Water Quality Standards Attainment Indicator and a first look into "Attainment Sensitivity"

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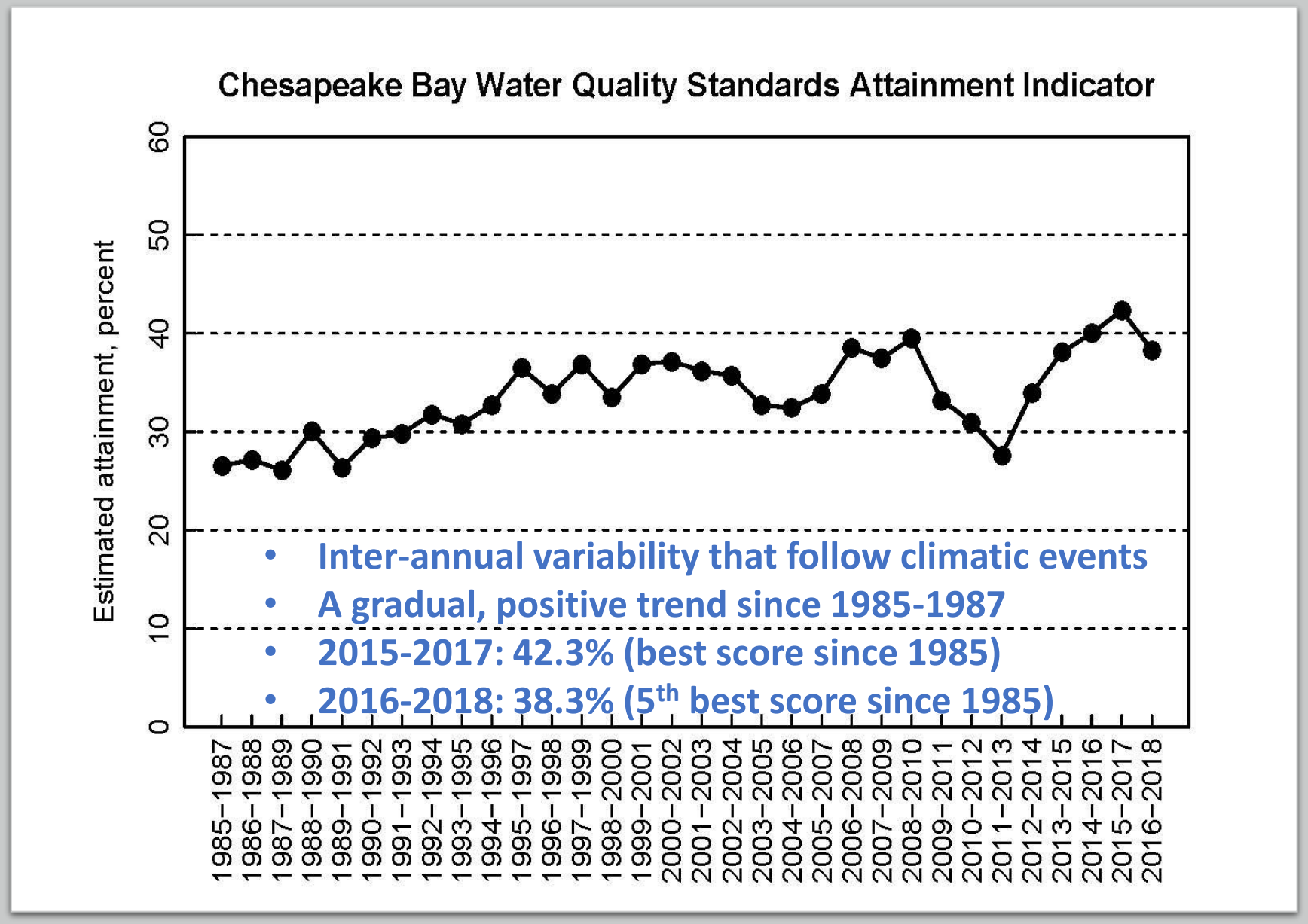
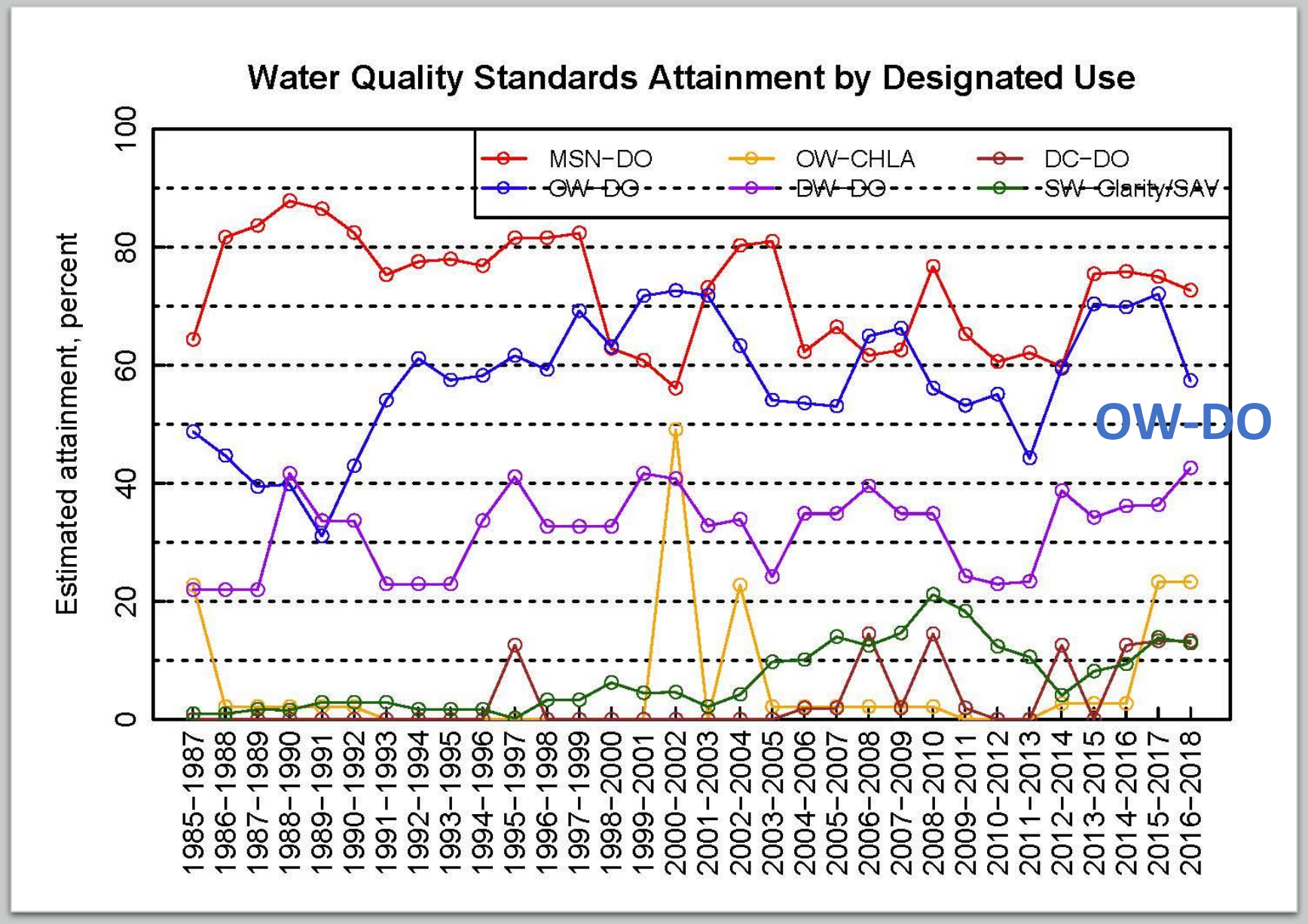
CAP Workgroup
August 19, 2020

