Nonattainment Diagnostics
Dissolved Oxygen
Open Water

WQGIT 17 May 2010

Analytical Diagnostics Team

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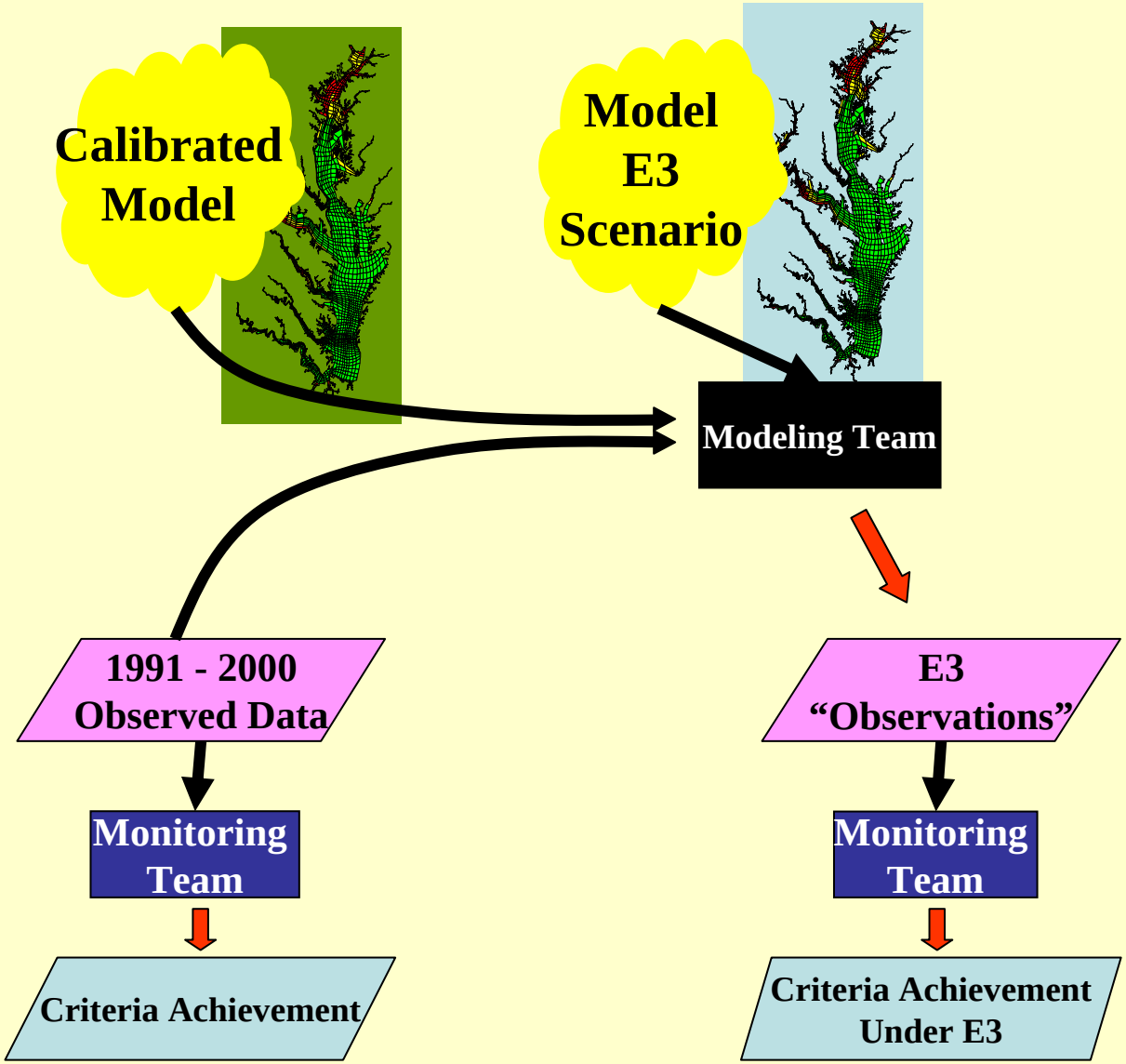
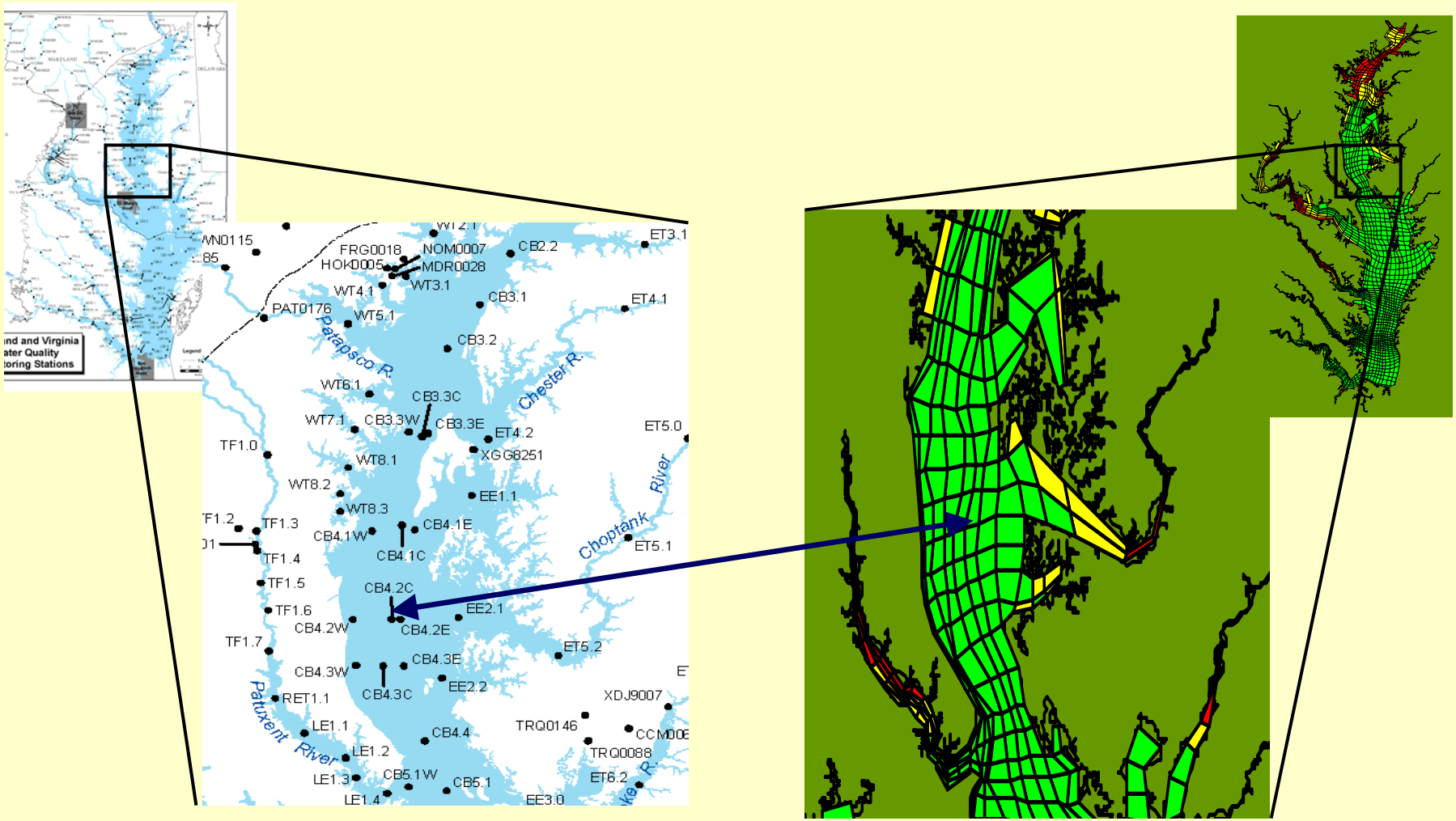
“Scenario’ing The Data”

1. Regress management scenario against calibration scenario
2. Use regression equation to “scenario” the historical data
3. Assess the scenario’d data



