AQUATOX MODELING

Elm Creek TMDL – Linked Lower Elm Creek Segments

Where we have been?

- Previous meeting topics:
  - Data summary
  - Stressor summary
  - Assigning allocations
  - Intro to modeling

TMDL "Equation"

$$TMDL = \sum WLA + \sum LA + MOS + RC$$

WLA = Wasteload Allocation (Permitted sources)

LA = Load Allocation (Non-permitted sources)

MOS = Margin of Safety

RC = Reserve Capacity

TMDL Process

$$TMDL = \sum WLA + \sum LA + MOS + RC$$

Science

$$1000 = 800 + 600 + 100 + 100$$

Current Conditions

Load Reduction

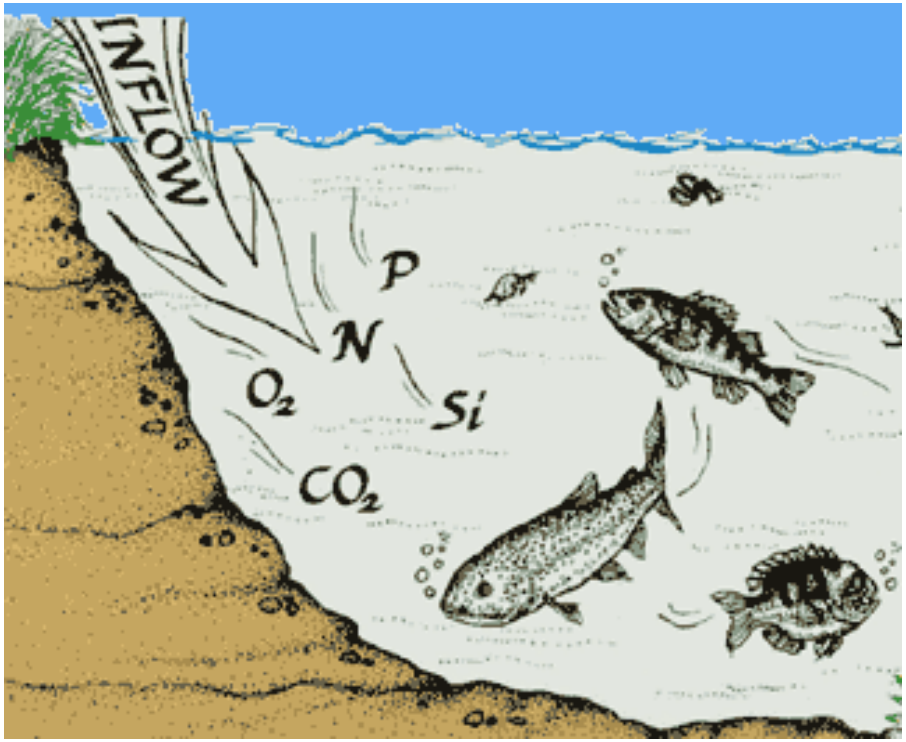
Policy and Technology

$$1000 = 500 + 300 + 100 + 100$$

Desired Conditions

AQUATOX

- EPA Supported Water Quality/Aquatic Response Model
  - http://water.epa.gov/scitech/datait/models/aquatox/index.cfm



Multi-segment Foodweb Model

Figure 2. State Variables in AQUATOX as implemented for Cahaba River, Alabama.

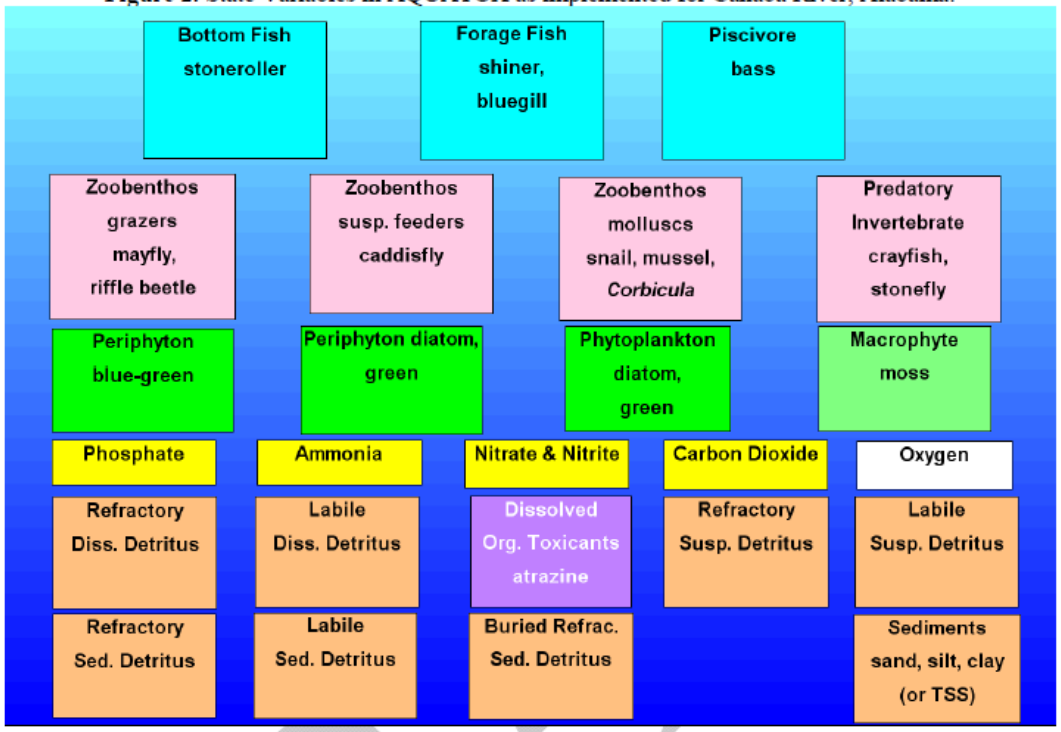
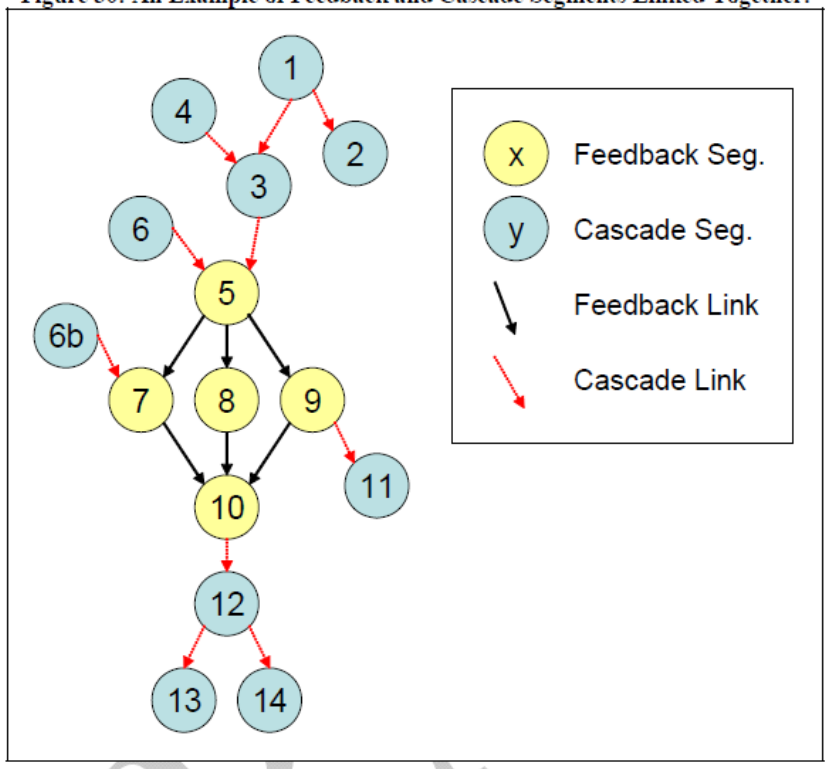
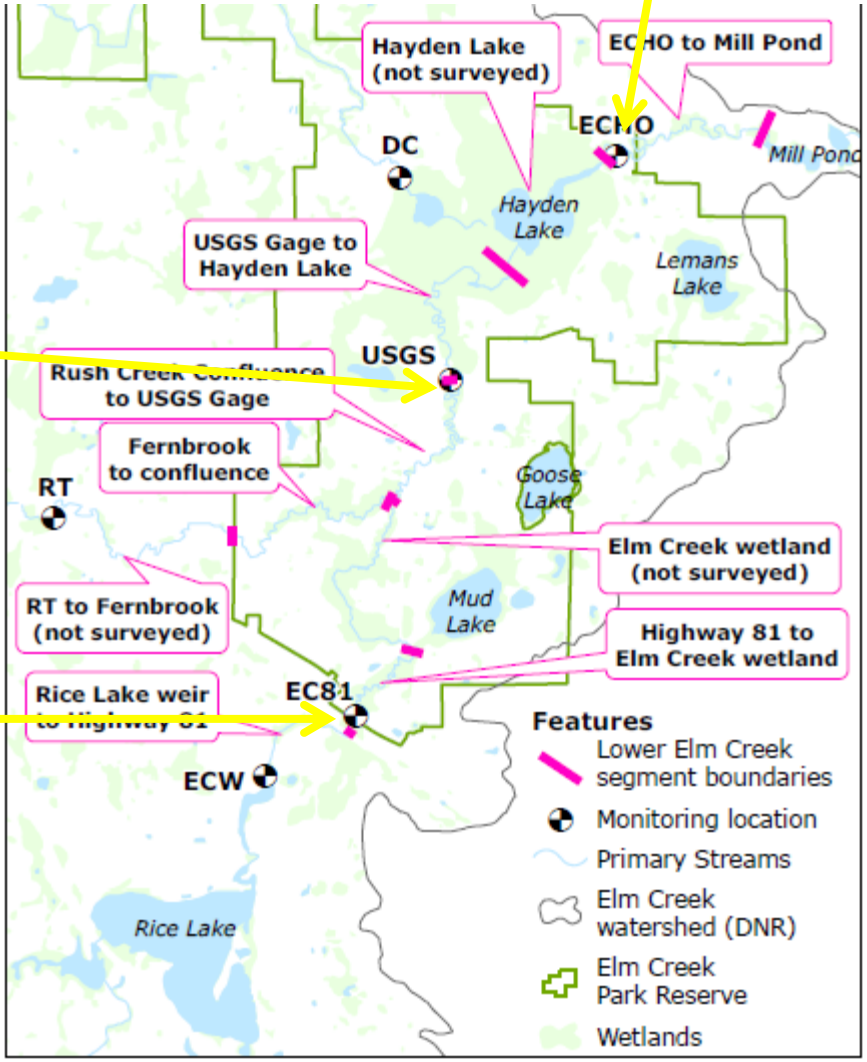


Figure 30: An Example of Feedback and Cascade Segments Linked Together.

