Evaluating impact of climate change on regulatory nutrient reduction in Chesapeake Bay

I. Irby

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Ph.D. Committee - C. Friedrichs, R. Hood, R. Najjar, C. Hershner

January 2016

Motivation

- We have previously established a degree of confidence in the modeled projections of water quality as a result of regulatory nutrient reduction under current conditions.

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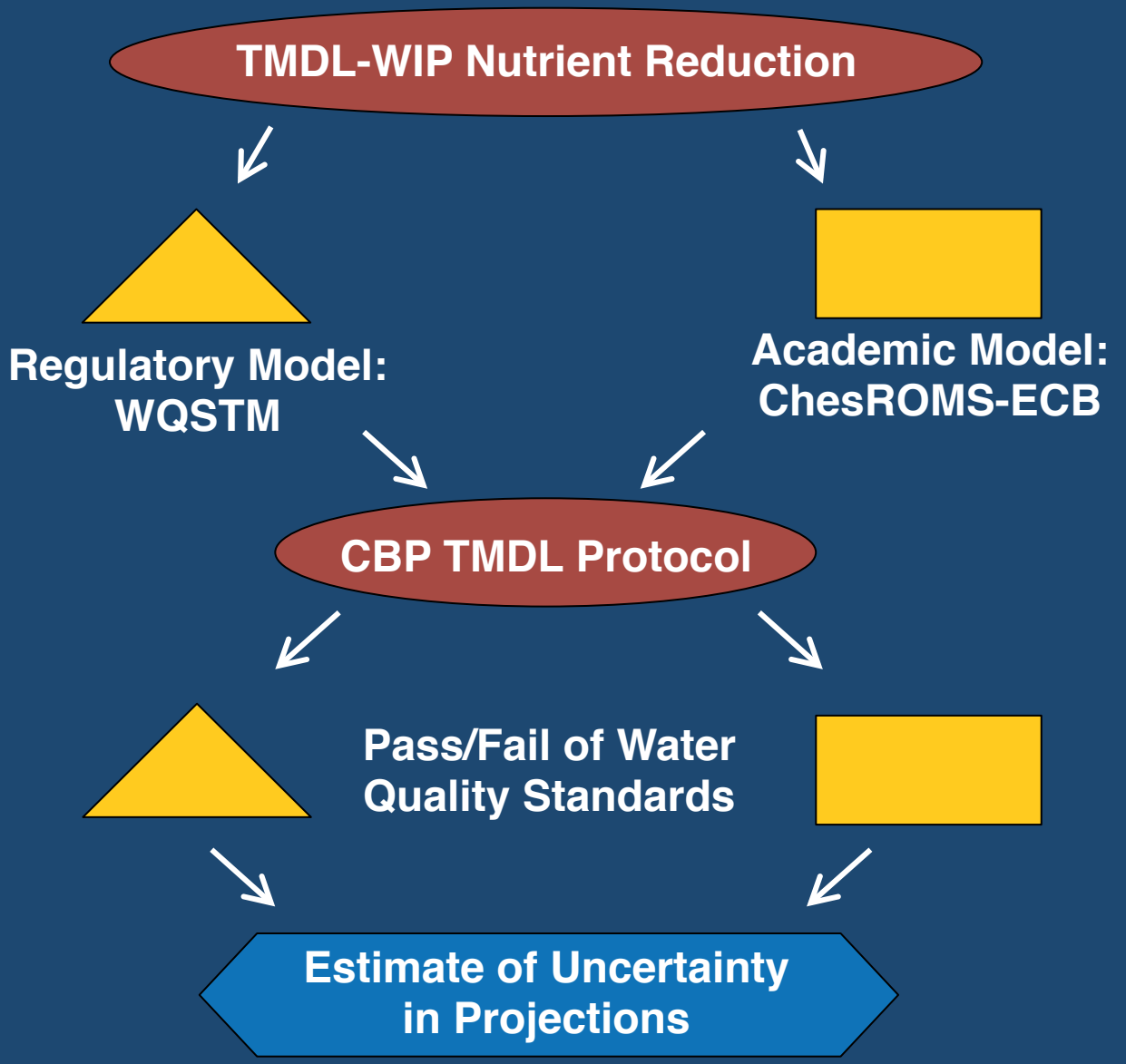
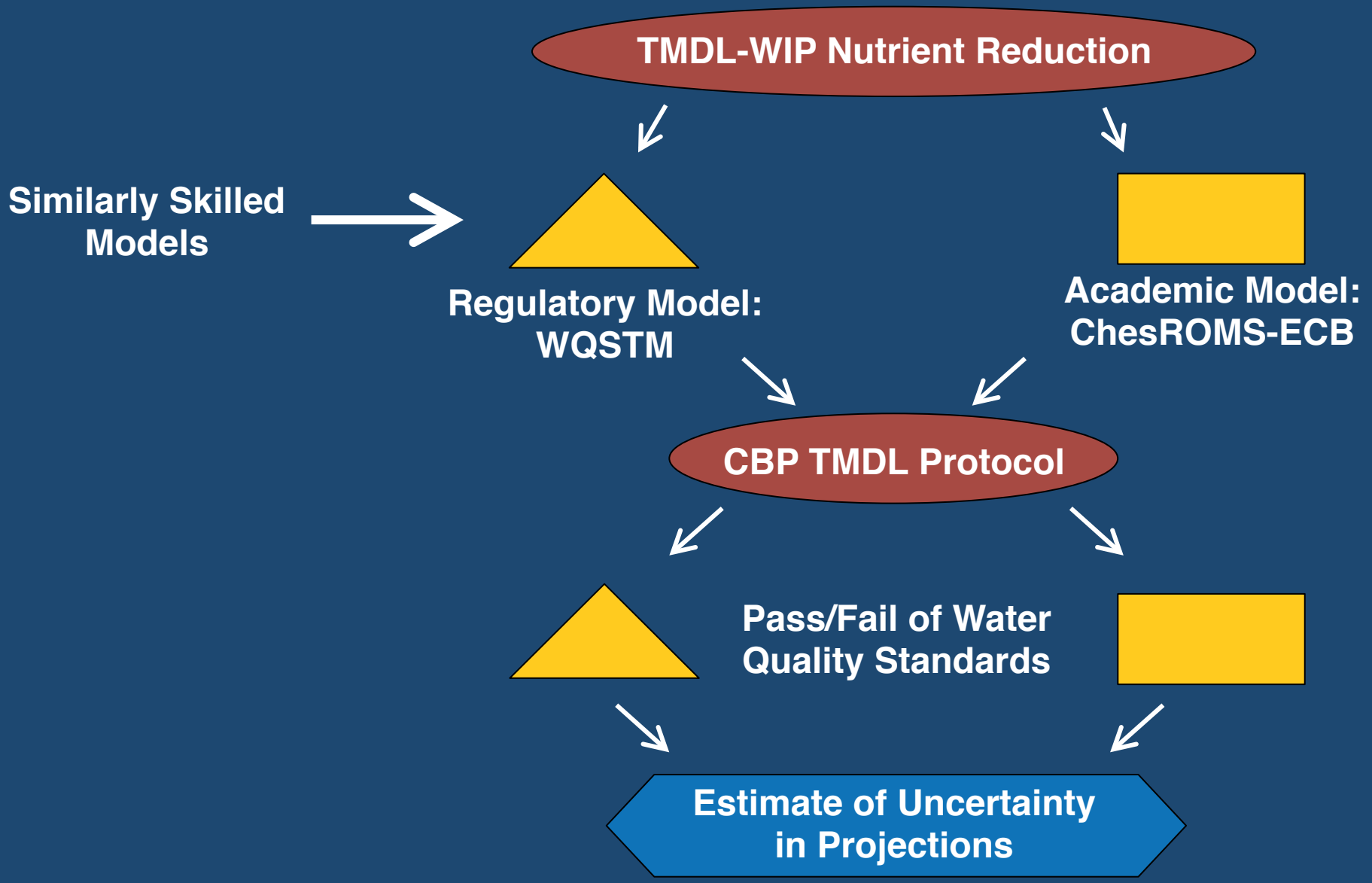
- How will changes in climate impact the success of those nutrient reductions?