I. WQS Attainment Indicator (2016-2018)



WQS Attainment Indicator (2016-2018)

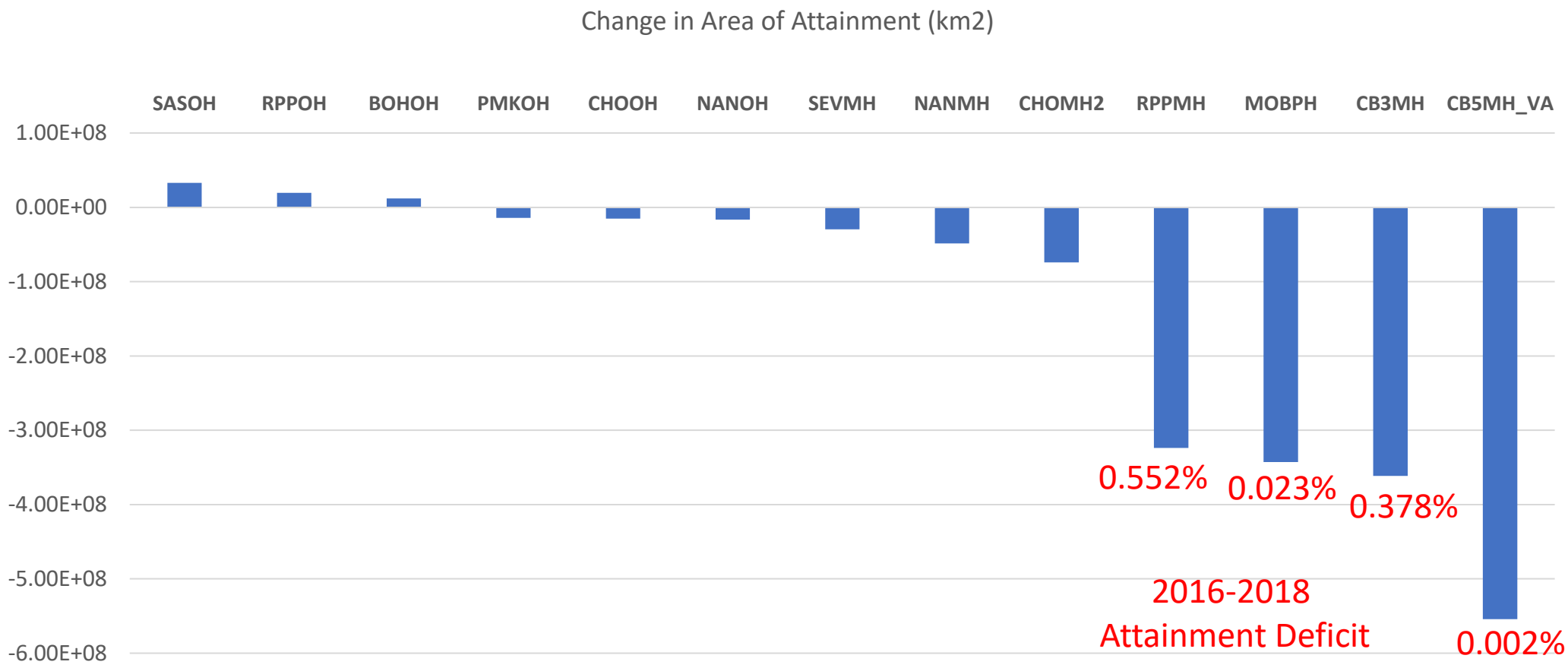


OW-DO

OW Segments

Segment Name	2015-2017 Attainment	2016-2018 Attainment	Change in Area of Attainment (km2)	2016-2018 Attainment Deficit
SASOH	No	Yes	3.31E+07	0.000%
RPPOH	No	Yes	1.95E+07	0.000%
BOHOH	No	Yes	1.19E+07	0.000%
PMKOH	Yes	No	-1.41E+07	2.607%
CHOOH	Yes	No	-1.50E+07	3.666%
NANOH	Yes	No	-1.65E+07	4.590%
SEVMH	Yes	No	-2.94E+07	0.251%
NANMH	Yes	No	-4.84E+07	4.590%
CHOMH2	Yes	No	-7.42E+07	1.052%
RPPMH	Yes	No	-3.24E+08	0.552%
MOBPH	Yes	No	-3.43E+08	0.023%
CB3MH	Yes	No	-3.62E+08	0.378%
CB5MH_VA	Yes	No	-5.54E+08	0.002%
SUM			-1.72E+09	

OW Segments


Change in Area of Attainment (km2)
SASOH
RPPOH
BOHOH
PMKOH
CHOOH
NANOH
SEVMH
NANMH
CHOMH2
RPPMH
MOBPH
CB3MH
CB5MH_VA
1.00E+08
0.00E+00
-1.00E+08
-2.00E+08
-3.00E+08
-4.00E+08
-5.00E+08
-6.00E+08
0.552%
0.023%
0.378%
0.002%
2016-2018
Attainment Deficit

