Progress report on Phase 7 criteria assessment – Water clarity

Richard Tian and
modeling team

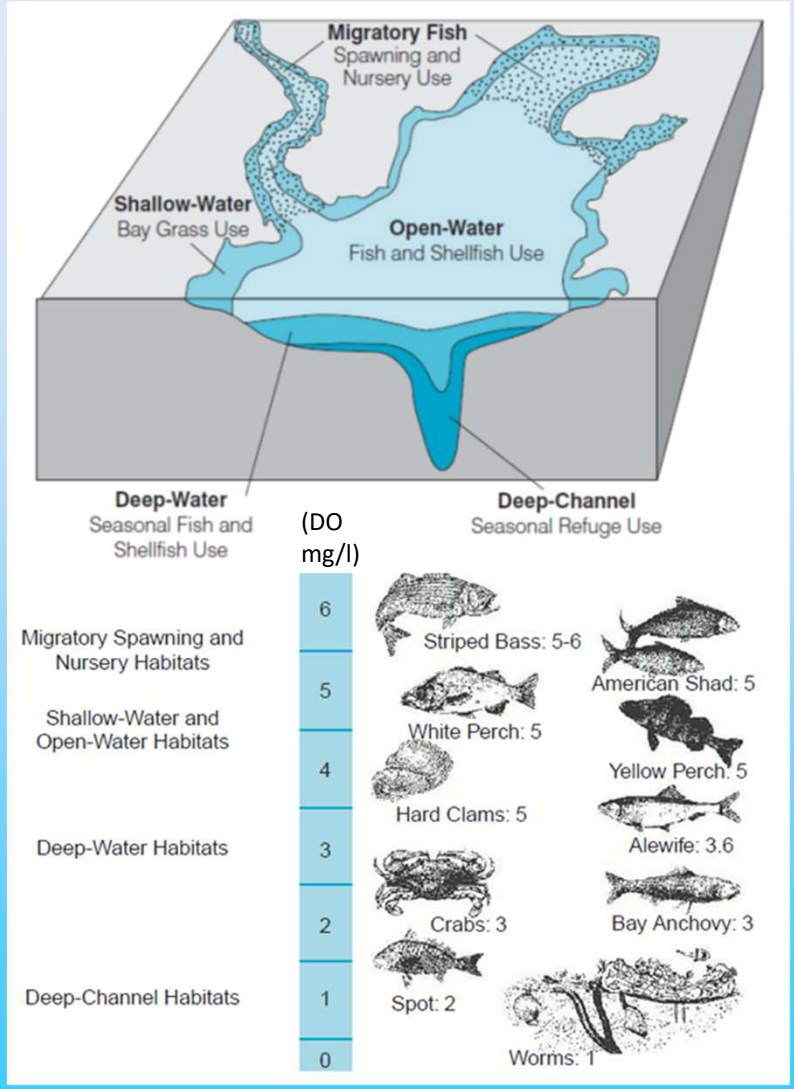
Modeling Quarterly Review Meeting

Annapolis, Oct. 09 2024

Designated Uses (DUs)

Six DUs:

- **DO DC: deep channel.**
- **DO DW: deep water.**
- **DO OW: open water.**
- **DO MSN: migratory fish spawning and nursery.**
- **Chlorophyll: James and Anacostia rivers.**
- **SAV and Water clarity: Shallow waters.**