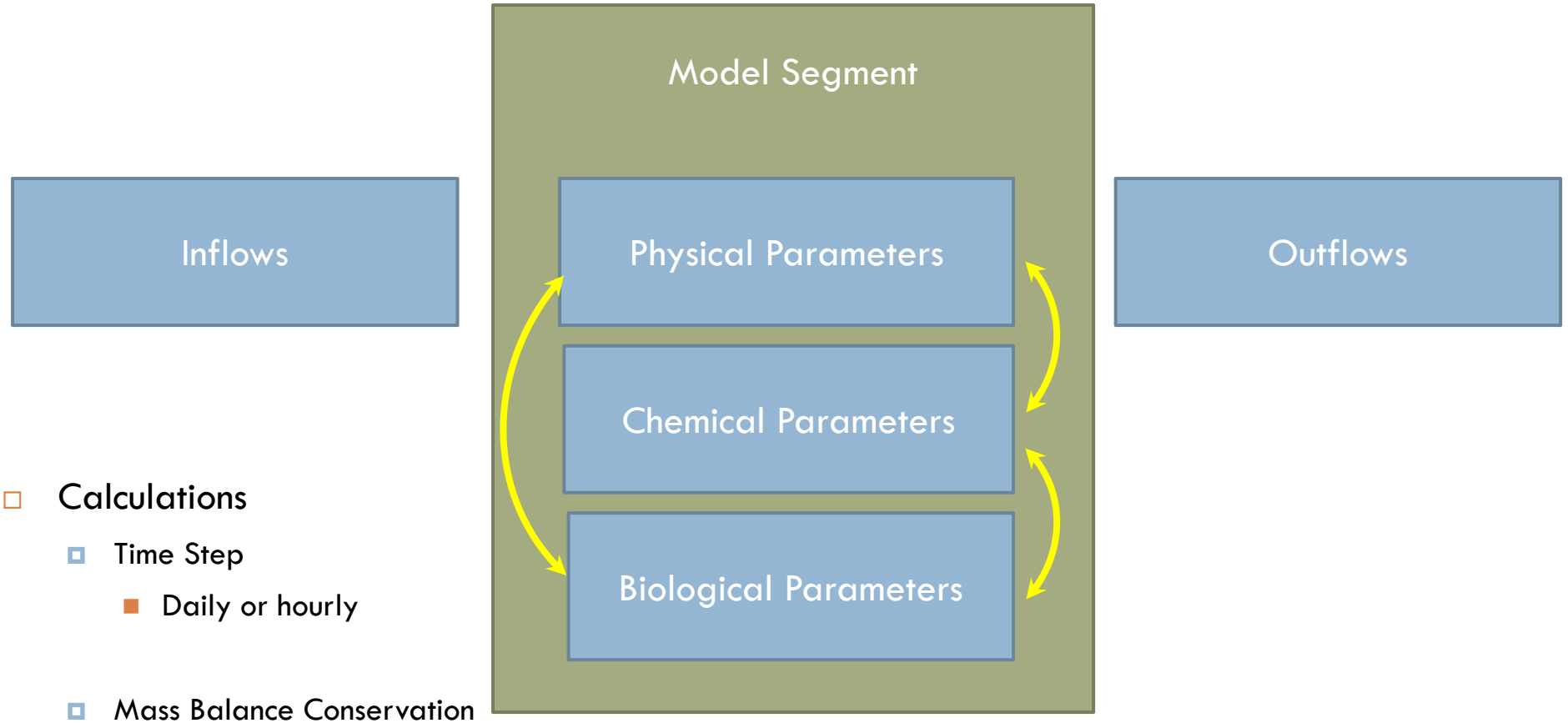


Lower EC Segments

- Individual segments differentially parameterized

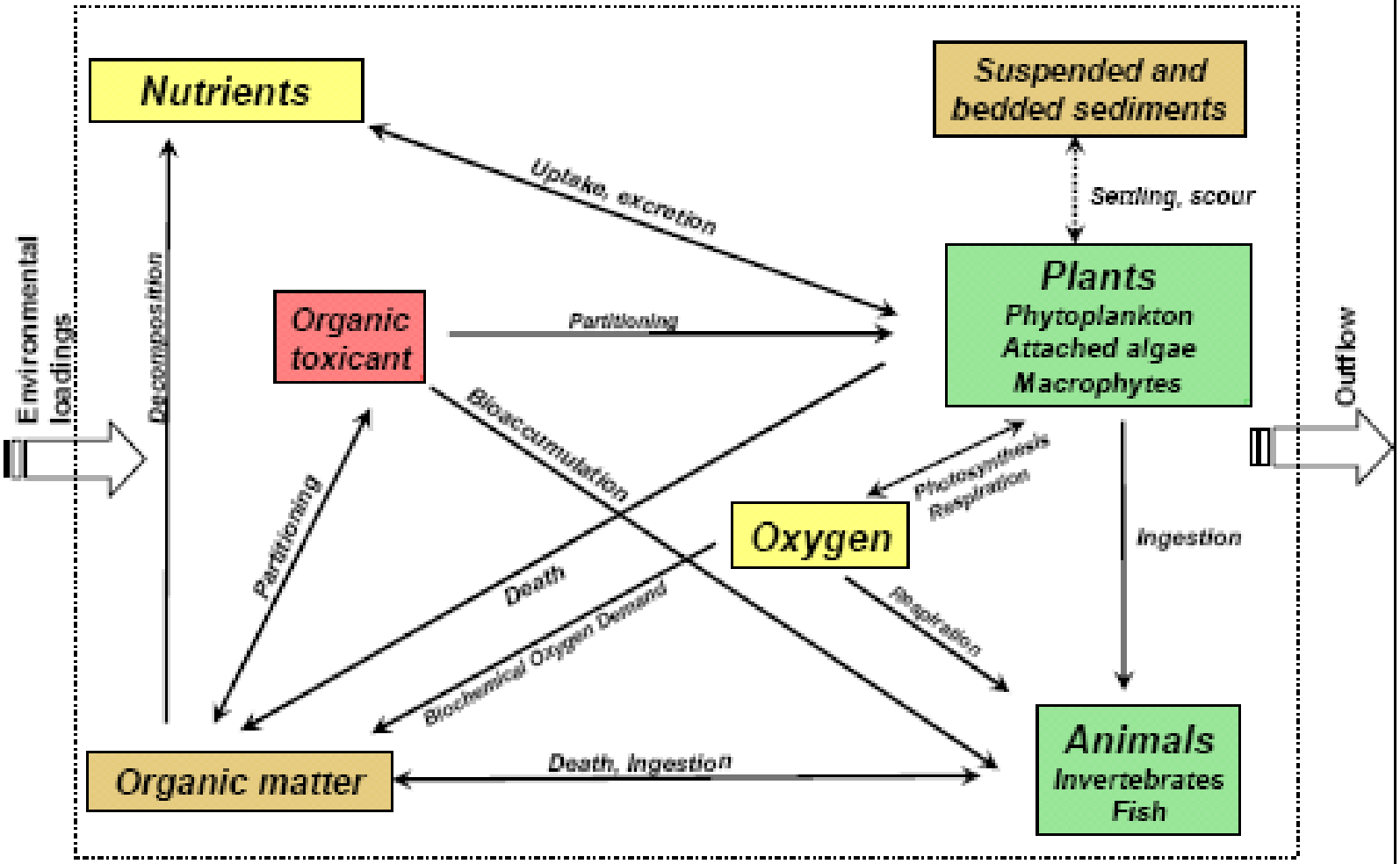


AQUATOX Structure



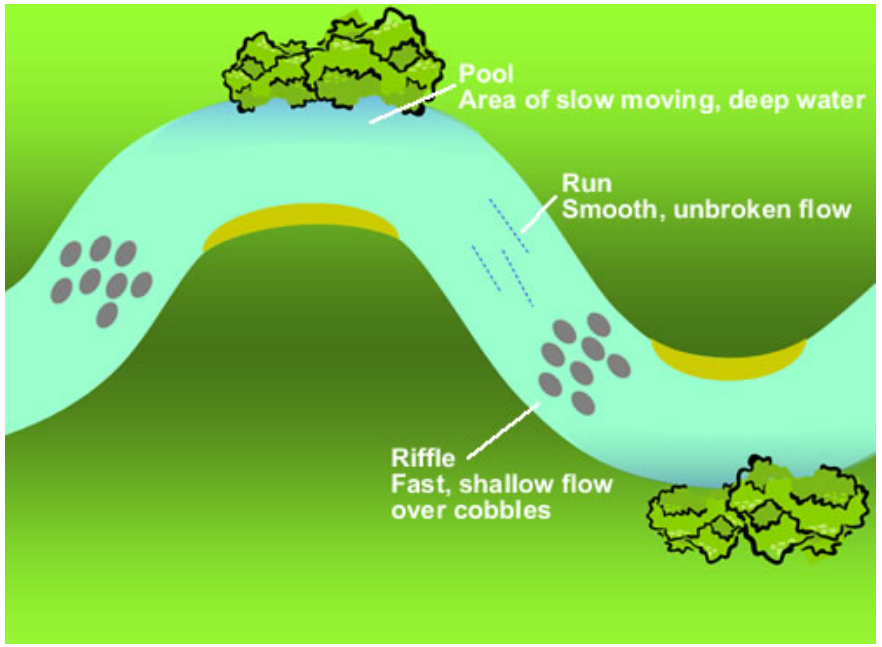
- Calculations
  - Time Step
    - Daily or hourly
  - Mass Balance Conservation