II. Attainment sensitivity analysis

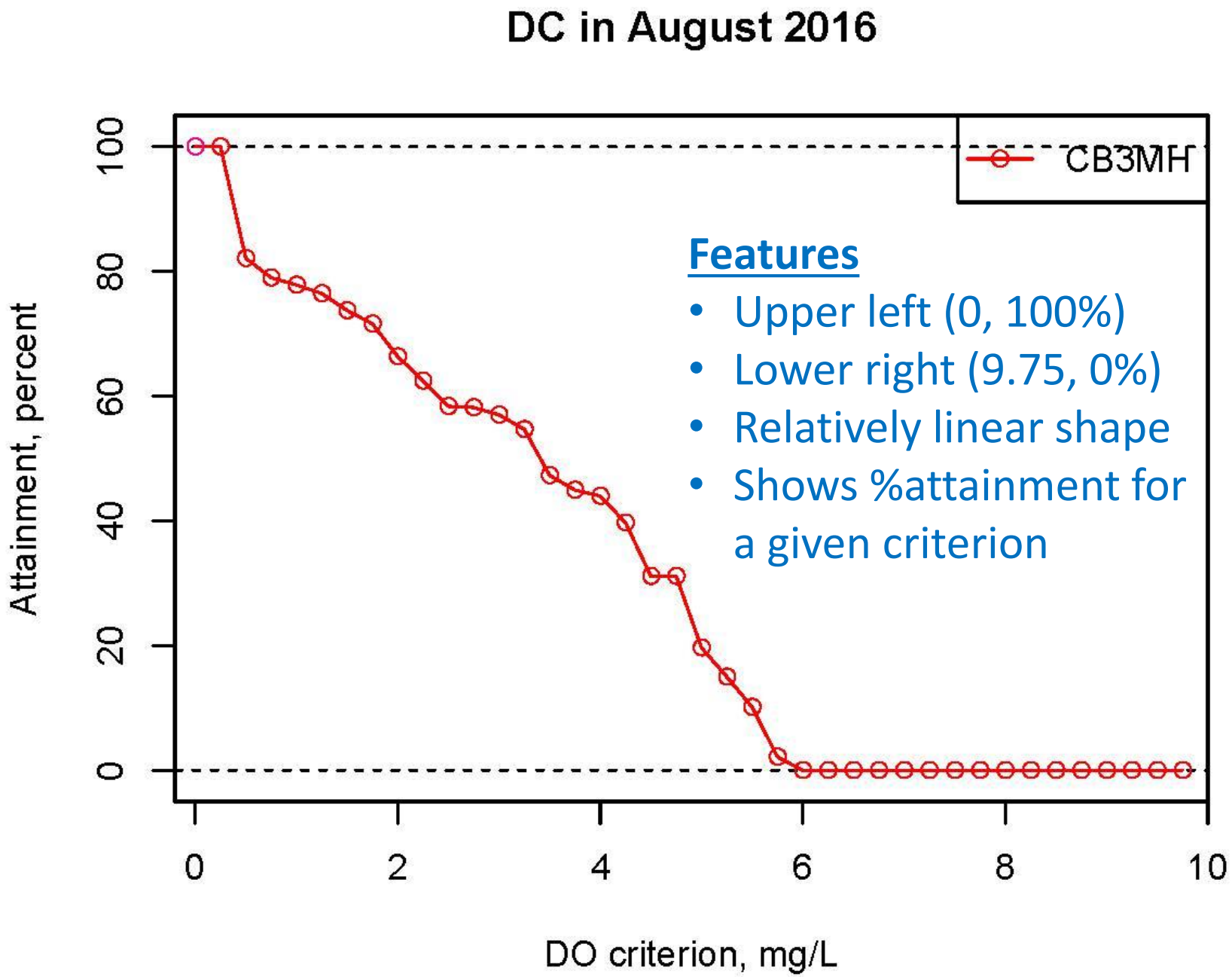
- The tools that we have now:
  - Attainment indicator (binary pass/fail analysis)
  - Attainment deficit (any value from 0% to 100% deficit; 0% could be very different in terms of buffer)

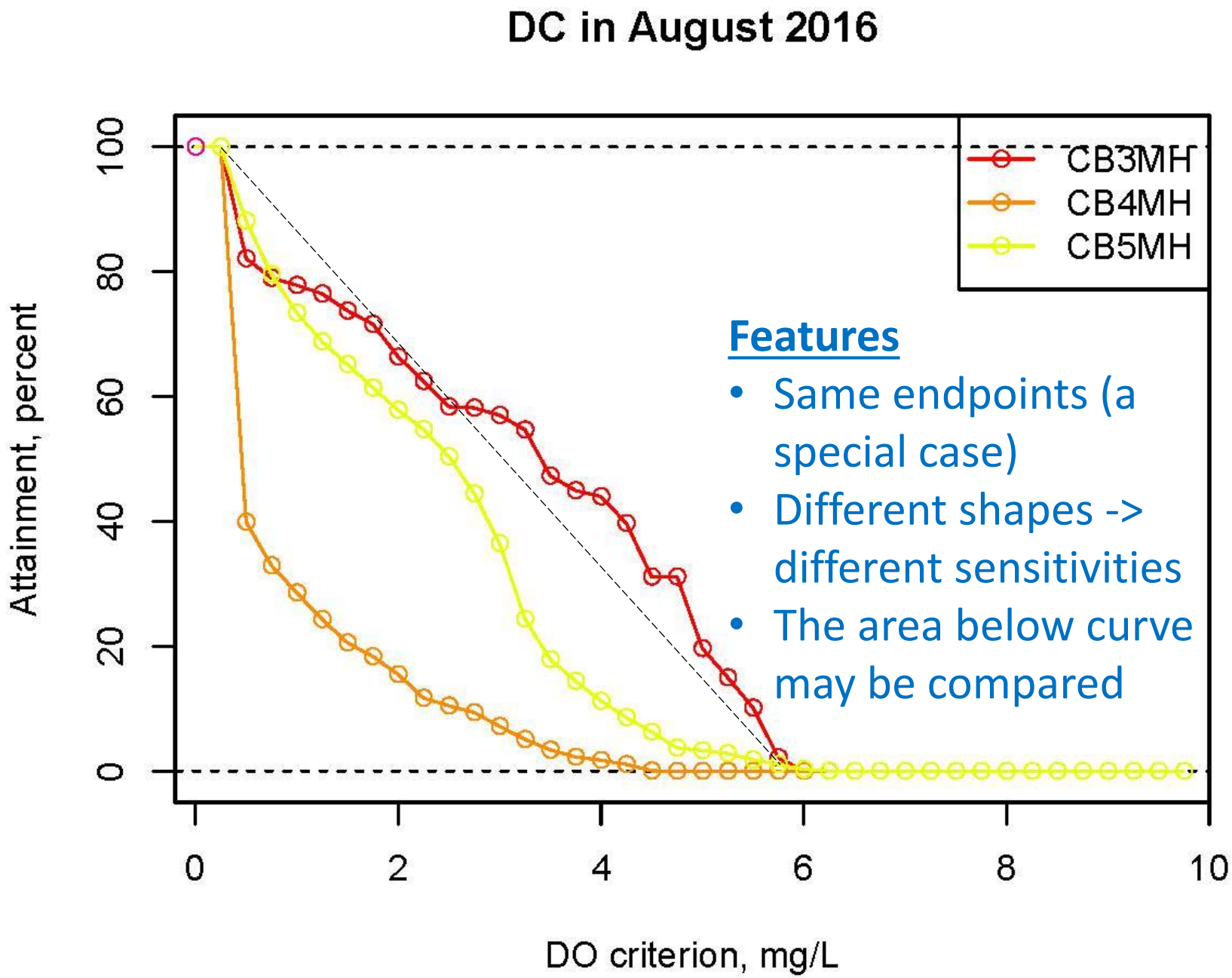
- To share a pilot analysis of DO attainment sensitivity (AS) to criteria threshold;
- The proposed tools are useful to quantify the resilience of attaining segments (the "attainment buffer" concept).

