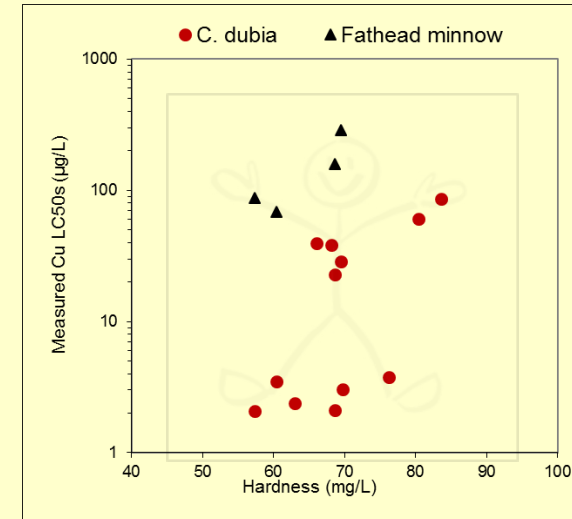
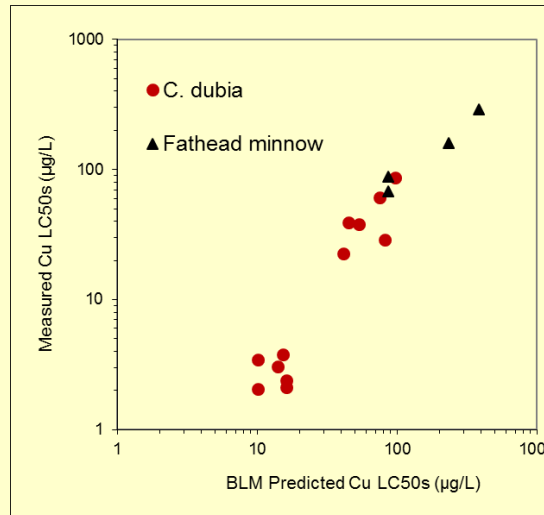


Update on the Copper BLM vs. MLR performance (Biotic Ligand Model vs. Multiple Linear Regression model)

- October 28 presentations and discussions:
 - BLM predicted actual results fairly well
 - Hardness-predicted copper toxicity produced weak or spurious patterns compared to actuals

