Exercise Bathtub 2. (Evaluating Scenarios)

Some background:

In this exercise we will use Bathtub to explore the effects of different loading, climate, and operations on trophic conditions within the reservoir. We'll run response models to look at scenarios (e.g. TMDL), we'll explore "***back calculation***" of watershed loads from reservoir data, and we'll use a little "trickery" to expand our examination of inputs in a little more realistic way.

1. **START BathTub**

2. **READ THE CASE FILE FOR EXERCISE 2 (Big Muddy Reservoir).**

   Data > READ > Exercises\DATA\Bathtub\Exercise2.btb

3. **RUN the Model and Plot the Results**

   Look at the Phosphorus and Chlorophyll predictions, compare to the observed value. What's wrong here? Note the observed value of TP in the upper reservoir segment (300 ppb). To investigate, we'll look at load response (use quit button to exit the plot).
   Main Screen Menu: Run > Load Response
   Trib: Main Inflow River
   Segment: Upper Reservoir
   Variable: start with Total P
   Method: Vary Inflow Concentration
   Click the RUN button on the upper left
   Now Change (increase) the TP load scale (these are multipliers of your original input TP value) to get the observed segment TP concentration into the predicted range (hint: it will take about 8x)

   Click on LIST Button at the top of the load response window to see the details.

   What sort of inflow concentration do you need in the Main Inflow River to get a match to the observed TP concentration (300 ppb) in the Upper Reservoir (Hint: almost 2000 ppb)?

   Can you see the value in this for evaluating an unmonitored watershed when you've got GOOD reservoir data? Can you see the value in using this for CROSS CHECKING your data for internal consistency?

4. **Return to the main Bathtub Screen, Edit Tributaries**

   Modify your information for the Main Inflow River (TP conc.) so that you now get predicted lake conditions that match the observed values – use the information from the response listing to assist.

   Run the model again to ensure you've got a good match.

   Plot the Phosphorus and Chlorophyll and Secchi predictions, compare to the observed value. Are we close?

   Keep your work:

   CASE > SAVE AS > Exercise2_FIXED.btb

5. **Consider a TMDL for Big Muddy – used your NEWLY MODIFIED case file**

   An algal bloom criterion has been established for this reservoir: Blooms conditions (chl > 10 ppb) cannot occur in more than 10% of the samples. What sort of TP input reduction in The Main Inflow River Watershed is needed to achieve this goal for the Big Muddy Reservoir on an Area-Weighted Basis?

   Run the Model
   Run Load Response

Tributary will be Main Inflow
Segment will be Area-Weighted Mean
Variable will be Freq(Chl > 10)
Method will be “Vary inflow concentrations”

RUN
Modify your lower scale limit to get the 10% value with range as needed. (Hint > 90% reduction is needed).
RUN
Examine the LIST for details

It’s looking like more than a 90% reduction in input TP concentration is needed to achieve the goal. Any hope? You’d best call the stakeholders and the regulators.

5. **Consider the potential effects of Climate Change on the Big Muddy Reservoir**
We anticipate that climate change will reduce the rainfall in the Main Inflow watershed. We won’t address all the things that might happen to Big Muddy as a result, but let’s examine the effects of reduced inflows.

Case > Read Exercises\Data\Bathtub**Exercise2_FXed.btb**
RUN > Model
RUN > Load Response
Tributary will be ALL
Segment will be Area-Weighted Mean
Variable will be now be Total P (also look at bloom frequency)
Method will be “Vary inflow”
RUN

What sort of “improvement” do we expect with a 50% REDUCTION in inflow?
Is this realistic?
What are we assuming if load is directly proportional to flow?
How would we model a case where load is constant, but flow is dropping? Hint, see next section

6. **Add a POINT SOURCE to your simulation**
To address the question in the previous exercise, I’ve modified the case file by adding a Point Source Tributary and almost eliminating TP from the Main Inflow River. Now most of the TP is coming from this fixed source. This allows us to examine the influence of water alone on the reservoir using the Load > Response function.

Case > Read Exercises\Data\Bathtub**Exercise2_AddWWTP.btb**
Edit > Tributaries – just take a look at what’s been changed

RUN > Model
RUN > Load Response.
Change the load from the Main Inflow River – it’s not contributing much TP so you are really just fluctuating the water input. Note that you get a standard “dilution curve” response in the impoundment.

You can play with this scenario to explore a number of possibilities with regard to how climate change might alter the input of TP AND water to this system.

6. **GOING FURTHER.**
We now have some templates for exploring Bathtub (and real life reservoirs/lakes). You might explore the effects of changed morphometry (i.e. lower water levels) in Big Muddy by editing the segment morphometry (mean depth, surface areas, etc.).