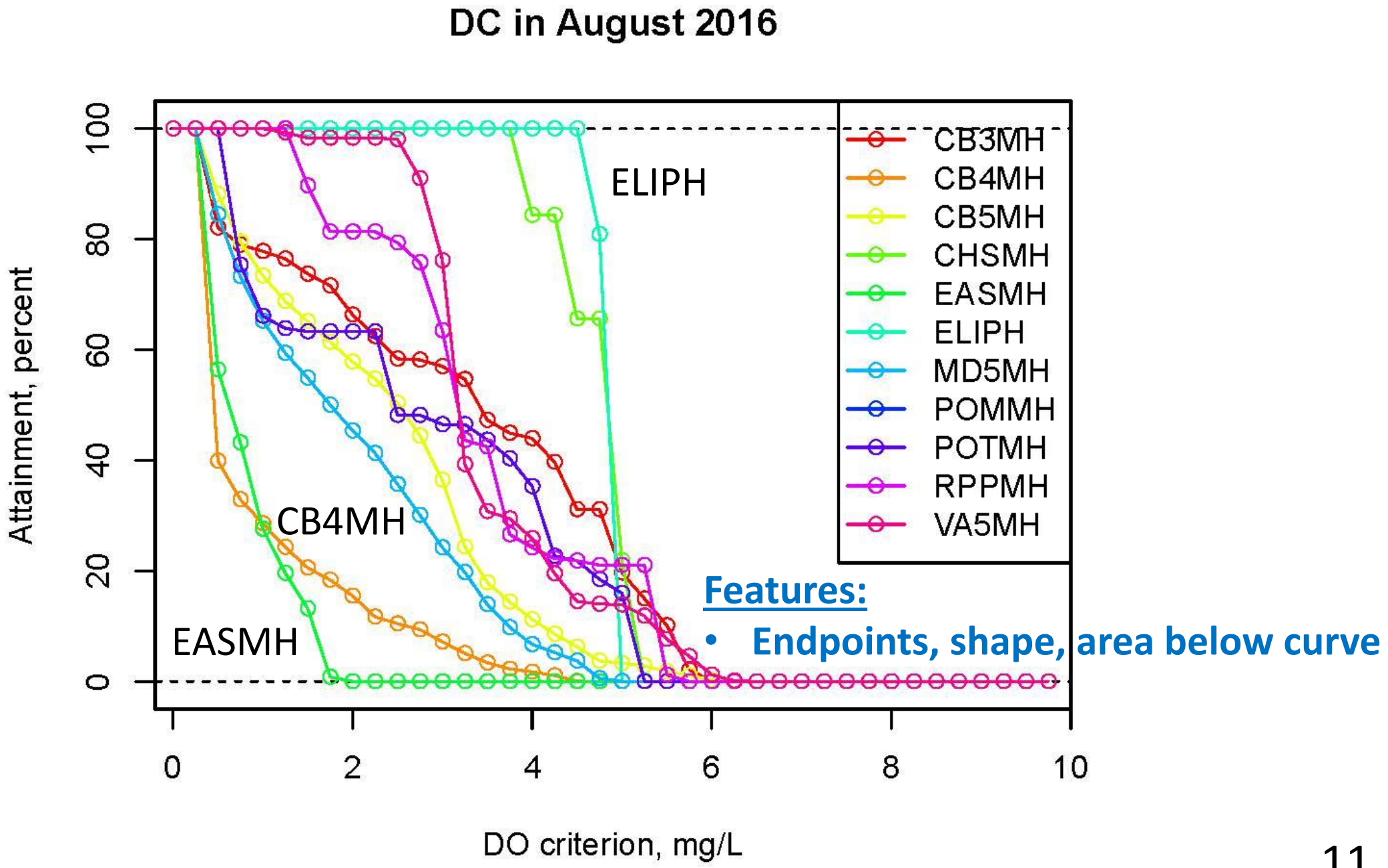
Designated Use	Season	Threshold	Critical Value	Applicable Segments
Open-water fish and shellfish (OW)	Year-round	30-day mean	5.5 mg L^{-1} in very low salinity; 5 mg L^{-1} otherwise	92
		7-day mean	4 mg L^{-1}	
		Instantaneous	3.2 mg L^{-1}	
Deep-water seasonal fish and shellfish (DW)	June 1 - September 30	30-day mean	3 mg L^{-1}	18
	June 1 - September 30	1-day mean	2.3 mg L^{-1}	
	June 1 - September 30	Instantaneous	1.7 mg L^{-1}	
	October 1 - May 31	OW criteria apply		
Deep-channel seasonal refuge (DC)	June 1 - September 30	Instantaneous	1 mg L^{-1}	10
	October 1 - May 31	OW criteria apply		

Calculation

- For each tidal segment
  - For each year (not 3-year period)
    - For each individual month (June-September)
      - Compute the interpolated DO concentrations
        - Assign a criterion threshold and compute the %attainment (i.e., above that criterion threshold)
        - Vary the threshold and re-do the computation
        - …
        - Plot %attainment as a function of threshold


DC in August 2016
CB3MH
Features
• Upper left (0, 100%)
• Lower right (9.75, 0%)
• Relatively linear shape
• Shows %attainment for a given criterion
Attainment, percent
0
20
40
60
80
100
0
2
4
6
8
10
DO criterion, mg/L


DC in August 2016
Attainment, percent
0
20
40
60
80
100
0
2
4
6
8
10
DO criterion, mg/L
CB3MH
CB4MH
CB5MH
Features
• Same endpoints (a special case)
• Different shapes -> different sensitivities
• The area below curve may be compared

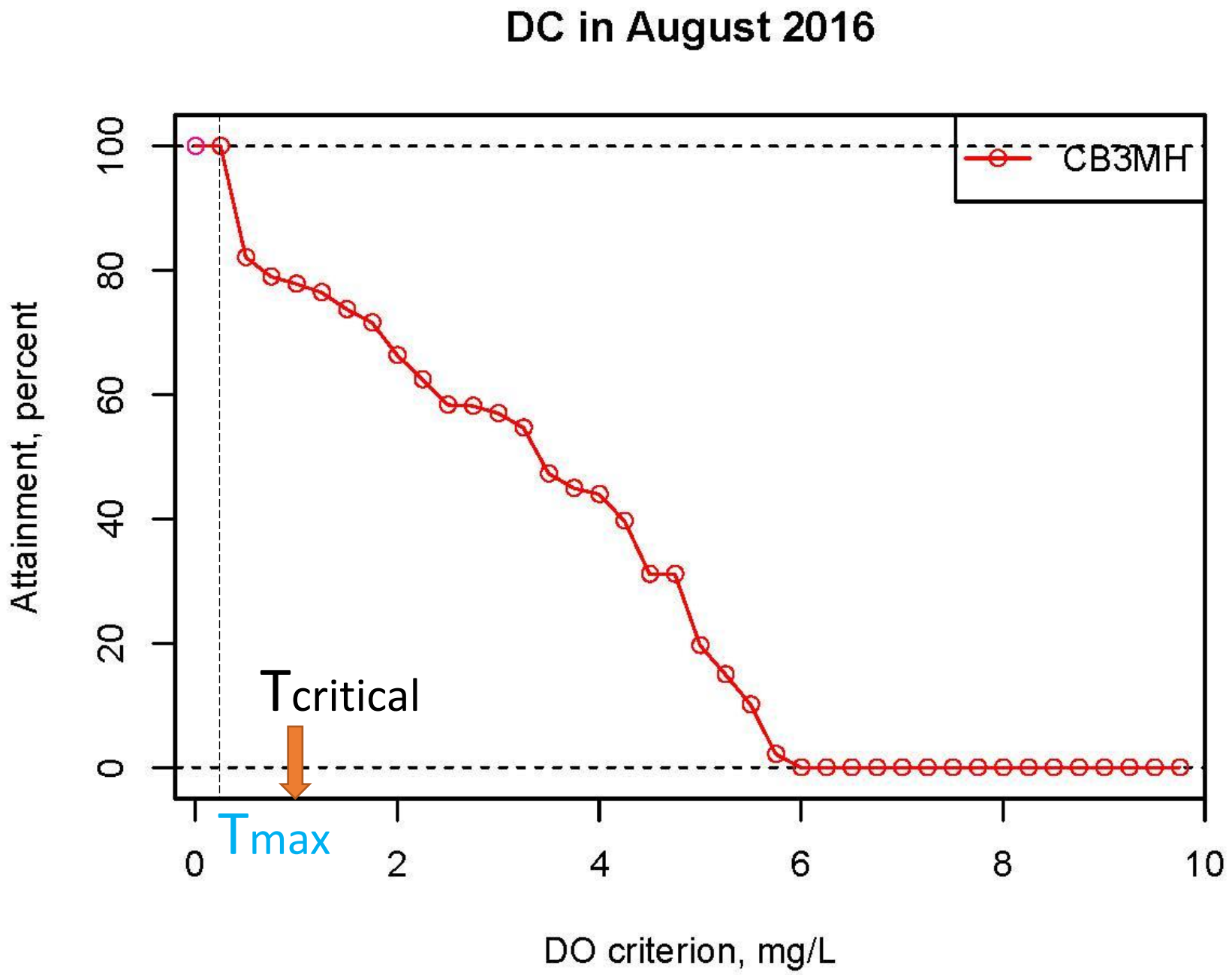


Features:

