



## Surface Water Quantity Models

### Progress Meeting Notes

December 9, 2015 – Teleconference

**Attendees:** **CDM Smith:** John Boyer, Tim Cox, Nina Caraway, Chris Kurtz  
**SCDNR:** Joe Gellici, Andy Wachob, Scott Harder, Alex Pellet, Bill Clendenin  
**DHEC:** David Baize, Rob Devlin, Leigh Anne Monroe  
**Clemson:** Katie Buckley  
**Technical Advisory Committee:** Eddie Twilley, Ed Bruce, K.C. Price, Charles Wingard, Heather Nix, Eric Kruger, Andy Fairey, Ruth Albright, Mike Harrelson

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#### 1. Saluda and Edisto 2<sup>nd</sup> Stakeholder Meeting Review

- The following comments and suggestions were offered, based on feedback received from the two “second” stakeholder meetings held for the Saluda and Edisto basins:
  - Spend less time on calibration results and avoid getting overly technical during the presentation.
  - Avoid including four graphs on a slide, as these are too difficult to read.
  - Provide a handout at the meeting which defines commonly used terms.
  - Provide a copy of the slides and the modeling report to DNR before each meeting for posting on the web site.
  - Provide more crowd control during the demos and focus group portion. Side discussions among attendees sometimes interfered with the scheduled activities. Also, make an announcement when it’s time to switch between demos and focus groups.



## 2. Saluda Basin

- a. Validation of Downstream UIFs (see attached slides)
  - John Boyer presented a comparison of Calculated Unimpaired Flows (UIFs) and Model UIFs. Model UIFs were generated by turning off withdrawals and discharges in the calibrated model, and removing reservoirs. These are then compared to Calculated UIFs as a validation step. The reasons for minor differences in Calculated vs. Model UIFs during the calibration period were presented.
  
- b. Response to Comments (slides)
  - In response to one of DNR's requests, John Boyer presented a comparison modeled vs. actual lake levels in Lake Greenwood, during the 2002 and 2007-8 droughts. In the 2002 drought, the graph demonstrates that the model simulates the lake level declines reasonably well, when inflow was likely insufficient to maintain the desired level. In 2008, the modeled levels closely follow the actual summertime declines, which varied greatly from the guide curve.
  - Ed Bruce noted that one thing water allocation models don't account for, which may be important in times of drought, is the potential loss to groundwater (i.e., seepage from the lake). This loss may explain why model lake level declines may not be as severe as actual declines, in some instances.
  - It was noted that SWAM accounts for evaporation from the lake (based on model estimates – not pan data).
  - Ed Bruce noted that the tailwater USGS gage from Lake Greenwood could be compared to modeled outflow as another evaluation of model performance during the droughts.
  - Heather Nix noted her preference for having the permitted withdrawal limit in the baseline model, rather than the most recent 10-year average withdrawal (i.e., baseline demand). Scott Harder suggested that perhaps the model users could toggle between baseline demand and permitted limits. Tim Cox said there is not current way to toggle between baseline demand and permitted limits. An easier approach might be to create two versions of each model – one with baseline demand and another with the permit limits input in place of the baseline demand.



- Eric Kruger noted his preference for agricultural withdrawal limits to be included in the models. Rob Devlin noted that DHEC sets monthly and annual limits for registered agricultural users, but that in times of high water need, they can request an exemption to the limit – and thus withdrawal more than the registration limit. CDM Smith will request from DHEC, the monthly agricultural withdrawal limits so that they can be included in the models.
- John Boyer indicated that CDM Smith is reviewing and addressing DNR’s other comments and questions on the Saluda calibration and baseline model, and will provide a response within the next week.

### 3. Draft Edisto Calibration Model

#### a. Updated Calibration Results (slides)

- John Boyer reviewed updates that were made to the Edisto Basin calibration. The updates included a test of using mainstem reference gages in place of reference gages from small, headwater tributaries. As expected, this resulted in a reduction in the high model-simulated peaks observed at mainstem gages, and a much better match of the overall hydrograph. Model simulated “shortages” were also significantly diminished at the handful of agricultural water users in the headwaters where shortages appeared, and for the City of Aiken withdrawal on Shaw Creek. However, the low flow calibration metrics, including the 7-day annual average low flows and the 7Q10s did not see any improvement, and in some instances, got slightly worse. Based on these results, the following comments were offered from DNR, DHEC, and the TAC:
  - Alex Pellet and Scott Harder noted that the use of the mainstem reference gages (i.e., EDO5 and EDO10) for ungaged headwater tributaries may result in a hydrograph shape that is uncharacteristic of the headwater tributaries. They also noted that the model-predicted shortages for agricultural water users could be a result of the model not accounting for the small impoundments that are common. John Boyer indicated this was likely the case, as CDM Smith’s preliminary review of the withdrawal locations where shortages were noted, suggested that many small impoundments were



present. John also noted that some of the model-predicted shortages would go away if multiple withdrawal points were disaggregated.

- Eric Kruger noted his opinion that more emphasis should be placed on representing the upstream/headwaters and tributaries more accurately, compared to the downstream portions of the North Fork, South Fork and Edisto River.
- Rob Devlin noted his agreement, suggesting that for evaluating future registrations and permits, his preference would be to have more confidence in the models headwaters, compared to the downstream portion, given that the majority of the withdrawals are from the tributaries and headwaters.

#### **4. Upcoming Deliverables**

- a. Response to Saluda Model comments
  - John Boyer noted that CDM Smith was reviewing and preparing written responses.
- b. Response to Broad UIF Methodology Memorandum comments
  - John Boyer noted that responses to DNR's comments were provided to DNR prior to the Progress Meeting.
- c. Finalize Draft Edisto Calibration Model, mid December
- d. Develop Edisto Baseline Model, early January
- e. Draft Broad UIF Dataset, early January
- f. Draft Pee Dee UIF Dataset, late January

#### **5. Other Items**

# December 9<sup>th</sup> Progress Meeting Materials

## South Carolina Surface Water Quantity Modeling Project

- Saluda Basin
  - Validation of Downstream UIFs
  - Response to Comments
- Edisto Basin
  - Updated Calibration Results

# Validation of Downstream UIFs Saluda Basin

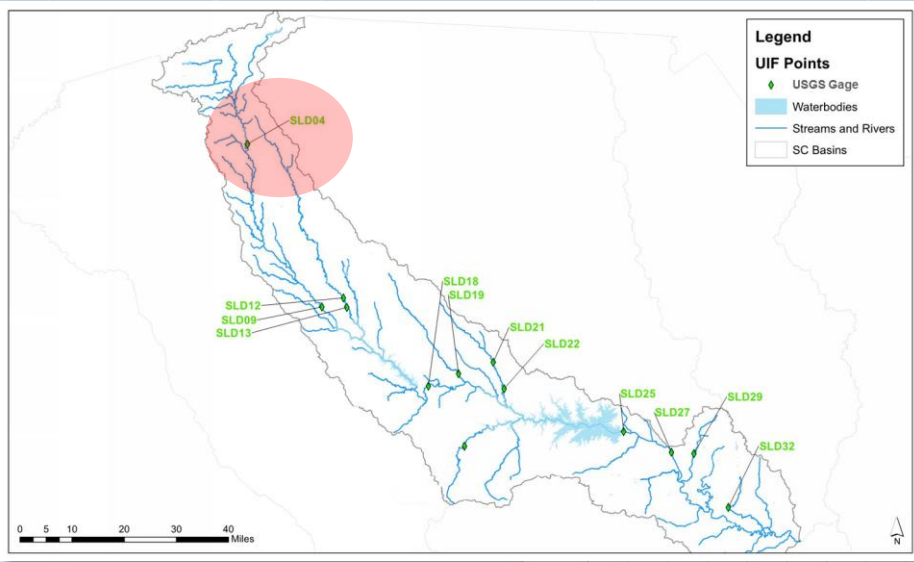
- 1. Calculated UIFs** were developed by unimpairing gage data
- 2. Model UIFs** are developed by turning off withdrawals and discharges in the calibrated model, and removing reservoirs
- 3. Model UIFs** are then compared to calculated UIFs as a validation step

# Validation of Downstream UIFs Saluda Basin

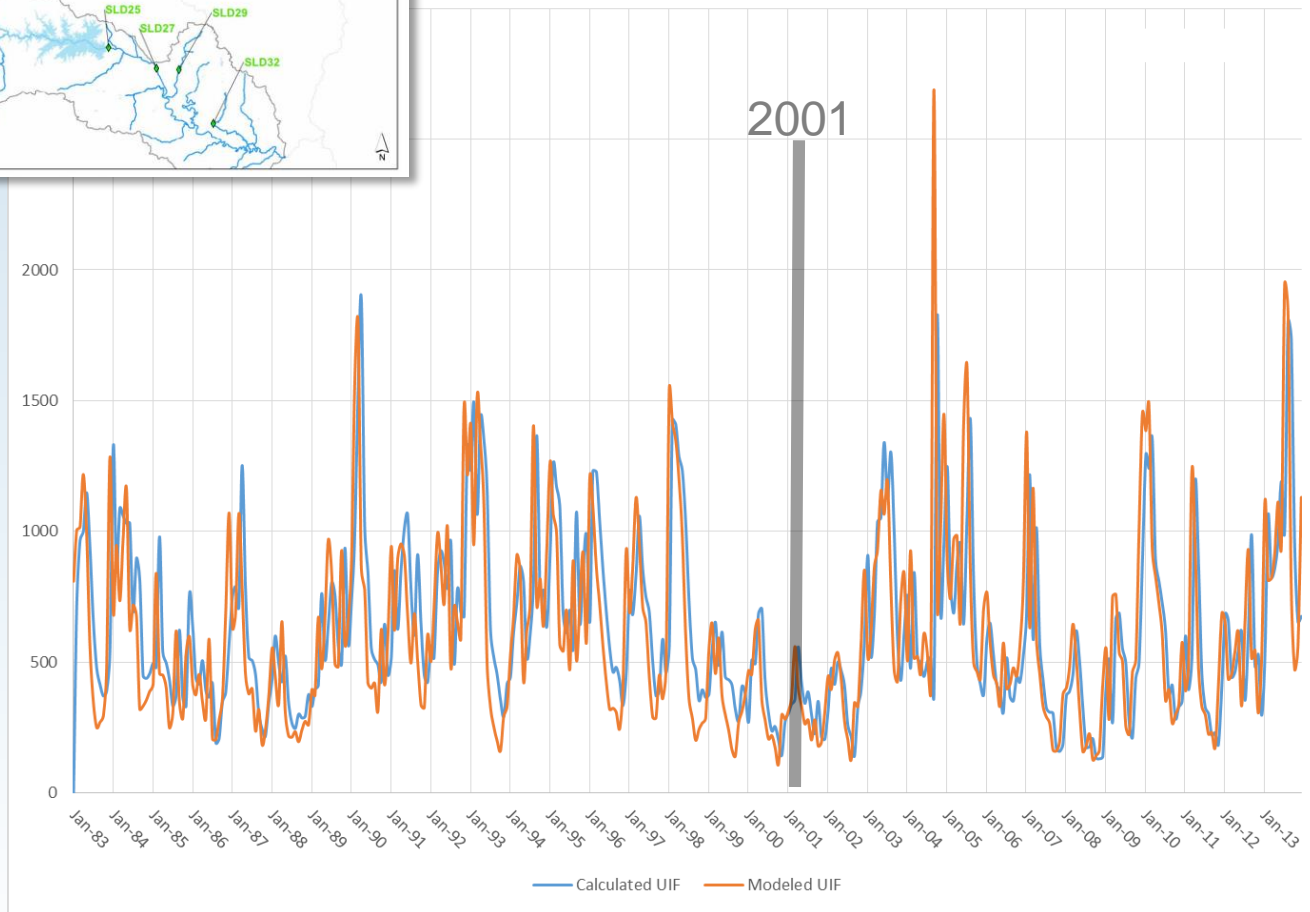
4. **Calculated UIFs** will not *exactly* match model UIFs for several reasons:

- **Model UIFs** are the sum of headwater UIFs and reach gains/losses; while **Calculated UIFs** are actual gage values minus impairments
- Reach gains/losses in **Model UIFs** are a simplification of complex reach hydrology; complex reach hydrology is implicit in **Calculated UIFs**
- Reservoirs are hindcasted as part of **Calculated UIFs**, adding in variability

# Validation of Downstream UIFs Saluda Basin



SLD04 - Saluda River near Greenville (cfs)

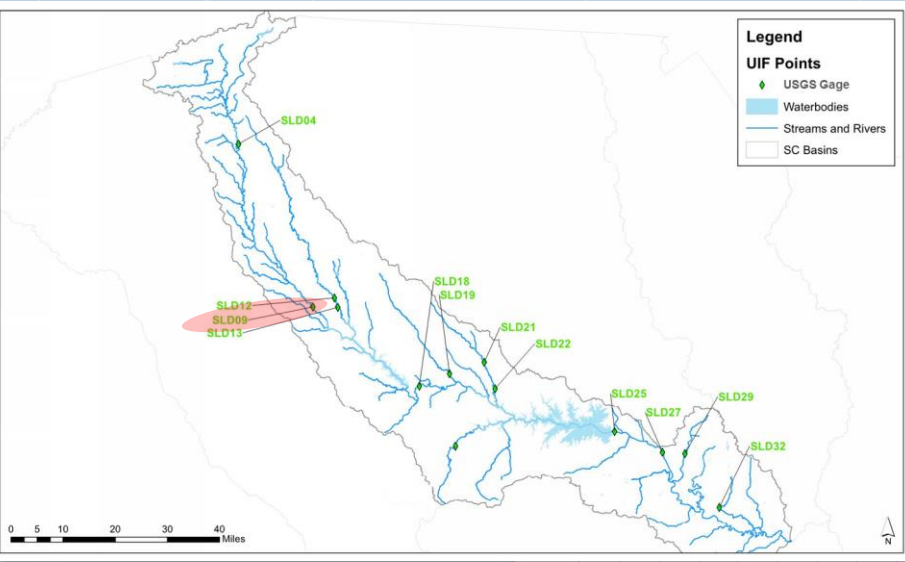


## Note:

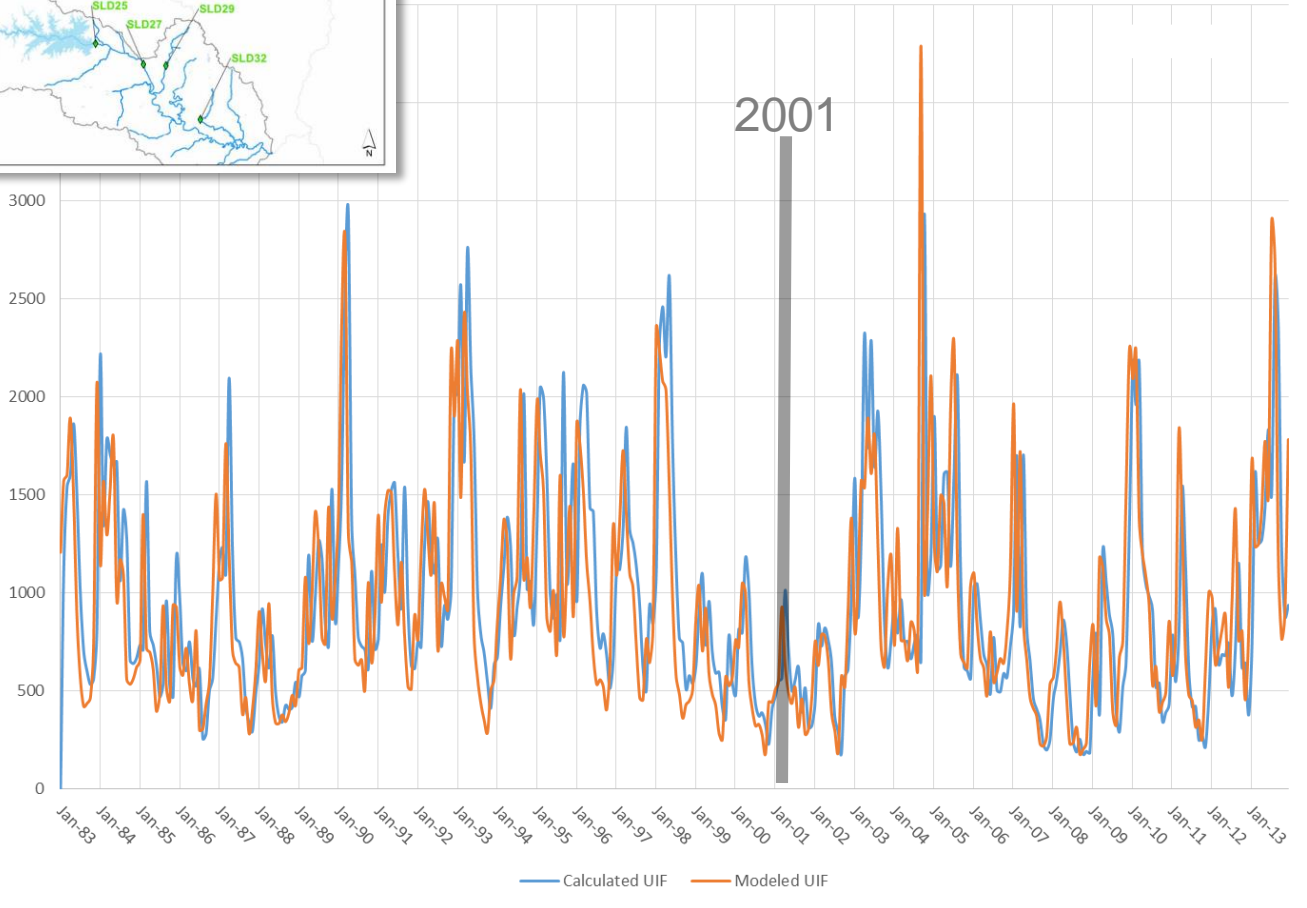
Daily reservoir elevations for Table Rock and North Saluda reservoirs were available after 2001. UIFs at both were based on hindcasting prior to 2001.



