LBWC TAC

October 24, 2013

LBR TP TMDL AQUATOX Modeling Discussion

Troy Smith

&

LBR TP TMDL AQUATOX Modeling Workgroup

AQUATOX Modeling Workgroup

Core Group

- Darcy Sharp – DEQ
- Ben Cope – EPA
- Bill Stewart – EPA
- Kate Harris – Boise
- Robbin Finch – Boise
- Tom Dupuis – HDR
- Michael Kasch – HDR
- Matt Gregg – Brown and Caldwell
- Jack Harrison - HyQual
- Lee Van de Bogart – Caldwell

Consultants

- Jonathan Clough – Warren Pinnacle Consult.
- Dick Park – Eco Modeling

Additional Assistance

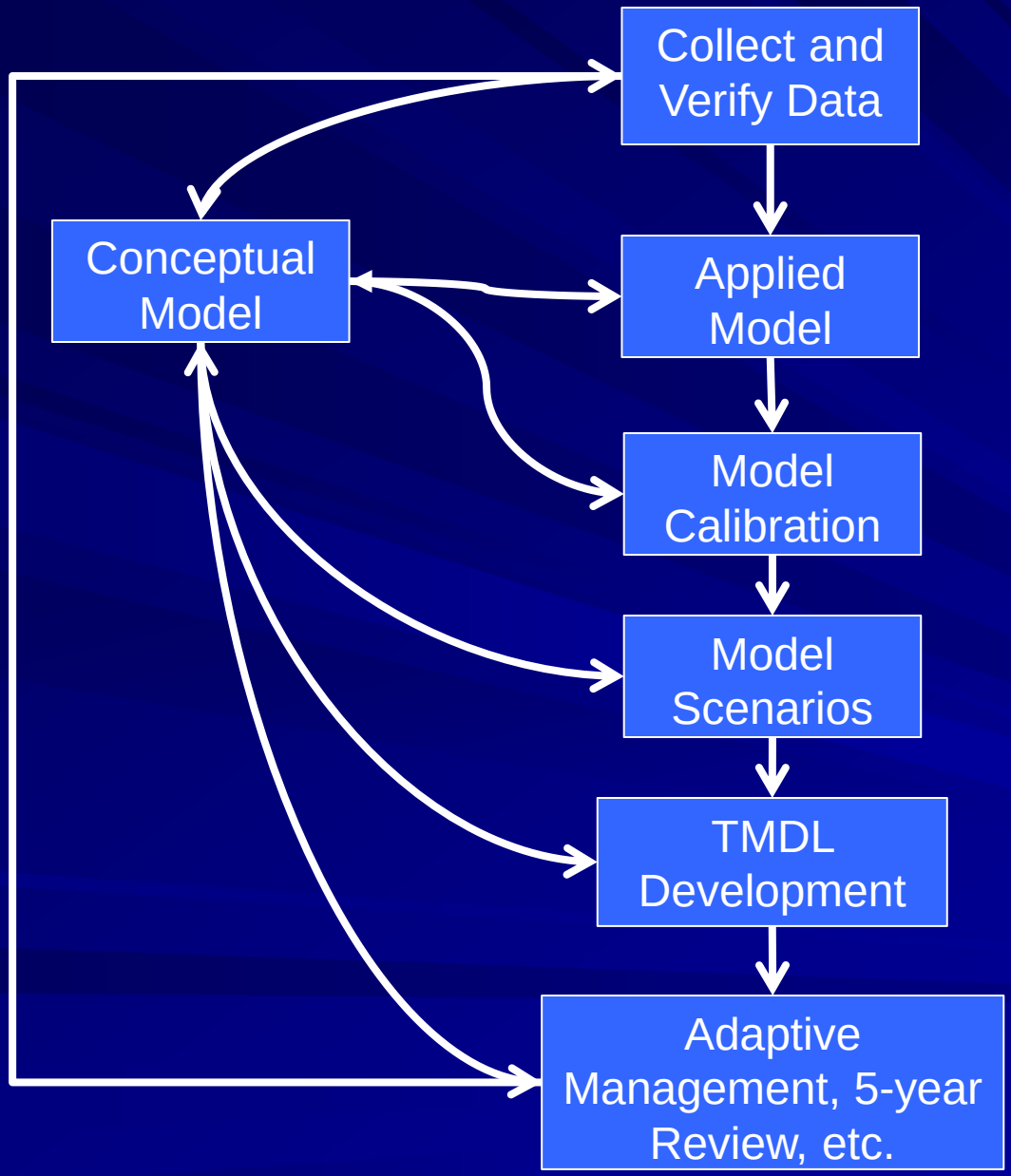
- Alex Etheridge, Dorene MacCoy, Chris Mebane – USGS
- Clifton Bell – Brown and Caldwell
- Others

AQUATOX Modeling for LBR TP TMDL

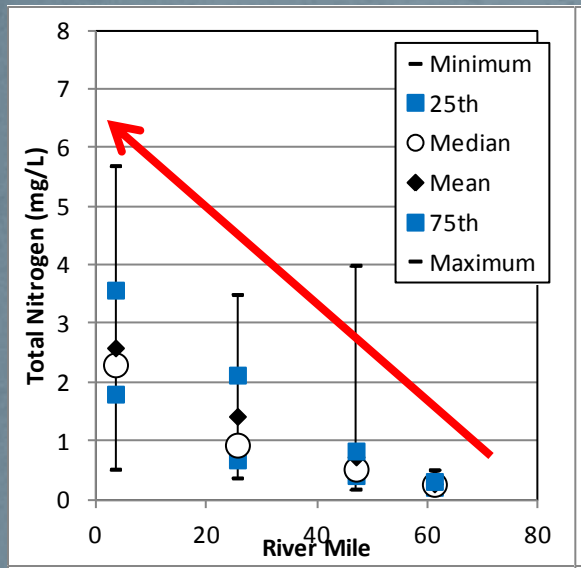
- Why modeling?
  - "…receiving water responses to nutrients depend on site specific characteristics (i.e., morphology, hydrology, turbidity, temperature, etc.), all of which vary in space and time."
  - "There is a need for practical, model-based approaches and guidance for deriving quantitative relationships between nutrient loads and site-specific water quality and ecological response indicators."

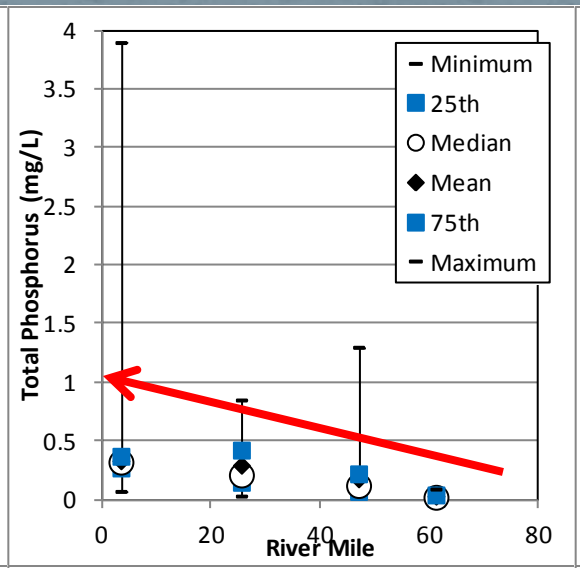
***2013. WERF. Modeling Guidance for Developing Site-Specific Nutrient Goals.*

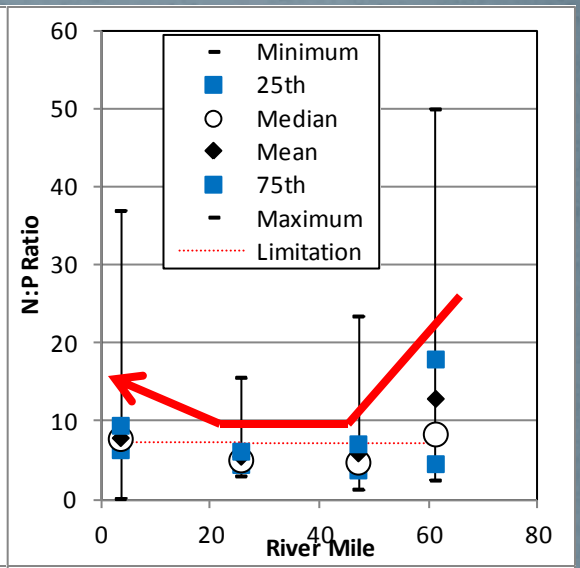
Simplified Process Representation

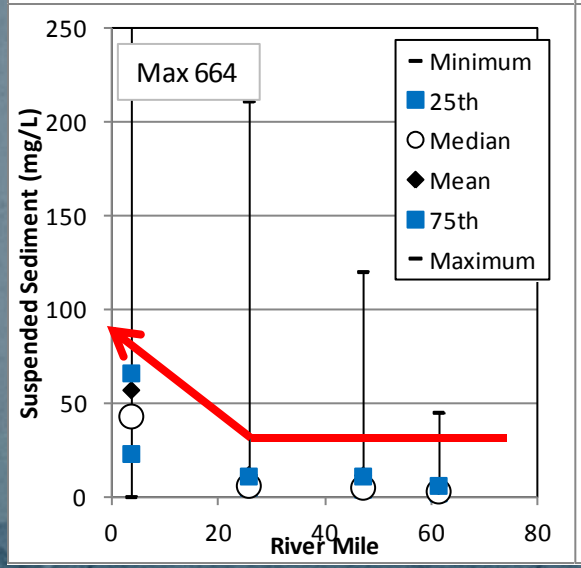


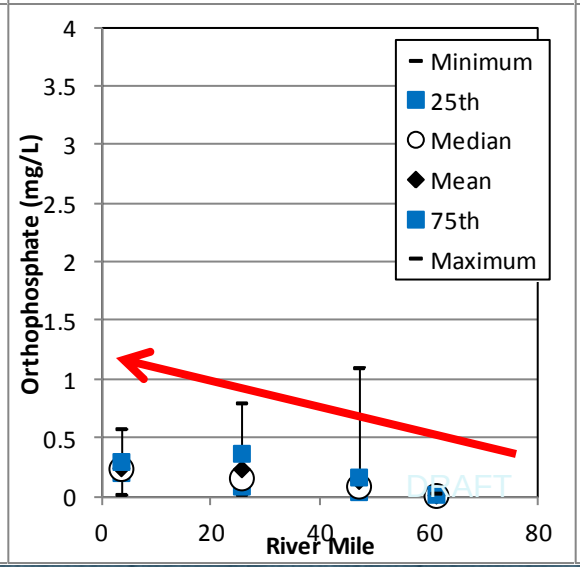
USGS Monitoring Data Period of Record – HDR 9/17/2012

