Periphyton and Substrate Modeling

Richard Park, 8/27/2013

Issues raised by Troy Smith, 8/19/2013:

The modeling workgroup is still struggling to identify appropriate transformation and use of substrate and periphyton data being in AQUATOX, as well as the appropriate use, transformation, and interpretation of periphyton data being output by AQUATOX.

Background

1. Previous use of AQUATOX for the LBR involved using estimated riffle/run/pool ratios;
    a. We recently field-identified the riffle/run/pool ratios for nearly every segment of the current modeling effort.
2. Previous use of AQUATOX for the LBR involved using estimated substrate based on 4 sample locations on the river;
    a. We recently field-identified the percent of substrate > 2mm for nearly every segment of the current modeling effort.
3. Previous use of AQUATOX for the LBR involved using a transformation of habitat (only riffles as suitable periphyton habitat);
    a. We recently field-identified the current the percent coverage by periphyton on substrate > 2 mm (sand) for nearly every segment of the LBR included in the current modeling effort.
    b. This assessment helps verify Alex Etheridge's and Dick Park's previous professional opinions that periphyton growth is likely similar in riffles and runs, given appropriate substrate. And, that other factors are likely more influential on periphyton growth such as turbidity, water velocity, water depth (light extinction), etc.
    - ❖ Attached are the riffle/run/pool and the substrate/periphyton/water depth/water clarity spreadsheets for the lower segments 8-12 of the river and Darcy's presentation is available on the ftp site at (we are currently entering and organizing the data for the upper segments 1-7): ftp://ftpext.usgs.gov/pub/wr/id/boise/Etheridge/ModelingWorkgroup/Presentations/

4. We are continuing to use the USGS periphyton data as input in the model and to help with model calibration. This data is collected in optimal riffle habitats at 5 locations on the river.