Data source: Boise River Water Effect Ratio Study, City of Boise, 2002



Ceriodaphnia dubia



Fathead Minnow

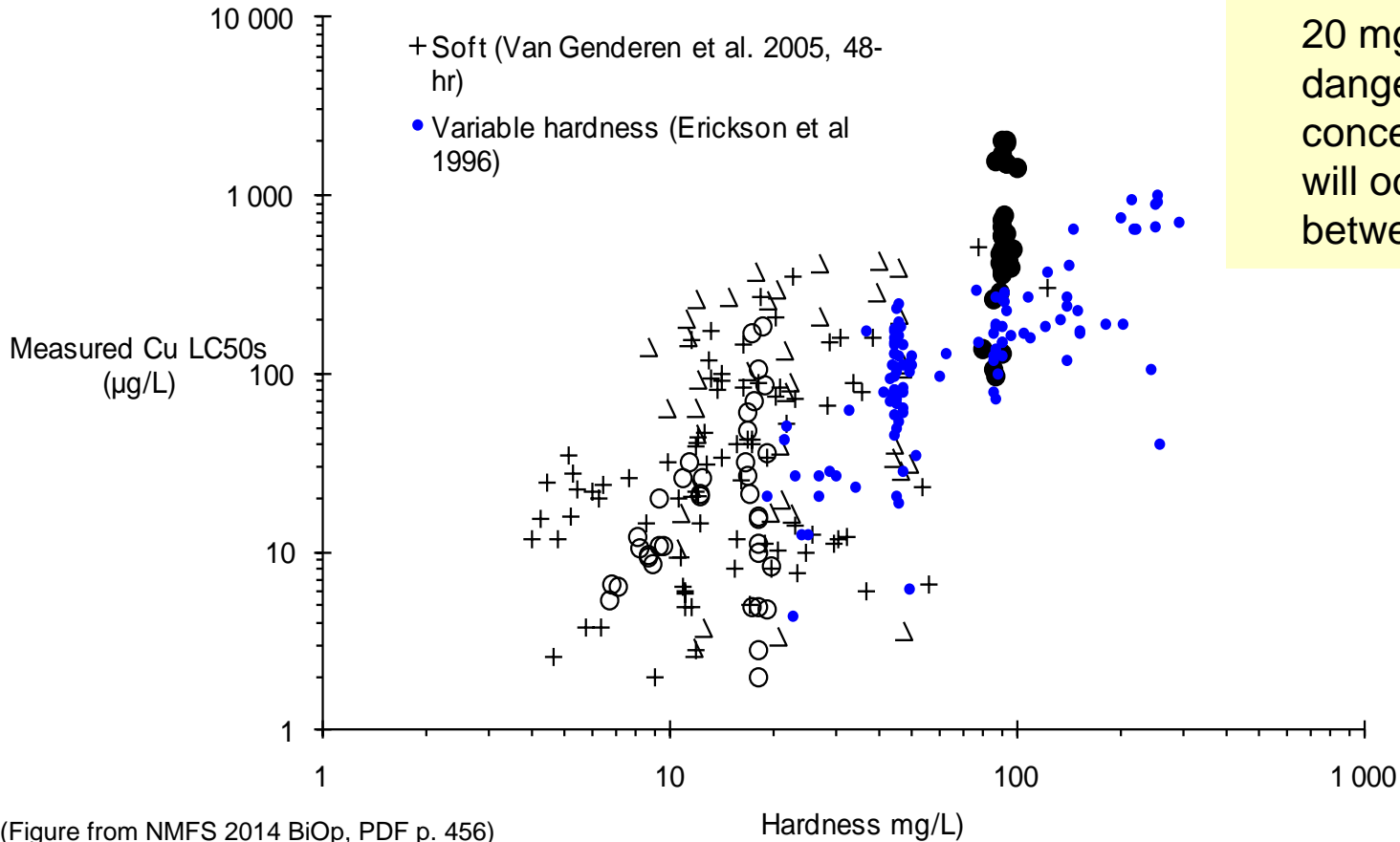
However, NMFS (2014) BiOp did not unequivocally endorse the 2007 Cu BLM

- **Areas where 2007 BLM performance was not optimal:**
 - **Soft water**
 - **May be overly sensitive to DOC**
- **Not fatal flaws**
 - **NMFS review tried to look at the totality of the hardness-criteria vs. alternatives**
 - **Even with the softwater & DOC concerns, overall performance of 2007 BLM was so much better than hardness-criteria, it was a reasonable alternative, with caveats**