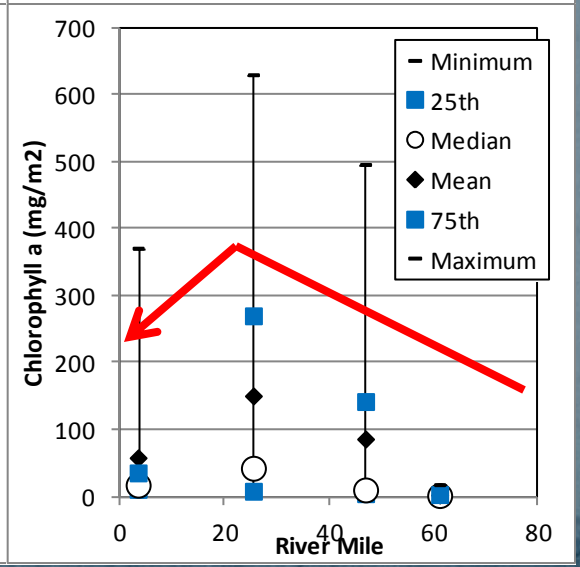






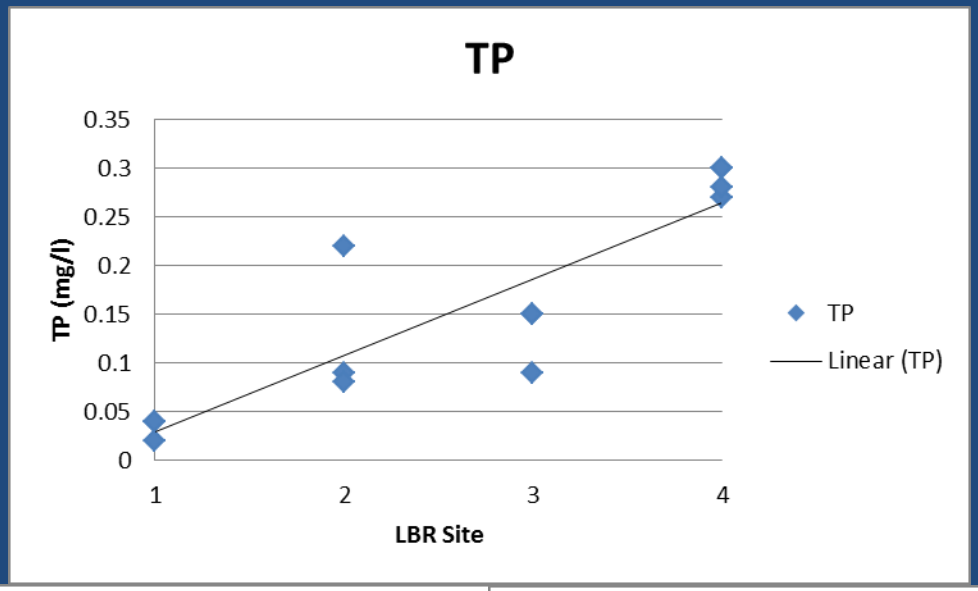


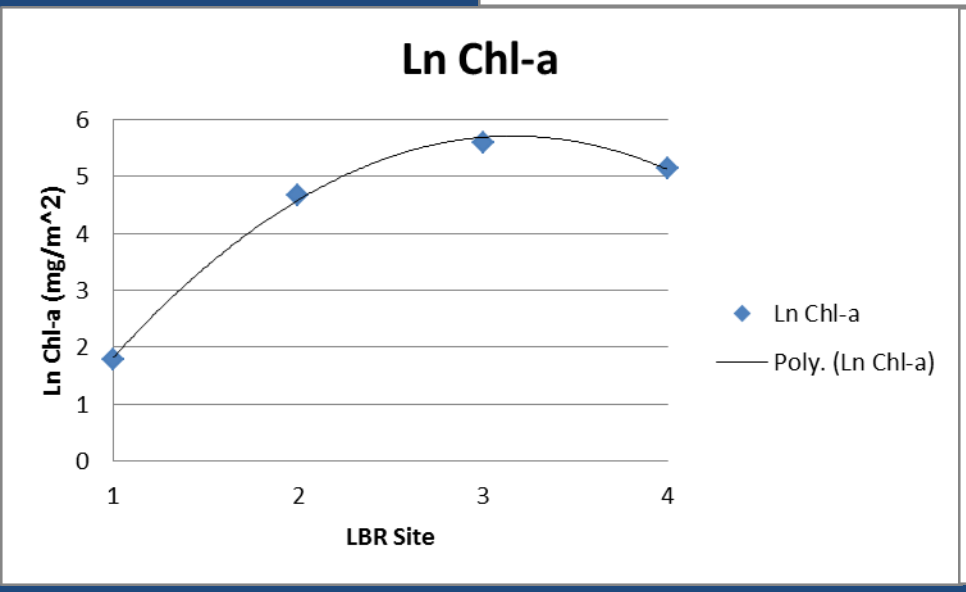


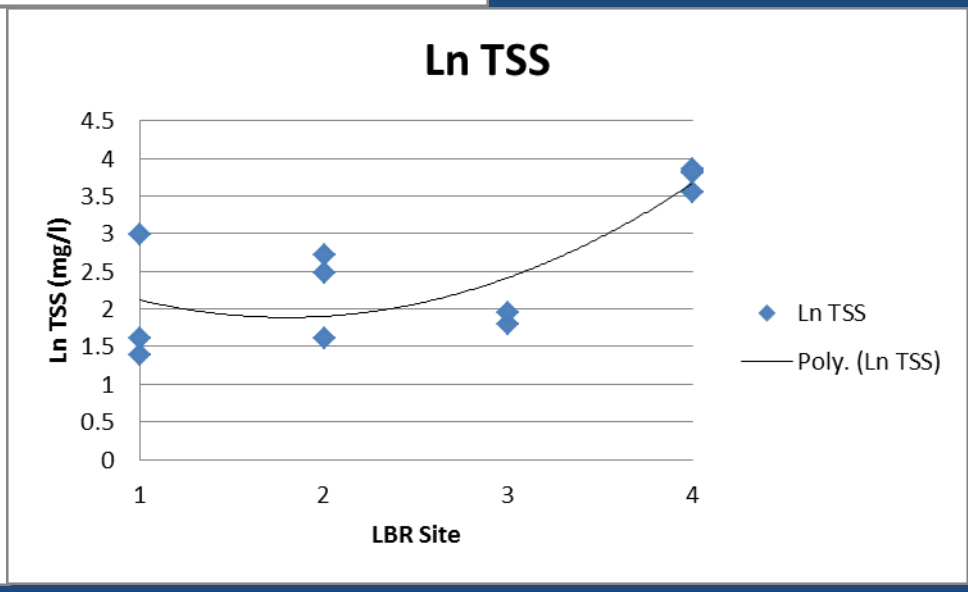


DRAFT

Lower Boise River-Specific







- Data points are means/medians as provided in USGS reports.
- Site 1 = Diversion; Site 2 = Glenwood Bridge; Site 3 = Middleton; Site 4 = Parma.

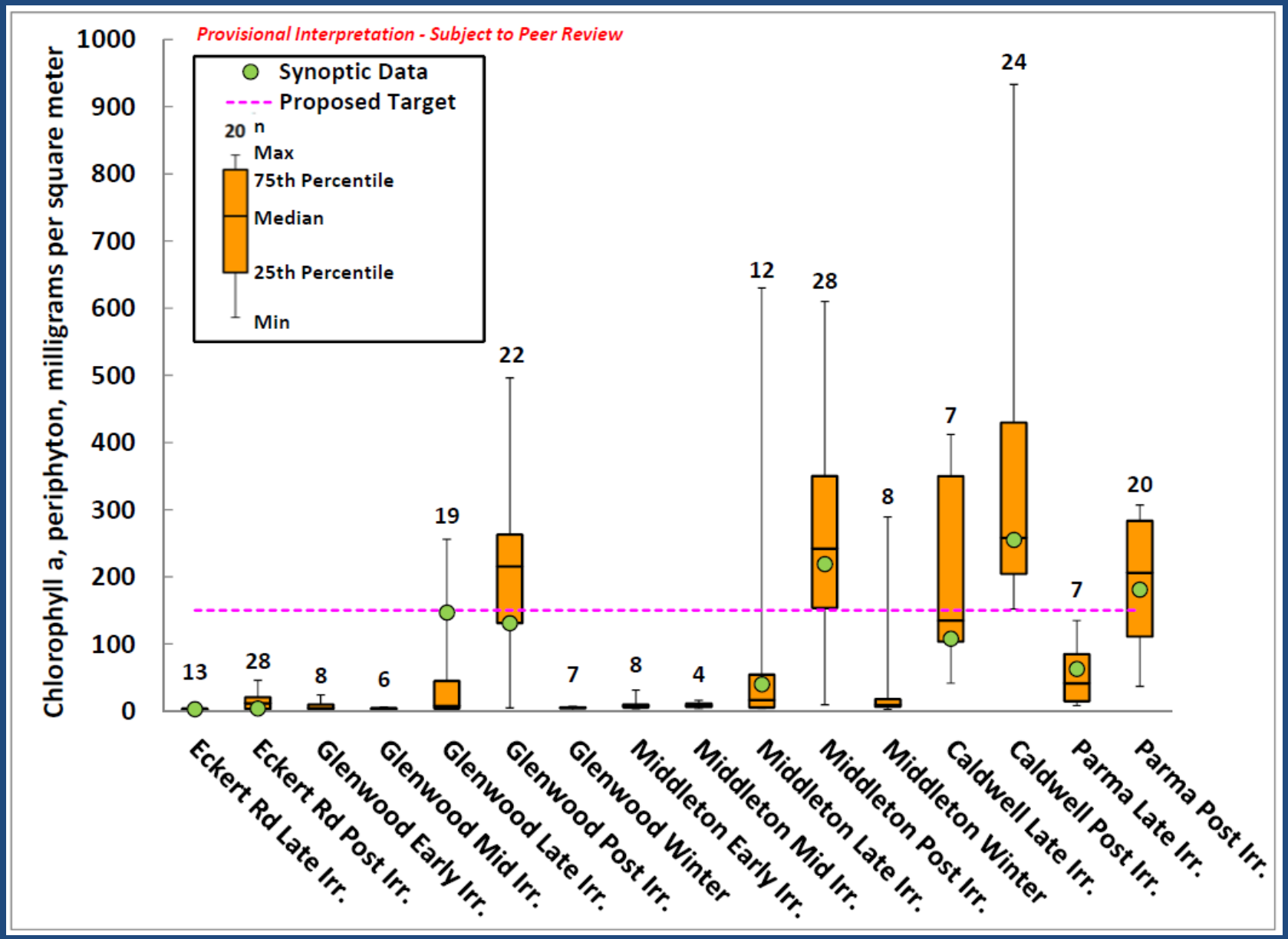


**Figure courtesy of Alex Etheridge (USGS).

Regulatory Objectives

- Identify conditions that achieve benthic chl a target
  - A mean benthic chlorophyll-a biomass target of $\leq$ 150 mg/m^2
    - Impaired mainstem AUs of the Lower Boise River
    - LBWC supported May-Sept timeframe as place holder while investigating other appropriate timeframes
- Translate nutrient-periphyton relationships into numeric nutrient WLAs/LAs

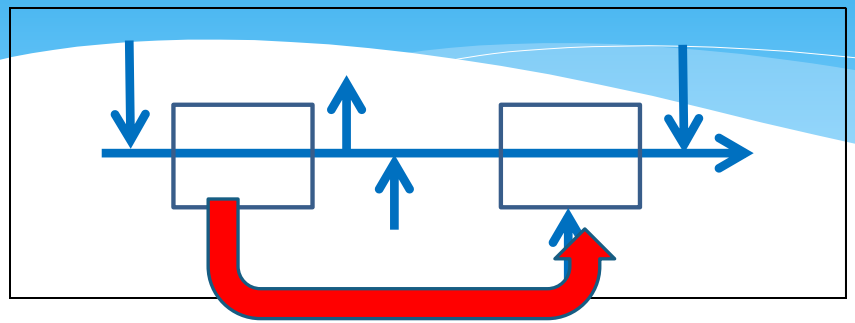
Two Primary Algae Models Considered

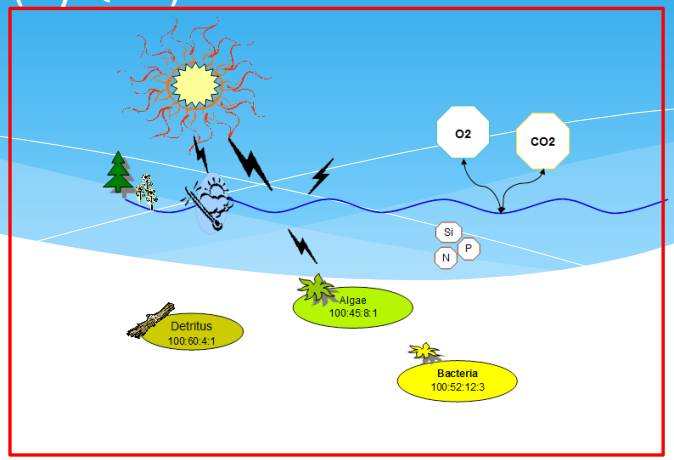
Simulation Capability	Model Code	
	QUAL2K	AQUATOX
Attached stream algae	√	√
Substrate limitation	√	√
Dynamic hydraulics		√
Intracellular nutrient storage	√	
Grazers		√
Flow stimulation effects		√
Scour/sloughing		√
Multiple algal taxa		√
Self-shading		√

**Figure modified from Clifton Bell presentation 7/9/2013 (Brown and Caldwell).

AQUATOX: Periphyton Biomass Model

**Slide courtesy of Jack Harrison (HyQual).





$$\frac{dBiomass_{Peri}}{dt} = Loading + Photosynthesis - Respiration - Excretion - Mortality - Predation + Sed_{Peri}$$