- **Endpoints, shape, area below curve**

Potential new metrics

1. Maximum allowed concentration, T_{max}
2. Area under the curve, AUC



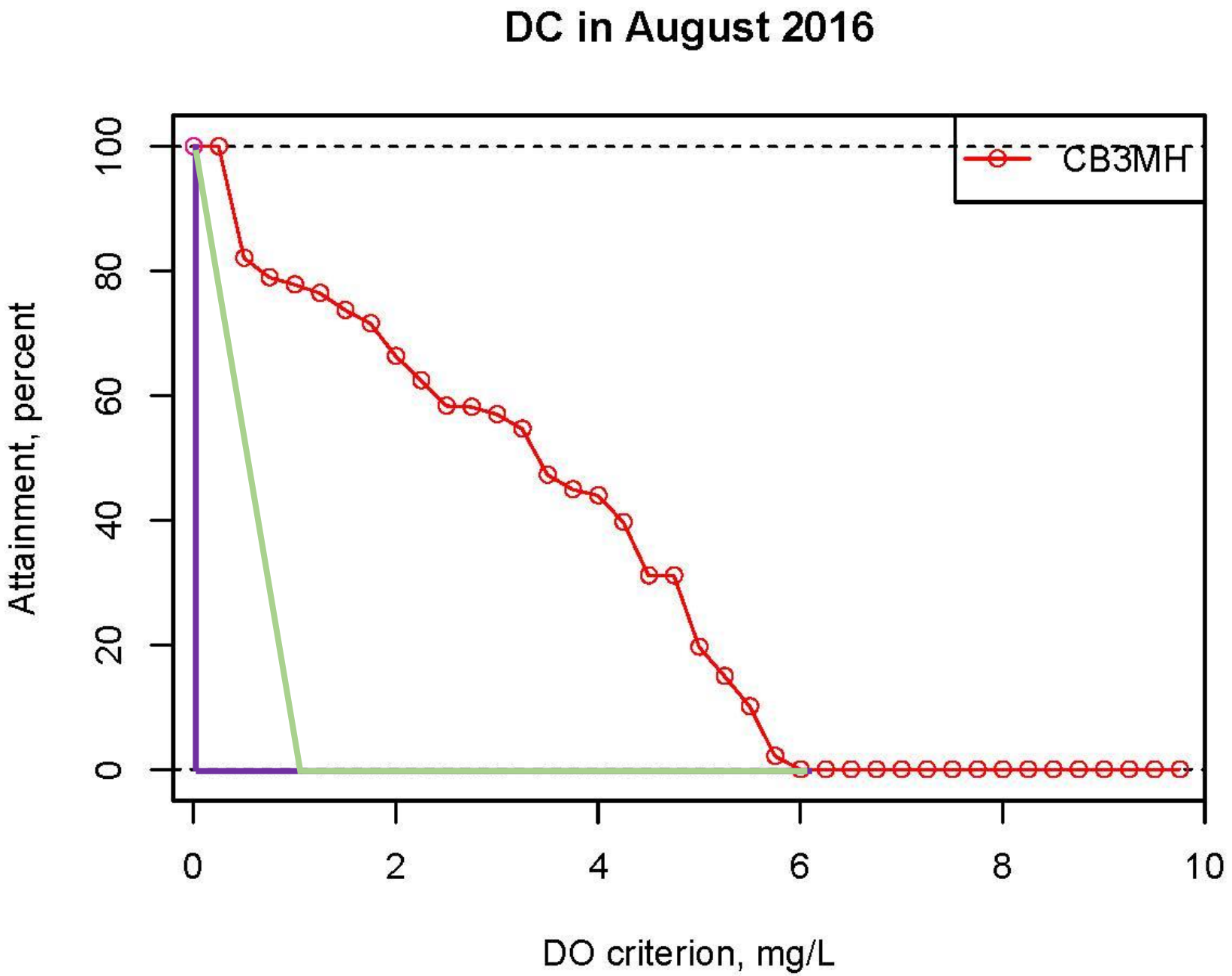
Metric 1: Tmax

= maximum allowed criterion that achieves an attainment of 100%.