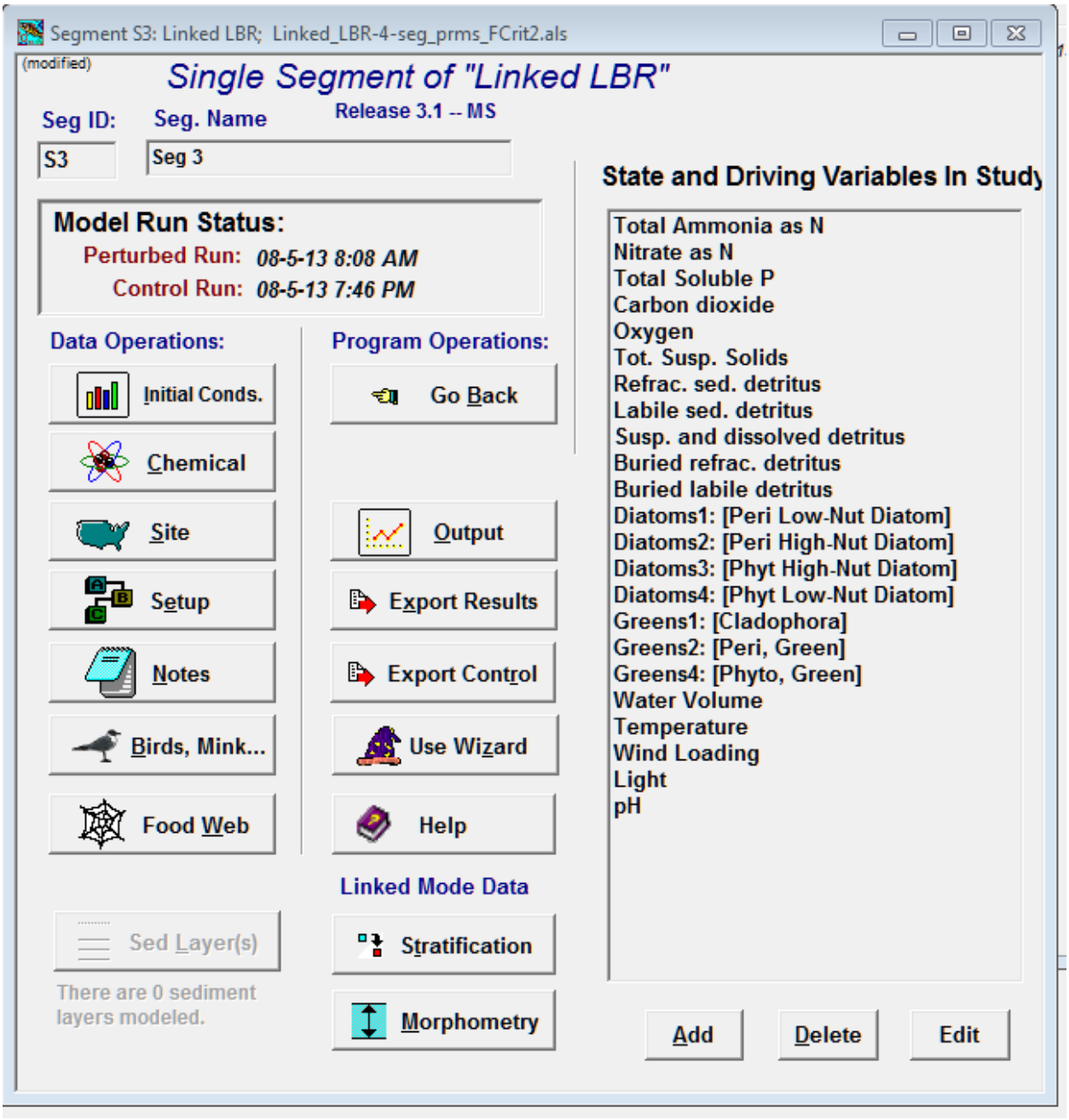
Questions/Issues

As a result, the modeling workgroup continues to try and address several questions, including:

1. Given our updated knowledge of the riffle/run/pool ratios, available substrate, and current periphyton occupation on those substrates, what data transformations, if any, are needed to:
    a. Appropriately interpret AQUATOX model output to represent the periphyton occupation/biomass on suitable substrate in each segment?
    b. Appropriately apply the USGS periphyton data collection (5 discrete riffles) in the model and interpret relative to AQUATOX results?
    c. Do the data support the current algal groups assemblage, or do we need some adjustment?

Dick Park's Response:

- Can ignore animals in simulation.
- Can represent plant response with four or five plant groups, including paired periphyton and phytoplankton—the latter are mostly sloughed and scoured periphyton, so-called "sestonic" algae.
- *FCrit*, the critical force necessary to scour periphyton, is a key parameter (although it is difficult to measure and is therefore a "free" parameter available for calibration).
- *Preference(habitat),* described in the Technical Documentation, actually tests for preference > 0



PlantName	PctRiffle	PctPool	PctRun (c	FCrit	PctSlough	PctSloughed Reference
Peri Low-Nut Diatom	50	0	50	0.005	90	90% lost in sloughing event as de
Peri High-Nut Diatom	50	0	50	0.007	90	
Phyt High-Nut Diatom	0	0	100	0	90	
Phyt Low-Nut Diatom	0	0	100	0	90	
Cladophora	100	0	0	0.002	25	
Peri, Green	50	0	50	0.003	90	
Phyto, Green	0	0	100	0	90	

$$HabitatLimit = \sum_{Preference_{habitat}>0} \left(\frac{Percent_{habitat}}{100} \right) \quad (13)$$

where:

$HabitatLimit_{Species}$ = fraction of site available to organism (unitless), used to limit ingestion, see **(91)**, and photosynthesis, see **(35)**, **(85)**;

$Preference_{habitat}$ = preference of animal or plant for the habitat in question (percentage); and

$Percent_{habitat}$ = percentage of site composed of the habitat in question (percentage).