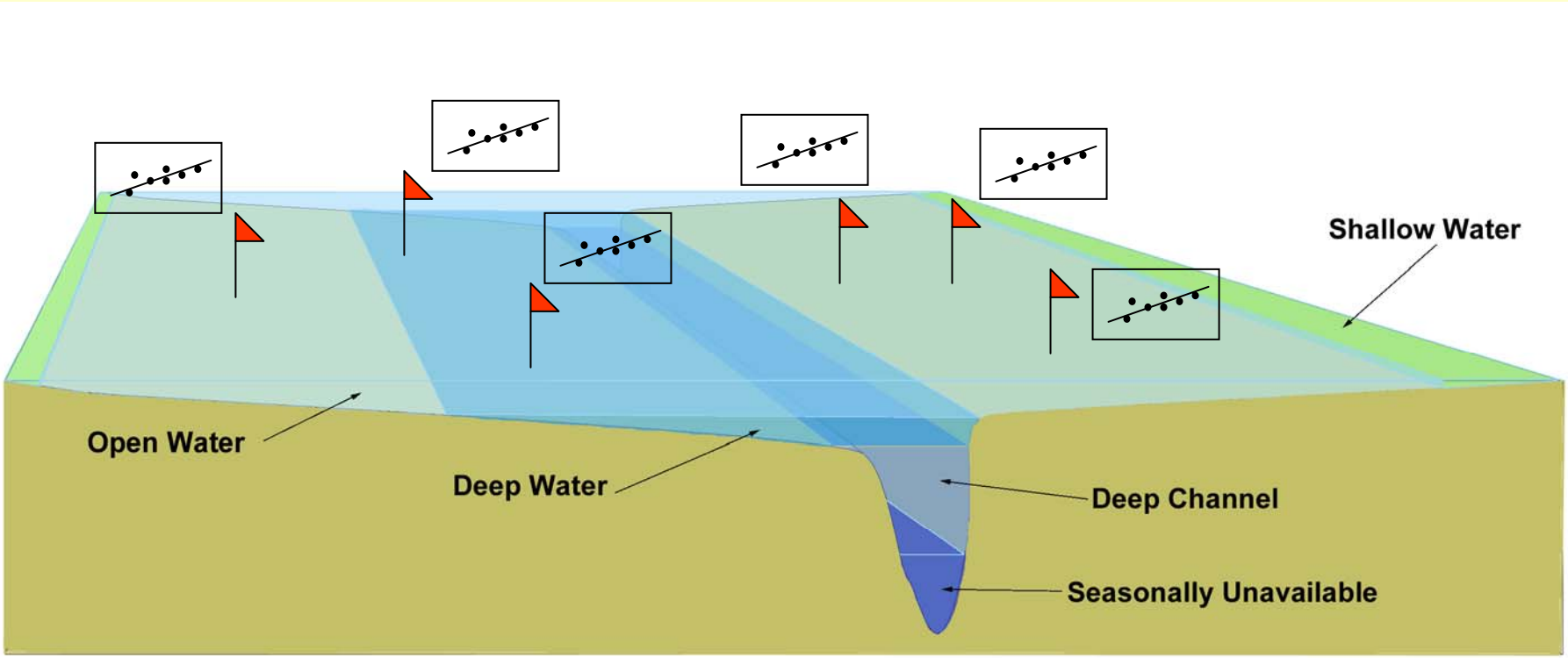
“Scenario’ing The Data”

monitoring stations mapped to model cells

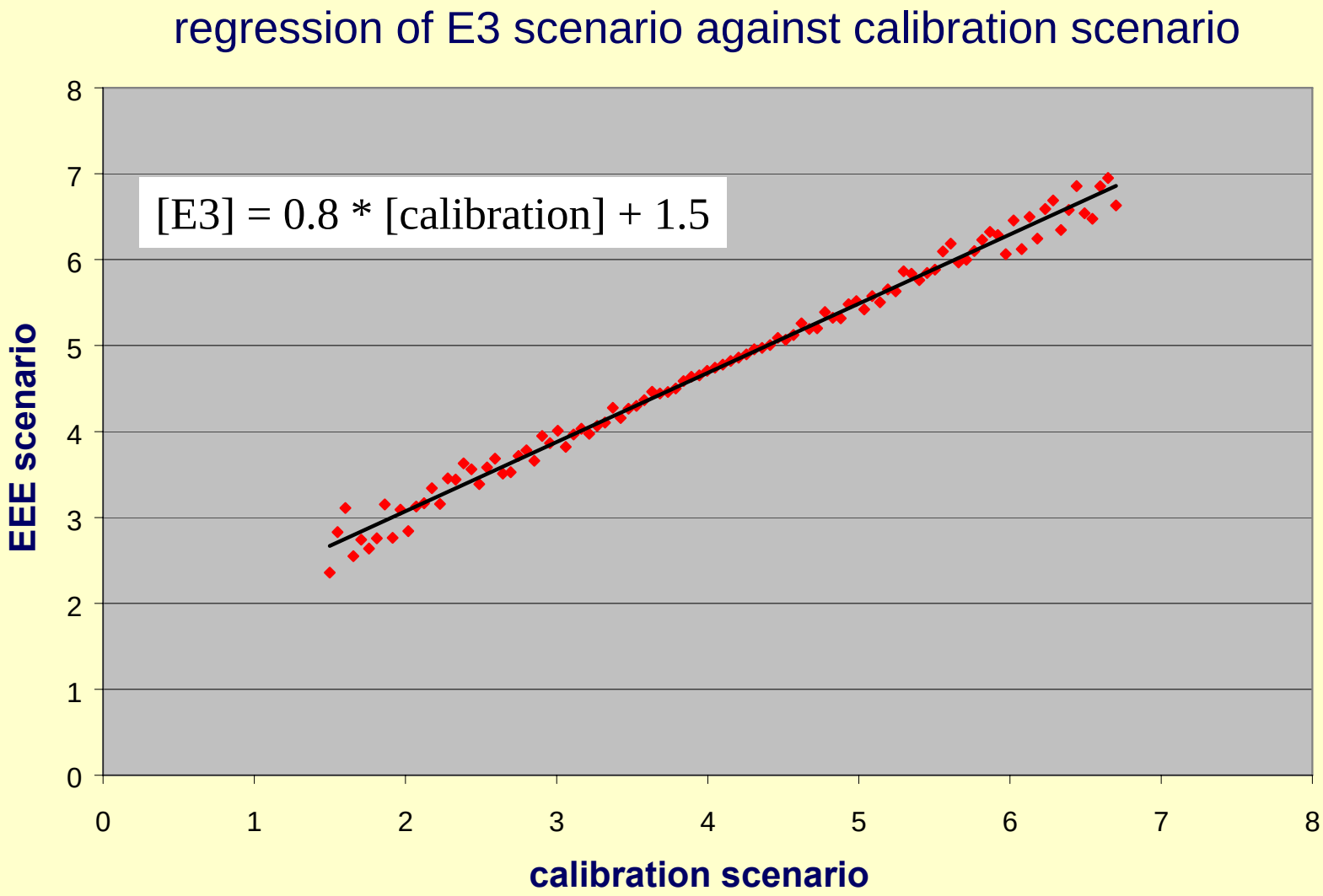


“Scenario’ing The Data”

One regression for each data point



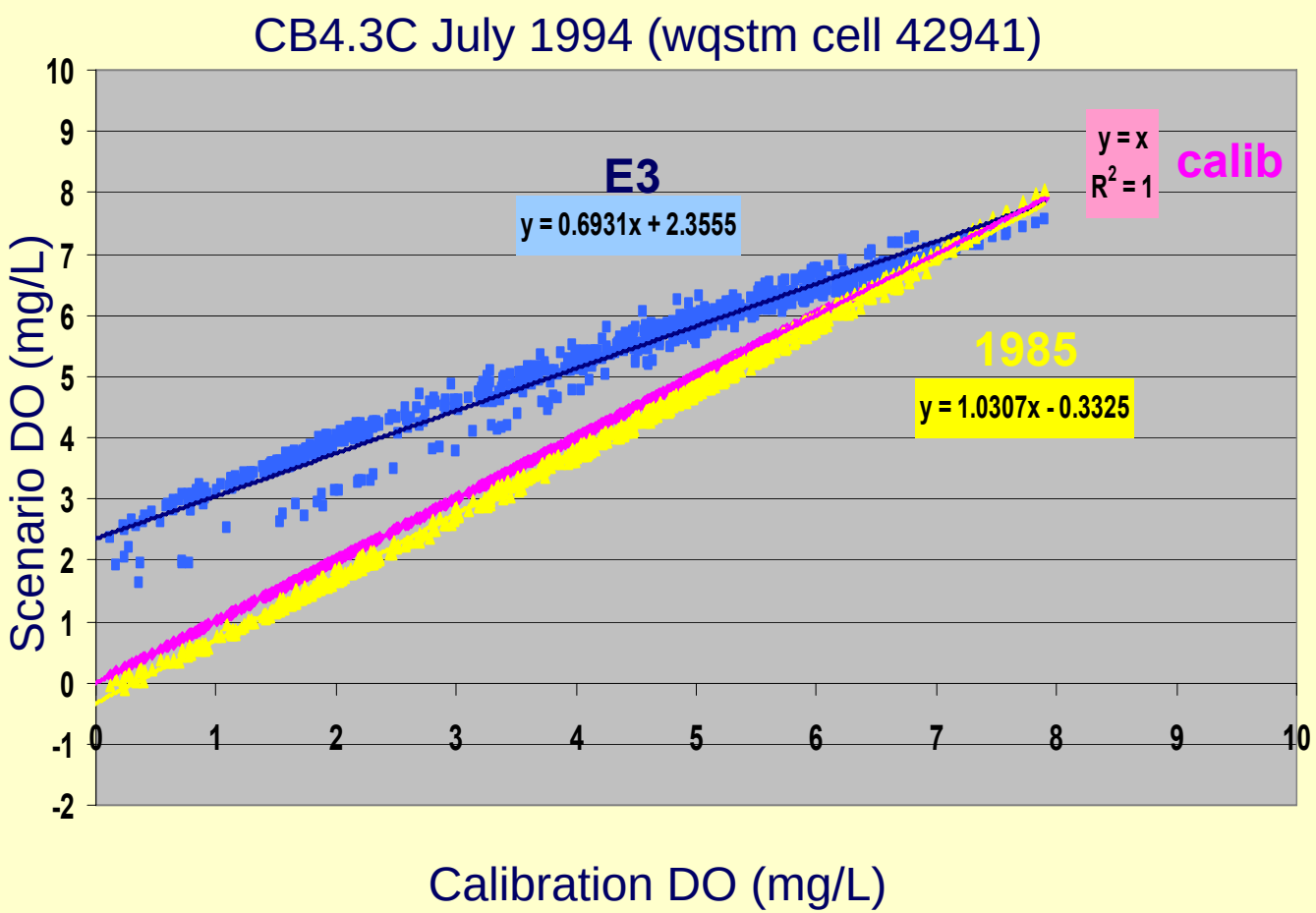
“Scenario’ing The Data”