Tmax = Tcritical (1mg/L)
→ just attaining

Tmax < Tcritical (1mg/L)
→ attainment deficit

Tmax > Tcritical (1mg/L)
→ attainment buffer

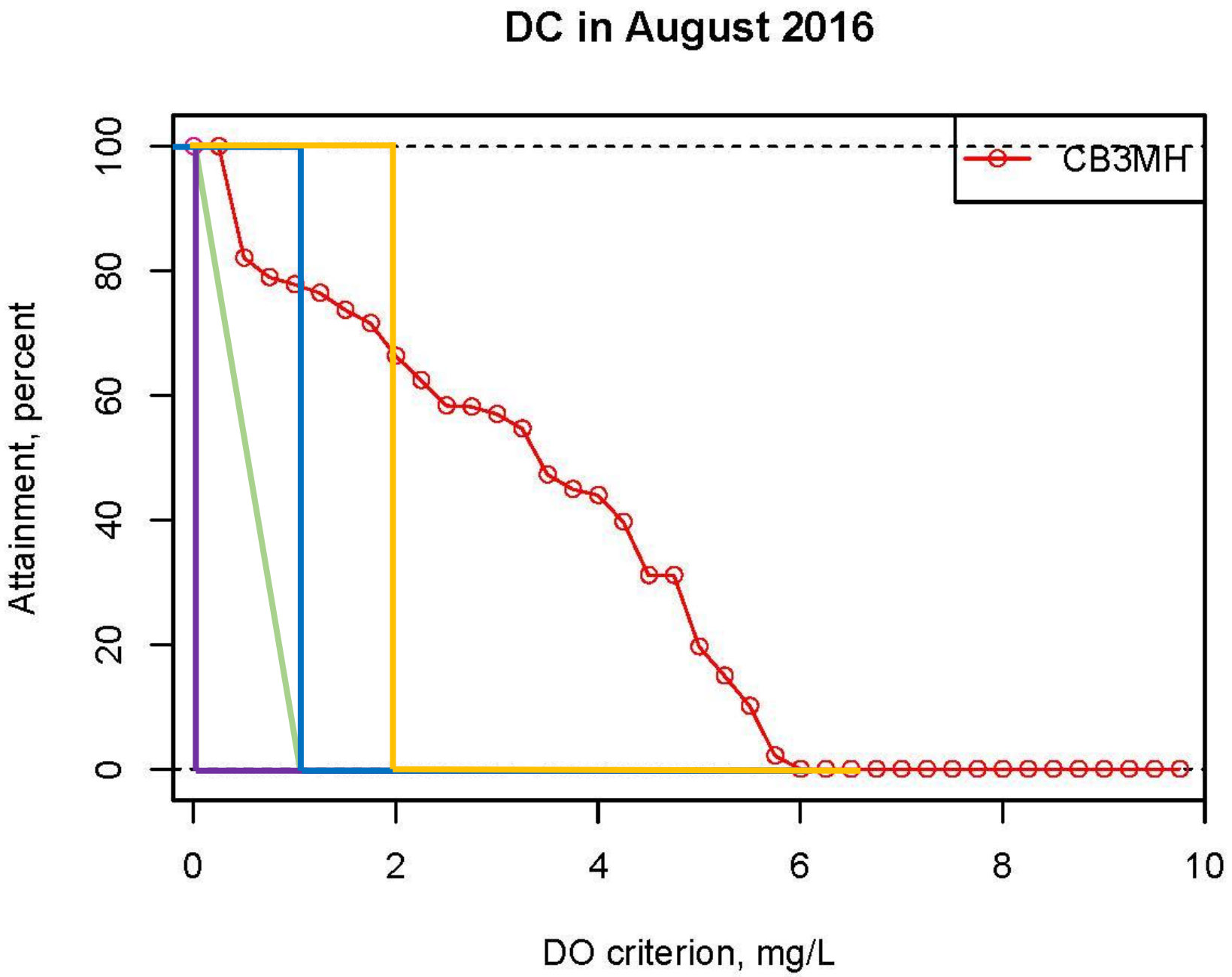


Metric 2: AUC

= area under the attainment curve

1) Purple: AUC = 0
→ 0% attainment

2) Green: AUC = 0.5
→ 0% attainment, but better than the purple line



Metric 2: AUC

= area under the attainment curve

1) Purple: AUC = 0
→ 0% attainment

2) Green: AUC = 0.5
→ 0% attainment, but better than the purple line

3) Blue: AUC = 1
→ 100% attainment

4) Orange: AUC = 2
→ 100% attainment, but better than the blue line

Summary of new metrics

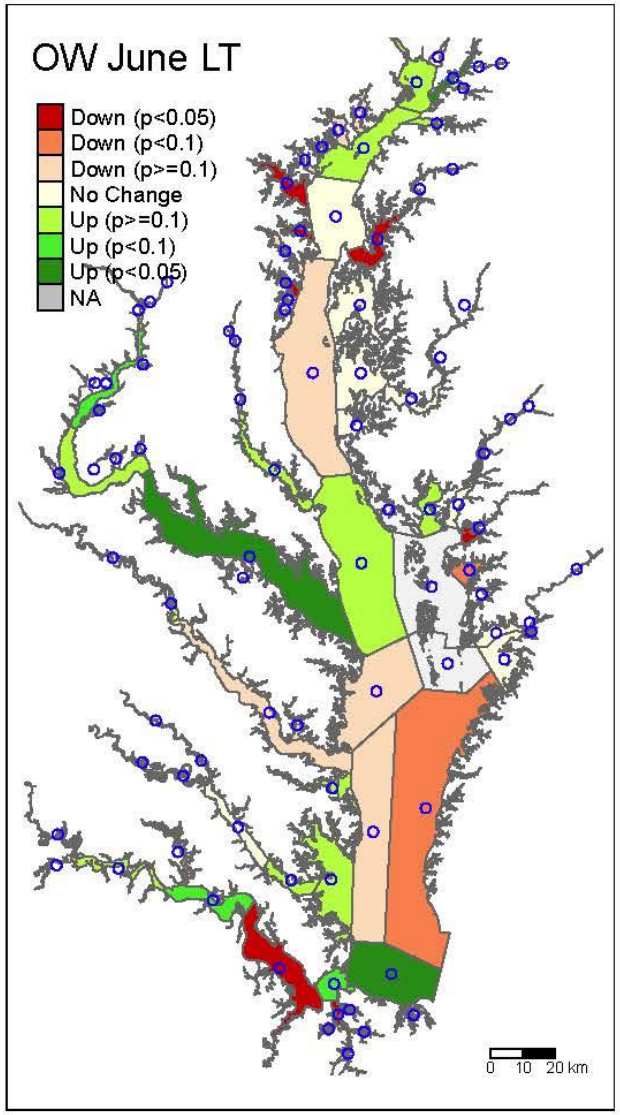
1. Maximum allowed concentration, T_{max}
   - The larger, the better condition
   - Examine attainment deficit and buffer simultaneously

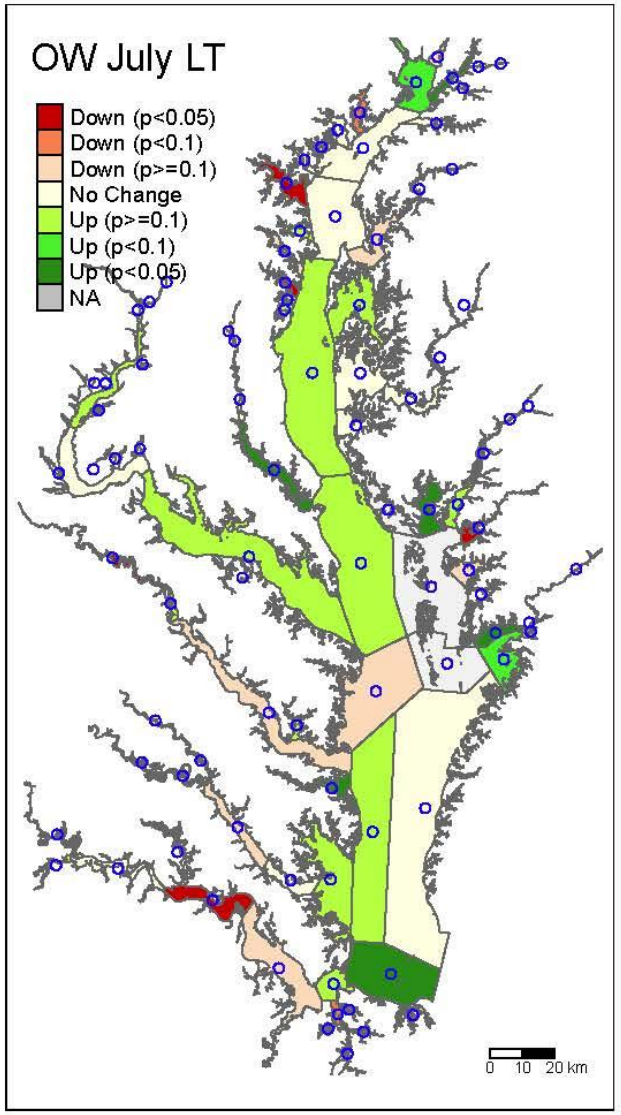
2. Area under the curve, AUC
   - The larger, the better condition
   - Examine attainment deficit and buffer simultaneously