Park, R. A. and J. S. Clough. 2012. AQUATOX (Release 3.1) Volume 2: Technical Documentation. U.S. Environmental Protection Agency, Washington D.C.

```
Function TPlant.PHabitat_Limit: Double;

Var HabitatAvail, PctRun, PrefRun: Double;

Begin

 PHabitat_Limit := 1.0;

 If Location.SiteType <> Stream then exit;

 With Location.Locale do With PAlgalRec^ do

  Begin

    PctRun := 100 - PctRiffle - PctPool;

    PrefRun := 100 - PrefRiffle - PrefPool;

    HabitatAvail := 0;

    if PrefRiffle>0 then HabitatAvail := HabitatAvail + PctRiffle/100;

    if PrefPool>0   then HabitatAvail := HabitatAvail + PctPool/100;

    if PrefRun>0    then HabitatAvail := HabitatAvail + PctRun/100;
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  End;

 PHabitat_Limit := HabitatAvail;

End;
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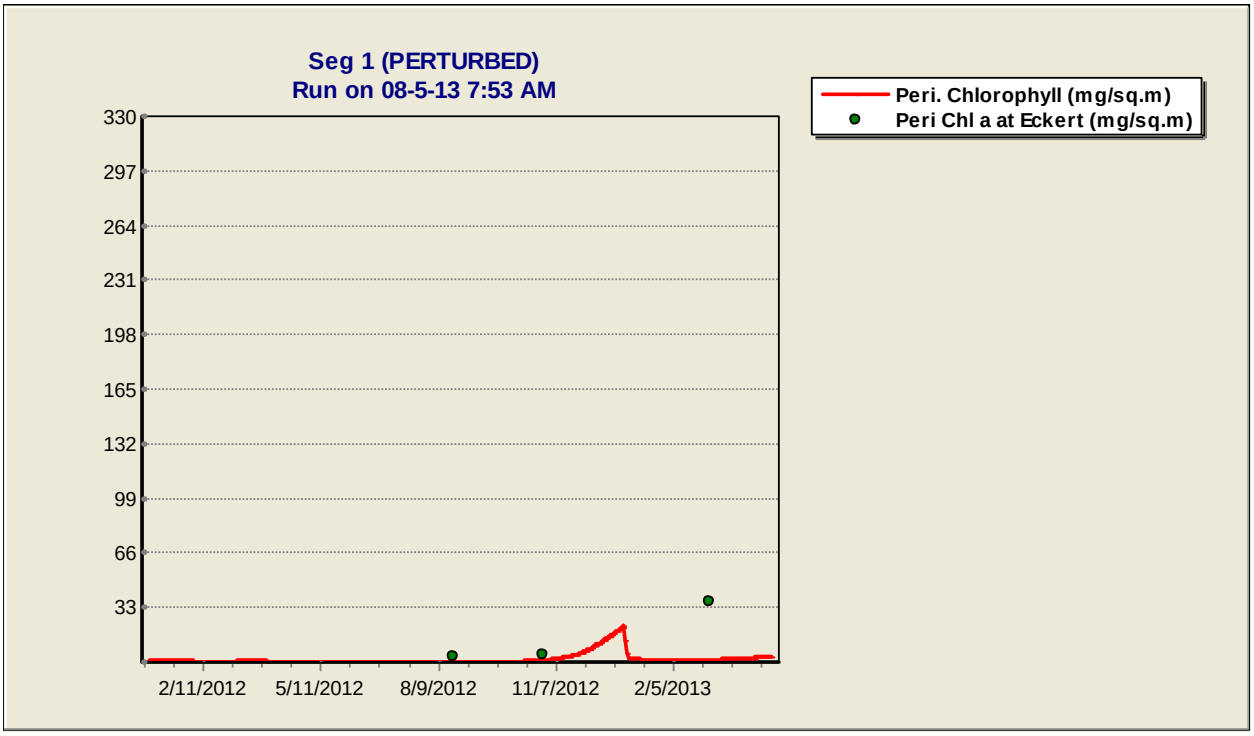
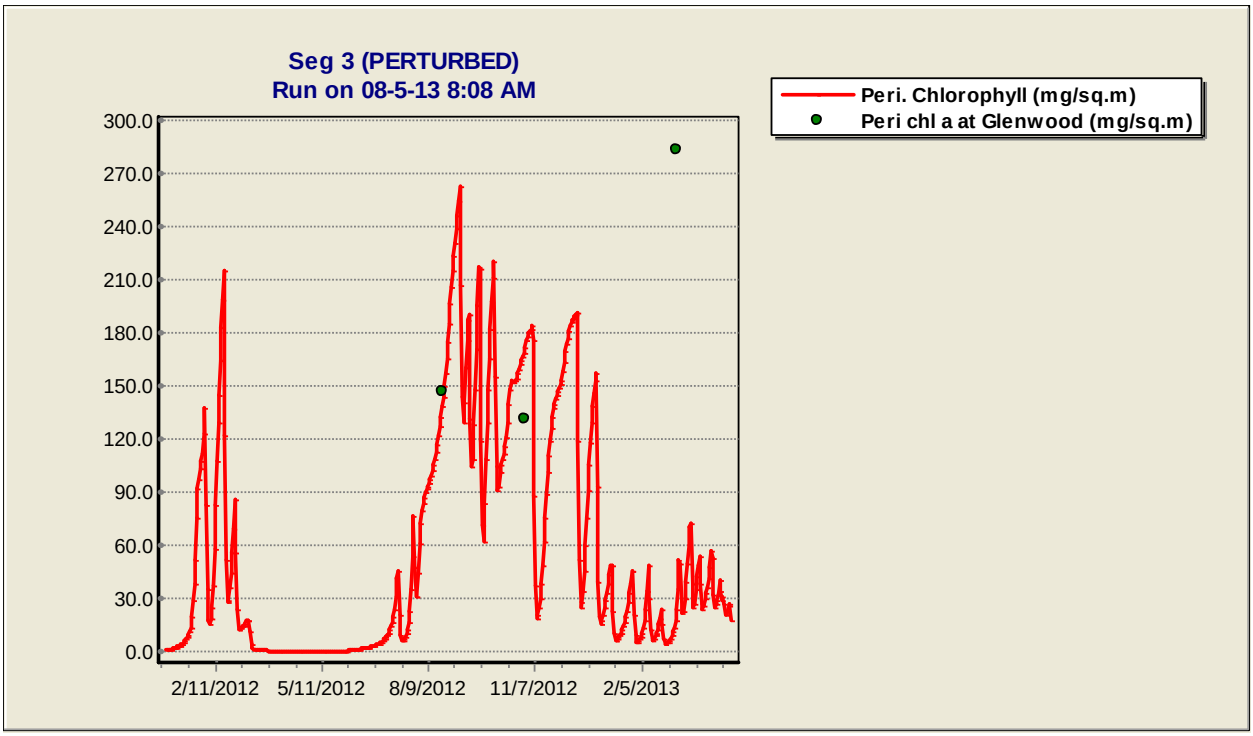
Further observations include:

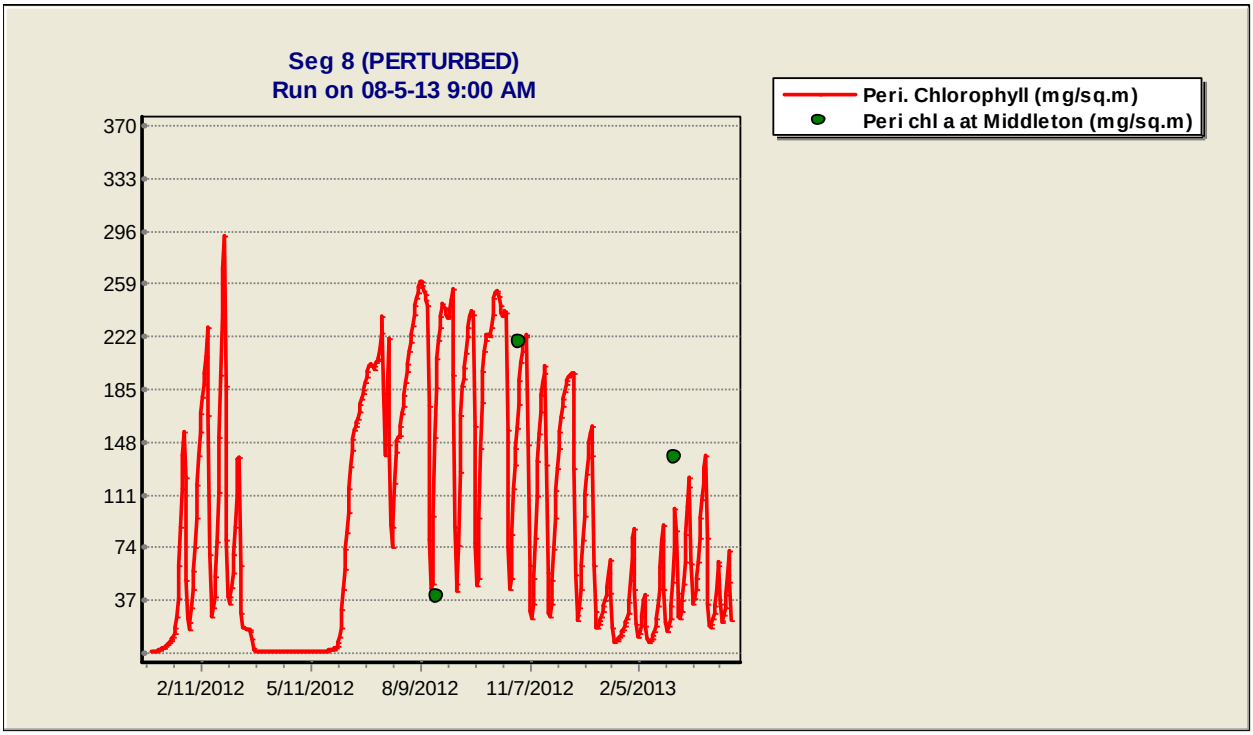
- Macrophytes can be ignored, although they do occur in the Lower Boise River (LBR).
- *Cladophora*, a nuisance filamentous macroalga, does occur and should be modeled.
- Periphyton mats have been observed on sand substrates, but they do not appear to be important and can be ignored.
- Pools account for a very small percentage of the LBR habitat and can be ignored.

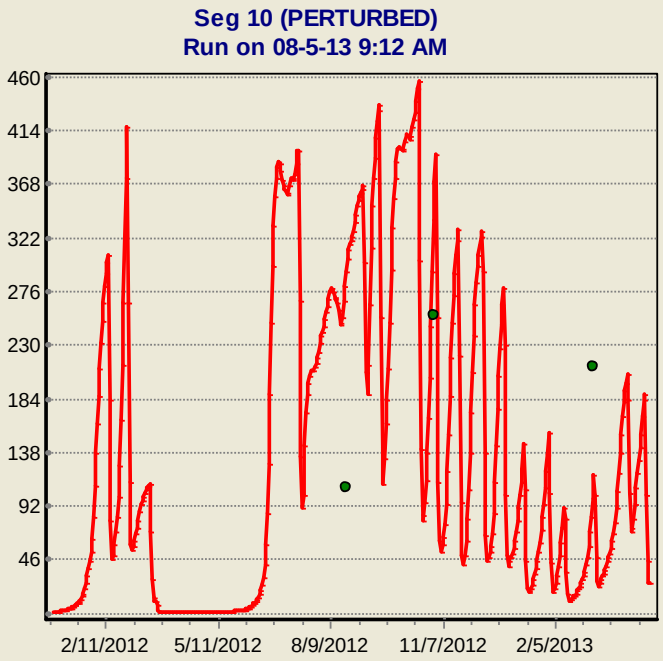