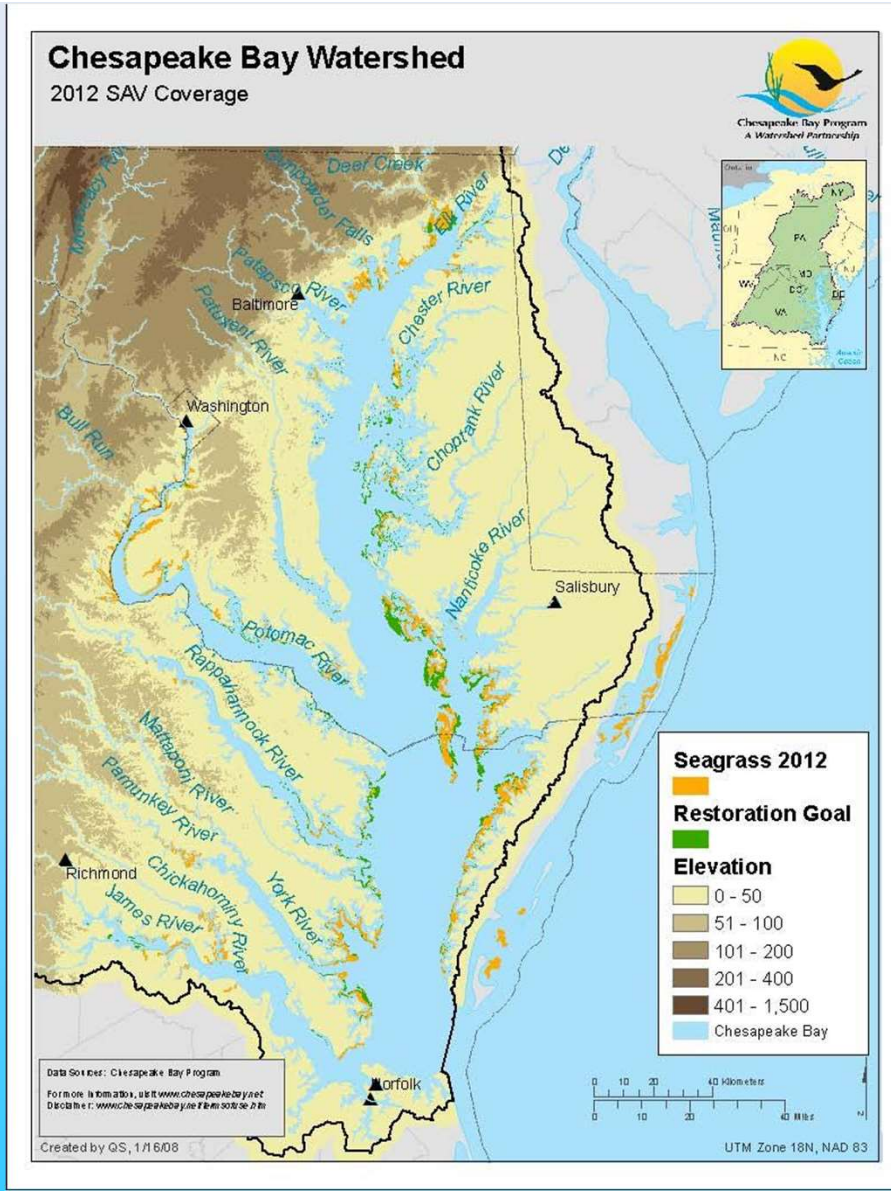


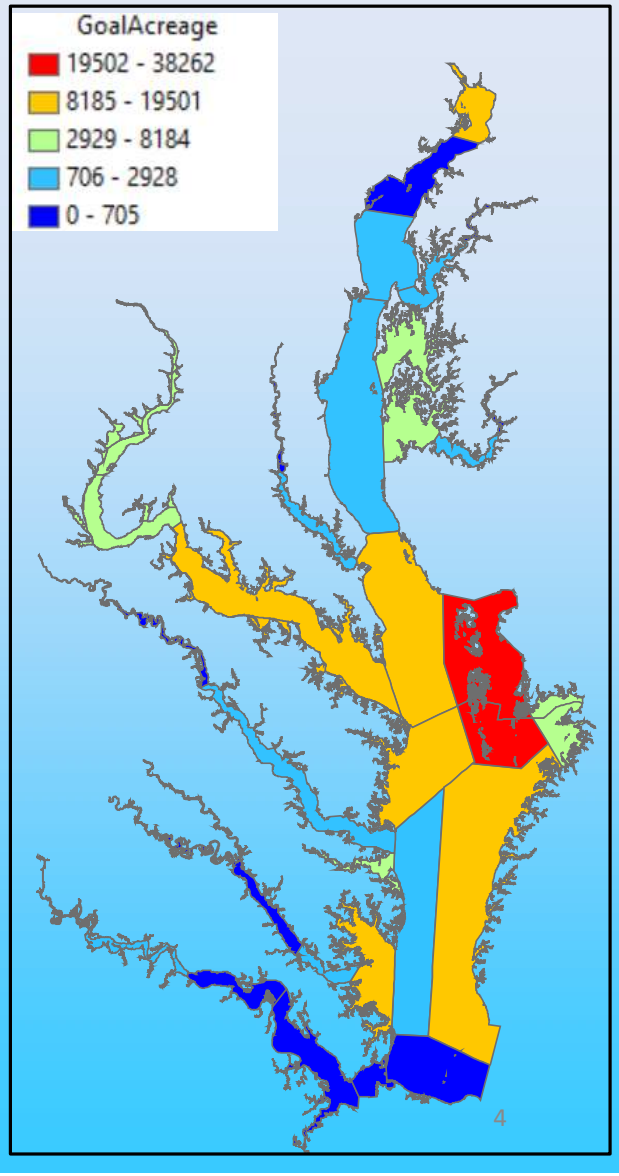
SAV restoration

- **Tier 1 restoration goal: Restored to the area where SAV has been observed (since 1971-)**
- **Tier 2 restoration goal: Restored to 1 m depth where SAV can potentially grow.**
- **Tier 3 restoration goal: Restored to 2 m depth where SAV can potentially grow.**

Tier 1 is in practice

SAV restoration goal