“Scenario’ing The Data”

A well-behaved regression

CB4.3C
8703
18347
26363
33165
38597
42941
46367
49051
50969
52391
53496
54417
55008
55504
55881
56242
56574



Open Water “Problem” Segments

- 20 Open Water segments don’t attain at “Trib Strategy”
- Of these, several demonstrate continued improving conditions with decreasing loads, and attain at E3
- 4 show inconsistent or poor response patterns suggesting unusual conditions
- Remaining 6-7 may need some adjustment in local loads and further investigation into drivers of non-attainment

Segment	Scenario→ Year →	1985 Scenario '93-'95	Tributary Stategy '93-'95	E3 2010 Scenario '93-'95
APPTF	VA	0.0%	4.6%	0.0%
GUNOH	MD	4.6%	4.6%	4.6%
MANMH	MD	0.4%	5.0%	5.1%
WICMH	MD	11.2%	4.6%	4.6%
CB7PH	VA	8.8%	0.3%	0.0%
PMKTF	VA	11.0%	4.6%	0.7%
POCOH	both	32.8%	25.0%	4.6%
MPCOH	MD	33.1%	25.0%	4.6%
VPCOH	VA	32.5%	25.0%	4.6%
POCTF	MD	33.2%	25.0%	4.6%
SEVMH	MD	20.5%	6.4%	1.4%
WSTMH	MD	9.4%	0.5%	0.5%
PIAMH	VA	5.3%	0.1%	0.0%
MOBPH	VA	1.0%	0.0%	0.0%
CHOMH1	MD	3.1%	0.0%	0.0%
MAGMH	MD	1.3%	0.3%	0.0%
MDATF	MD	34.3%	12.1%	0.0%
PAXOH	MD	35.9%	1.2%	0.0%
PAXTF	MD	36.5%	7.1%	0.0%
SBEMH	VA	30.3%	0.1%	0.0%
WBEMH	VA	15.3%	7.8%	0.0%
YRKMH	VA	17.6%	1.0%	0.0%

“Problem” Segments: Diagnostic Approach

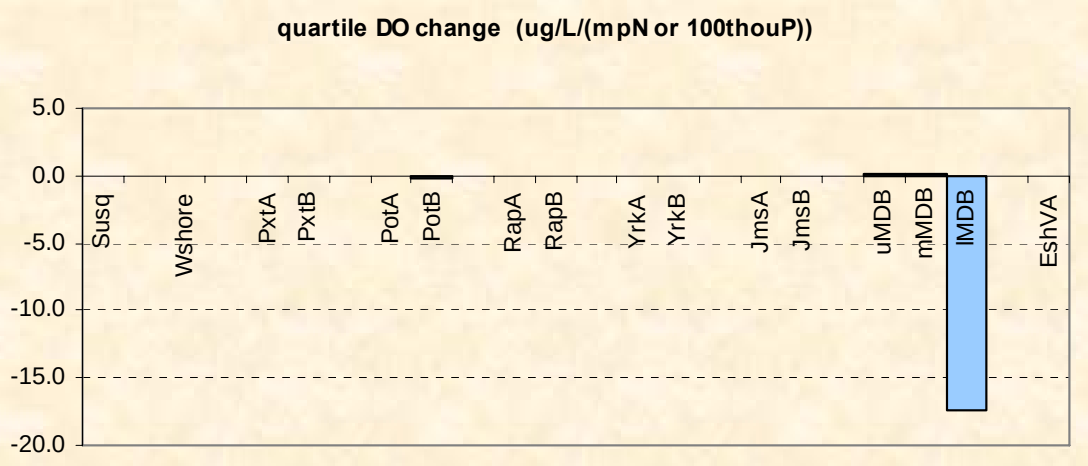
- Is influence on segment local or external?
- Segment-level loads (10-yr average)
- Cell-level loads (10-yr average)
- What does regression look like? Are we seeing the response that we expect?
- If not, why not? Some possible reasons:
  - Estuarine model not capturing small-scale local process?
  - Loads at segment- or cell-level not being reduced in same proportion, different N:P ratio, etc, as global scenario?
  - Anomaly in monthly loads?
  - Anomaly in monitoring data?

Diagnostic Approach

Primary Geographical Influence

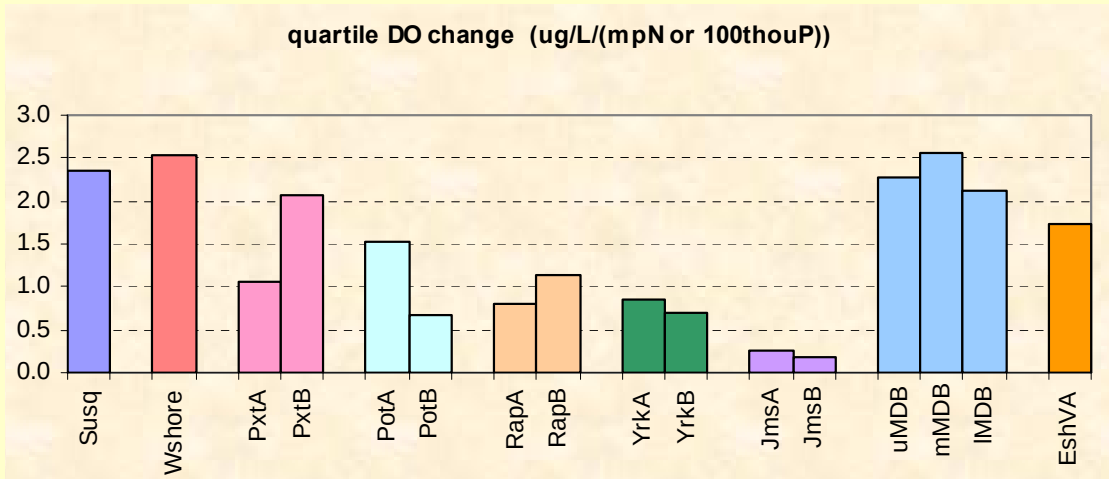
WICMH:

Lower Eastern Shore of MD



POTMH:

Multiple Influences



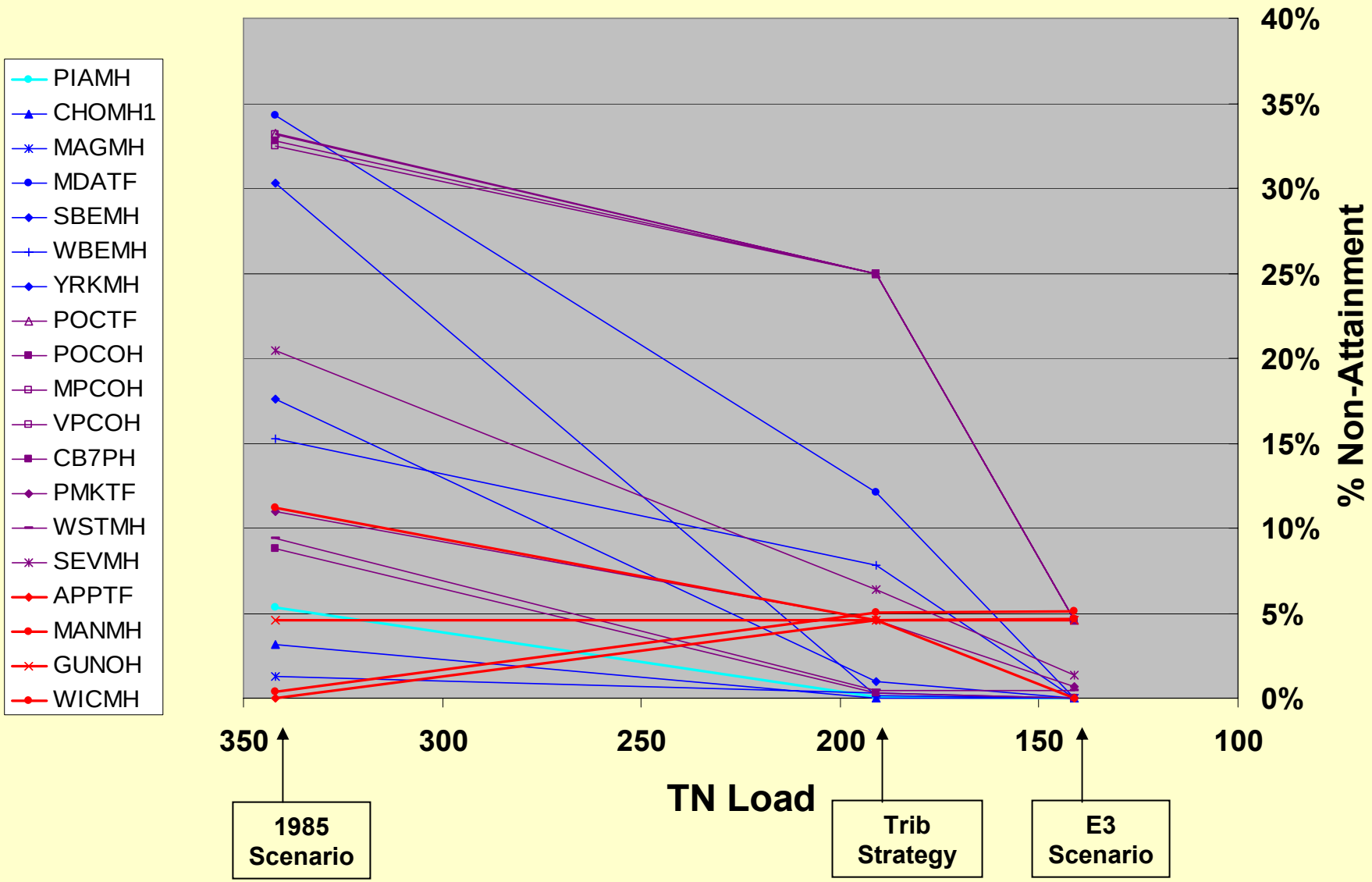
Open Water “Problem” Segments

Primary Geographical Influence

Segment	State	Primary Geographical Influence
APPTF	VA	James River
GUNOH	MD	Western Shore MD
MANMH	MD	Lower MD Eastern Shore
WICMH	MD	Lower MD Eastern Shore
CB7PH	VA	Multiple Influences
PMKTF	VA	York River
POCOH	both	Lower MD Eastern Shore
MPCOH	MD	Lower MD Eastern Shore
VPCOH	VA	Lower MD Eastern Shore
POCTF	MD	Lower MD Eastern Shore
SEVMH	MD	Western Shore MD
WSTMH	MD	Western Shore MD
PIAMH	VA	Multiple Influences
MOBPH	VA	Multiple Influences
CHOMH1	MD	Middle MD Eastern Shore
MAGMH	MD	W. Shore MD, E. Shore MD, Susquehanna River
MDATF	MD	?
PAXOH	MD	Patuxent River
PAXTF	MD	Patuxent River
SBEMH	VA	??
WBEMH	VA	??
YRKMH	VA	York River

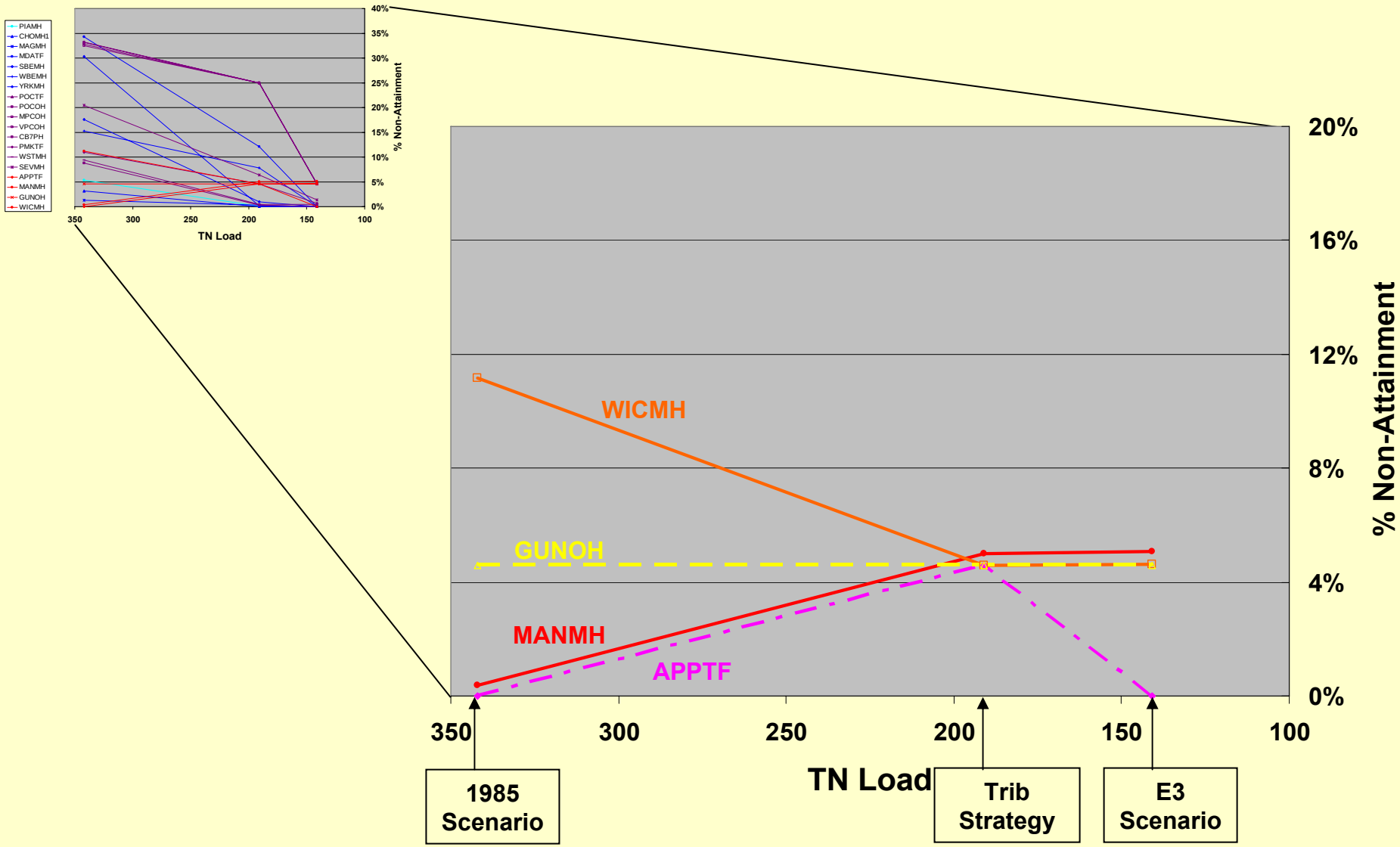
Open Water “Problem” Segments

3 Groups



Open Water “Problem” Segments

Group 1: inconsistent or poor response



Open Water “Problem” Segments

Group 1: GUNOH

Cbseg	1985 Scenario '93-'95 DO Open Water Summer Monthly	Tributary Stategy '93-'95 DO Open Water Summer Monthly	E3 2010 Scenario '93-'95 DO Open Water Summer Monthly
GUNOH	4.6%	4.6%	4.6%

Overall	1985	E3	1985 to E3
TN	342	141	59%
TP	24	9	65%

GUNOH	1985	E3	1985 to E3
TN	1,983,541	632,450	68%
TP	85,909	31,195	64%

CELL 10576	1985	E3	1985-to-E3
TN	7991	3362	58%
TP	728	226	69%

violations: monitoring data

year	month	vio rate
1993	6	0
1993	7	0
1993	8	0
1993	9	0
1994	6	0
1994	7	1
1994	8	0
1994	9	0
1995	6	0
1995	7	0
1995	8	0
1995	9	0

