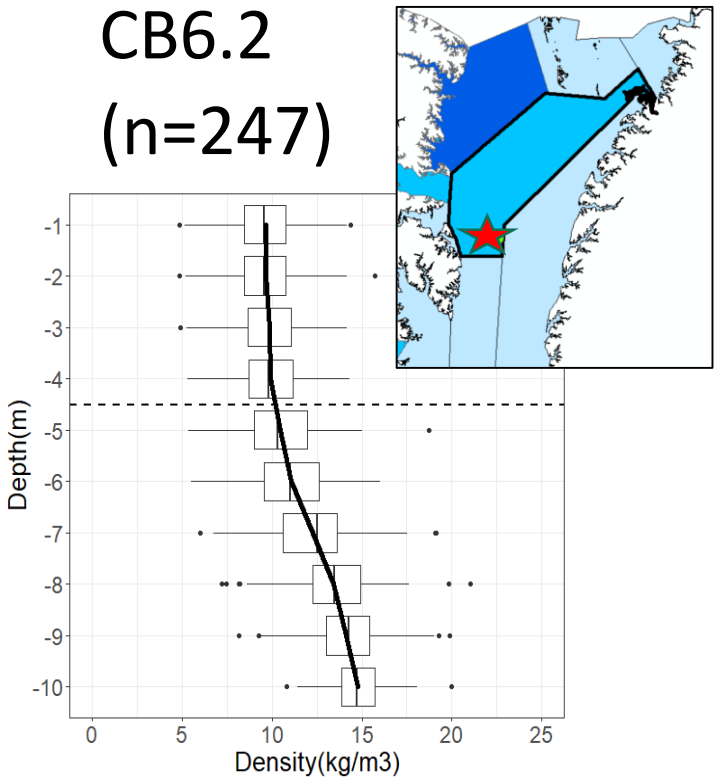


Average summertime density vertical profile, based on monitoring events from 1985 to 2021

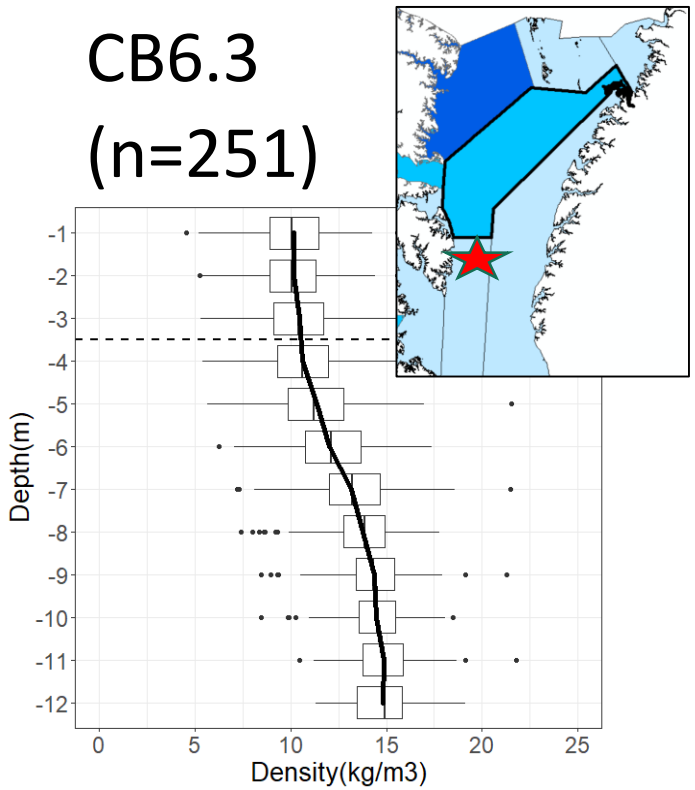
DEQ

Stratification

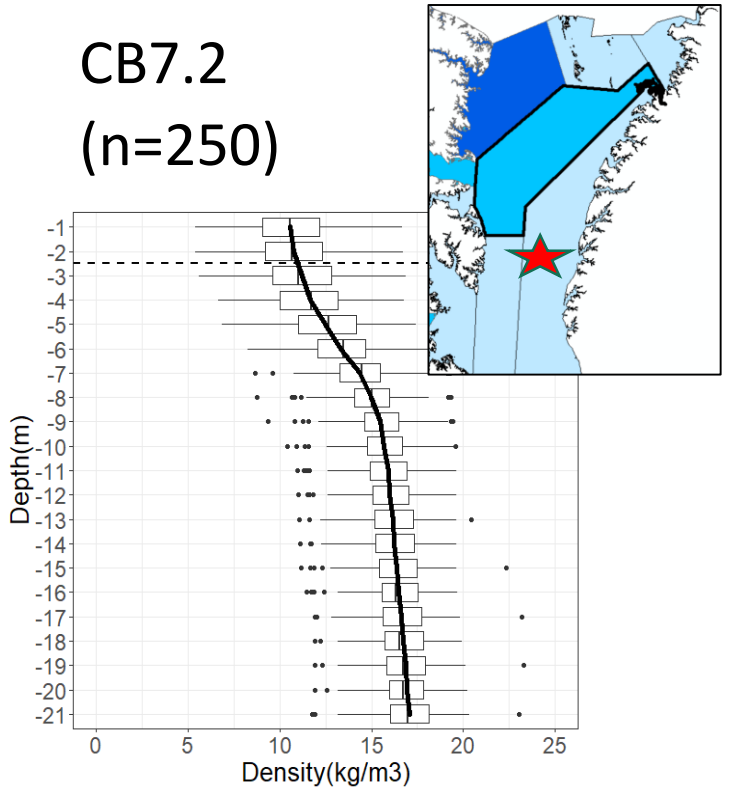
CB6.2
(n=247)