Experimentation with the current linked-segment setup using a minimal number of algal groups with attention to *FCrit* values and without normalization of the observed data, yields the following results (note that a slightly dfferent version of AQUATOX is used, so the results may differ from ones obtained in Boise).

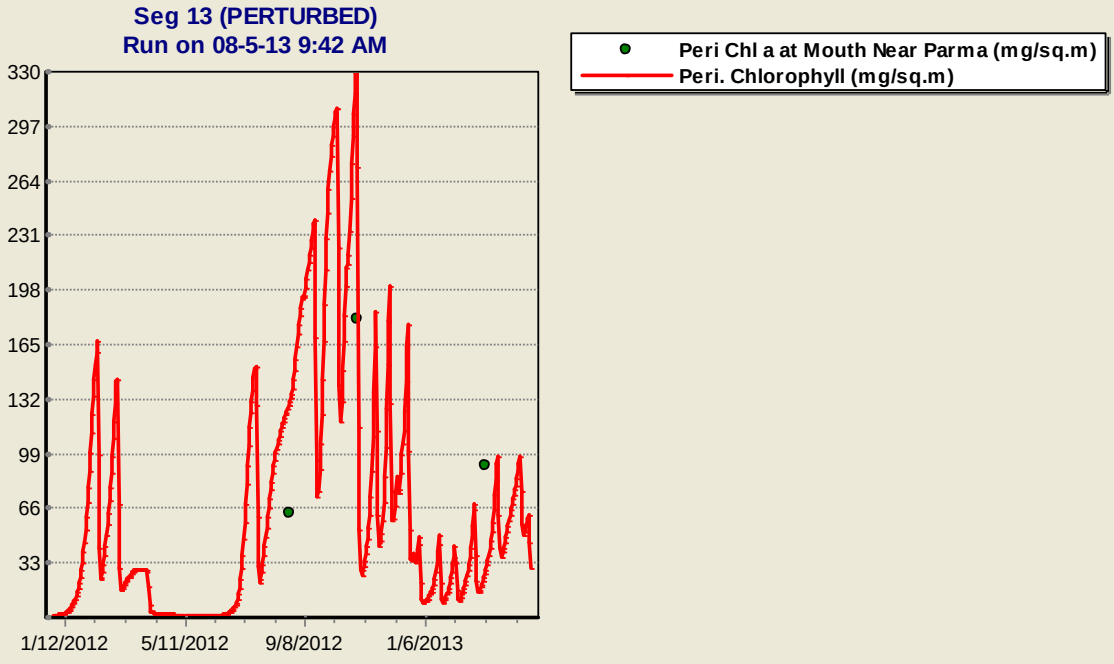




The outlier in Segment 3 may be in error; it is an order of magnitude greater than any simulated value.




Seg 10 (PERTURBED)
Run on 08-5-13 9:12 AM
Peri. Chlorophyll (mg/sq.m)
Peri Chl a at Caldwell (mg/sq.m)
460
414
368
322
276
230
184
138
92
46
2/11/2012
5/11/2012
8/9/2012
11/7/2012
2/5/2013


Seg 13 (PERTURBED)
Run on 08-5-13 9:42 AM
Peri Chl a at Mouth Near Parma (mg/sq.m)
Peri. Chlorophyll (mg/sq.m)
330
297
264
231
198
165
132
99
66
33
1/12/2012
5/11/2012
9/8/2012
1/6/2013