# Memorandum

*To:* *SCDNR*

*From:* *CDM Smith*

*Date:* *June 30, 2020; **Updated November 11, 2020 (updates are in blue)***

*Subject:* *2020 Pee Dee SWAM Model Updates*

## 1.0 Introduction and Overview

The Pee Dee Basin baseline water allocation model was updated to incorporate newly available water use and return data, to extend the baseline hydrologic period, and to improve the spatial resolution of the model. Model updates included recalculating baseline 10-year average water demands (2009 – 2018) for all water users, adding new water users, removing water users with inactive permits, adding several new explicit tributary objects, and extending the baseline simulation period from January 2014 through December 2018. Extending the baseline simulation period required using recent USGS streamflow gage data, combined with water use and return data and area transposition methods, to "un-impair" flow records and generate un-impaired model headwater boundary condition flows. Updated downstream flow records were then used to validate model hydrologic parameterization.

The result of this work is an updated model with more recent representation of water demands in the basin and a larger range of hydrologic variability captured by the simulation period. Previously calibrated hydrologic parameters throughout the basin were validated with comparisons of modeled and gaged flows for the simulation extension period.

## 2.0 Model Object Changes

Six new tributary objects (Trib of Lynches River, Read Oak Camp Creek, Little Boggy Swamp, Cottingham Creek, Gulley Branch, and Fowler Branch) were added to the model and as part of this update. New tributaries were added to the model to improve spatial resolution in specific sub-catchments and to allow for a more accurate and explicit representation of source streams for new or existing water users. The new tributaries do not represent new source waters in the model. Rather, they are a more explicit representation in the model, compared to a more implicit, lumped representation within larger tributary objects in the previous version of the model. As such, in coordination with the addition of these new tributary objects, drainage areas associated with existing, previously lumped, tributary objects were reduced accordingly. The total basin drainage area captured by the model is unchanged.

**Table 1** (all tables and figures are included in **Attachment A**) lists the explicit tributaries and the gages and reference gages used for computing headwater flows. Newly added explicit tributaries and their drainage areas are shown in **Figure 1**. **Table 2** lists the implicit tributaries and their reference gages used for confluence flows. **Table 3** lists all tributary objects, their confluence location, drainage area, headwater area, drainage area ratio and subbasin flow factors. **Table 4** lists the reservoir inputs. The evaporation time series was updated for each reservoir through 2018.

New water users represent those that are newly registered or have just recently surpassed the minimum water use threshold for inclusion in the model of 3 million gallons per month (MGM). Water demands associated with the new users were quantified based on the South Carolina Department of Health and Environmental Control (DHEC) reported water use and discharge databases. **Table 5** lists the surface water user objects included in the model and their sources of supply. Water demands are specified in the baseline model as monthly mean values for all water user objects.

To facilitate DNR model review, responses to SCDNR inquiries and suggested model updates, as noted in TM-PD1 (SCDNR, 2020), are included in **Attachment B**.

## 3.0 Baseline Period Extension

The baseline simulation period was extended by five years, from 1929 – 2013 to 1929 – 2018. For the extension, model boundary condition (headwater) flows were developed for the additional five years, on both a monthly and daily timestep. As done for the original model development, un-impaired gaged flow data were used to estimate flows at ungaged model input locations. The un-impairment process exactly followed the process detailed elsewhere (CDM Smith, 2016) whereby un-impaired flows were calculated by adding in all known upstream consumptive water withdrawals and subtracting out upstream discharges from a downstream USGS gaged flow record. This process was applied to the following gages in the Pee Dee basin: PDE04, PDE05, PDE08, PDE10, PDE11, PDE12, PDE13, PDE14, PDE15, PDE26 and PDE28. Additionally, statistical methods (MOVE.1 with log transform) were used to extend the unimpaired flow records of the following inactive gages: PDE01, PDE02, PDE03, PDE06, PDE07, PDE009, PDE16, PDE17, PDE20, PDE21, PDE22, PDE23, DPE24.25, and PDE27. The statistical methods employed, and the assignment of reference gages, are described elsewhere (CDM Smith, 2016).

The USGS gages serve as key reference points for ungaged flow estimates at model input points. Area transposition methods, based on ratios of drainage areas, were used to estimate monthly and daily flows for the period extension, for key model headwater input locations. Again, the assignment of reference gages for this exercise matched that employed during the original model development. As described above, new model tributaries were assigned reference gages based on those used for other tributaries within their larger sub-catchment. The extended headwater flows were added to all model tributary objects. Flows prior to 2014 were unchanged in the model, except those associated with new tributary objects.

In addition to extending model flow inputs, water demand estimates were updated to more accurately reflect current conditions. New baseline water demand, discharge and consumptive use estimates for the 10-year period 2009 through 2018, were developed using the DHEC reported water use and discharge data. These calculations were consistent with methodologies employed for the original baseline model development (CDM Smith, 2017). Updated mean monthly water demands and discharge parameters were entered into the model for all water user objects. The updated baseline water demands are provided in **Table 6** for industrial (IN), mining (MI) power/nuclear (PN) and water supply (WS) users and in **Table 7** for agriculture (IR) and golf course (GC) users. Model return (discharge) locations are listed in **Table 8**. Updated consumptive use percentages are provided in **Table 9** and updated return flows for discharge objects are provided in **Table 10**.

## 4.0 Model Corrections

As part of the model update, several corrections were made to tributaries and surface water withdrawal amounts. For tributaries, the confluence stream for Swift Creek was discovered to be incorrectly assigned to Black River, instead of Black Creek. Swift Creek's confluence stream was corrected to Black Creek, and adjustments to downstream subbasin flow factors were made for Black Creek. No adjustments were necessary for Black River, after making the correction in the calibration model, and rechecking flows. Additionally, an error in units resulted in incorrect water withdrawal amounts for the White Plains, Florence, and Cheraw golf courses. These were corrected in the model.

The water user object IN: IP (Jefferson) was updated to reflect the source to be from surface water. DHEC reported that groundwater withdrawals were no longer active. Monthly water demands for IN: Nucor were also corrected. Previously, groundwater use totals had been incorrectly included from Nucor's other (Santee) facility. Demands are now from two sources: 3 groundwater well withdrawals and 1 surface water withdrawal. This update is reflected in Tables 6 and 9.

## 5.0 Model Validation

Existing model hydrologic parameters throughout the basin were validated using data associated with the extended simulation period. Comparison of modeled and gaged flow for the extension period (2014 – 2018) returned satisfactory results for all basin gages, thereby validating previous calibration work. Model validation results generated using the updated baseline model are provided in **Attachment C**. Only graphs where comparison to gage data was available for the 2014 – 2018 extension period are provided.

## 6.0 References

CDM Smith, 2016. Technical Memorandum - Unimpaired Flow Methodology and Dataset for the Pee Dee River Basin.

CDM Smith, 2017. South Carolina Surface Water Quantity Models – Pee Dee River Basin Model.

SCDNR, 2020. Technical Memorandum TM-PD1.