Methods


TMDL-WIP Nutrient Reduction
Regulatory Model:
WQSTM
Academic Model:
ChesROMS-ECB
CBP TMDL Protocol
Pass/Fail of Water
Quality Standards
Estimate of Uncertainty
in Projections

Methods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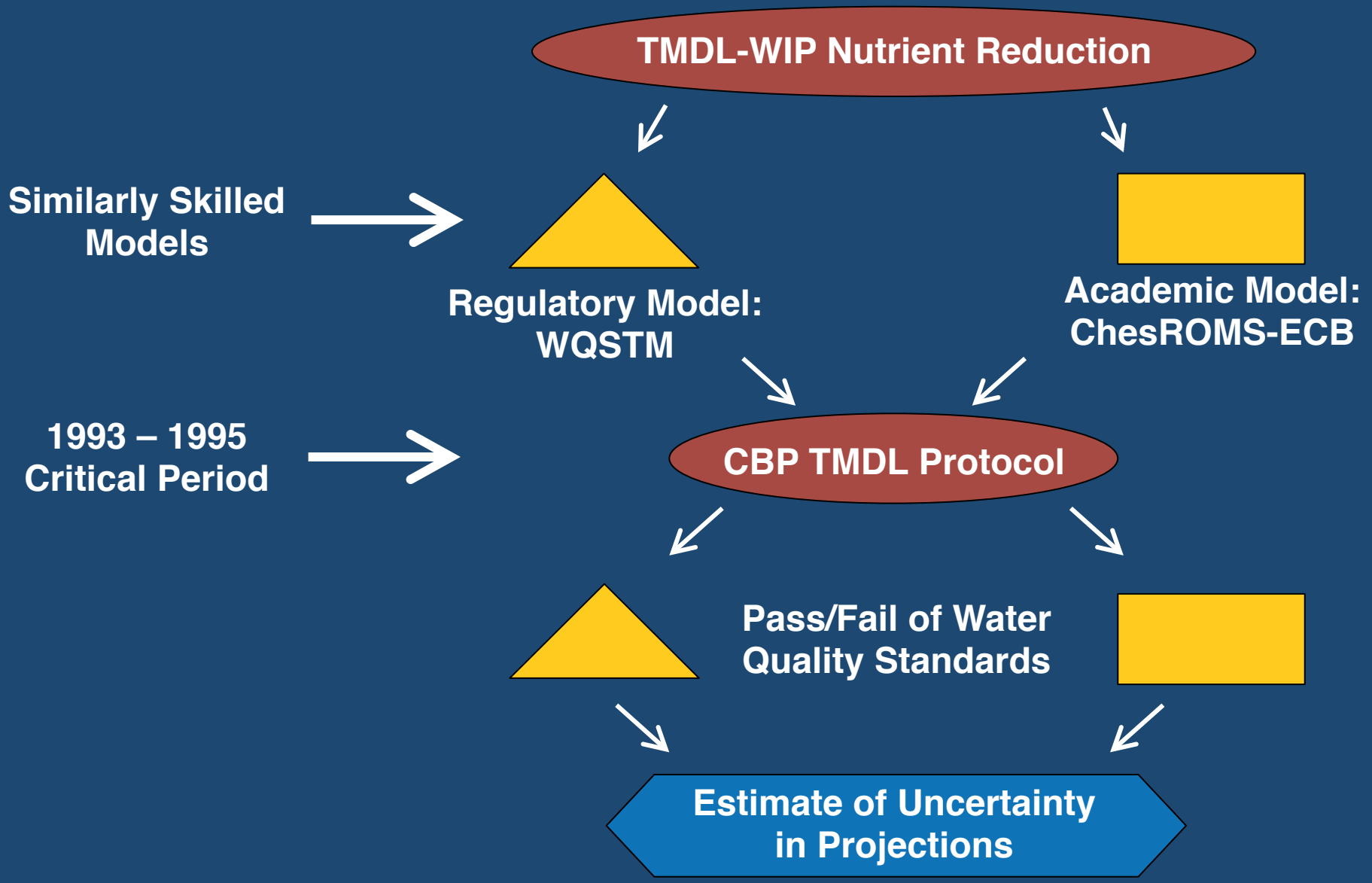
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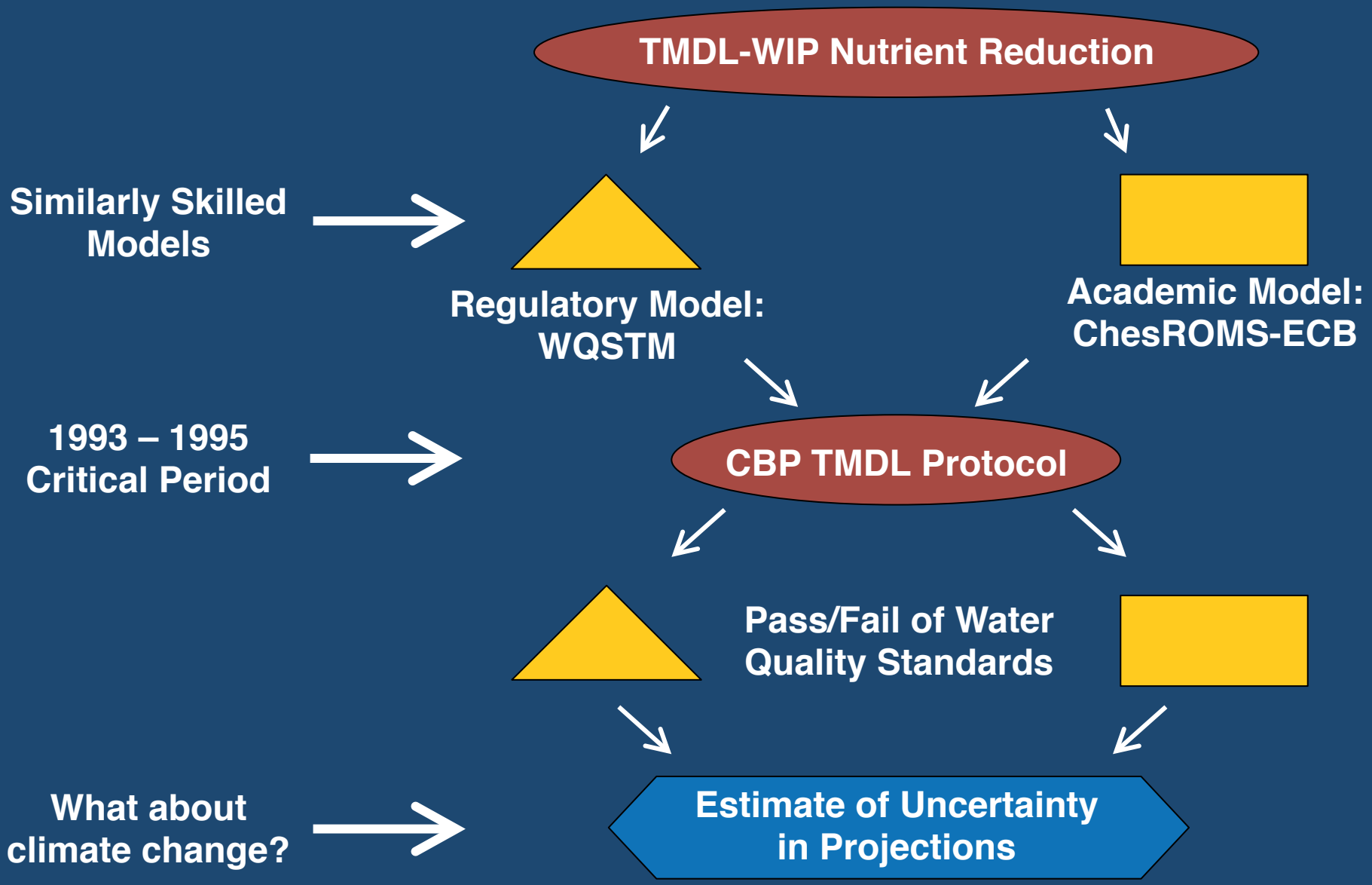
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