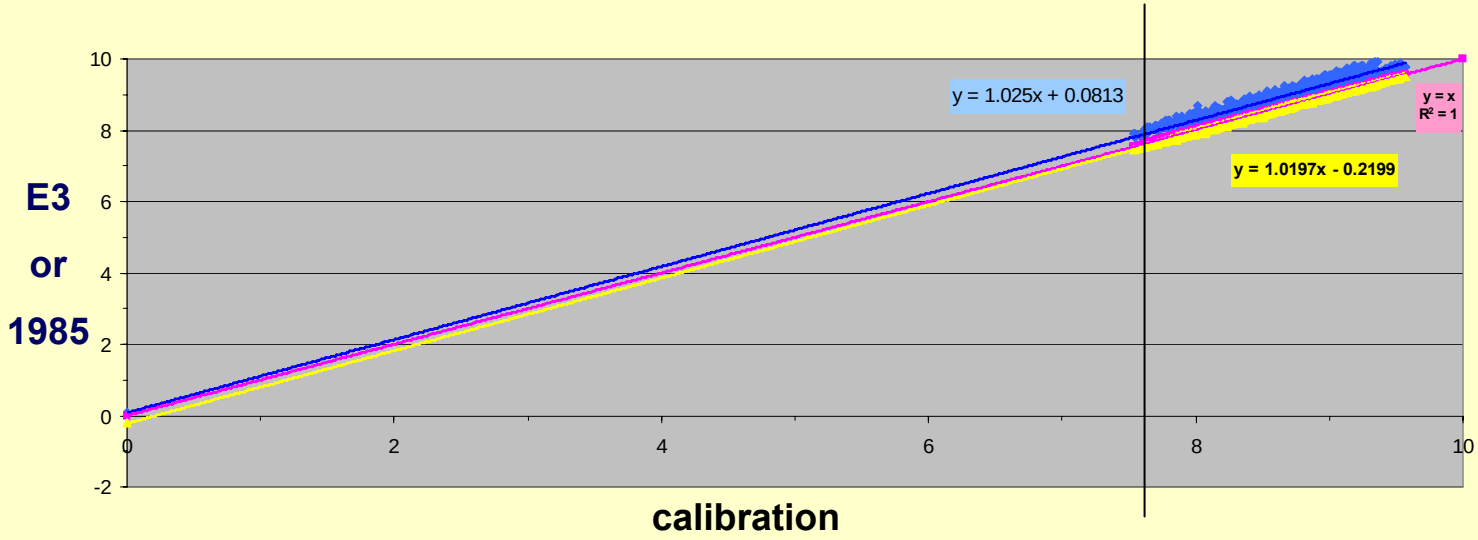
violations: E3 scenario

year	month	vio rate
1993	6	0
1993	7	0
1993	8	0
1993	9	0
1994	6	0
1994	7	1
1994	8	0
1994	9	0
1995	6	0
1995	7	0
1995	8	0
1995	9	0

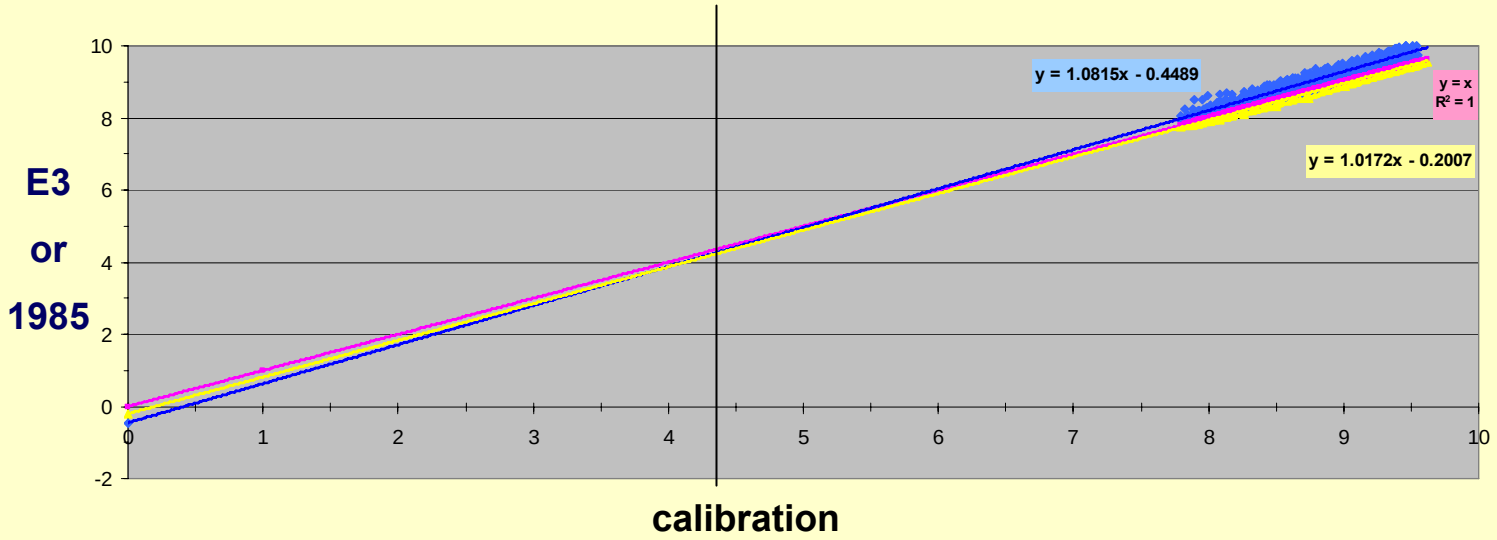
Open Water “Problem” Segments

Group 1: GUNOH

July 1993

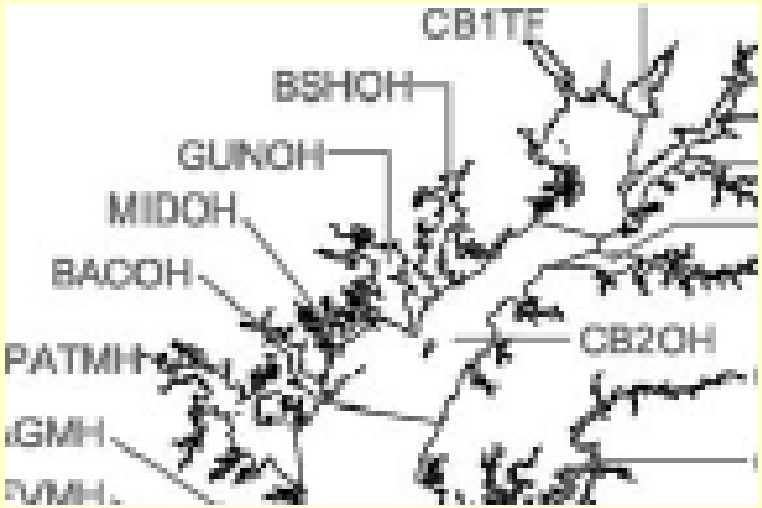


July 1994



Open Water “Problem” Segments

Group 1: GUNOH



Attainment compared to nearby segments:

Cbseg	1985 Scenario 342TN, 24.1TP, 9790TSS '93-'95 DO Open Water Summer Monthly	"91 -'00 Base Scenario 309TN, 19.5TP, 8950TSS '93-'95 DO Open Water Summer Monthly	Tributary Stategy 191TN 14.4TP, 6462 TSS '93-'95 DO Open Water Summer Monthly
BSHOH	0.0%	0.0%	0.0%
CB2OH	0.5%	0.0%	0.0%
GUNOH	4.6%	4.6%	4.6%
MIDOH	0.0%	0.0%	0.0%

Open Water “Problem” Segments

Group 1: MANMH

Cbseg	1985 Scenario 342TN, 24.1TP, 9790TSS '93-'95 DO Open Water Summer Monthly	Tributary Stategy 191TN 14.4TP, 6462 TSS '93-'95 DO Open Water Summer Monthly	E3 2010 Scenario 141TN 8.5TP, 5060TSS '93-'95 DO Open Water Summer Monthly
MANMH	0.4%	5.0%	5.1%

MANMH	1985	E3	1985 to E3
TN	516,230	291,604	44%
TP	48,409	29,938	38%

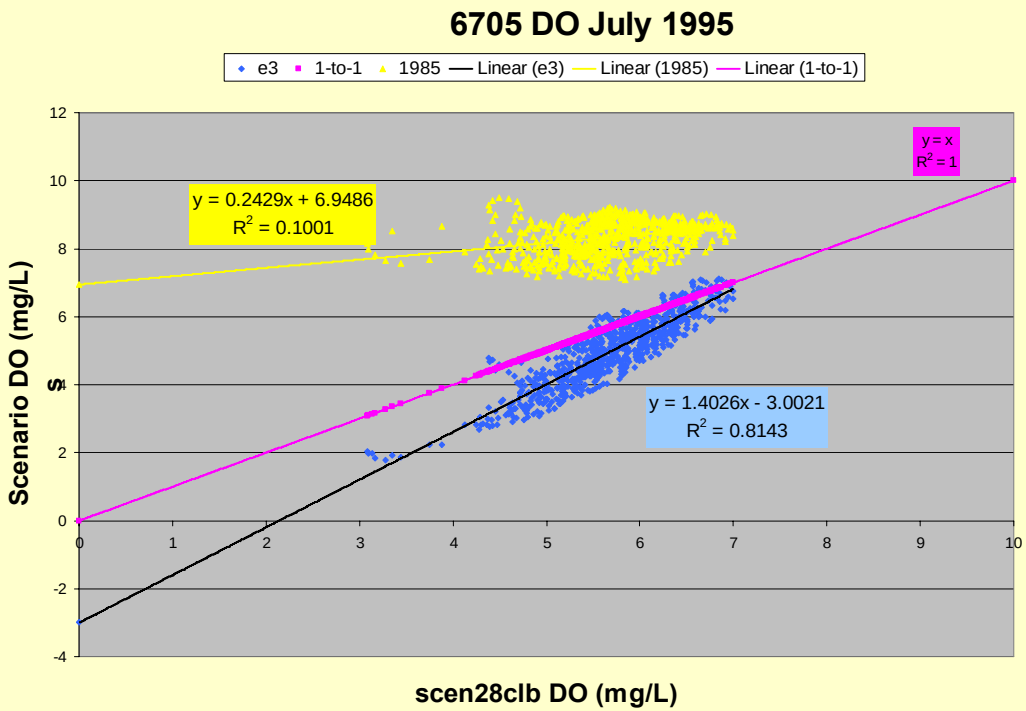
CELL 6705	1985	E3	1985 to E3
TN	5026	3798	24%
TP	236	209	11%