# 2020 Pee Dee SWAM Model Updates

## Attachment A

## Tables and Figures

## Table 1. Gages and Reference Gages Used for Headwater Flows on Explicit Tributaries

| | Headwater Input | | | USGS Reference Gage (Unimpaired) | | |
|---|---|---|---|---|---|---|
| **Project ID** | **Type** | **USGS Number** | **SWAM Tributary** | **Project Gage ID** | **USGS Number** | **Stream** |
| NC01 | Gaged | 02129000 | Great Pee Dee River (Mainstem) | - | - | - |
| NC01 | Gaged | 02134500 | Lumber River | - | - | - |
| PDE20 | Gaged | 02135300 | Scape Ore Swamp | - | - | - |
| PDE237 | Ungaged | - | Fork Creek | PDE01 | 02131309 | Fork Creek |
| PDE201 | Ungaged | - | Little Fork Creek | PDE02 | 02131320 | Little Fork Creek |
| PDE203 | Ungaged | - | Buffalo Creek | PDE03 | 02131472 | Hanging Rock Creek |
| PDE204 | Ungaged | - | Hanging Rock Creek | | | |
| PDE205 | Ungaged | - | Little Lynches River | | | |
| PDE202 | Ungaged | - | Lynches River | PDE05 | 02132000 | Lynches River |
| PDE206 | Ungaged | - | Sparrow Swamp | | | |
| PDE209 | Ungaged | - | Pee Dee River | PDE06 | 02129590 | Whites Creek |
| PDE210 | Ungaged | - | Naked Creek | | | |
| PDE211 | Ungaged | - | Crooked Creek | | | |
| PDE213 | Ungaged | - | Three Creeks (Hagins Prong) | | | |
| PDE219 | Ungaged | - | Westfield Creek | | | |
| PDE238 | Ungaged | - | Whites Creek | | | |
| PDE207 | Ungaged | - | Juniper Creek | PDE07 | 02130500 | Juniper Creek |
| PDE208 | Ungaged | - | Thompson Creek | | | |
| PDE212 | Ungaged | - | Cedar Creek | PDE09 | 02130600 | Cedar Creek |
| PDE214 | Ungaged | - | Back Swamp | | | |
| PDE217 | Ungaged | - | Black Creek | PDE11 | 02130900 | Black Creek |
| PDE215 | Ungaged | - | Bellyache Creek | PDE13 | 02130980 | Black Creek |
| PDE216 | Ungaged | - | Swift Creek | | | |
| PDE236 | Ungaged | - | Jeffries Creek | PDE16 | 02131110 | Jeffries Creek |
| PDE220 | Ungaged | - | Catfish Creek | PDE17 | 02131150 | Catfish Creek |
| PDE239 | Ungaged | - | Pocotaligo River | PDE22 | 02135517 | Pocotaligo River |
| PDE230 | Ungaged | - | Turkey Creek | PDE24 | 02135600 | Pocotaligo River |
| PDE228 | Ungaged | - | Black River | PDE26 | 02136000 | Black River |
| PDE229 | Ungaged | - | Pudding Swamp | | | |
| PDE231 | Ungaged | - | Deep Creek | | | |
| PDE232 | Ungaged | - | Bear Creek | | | |
| PDE233 | Ungaged | - | Ox Swamp | | | |
| PDE221 | Ungaged | - | Little Pee Dee River | PDE27 | 02132500 | Little Pee Dee River |
| PDE222 | Ungaged | - | Buck Swamp | | | |
| PDE224 | Ungaged | - | Brown Swamp | PDE41 | 2135060 | Chinners Swamp |
| PDE225 | Ungaged | - | Lake Swamp | | | |
| PDE226 | Ungaged | - | Chinners Swamp | | | |
| PDE5001 | Ungaged | - | Trib of Lynches River | PDE02 | 02131320 | Little Fork Creek |
| PDE5004 | Ungaged | - | Little Boggy Swamp | PDE12 | 02130910 | Black Creek |
| PDE5005 | Ungaged | - | Gulley Branch | PDE06 | 02129590 | Whites Creek |
| PDE5006 | Ungaged | - | Fowler | PDE41 | 02135060 | Chinners Swamp |
| PDE5007 | Ungaged | - | Cottingham Creek | PDE06 | 02129590 | Whites Creek |
| PDE5008 | Ungaged | - | Boggy Swamp | PDE12 | 02130910 | Black Creek |
| PDE5010 | Ungaged | - | Red Oak Camp Creek | PDE03 | 02131472 | Hanging Rock Creek |

## Table 2. Reference Gages Used for Headwater Flows on Implicit Tributaries

| | Ungaged Basin | USGS Reference Gage (Unimpaired) | | |
|---|---|---|---|---|
| **Project ID** | **SWAM Tributary** | **Project Gage ID** | **USGS Number** | **Stream** |
| PDE101 | Huckleberry Branch | PDE06 | 02129590 | Whites Creek |
| PDE102 | Phils Creek | | | |
| PDE103 | Roger's Creek | PDE09 | 02130600 | Cedar Creek |
| PDE104 | Hurricane Branch | | | |
| PDE105 | Toby's Creek | PDE17 | 02131150 | Catfish Creek |