Hardness performance with fathead minnow in diverse waters: pretty bad

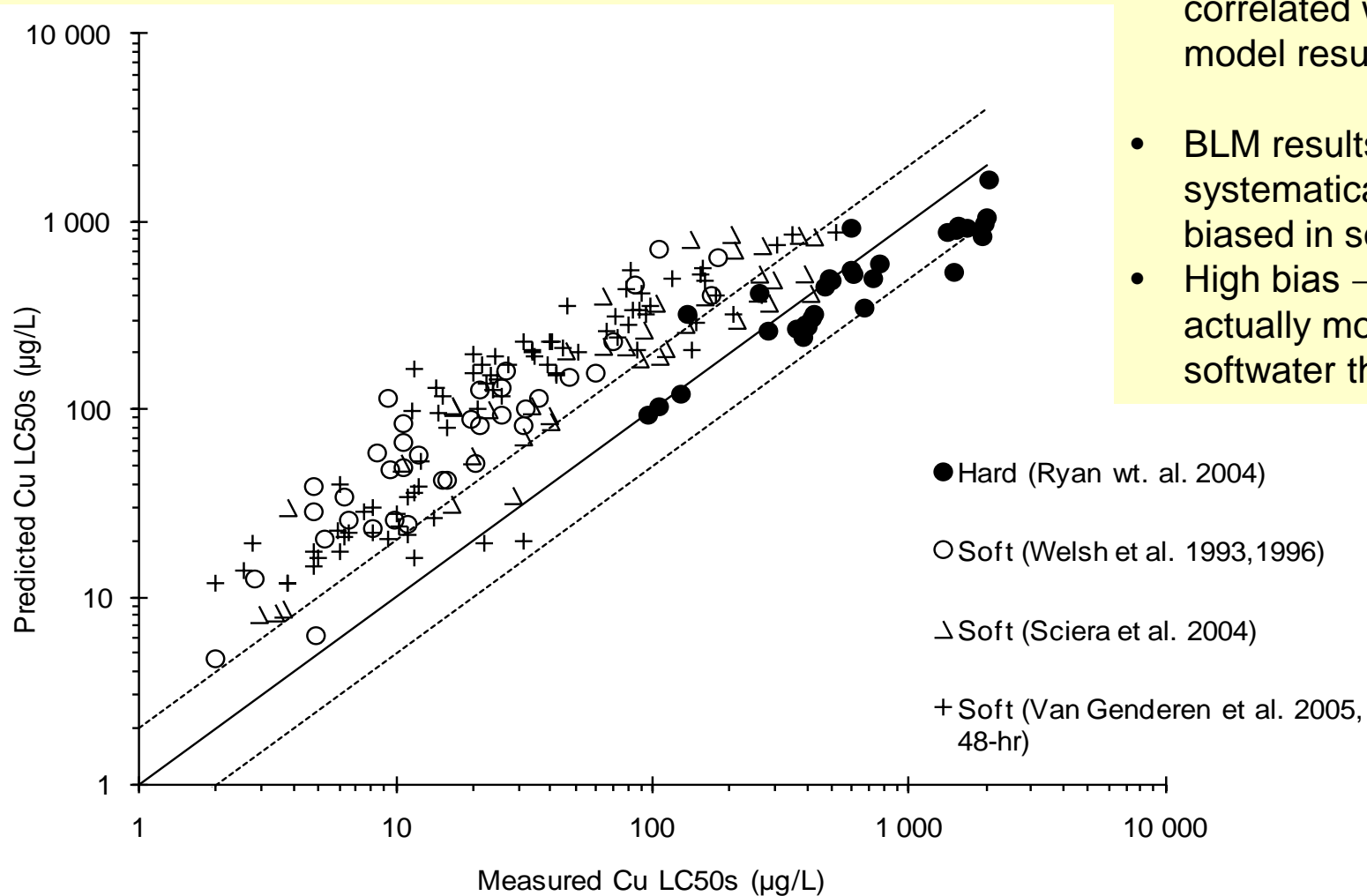
Measured Cu LC50s for fathead minnows versus hardness

- Hard (Ryan wt. al. 2004)
- Soft (Welsh et al. 1993,1996)
- △ Soft (Sciera et al. 2004)
- + Soft (Van Genderen et al. 2005, 48-hr)
- Variable hardness (Erickson et al 1996)