AQUATOX Simulates Ecological Processes & Effects Over Time

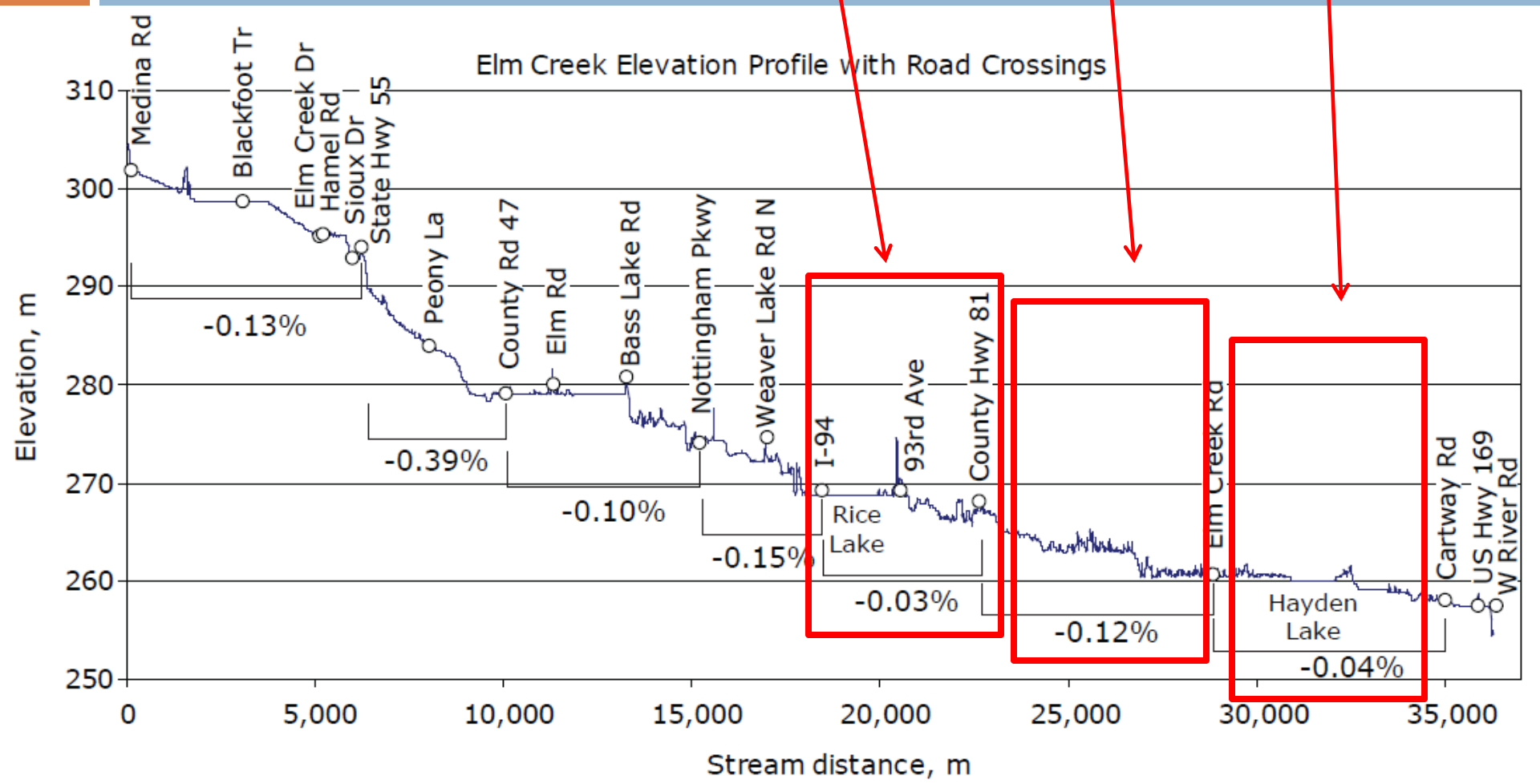


Morphological Parameters

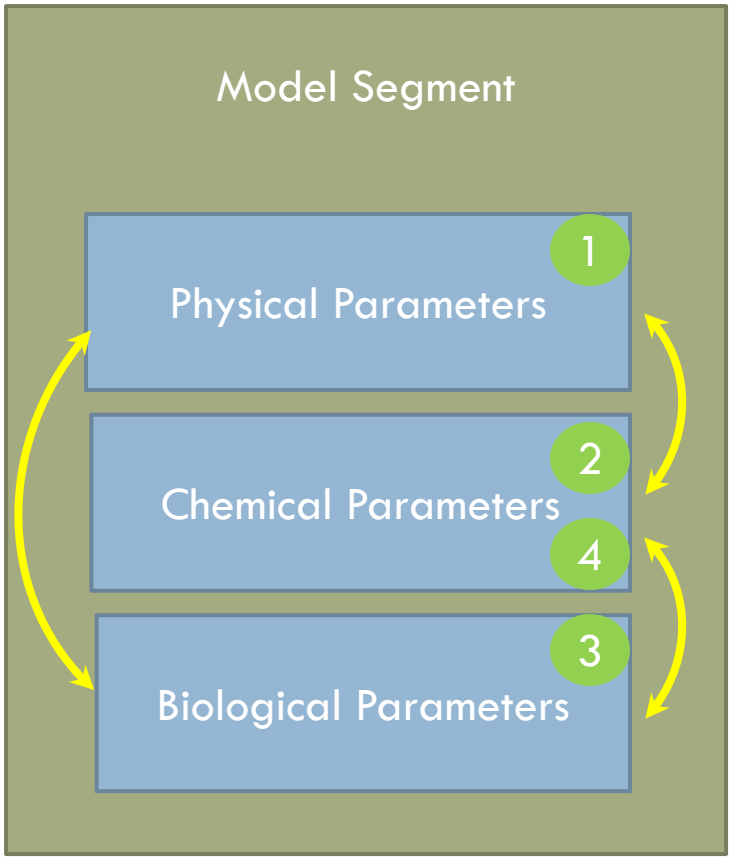
- Channel Morphometry
  - Average site cross sections
    - Length
    - Width
    - Slope
    - Manning's roughness
- Fraction of site shaded
- Percent riffle, run and pool
- Reservoirs



Stream Slope



AQUATOX Segment Calibration

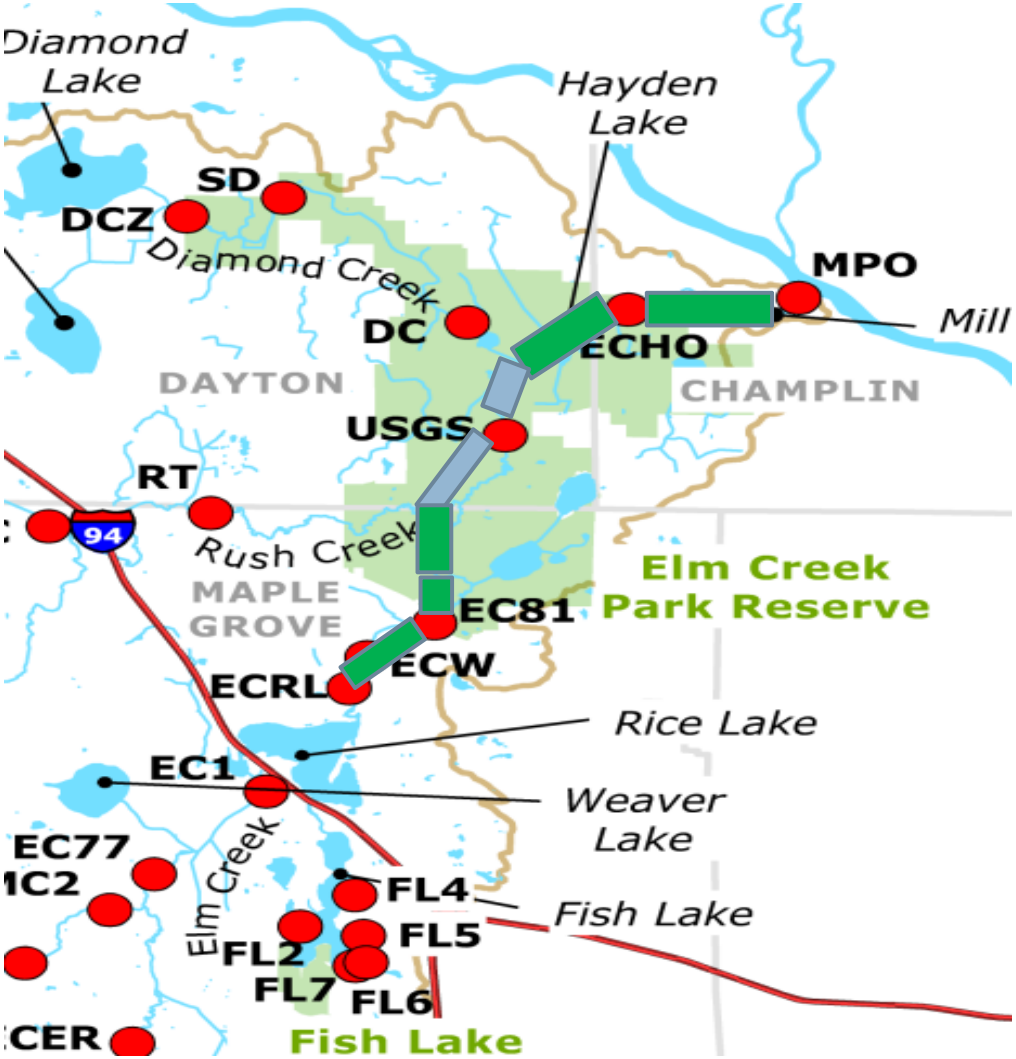


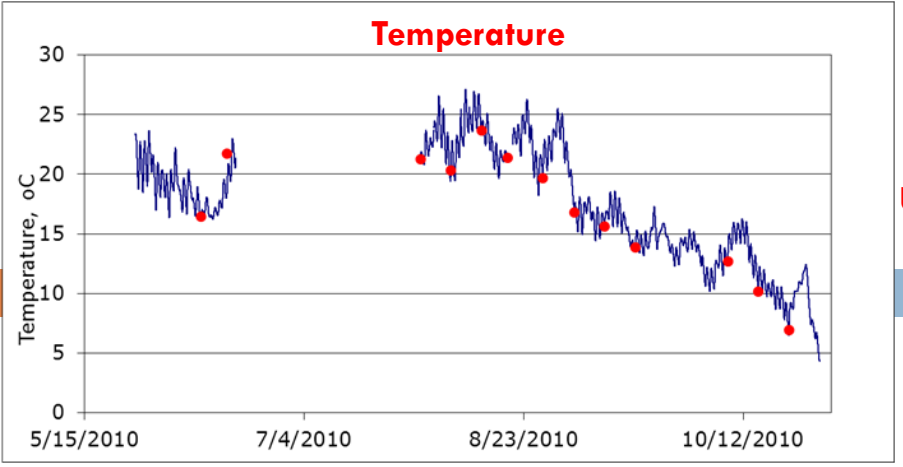
- Inputs
  - Flow
  - Nutrients
  - Organic matter (BOD)
  - Temp
  - Channel Morphology

- Outputs
  - TP and SRP
  - Nitrogen
  - TSS
  - BOD
  - SOD
  - Velocity
  - Biota

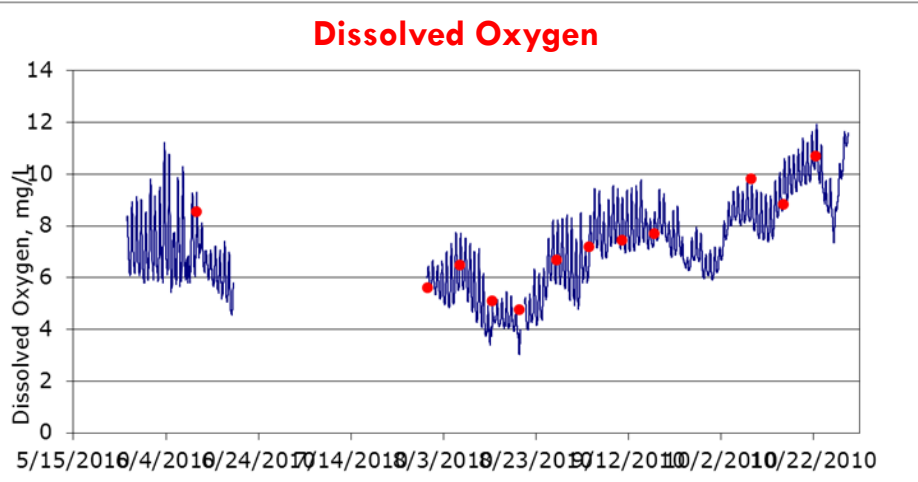
Multi-segment Calibration

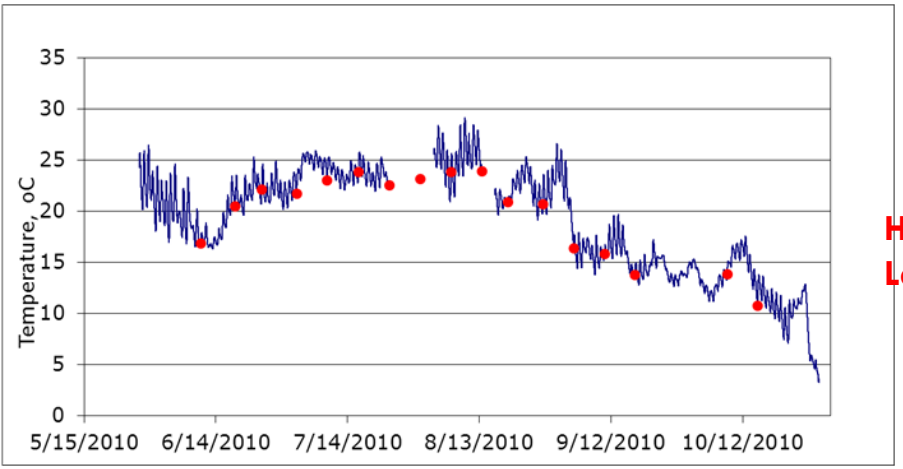
- Individual segment types are differentially calibrated
  - Wetland vs. non-wetland
    - Sediments
      - Nutrient
      - Organic C
    - Morphology
      - Pool vs. Run/Riffle