## Table 3. Model Tributary Inputs

| SWAM Tributary Object | Tributary Type | Confluence Stream | Confluence Location (mile) | Confluence Drainage Area (ac) | Head-water ID | End Mile | Drainage Area Ratio | Subbasin Flow Factor (unitless) |
|---|---|---|---|---|---|---|---|---|
| Mainstem | Explicit | none | none | 5,200,000 | NC01 | 12.0 | *NA* | -0.0015* |
| | | | | | | 65.8 | | 0.0018* |
| | | | | | | 70.0 | | -0.0035* |
| | | | | | | 500.0 | | 0* |
| Back Swamp | Explicit | Mainstem | 54.7 | 19,448 | PDE214 | 6.1 | 5.4 | 5.4 |
| Bear Creek | Explicit | Pocotaligo River | 32 | 7,307 | PDE232 | 5.6 | 5.1 | 5.1 |
| Bellyache Creek | Explicit | Swift Creek | 7.8 | 12,342 | PDE215 | 4.9 | 1.9 | 1.9 |
| Black Creek | Explicit | Mainstem | 57.5 | 302,127 | PDE217 | 14.9 | 51.9 | 51.9 |
| | | | | | | 28.7 | 114.5 | 114.5 |
| | | | | | | 38.7 | 171.5 | 171.5 |
| | | | | | | 80.1 | 359.6 | 377.0 |
| | | | | | | 91.0 | 384.0 | 384.0 |
| Black River | Explicit | Mainstem | 156.6 | 1,195,458 | PDE228 | 23.3 | 8.9 | 8.9 |
| | | | | | | 60.3 | 28.8 | 20.0 |
| | | | | | | 156.8 | 86.3 | 86.3 |
| Brown Swamp | Explicit | Little Pee Dee River | 68.6 | 6,065 | PDE224 | 1.8 | 7.8 | 7.8 |
| Buck Swamp | Explicit | Little Pee Dee River | 55.6 | 94,836 | PDE222 | 15.3 | 1.6 | 1.6 |
| Buffalo Creek | Explicit | Lynches River | 23.6 | 22,827 | PDE203 | 1.8 | 1.1 | 1.1 |
| Catfish Creek | Explicit | Mainstem | 95.5 | 113,238 | PDE220 | 3.3 | 1.4 | 1.4 |
| | | | | | | 31.9 | 8.7 | 8.7 |
| Cedar Creek | Explicit | Mainstem | 18.9 | 43,796 | PDE212 | 17.2 | 30.9 | 30.9 |
| Chinners Swamp | Explicit | Little Pee Dee River | 101.6 | 21,599 | PDE226 | 9.2 | 2.3 | 2.3 |
| Crooked Creek | Explicit | Mainstem | 15.1 | 46,839 | PDE211 | 10.4 | 1.6 | 1.6 |
| Deep Creek | Explicit | Pocotaligo River | 33.3 | 11,292 | PDE231 | 21.4 | 3.2 | 3.2 |
| Fork Creek | Explicit | Lynches River | 14.4 | 26,674 | PDE237 | 10.4 | 21.7 | 23.9 |
| Hanging Rock Creek | Explicit | Little Lynches River | 11.3 | 19,872 | PDE204 | 1.4 | 1.7 | 1.8 |
| | | | | | | 5.0 | 2.2 | 2.2 |
| Jeffries Creek | Explicit | Mainstem | 79.9 | 125,628 | PDE236 | 2.1 | 1.3 | 1.0 |
| | | | | | | 24.1 | 7.9 | 7.9 |
| Juniper Creek | Explicit | Thompson Creek | 19.0 | 40,997 | PDE207 | 6.9 | 1.4 | 1.4 |
| Lake Swamp | Explicit | Little Pee Dee River | 75.0 | 108,875 | PDE225 | 9.1 | 19.0 | 19.0 |
| | | | | | | 27.5 | 36.3 | 36.3 |
| Little Fork Creek | Explicit | Fork Creek | 9.8 | 9,657 | PDE201 | 2.3 | 1.6 | 1.8 |
| Little Lynches River | Explicit | Lynches River | 45.5 | 124,875 | PDE205 | 11.2 | 5.2 | 5.2 |
| | | | | | | 34.3 | 13.8 | 13.8 |
| Little Pee Dee River | Explicit | Mainstem | 132.5 | 565,718 | PDE221 | 32.2 | 3.4 | 3.4 |
| | | | | | | 77.5 | 10.3 | 10.3 |
| | | | | | | 119.0 | 16.3 | 16.3 |
| Lumber River | Explicit | Little Pee Dee River | 62.7 | 1,123,354 | PDE223 | 8.4 | 1.1 | 1.3 |
| Lynches River | Explicit | Mainstem | 105.3 | 906,056 | PDE202 | 60.5 | 8.3 | 9.5 |
| | | | | | | 117.9 | 11.3 | 10.2 |
| | | | | | | 160.6 | 18.8 | 18.9 |
| Naked Creek | Explicit | Mainstem | 11.2 | 19,718 | PDE210 | 8.7 | 2.4 | 2.4 |
| Ox Swamp | Explicit | Pocotaligo River | 29.8 | 17,496 | PDE233 | 5.1 | 4.1 | 4.1 |

## Table 3. Model Tributary Inputs (continued)

| SWAM Tributary Object | Tributary Type | Confluence Stream | Confluence Location (mile) | Confluence Drainage Area (ac) | Head-water ID | End Mile | Drainage Area Ratio | Subbasin Flow Factor (unitless) |
|---|---|---|---|---|---|---|---|---|
| Pocotaligo River | Explicit | Black River | 42.4 | 264,097 | PDE239 | 12.0 | 10 | 9.0 |
| | | | | | | 19.2 | 13 | 12.5 |
| | | | | | | 28.0 | 21 | 14.0 |
| | | | | | | 41.7 | 24 | 24.3 |
| Pudding Swamp | Explicit | Black River | 48.3 | 115,753 | PDE229 | 23.1 | 9.5 | 9.5 |
| Scape Ore Swamp | Explicit | Black River | 22.8 | 166,790 | PDE20 | 24.1 | 2.7 | 2.7 |
| Sparrow Swamp | Explicit | Lynches River | 114.7 | 144,543 | PDE206 | 15.8 | 2.3 | 2.3 |
| Swift Creek | Explicit | Black Creek | 71.0 | 42,996 | PDE216 | 10.8 | 2.3 | 2.3 |
| Thompson Creek | Explicit | Mainstem | 3.8 | 167,338 | PDE208 | 23.1 | 1.3 | 1.1 |
| Three Creeks (Hagins Prong) | Explicit | Mainstem | 39.4 | 58,585 | PDE213 | 9.1 | 11.3 | 11.3 |
| Turkey Creek | Explicit | Pocotaligo River | 12.0 | 11,948 | PDE230 | 2.9 | 7.0 | 9.0 |
| Westfield Creek | Explicit | Mainstem | 1.0 | 20,538 | PDE219 | 6.6 | 2.9 | 2.9 |
| Whites Creek | Explicit | Mainstem | 0.1 | 30,237 | PDE238 | 9.7 | 2.6 | 1.7 |
| Trib of Lynches River | Explicit | Lynches River | | 939 | PDE5001 | | 2.5 | 2.5 |
| Little Boggy Swamp | Explicit | Boggy Swamp | | 6,224 | PDE5004 | | 2.9 | 2.9 |
| Gulley Branch | Explicit | Cottingham Creek | | 3,727 | PDE5005 | | 3.4 | 3.4 |
| Fowler | Explicit | Brown Swamp | | 601 | PDE5006 | | 2.5 | 2.5 |
| Cottingham Creek | Explicit | Three Creeks (Hagins Prong) | | 22,384 | PDE5007 | | 5.3 | 5.3 |
| Boggy Swamp | Explicit | Black Creek | | 12,145 | PDE5008 | | 1.2 | 1.2 |
| Red Oak Camp Creek | Explicit | Lynches River | | 7,425 | PDE5010 | | 1.4 | 1.4 |
| Huckleberry Branch | Implicit | Mainstem | 1.4 | 6,405 | none | 0.0 | 1 | 1 |
| Hurricane Branch | Implicit | Mainstem | 49.5 | 10,559 | none | 0.0 | 1 | 1 |
| Phils Creek | Implicit | Mainstem | 4.4 | 17,263 | none | 0.0 | 1 | 1 |
| Rogers Creek | Implicit | Mainstem | 45.8 | 16,310 | none | 0.0 | 1 | 1 |
| Tobys Creek | Implicit | Mainstem | 66.0 | 38,838 | none | 0.0 | 1 | 1 |

** On the Mainstem, these are referred to as "gain/loss factors", not "subbasin flow factors".*

## Table 4. Reservoir Inputs

| Reservoir | Purpose | Receiving Stream | Temperature Station for Evaporation | Precipitation Station | Release Location (mi) | Storage Capacity (MG) | Initial Storage (MG) | Dead Pool (MG) | Area-Capacity Table | Operating Rules |
|---|---|---|---|---|---|---|---|---|---|---|
| Lake Robinson | Industry, power & recreation | Black Creek | Darlington USC00382260 | Florence USC00383111 | 38.5 | 10,101 | 10,000 | 0 | Simple | No minimum releases or storage targets |
| Prestwood Lake | Industry & recreation | Black Creek | Darlington USC00382260 | Florence USC00383111 | 42.7 | 586 | 500 | 0 | Simple | No minimum releases or storage targets |
| Lake Wallace | Water supply & recreation | Crooked Creek | Cheraw USC00381588 | Florence USC00383111 | 2 | 541 | 500 | 0 | Simple | No minimum releases or storage targets |