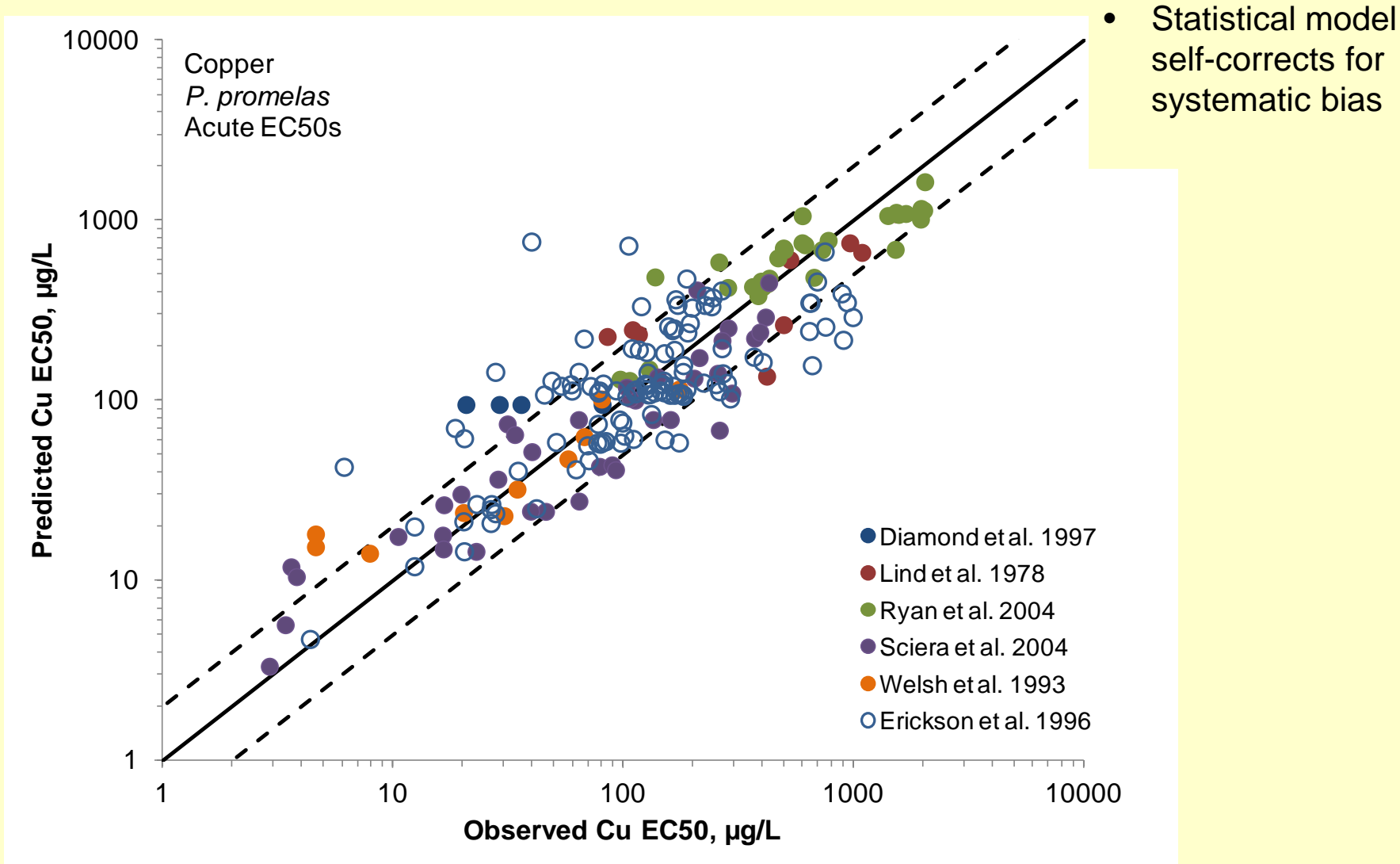
- With enough data, we see copper toxicity does tend to decrease with increasing hardness, but with great uncertainty
- Example: At hardness of 20 mg/L, confident that dangerous copper concentrations (LC50s) will occur somewhere between 2 and 400 µg/L

BLM performance with fathead minnow in diverse natural waters: a lot better but biased