# Validation of Downstream UIFs Saluda Basin

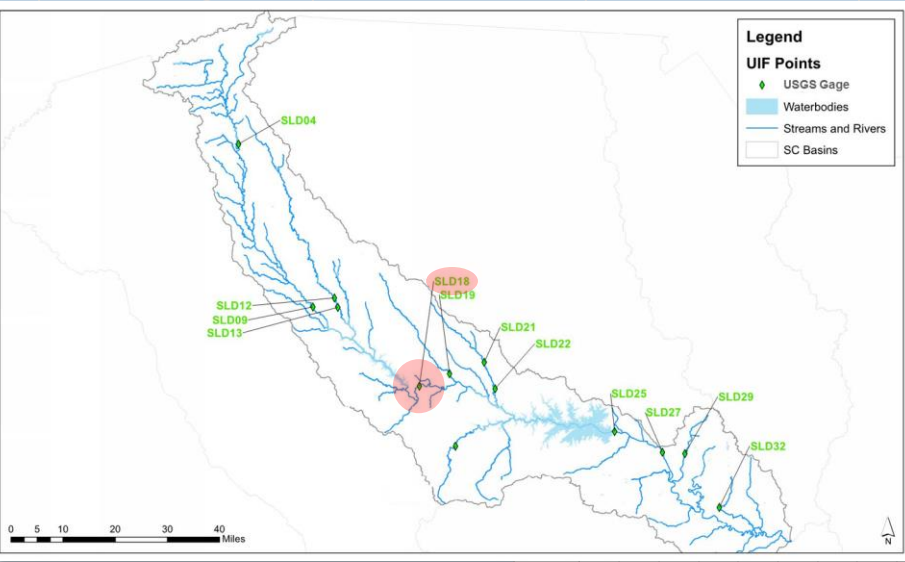


SLD09 - Saluda River near Ware Shoals (cfs)

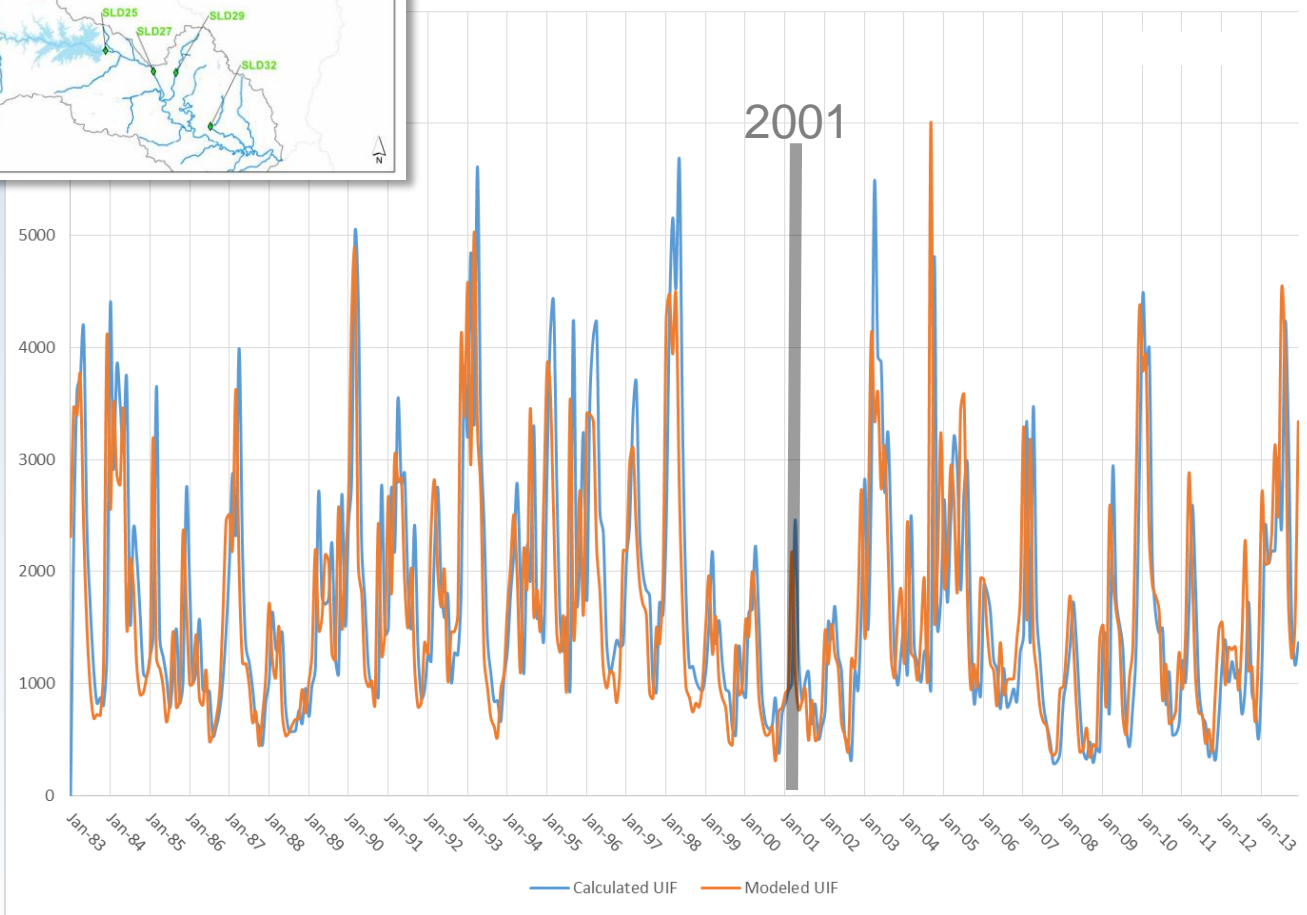


**Note:**  
 Daily reservoir elevations for Table Rock and North Saluda reservoirs were available after 2001. UIFs at both were based on hindcasting prior to 2001.

# Validation of Downstream UIFs Saluda Basin

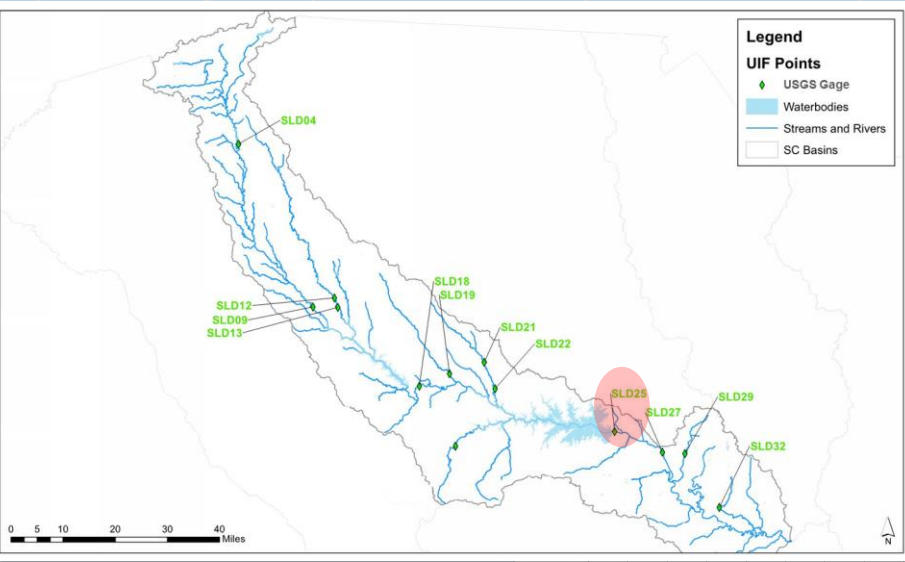


SLD18 - Saluda River at Chappells (cfs)

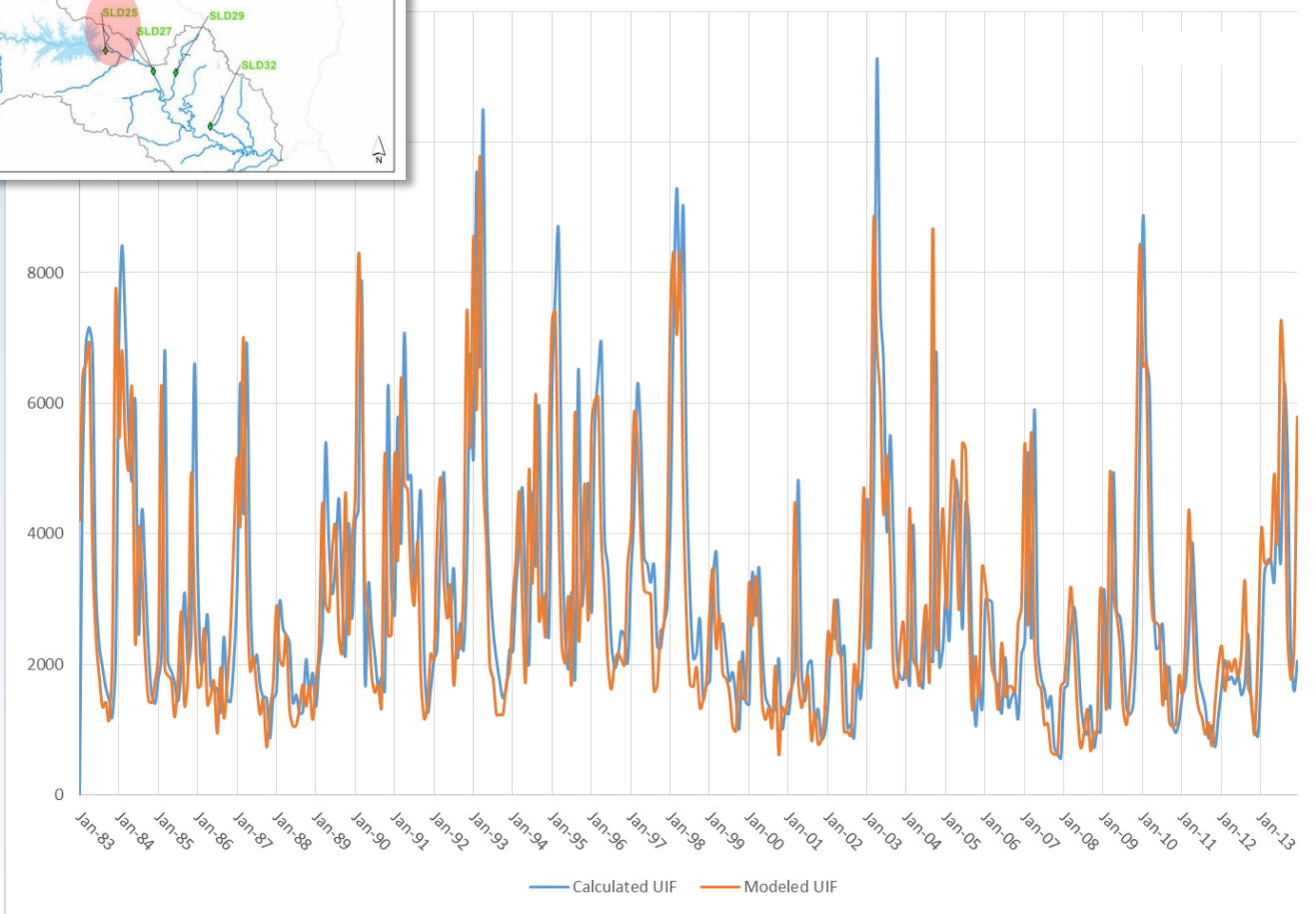


**Note:**  
Daily reservoir elevations for Table Rock and North Saluda reservoirs were available after 2001. UIFs at both were based on hindcasting prior to 2001.

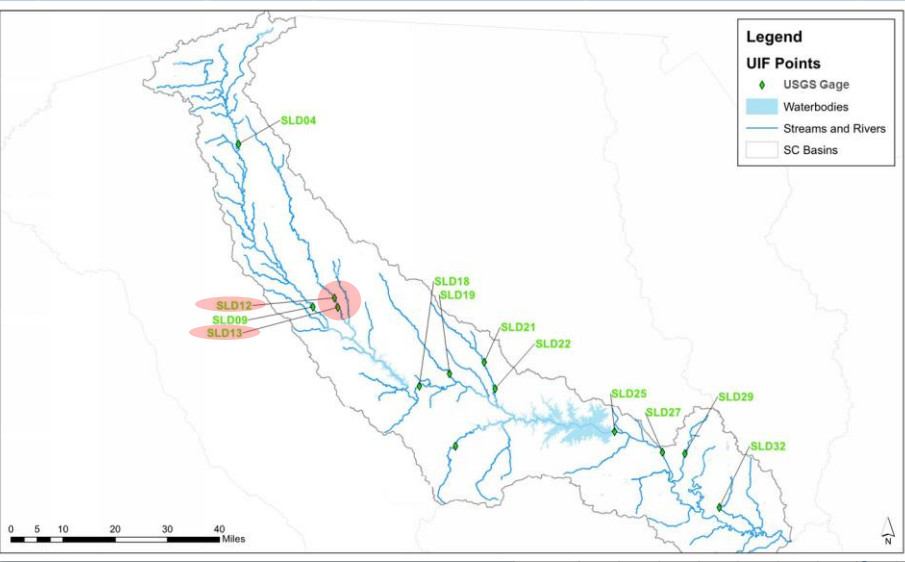
# Validation of Downstream UIFs Saluda Basin