## Table 5. Water User Objects and Sources of Supply Included in the Pee Dee River Basin Model

| Model Object ID | Facility Name | Source of Supply | Intake ID | Diversion Location (mi) | Permit or Registration Limit (MGM) |
|---|---|---|---|---|---|
| WS: Bennettsville | BENNETTSVILLE WTP | Crooked Creek (Lake Wallace) | 34WS001S01 | 2.0 | 120.0 |
| WS: Cheraw | TOWN OF CHERAW WTP | Great Pee Dee River | 13WS001S01 | 1.1 | 357.0 |
| WS: Florence | CITY OF FLORENCE PEE DEE SWTP | Great Pee Dee River | 21WS002S01 | 55.8 | 930.0 |
| MI: Hanson (Jefferson) | HANSON AGGREGATES - JEFFERSON FACILITY | Trib of Lynches River | 13MI003S01 | 0.3 | 26.8 |
| MI: Hanson (Marlboro) | HANSON AGGREGATES - MARLBORO FACILITY | Naked Creek | 34MI001S03 | 7.2 | 133.9 |
| MI: Martin Marietta | MARTIN MARIETTA MATERIALS PLANT | Buffalo Creek | 28MI001S01 | 0.9 | 98.2 |
| IN: Domtar | DOMTAR PAPER | Great Pee Dee River | 34IN005S01 | 11.7 | 937.0 |
| IN: Hanson (Brewer) | HANSON AGGREGATES - BREWER FACILITY | Black Creek | 13IN002S01 | 6.8 | 205.3 |
| IN: Galey & Lord | GALEY & LORD | Cedar Creek | 16IN004S01 | 16.9 | 335.0 |
| | | Great Pee Dee River | 16IN004S02 | 19.0 | 81.0 |
| IN: IP (Georgetown) | INTERNATIONAL PAPER - GEORGETOWN MILL | Great Pee Dee River | 22IN006S01 | 124.5 | *NA* |
| IN: Nucor | NUCOR CORP | Black Creek | 16IN006S01 | 60.2 | 31.0 |
| IN: Sonoco | SONOCO PRODUCTS CO | Black Creek (Prestwood Lake) | 16IN005S01 | 42.7 | 334.8 |
| | | | 16IN005S02 | | 873.9 |
| IN: WestRock | WESTROCK - FLORENCE MILL | Great Pee Dee River | 21IN001S01 | 70.1 | 1249.9 |
| PN: HB Robinson | H.B. ROBINSON NUCLEAR PLANT | Black Creek (Lake Robinson) | 16PN001S01 | 38.5 | 22386.0 |
| | | | 16PN001S02 | | 3884.0 |
| GC: Cheraw | CHERAW STATE PARK | Juniper Creek | 13GC001S01 | 4.5 | 46.8 |
| GC: Florence | FLORENCE COUNTRY CLUB | Jeffries Creek | 21GC001S01 | 2.7 | 49.1 |
| GC: White Plains | WHITE PLAINS COUNTRY CLUB | Fork Creek | 13GC003S01 | 0.1 | 49.0 |
| IR: Atkinson | ATKINSON FARMS, LLC | Fowler Branch | 33IR033S01 | 0.8 | 8.0 |
| IR: Belger | BELGER FARMS | Red Oak Camp Creek | 28IR011S03 | 0.1 | 91.3 |
| IR: Black Crest | BLACK CREST FARMS MCLEOD W R FARMS | Pocotaligo River | 43IR007S03 | 16.6 | 35.1 |
| | | | 43IR007S01 | | 33.7 |
| | | | 43IR007S02 | | 33.9 |
| IR: Carolina Plantation | CAROLINA PLANTATION RICE | Great Pee Dee River | 16IR080S01 | 31 | 60.0 |
| IR: Chapman | CHAPMAN FARM | Little Boggy Swamp | 16IR030S01 | 0.1 | 8.0 |
| | | | 16IR030S02 | | 2.4 |
| IR: Dargan | DARGAN FARMS PARTNERSHIP | Back Swamp | 16IR015S01 | 0.3 | 5.5 |
| | | | 16IR015S02 | 4.6 | 5.0 |
| IR: Hinson | HINSON FARM | Three Creeks (Hagins Prong) | 34IR002S01 | 0.1 | 11.5 |
| | | Gulley Branch | 34IR002S02 | 0.8 | 9.7 |
| IR: Irwin | IRWIN MCINTOSH FARMS, INC. | Pudding Swamp | 45IR002S01 | 21.8 | 4.8 |

## Table 5. Water User Objects and Sources of Supply Included in the Pee Dee River Basin Model (continued)

| Model Object ID | Facility Name | Source of Supply | Intake ID | Diversion Location (mi) | Permit Limit (MGM) |
|---|---|---|---|---|---|
| IR: Lawson Turf | LAWSON TURF FARMS | Bellyache Creek | 16IR041S01 | 0.8 | 25.8 |
| | | | 16IR041S02 | | 9.5 |
| | | | 16IR041S03 | | 7.6 |
| | | | 16IR041S04 | | 2.8 |
| IR: McDonald | MCDONALD FARM | Little Pee Dee River | 34IR007S01 | 5.4 | 9.2 |
| IR: O'Tuel | O'TUEL FARM | Naked Creek | 34IR004S01 | 0.2 | 69.0 |
| IR: Richard Rogers | RICHARD ROGERS FARMS | Crooked Creek | 34IR003S01 | 5.6 | 57.0 |
| IR: Rogers | ROGER BROTHERS FARM | Black Creek | 16IR016S01 | 49.6 | 90.4 |
| IR: Sugar Hill | SUGAR HILL ACRES, LLC | Little Boggy Swamp | 16IR012S01 | 1.4 | 3.3 |
| | | | 16IR012S02 | | 1.6 |
| IR: Tolson | TOLSON FARMS | Lynches River | 31IR008S01 | 84 | 5.0 |
| | | | 31IR008S03 | | 7.0 |
| IR: Turf Connections | TURF CONNECTIONS | Westfield Creek | 13IR008S03 | 2.3 | 6.0 |