violations: monitoring data

Year	Month	Vio rate
1993	6	0
1993	7	0
1993	8	0
1993	9	0
1994	6	0
1994	7	0
1994	8	0
1994	9	0
1995	6	0
1995	7	0.44898
1995	8	0
1995	9	0

violations: E3 scenario

year	month	vio rate
1993	6	0
1993	7	0.148688
1993	8	0
1993	9	0
1994	6	0
1994	7	0
1994	8	0
1994	9	0
1995	6	0.148688
1995	7	1
1995	8	0
1995	9	0

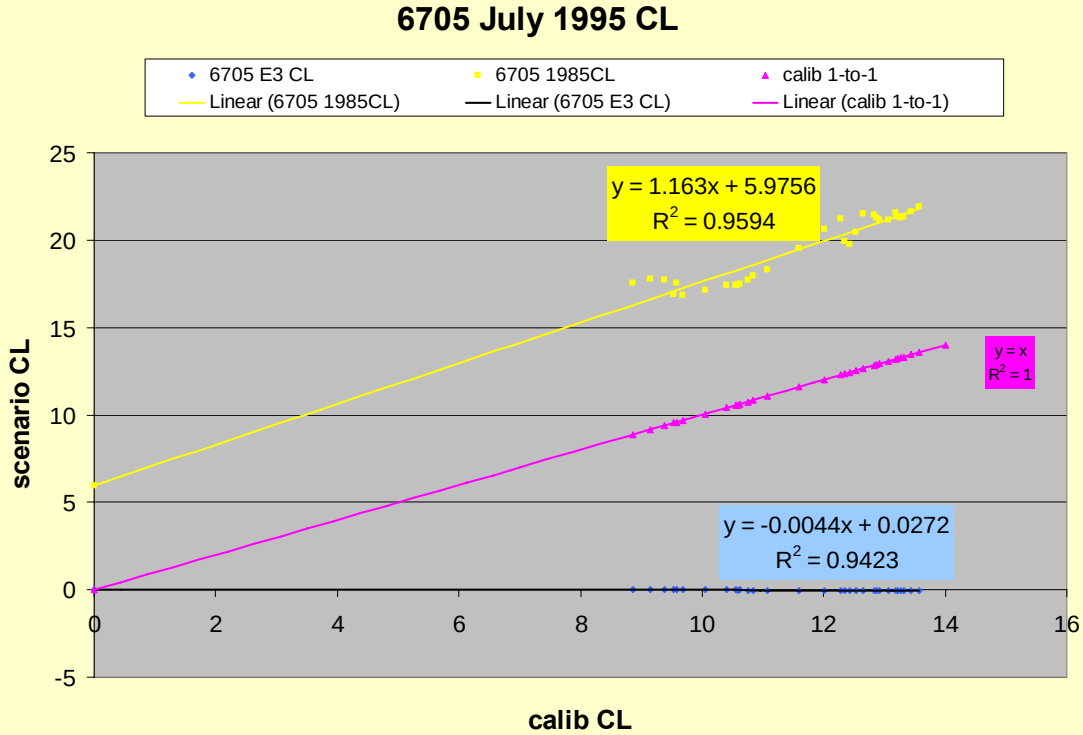


MANMH DO and CL

1985 v E3

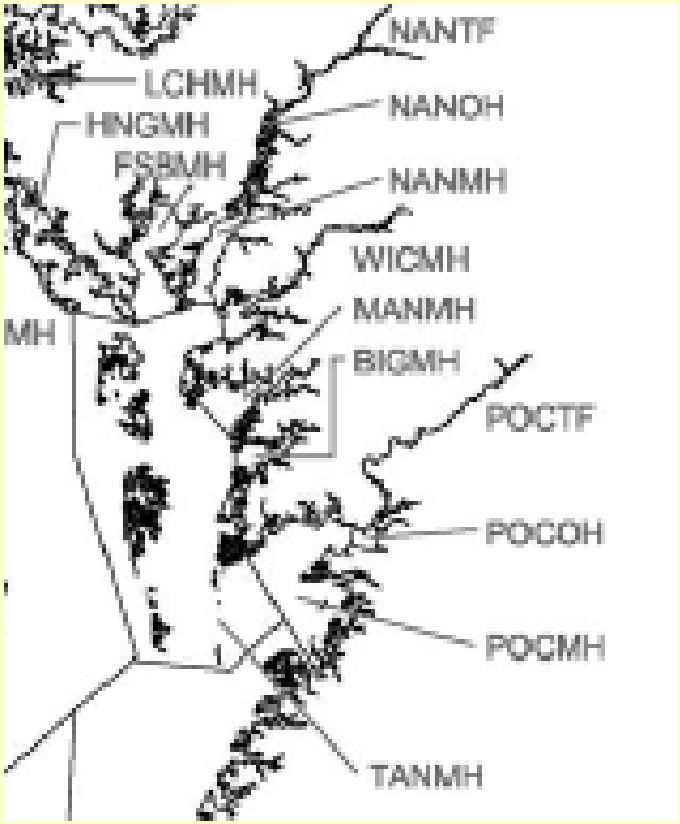
Observed DO July 1995:

station	depth	DO (mg/L)
ET8.1	0.5	5.2
ET8.1	1	4.9
ET8.1	1.5	4.8
ET8.1	2	4.7
ET8.1	2.5	4.8
ET8.1	3	4.9
ET8.1	3.5	4.95
ET8.1	4	5



Open Water “Problem” Segments

Group 1: MANMH



Attainment compared to nearby segments:

Cbseg	1985 Scenario 342TN, 24.1TP, 9790TSS '93-'95 DO Open Water Summer Monthly	"91 -'00 Base Scenario 309TN, 19.5TP, 8950TSS '93-'95 DO Open Water Summer Monthly	Tributary Stategy 191TN 14.4TP, 6462 TSS '93-'95 DO Open Water Summer Monthly
FSBMH	0.0%	0.0%	0.0%
MANMH	0.4%	0.6%	5.0%
NANMH	0.0%	0.0%	0.0%
POCMH	0.0%	0.0%	0.0%
TANMH	1.5%	0.1%	0.0%
WICMH	11.2%	11.2%	4.6%

Open Water “Problem” Segments

Group 1: WICMH

Cbseg	1985 Scenario 342TN, 24.1TP, 9790TSS '93-'95 DO Open Water Summer Monthly	Tributary Stategy 191TN 14.4TP, 6462 TSS '93-'95 DO Open Water Summer Monthly	E3 2010 Scenario 141TN 8.5TP, 5060TSS '93-'95 DO Open Water Summer Monthly
WICMH	11.2%	4.6%	4.6%