AQUATOX

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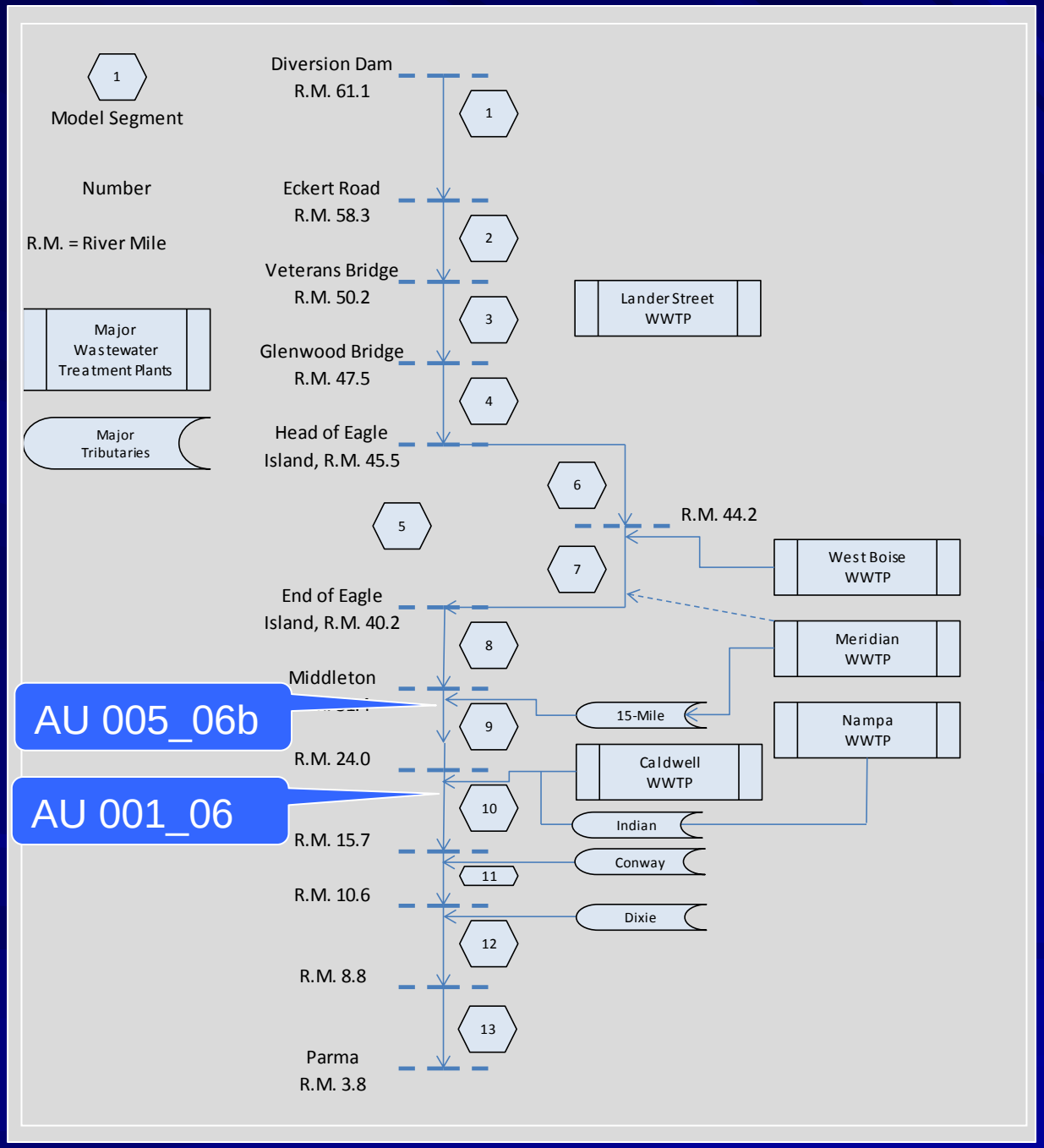
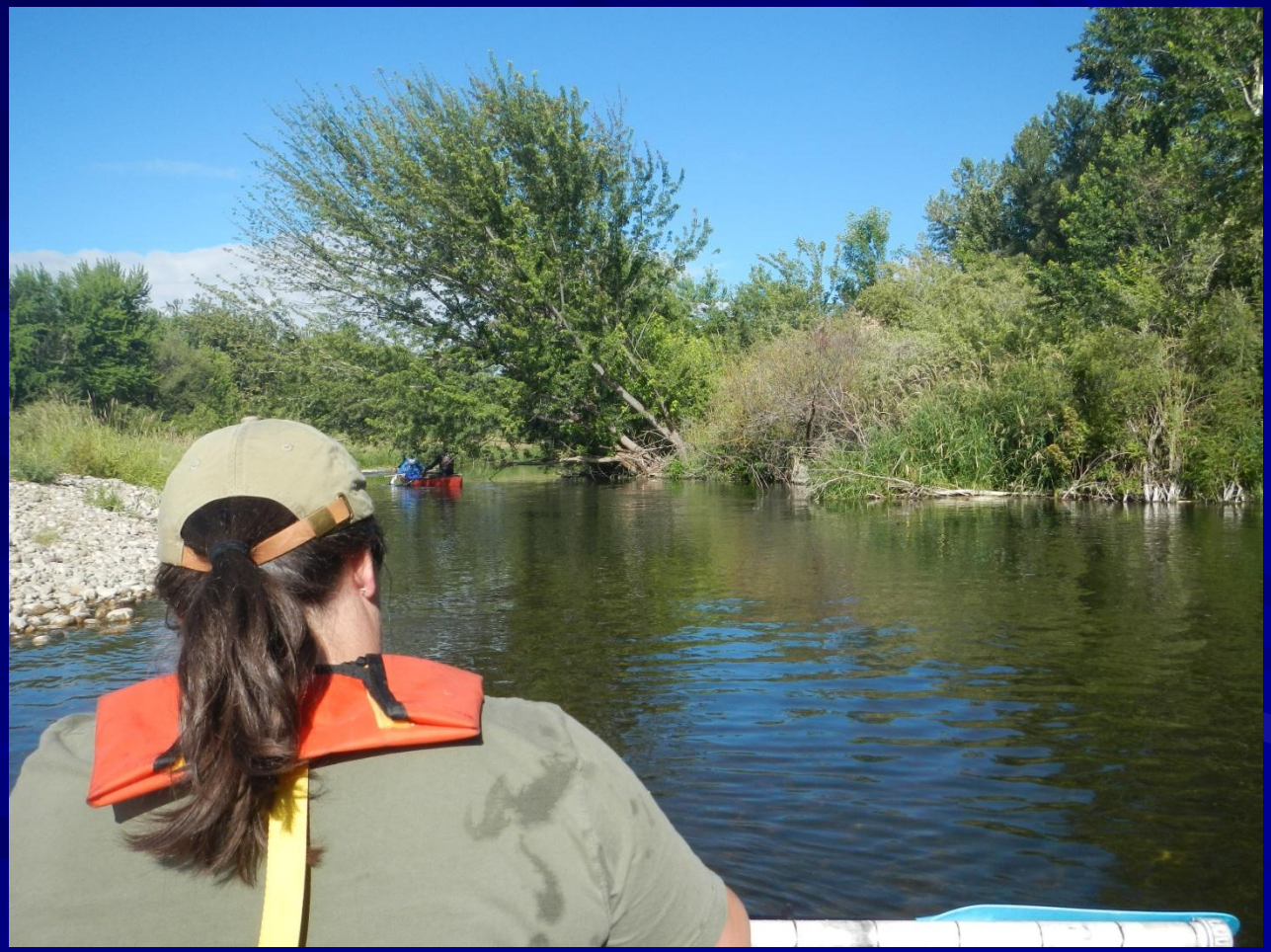
- Jonathan S. Clough, Warren Pinnacle Consulting, Warren VT jclough@warrenpinnacle.com
- Marjorie Coombs Wellman, Office of Water, US EPA, Washington DC wellman.marjorie@epamail.epa.gov

AQUATOX Diagram and LBR Data Sites



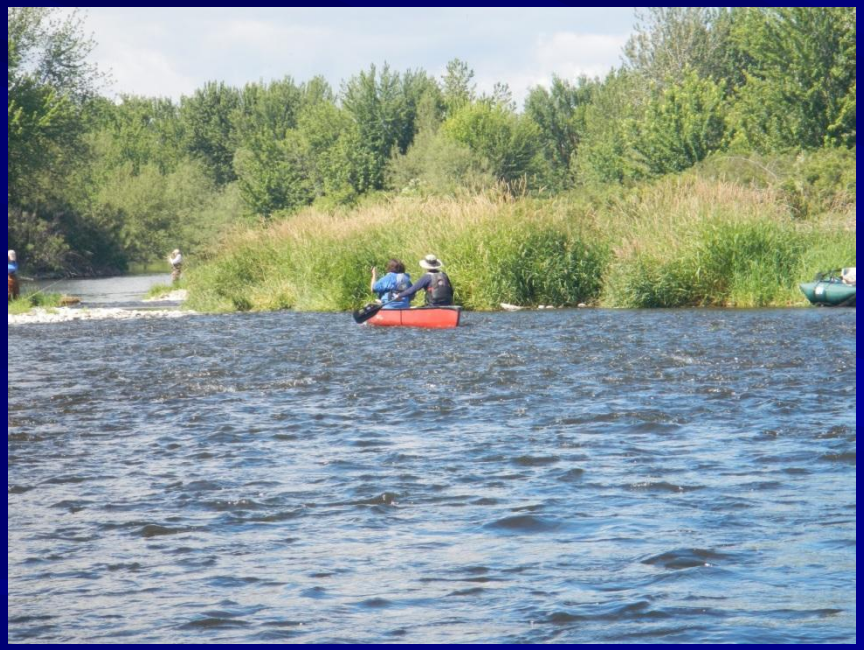
Segment	Sample Location
1	13203510 BR Diversion Dam
2	13203760 BR Eckert
3	13205642 BR Veterans Mem
	LND
4	13206000 BR Glenwood Br
	13206400 Eagle Drain
5	13206300 BR N Channel (Eagle)
7	13206305 BR S Channel
	13208800 BR Phyllis Diversion
	WBW
	IDFG
	13208750 Thurman Drain
8	13210000 Boise River Star
9	13210050 BR Middleton
	13210820 BR Middleton Rd
	13210815 15mile
	MDW
	132108247 Mill Slough
	13210835 Willow Creek
	13210983 Mason Creek
	13210988 Hartley Drain
10	13211000 BR Hwy 20-26
	13211600 BR Caldwell WWTP
	13211445 Indian Creek
	CAL
11	13212500 Boise River Notus
	13212550 Conway Gulch
12	13212890 Dixie Drain
13	13212900 BR Hwy 95
	13213000 BR nr Parma