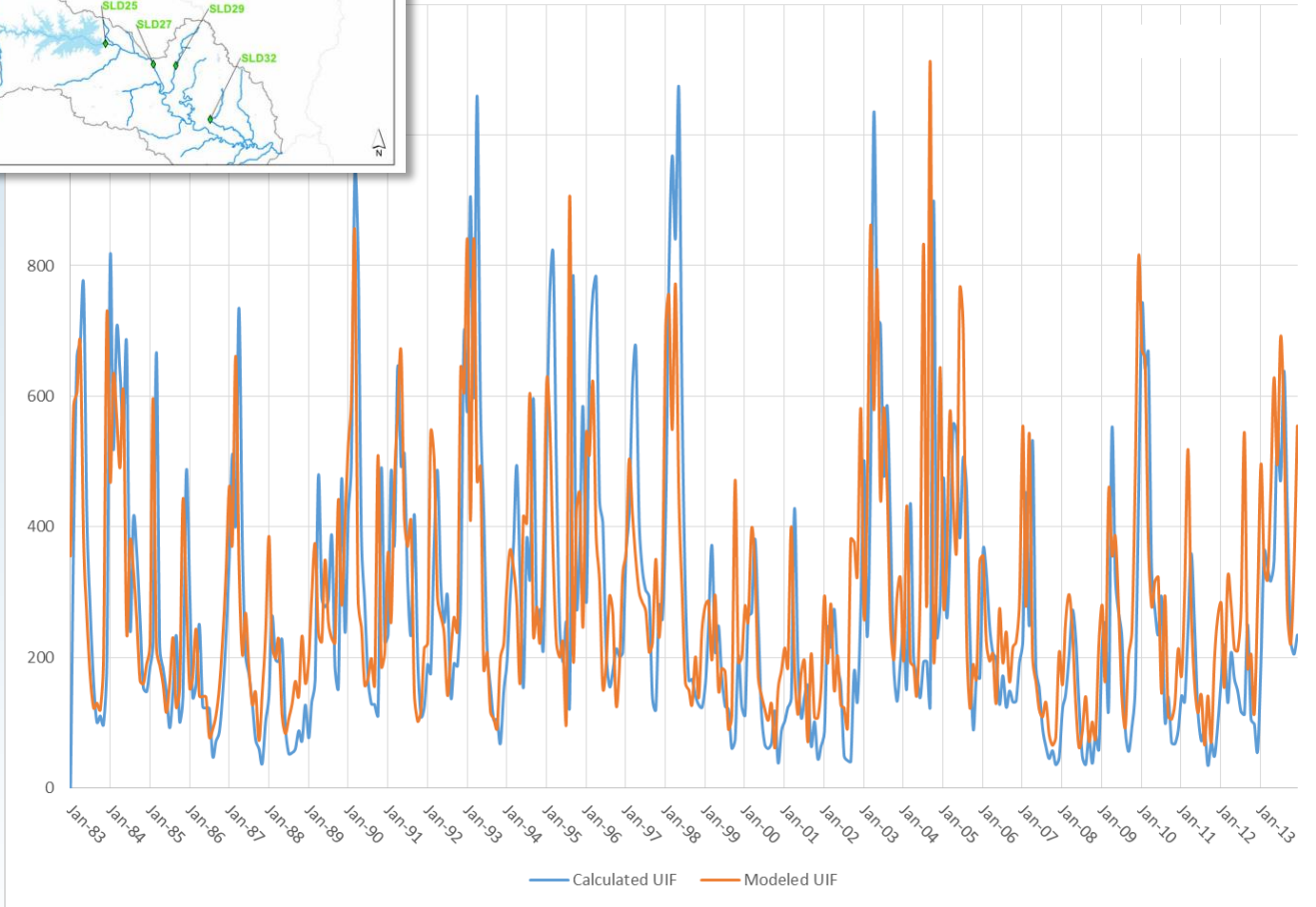
SLD25 - Saluda River below Lake Murray (cfs)



# Validation of Downstream UIFs Saluda Basin

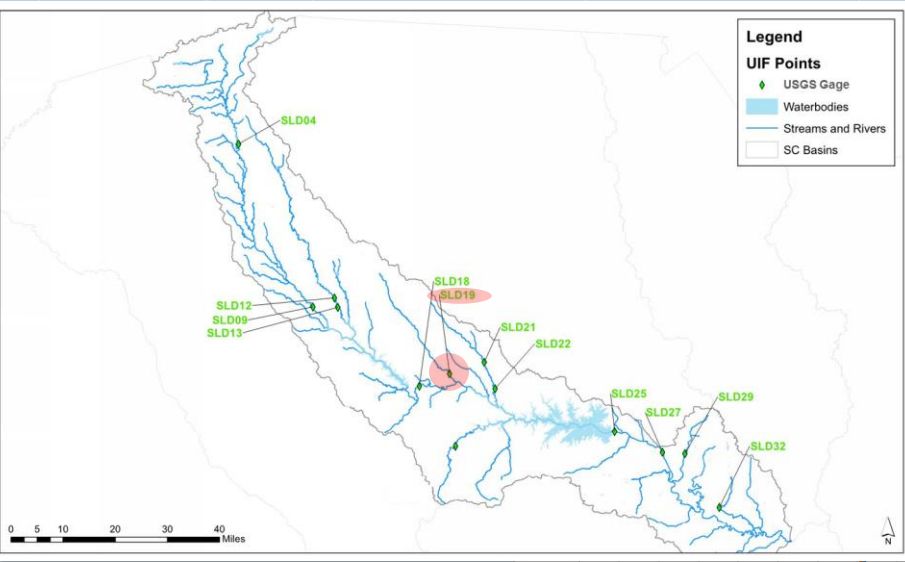


SLD13 - Reedy River near Waterloo (cfs)

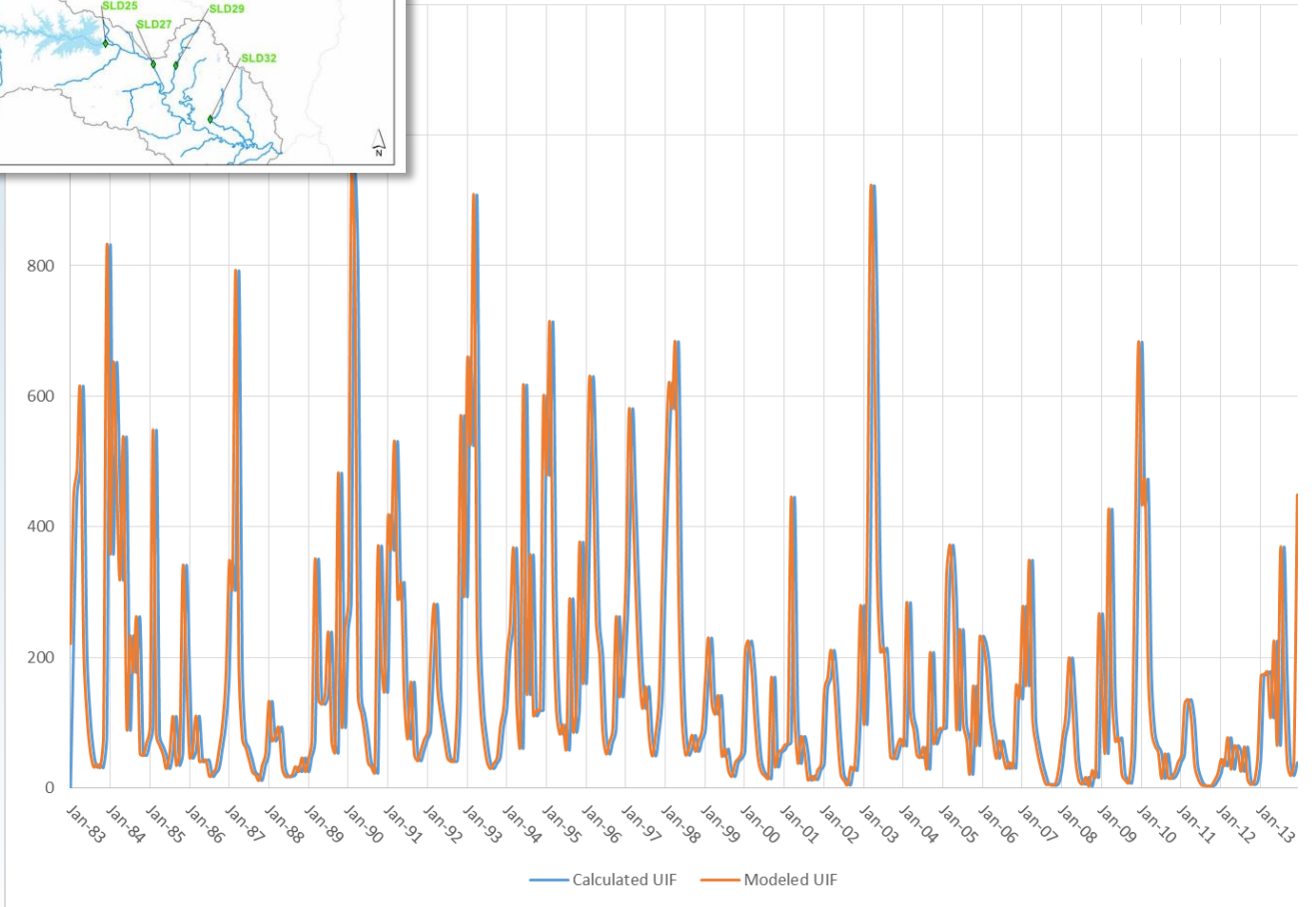


**Note:**  
SLD12 and SLD13 were combined.

# Validation of Downstream UIFs Saluda Basin



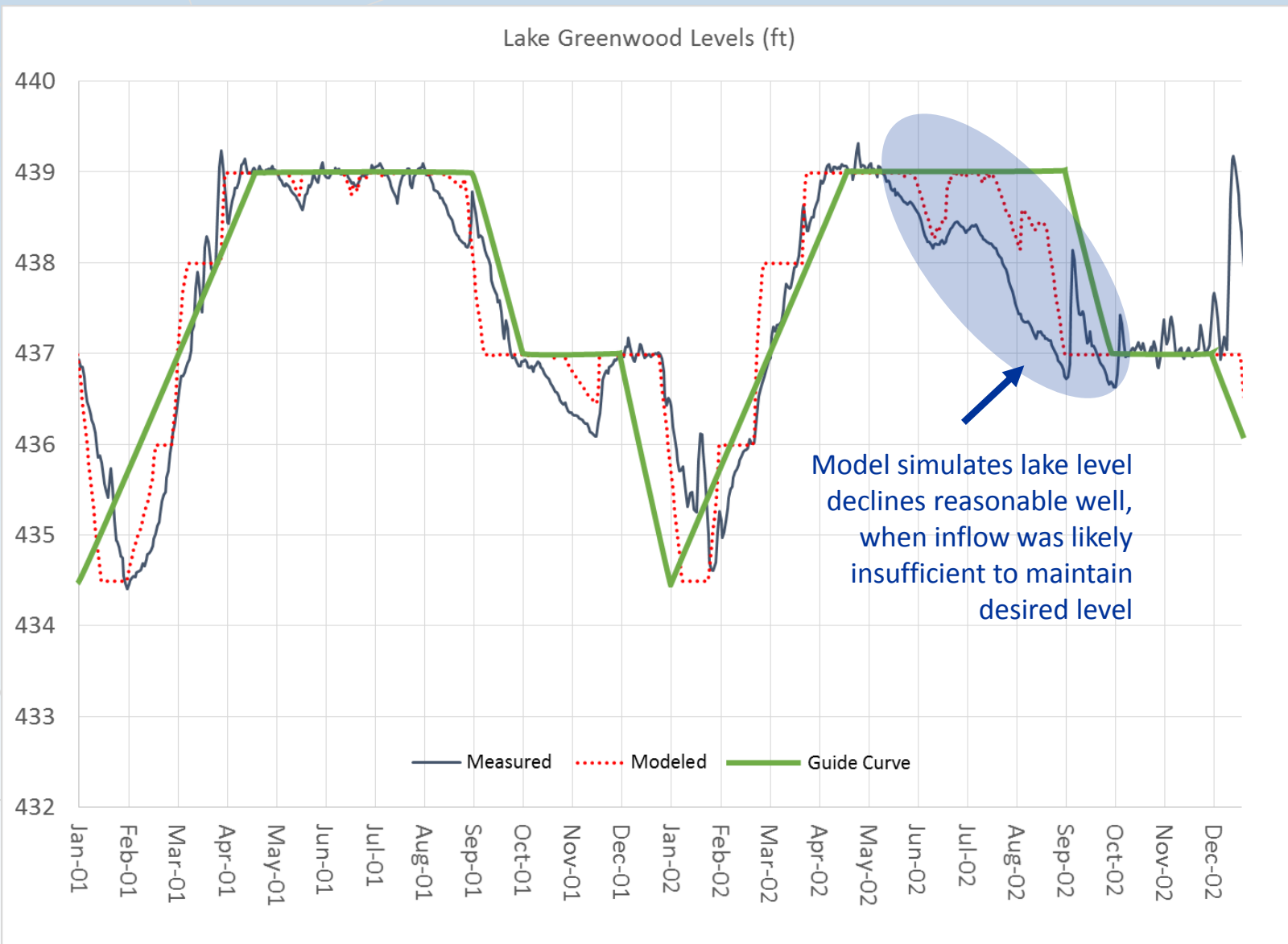
SLD19 - Little River near Silverstreet (cfs)



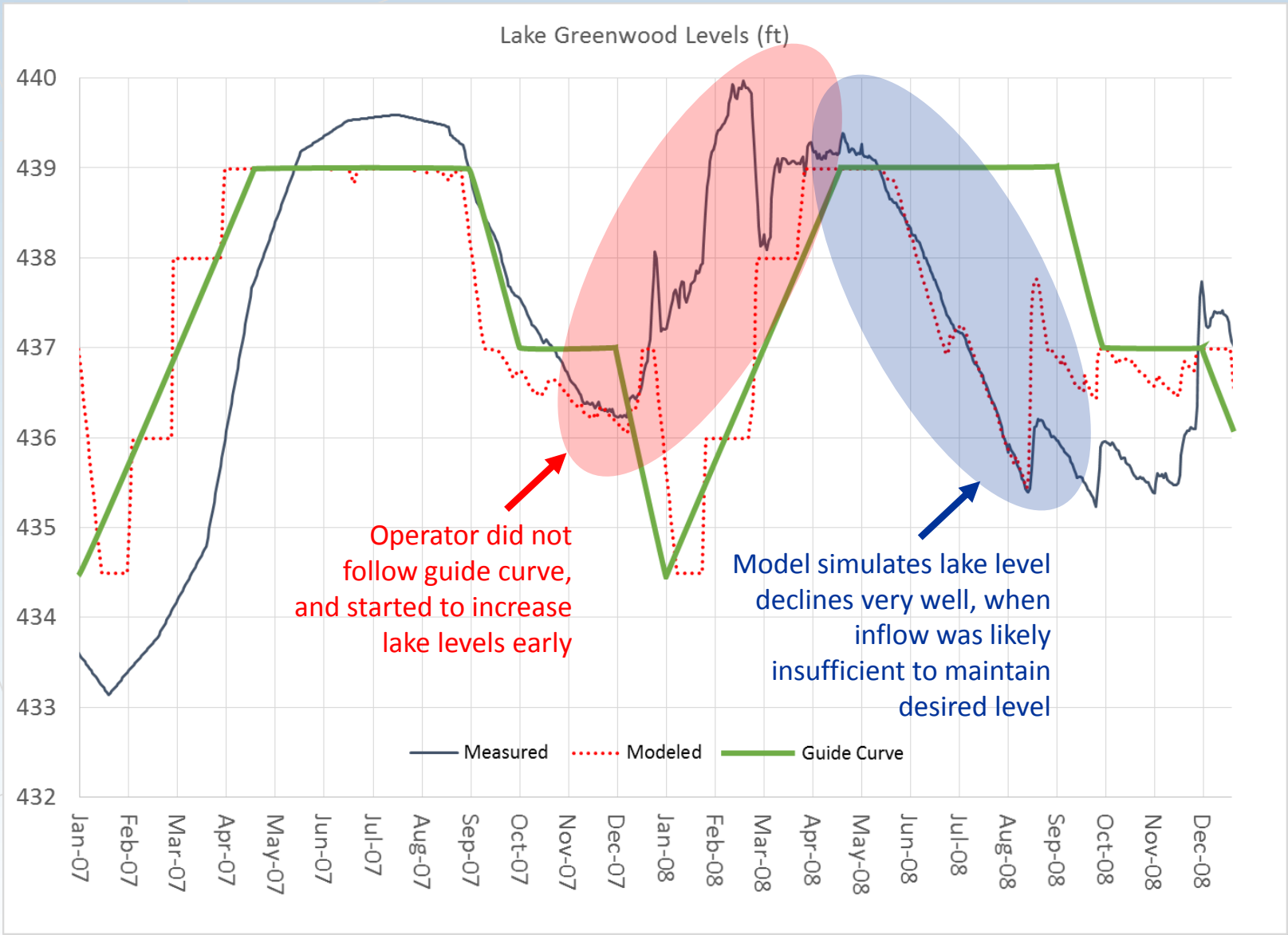
# DNR Saluda Model Comments

- Comment #5 (11/23/2015)
  - “...detailed review of a drought year(s) for Lake Greenwood and Lake Murray to test whether the model was reproducing any resulting declines in lake elevations. “