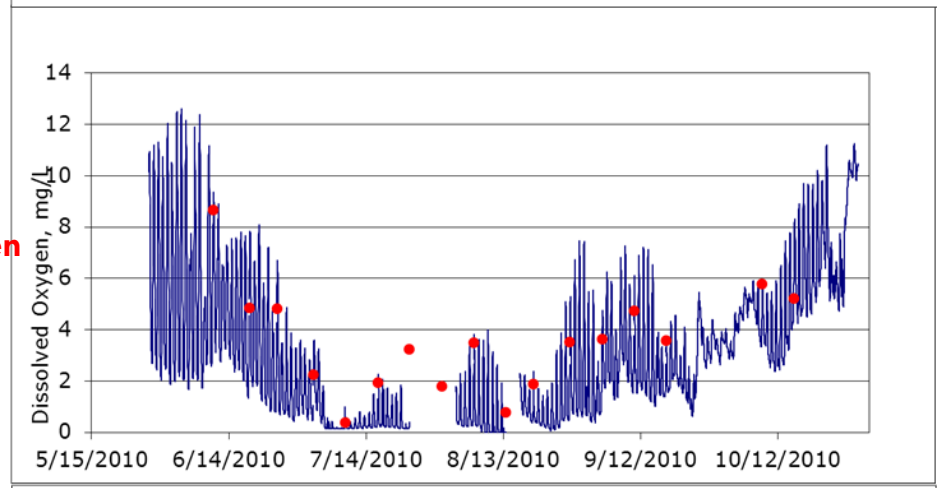


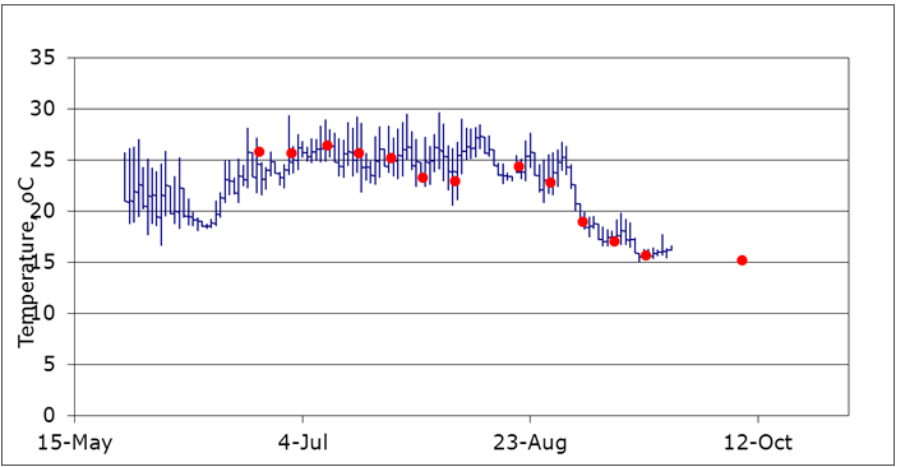
USGS



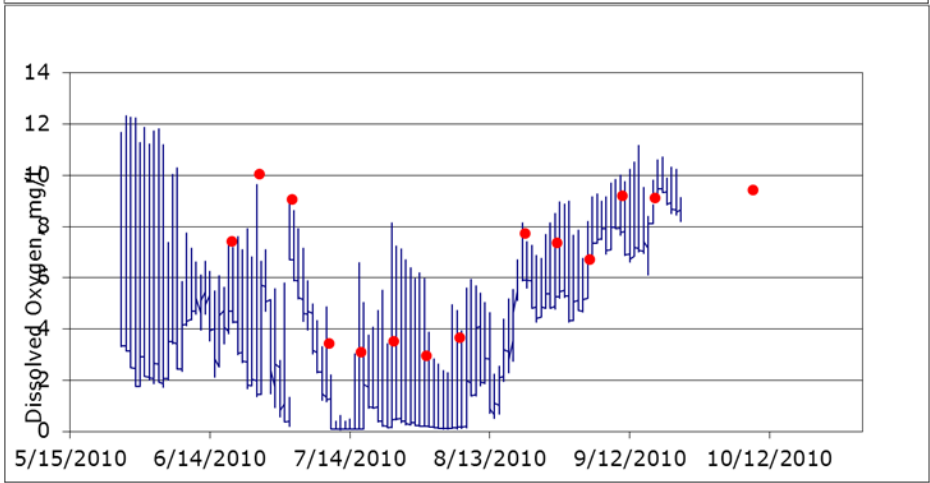


Hayden Lake

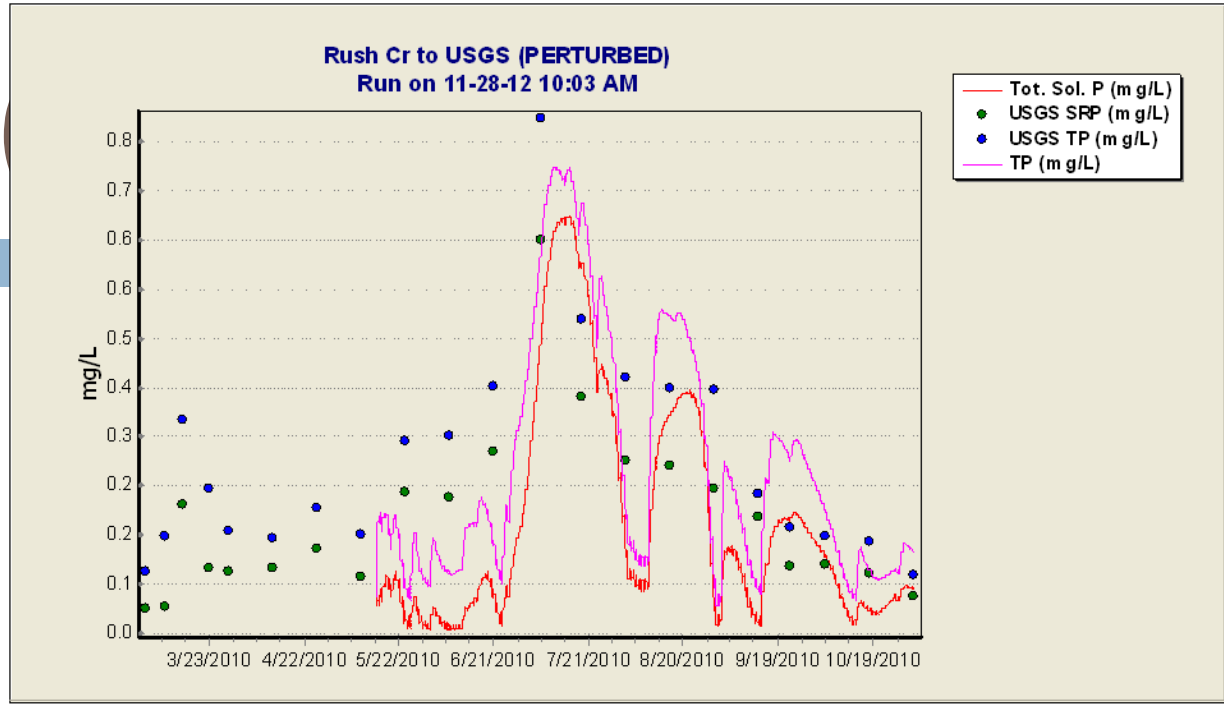


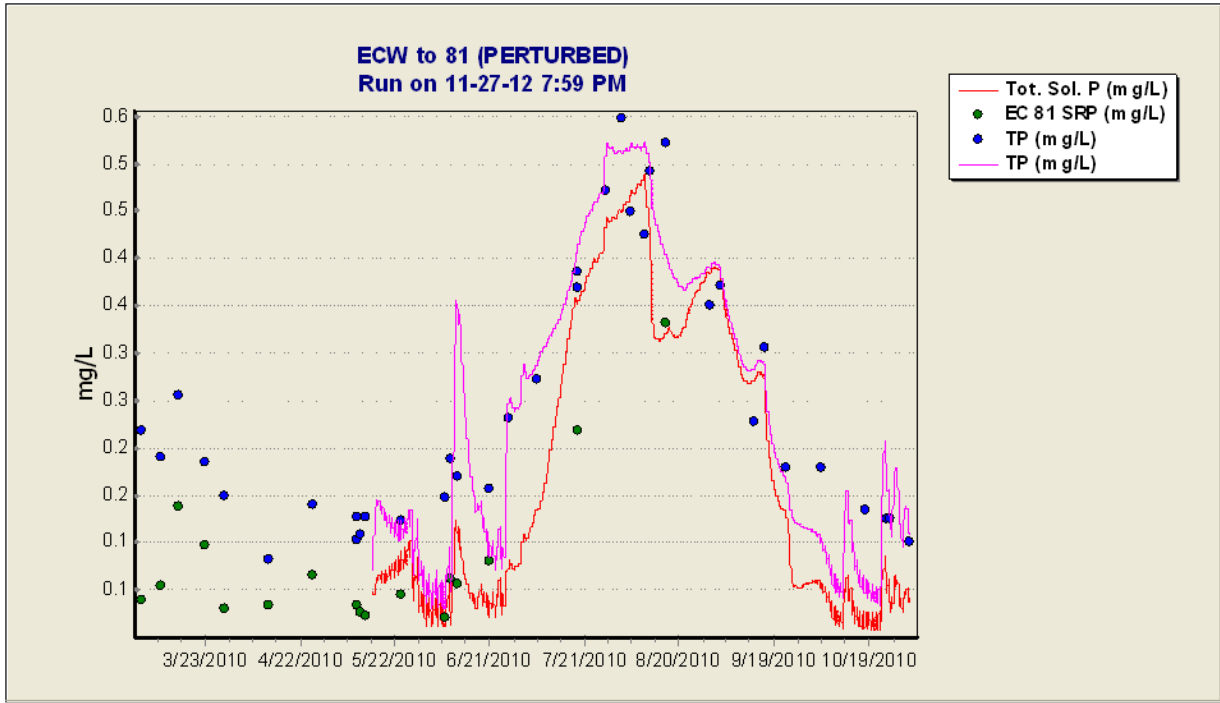


EC 81

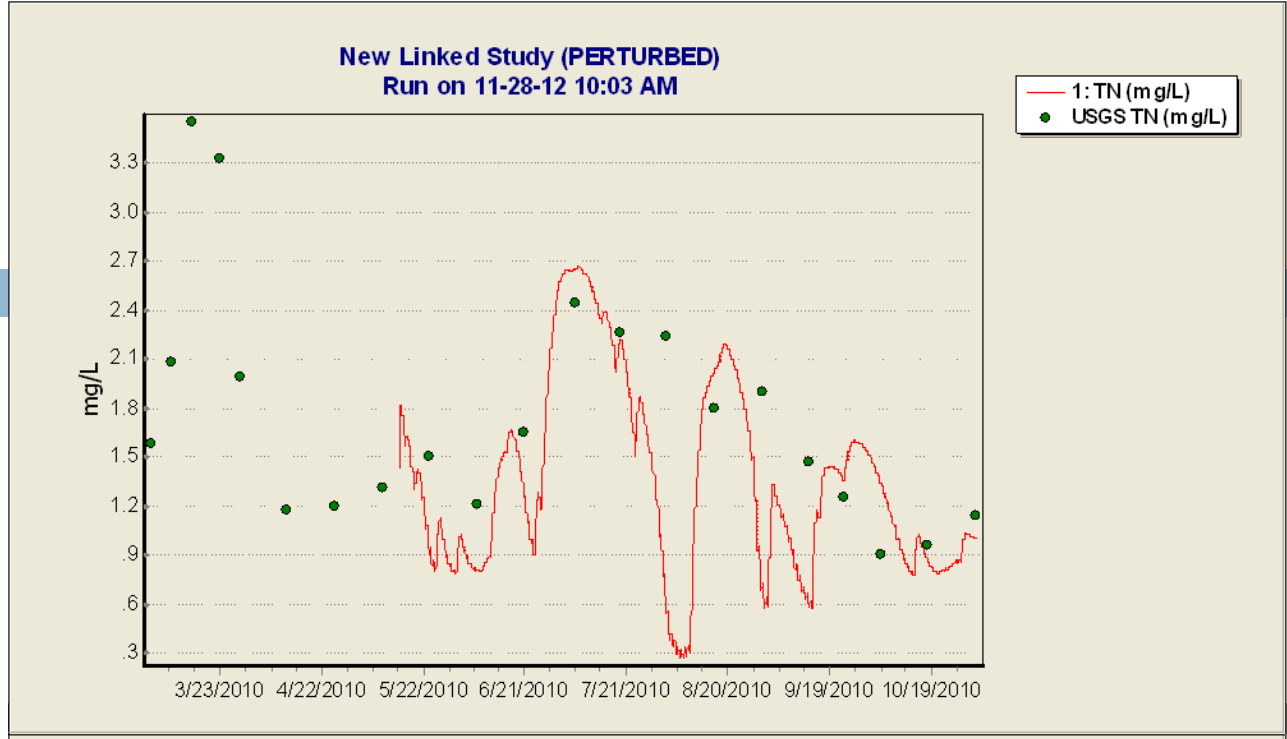


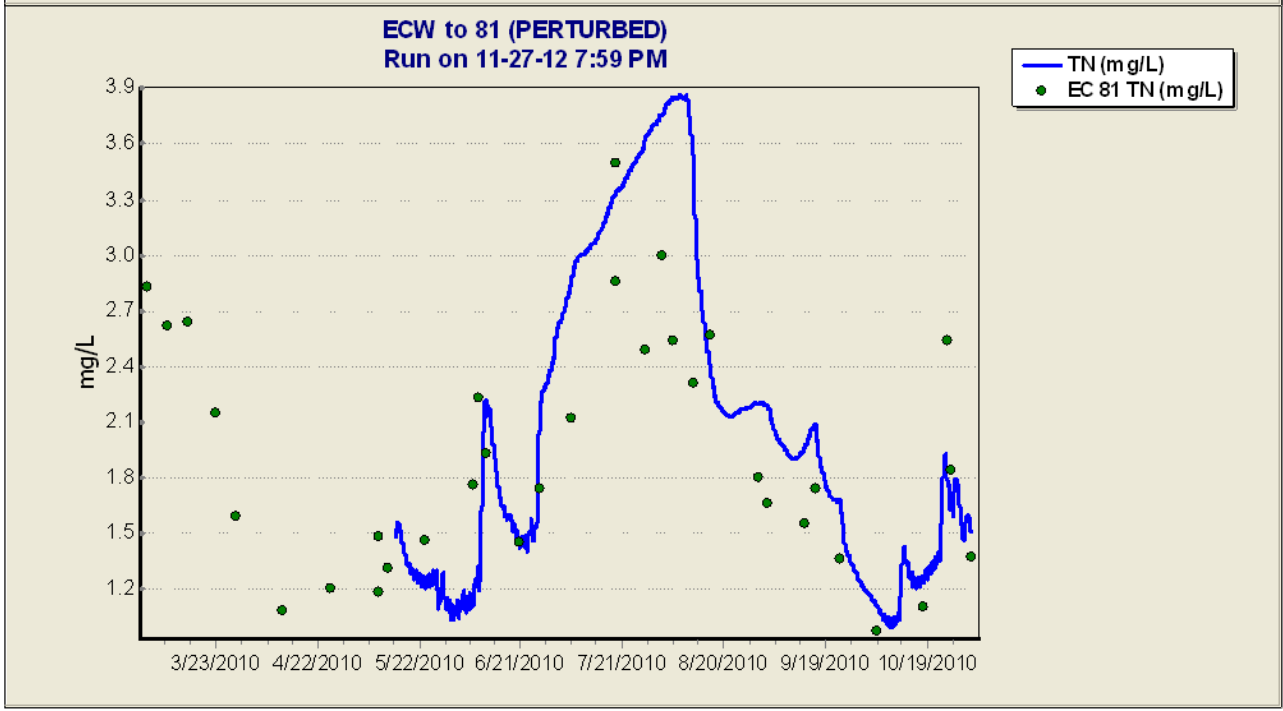
Phosphorus (


Rush Cr to USGS (PERTURBED)
Run on 11-28-12 10:03 AM
Tot. Sol. P (m g/L)
USGS SRP (m g/L)
USGS TP (m g/L)
TP (m g/L)
mg/L
0.8
0.7
0.6
0.6
0.5
0.4
0.3
0.2
0.2
0.1
0.0
3/23/2010 4/22/2010 5/22/2010 6/21/2010 7/21/2010 8/20/2010 9/19/2010 10/19/2010