CB6.3
(n=251)



CB7.2
(n=250)

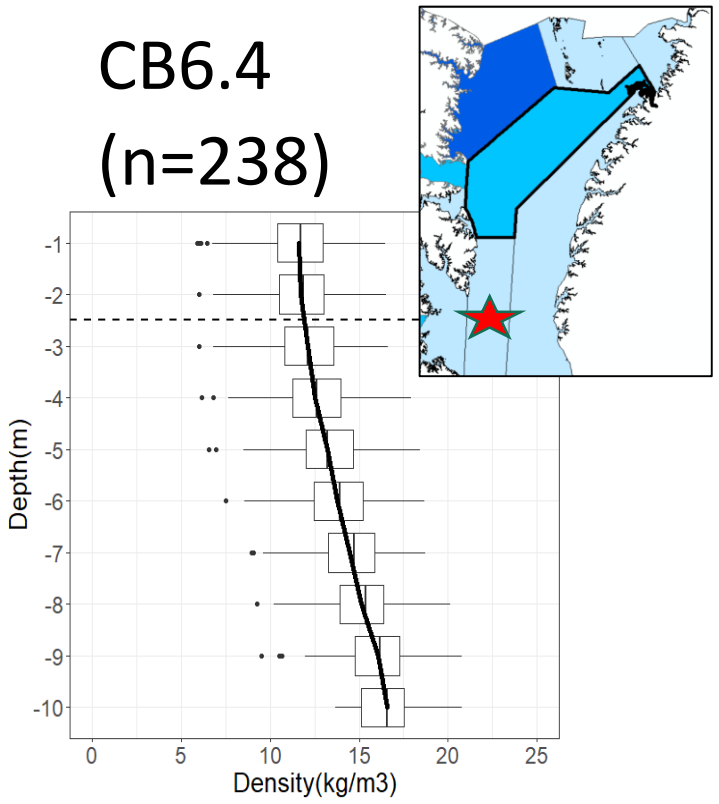


Average summertime density vertical profile, based on monitoring events from 1985 to 2021