# Lake Greenwood during 2002 Drought



# Lake Greenwood during 2007-8 Drought

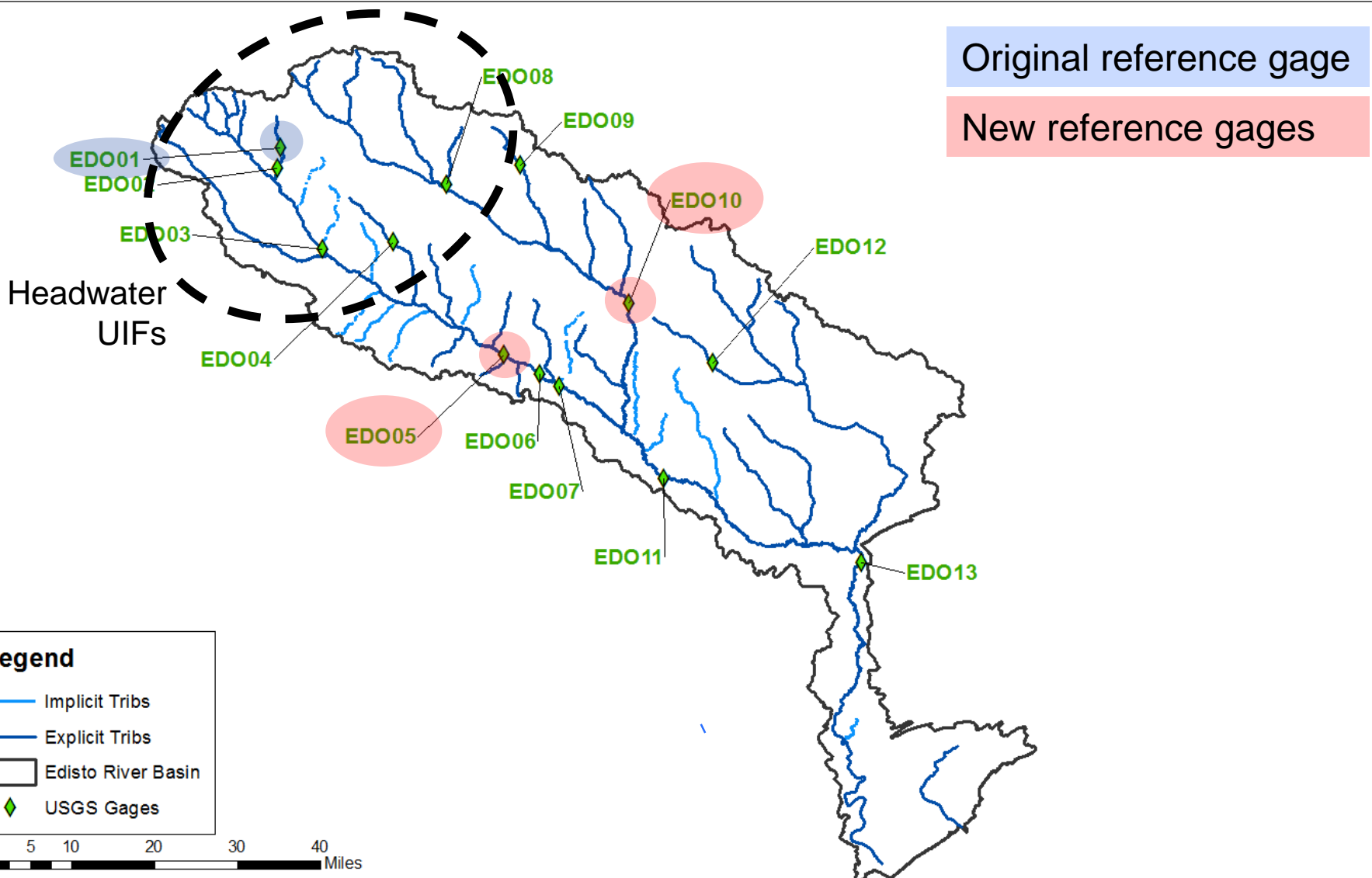




# Overview of Edisto Calibration Adjustments

- Unimpaired Flows (UIFs) Updated for 27 Tributaries
  - Changed reference gage from small area tributary to mainstem
  - South Fork – EDO 05 (USGS 2173000)
  - North Fork – EDO 10 (USGS 2173500)
  - Volume – slight reduction, flow factors adjusted
  - Timing – big change, less “flashy”
- Tributary Flow Factors
  - Slight adjustments on North Fork and Four Hole Swamp
  - No change in order of magnitude
- Mainstem Flow Factors
  - Slight adjustments
  - No change in order of magnitude.

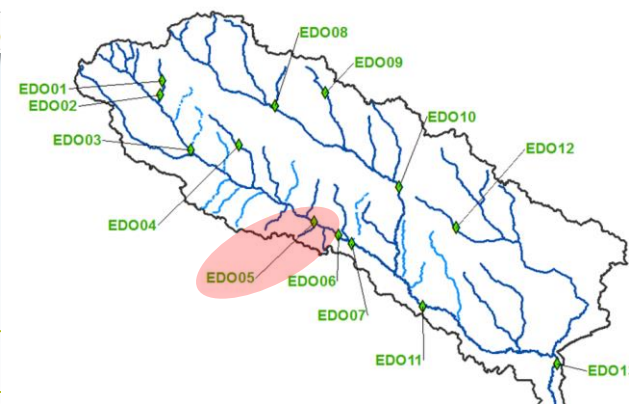
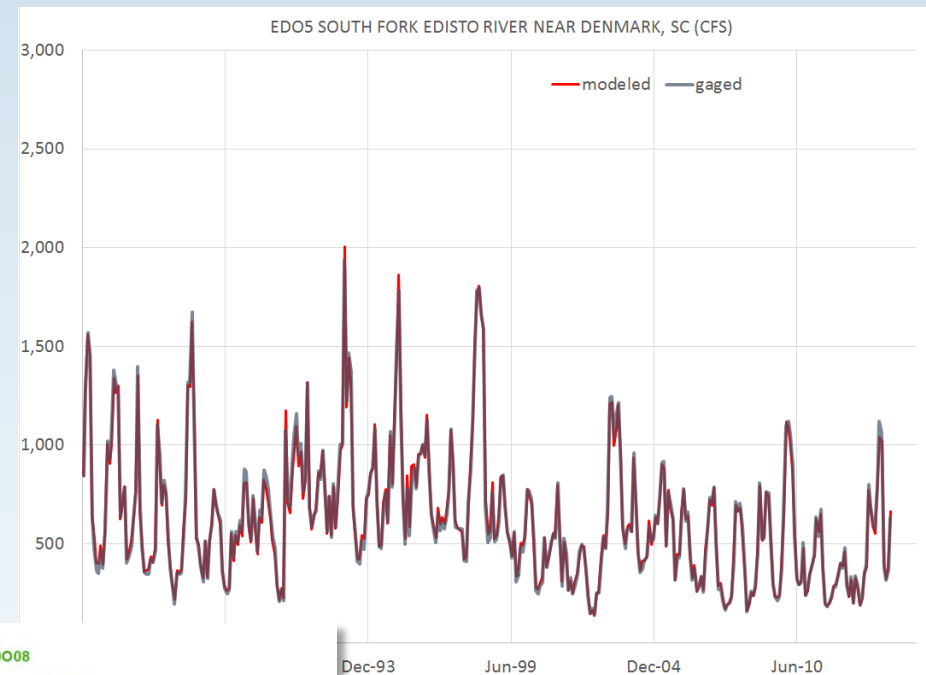
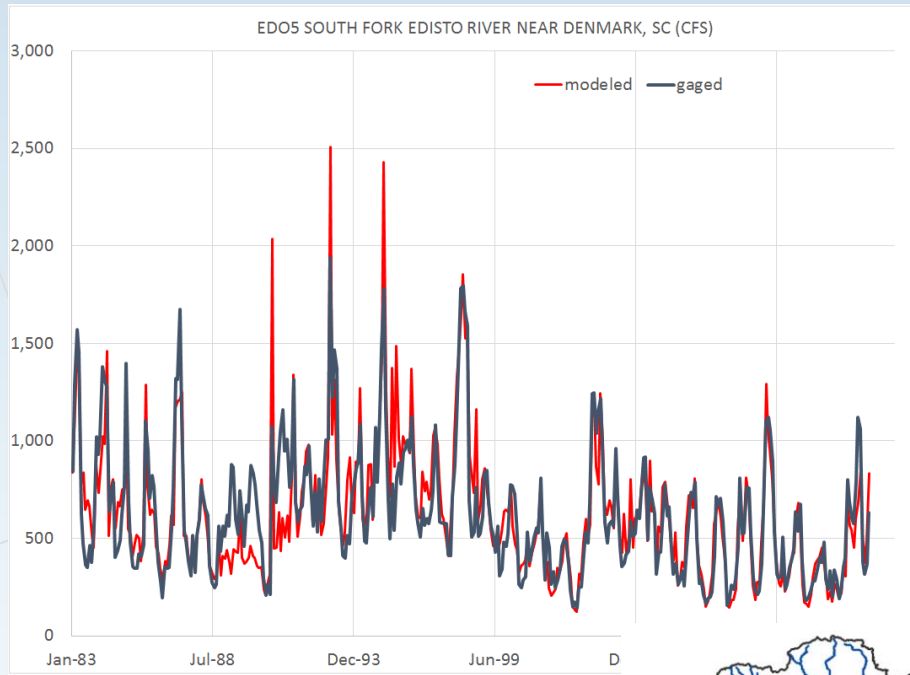
# Edisto Basin Calibration/Validation Locations



# EDO 05 – South Fork near Denmark (USGS 2173000) - MONTHLY

Old UIFs

New UIFs

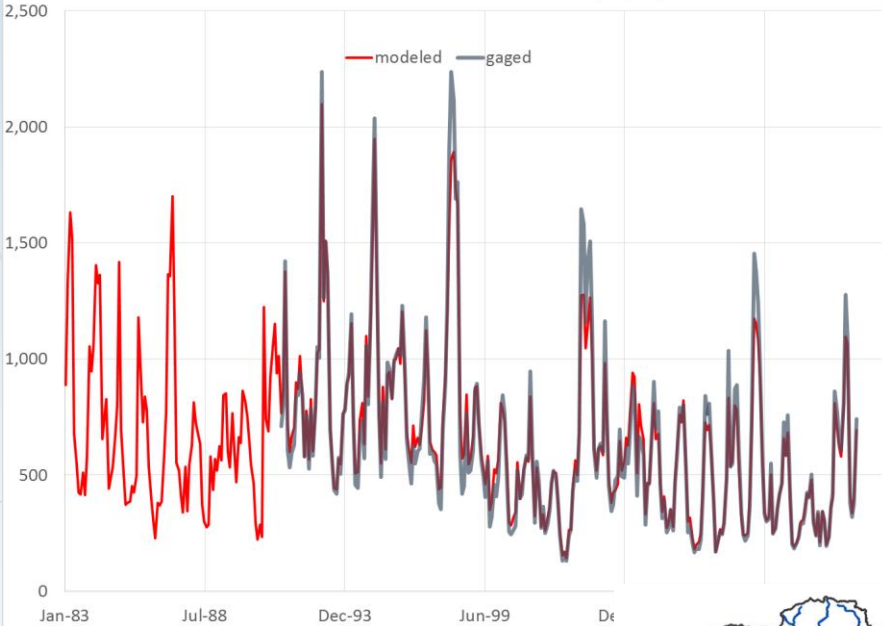


# EDO 06 and 07 – South Fork

## MONTHLY

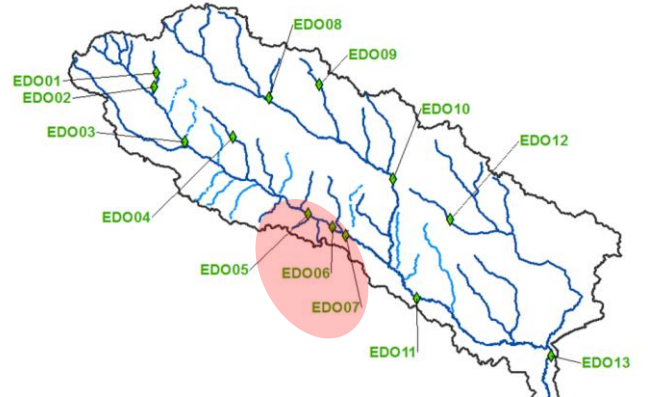
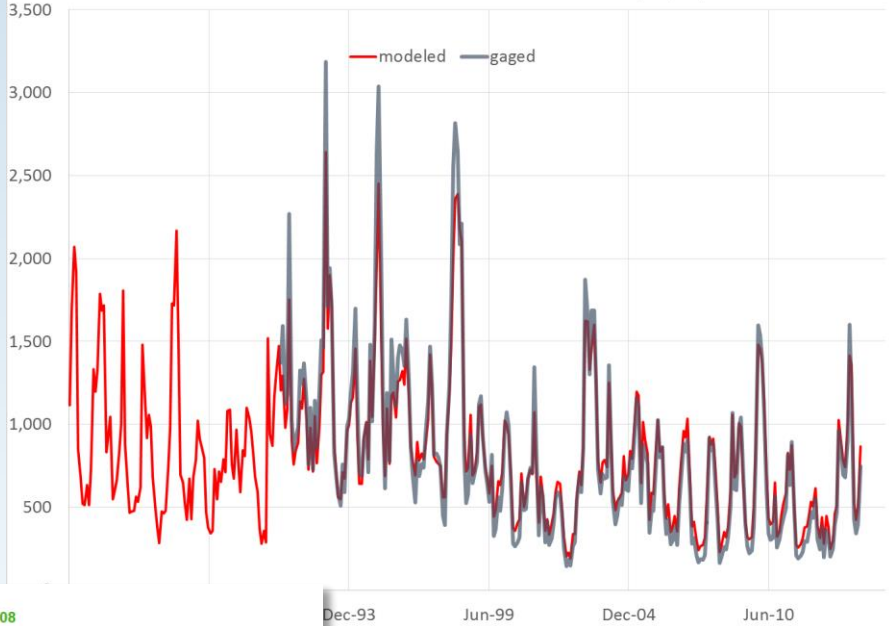
### EDO6 (New)

EDO6 SOUTH FORK EDISTO RIVER NEAR COPE, SC (CFS)