## Table 6. Baseline Model Average Water Demand for IN, MI, PN and WS Water Users

| Baseline Model Average Monthly Water Demand (MGD)<br>Surface Water or Surface Water and Groundwater Users | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **IN: Domtar** | **MI: Hanson (Jefferson)** | **MI: Hanson (Brewer)** | **MI: Hanson (Marlboro)** | **MI: Martin Marietta** | **IN: Nucor** | **IN: Sonoco** | **IN: IP (George-town)** | **PN: HB Robinson** | **IN: West-Rock** | **WS: Cheraw** | **WS: Florence** | **WS: Bennetts-ville** |
| **Surface Water Permit Limit (MGD)-->** | **30.8** | **0.9** | **NA** | **NA** | **NA** | **1.0** | **39.8** | **NA** | **864.1** | **41.1** | **11.7** | **30.6** | **3.9** |
| Jan | 15.88 | 0.03 | 0.01 | 0.02 | 0.03 | 2.01 | 11.99 | 30.58 | 767.05 | 16.23 | 2.31 | 13.95 | 2.26 |
| Feb | 16.61 | 0.04 | 0.18 | 0.03 | 0.04 | 1.31 | 11.72 | 30.80 | 726.60 | 16.20 | 2.27 | 13.68 | 2.20 |
| Mar | 15.51 | 0.04 | 0.12 | 0.03 | 0.04 | 1.25 | 11.89 | 24.50 | 771.05 | 16.05 | 2.32 | 13.37 | 2.09 |
| Apr | 16.31 | 0.05 | 0.03 | 0.03 | 0.05 | 1.18 | 13.58 | 30.55 | 669.04 | 16.51 | 2.41 | 13.61 | 2.10 |
| May | 16.45 | 0.04 | 0.10 | 0.03 | 0.04 | 2.63 | 11.36 | 31.38 | 678.57 | 16.84 | 2.51 | 14.26 | 2.16 |
| Jun | 17.11 | 0.04 | 0.11 | 0.03 | 0.04 | 4.94 | 13.81 | 32.15 | 753.18 | 17.29 | 2.72 | 15.22 | 2.29 |
| Jul | 17.12 | 0.05 | 0.06 | 0.03 | 0.05 | 8.02 | 13.10 | 32.61 | 792.13 | 17.58 | 2.65 | 15.39 | 2.20 |
| Aug | 17.15 | 0.04 | 0.15 | 0.03 | 0.04 | 5.31 | 14.09 | 32.47 | 823.22 | 17.49 | 2.80 | 15.24 | 2.22 |
| Sep | 16.55 | 0.04 | 0.05 | 0.03 | 0.04 | 4.74 | 13.17 | 31.48 | 747.72 | 17.15 | 2.64 | 14.97 | 2.27 |
| Oct | 16.03 | 0.03 | 0.05 | 0.02 | 0.03 | 4.74 | 12.62 | 31.13 | 627.12 | 15.70 | 2.50 | 14.05 | 2.16 |
| Nov | 15.60 | 0.03 | 0.14 | 0.02 | 0.03 | 1.18 | 11.79 | 30.75 | 784.45 | 15.73 | 2.36 | 13.50 | 2.12 |
| Dec | 15.97 | 0.02 | 0.35 | 0.02 | 0.02 | 1.18 | 12.47 | 30.88 | 803.20 | 15.32 | 2.20 | 13.18 | 2.01 |

| Baseline Model Average Monthly Water Demand (MGD)<br>Groundwater Users | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Month** | **WS: Bishop-ville** | **WS: Lynch-burg** | **WS: Hartsville** | **WS: Manning** | **IN: Martek** | **IN: McCall Farms** | **WS: McColl** | **IN: Pilgrims Pride** | **WS: Sumter** |
| **Surface Water Permit Limit (MGD)-->** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| Jan | 1.29 | 1.34 | 1.11 | 1.05 | 1.15 | 0.60 | 0.30 | 0.47 | 10.73 |
| Feb | 1.29 | 1.36 | 1.12 | 1.01 | 1.19 | 0.56 | 0.28 | 0.56 | 10.67 |
| Mar | 1.31 | 1.38 | 1.11 | 0.95 | 0.99 | 0.47 | 0.27 | 0.53 | 10.73 |
| Apr | 1.32 | 1.38 | 1.21 | 1.00 | 0.99 | 0.49 | 0.28 | 0.48 | 10.93 |
| May | 1.37 | 1.45 | 1.17 | 1.06 | 1.05 | 0.59 | 0.29 | 0.46 | 11.52 |
| Jun | 1.35 | 1.47 | 1.32 | 1.10 | 1.14 | 0.58 | 0.31 | 0.47 | 12.28 |
| Jul | 1.38 | 1.45 | 1.33 | 1.13 | 0.97 | 0.57 | 0.31 | 0.48 | 11.89 |
| Aug | 1.35 | 1.44 | 1.37 | 1.09 | 1.09 | 0.68 | 0.31 | 0.48 | 12.07 |
| Sep | 1.28 | 1.37 | 1.35 | 1.05 | 1.10 | 0.73 | 0.30 | 0.46 | 11.82 |
| Oct | 1.25 | 1.33 | 1.52 | 1.09 | 0.96 | 0.86 | 0.29 | 0.61 | 11.31 |
| Nov | 1.19 | 1.28 | 1.13 | 1.02 | 1.00 | 0.83 | 0.27 | 0.50 | 10.84 |
| Dec | 1.19 | 1.28 | 1.05 | 0.98 | 1.15 | 0.79 | 0.27 | 0.47 | 10.26 |

*Permit limits are shown in MGD rather than MGM for comparative purposes. Actual permit limits are in MGM. Domtar, Florence, Nucor, Sonoco, WestRock and Bennettsville use both groundwater and surface water to satisfy their demand. The demand listed includes both sources. Bishopville, Lynchburg, Hartsville, Manning, Martek, McCall Farms, McColl, Pilgrims Pride, and Sumter all use groundwater only.*

## Table 7. Baseline Model Average Monthly Demand for GC and IR Water Users

| Baseline Model Average Monthly Demand (MGD) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | IR: Atkinson | IR: Belger | IR: Black Crest* | IR: Carolina Plantation | IR: Chapman* | IR: Dargan* | IR: Hinson* | IR: Irwin | IR: Lawson Turf* | IR: McDonald |
| Limit (MGD)--> | 0.3 | 3.0 | 3.4 | 2.0 | 0.3 | 0.3 | 0.7 | 0.2 | 1.5 | 0.3 |
| Jan | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| Feb | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mar | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 |
| Apr | 0.02 | 0.00 | 0.31 | 0.07 | 0.00 | 0.06 | 0.00 | 0.01 | 0.09 | 0.00 |
| May | 0.01 | 0.00 | 1.33 | 0.29 | 0.02 | 0.11 | 0.00 | 0.03 | 0.29 | 0.00 |
| Jun | 0.01 | 0.00 | 1.81 | 0.90 | 0.10 | 0.15 | 0.00 | 0.06 | 0.50 | 0.02 |
| Jul | 0.01 | 0.00 | 2.05 | 1.14 | 0.13 | 0.15 | 0.00 | 0.05 | 0.62 | 0.03 |
| Aug | 0.00 | 0.00 | 1.25 | 0.66 | 0.05 | 0.14 | 0.00 | 0.02 | 0.56 | 0.02 |
| Sep | 0.01 | 0.00 | 0.34 | 0.17 | 0.00 | 0.17 | 0.00 | 0.01 | 0.34 | 0.02 |
| Oct | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.17 | 0.00 |
| Nov | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.07 | 0.00 |
| Dec | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |

| Baseline Model Average Monthly Demand (MGD) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Month | IR: O'Tuel | IR: Richard Rogers | IR: Rogers | IR: Sugar Hill* | IR: Tolson | IR: Turf Connections* | GC: White Plains | GC: Florence | GC: Cheraw |
| Limit (MGD)--> | 2.3 | 1.9 | 3.0 | 0.2 | 0.2 | 0.3 | 1.6 | 1.6 | 1.5 |
| Jan | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.11 |
| Feb | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.38 |
| Mar | 0.03 | 0.02 | 0.00 | 0.00 | 0.00 | 0.03 | 0.03 | 0.03 | 0.52 |
| Apr | 0.15 | 0.05 | 0.00 | 0.01 | 0.04 | 0.09 | 0.07 | 0.06 | 1.25 |
| May | 0.56 | 0.38 | 0.27 | 0.01 | 0.09 | 0.15 | 0.08 | 0.08 | 1.63 |
| Jun | 0.84 | 1.06 | 0.94 | 0.03 | 0.19 | 0.22 | 0.12 | 0.10 | 4.03 |
| Jul | 0.66 | 0.70 | 1.07 | 0.05 | 0.19 | 0.19 | 0.13 | 0.13 | 3.94 |
| Aug | 0.34 | 0.30 | 0.47 | 0.02 | 0.12 | 0.31 | 0.10 | 0.12 | 3.09 |
| Sep | 0.08 | 0.13 | 0.05 | 0.00 | 0.01 | 0.30 | 0.08 | 0.09 | 3.14 |
| Oct | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.25 | 0.04 | 0.04 | 1.82 |
| Nov | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.02 | 0.04 | 0.91 |
| Dec | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.10 |