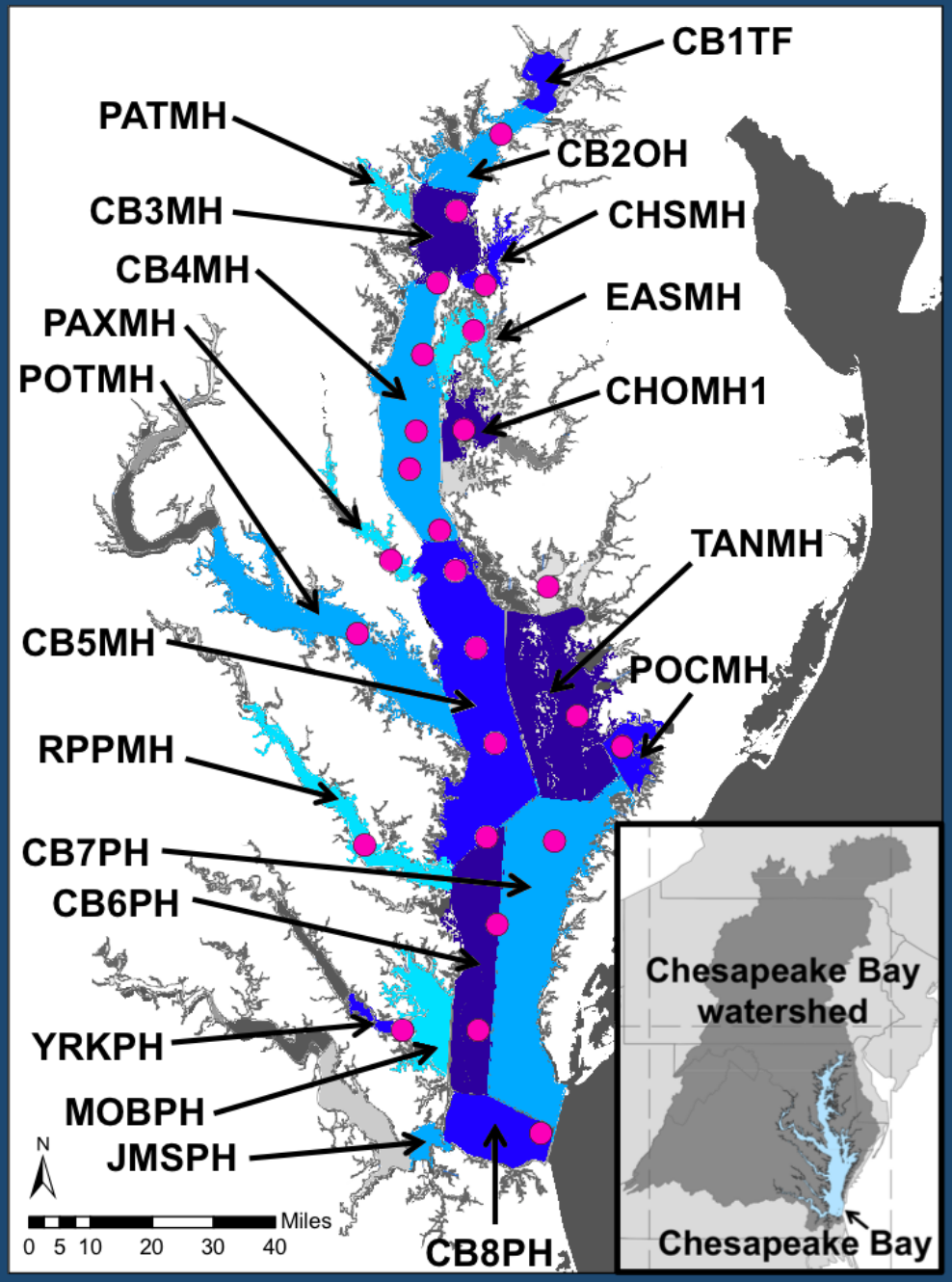
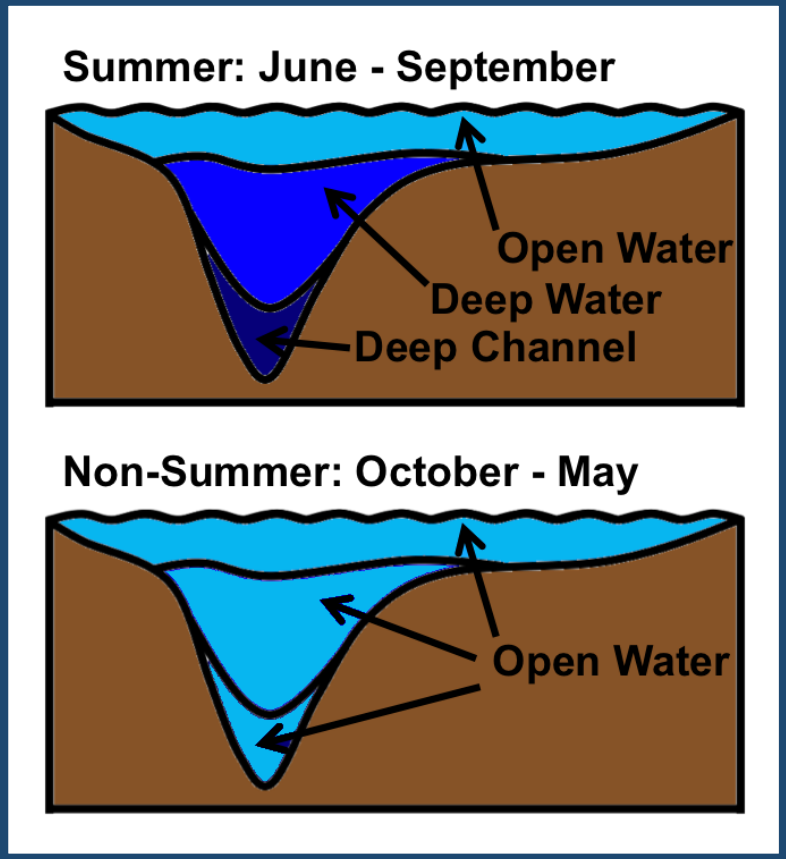
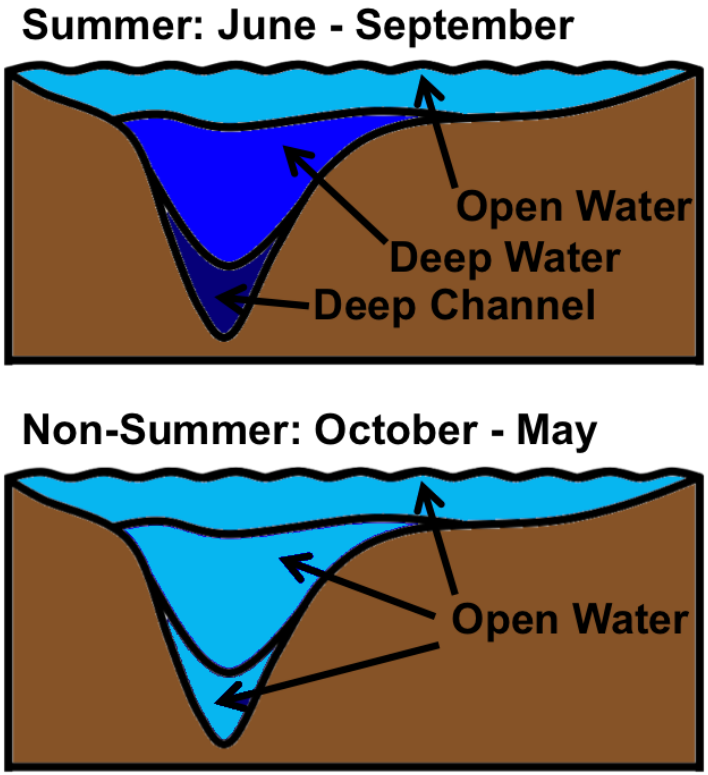
What about climate change?
Estimate of Uncertainty in Projections