### EDO7 (New)

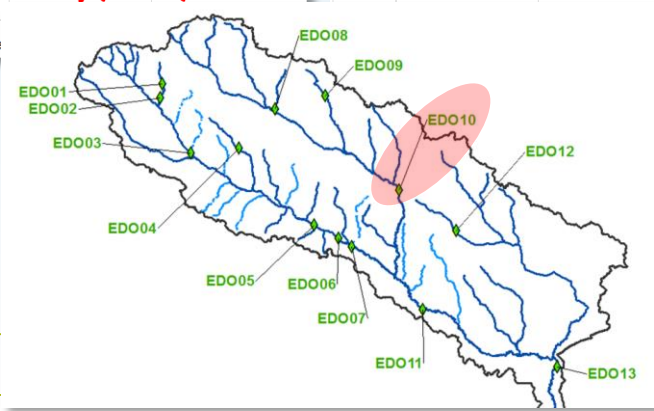
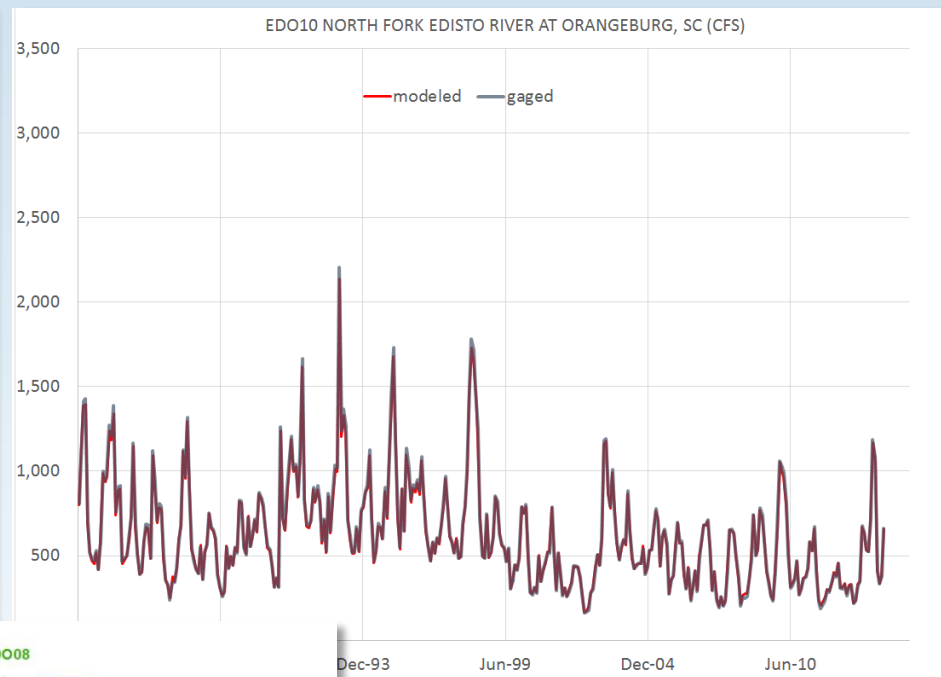
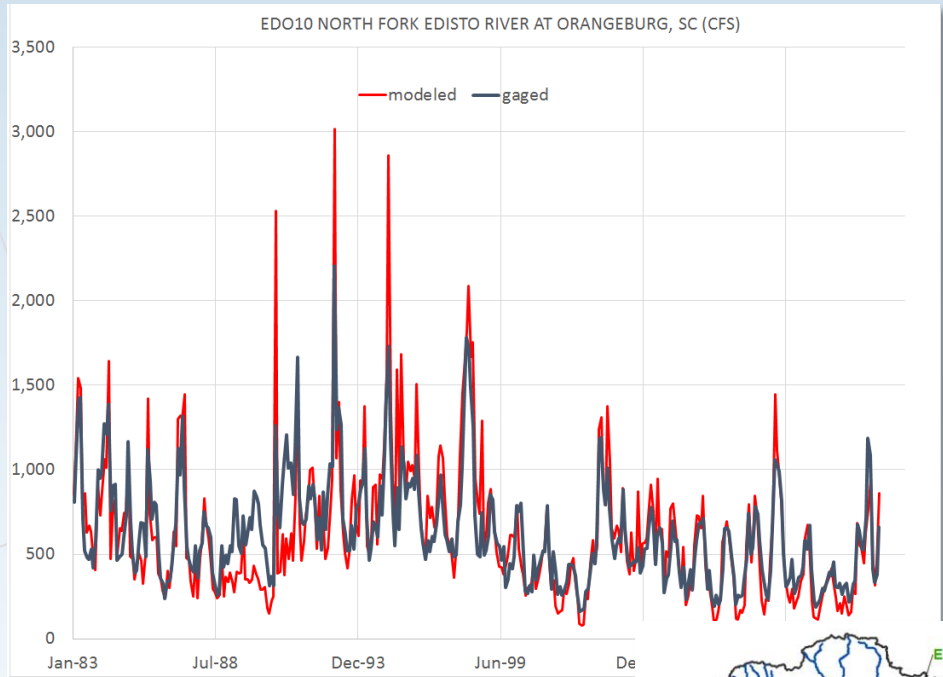
EDO7 SOUTH FORK EDISTO RIVER NEAR BAMBERG, SC (CFS)



# EDO10 NORTH FORK AT ORANGEBURG (USGS 2173500) - MONTHLY

Old UIFs

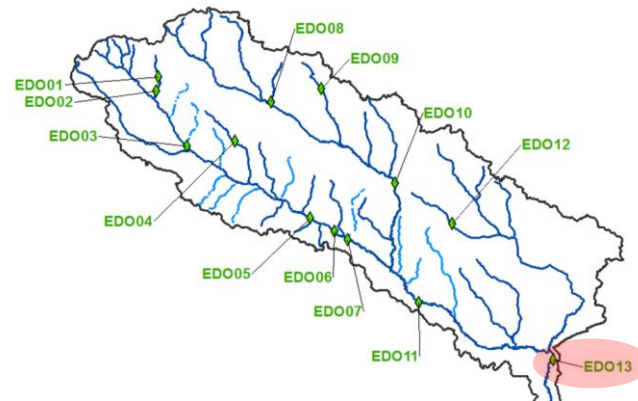
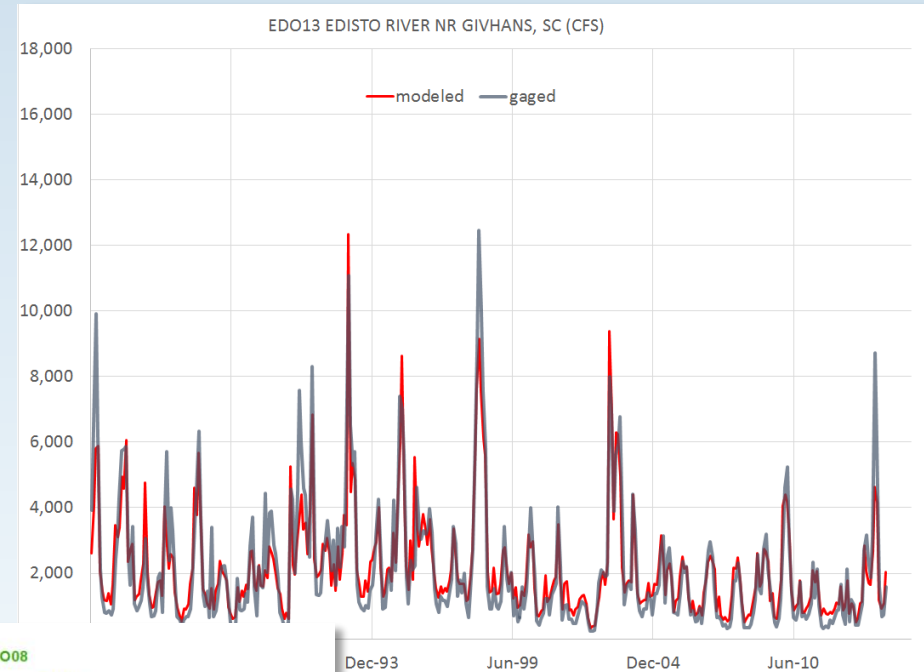
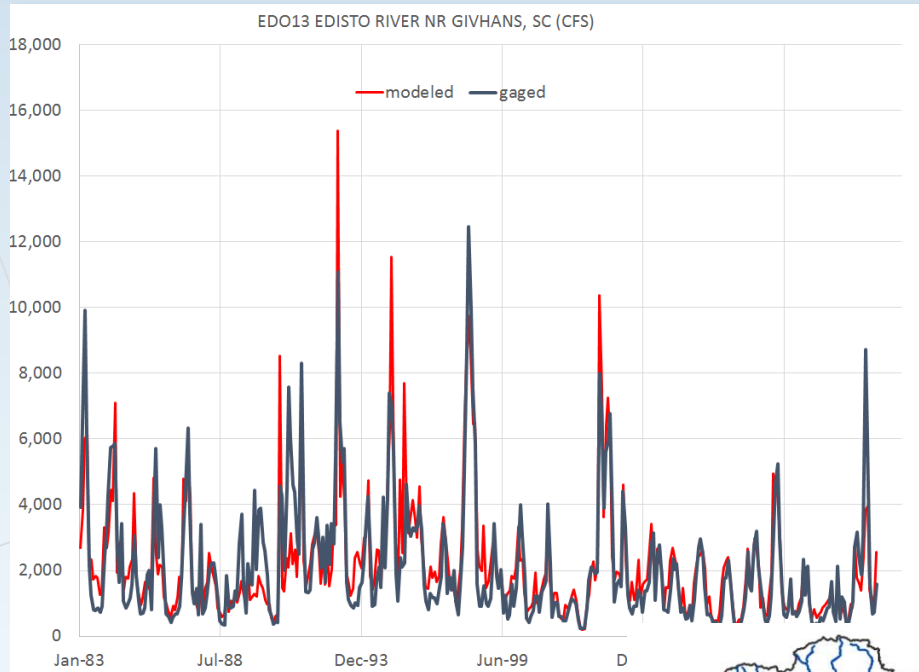
New UIFs



# EDO13 EDISTO RIVER Near GIVHANS (USGS 2175000) - MONTHLY

Old UIFs

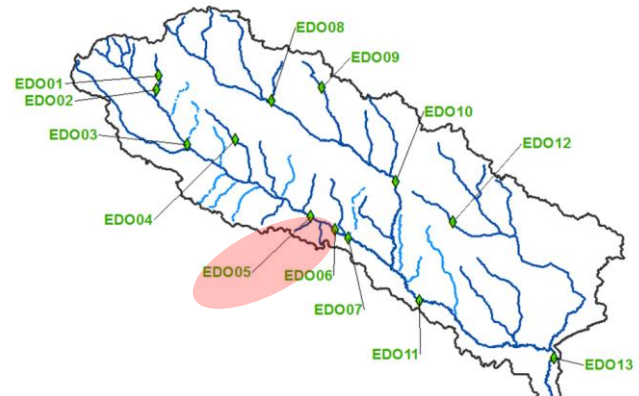
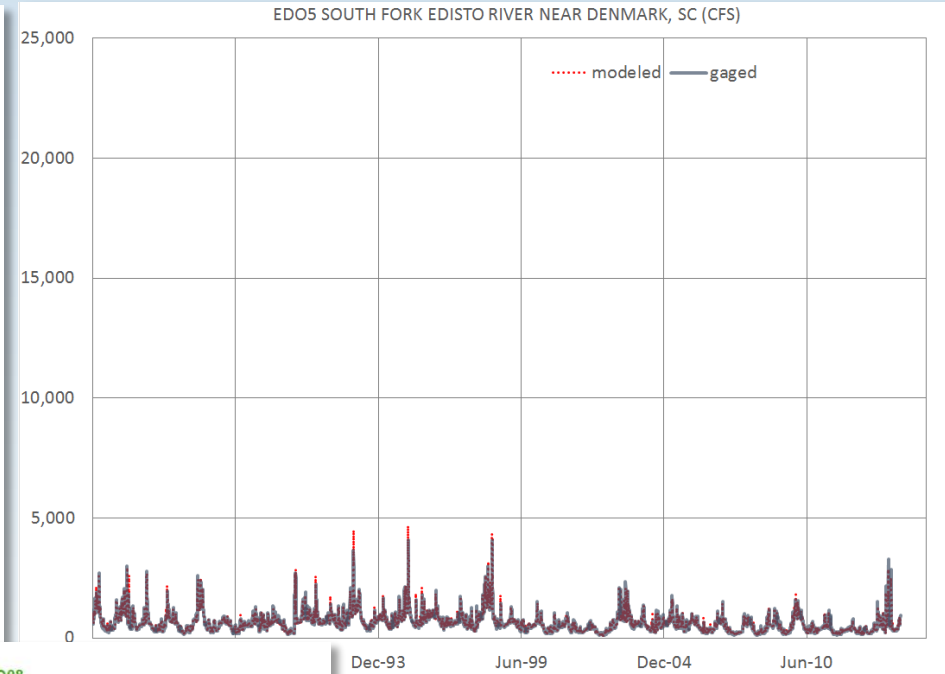
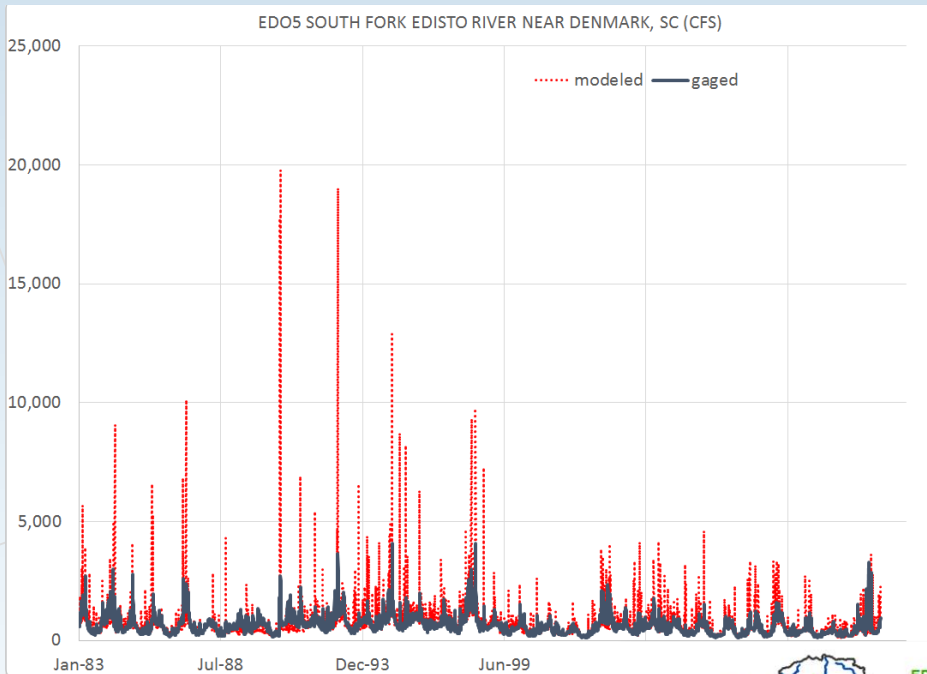
New UIFs