*1. "Limit" shown is the total permit limit (for golf courses) or registered limit (for agricultural irrigators).*

*2. Limits are shown in MGD rather than MGM for comparative purposes. Actual permit/registration limits are in MGM.*

** = Water users with multiple withdrawal locations. Withdrawal limits reflect the total permit or registration limit, accounting for all withdrawal locations.*

## Table 8. Returns and Associated Model Objects

| Model Object ID | Facility Name | NPDES Pipe ID | | Associated Water Permit | Discharge Tributary | Model River Mile | % of Return Flow |
|---|---|---|---|---|---|---|---|
| ***Returns Represented Within Water User Objects*** | | | | | | | |
| IN: Domtar | DOMTAR PAPER CO LLC/ MARLBORO MILL | SC0042188 | -001 | 34IN005 | Great Pee Dee River | 11.9 | 100 |
| IN: Hanson (Brewer) | HANSON AGGR SE/BREWER | SCG730286 | -1AA | 13IN002 | Black Creek | 6.8 | 100 |
| IN: IP (Georgetown) | INTERNATIONAL PAPER/GEORGETOWN | SC0000868 | -001 | 22IN006 | Whites Creek | 129.5 | 100 |
| IN: Martek | MARTEK BIOSCIENCES KINGSTREE | SC0003123 | -001,-002 | 45IN001G | Black River | 61.2 | 100 |
| IN: McCall Farms | MCCALL FARMS INC | SC0039284 | -001,-01A | 21IN008G | Lynches River | 117.5 | 100 |
| IN: Pilgrims Pride | PILGRIMS PRIDE POULTRY PROC. PLANT | SC0000795 | -001,-002 | 43IN005G | Pocotaligo River | 12.2 | 100 |
| IN: Sonoco | SONOCO PRODUCTS/HARTSVILLE | SC0003042 | -001,-002,-003,-004,-005,-006 | 16IN005 | Black Creek | 45.5 | 100 |
| IN: WestRock | WESTROCK | SC0000876 | -001 | 21IN001 | Great Pee Dee River | 75.0 | 100 |
| MI: Hanson (Jefferson) | HANSON AGGR SE/JEFFERSON | SCG730062 | -000 | 13MI003 | Lynches River | 6.6 | 100 |
| PN: HB Robinson | PROGRESS ENERGY/ROBINSON | SC0002925 | -001,-003,-006,-008,-009,-011,-013,-014 | 16PN001 | Black Creek | 39.0 | 100 |
| WS: Bennettsville | BENNETTSVILLE WWTF | SC0025178 | -001 | 34WS001 | Crooked Creek | 4.2 | 100 |
| WS: Bishopville | BISHOPVILLE WWTF | SC0035378 | -001 | 31WS001G | Lynches River | 62.9 | 100 |
| WS: Cheraw | CHERAW WWTF | SC0020249 | -001 | 13WS001 | Great Pee Dee River | 2.2 | 100 |
| WS: Florence | DARLINGTON/BLACK CREEK WWTF | SC0039624 | -001 | 21WS002 | Black Creek | 66.6 | 8 |
| | FLORENCE/PEE DEE RIVER PLANT | SC0045462 | -001 | | Great Pee Dee River | 70.2 | 92 |
| WS: Hartsville | HARTSVILLE WWTF | SC0021580 | -001 | 16WS003G | Black Creek | 49.9 | 100 |
| WS: Lynchburg | LYNCHBURG WWTF | SC0042676 | -001 | 31WS002G | Lynches River | 85.5 | 100 |
| WS: Manning | MANNING WWTF | SC0020419 | -001 | 14WS001G | Ox Swamp | 4.6 | 100 |
| WS: McColl | MCCOLL WWTF | SC0041963 | -001 | 34WS003G | Little Pee Dee River | 0.1 | 100 |
| WS: Sumter | SUMTER/POCOTALIGO RIV. PLANT | SC0027707 | -001 | 43WS001G | Pocotaligo River | 3.0 | 100 |
| ***Transbasin Imports Represented by Discharge Objects*** | | | | | | | |
| LCW&SD Import (Catawba) | LANCASTER COUNTY WATER & SEWER DISTRICT | SC0025798 | -001 | 29WS005 | Hanging Rock Creek | 0.3 | - |
| ***In-basin Returns Represented by Individual Discharge Objects*** | | | | | | | |
| Clio | CLIO WWTF | SC0040606 | -01C,01A | 34WS050G | Three Creek (Hagins Prong) | 5.8 | - |
| Dillon | DILLON/LITTLE PEE DEE | SC0021776 | -001,-002,-003,-004 | 17WS001G | Little Pee Dee River | 32.7 | - |
| Haile | HAILE GOLD MINE | SC0040479 | -002 | none | Little Lynches Creek | 5.5 | - |
| Hemingway | HEMINGWAY, TOWN OF | SC0039934 | -001 | 45WS001G | Lynches River | 160.5 | - |
| Jefferson | JEFFERSON WWTF | SC0024767 | -001 | none | Little Fork Creek | 1.9 | - |
| Johnsonville | JOHNSONVILLE/EAST PLANT | SC0025933 | -001 | 21IN002G | Lynches River | 155.1 | - |
| Kingstree | KINGSTREE, TOWN OF | SC0035971 | -001 | 45WS002G | Black River | 62.2 | - |
| Koppers | KOPPERS INC | SC0003018 | -001,-002 | none | Black Creek | 82.1 | - |
| Lake City | LAKE CITY/LAKE SWAMP WW PLANT | SC0046311 | -001 | 21WS005G | Lynches River | 139.2 | - |
| Lamar | LAMAR WWTF | SC0043702 | -001 | 16WS005G | Lynches River | 75.0 | - |
| Latta | LATTA, TOWN OF | SC0025402 | -001 | 17WS003G | Buck Swamp | 0.6 | - |
| Marion | MARION/S. MAIN ST. WWTF | SC0046230 | -001 | 33WS001G | Great Pee Dee River | 65.5 | - |
| Mohawk | MOHAWK IND/OAK RIVER PLANT | SC0001996 | -001,-002,-003 | 34IN003G | Great Pee Dee River | 31.6 | - |
| Mullins | MULLINS/WHITE OAK CREEK WWTF | SC0029408 | -001 | 33WS002G | Brown Swamp | 0.3 | - |
| Pageland (Lynches) | PAGELAND/NORTHWEST WWTF | SC0021504 | -001 | none | Lynches River | 0.1 | - |
| Pageland (Black) | PAGELAND/SOUTHEAST WWTF | SC0021539 | -001 | none | Black Creek | 1.9 | - |
| Pamplico | PAMPLICO, TOWN OF | SC0021351 | -002 | 21WS007G | Great Pee Dee River | 88.7 | - |
| Timmonsville | TIMMONSVILLE, TOWN OF | SC0025356 | -001 | 21WS003G | Sparrow Swamp | 0.3 | - |