CB1TF
PATMH
CB2OH
CB3MH
CHSMH
CB4MH
EASMH
PAXMH
POTMH
CHOMH1
TANMH
CB5MH
POCMH
RPPMH
CB7PH
CB6PH
YRKPH
MOBPH
JMSPH
CB8PH
N
Miles
0 5 10 20 30 40
Chesapeake Bay watershed
Chesapeake Bay



CBP Habitats examined (Designated Uses)



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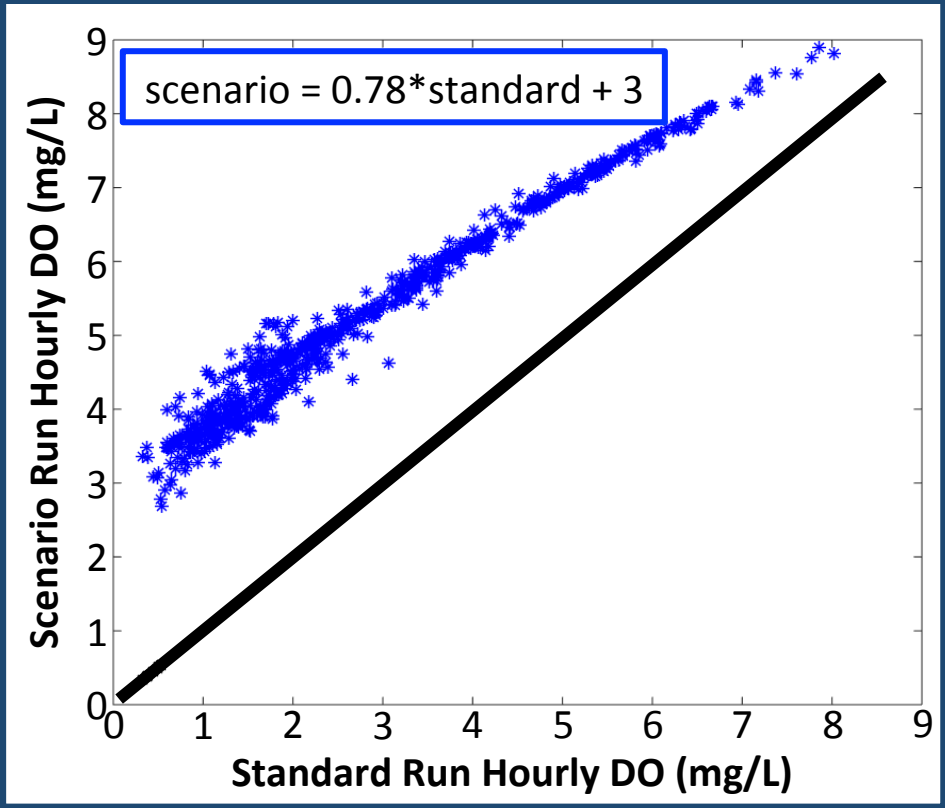
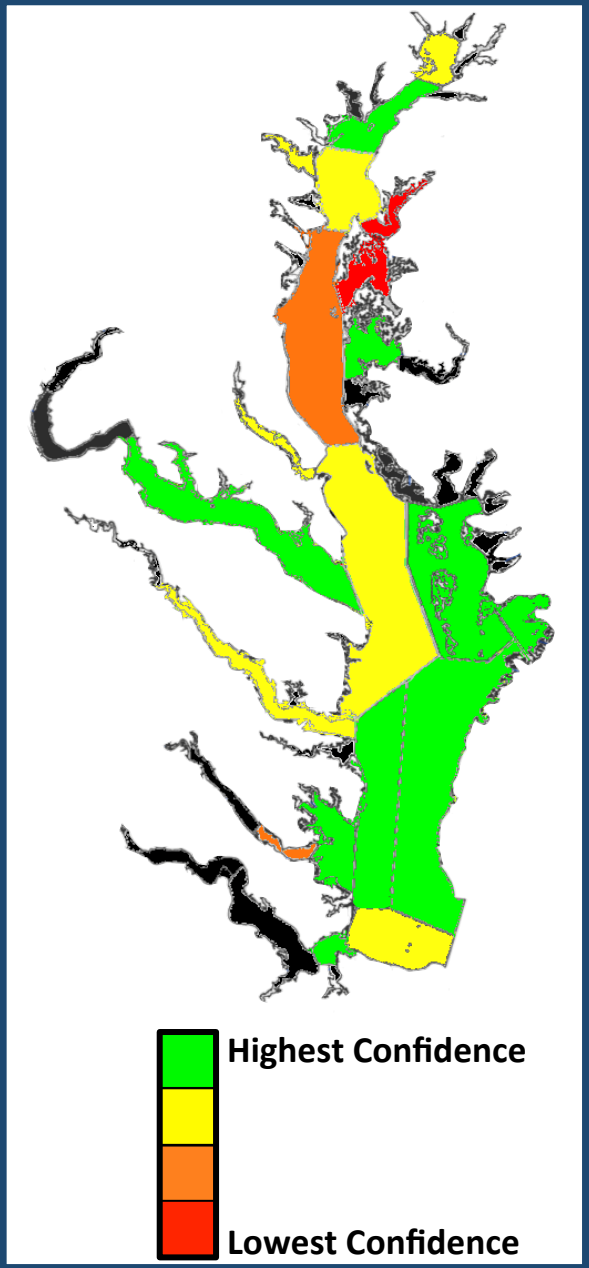
CBP Regression method



Confidence Index

Segment	Designated Use	Critical Period	Regression Statistics	Confidence Index
CB1TF	1	1	.55	.85
CB2OH	.93	1	.85	.95
PATMH	.80	.99	.69	.82
CB3MH	.83	.88	.87	.86
CHSMH	0	0	.62	0
CB4MH	.60	.86	.73	.69
EASMH	.70	.81	0	.39
CHOMH1	.93	.99	.73	.90
PAXMH	.78	.97	.90	.89
CB5MH	.73	.97	.89	.87
TANMH	.93	1	.90	.98
POTMH	.90	.97	.84	.92
POCMH	1	1	.86	.99
RPPMH	.87	.96	.80	.89
CB6PH	.87	.98	.83	.91
CB7PH	.87	.99	.79	.90
YRKPH	.78	.51	1	.74
MOBPH	.93	1	.95	1
JMSPH	1	1	.85	.98
CB8PH	.93	1	.65	.87



2050 Climate Change

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Academic Model

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- Fresh water flow

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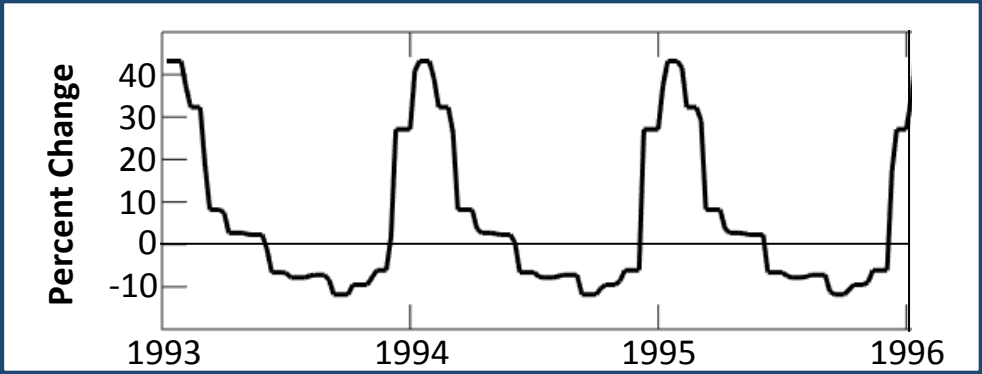

