

## Comments on Seth Wenger's conceptual model

*From Michael Miller:*

I like the model except that our work on 3rd order, not headwater streams, finds that the biggest stressor to the fish IBI and macroinvertebrate ICI in Ohio EPAs stream set is a peak flow estimated from landuse, slope, and rainfall data. The sheer force, abrasion by sand blasting and burial are likely the most direct impacts of urbanization. Reference streams receiving the same rainfall events had not loss of IBI or ICI. This peak is a setback for Ohio's stream anytime during the year. The Ohio EPA does their survey work from May to October, when flows are near pool, so they can sample. And yet the negative impact of peak flows remain. We are preparing a manuscript on this analysis now. Does anyone else see annual flow maxima as being a direct stressor in urban streams?

*From Allison Roy:*

Thanks, Seth, for developing a new conceptual model to work with. I think it's great that you've used CADDIS conventions, and I support your proposal for doing the same with the submodels.

Thoughts on the overall conceptual model:

1. Stressors 1 & 3 could possibly be combined into one called "channel modification and loss" or "morphological change and channel loss."
2. You left some ecosystem functions off the "food web"...was this intentional? It seems reasonable to include nutrient uptake and ecosystem metabolism as response variables.

We could mull over this large conceptual model for a while, or we could move on to the submodels and leave time at the end to tweak it (as suggested by the submodels) and define some large, overall research questions. I fear if we do the former, we'll end up piecing in more and more of the details (a good example being what Mike Miller thought was missing in terms of peak flows), which really should be part of the submodels. The same will happen with questions; we'll start writing more detailed questions that fit within submodels, rather than getting a good list of broad, overarching questions. So, my recommendation is that we move to the submodels ASAP...going once, going twice....

So, my thoughts on splitting up the submodels:

1. We start with the stressors (blue squares). 7 of the 12 have already been done by CADDIS (sediments, flow alteration, temperature, toxins and metals, ionic strength, nutrients, and dissolved oxygen). No point in reinventing the wheel. Let's use those directly (or tweak, as appropriate) and create the other 5 (or 4 as I propose in #2 above). Then, for each of those, we should develop a list of: 1) spatial differences (e.g., regional, based on stream size), 2) temporal differences (e.g., time of year, time since development), and 3) major research questions.
2. We should work on biotic and ecosystem responses, separated into ~7 (algae, invertebrates, fish, other vertebrates, OM retention/processing, nutrient uptake, and ecosystem metabolism). This is largely a "black box" in the CADDIS models, and so we would basically be starting from scratch, and each one would require some literature synthesis. For some of the responses we

may have data to directly link to stressors, while others might be general responses to urbanization or imperviousness. Assuming 7 different individuals or groups of individuals will be working on this, we should probably develop an example depiction of these submodels first. Then, just like the stressors, we should develop a list of: 1) spatial differences (e.g., regional, based on stream size), 2) temporal differences (e.g., time of year, time since development), and 3) major research questions.

I am not opposed to how Seth suggested breaking into groups, we just need to acknowledge the level of effort with each (i.e., the trophic base is a huge job, while the water quality models are all completed, we just need a list of spatial & temporal differences and questions). Perhaps we should get volunteers to take a first stab at each of the following stressor (s) and response (r) variables, and then organize in logical groups to review each other's model and list. - channel modification and loss (s) - leaves/woody debris (s) - light (s) - movement barriers (s) - algae (r) - invertebrates (r) - fish (r) - other vertebrates (salamanders, birds, etc) (r) - OM retention/processing (r) - nutrient uptake (r) - ecosystem metabolism (r)

*From Alison Purcell:*

Seth,

Here are my thoughts/comments about your conceptual model:

- It would be helpful to have a legend (like CADDIS) that defines the categories of each symbol/color box.
- The term "stream destruction" (#1) is kind of ambiguous. Can you use a different, more specific term? Also, there is an arrow from 'restoration' to 'stream destruction', does that mean that restoration increases or decreases stream destruction? or neither? please clarify.
- Is #7 (ionic strength) the same thing as conductivity? If so, why not call it conductivity?
- #12 'movement barriers' - are you essentially referring to migrational barriers? If so, what kinds? dams? waterfalls? These types of barriers might influence invertebrate migration as well (drift etc.).
- I like the stressor category titles that Walsh et al., 2005 used in their model. Might want to add those.
- Right now the Food Web column is obviously a bit oversimplified, but I'm guessing that this will get taken care of in the submodel groups, yes?
- Also, having one big arrow pointing to the food web column doesn't really get at which mechanisms are more detrimental to aquatic fauna. Yeah, for our conference! Let's figure out that piece of the puzzle.

Lastly, it might be helpful to send around some of the CADDIS models for the group to have for reference (see attached).

thanks, -Alison