Assessment methods

- **Level 1 assessment: Largest SAV acreage of 3yr rolling period >= restoration goal acreage.**
- **Level 2 assessment: Largest attained water clarity acreage of 3yr rolling period >= 2.5 x restoration goal.**
- **Level 3 assessment: The sum of SAV and attained water clarity acreage >= 2.5 x restoration goal.**

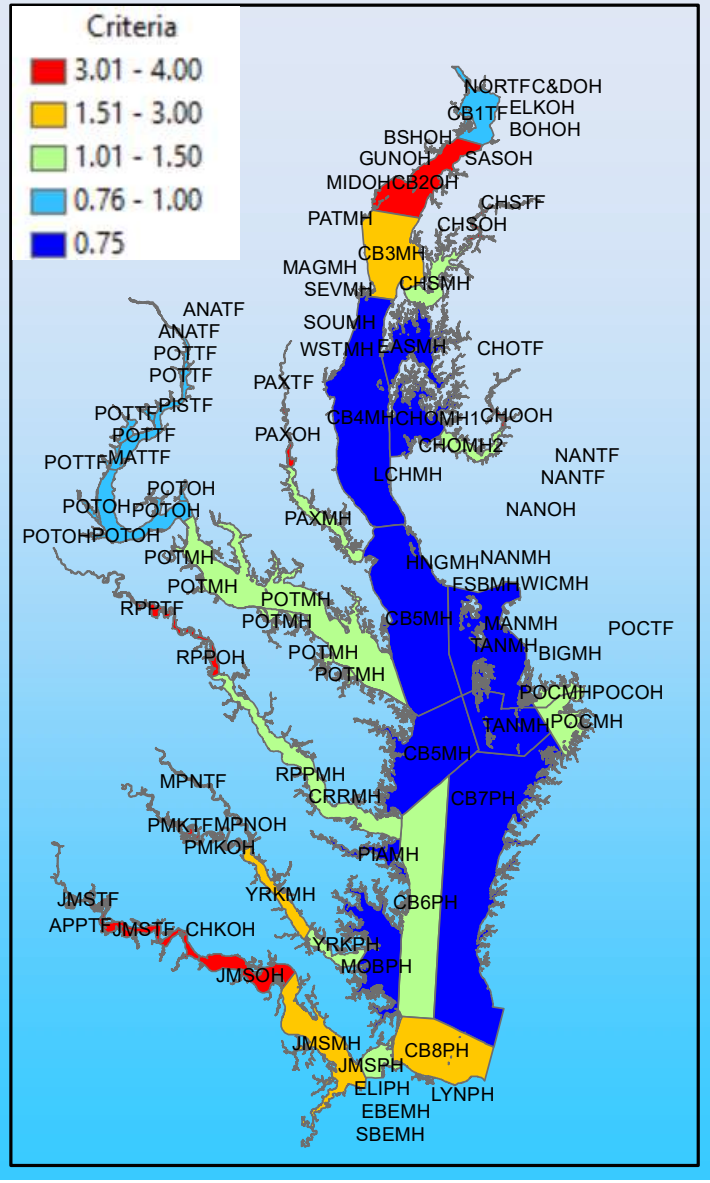
(Model application can only do level 2 assessment)