# EDO 05 – South Fork near Denmark (USGS 2173000) - DAILY

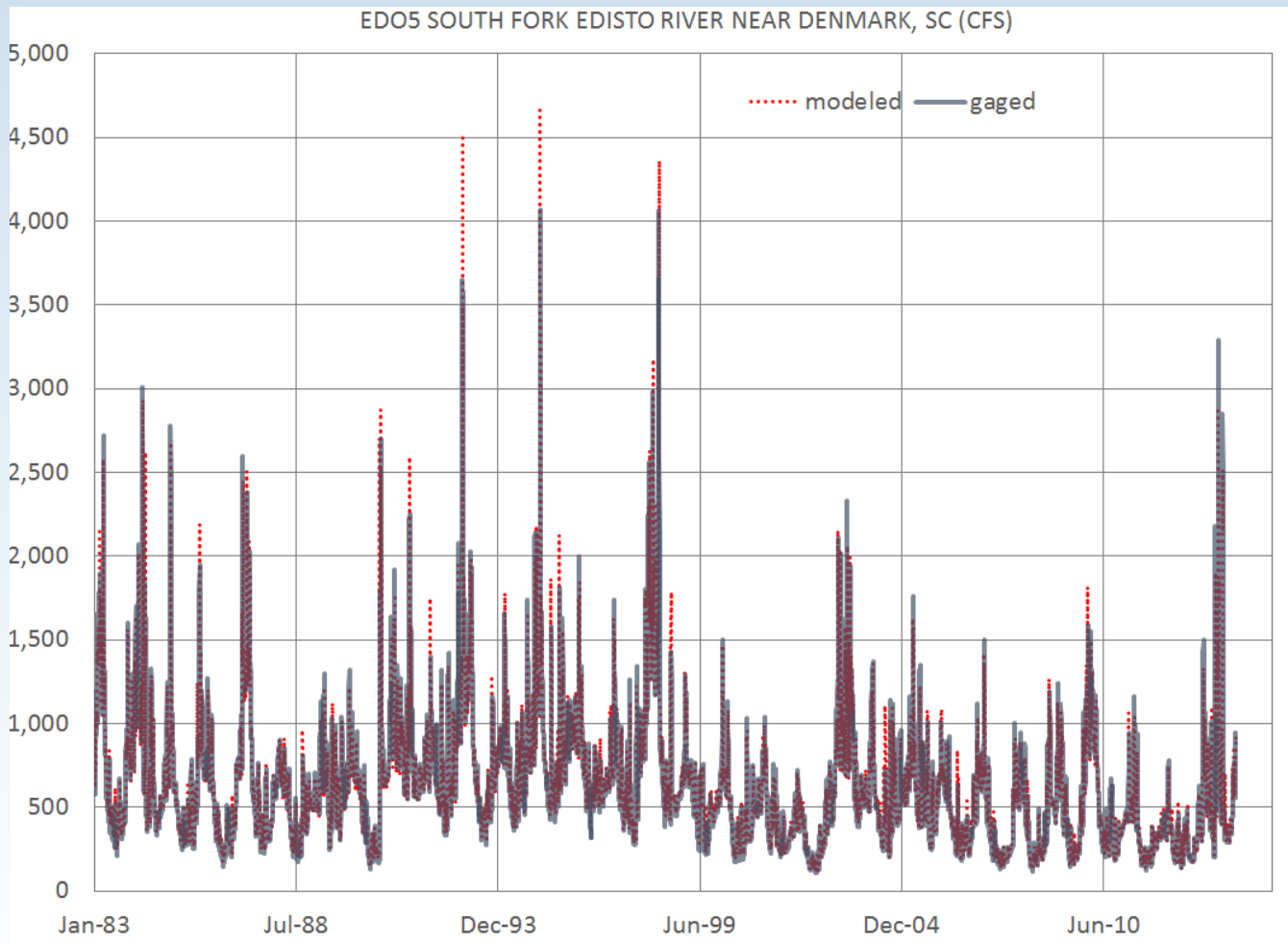
Old UIFs

New UIFs



# EDO 05 – South Fork near Denmark (USGS 2173000) - DAILY

New UIFs

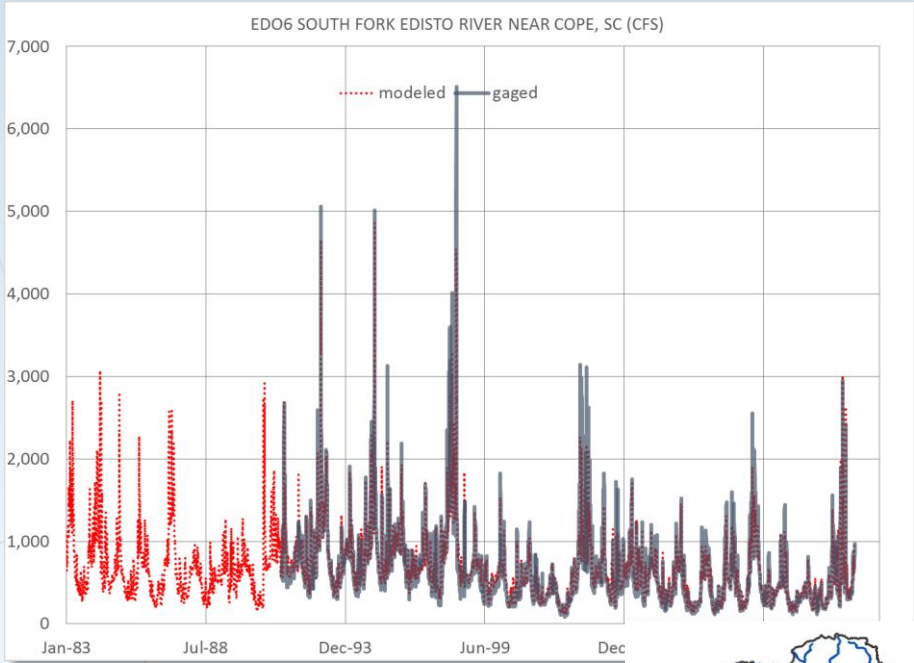




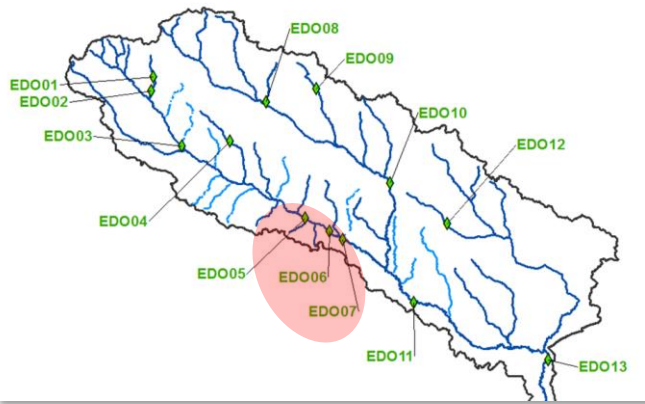
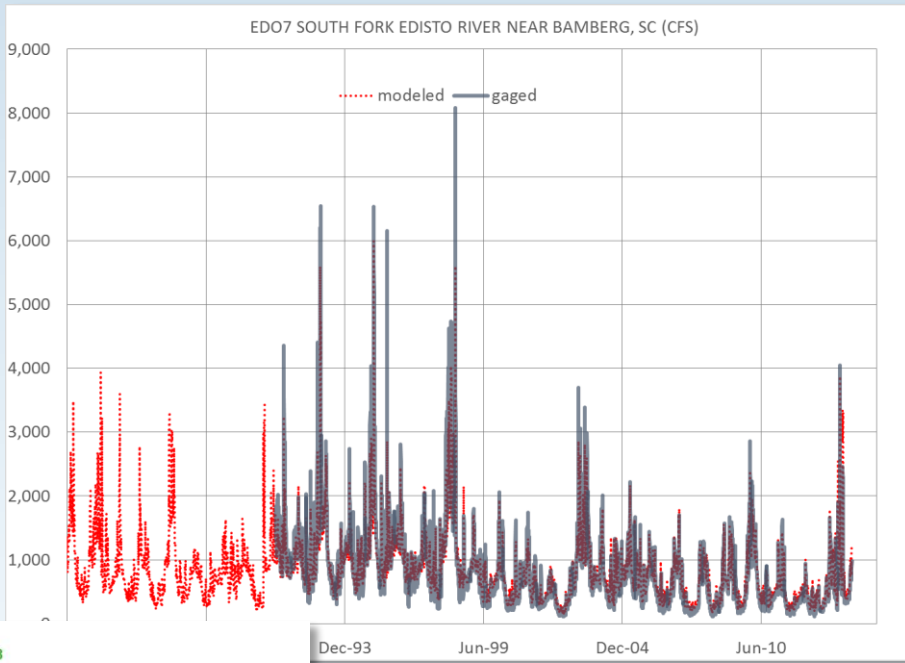
# EDO 06 and 07 – South Fork

## DAILY

### EDO6 (New)



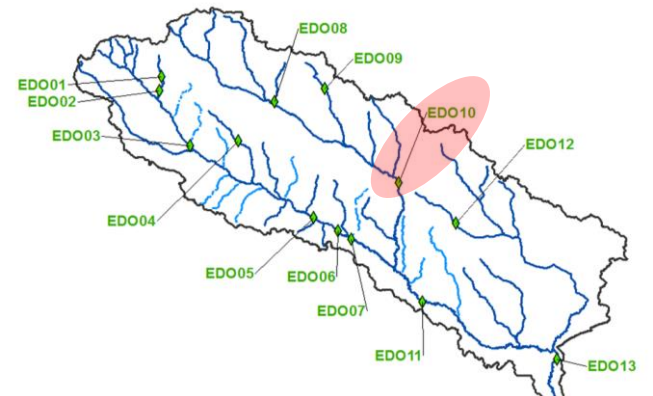
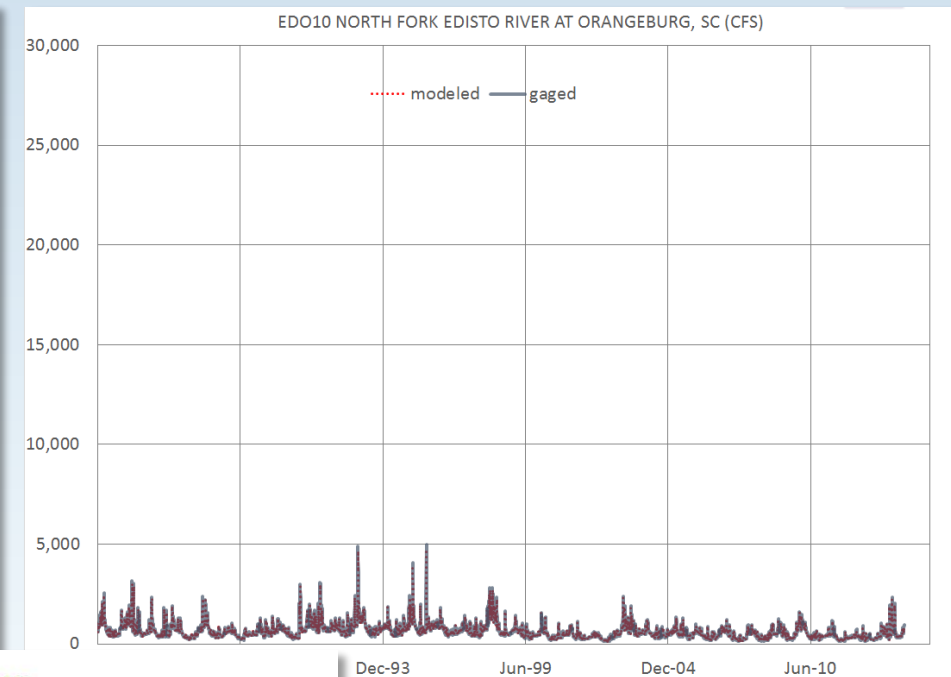
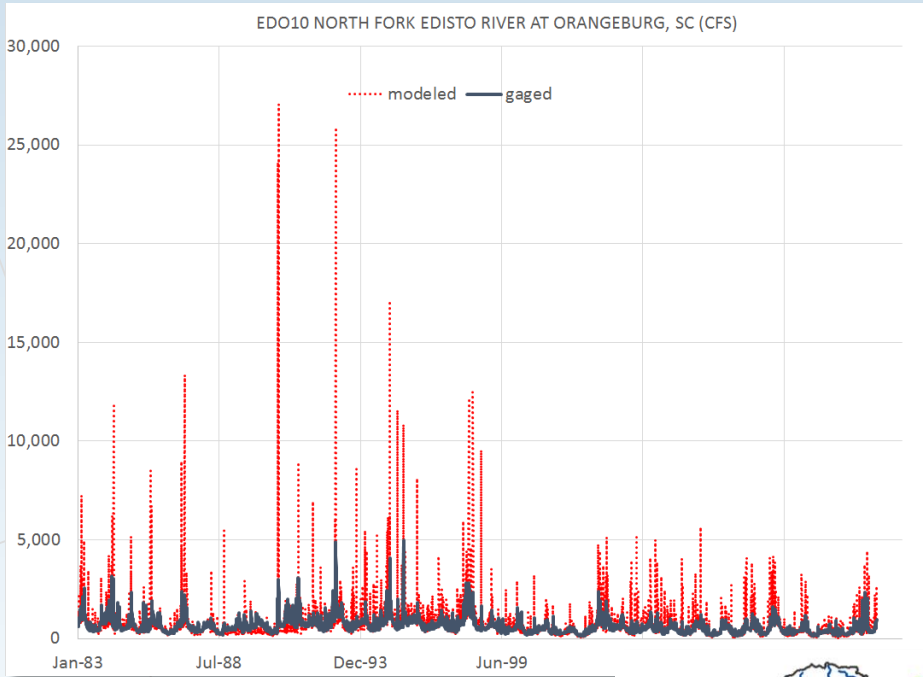
### EDO7 (New)