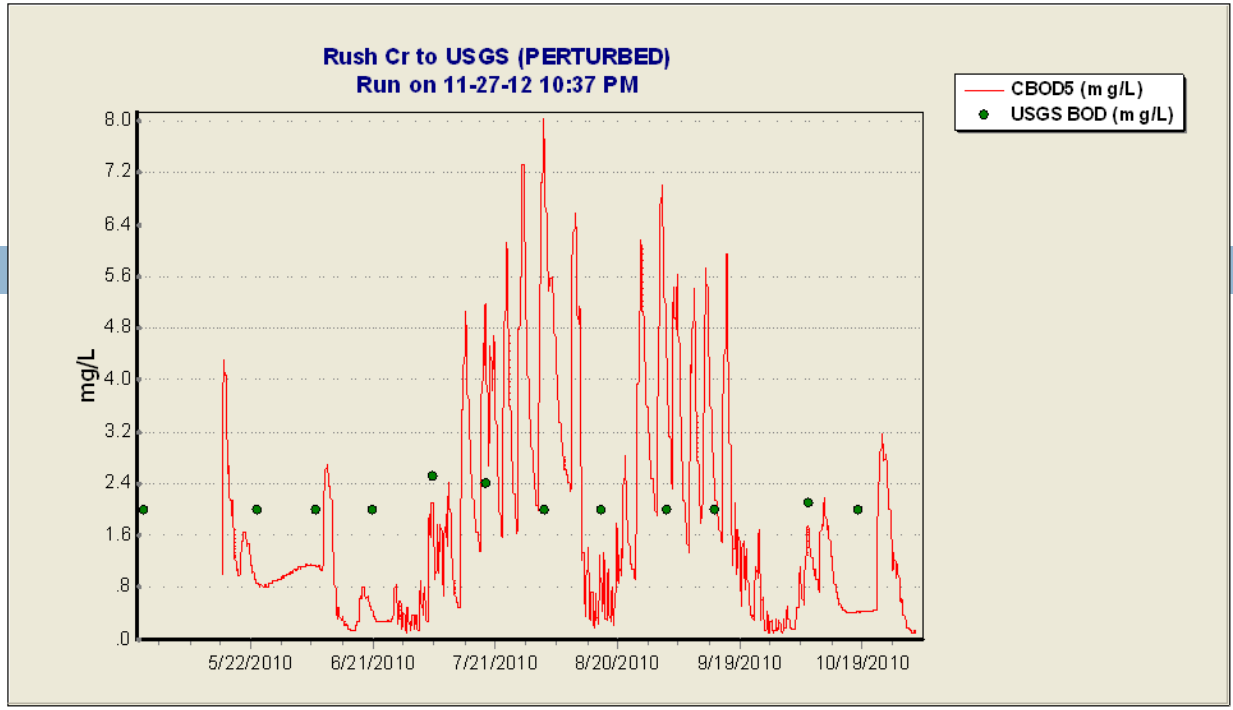

ECW to 81 (PERTURBED)
Run on 11-27-12 7:59 PM
Tot. Sol. P (m g/L)
EC 81 SRP (m g/L)
TP (m g/L)
TP (m g/L)
mg/L
0.6
0.5
0.5
0.4
0.4
0.3
0.3
0.2
0.2
0.1
0.1
3/23/2010 4/22/2010 5/22/2010 6/21/2010 7/21/2010 8/20/2010 9/19/2010 10/19/2010

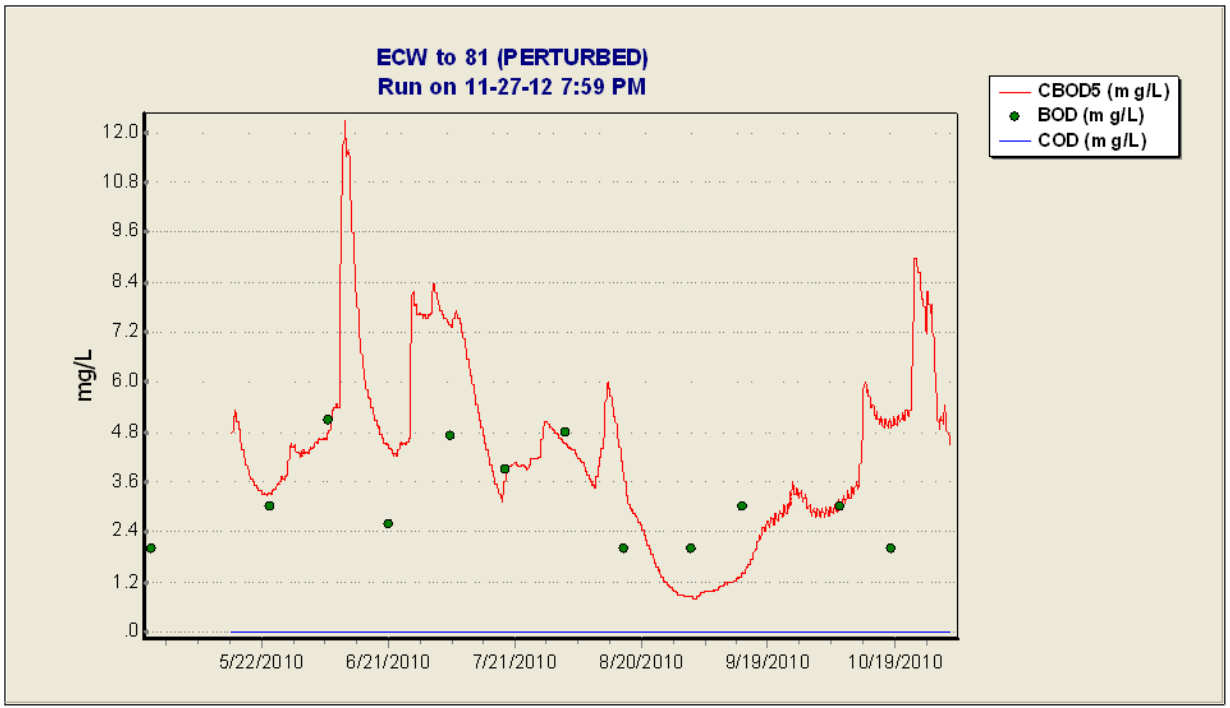
Nitrogen


New Linked Study (PERTURBED)
Run on 11-28-12 10:03 AM
1: TN (mg/L)
USGS TN (mg/L)
mg/L
3.3
3.0
2.7
2.4
2.1
1.8
1.5
1.2
.9
.6
.3
3/23/2010
4/22/2010
5/22/2010
6/21/2010
7/21/2010
8/20/2010
9/19/2010
10/19/2010