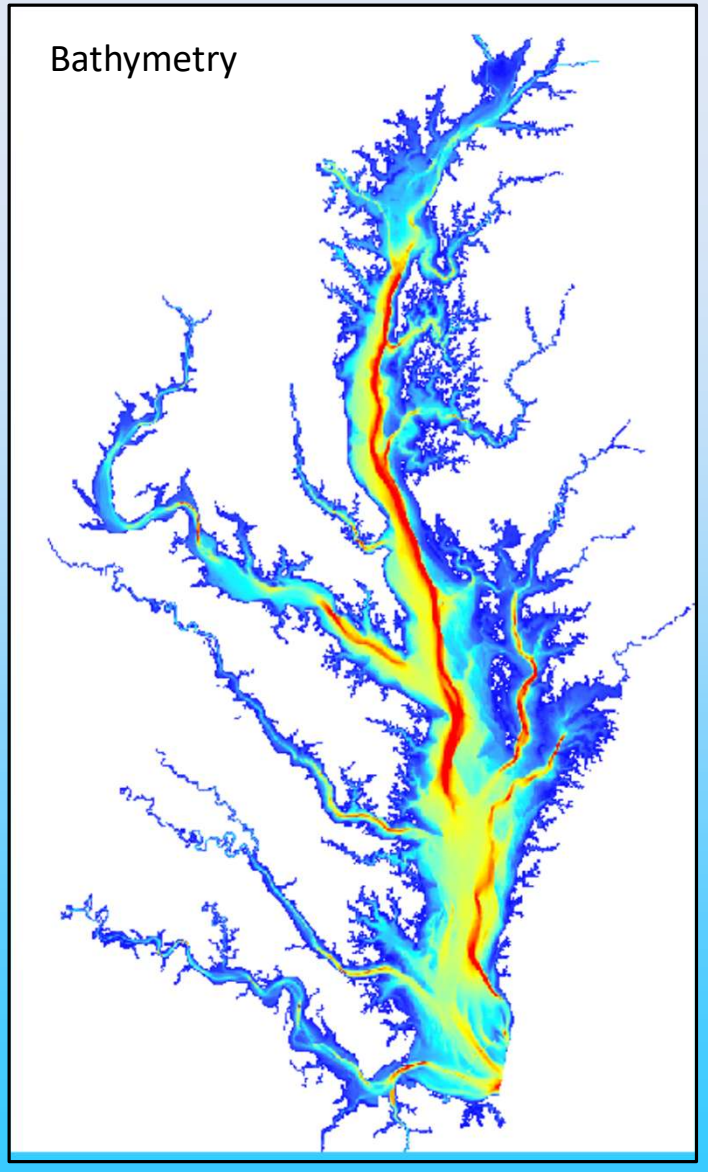
Examples of 3-levels assessment

CBPSEG	Growning Season Year	TOTAL	SAV Goal*	WCA Goal*	CUSAV	WCA	NSWCA	Level_1?	Level_2?	Level_3?
pmktf	2003	2522	187	468	214	337	310	yes	no	yes
pmktf	2004	2522	187	468	328	408	372	yes	no	yes
pmktf	2005	2522	187	468	563	955	742	yes	yes	yes
yrkph	2008	7138	2793	6982	463	279	180	no	no	no