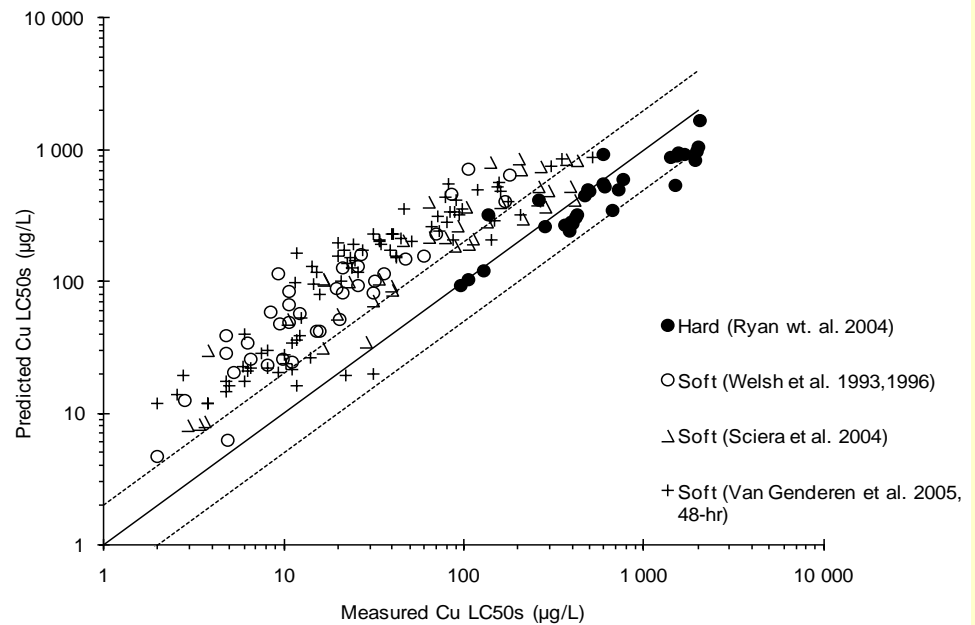
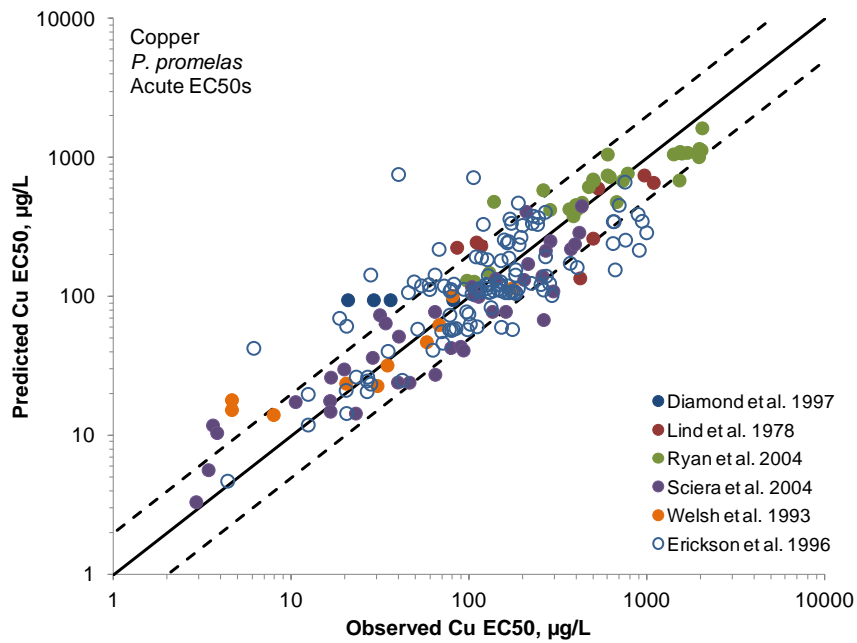
- BLM was strongly correlated with actual model results, but ...
- BLM results were systematically high-biased in soft water
- High bias \rightarrow copper was actually more toxic in softwater than predicted