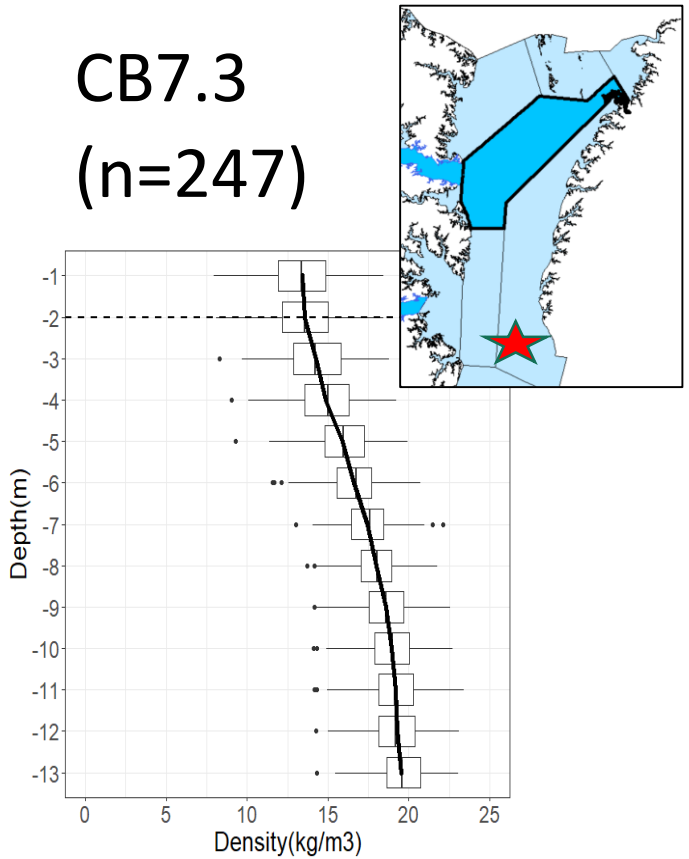
DEQ

Stratification

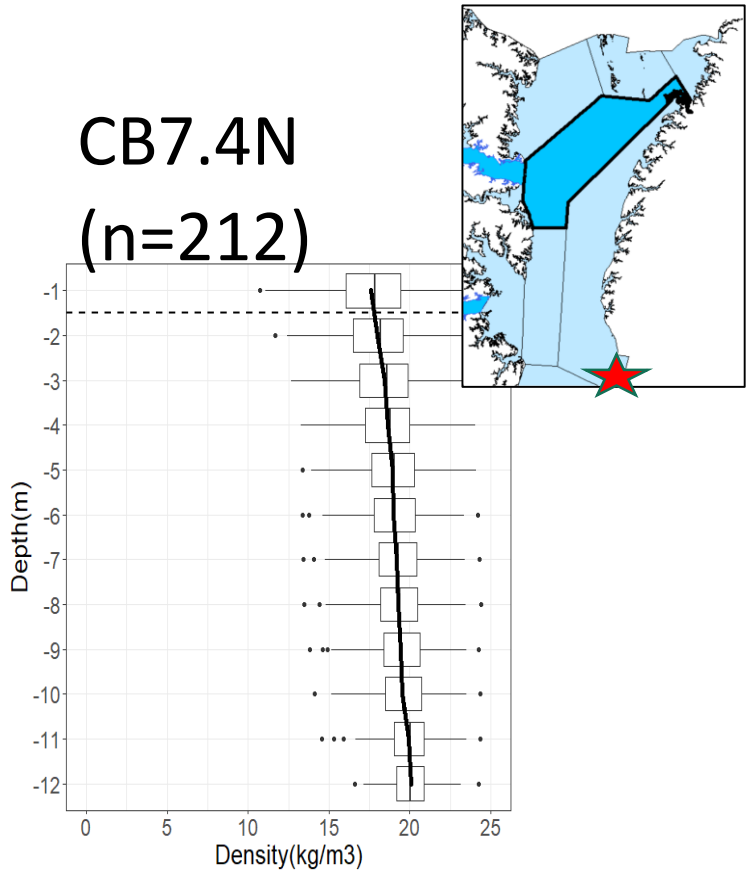
CB6.4
(n=238)



CB7.3
(n=247)



CB7.4N
(n=212)

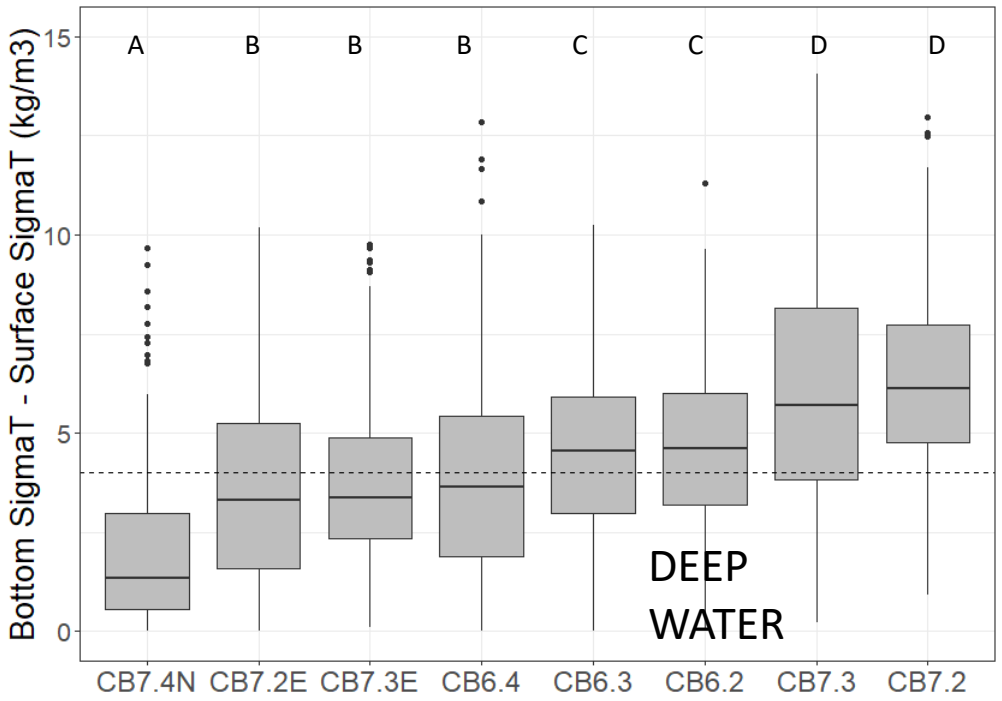


Average summertime density vertical profile, based on monitoring events from 1985 to 2021

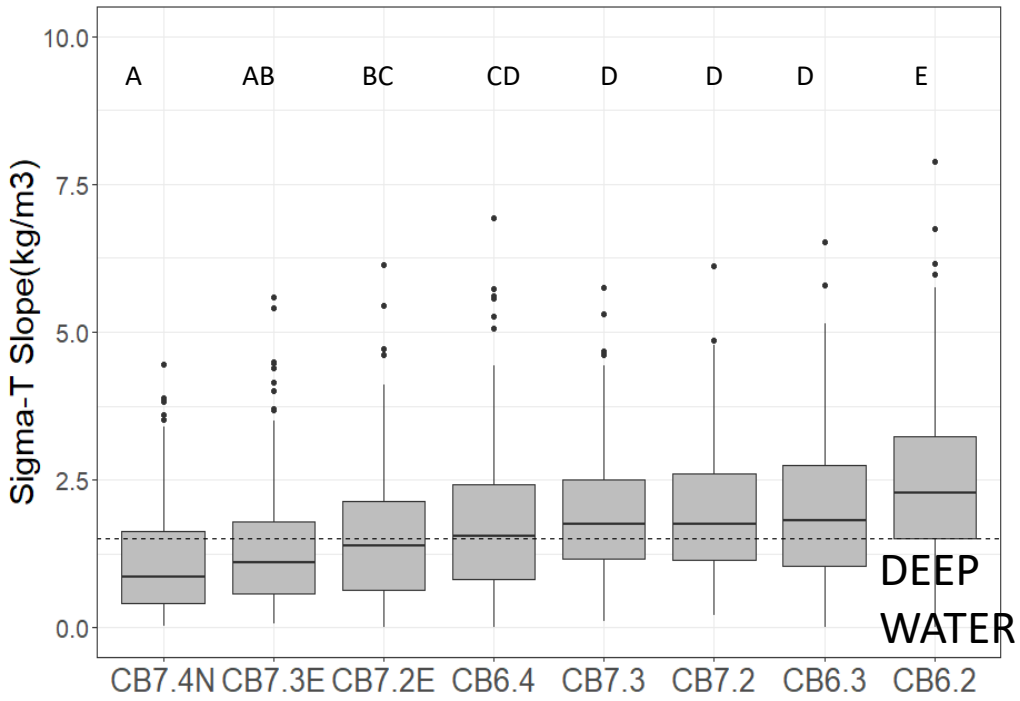
DEQ

Strong stratification occurs in the lower portions of CB6PH and CB7PH

Density Gradient (Bottom-Surface)