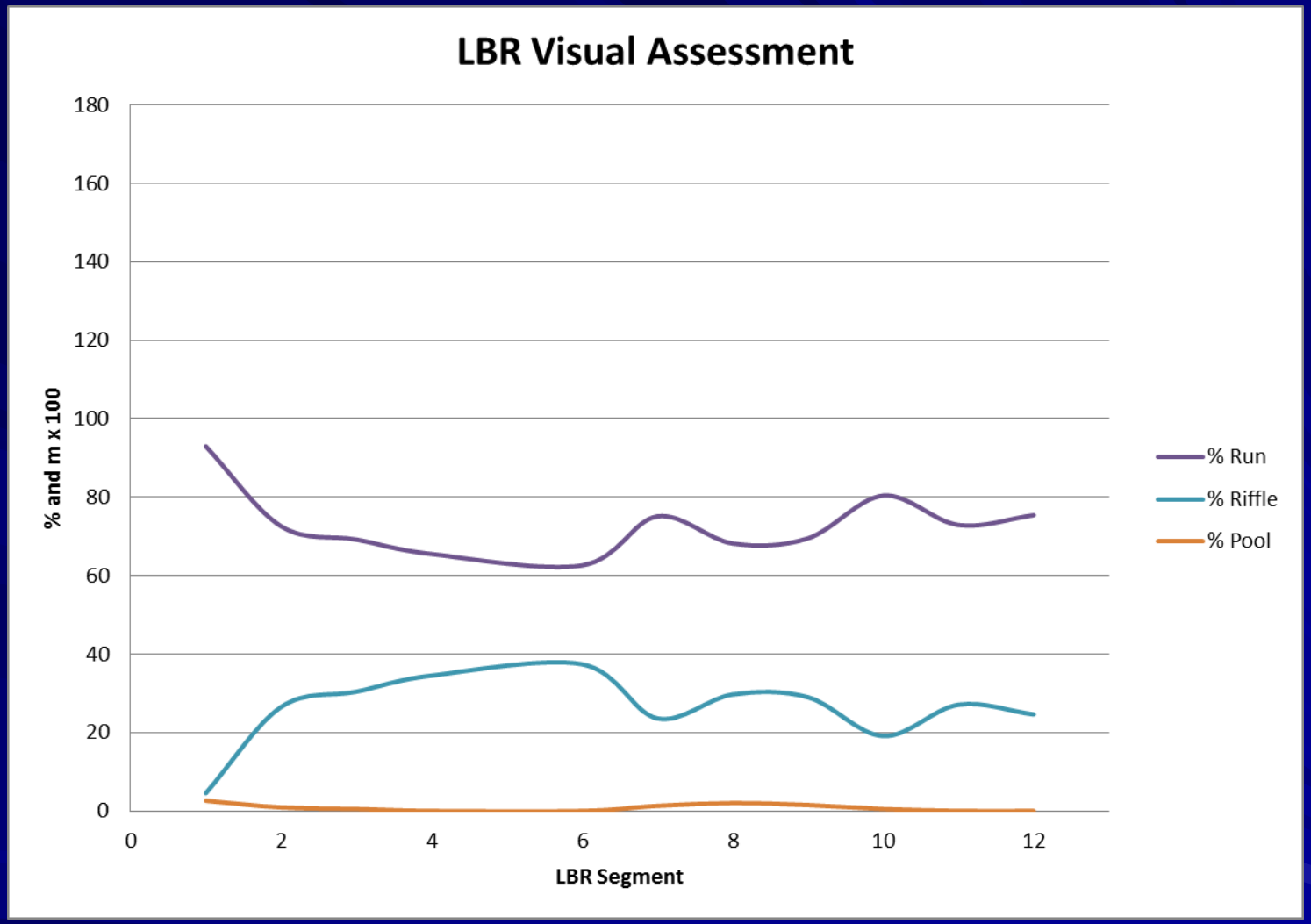
LBR Visual Assessment 2013



ATOX Segment	% Run	% Riffle	% Pool		
1	93.0%	4.5%	2.6%		
2	72.6%	26.5%	0.9%		
3	69.2%	30.4%	0.5%		
4	65.5%	34.5%	0.0%		
5	72.8%	26.1%	1.1%	(average of 6 & 7)	
6	62.6%	37.4%	0.0%		
7	75.1%	23.6%	1.3%		
8	68.2%	29.7%	2.0%		
9	69.5%	29.0%	1.5%		
10	80.4%	19.1%	0.5%		
11	72.9%	27.1%	0.0%		
12	75.4%	24.6%	0.0%		
13	75.4%	24.6%	0.0%	(same as 12)	

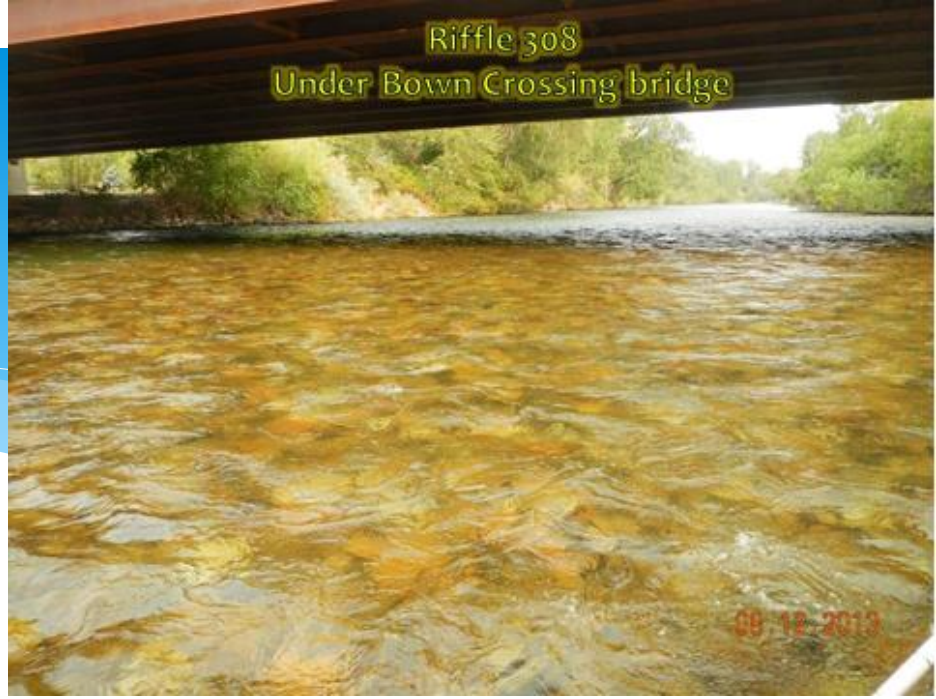
Riffles and Runs





Assumption: riffles and runs provide equally-suitable habitat, given other environmental conditions.

08.12.2013


Riffle 308
Under Bown Crossing bridge

08.12.2013

08.09.2013

Aquatox Model Segment Summaries

- Segment 1
- 1.8 meter visibility
- 4% periphyton present
  - 49% habitat available
  - 9% periphyton coverage
- Segment 2
- 1.7 meter visibility
- 16% periphyton present
  - 82% habitat available
  - 20% periphyton coverage
- Segment 3
- 1.5 meter visibility
- 65% periphyton present
  - 92% habitat available
  - 71% periphyton coverage
- Segment 4
- 1.3 meter visibility
- 71% periphyton present
  - 95% habitat available
  - 75% periphyton coverage
- Segment 6
- 1.3 meter visibility
- 49% periphyton present
  - 96% habitat available
  - 51% periphyton coverage
- Segment 7
- 0.9 meter visibility
- 55% periphyton present
  - 79% habitat available
  - 70% periphyton coverage
- Segment 8
- 0.9 meter visibility
- 72% periphyton present
  - 82% habitat available
  - 88% periphyton coverage

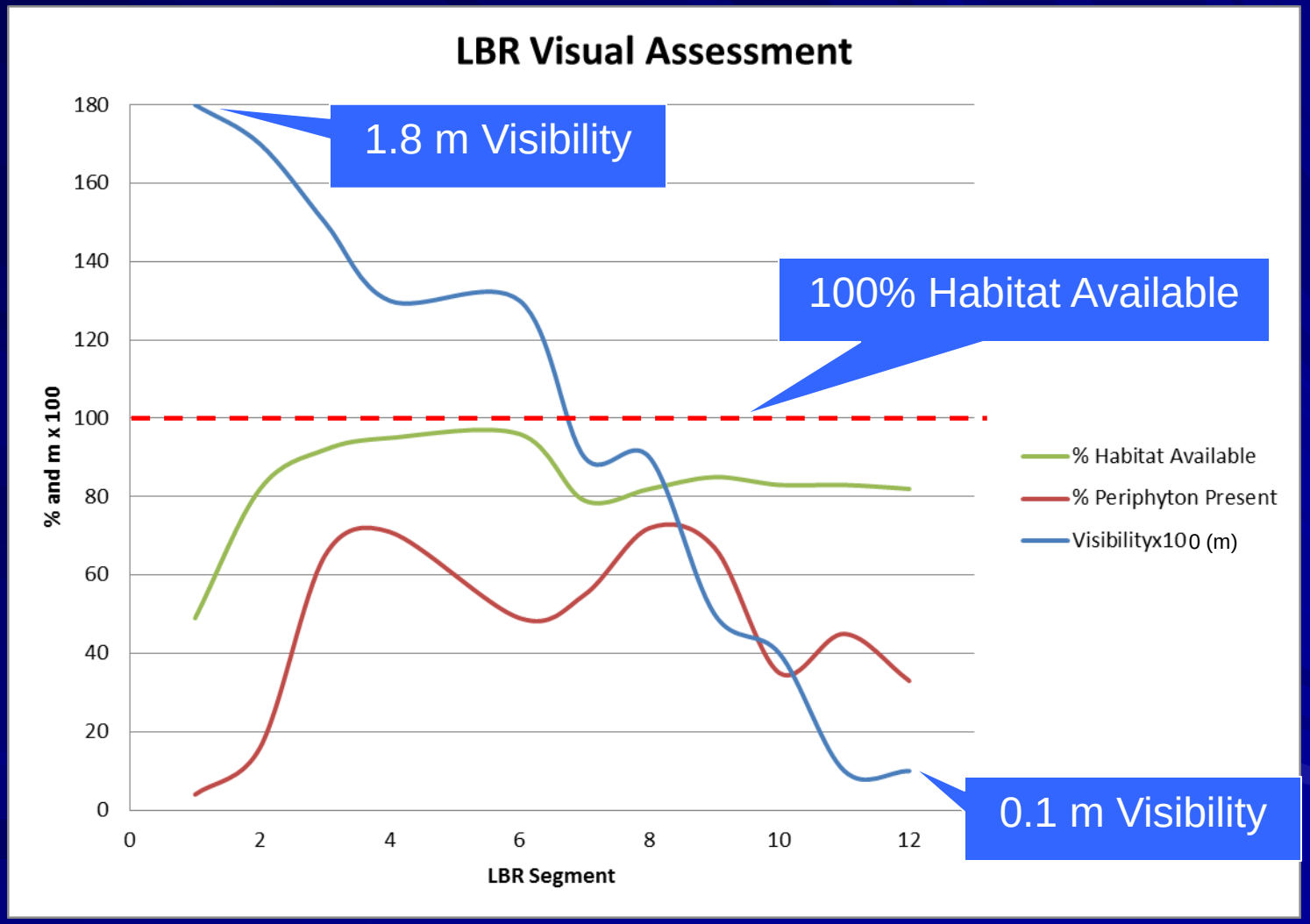
Aquatox Model Segment Summaries

* Segment 9
* 0.5 meter visibility
* 67% periphyton present
  * 85% habitat available
  * 79% periphyton coverage

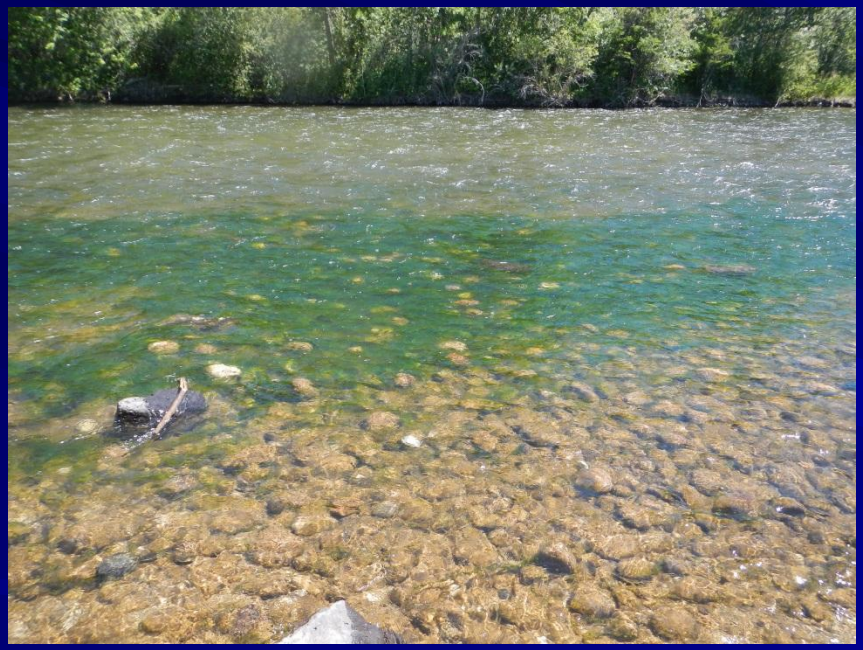
* Segment 10
* 0.4 meter visibility
* 35% periphyton present
  * 83% habitat available
  * 42% periphyton coverage