2050 Climate Change

Academic Model

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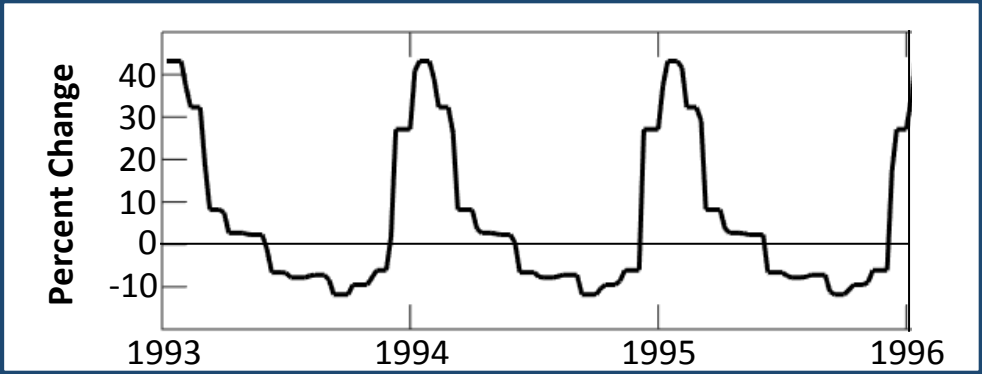

~10% annual increase

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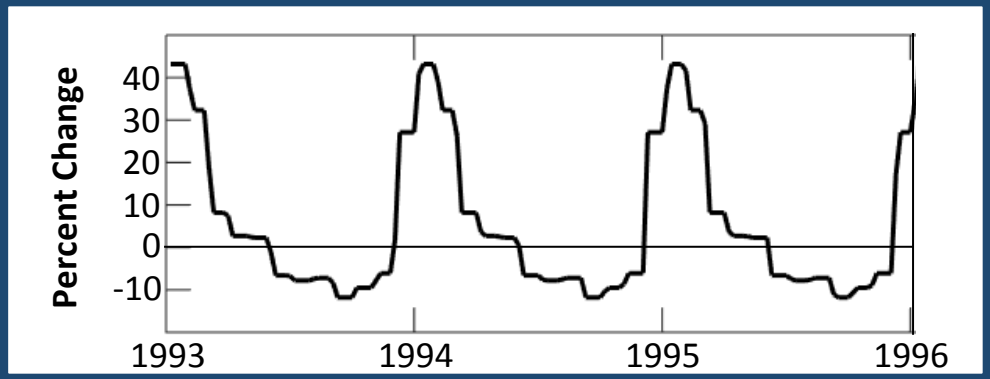

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- Temperature increase
  - 1.75°C flat increase across time and space

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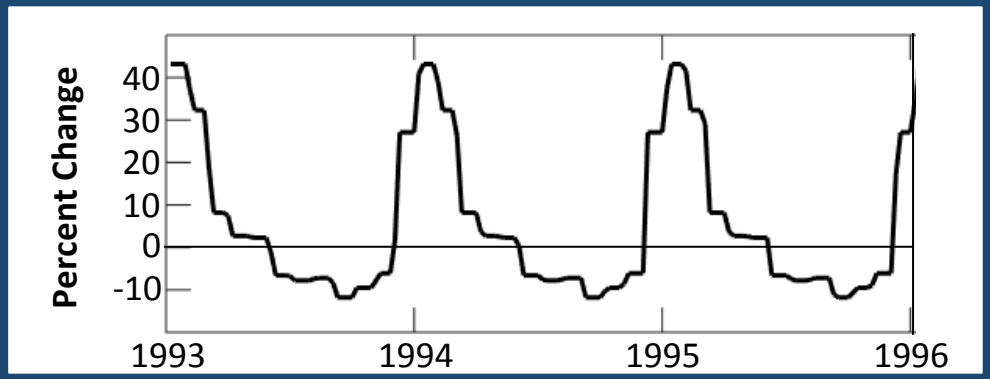
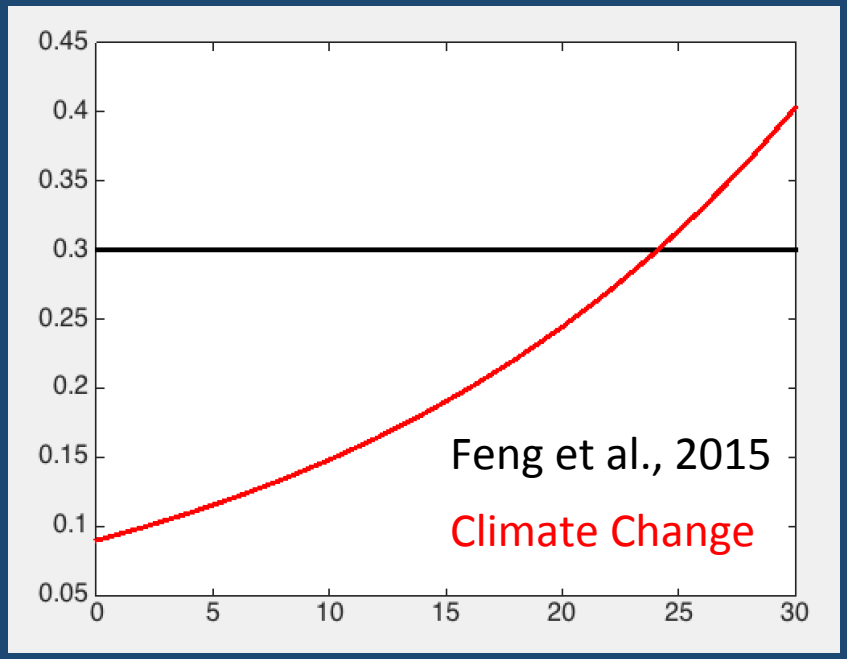