# EDO10 NORTH FORK AT ORANGEBURG (USGS 2173500) - DAILY

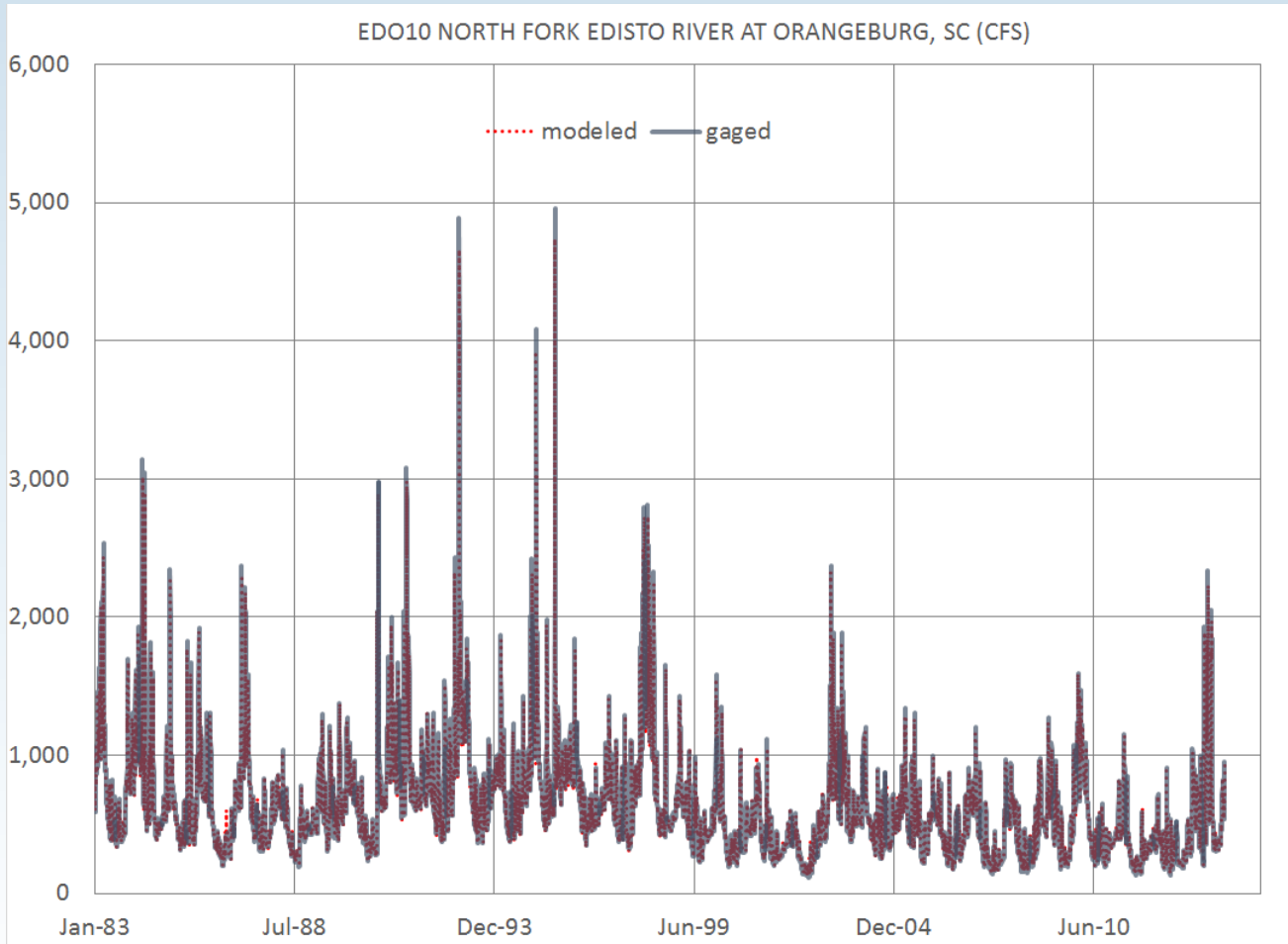
Old UIFs

New UIFs



# EDO10 NORTH FORK AT ORANGEBURG (USGS 2173500) - DAILY

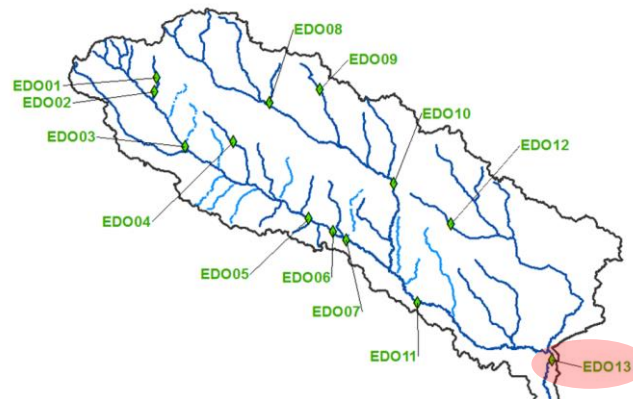
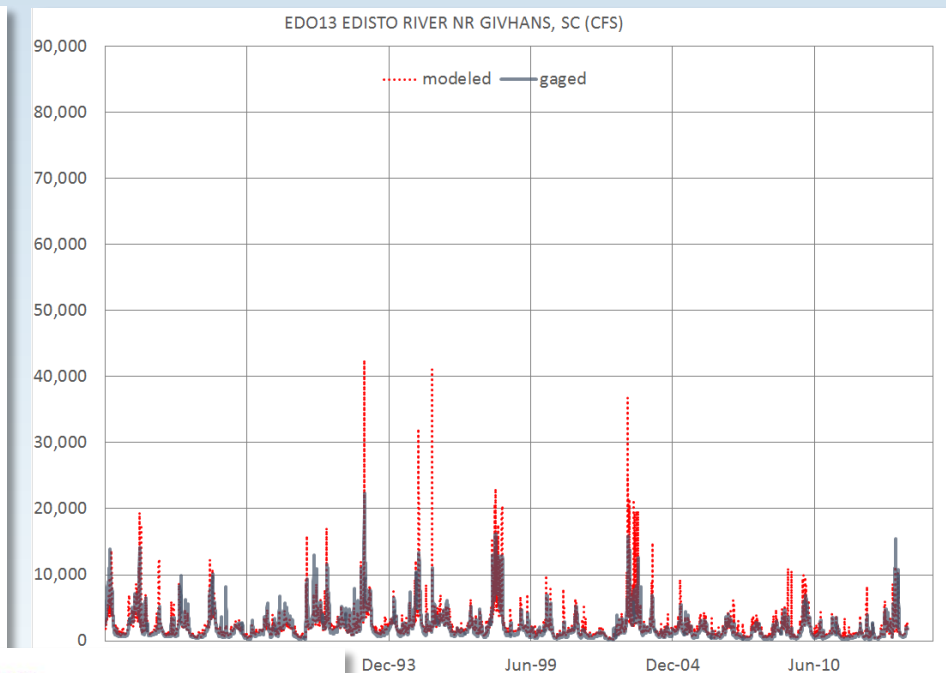
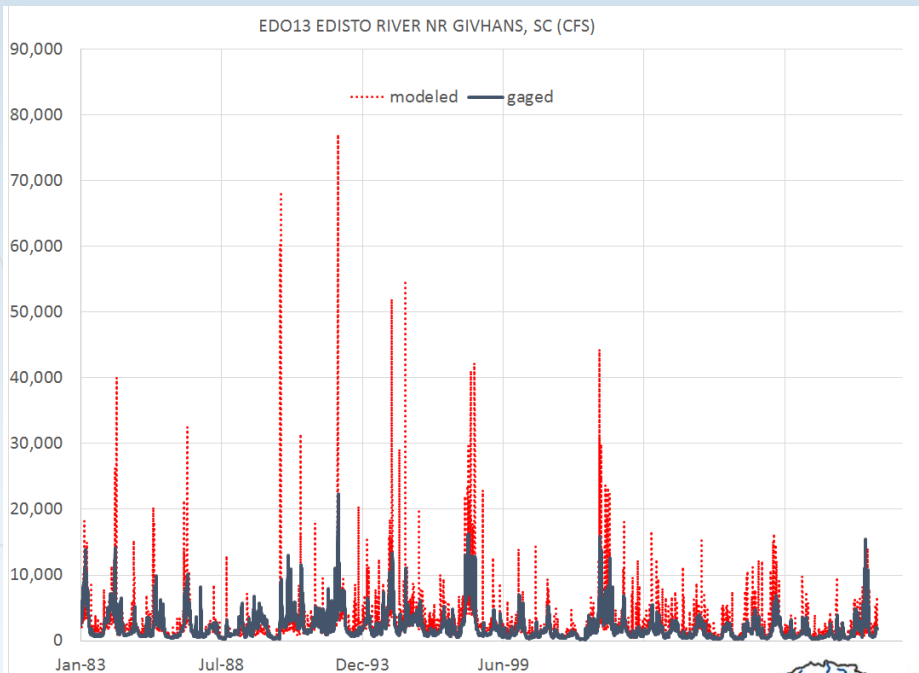
New UIFs



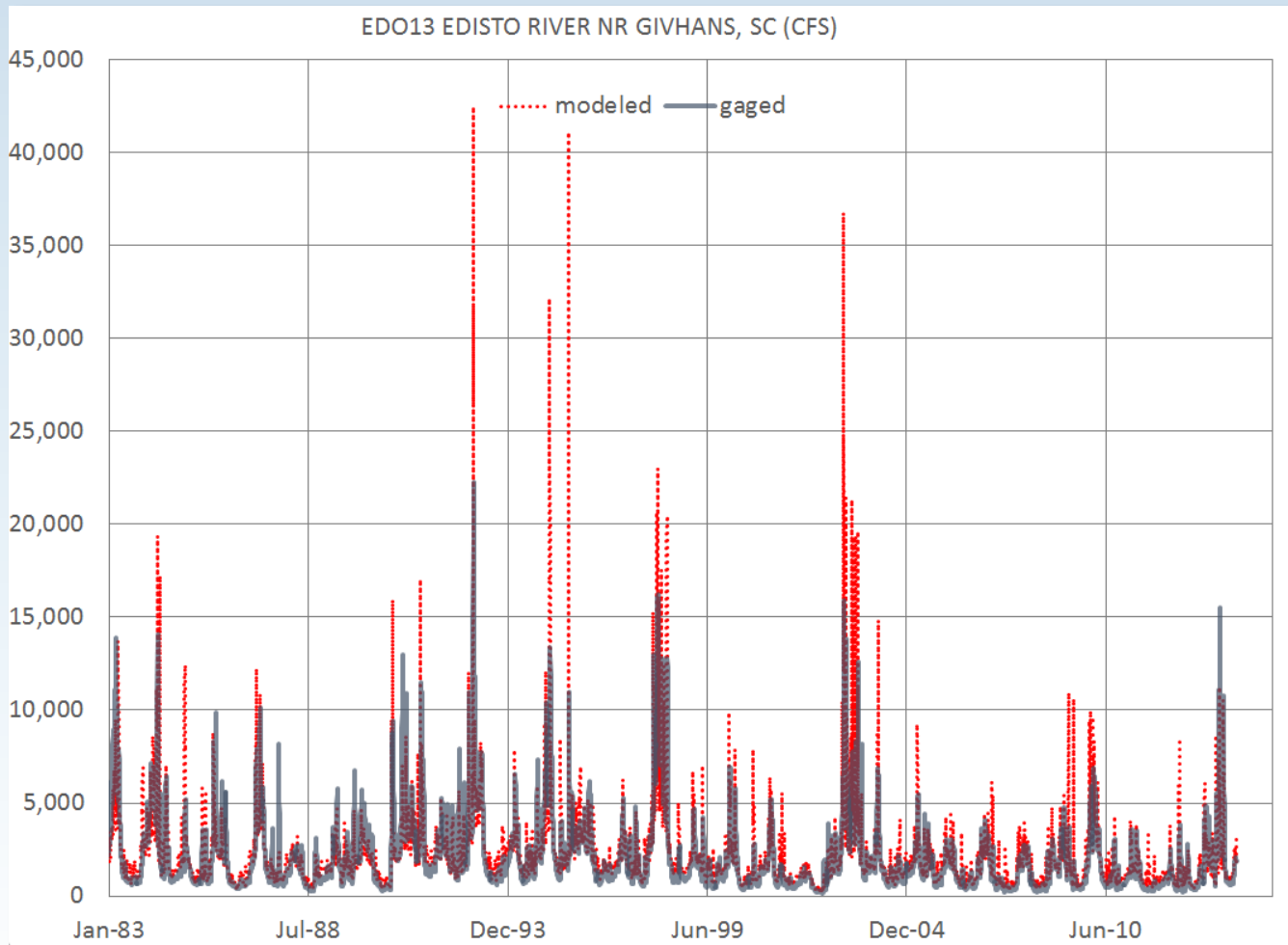
# EDO13 EDISTO RIVER Near GIVHANS (USGS 2175000) - DAILY

Old UIFs

New UIFs



# EDO13 EDISTO RIVER Near GIVHANS (USGS 2175000) - DAILY New UIFs

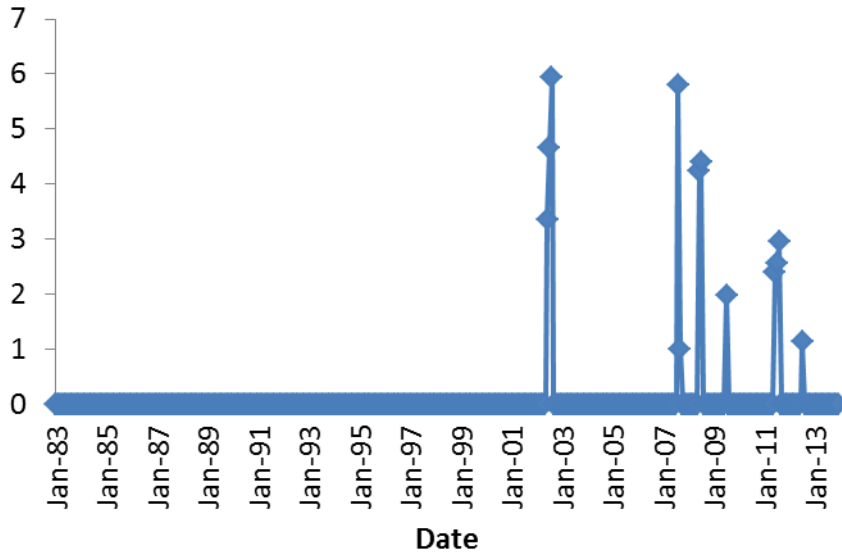


# WS: Aiken (Shaw Crk) - SHORTAGE

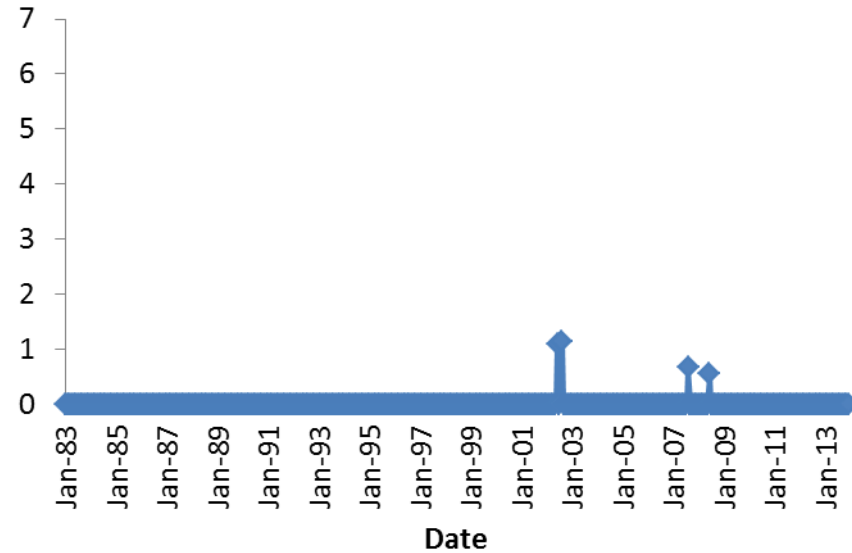
## Old UIFs

## New UIFs

WS: Aiken Shortage (MGD)



WS: Aiken Shortage (MGD)

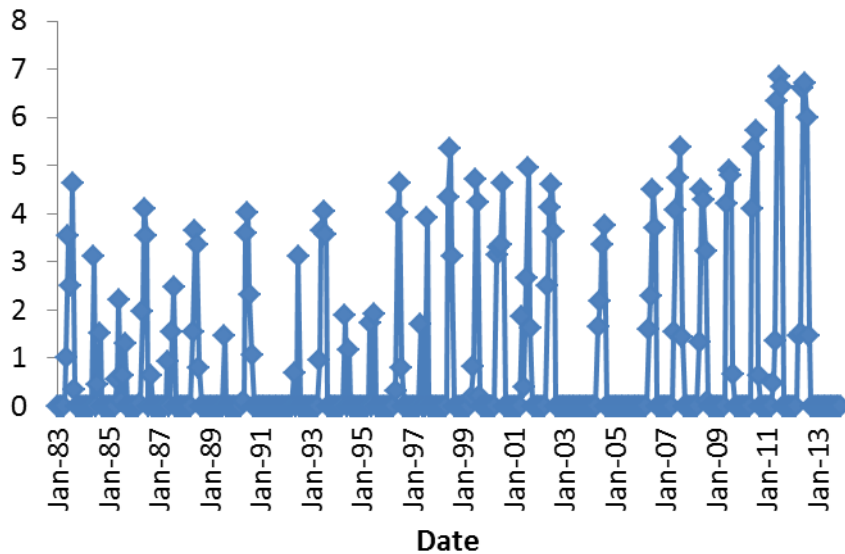


# IR: Millwood (Limestone Crk) - SHORTAGE

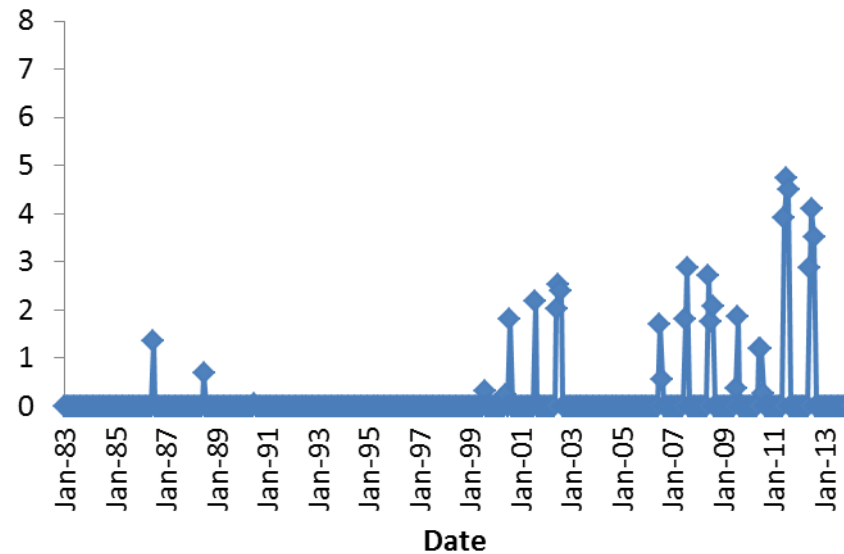
Old UIFs

New UIFs

IR: Millwood Shortage (MGD)



IR: Millwood Shortage (MGD)

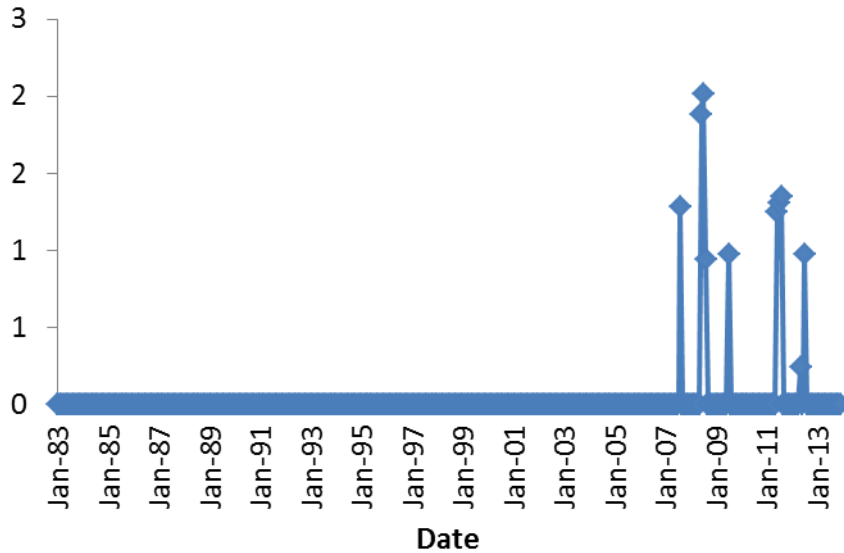


# IR: Titan – South Fork - SHORTAGE

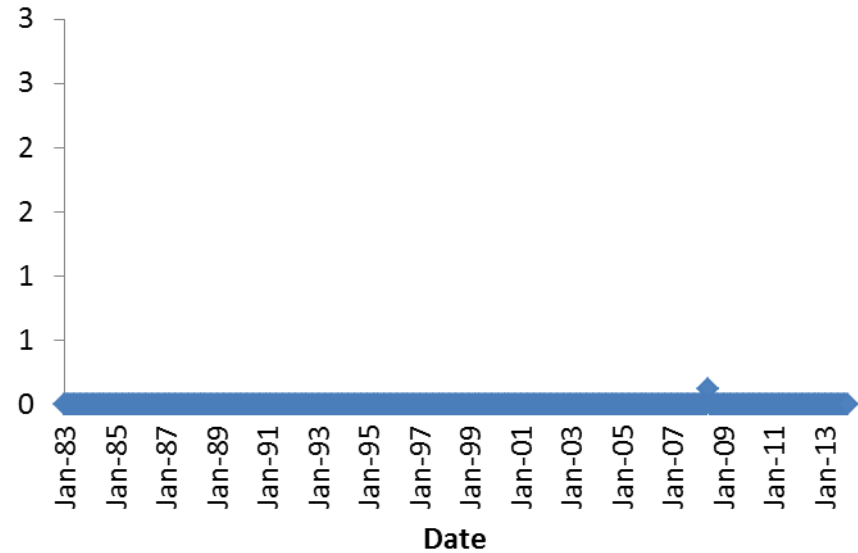
Old UIFs

New UIFs

IR: Titan - South Fork Shortage (MGD)