**Table 9. Baseline Model Monthly Consumptive Use Percentage**

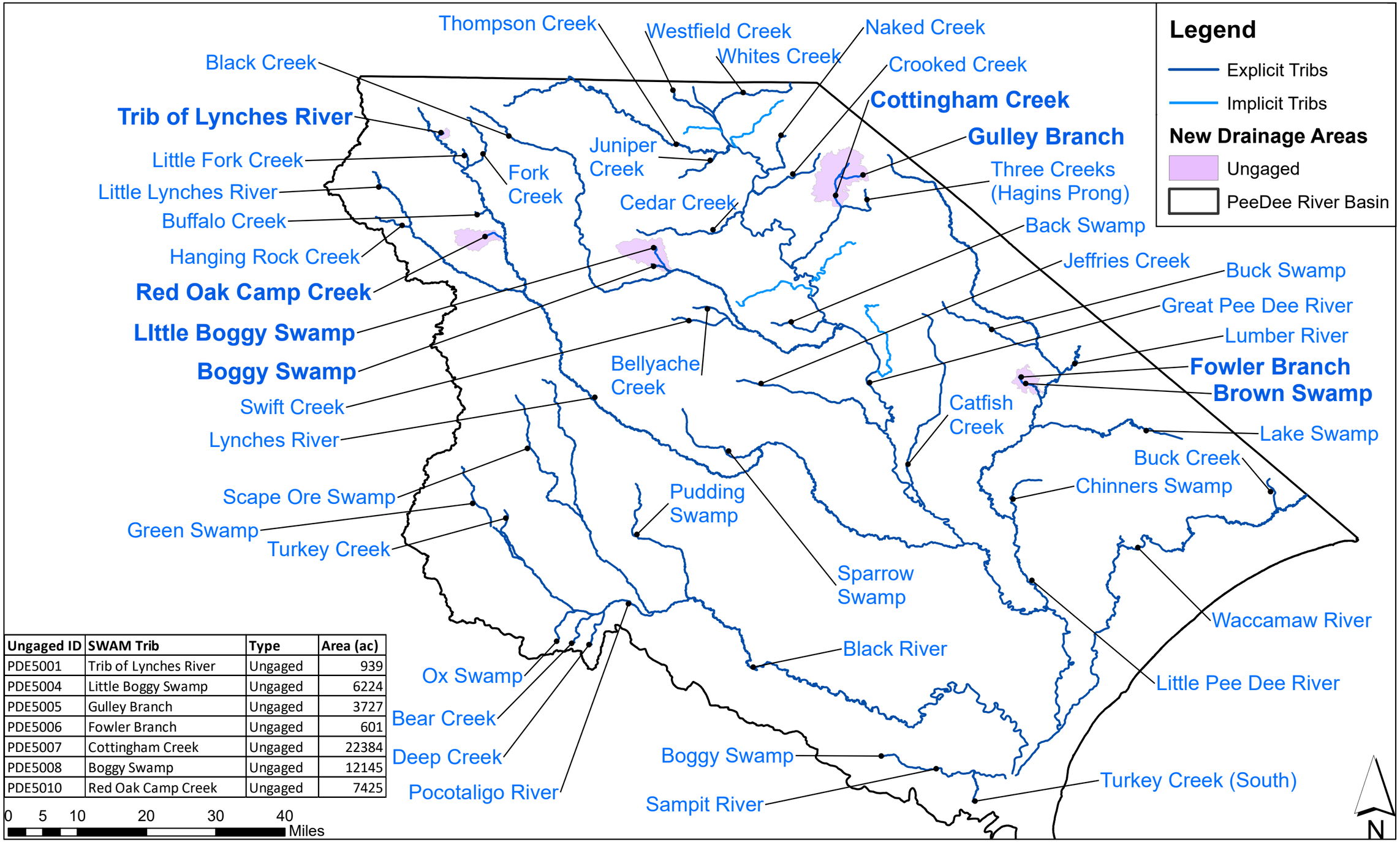
| Monthly Consumptive Use (%) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | IN: Domtar | IN: Hanson (Jefferson) | IN: Hanson (Brewer) | MI: Hanson (Marlboro) | MI: Martin Marietta | IN: Nucor | IN: Sonoco | IN: IP (George-town) | PN: HB Robinson | IN: West-Rock | WS: Cheraw | WS: Florence | WS: Bennetts-ville |
| Jan | 2 | 85 | 100 | 100 | 85 | 92 | 39 | 31 | 0 | 21 | 8 | 19 | 10 |
| Feb | 1 | 85 | 100 | 100 | 85 | 90 | 30 | 31 | 1 | 16 | 4 | 10 | 12 |
| Mar | 2 | 85 | 100 | 100 | 85 | 91 | 33 | 24 | 0 | 17 | 3 | 8 | 9 |
| Apr | 3 | 85 | 100 | 100 | 85 | 91 | 39 | 31 | 0 | 23 | 11 | 11 | 16 |
| May | 2 | 85 | 100 | 100 | 85 | 94 | 29 | 31 | 0 | 25 | 12 | 21 | 22 |
| Jun | 3 | 85 | 100 | 100 | 85 | 95 | 30 | 32 | 0 | 24 | 21 | 29 | 27 |
| Jul | 2 | 85 | 100 | 100 | 85 | 90 | 37 | 33 | 0 | 31 | 22 | 30 | 26 |
| Aug | 2 | 85 | 100 | 100 | 85 | 94 | 31 | 32 | 0 | 26 | 23 | 31 | 28 |
| Sep | 4 | 85 | 100 | 100 | 85 | 95 | 32 | 31 | 0 | 19 | 22 | 30 | 26 |
| Oct | 4 | 85 | 100 | 100 | 85 | 90 | 35 | 31 | 0 | 20 | 16 | 25 | 25 |
| Nov | 3 | 85 | 100 | 100 | 85 | 90 | 36 | 31 | 0 | 26 | 15 | 23 | 22 |
| Dec | 2 | 85 | 100 | 100 | 85 | 89 | 37 | 31 | 0 | 23 | 6 | 17 | 14 |

| Monthly Consumptive Use (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Month | WS: Bishop-ville | WS: Lynch-burg | WS: Hartsville | WS: Manning | IN: Martek | IN: McCall Farms | WS: McColl | IN: Pilgrims Pride | WS: Sumter |
| Jan | 17 | 95 | 2 | 2 | 75 | 7 | 35 | 43 | 17 |
| Feb | 9 | 94 | 3 | 1 | 68 | 9 | 30 | 42 | 11 |
| Mar | 8 | 94 | 1 | 2 | 72 | 5 | 34 | 42 | 9 |
| Apr | 11 | 95 | 2 | 3 | 69 | 12 | 37 | 43 | 13 |
| May | 21 | 95 | 5 | 9 | 69 | 0 | 47 | 44 | 19 |
| Jun | 25 | 95 | 9 | 14 | 63 | 0 | 48 | 48 | 24 |
| Jul | 29 | 96 | 10 | 19 | 77 | 3 | 49 | 44 | 27 |
| Aug | 22 | 96 | 10 | 11 | 80 | 12 | 49 | 44 | 24 |
| Sep | 22 | 96 | 10 | 18 | 79 | 8 | 50 | 44 | 26 |
| Oct | 23 | 95 | 3 | 15 | 75 | 6 | 43 | 43 | 23 |
| Nov | 26 | 93 | 1 | 12 | 75 | 3 | 40 | 46 | 22 |
| Dec | 17 | 93 | 2 | 5 | 76 | 5 | 37 | 44 | 15 |