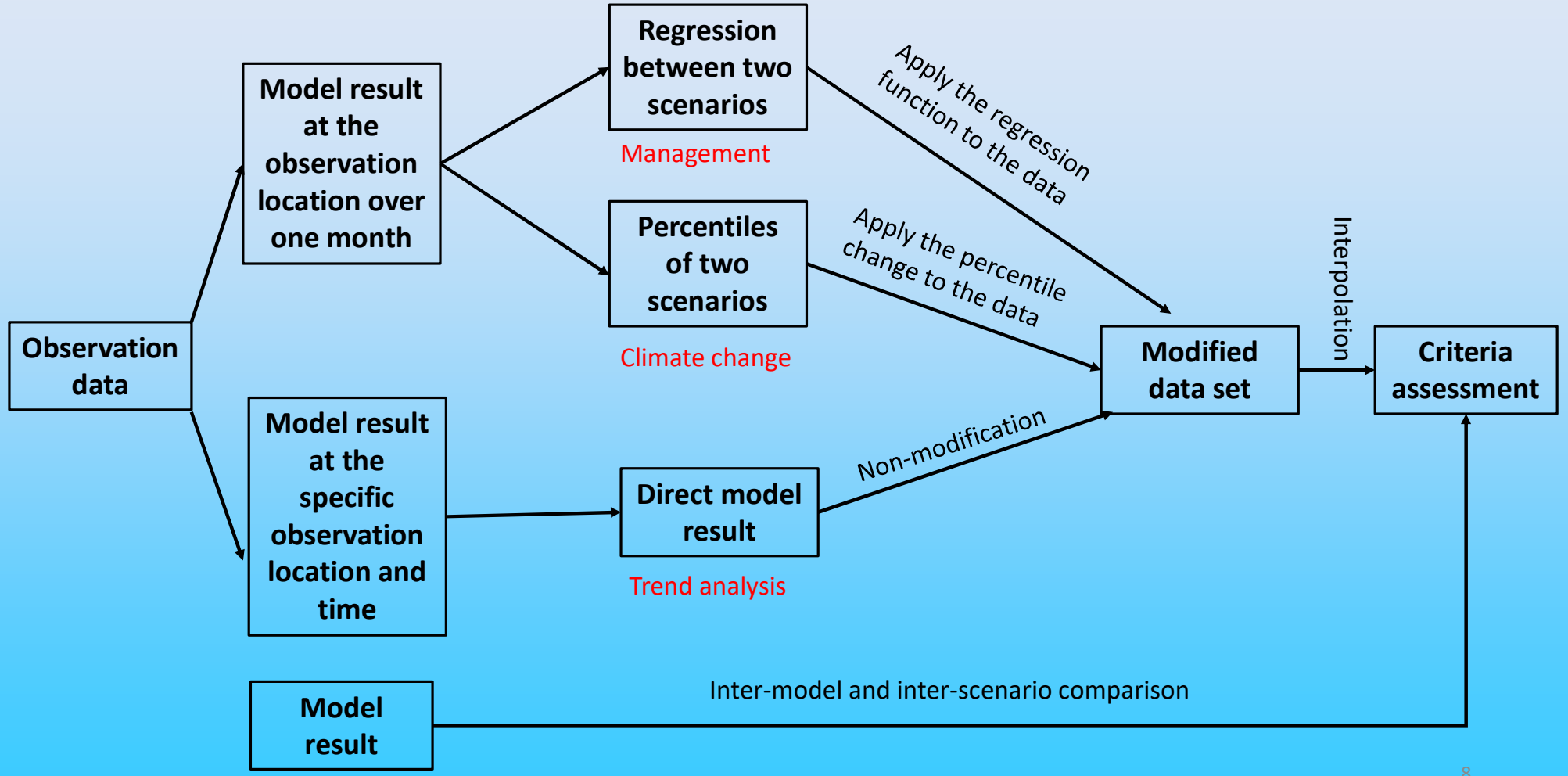
CBPSEG = Chesapeake Bay Program Segment
TOTAL = Total Acreage of available bottom (0-2m)
WCAG = Water Clarity Acreage Goal (0-2m)
WCA = Mean Annual Acreage Meeting Water Clarity Threshold (0-2m)
NSWCA = Mean Annual Acreage Outside of Current SAV Areas that Meet the Water Clarity Threshold (0-2m)
CUSAVa = Total SAV acreage as reported by Orth et al.
CUSAV = Current SAV acreage (0-2m) as used in Level 1 and Level 2 attainment analysis, whereas Orth et al. numbers are used to determine Level 1 Attainment
Lvl1_Attain: CUSAVa >= SAV Goal
Lvl2_Attain: WCA >= WCAG
Lvl3_Attain: CUSAV+NSWCA >= WCAG

Water clarity (Kd) criteria (m^{-1})





Methods to modify the data based on model scenarios



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SECCHI depth and Kd conversion

kd = 1.45 / secchi

TABLE III-5. Conversion of Secchi depth (SD) to K_d, Secchi depth equivalences, and percent light at the 1-meter depth for Secchi depths equal to 0.5, 1.0 or 2.0 meters.