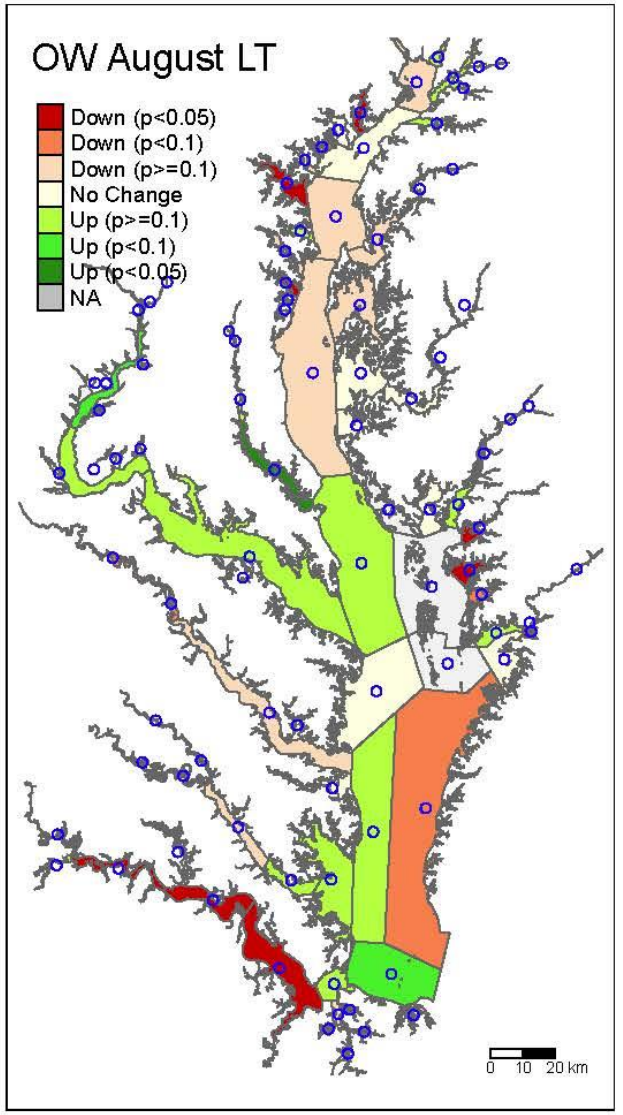
Application of the metrics

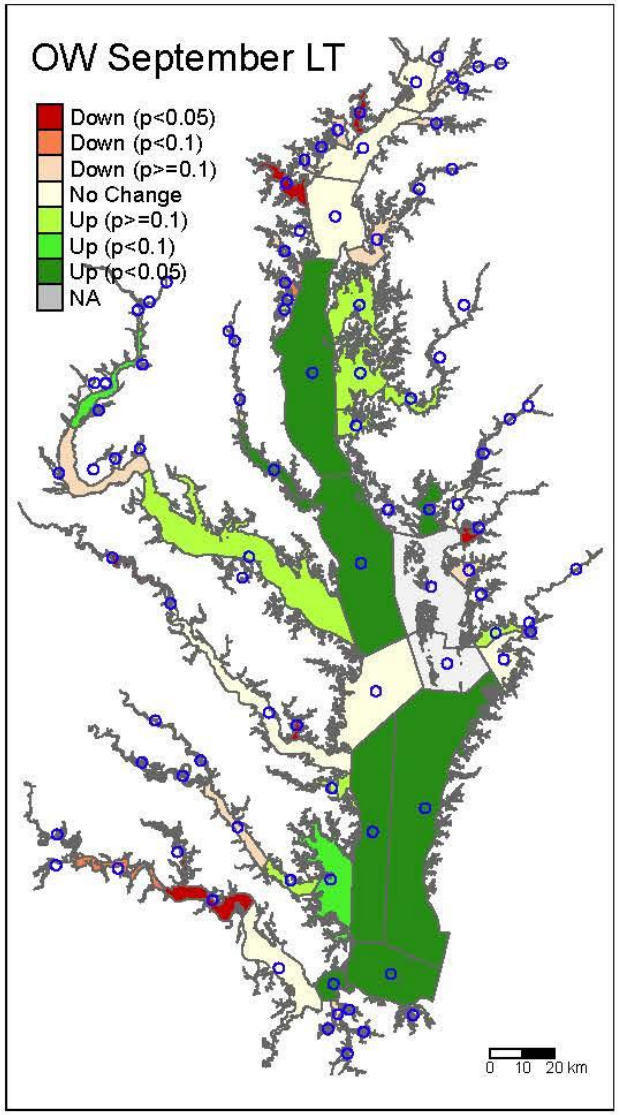
- For each segment
  - For each year
    - For each individual month (June-September)
      - Extract the AS curve (%attainment vs. DO threshold)
        - Compute T_{max} and AUC for that segment, month, year
          - Compute MK trend for both metrics, respectively
            - Plot long-term trend (LT), short-term trend (ST), and current status maps for the Bay segments

OW Tmax Long-term Trend (1985-2017)