MLR performance with fathead minnow in diverse natural waters: pretty good

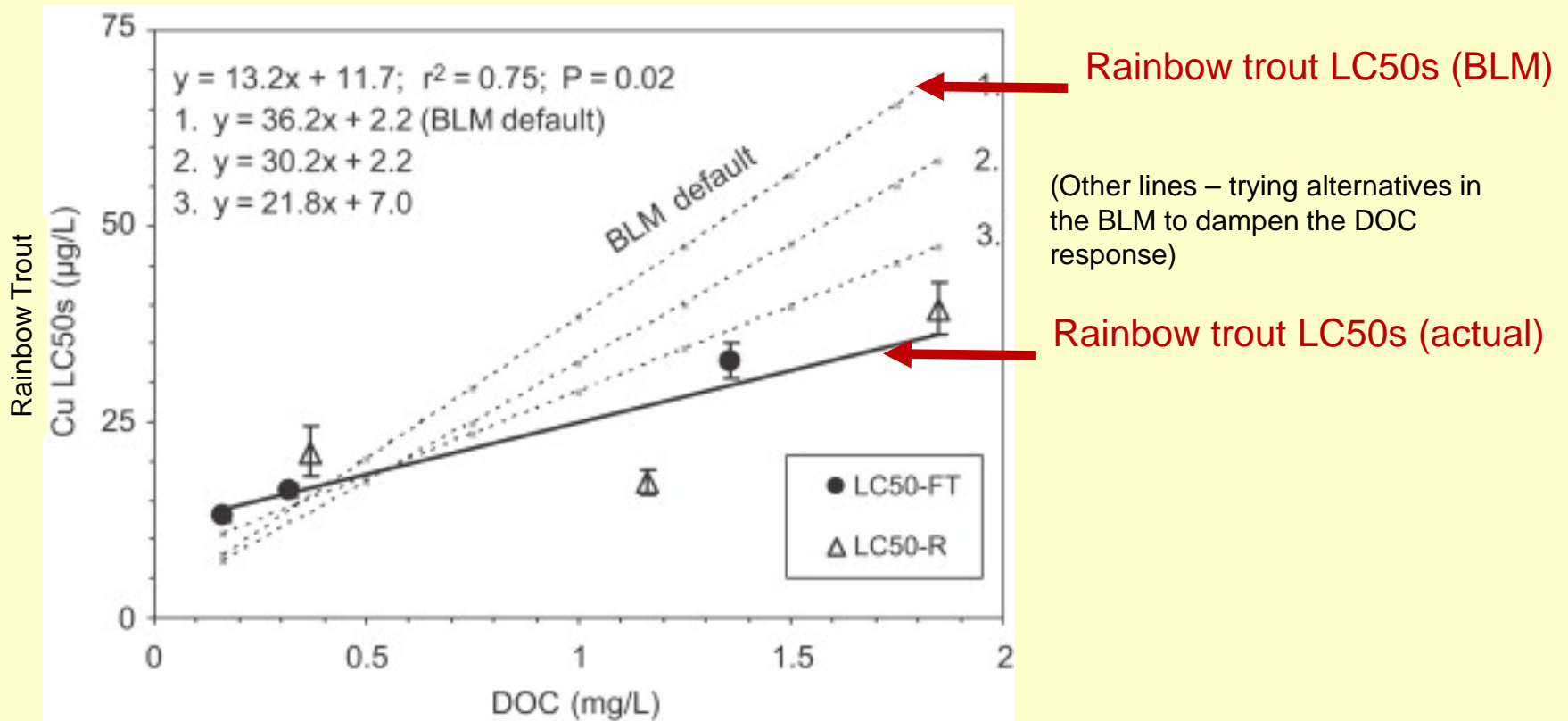


(Figure courtesy of David DeForest and Kevin Brix, 9Dec2015)