Slope
(Largest density change between consecutive depths)

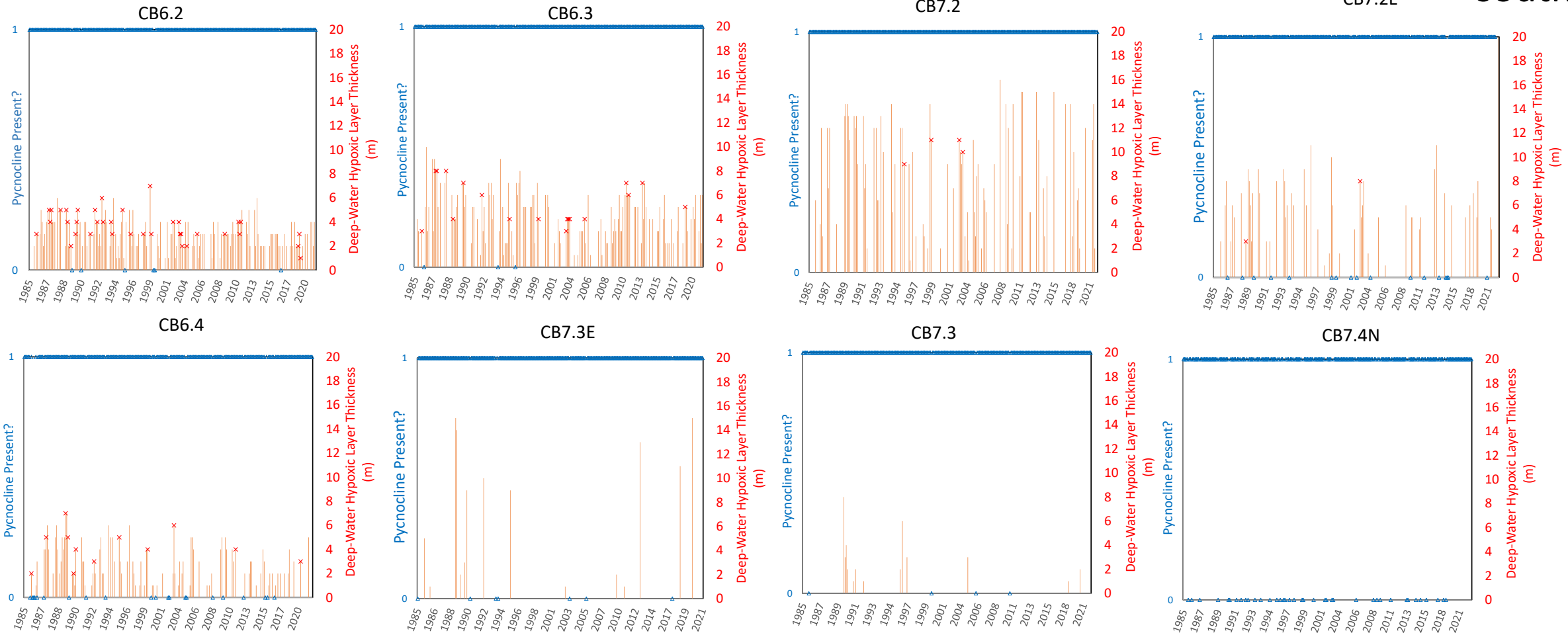


Letters represent statistically different groups ($p<0.05$, Kruskal-Wallis test, post-hoc Conover-Iman test).
Dashed line represents the median of all observations. n = number of monitoring events.