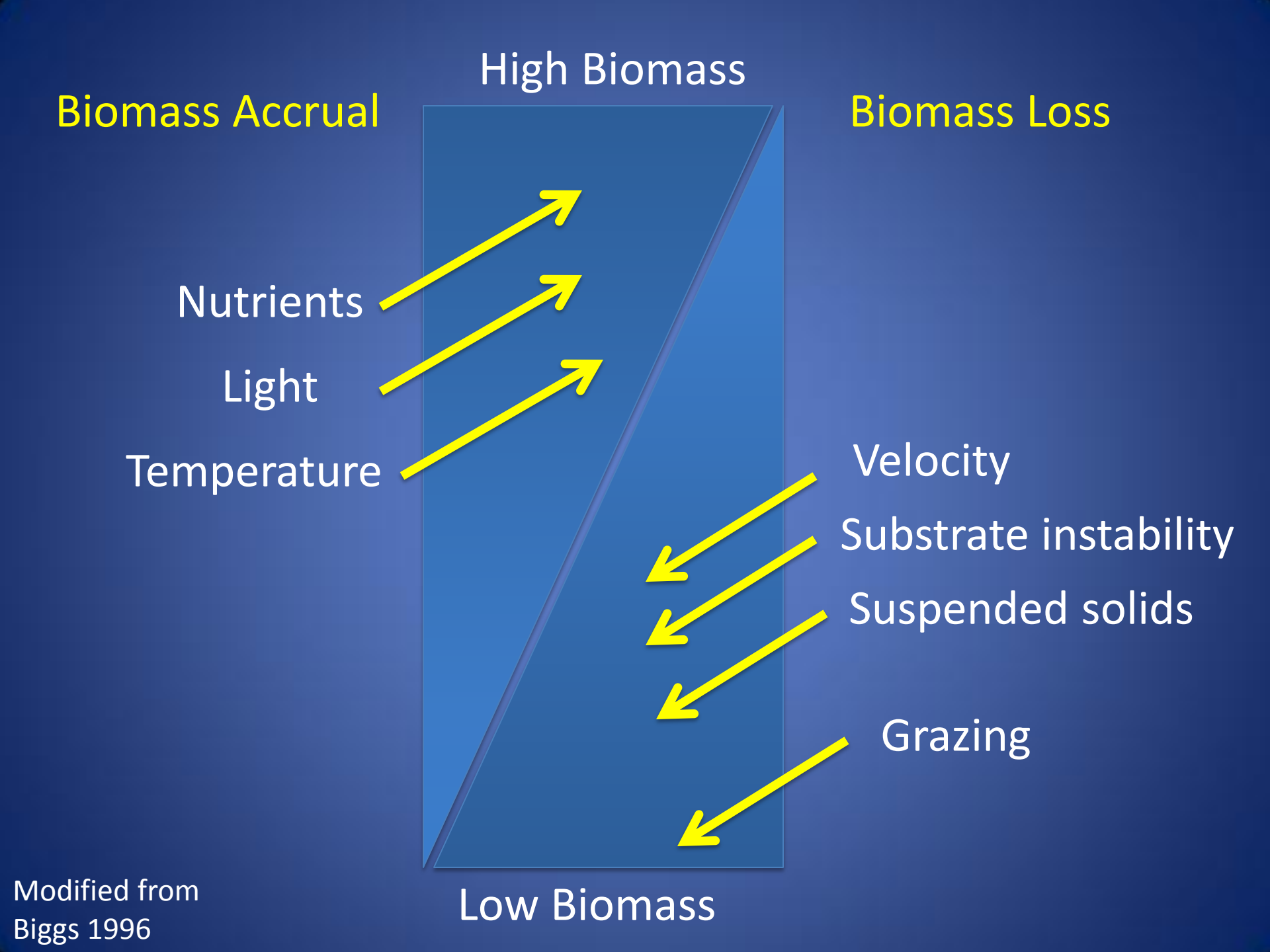
* Segment 11
* 0.1 meter visibility
* 45% periphyton present
  * %83 habitat available
  * % 54 periphyton coverage

* Segment 12
* 0.1 meter visibility
* 33% periphyton present
  * 82% habitat available
  * 40% periphyton coverage

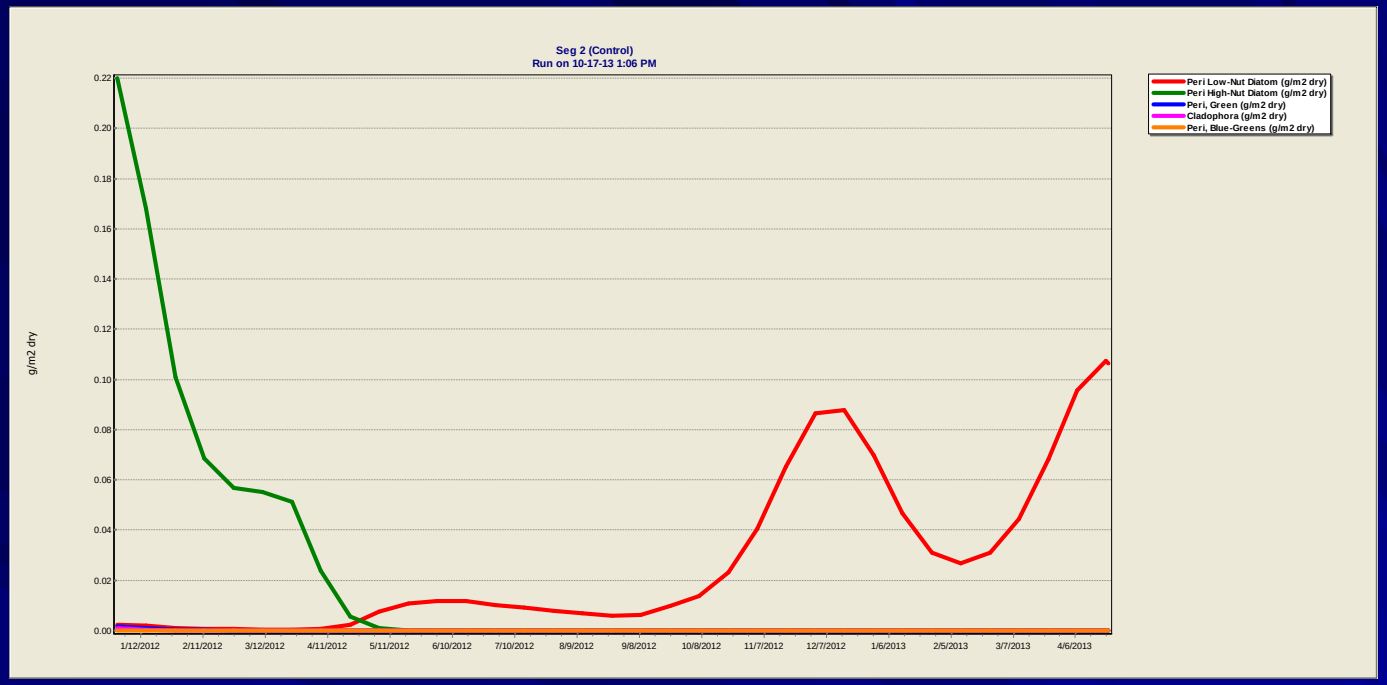

LBR Visual Assessment
1.8 m Visibility
100% Habitat Available
0.1 m Visibility
% and m x 100
LBR Segment
% Habitat Available
% Periphyton Present
Visibilityx100 (m)
180
160
140
120
100
80
60
40
20
0
0
2
4
6
8
10
12