MLR & BLM performance contrasted in diverse natural waters

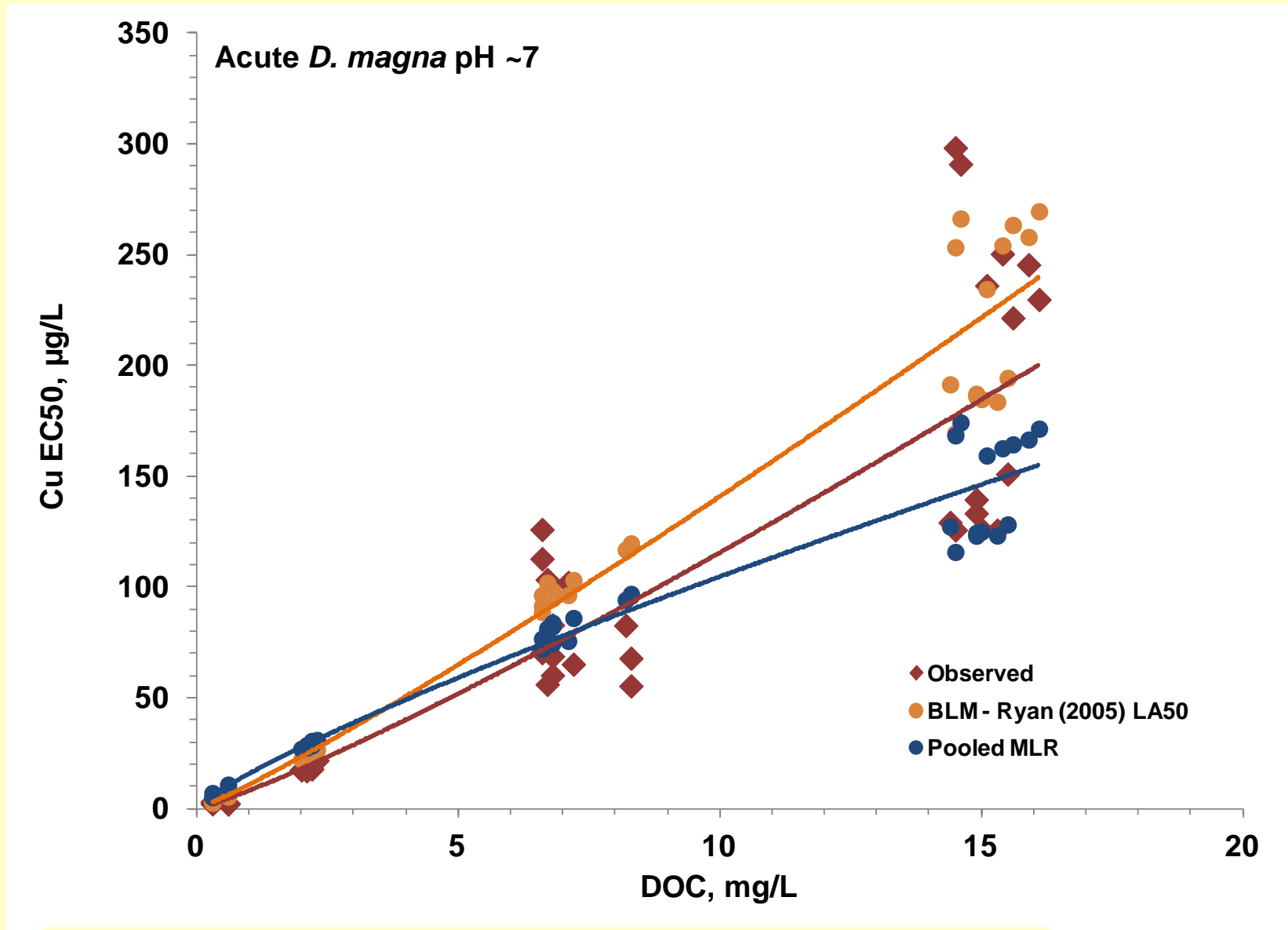


The BLM is highly sensitive to DOC



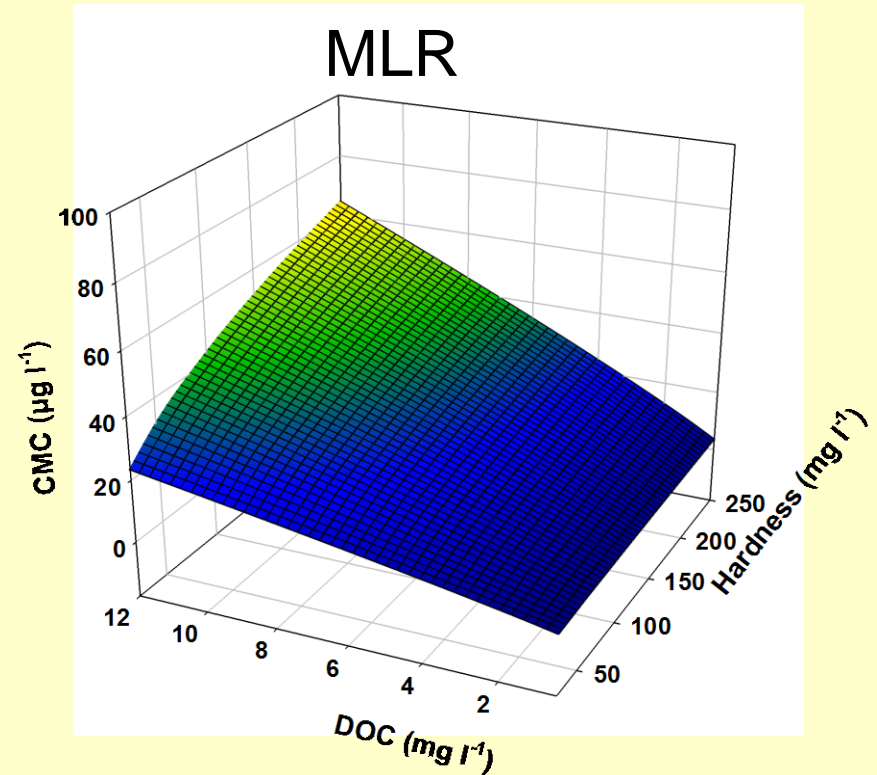
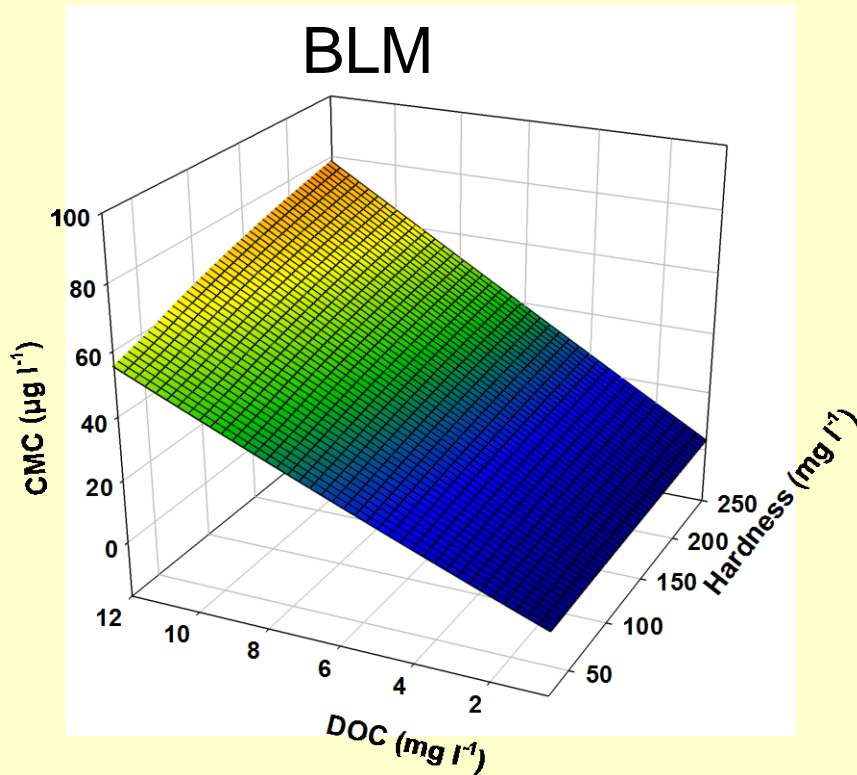
- With these data, BLM too sensitive to DOC
- Implications of too steep of a response slope:
 - Low DOC values, model over-predicts toxicity (over protective)
 - Higher DOC values, model under-predicts toxicity (under protective)

The MLR has a shallower DOC-toxicity slope than does the BLM



(Figure courtesy of David DeForest and Kevin Brix, May2015)

The strengths of the MLR go beyond administrative convenience



- Overall, performance generally similar
 - On the whole, the MLR tends to be slightly more protective
(More blue in the surface plots above)
 - BLM may over-respond to DOC
 - MLR “tones down” the DOC response
- **Suggestions to group:**
 - Question of which BLM version or MLR surrogate is not ripe for decision today
 - Revisit at the April 2016 meeting
 - In the interim – complete report from Brix and DeForest will be distributed for review

(Figure courtesy of David DeForest and Kevin Brix, May2015)