DEQ

Hypoxia within and below the pycnocline

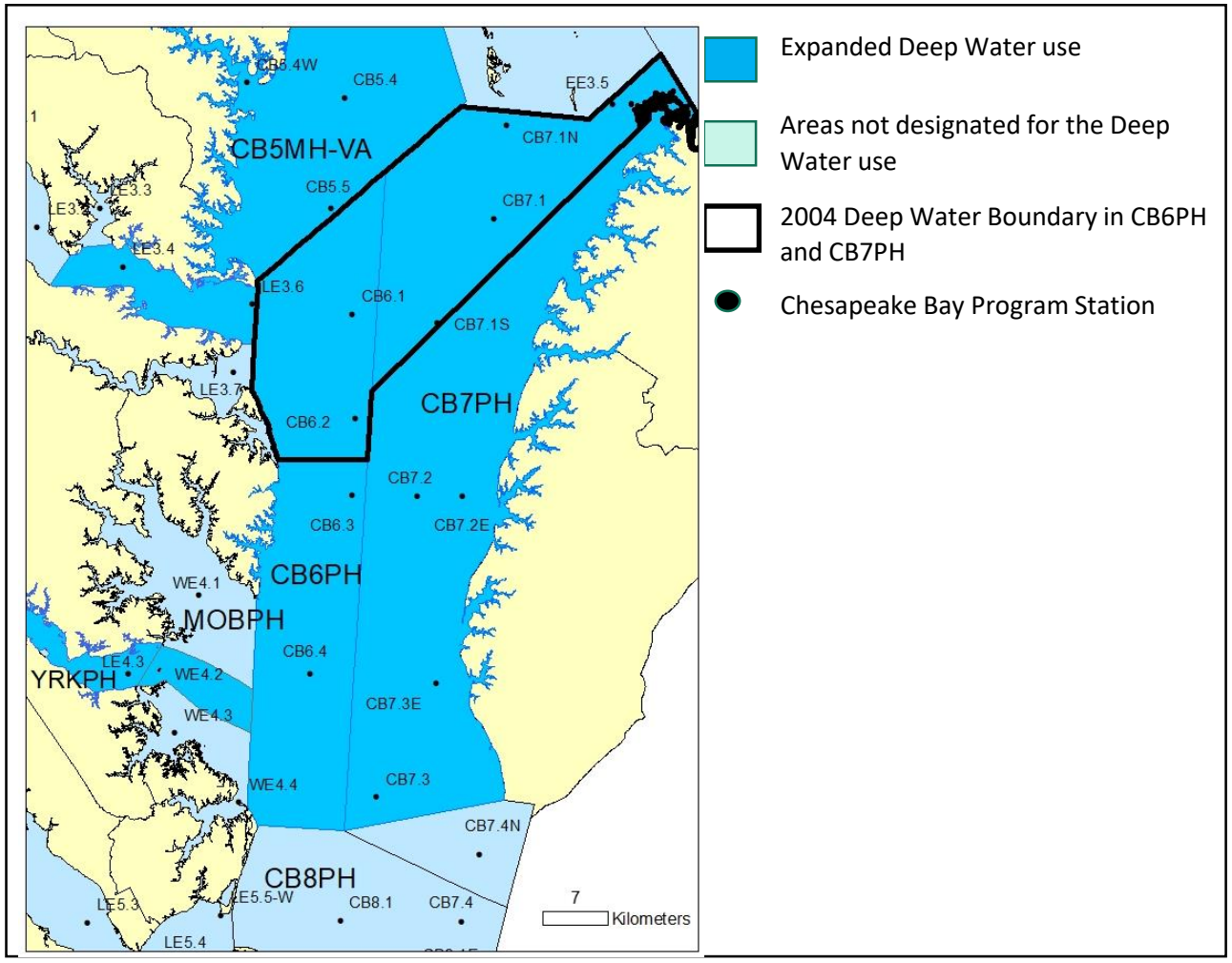
north → south



The frequency and thickness of deep-water hypoxic layers decrease as you get closer to the mouth.

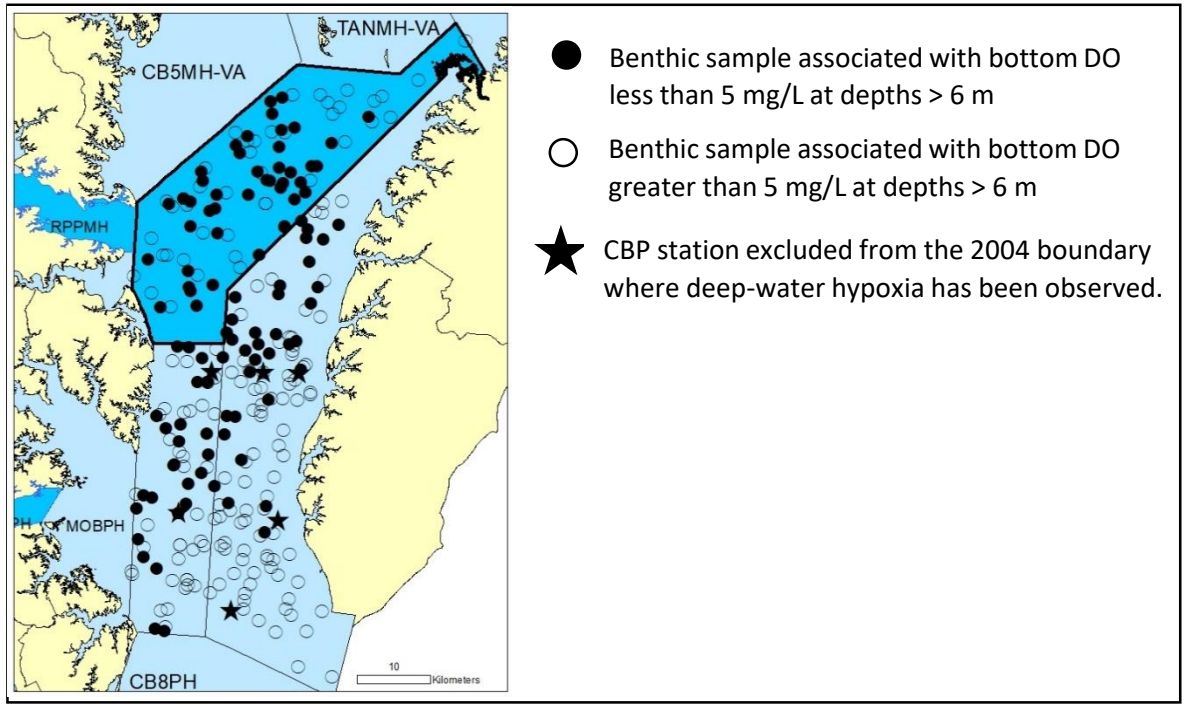
Deep Water habitat exists in the lower portions of CB6PH and CB7PH.