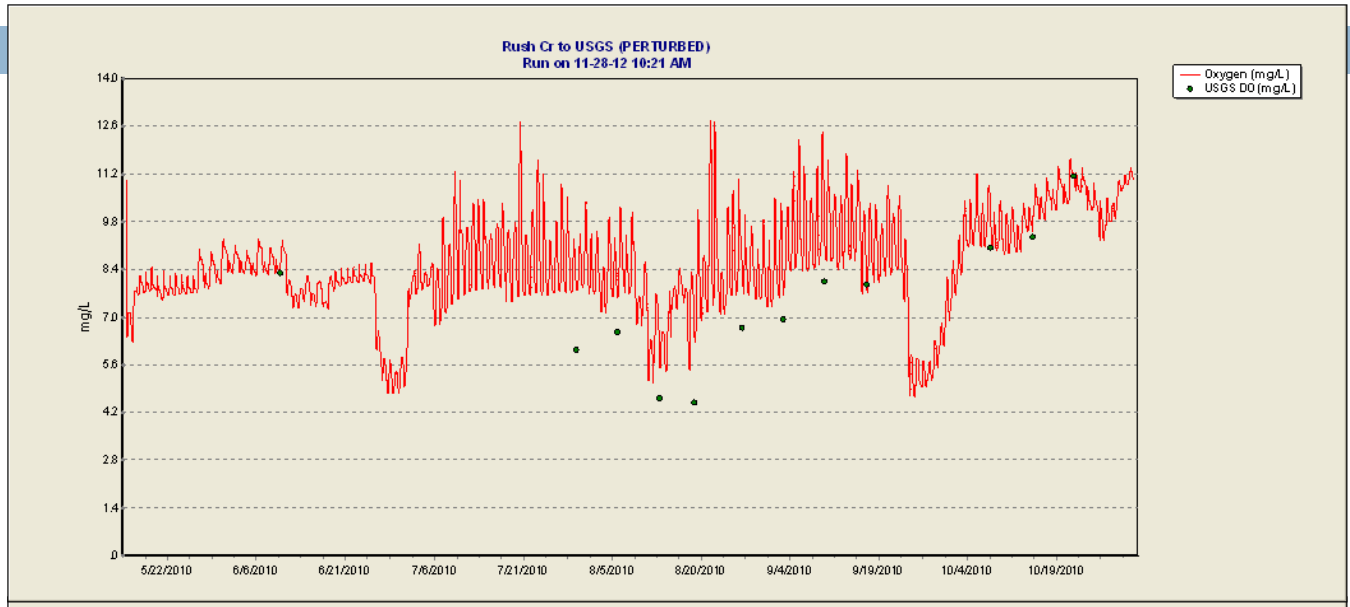

ECW to 81 (PERTURBED)
Run on 11-27-12 7:59 PM
TN (mg/L)
EC 81 TN (mg/L)
mg/L
3.9
3.6
3.3
3.0
2.7
2.4
2.1
1.8
1.5
1.2
3/23/2010
4/22/2010
5/22/2010
6/21/2010
7/21/2010
8/20/2010
9/19/2010
10/19/2010

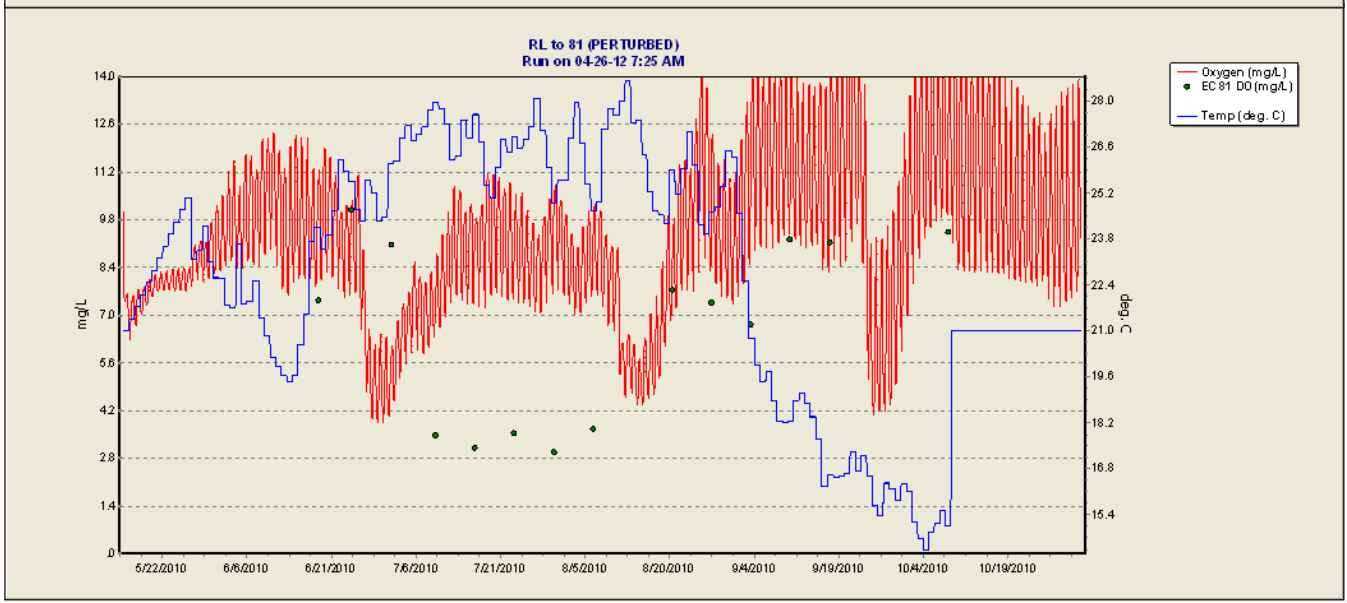
BOD


Rush Cr to USGS (PERTURBED)
Run on 11-27-12 10:37 PM
CBOD5 (m g/L)
USGS BOD (m g/L)
mg/L
8.0
7.2
6.4
5.6
4.8
4.0
3.2
2.4
1.6
.8
.0
5/22/2010
6/21/2010
7/21/2010
8/20/2010
9/19/2010
10/19/2010

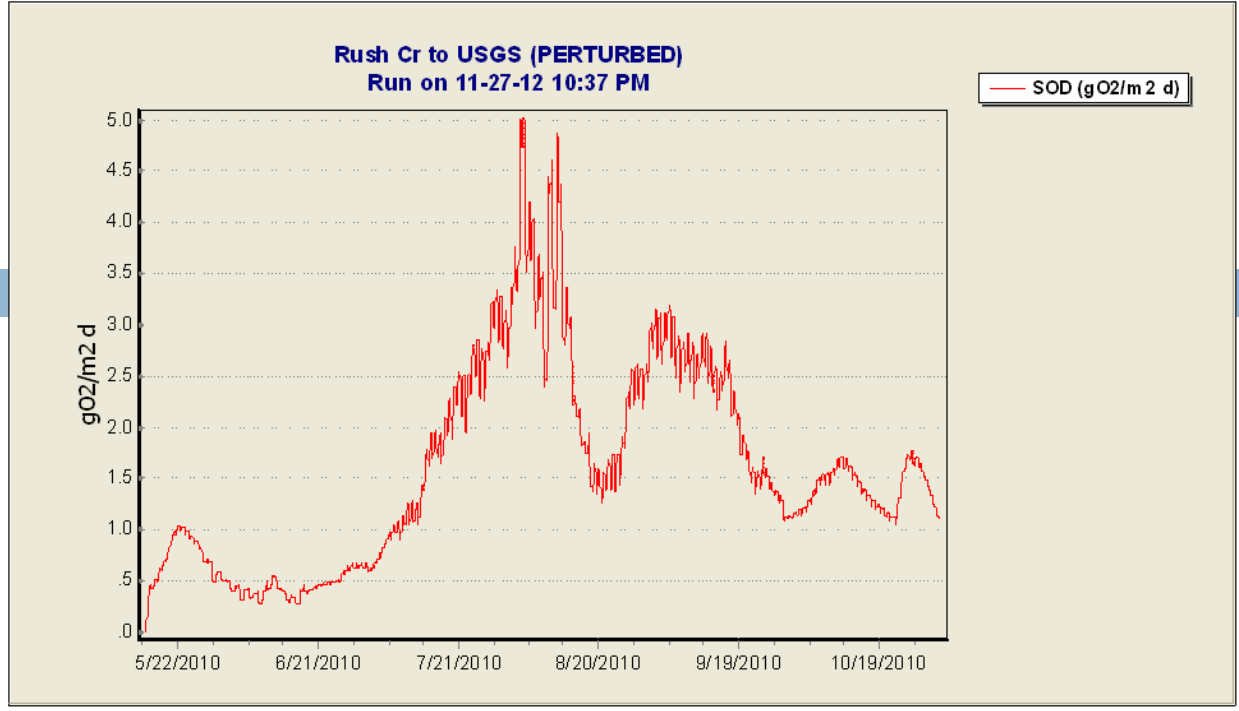

ECW to 81 (PERTURBED)
Run on 11-27-12 7:59 PM
CBOD5 (m g/L)
BOD (m g/L)
COD (m g/L)
mg/L
12.0
10.8
9.6
8.4
7.2
6.0
4.8
3.6
2.4
1.2
.0
5/22/2010
6/21/2010
7/21/2010
8/20/2010
9/19/2010
10/19/2010