~10% annual increase

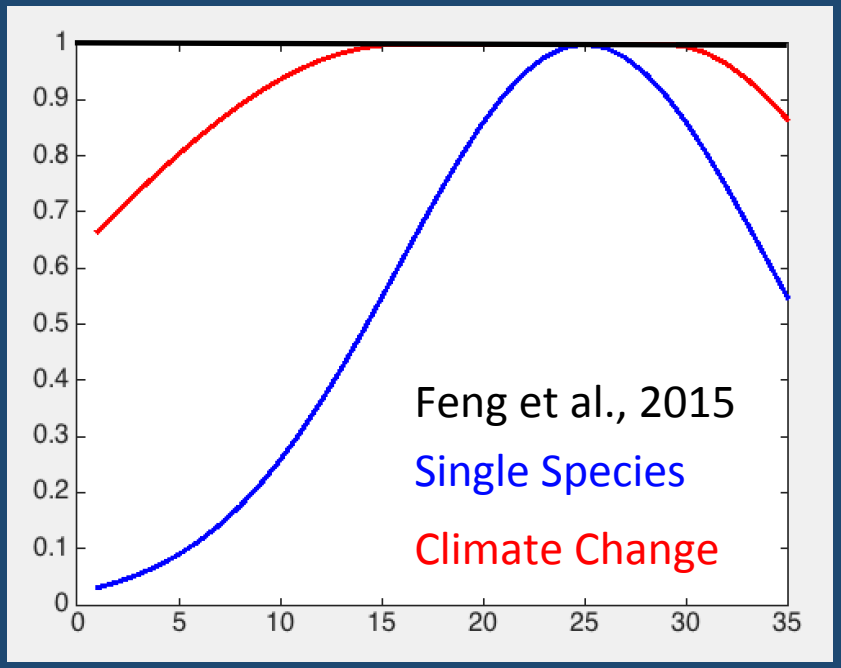
- Temperature increase
  - 1.75°C flat increase across time and space
  - Requires introducing temp-dependent controls on zooplankton grazing and phytoplankton growth

2050 Climate Change

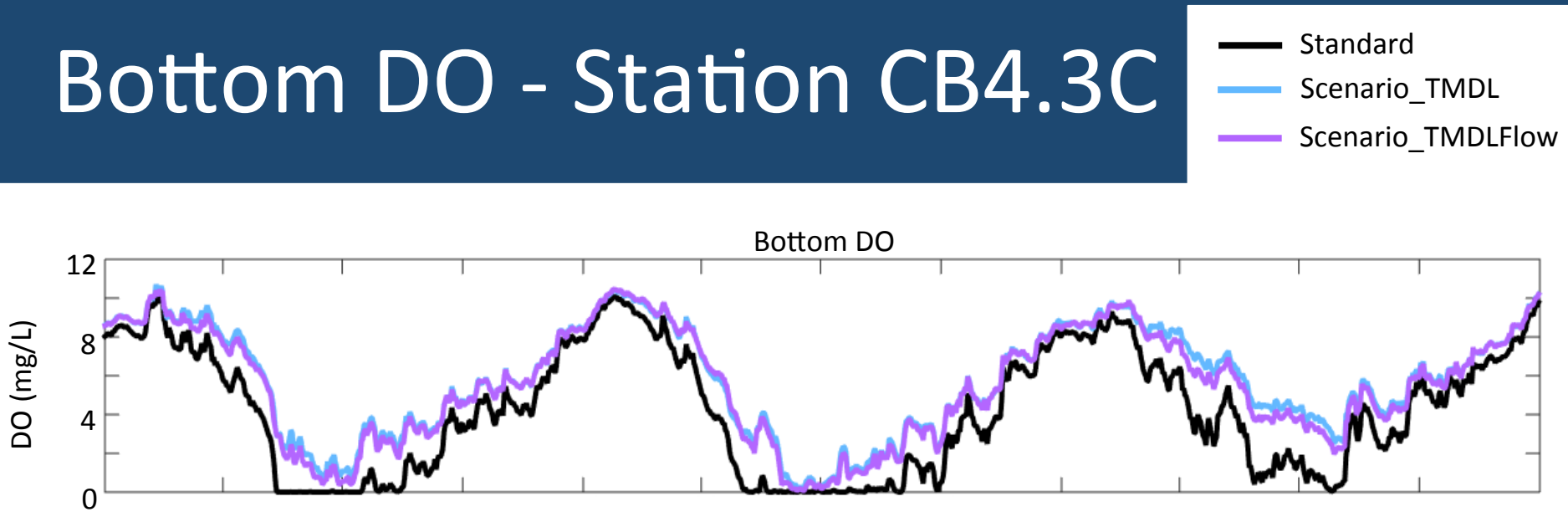
Zooplankton Max Grazing Rate



Phytoplankton Growth Rate



Bottom DO - Station CB4.3C



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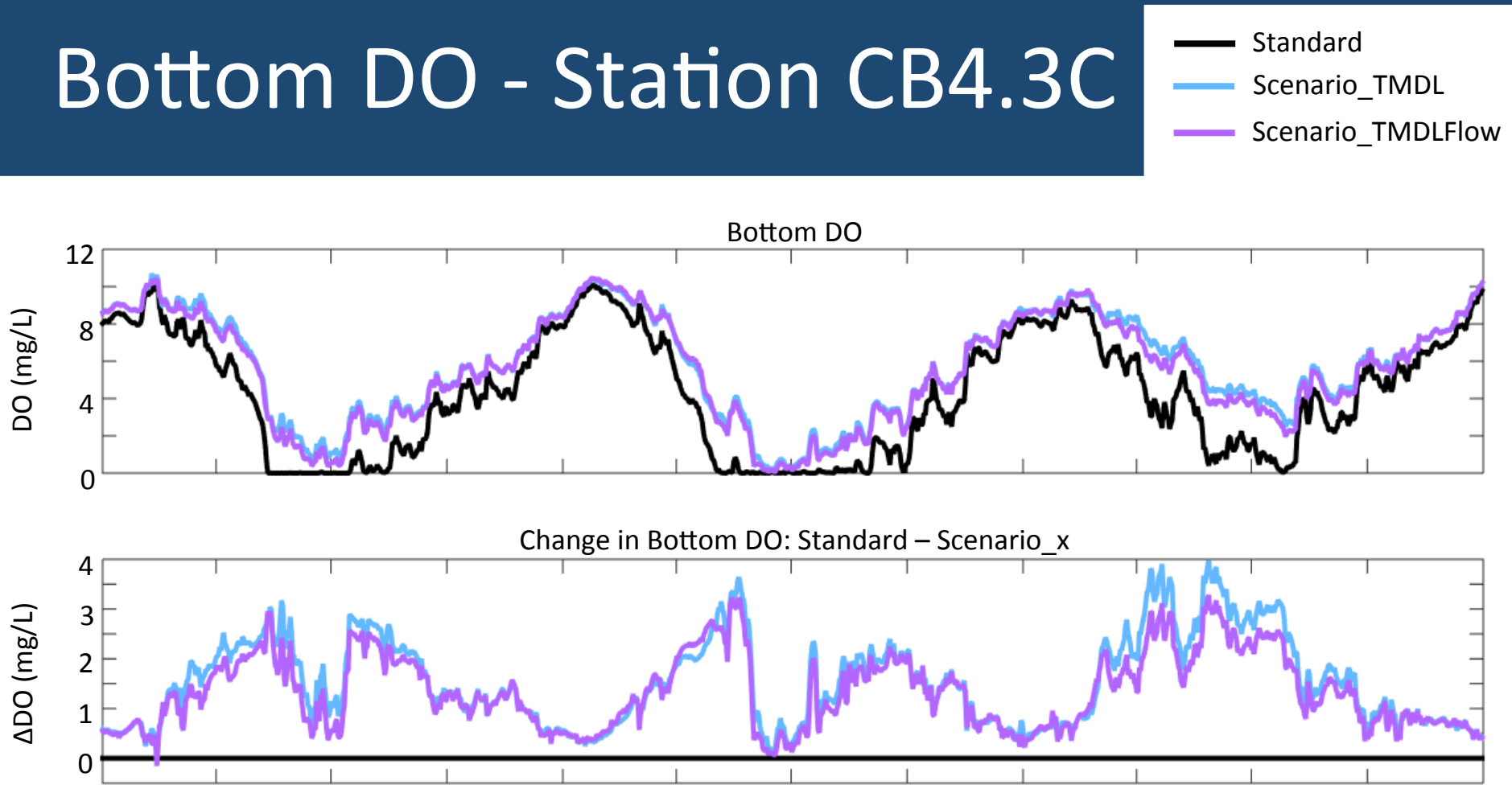