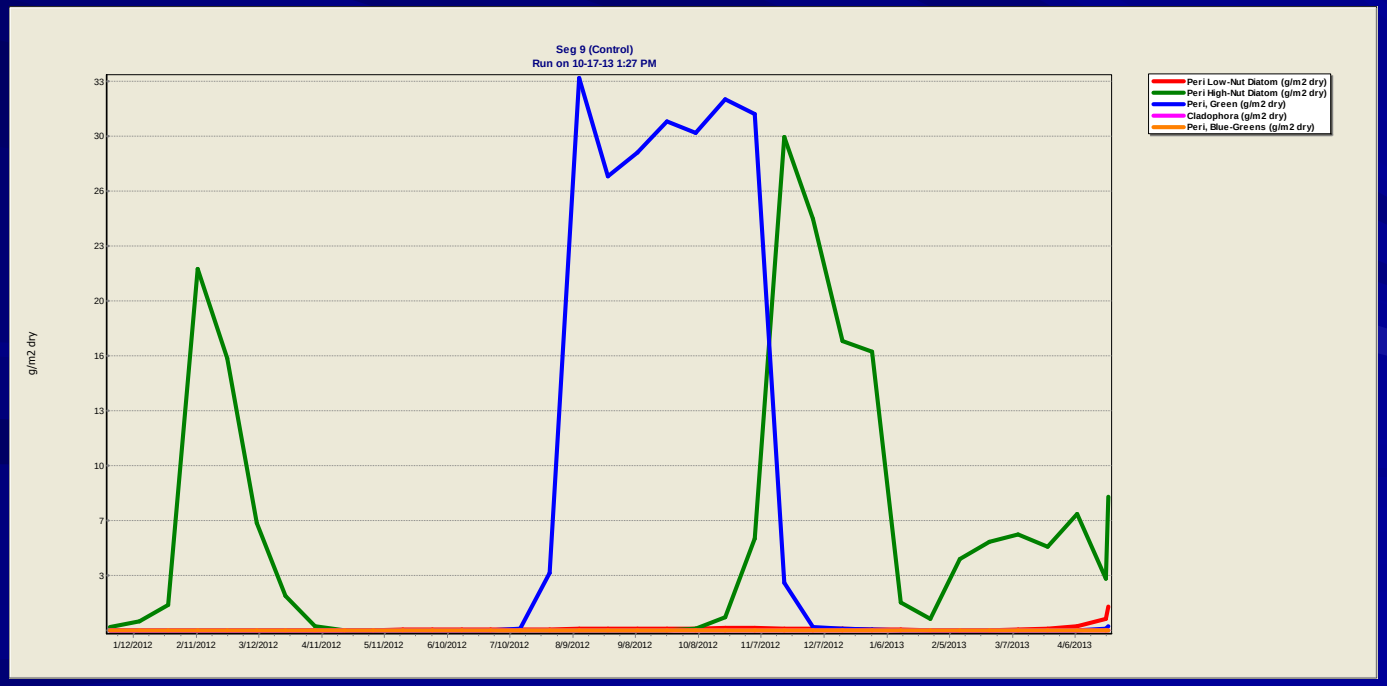
Algae Speciation

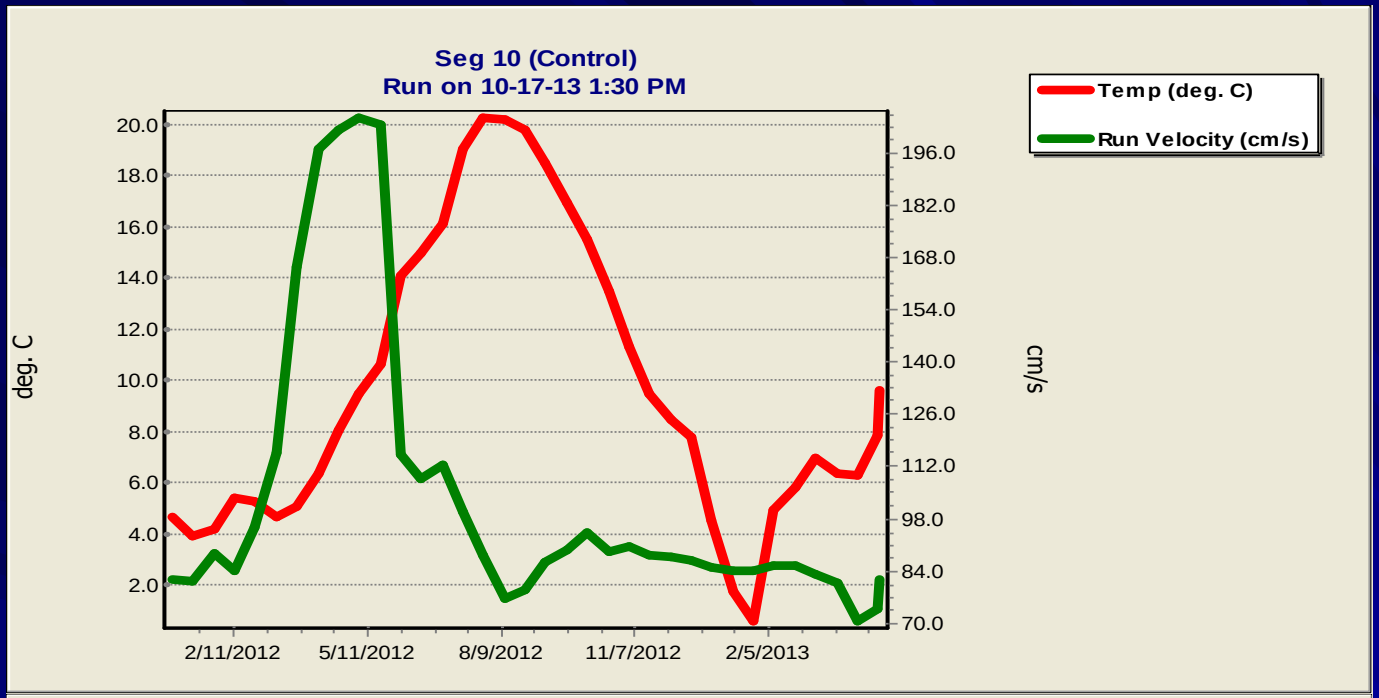


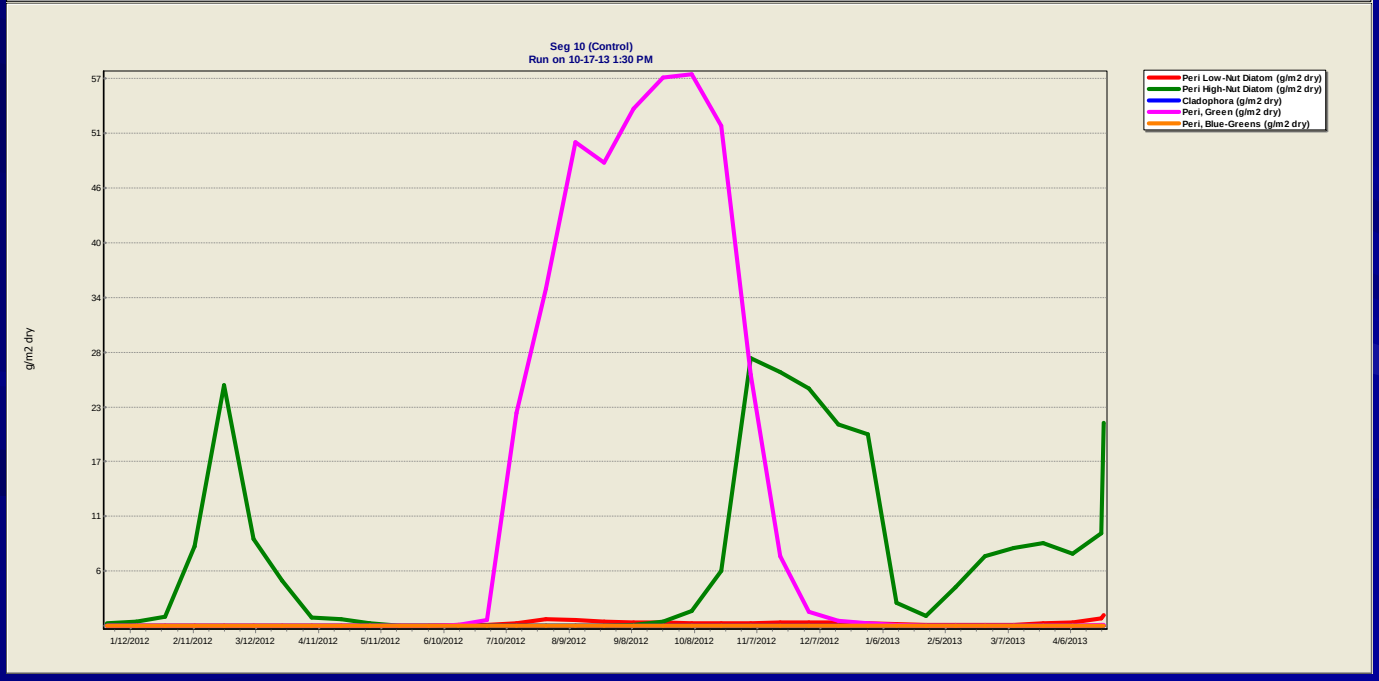


Modified from
Biggs 1996


Seg 2 (Control)
Run on 10-17-13 1:06 PM
g/m2 dry
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1/12/2012
2/11/2012
3/12/2012
4/11/2012
5/11/2012
6/10/2012
7/10/2012
8/9/2012
9/8/2012
10/8/2012
11/7/2012
12/7/2012
1/6/2013
2/5/2013
3/7/2013
4/6/2013
Peri Low-Nut Diatom (g/m2 dry)
Peri High-Nut Diatom (g/m2 dry)
Peri, Green (g/m2 dry)
Cladophora (g/m2 dry)
Peri, Blue-Greens (g/m2 dry)


Seg 9 (Control)
Run on 10-17-13 1:27 PM
g/m2 dry
33
30
26
23
20
16
13
10
7
3
1/12/2012
2/11/2012
3/12/2012
4/11/2012
5/11/2012
6/10/2012
7/10/2012
8/9/2012
9/8/2012
10/8/2012
11/7/2012
12/7/2012
1/6/2013
2/5/2013
3/7/2013
4/6/2013
Peri Low-Nut Diatom (g/m2 dry)
Peri High-Nut Diatom (g/m2 dry)
Peri, Green (g/m2 dry)
Cladophora (g/m2 dry)
Peri, Blue-Greens (g/m2 dry)


Seg 10 (Control)
Run on 10-17-13 1:30 PM
Temp (deg. C)
Run Velocity (cm/s)
deg. C
cm/s
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
196.0
182.0
168.0
154.0
140.0
126.0
112.0
98.0
84.0
70.0
2/11/2012
5/11/2012
8/9/2012
11/7/2012
2/5/2013


Seg 10 (Control)
Run on 10-17-13 1:30 PM
Peri Low-Nut Diatom (g/m2 dry)
Peri High-Nut Diatom (g/m2 dry)
Cladophora (g/m2 dry)
Peri, Green (g/m2 dry)
Peri, Blue-Greens (g/m2 dry)
g/m2 dry
57
51
46
40
34
28
23
17
11
6
1/12/2012
2/11/2012
3/12/2012
4/11/2012
5/11/2012
6/10/2012
7/10/2012
8/9/2012
9/8/2012
10/8/2012
11/7/2012
12/7/2012
1/6/2013
2/5/2013
3/7/2013
4/6/2013

Algae Speciation

City of Boise collected periphyton data for initial AQUATOX model

- “Soft” algae were identified and relative abundance was categorized
- Diatoms were identified and quantified
- Diatoms were assigned to autecological guilds or used as indicator species

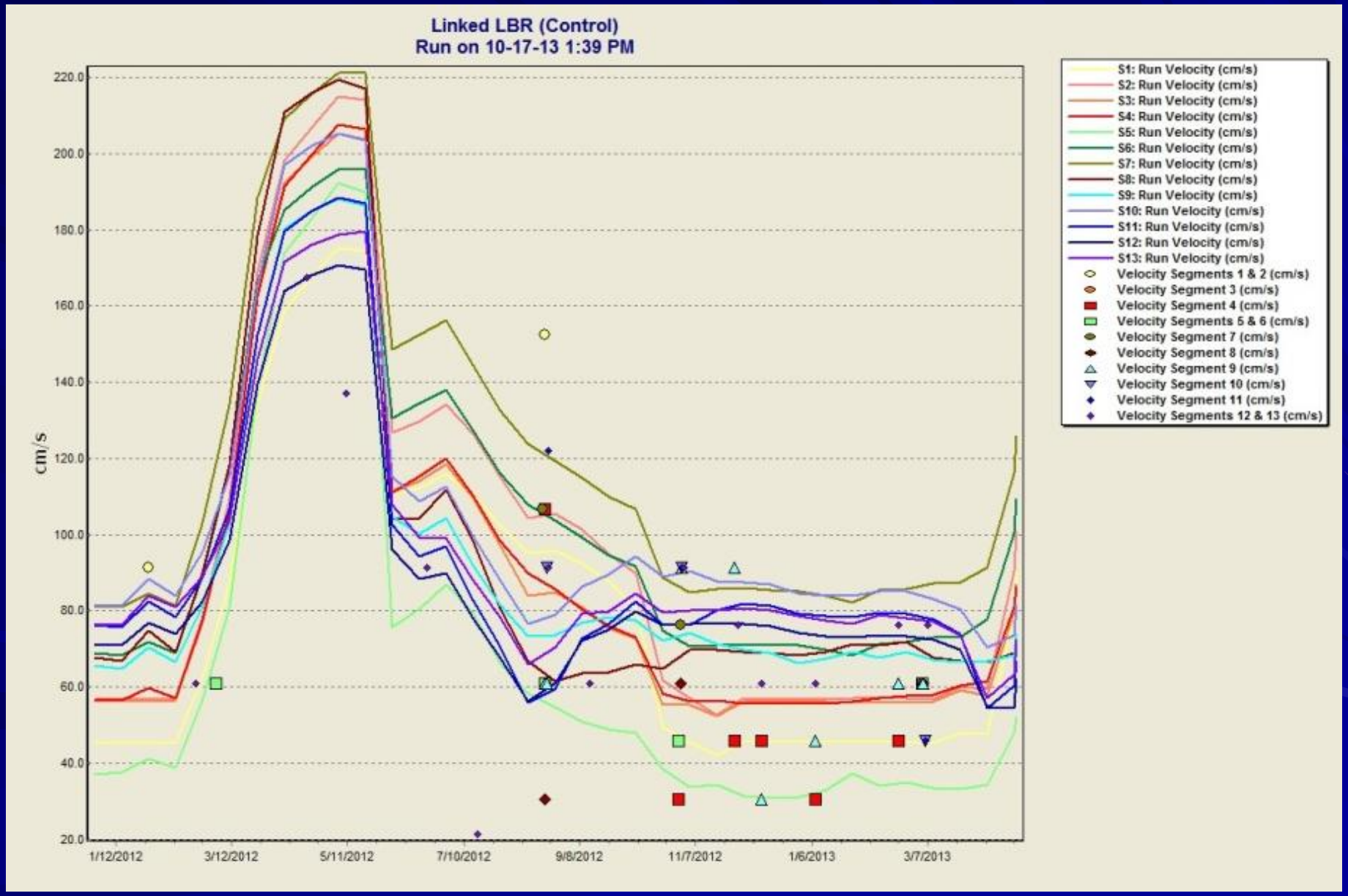
Modeling TP-Periphyton-Habitat Relationships

- Calibrate to current conditions
- Evaluate periphyton responses to changes in TP, TSS, Velocity, Light, Temp, other
- Apply results toward developing TP TMDL targets

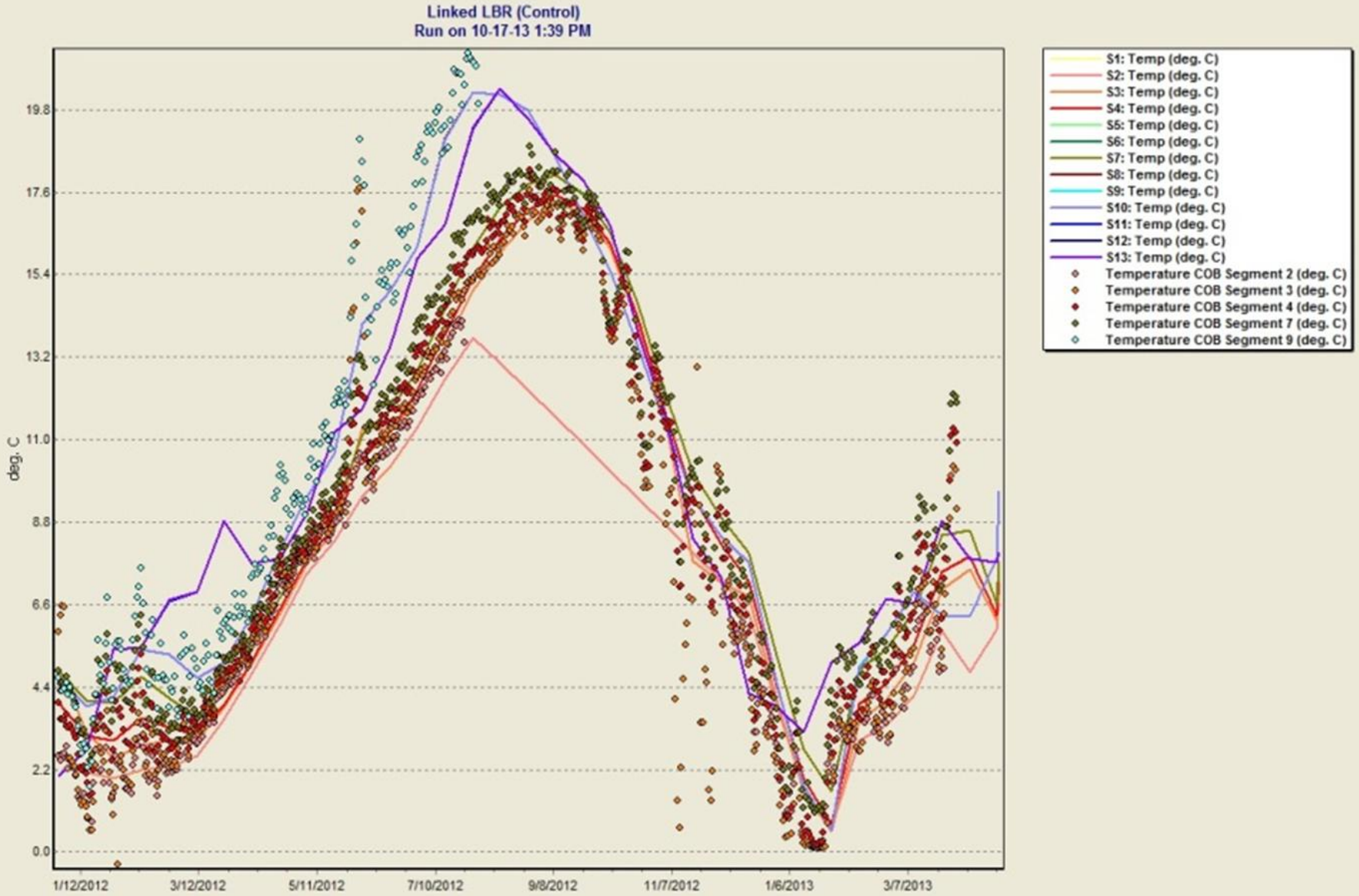
Proposed Calibration Goals

* Velocity within 10-20 cm/sec
* Water level within 10 cm
* Temperature within 1°C
* Dissolved oxygen <2 mg/L in eutrophic system
* TSS, nutrient, and algal concentration within 10-25% of the range of the field data