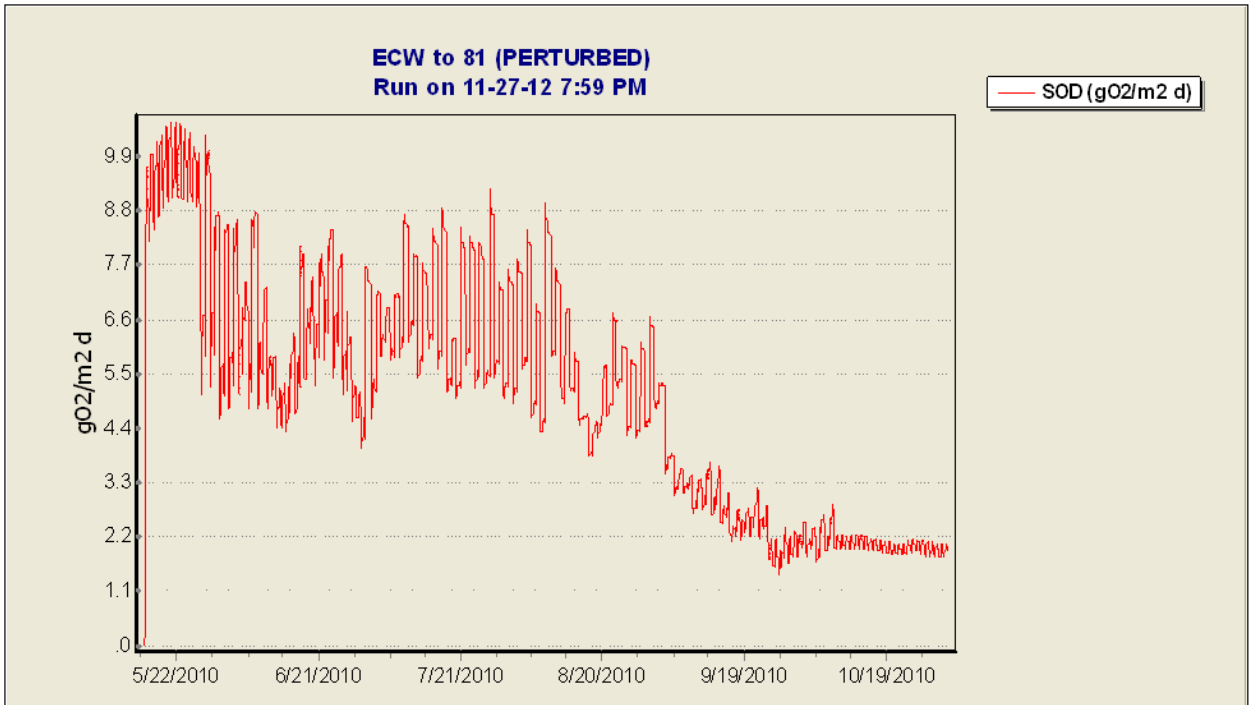
Dissolved O_2





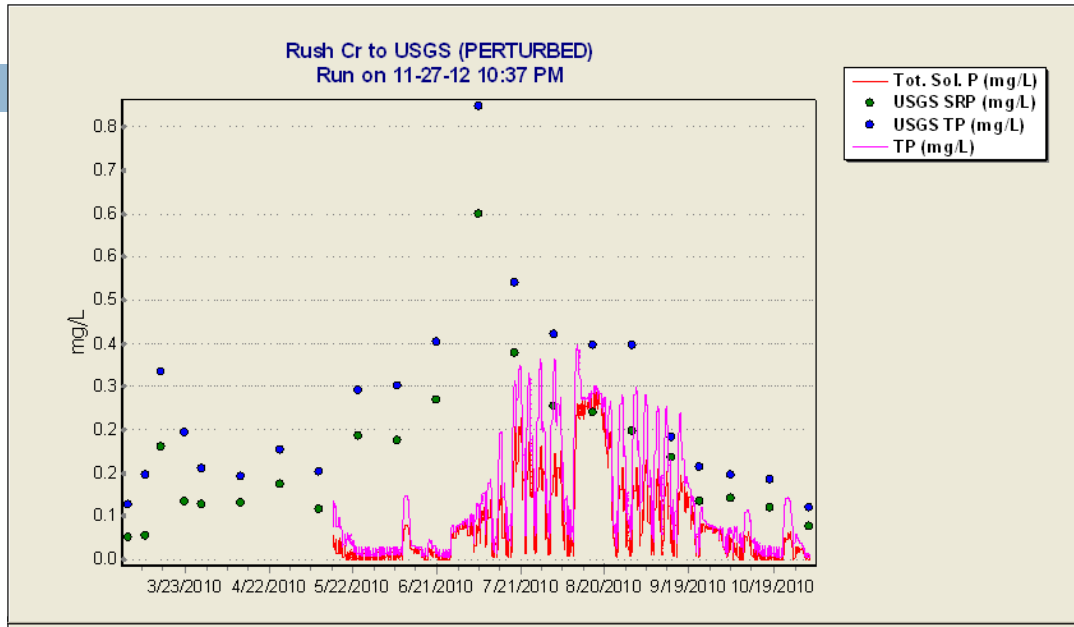
SOD

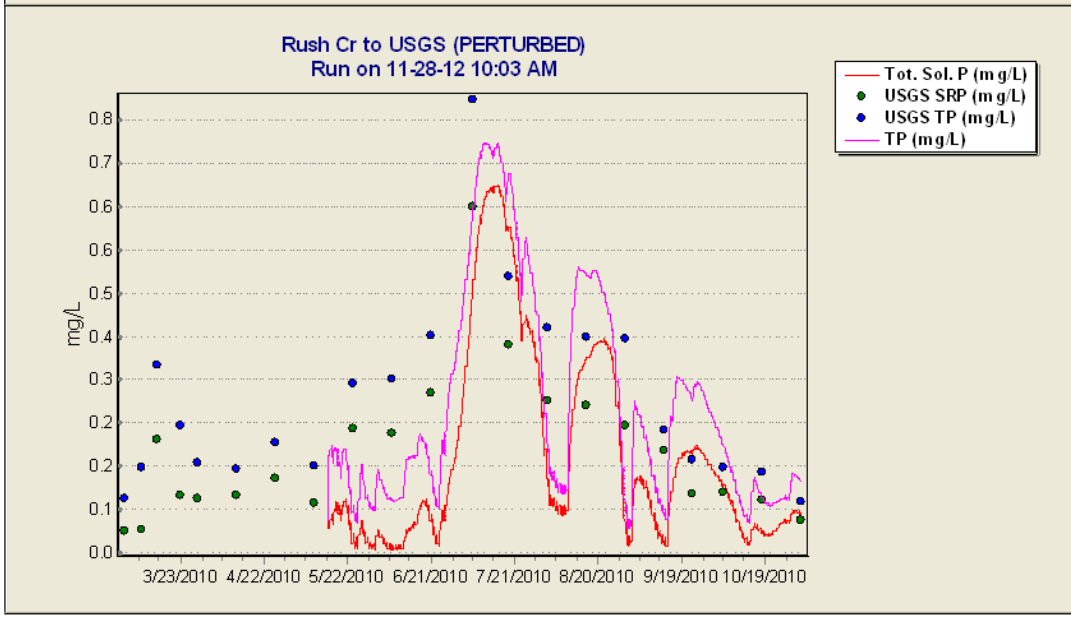

Rush Cr to USGS (PERTURBED)
Run on 11-27-12 10:37 PM
SOD (gO2/m 2 d)
gO2/m2 d
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
.0
5/22/2010
6/21/2010
7/21/2010
8/20/2010
9/19/2010
10/19/2010


ECW to 81 (PERTURBED)
Run on 11-27-12 7:59 PM
SOD (gO2/m2 d)
gO2/m2 d
9.9
8.8
7.7
6.6
5.5
4.4
3.3
2.2
1.1
.0
5/22/2010
6/21/2010
7/21/2010
8/20/2010
9/19/2010
10/19/2010

Internal Loads and Calibration

- Connections to SWAT





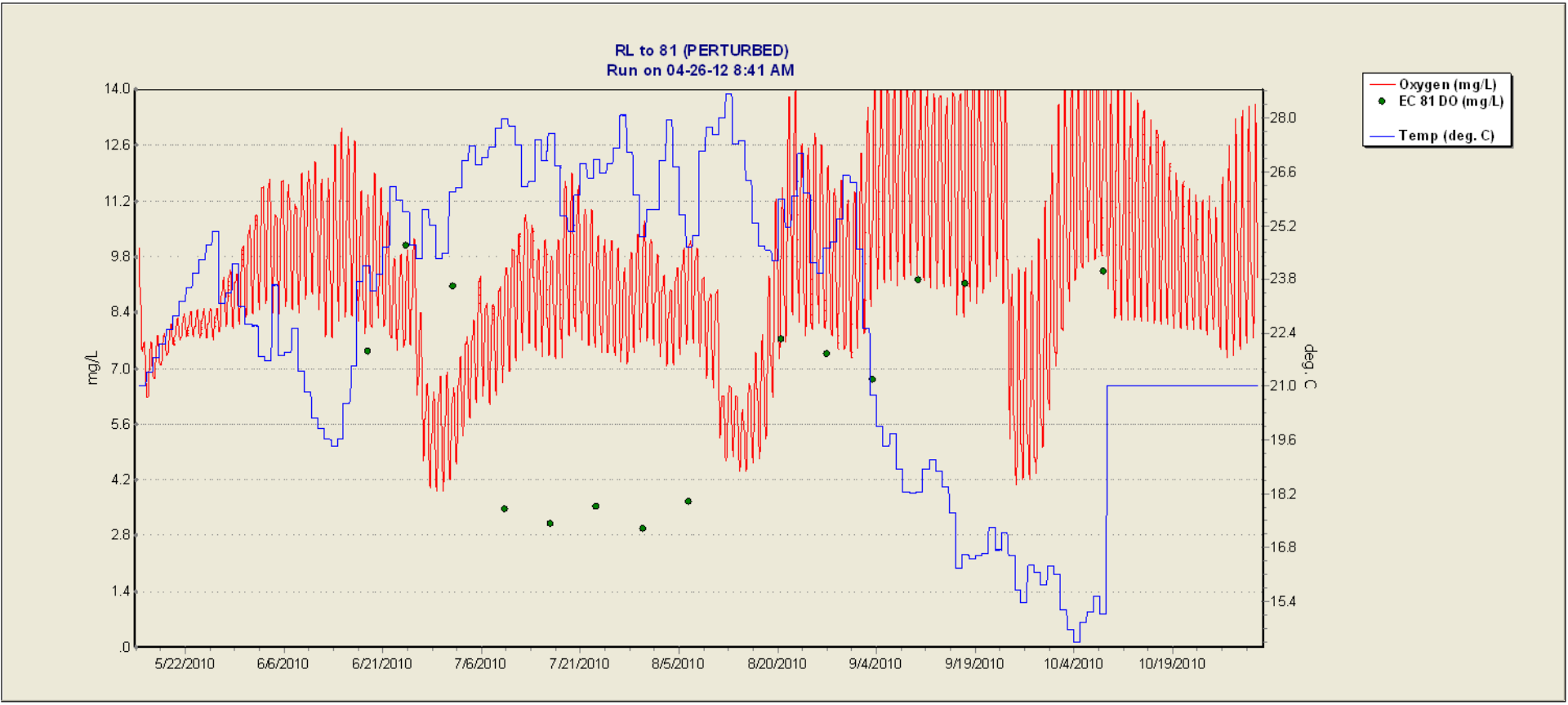
Load and Wasteload Allocations

- Based off on SWAT model output
  - Likely to be particularly important for:
    - Lake impairments
  - Any instream nutrient impairments
- Internal loads based on AQUATOX