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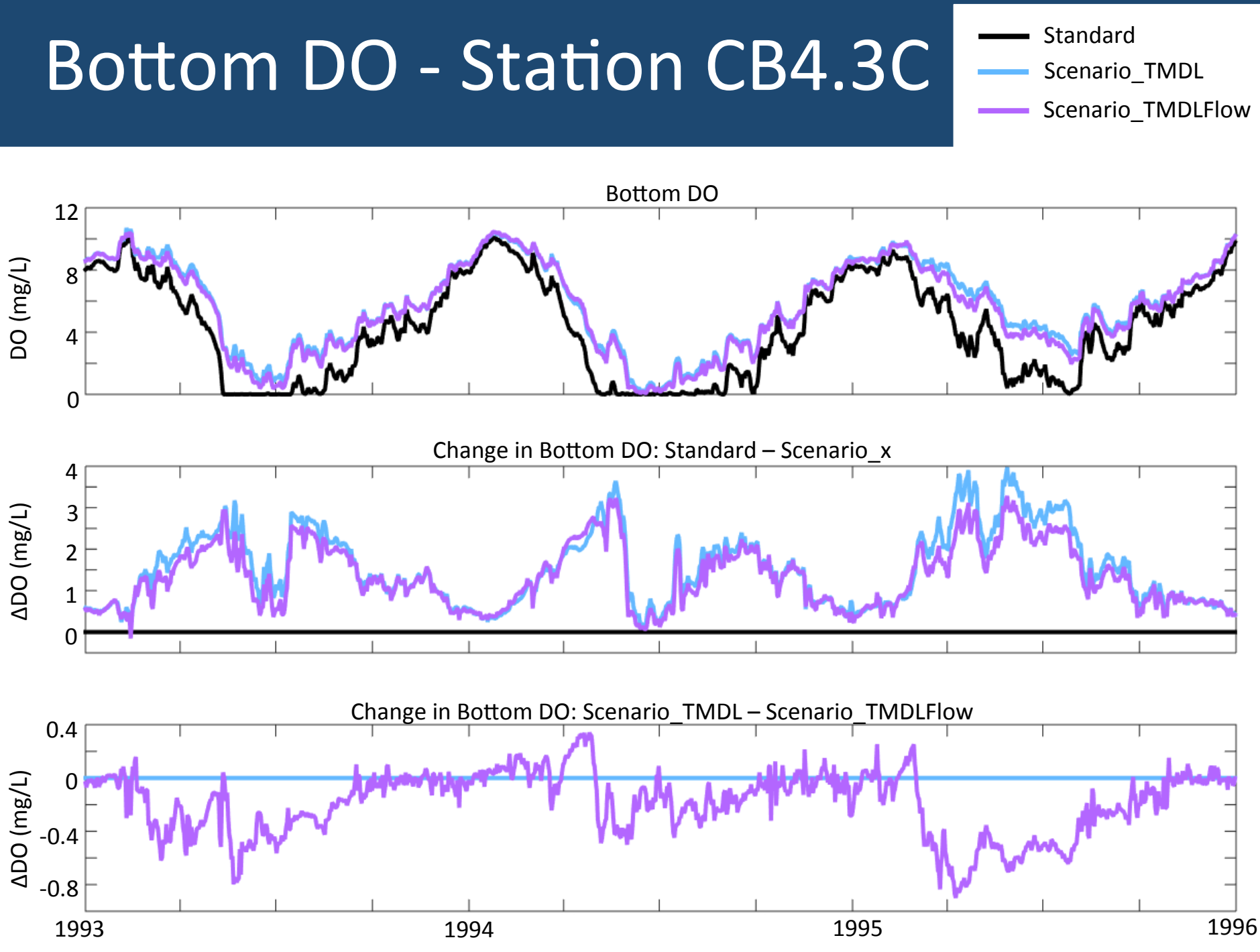

Impact on % not meeting Water Quality Standards

	Deep Channel			Deep Water		
	TMDL	FLOW	Δ	TMDL	FLOW	Δ
PATMH	0	0	0	0	0	0
CB3MH	2	2	0	0	0	0
CHSMH	0	0	0	0	0	0
CB4MH	0	1	+1	1	3	+2
EASMH	0	0	0	0	1	+1
PAXMH				0	0	0
CB5MH	0	0	0	0	0	0
POTMH	0	0	0	0	0	0
RPPMH	0	0	0	0	1	+1
CB6PH				0	0	0
CB7PH				0	0	0
YRKPH				0	0	0

Initial Conclusions

- **While the impact of climate change on absolute DO concentrations may be small, the impact on attainment of water quality standards may be significant**

Thank You

- M. Friedrichs
- R. Tian & G. Shenk – Chesapeake Bay Program
- A. Ross & R. Najjar – Penn State
- VIMS BioCOM Lab