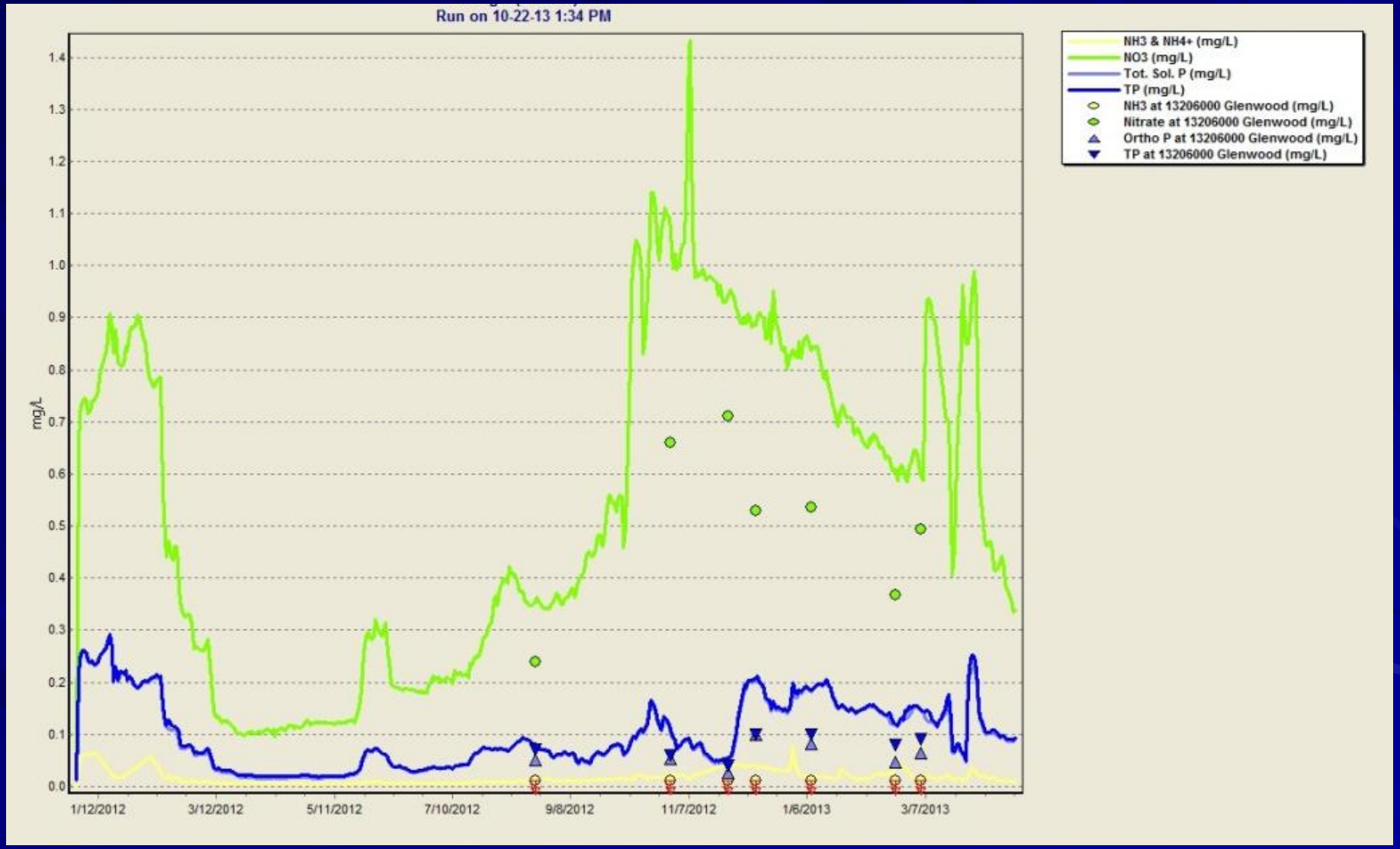
Initial Calibration - Velocity



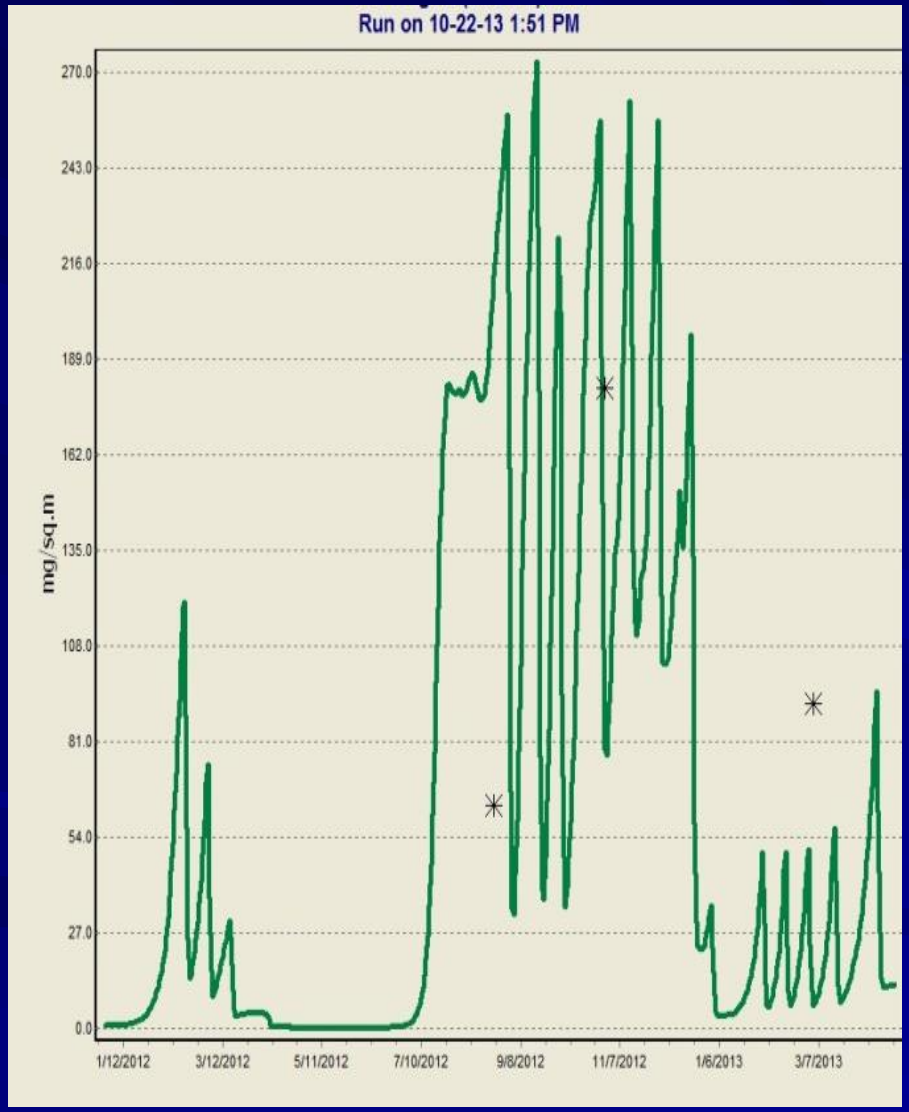
Initial Calibration - Temperature



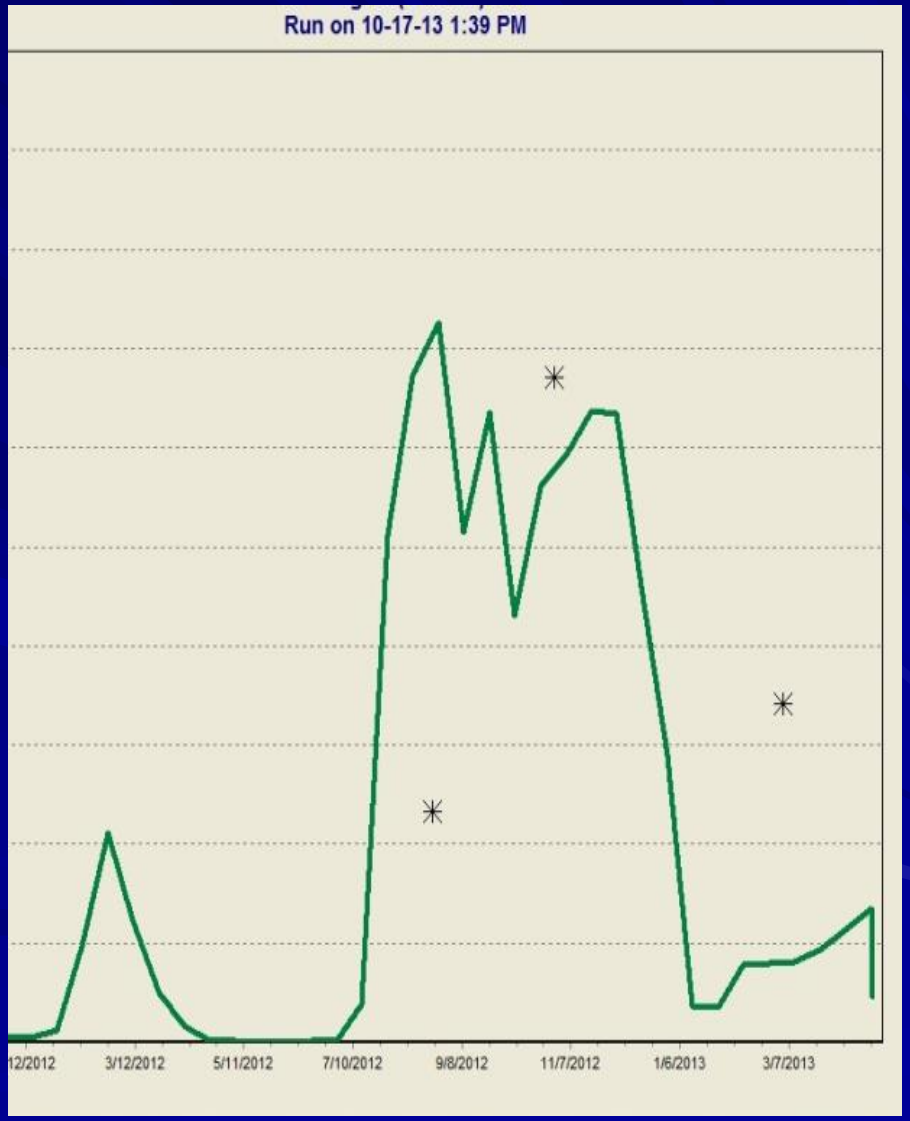
Initial Calibration - Nutrients



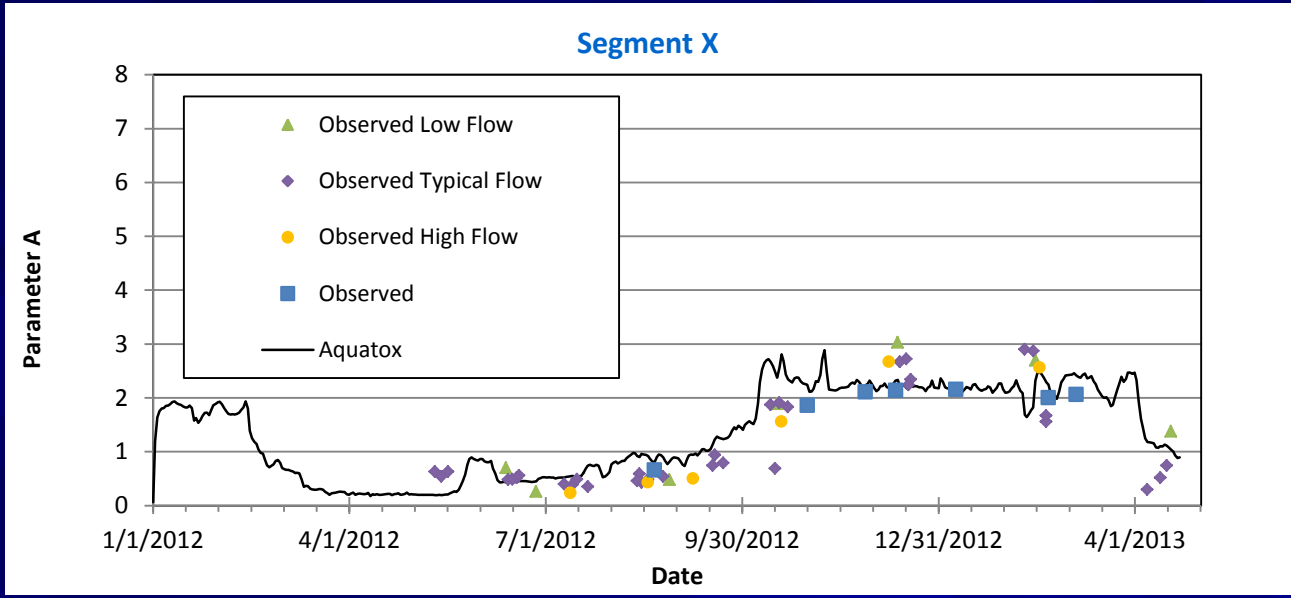
Initial Calibration – Chl a (Daily)

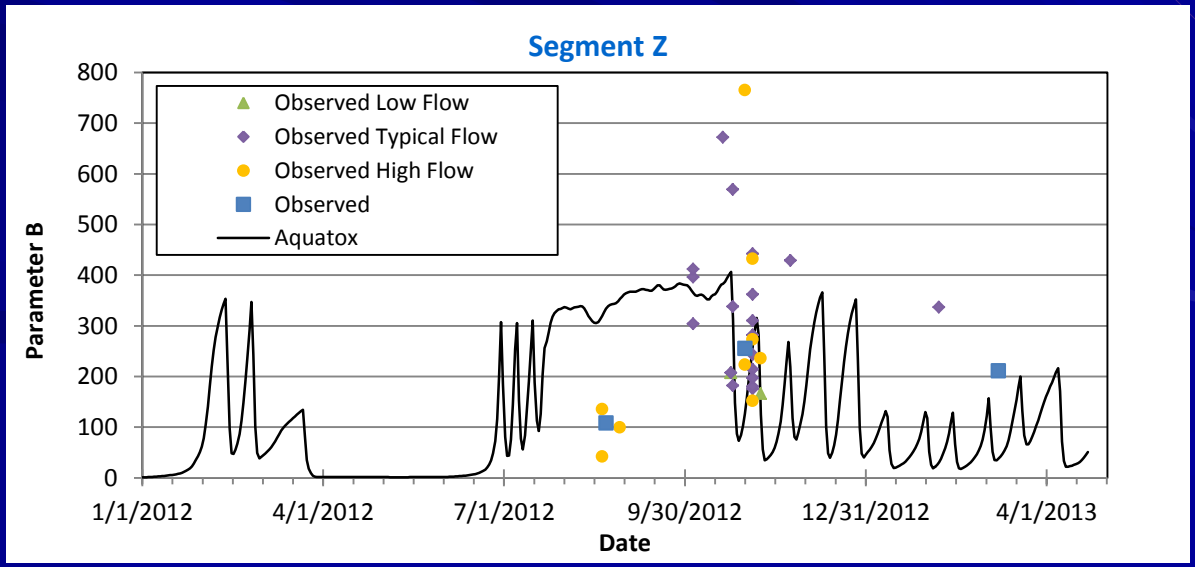


Initial Calibration – Chl a (14-day)



Modeled/Observed/Historical Values

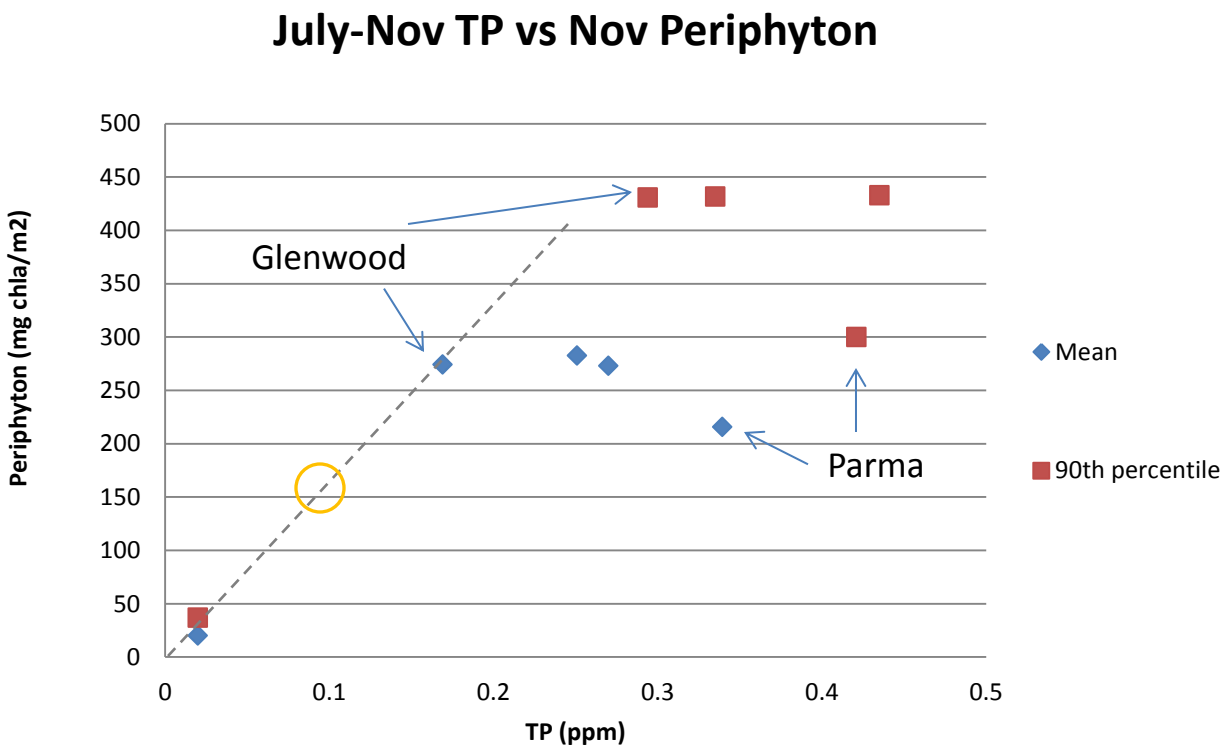




**Figures courtesy of Michael Kasch (HDR).

Summer/Fall TP and November Periphyton

**Slide courtesy of Ben Cope (EPA).



Notes:

- Reasonable line of evidence to compare to AQUATOX estimates?

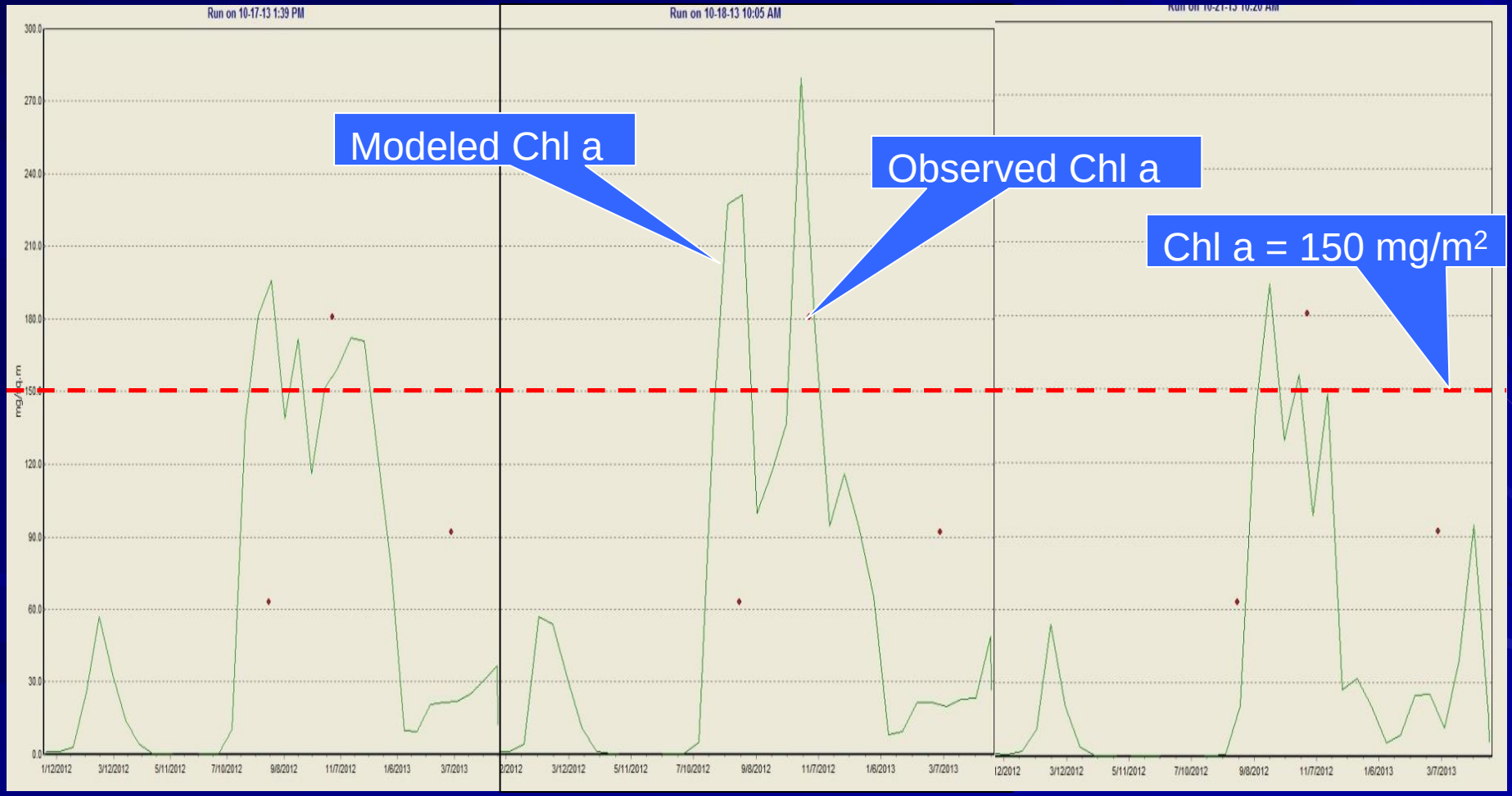
-Linear extrapolation → target would be approx. 100 ug/L TP to reduce mean November periphyton density to 150 mg chla/m2

Scenario Modeling

- Identify appropriate TP, TSS, and other habitat parameter adjustments…
- Identify impacts on chl a biomass and other important WQ standards/criteria resulting from parameter adjustments…
- Use model results to help develop TP targets for TMDL

Modeling Periphyton

Existing < TSS < TSS & < TP



Potential Scenarios

- Reduce mainstem LBR TSS by 37%
- Parma TP load ≤ 0.07 mg/L, May – Sept
- Critical low flows
- Model results to help inform location, duration, frequency target refinement

Contact Information

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