Formula	Percent light at 1 meter			References	Source
	SD = 0.5 m	SD = 1.0 m	SD = 2 m		
$K_d = 1.45/SD$	5.5	23.5	48.4	Batiuk et al. 1992	
$K_d = 1.7/SD$	3.3	18.3	42.7	Poole and Atkins 1929	Geisen 1990, Duarte 1991a
$K_d = 1.44/SD$	5.6	23.7	48.7	Holmes 1970	Geisen 1990
$K_d = 1.25/SD$	8.2	28.7	53.5	Visser 1970	Geisen 1990
$K_d = (2.6/(SD+2.5))-0.0480$	44.1	49.9	58.9	Weinberg 1976	Geisen 1990
$K_d = 1.052 * SD^{-0.536}$	21.8	34.9	48.4	Pellikaan 1976	Geisen 1990
$K_d = 1.47/SD$	5.3	23.0	48.0	Duarte and Kalff 1987	
$K_d = 1.46/SD$	5.4	23.0	48.0	Chambers and Kalff 1985	
$K_d = 2.02/SD$	1.8	13.3	36.4	Middleboe and Markager 1997	
SD = 15% subsurface intensity *Implies $K_d = 1.90/SD$	2.2	15	38.7	Vollenweider 1971	Vincente and Rivera 1982
SD = 18-24% subsurface intensity *Implies $K_d = 1.71/SD$ to 1.43/SD	3.3 to 5.7	18.1 to 23.9	42.5 to 48.9	Backman and Barilotti 1976	Vincente and Rivera 1982
SD assumed = 10% light level *Implies $K_d = 2.30/SD$	1.0	10.0	31.7	Chambers and Kalff 1985	
SD = 22% surface irradiance *Implies $K_d = 1.51/SD$	4.9	22.1	47.0	Megard and Berman 1989	Dunton 1994

*Note: $K_d = \ln(I_o/I_{SD})/SD$

Water clarity assessment for model scenarios

Scenario	name	Calib	Phase7_wip	Phase6_wip
Nitrogen	loading	325TN	183TN	183TN
Phosphorous	loading	21.9TP	11.9TP	11.9TP
Start	End	1993_1995	1993_1995	1993_1995
Cbseg	State	WC_S_pol	WC_S_pol	WC_S_pol
CB6PH	VA	0.00%	0.00%	0.00%
CB7PH	VA	56.82%	37.84%	45.04%
CB8PH	VA	0.00%	0.00%	0.00%
JMSPH	VA	0.00%	0.00%	0.00%
MOBPH	VA	97.59%	72.63%	97.34%
YRKPH	VA	23.03%	23.03%	23.03%

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CB1TF	MD	100.00%	100.00%	100.00%
CB2OH	MD	0.00%	0.00%	0.00%
CB3MH	MD	0.00%	0.00%	0.00%
CB4MH	MD	100.00%	100.00%	100.00%
CB5MH	MD	100.00%	95.03%	82.60%
CHOMH1	MD	100.00%	100.00%	100.00%
CHOMH2	MD	71.04%	0.00%	78.66%
CHOOH	MD	0.00%	0.00%	0.00%
CHSTF	MD	100.00%	0.00%	100.00%
CHSOH	MD	91.98%	0.00%	0.00%
CHSMH	MD	0.00%	0.00%	0.00%
EASMH	MD	100.00%	100.00%	100.00%
JMSMH	MD	0.00%	0.00%	0.00%
JMSOH	MD	0.00%	0.00%	0.00%
JMSTF	MD	0.00%	0.00%	0.00%
JMSTFL	MD	0.00%	0.00%	0.00%
JMSTFU	MD	0.00%	0.00%	0.00%
MPNOH	MD	0.00%	0.00%	0.00%
MPNTF	MD	0.00%	0.00%	0.00%
PAXMH	MD	36.48%	1.70%	7.75%
PAXOH	MD	0.00%	0.00%	0.00%
PAXTF	MD	39.61%	39.61%	39.61%
PIAMH	MD	100.00%	100.00%	100.00%
PMKOH	MD	0.00%	0.00%	0.00%
PMKTF	MD	0.00%	0.00%	0.00%
POCMH	MD	71.01%	0.00%	94.00%
MPCMH	MD	100.00%	0.00%	100.00%
VPCMH	MD	64.75%	0.00%	92.71%
POTMH	MD	6.72%	0.00%	0.00%
POTOH	MD	100.00%	100.00%	100.00%
POTTF	MD	100.00%	98.39%	100.00%
RPPMH	MD	0.00%	0.00%	0.00%
RPPOH	MD	0.00%	0.00%	0.00%
RPPTF	MD	0.00%	0.00%	0.00%
TANMH	MD	100.00%	100.00%	97.93%
YRKMH	MD	0.00%	0.00%	0.00%
VA5MH	MD	100.00%	89.64%	77.99%
MD5MH	MD	100.00%	100.00%	86.85%