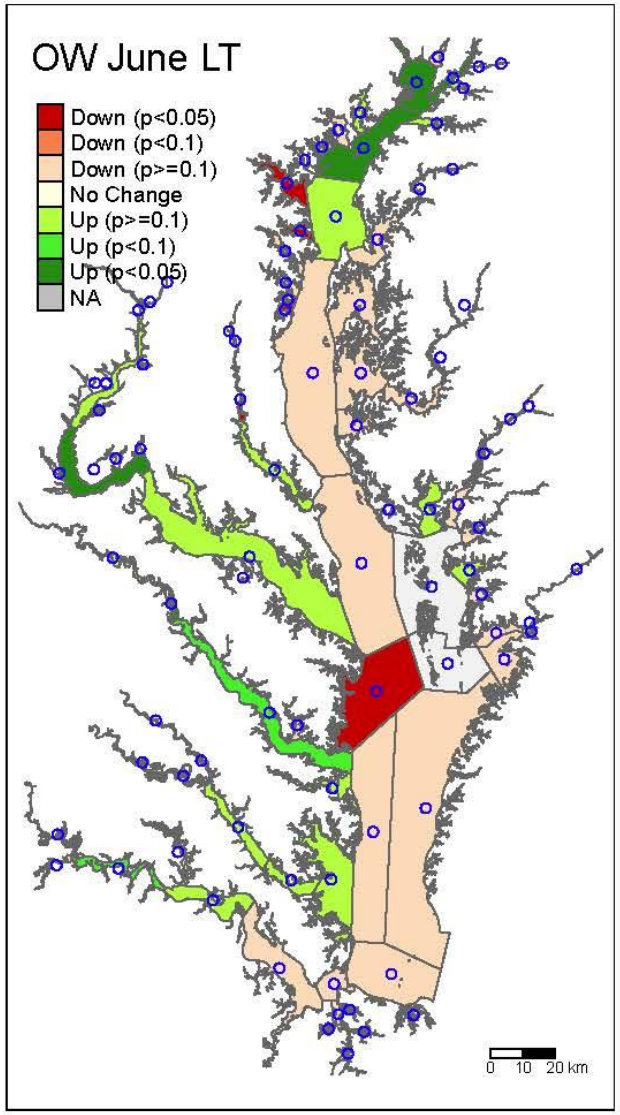


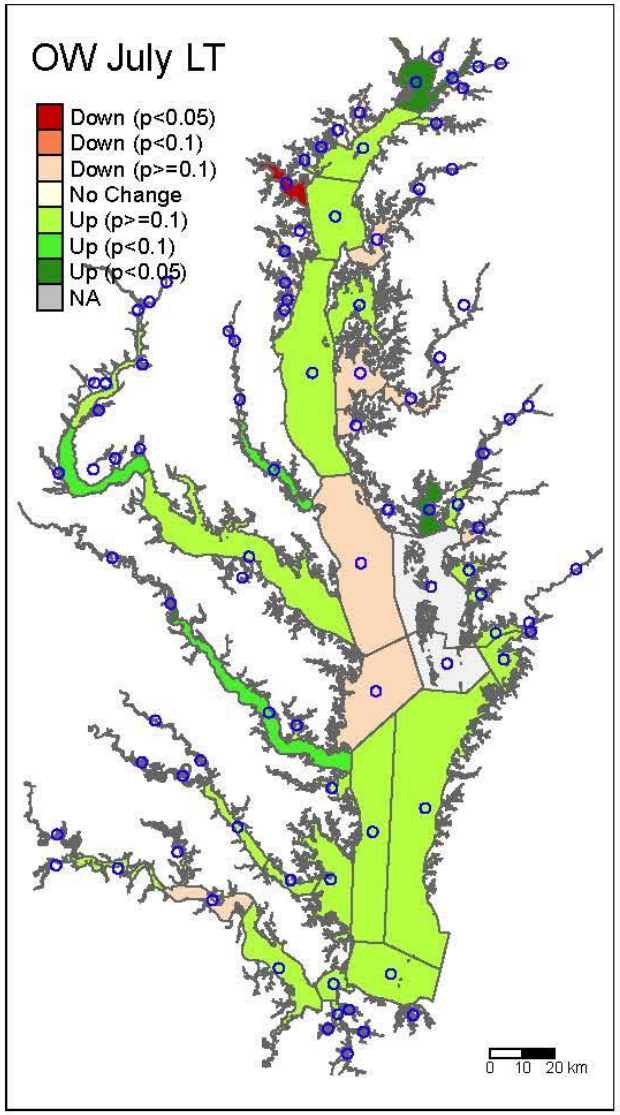


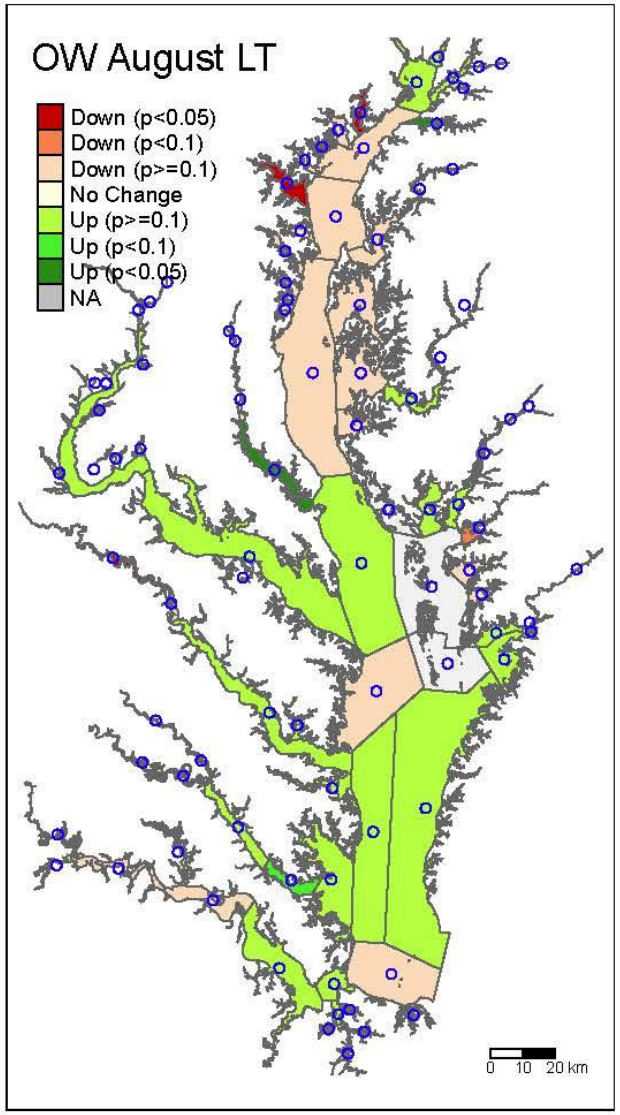


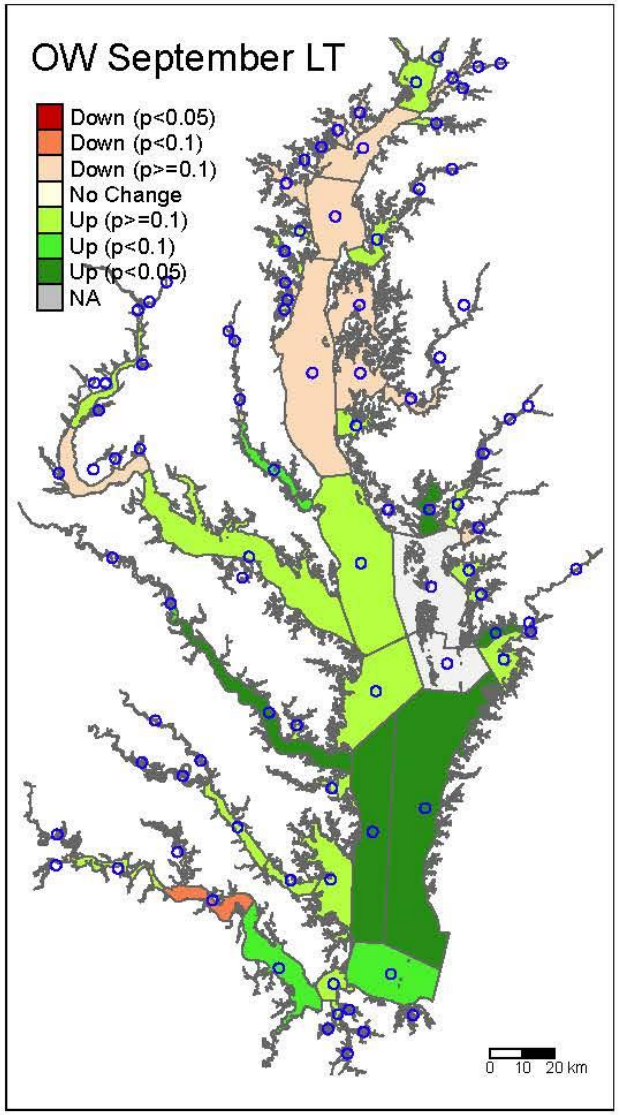
Preliminary results, subject to change.

OW AUC Long-term Trend (1985-2017)









Preliminary results, subject to change.

Summary on attainment sensitivity analysis

- The proposed metrics for attainment sensitivity (AS) help:
  - Expand from the specific thresholds (as in previous attainment indicator or attainment deficit analysis)
  - Describe the status of segments in a more comprehensive way:
    - ❑The segments' deficit (if not attaining)
    - ❑The segments' resilience ("buffer") (if attaining)
  - Quantify segments' evolution over seasons or years
  - Make comparison among segments