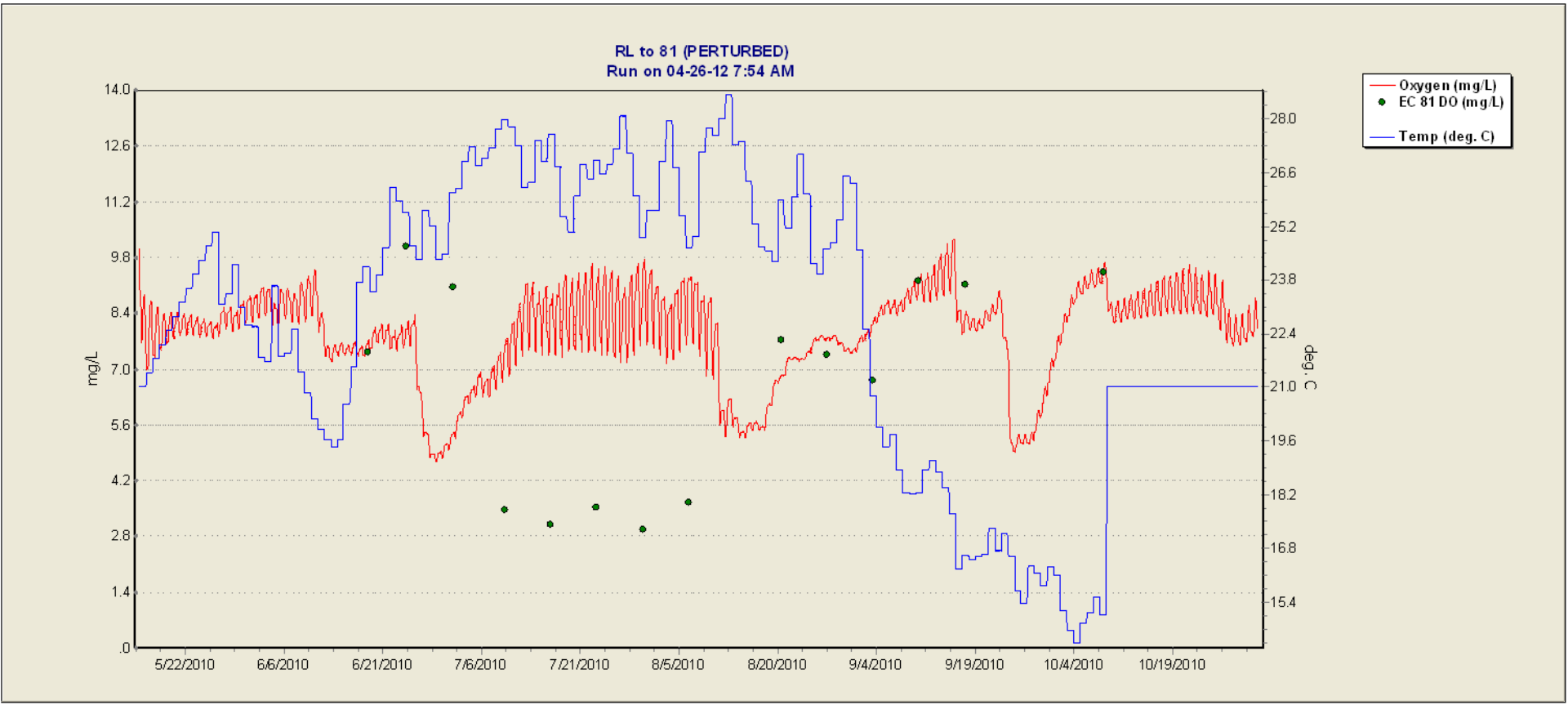
“Load” Reductions

- Drivers of DO
  - Shading and Temp
  - Re-aeration
  - Nutrients reductions
  - Sediment Oxygen Demand
- Respiration?
  - Most periods of low DO occur during nighttime hours

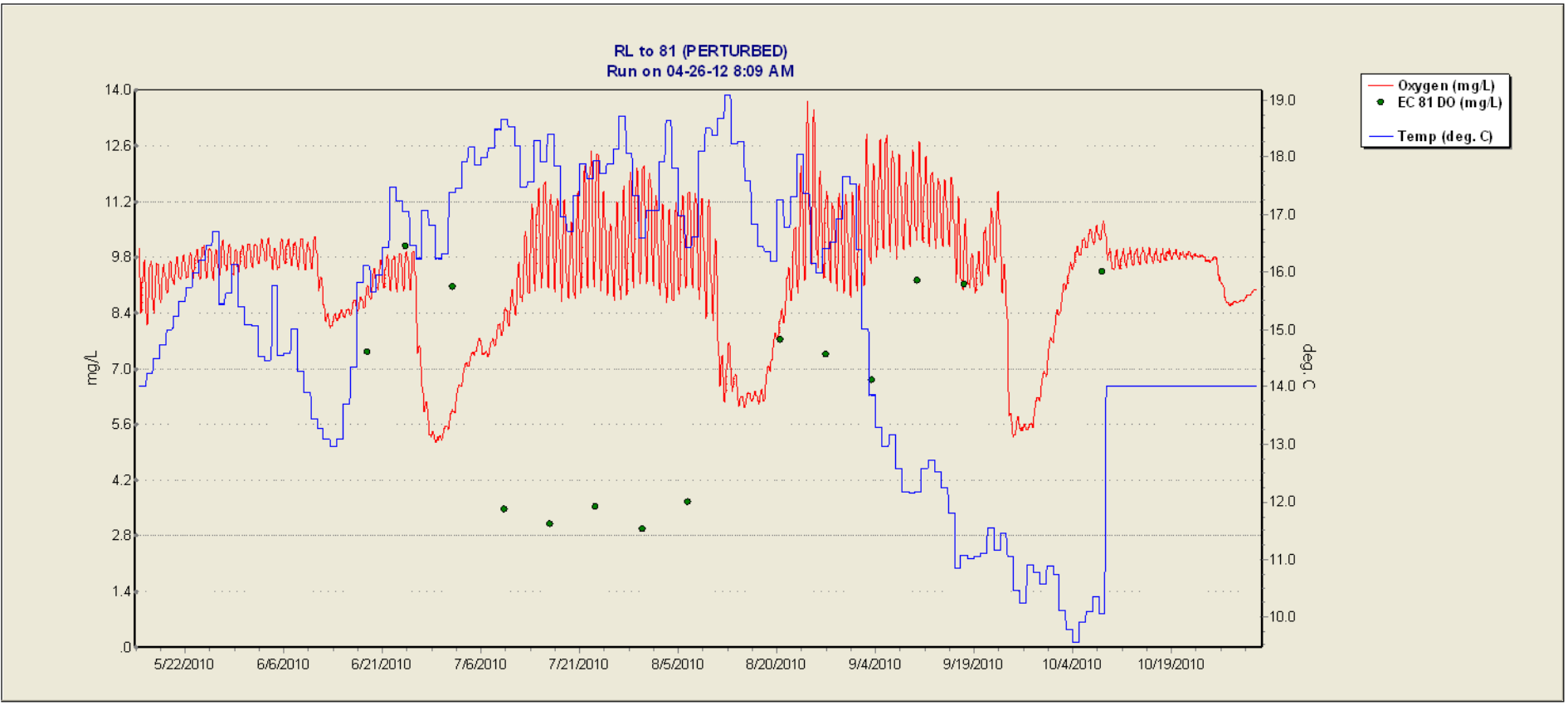
Reduced BOD Loading 30%



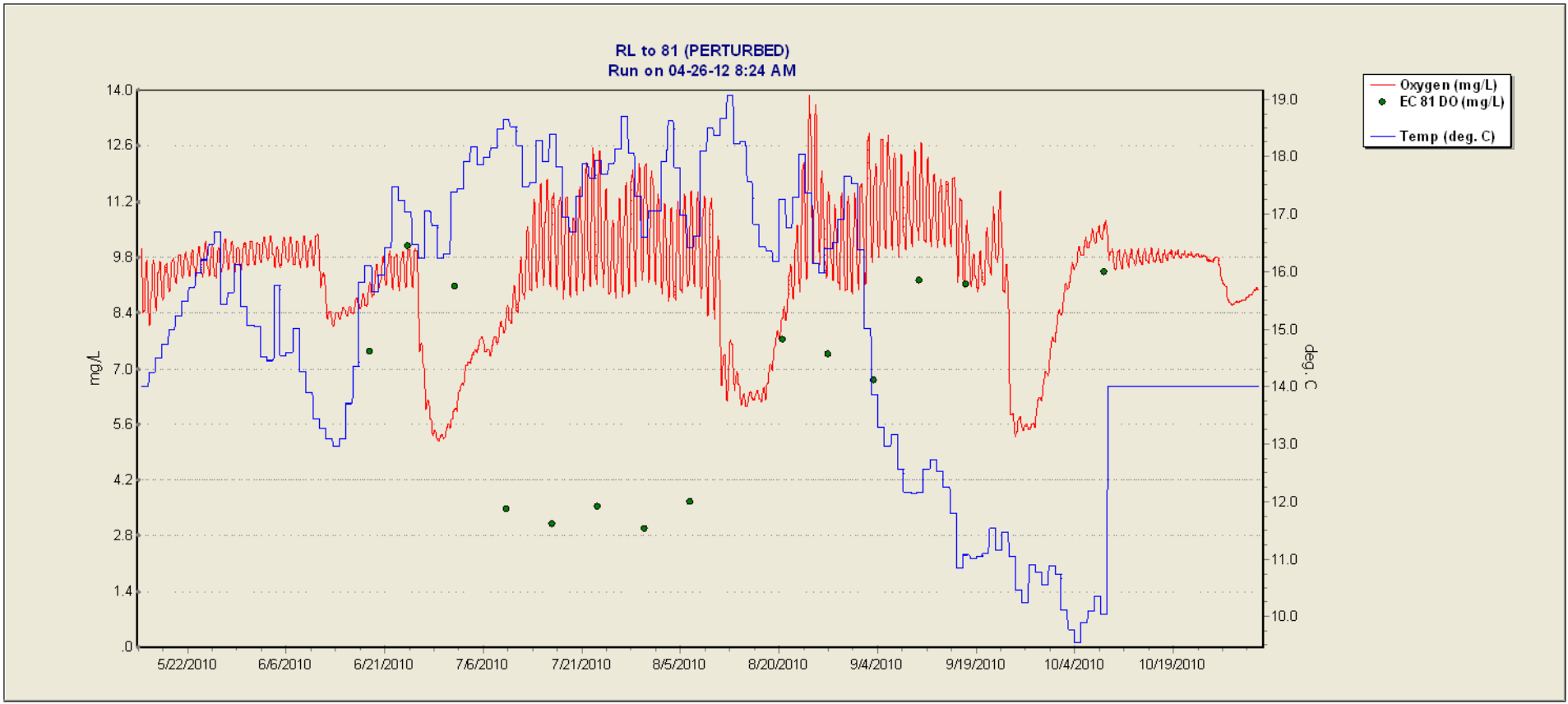
Increase Riffle Habitat 30%



30% Riffle + 30% Temp Reduction



Reduced SOD


RL to 81 (PERTURBED)
Run on 04-26-12 8:24 AM
Oxygen (mg/L)
EC 81 DO (mg/L)
Temp (deg. C)
mg/L
deg. C
14.0
12.6
11.2
9.8
8.4
7.0
5.6
4.2
2.8
1.4
.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
5/22/2010
6/6/2010
6/21/2010
7/6/2010
7/21/2010
8/5/2010
8/20/2010
9/4/2010
9/19/2010
10/4/2010
10/19/2010

Next Steps

- Use SWAT hydrology as inputs
  - Particularly important in upper watersheds
- Integrate respiration into sediment routines
  - Detritus subroutine
  - BOD input

Questions/Comments ?

picasaweb.google.com/.../ykP0FXGP2CvxLTJQYbGwNw