Proposed Deep Water Boundary



Support for the expanded boundary

- Long-term and probabilistic monitoring data show bottom hypoxia has been encountered throughout the entirety of CB6PH and CB7PH, except for the area closest to the mouth.



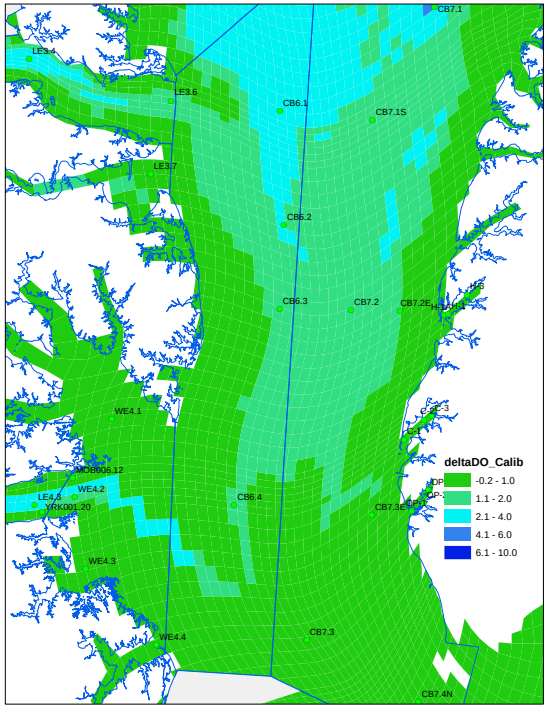
DEQ

Support for the expanded boundary

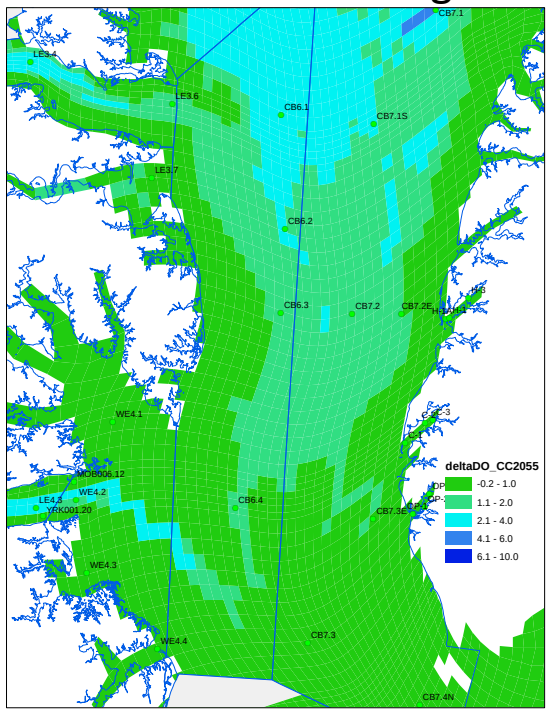
- The Bay estuarine model (Phase 6) forecasts a widening of the DO gradient (surface-bottom) in the lower portion of CB6PH under climate change.

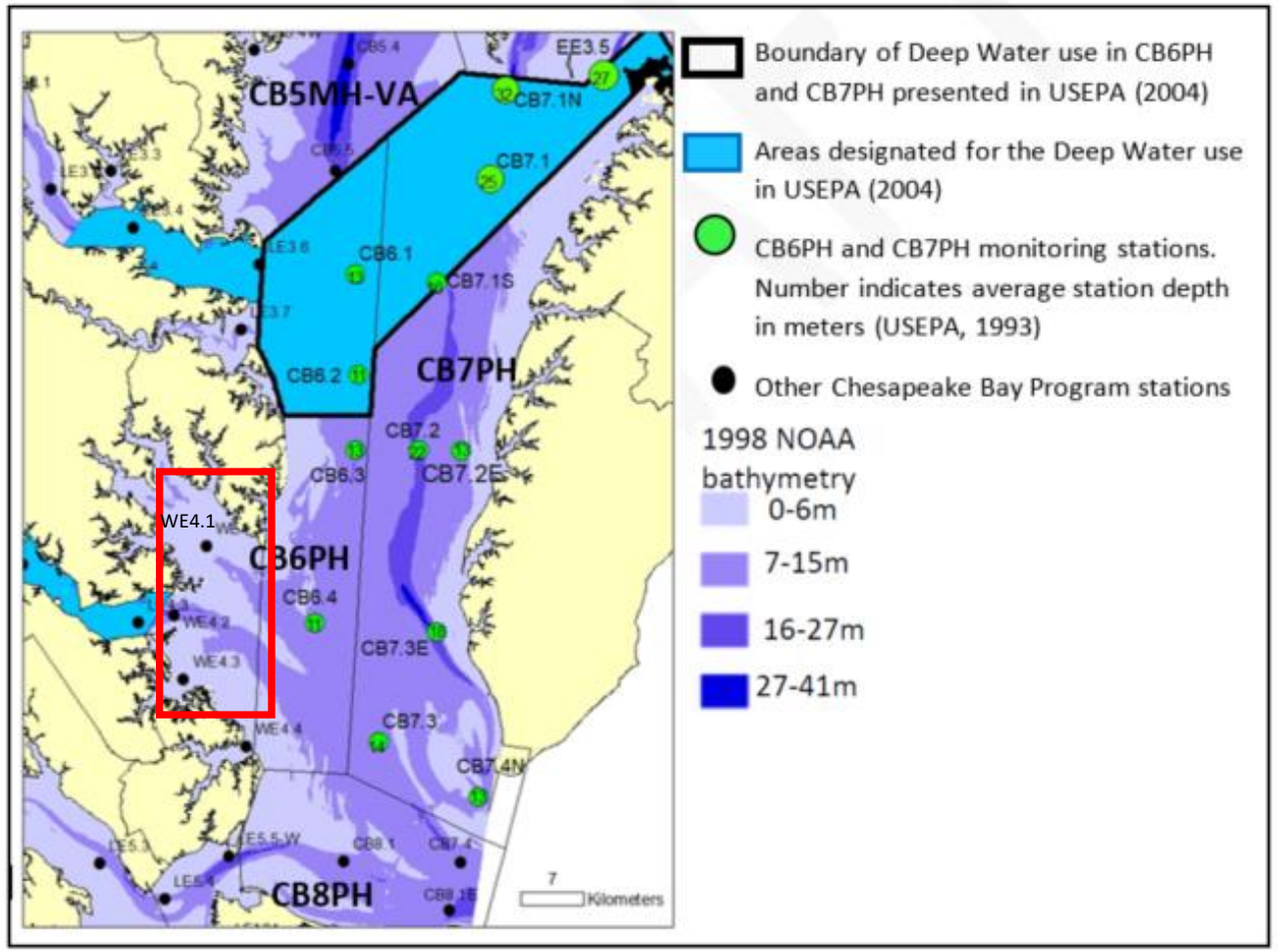
- The model output also indicates that the deeper water of MOBPH looks very much like Deep Water habitat.