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POTOH	MD	100.00%	100.00%	100.00%
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MD5MH	MD	100.00%	100.00%	86.85%

Certain segments have <=2m area smaller than the water clarity goal

Areas of Segments and Split Segments to 2 Meters in Depth and their Relationship to the Water Clarity Goal

CBPSEG	ACRES to 2m	GOAL ACRES	CBPSEG	ACRES to 2m	GOAL ACRES
ANATF -DC	273		MPNOH	554	0
ANATF -MD	54		MPNTF	1,409	213
APPTF	1,603	948	NANMH	7,712	8
BACOH	2,859	0	NANOH	2,053	30
BIGMH1	4,302	5,053	NANTF	0	0
BIGMH2	763	55	NORTF	2,742	223
BOHOH	1,904	885	PATMH	3,418	973
BSHOH	4,605	875	PAXMH1	5,497	3,648
C&DOH	171	18	PAXMH2	2,206	430
CB1TF1	3,088	1,885	PAXMH3	282	0
CB1TF2	17,820	30,373	PAXMH4	348	3
CB2OH	8,787	1,763	PAXMH5	378	5
CB3MH	4,671	3,425	PAXMH6	82	0
CB4MH	10,630	6,333	PAXOH	2,072	288
CB5MH - MD	15,586	20,675	PAXTF	54	513
CB5MH - VA	14,514	14,514	PIAMH	8,014	8,014
CB6PH	5,569	3,168	PISTF	914	1,973
CB7PH	34,085	34,085	PMKOH	806	0
CB8PH	1,050	28	PMKTF	2,652	468
CHKOH	4,501	1,338	POCMH - MD	5,049	2,193
CHOMH1	20,857	20,460	POCMH - VA	9,368	9,368
CHOMH2	6,833	4,053	POCOH	457	0
CHOOH	1,284	180	POCTF	0	0
CHSMH	11,500	7,320	POTMH - MD	32,323	17,720
CHSOH	2,308	193	POTMH - VA	13,481	10,625
CHSTF	870	0	POTOH1 -MD	6,576	3,468
CRRMH	2,611	1,920	POTOH2	1,079	655
EASMH	20,805	15,523	POTOH3	2,687	2,883
ELKOH1	3,648	4,610	POTOH - VA	4,851	3,758
ELKOH2	1,377	475	POTTF - DC	1,466	
FSBMH	13,643	493	POTTF - MD	5,958	5,355
GUNOH1	3,540	4,650	POTTF - VA	10,078	5,233
GUNOH2	3,819	1,430	RHDMH	710	150
HNGMH	16,456	19,403	RPPMH	30,108	5,000
JMSMH	26,598	500	RPPOH	2,510	0
JMSOH	10,944	38	RPPTF	4,512	165
JMSPH	2,402	750	SASOH1	1,772	2,683
JMSTF1	9,947	2,500	SASOH2	1,938	238
JMSTF2	2,888	500	SEVMH	2,108	1,138
LCHMH	12,368	10,190	SOUMH	2,236	1,198
LYNPH	3,941	268	TANMH1 - MD	43,558	61,708
MAGMH	2,055	1,448	TANMH - VA	22,064	22,064
MANMH1	8,615	10,735	TANMH2	4,251	185
MANMH2	2,085	148	WICMH	5,911	8
MATTF	1,389	1,980	WSTMH	1,468	595
MIDOH	2,479	2,198	YRKMH	12,715	598
MOBPH	33,990	33,990	YRKPH	6,998	6,982

2m acreage less than WC goal
2m acreage equal to WC goal
WC goal unkown

Certain segments have <=2m area smaller than the water clarity goal

CBPSEG	ACRES to 2m
BIGMH1	4,302
CB1TF2	17,820
CB5MH - MD	15,586
CB5MH - VA	14,514
CB7PH	34,085
ELKOH1	3,648
GUNOH1	3,540
HNGMH	16,456
MANMH1	8,615
MATTF	1,389
MOBPH	33,990
PAXTF	54
PIAMH	8,014
PISTF	914
POCMH - VA	9,368
POTOH3	2,687
SASOH1	1,772
TANMH1 - MD	43,558
TANMH - VA	22,064

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Message

- **Model scenarios can provide Level 2 water clarity assessment based on the delta approach**
- **Should the water clarity goal be reduced to the maximum available area?**