IR: Titan - South Fork Shortage (MGD)





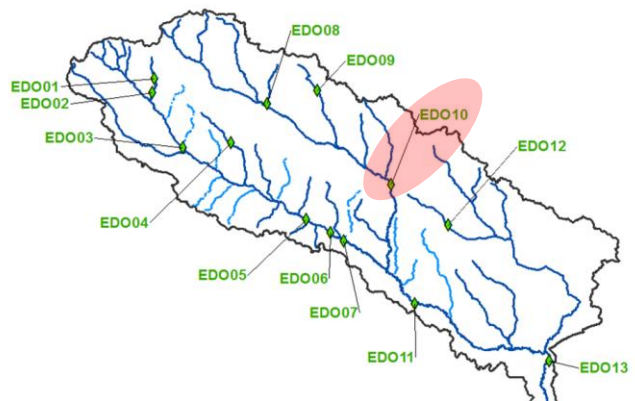
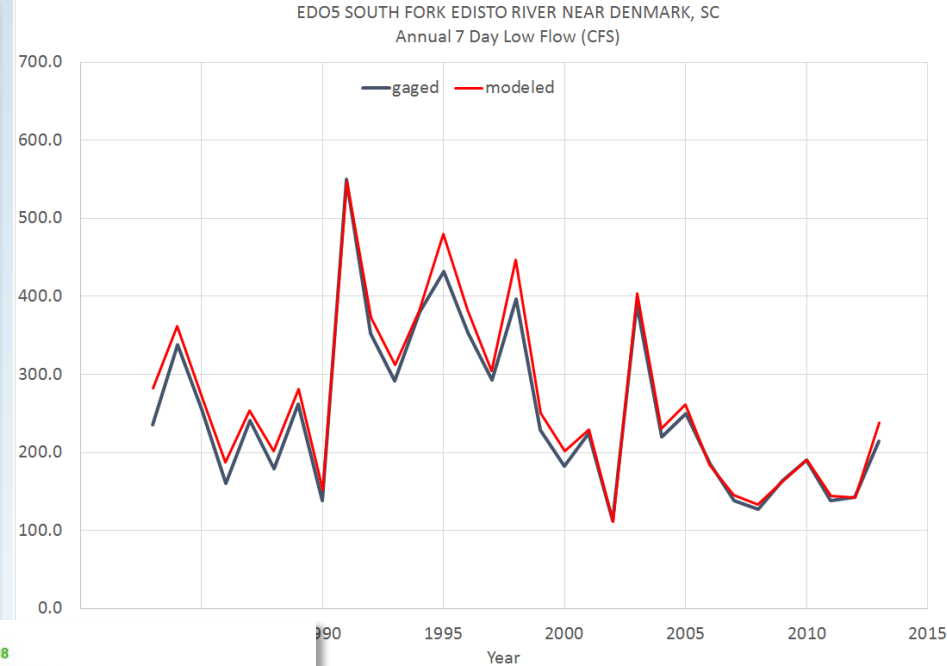
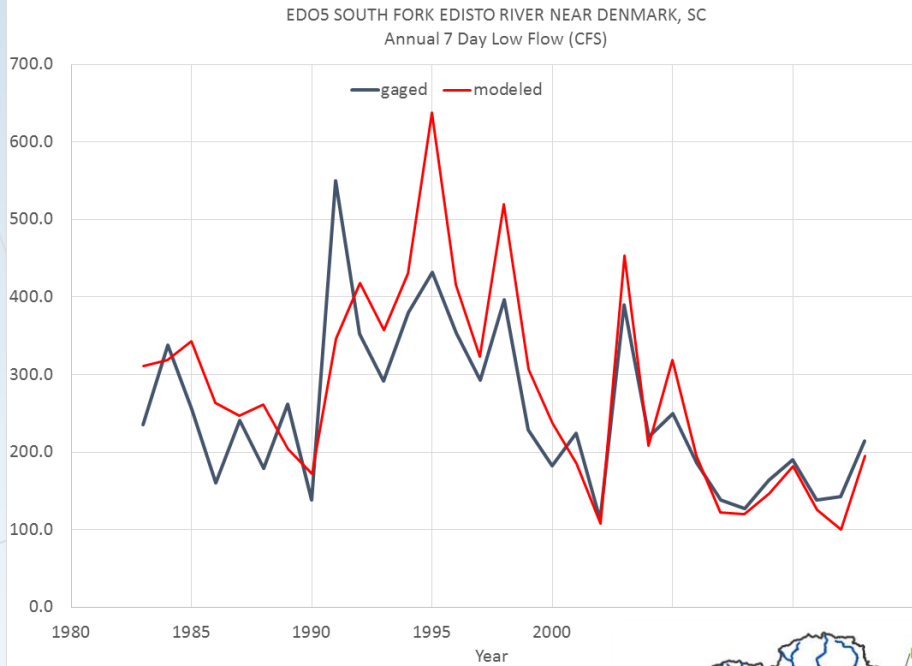
# EDO 05 – South Fork near Denmark (USGS 2173000) – 7 Day Low Flows

## Old UIFs

## New UIFs

ED05 SOUTH FORK EDISTO RIVER NEAR DENMARK, SC  
Annual 7 Day Low Flow (CFS)

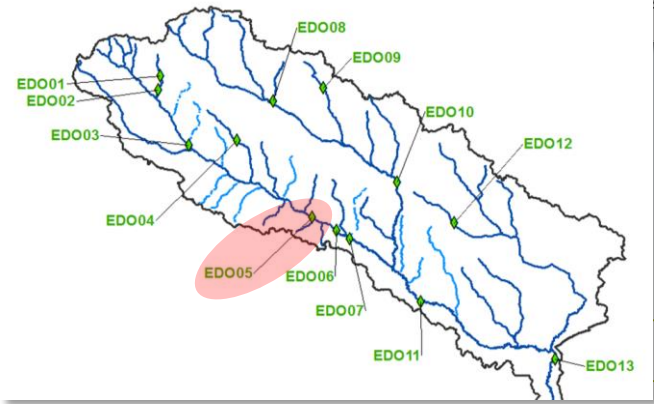
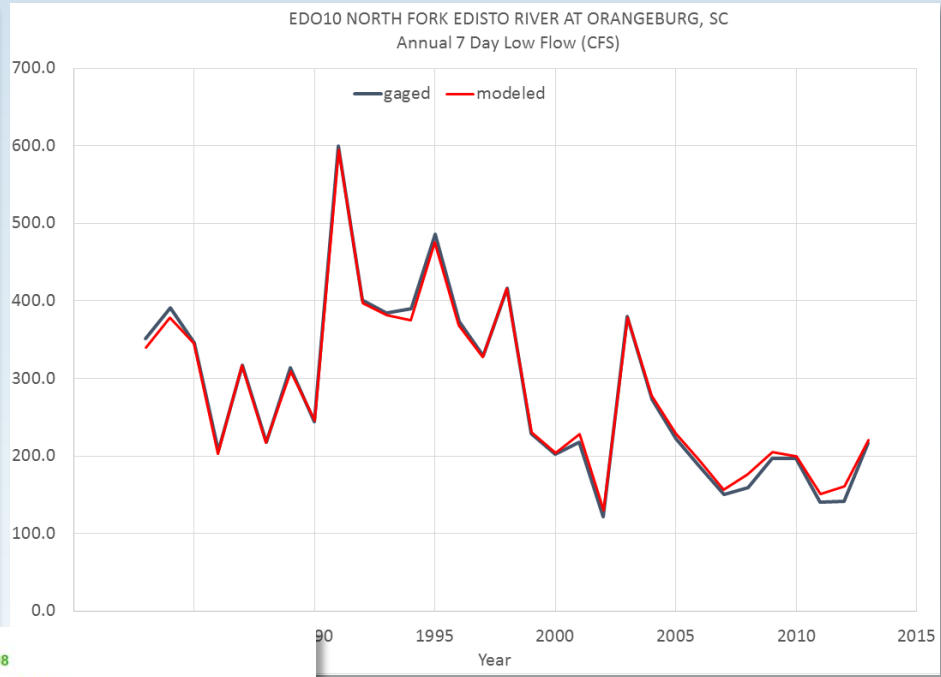
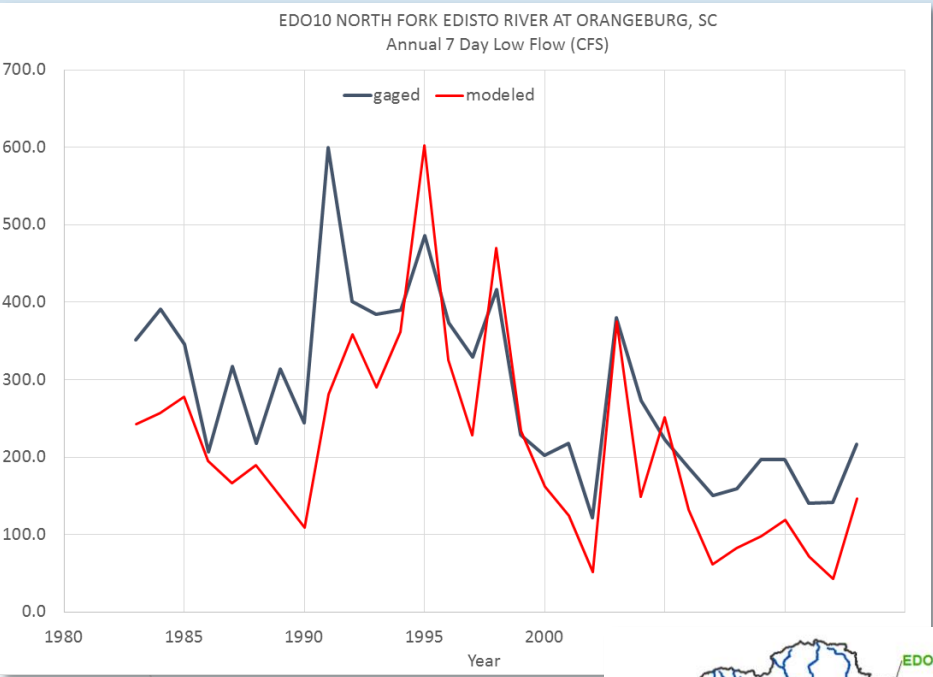
ED05 SOUTH FORK EDISTO RIVER NEAR DENMARK, SC  
Annual 7 Day Low Flow (CFS)



# EDO10 NORTH FORK AT ORANGEBURG (USGS 2173500) – 7 Day Low Flows

## Old UIFs

## New UIFs

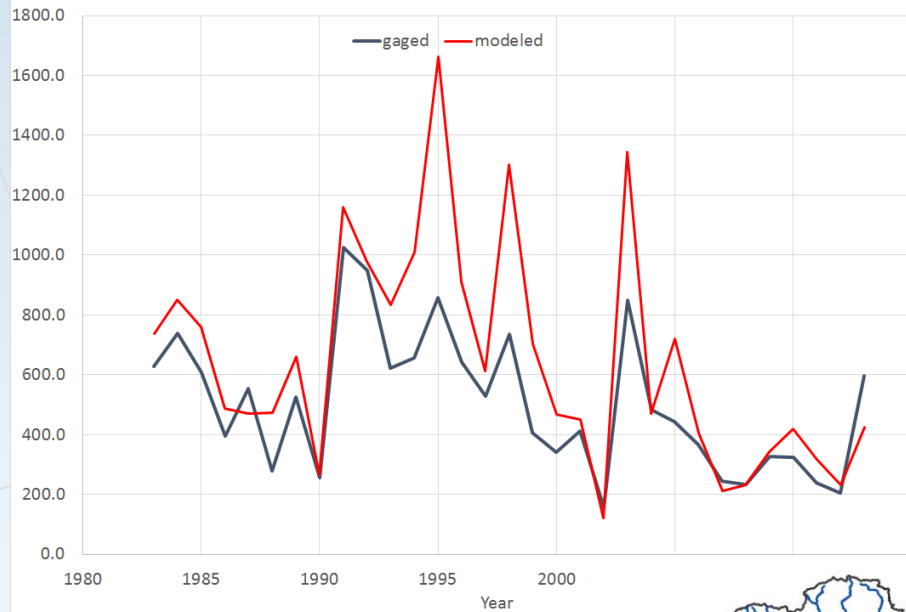


# EDO13 EDISTO RIVER Near GIVHANS (USGS 2175000) – 7 Day Low Flows

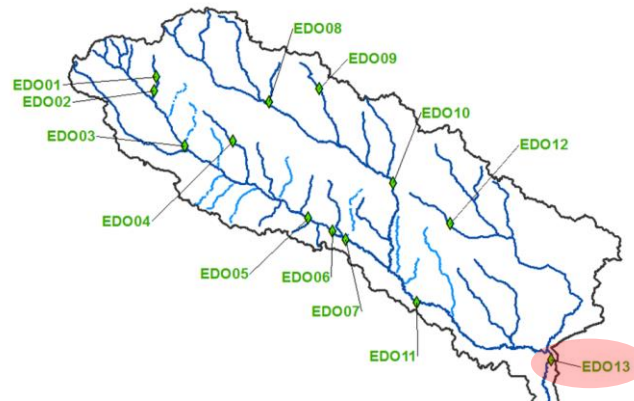
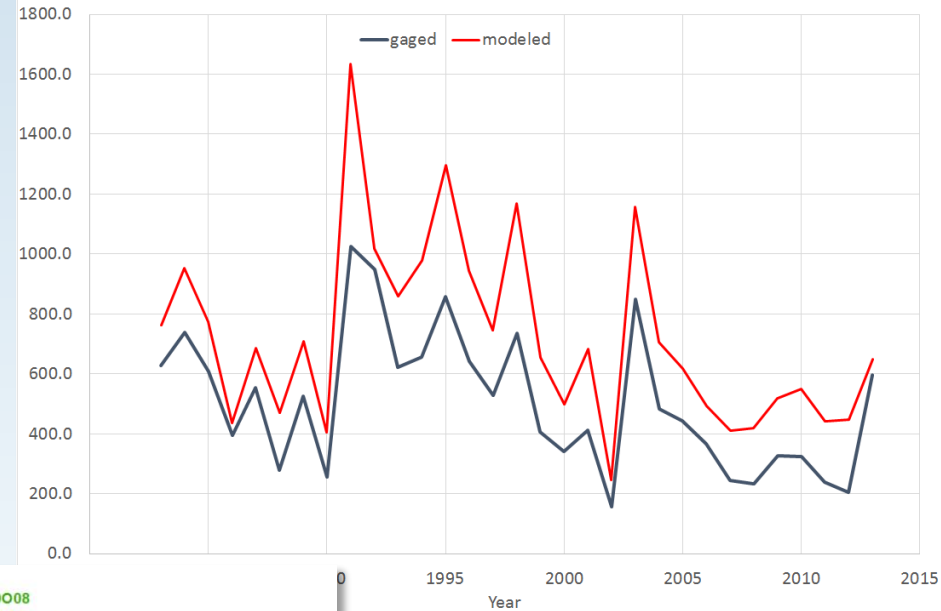
Old UIFs

New UIFs

EDO13 EDISTO RIVER NR GIVHANS, SC  
Annual 7 Day Low Flow (CFS)



EDO13 EDISTO RIVER NR GIVHANS, SC  
Annual 7 Day Low Flow (CFS)



# Edisto Calibration Updates Summary

- Change in reference gages for headwater UIFs improves the shape of the hydrograph
  - Reduction in peak flows
  - Better agreement on monthly flows
  - Much better agreement on daily flows
  - Reduction in shortages for most users where modeled shortages were observed
- Low flows are still being reviewed