WICMH	1985	E3	1985 to E3
TN	1,304,200	583,200	55%
TP	193,070	48,215	75%

CELL 7658	1985	E3	1985 to E3
TN	41,053	21,475	48%
TP	3,320	2,034	39%

violations: monitoring data

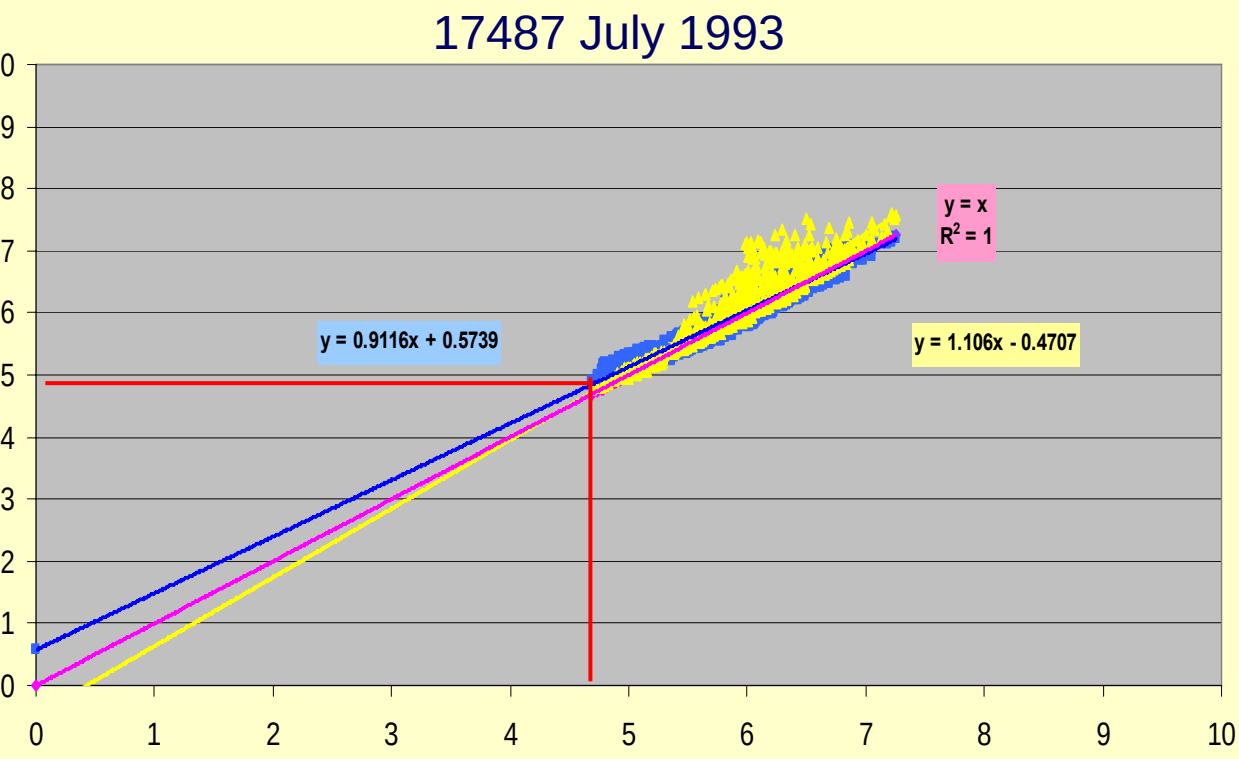
year	month	vio rate
1993	6	0.0%
1993	7	5.5%
1993	8	0.0%
1993	9	0.0%
1994	6	100.0%
1994	7	100.0%
1994	8	0.0%
1994	9	0.0%
1995	6	0.0%
1995	7	0.0%
1995	8	0.0%
1995	9	0.0%

violations: E3 scenario

year	month	vio rate
1993	6	0.0%
1993	7	1.9%
1993	8	0.0%
1993	9	0.0%
1994	6	100.0%
1994	7	0.0%
1994	8	0.0%
1994	9	0.0%
1995	6	0.0%
1995	7	0.0%
1995	8	0.0%
1995	9	0.0%

Open Water “Problem” Segments

Group 1: WICMH



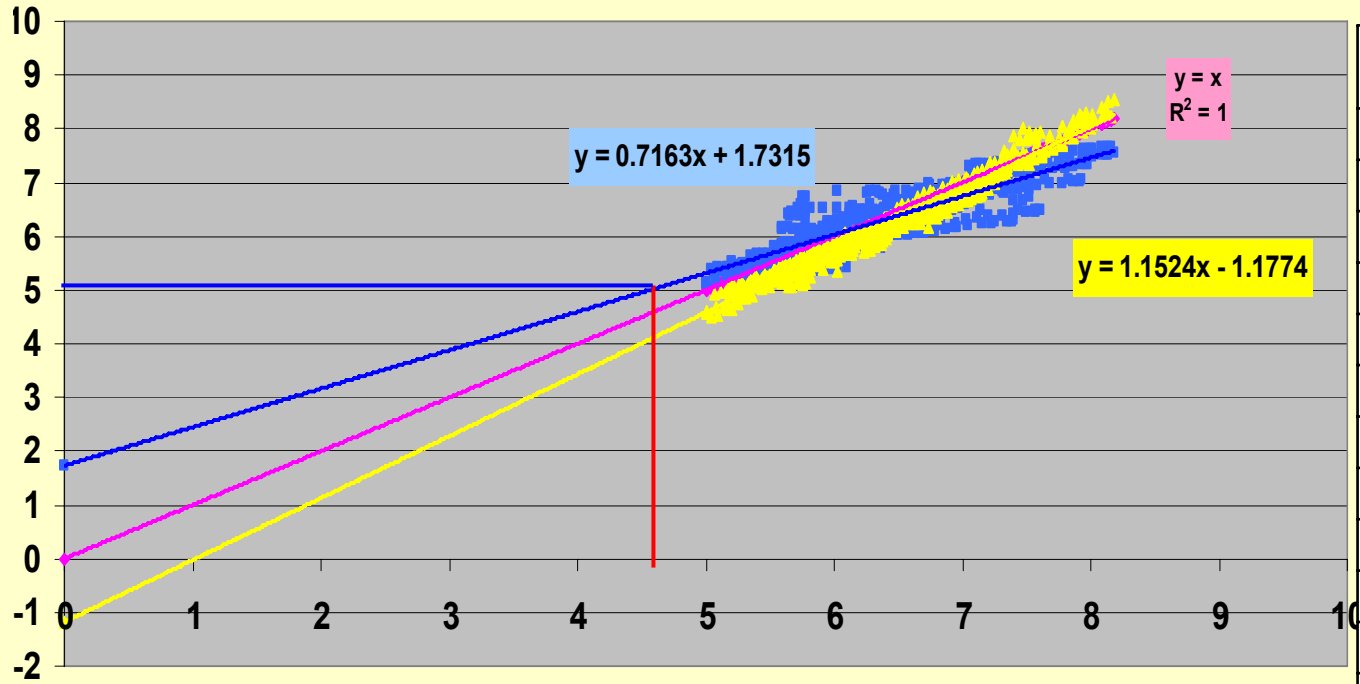
observed	
depth	DO (mg/L)
0.5	6.4
1	6.2
1.5	5.9
2	5.6
2.5	5.4
3	5.2
3.5	5.1
4	5
4.5	4.85
5	4.7
5.5	4.7
6	4.7

E3	
depth	DO (mg/L)
0.5	6.33
1	6.15
1.5	5.91
2	5.68
2.5	5.49
3	5.31
3.5	5.22
4	5.13
4.5	5
5	4.86
5.5	4.86
6	4.86

Open Water “Problem” Segments

Group 1: WICMH

17487 July 1994



observed

depth	DO (mg/L)
0.5	4.7
1	4.7
1.5	4.7
2	4.7
2.5	4.65
3	4.6
3.5	4.6
4	4.6
4.5	4.6
5	4.6
5.5	4.6
6	4.6

E3

depth	DO (mg/L)
0.5	5.08
1	5.08
1.5	5.09
2	5.1
2.5	5.07
3	5.03
3.5	5.03
4	5.03
4.5	5.03
5	5.03
5.5	5.03
6	5.03

Open Water “Problem” Segments

Group 1: APPTF

Cbseg	1985 Scenario 342TN, 24.1TP, 9790TSS '93-'95 DO Open Water Summer Monthly	Tributary Stategy 191TN 14.4TP, 6462 TSS '93-'95 DO Open Water Summer Monthly	E3 2010 Scenario 141TN 8.5TP, 5060TSS '93-'95 DO Open Water Summer Monthly
APPTF	0.0%	4.6%	0.0%

APPTF	1985	E3
TN	2,913,600	1,532,200
TP	360,740	117,890

violations: monitoring data

year	month	vio rate
1993	6	0.0%
1993	7	0.0%
1993	8	0.0%
1993	9	0.0%
1994	6	0.0%
1994	7	0.0%
1994	8	0.0%
1994	9	0.0%
1995	6	0.0%
1995	7	0.0%
1995	8	0.0%
1995	9	0.0%

violations: Trib Strategy

year	month	vio rate
1993	6	0.0%
1993	7	0.0%
1993	8	0.0%
1993	9	0.0%
1994	6	0.0%
1994	7	0.0%
1994	8	0.0%
1994	9	0.0%
1995	6	0.0%
1995	7	100.0%
1995	8	0.0%
1995	9	0.0%

Open Water “Problem” Segments

Group 1: APPTF

Historical monitoring observations:

July 1993

depth	DO (mg/L)
0.5	9.7
1.5	9.3
2.5	8.9
3	8.7
3.5	8.27
4.5	7.42
5	7

July 1994

depth	DO (mg/L)
0.5	8.8
1.5	8.36
2.5	7.92
3	7.7
3.5	7.5
4.5	7.1
5	6.9
5.5	6.83
6.5	6.67
7	6.6
7.5	6.6
8	6.6

July 1995

depth	DO (mg/L)
0.5	5.6
1.5	5.6
2.5	5.6
3	5.6
3.5	5.6
4.5	5.6
5	5.6
5.5	5.55
6	5.5

July 1996

depth	DO (mg/L)
0.5	8.1
1.5	8.06
2.5	8.02
3	8
3.5	7.98
4.5	7.93
5	7.9
5.5	7.88
6.5	7.83
7	7.8
7.5	7.8
8	7.8