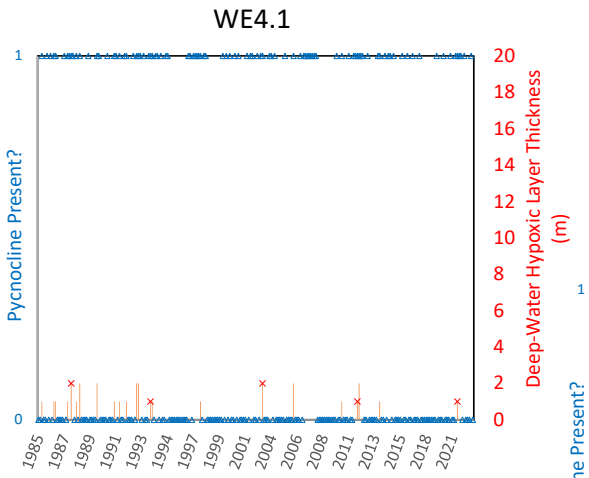
1993-1995 (Calibration)

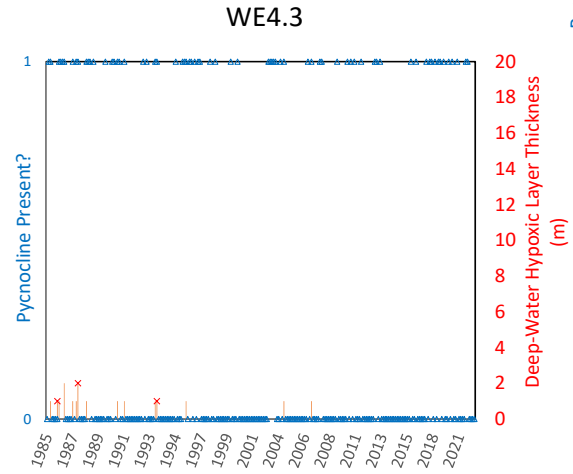


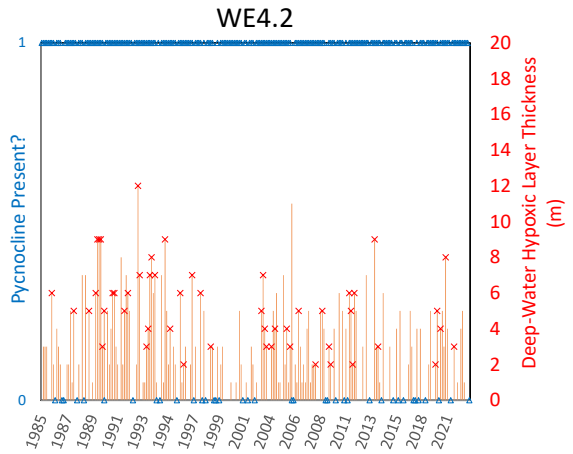
2055 Climate Change




CB5MH-VA
CB7PH
CB6PH
CB8PH
WE4.1
WE4.2
WE4.3
CB6.1
CB6.2
CB6.3
CB6.4
CB7.1
CB7.1N
CB7.1S
CB7.2
CB7.2E
CB7.3
CB7.3E
CB7.4N
EE3.5
7
Kilometers
Boundary of Deep Water use in CB6PH and CB7PH presented in USEPA (2004)
Areas designated for the Deep Water use in USEPA (2004)
CB6PH and CB7PH monitoring stations. Number indicates average station depth in meters (USEPA, 1993)
Other Chesapeake Bay Program stations
1998 NOAA bathymetry
0-6m
7-15m
16-27m
27-41m


WE4.1
Pycnocline Present?
Deep-Water Hypoxic Layer Thickness (m)
1985 1987 1989 1991 1993 1994 1997 1999 2001 2004 2006 2008 2011 2013 2015 2018 2021


WE4.3
Pycnocline Present?
Deep-Water Hypoxic Layer Thickness (m)
1985 1987 1989 1991 1993 1994 1997 1999 2001 2004 2006 2008 2011 2013 2015 2018 2021

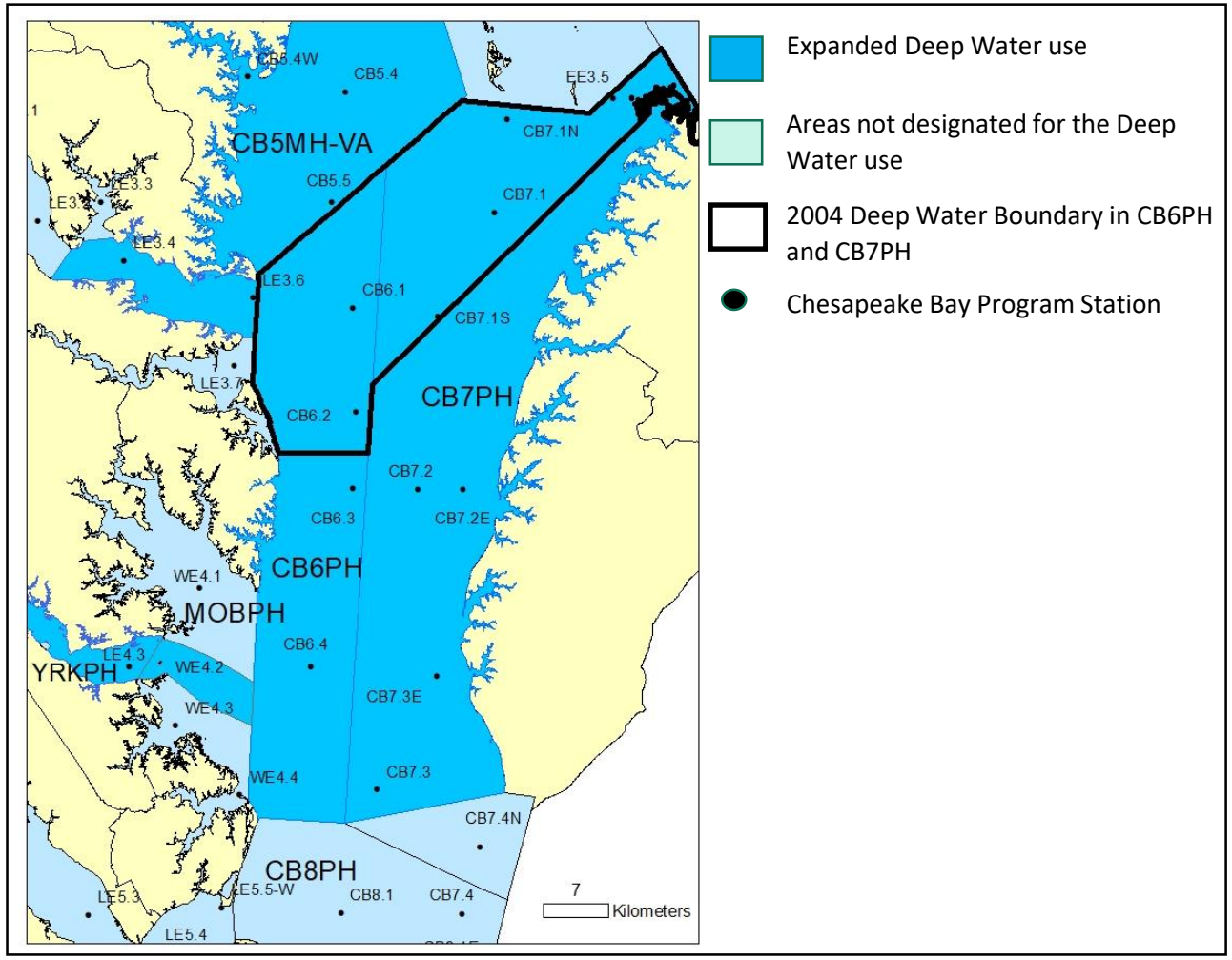

WE4.2
Pycnocline Present?
Deep-Water Hypoxic Layer Thickness (m)
1985 1987 1989 1991 1993 1994 1997 1999 2001 2004 2006 2008 2011 2013 2015 2018 2021

- A technical support document is currently being reviewed by CBP and EPA R3 staff.

- An amendment to the WQS will be required before changes to the assessment procedure can be made.

DEQ

Questions?


CB5MH-VA
CB6PH
CB7PH
CB8PH
MOBPH
YRKPH
CB5.4W
CB5.4
EE3.5
CB7.1N
CB5.5
CB7.1
LE3.3
LE3.4
LE3.6
CB6.1
CB7.1S
LE3.7
CB6.2
CB7.2
CB7.2E
CB6.3
WE4.1
CB6.4
LE4.3
WE4.2
CB7.3E
WE4.3
WE4.4
CB7.3
CB7.4N
LE5.3
LE5.5-W
CB8.1
CB7.4
LE5.4
7
Kilometers
Expanded Deep Water use
Areas not designated for the Deep Water use
2004 Deep Water Boundary in CB6PH and CB7PH
Chesapeake Bay Program Station