Etc…

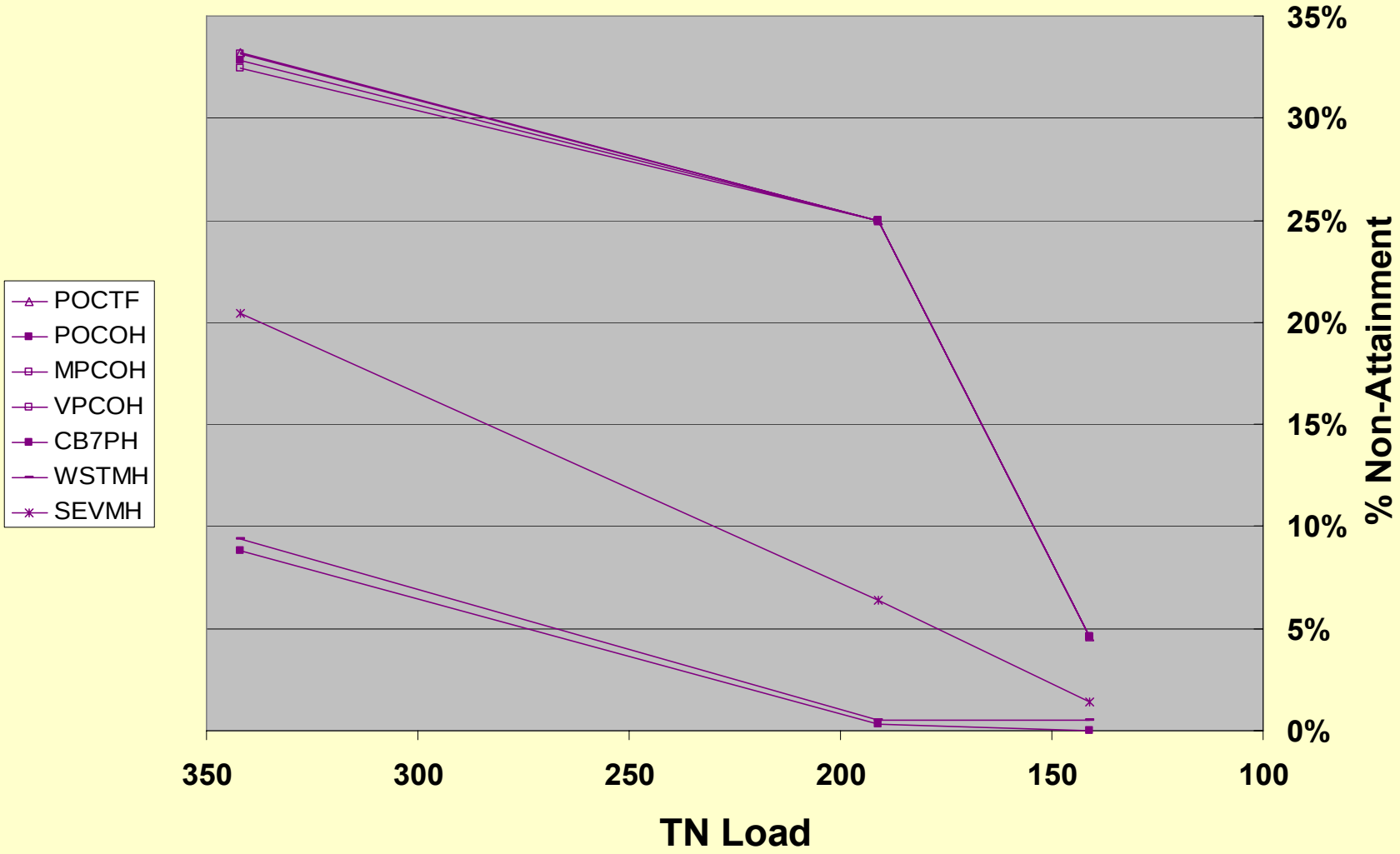
Open Water “Problem” Segments

Group 1 Summary

1. All 4 “Group 1” segments are influenced primarily by local loads
2. GUNOH and APPTF generally have attaining DO conditions in the 1991-2000 period
    - Combination of single month with lower-than-usual DO plus poorly-behaved regressions may be driving non-attainment
3. MANMH has borderline – but generally attaining or close-to-attaining observed DO – in the 1991-2000 period
    - Estuarine model may have difficulty integrating multiple drivers of DO levels in this shallow, local region
    - Further investigation of estuarine model response to loads in nearby – but deeper – locations necessary to determine local response to load reductions
4. WICMH has hypoxia issues, and estuarine model is not responding as strongly as one might hope to load reductions
    - Further investigation of local loads on monthly timescale and of estuarine model response in nearby locales warranted

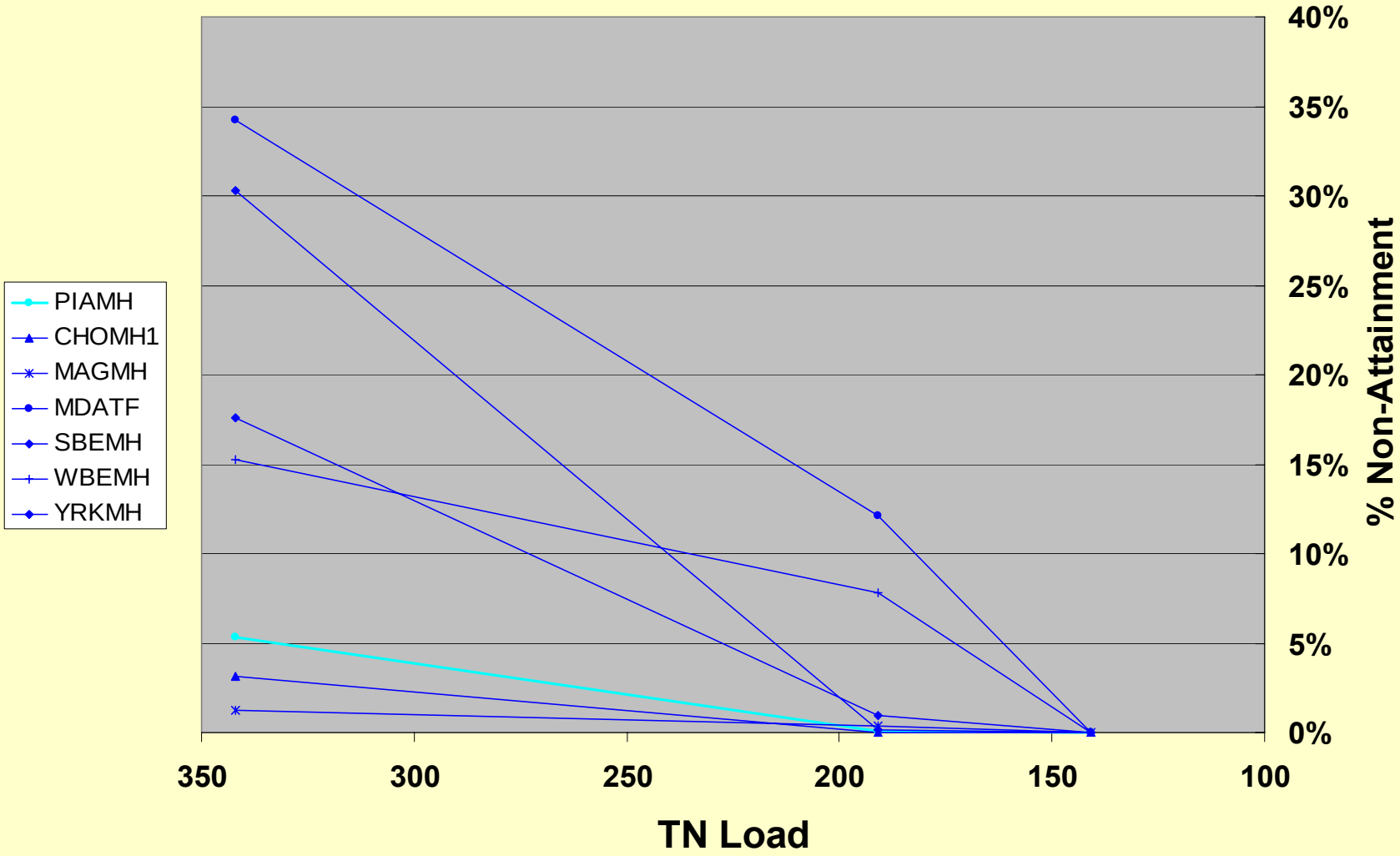
Open Water “Problem” Segments

Group 2:



Open Water “Problem” Segments

Group 3:



Diagnostic Approach, Groups 2 & 3

- With 1 or 2 exceptions, DO change in these segments is driven primarily by local load reductions
- These segments have shown responses to load reductions
- Some have shown greater responses than others

Plan:

1. **Confirm good estuarine model and regression fit**
2. **Look at local proportions of load reductions relative to overall scenario**
3. **Look at temporal variation in scenario loads (e.g monthly loads within critical period)**
4. **Determine potential environmental drivers of persistent violations**