**Table 10. Baseline Model Monthly Return Flows for Discharge Objects**

| Monthly Return Flow (MGD) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | Clio | Dillon | Haile | Hemingway | Jefferson | Johnsonville | Kingstree | Koppers | Lake City | LCW&SD Import (Catawba) |
| Jan | 0.2 | 3.0 | 0.2 | 0.4 | 0.1 | 1.5 | 1.7 | 0.0 | 3.3 | 0.7 |
| Feb | 0.2 | 3.4 | 0.1 | 0.5 | 0.1 | 1.5 | 1.8 | 0.4 | 3.7 | 0.7 |
| Mar | 0.2 | 3.4 | 0.2 | 0.4 | 0.1 | 1.5 | 1.7 | 0.0 | 3.6 | 0.7 |
| Apr | 0.2 | 3.1 | 0.2 | 0.4 | 0.1 | 1.5 | 1.6 | 0.1 | 3.7 | 0.7 |
| May | 0.1 | 3.0 | 0.2 | 0.4 | 0.1 | 1.6 | 1.5 | 0.1 | 3.0 | 0.7 |
| Jun | 0.1 | 3.3 | 0.3 | 0.4 | 0.1 | 1.6 | 1.5 | 0.1 | 2.8 | 0.6 |
| Jul | 0.2 | 3.1 | 0.2 | 0.3 | 0.1 | 1.6 | 1.5 | 0.3 | 2.8 | 0.6 |
| Aug | 0.1 | 2.8 | 0.2 | 0.4 | 0.1 | 1.7 | 1.5 | 0.1 | 2.8 | 0.6 |
| Sep | 0.1 | 3.0 | 0.2 | 0.4 | 0.1 | 1.6 | 1.6 | 0.6 | 2.7 | 0.6 |
| Oct | 0.1 | 2.9 | 0.2 | 0.5 | 0.1 | 1.5 | 1.4 | 0.1 | 2.9 | 0.6 |
| Nov | 0.1 | 2.8 | 0.2 | 0.3 | 0.1 | 1.5 | 1.5 | 0.1 | 2.8 | 0.7 |
| Dec | 0.2 | 3.2 | 0.2 | 0.4 | 0.1 | 1.5 | 1.7 | 0.5 | 3.3 | 0.7 |

| Monthly Return Flow (MGD) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Lamar | Latta | Marion | Mohawk | Mullins | Pageland (Lynches) | Pageland (Black) | Pamplico | Timmonsville |
| Jan | 0.2 | 0.6 | 1.9 | 0.2 | 1.3 | 0.2 | 0.4 | 0.2 | 1.1 |
| Feb | 0.3 | 0.7 | 2.2 | 0.3 | 1.6 | 0.2 | 0.4 | 0.2 | 1.1 |
| Mar | 0.3 | 0.6 | 2.1 | 0.3 | 1.5 | 0.2 | 0.4 | 0.2 | 1.2 |
| Apr | 0.2 | 0.6 | 1.8 | 0.3 | 1.2 | 0.1 | 0.4 | 0.2 | 1.2 |
| May | 0.2 | 0.5 | 1.6 | 0.3 | 1.2 | 0.1 | 0.3 | 0.2 | 0.9 |
| Jun | 0.2 | 0.5 | 1.8 | 0.3 | 1.3 | 0.1 | 0.3 | 0.2 | 0.8 |
| Jul | 0.2 | 0.5 | 1.7 | 0.3 | 1.1 | 0.1 | 0.3 | 0.2 | 0.9 |
| Aug | 0.2 | 0.4 | 1.6 | 0.3 | 1.1 | 0.1 | 0.2 | 0.2 | 0.7 |
| Sep | 0.2 | 0.6 | 1.7 | 0.3 | 1.3 | 0.2 | 0.3 | 0.2 | 0.8 |
| Oct | 0.2 | 0.5 | 1.6 | 0.3 | 1.2 | 0.1 | 0.3 | 0.3 | 1.0 |
| Nov | 0.3 | 0.5 | 1.6 | 0.3 | 1.1 | 0.1 | 0.4 | 0.2 | 0.8 |
| Dec | 0.2 | 0.6 | 2.0 | 0.2 | 1.4 | 0.2 | 0.4 | 0.2 | 1.1 |




| Ungaged ID | SWAM Trib | Type | Area (ac) |
|---|---|---|---|
| PDE5001 | Trib of Lynches River | Ungaged | 939 |
| PDE5004 | Little Boggy Swamp | Ungaged | 6224 |
| PDE5005 | Gulley Branch | Ungaged | 3727 |
| PDE5006 | Fowler Branch | Ungaged | 601 |
| PDE5007 | Cottingham Creek | Ungaged | 22384 |
| PDE5008 | Boggy Swamp | Ungaged | 12145 |
| PDE5010 | Red Oak Camp Creek | Ungaged | 7425 |

**Figure 1. Drainage Areas for New or Updated Explicit Tributaries in the Pee Dee River Basin**

# 2020 Pee Dee SWAM Model Updates

## Attachment B

## Responses to TM-PD1

## Technical Memorandum, TM-PD1

To: John Boyer, CDM Smith

From: Scott Harder, Hydrology Section Chief, South Carolina Department of Natural Resources

Date: 3/31/20

Re: Pee Dee SWAM Model Updates

Please find below a list of recommended revisions to the Pee Dee SWAM Model as determined from a SCDNR review of the current Pee Dee SWAM baseline model. Some of the revisions will require further review by CDM Smith and may require an additional meeting with CDM Smith and SCDHEC for further discussion.

Red text below each comment indicates how model was adjusted by CDM Smith as part of the 2020 Pee Dee SWAM Updates.

**Agricultural Irrigation Objects:**

1. IR: Atkinson (33IR033S01): Intake is on Fowler Branch, a HW tributary to Brown Swamp. Either add Fowler Branch or adjust Brown Swamp HW area to be the drainage area above the intake on Fowler Branch and scale SBFFs to reflect new drainage area ratios. The model currently has a HW area for Brown Swamp of 4141 acres, but HW area for intake on Fowler Branch from Streamstats is more like 122 acres. Fowler Branch was added and headwater and drainage area adjustments to Brown Swamp were made.

2. IR: Belger (28IR011S03): Intake is on Red Oak Camp Creek Tributary. Add tributary and move source for intake to Red Oak Camp Creek. Red Oak Camp Creek tributary was added and the IR: Belger source was moved.

3. IR: Black Crest (43IR007S01, S02, and S03): Unclear from S03 intake coordinates what water body this intake is on. It does not appear to be directly on the Pocotaligo however. S01 also appears to be on a separate unnamed tributary off the Pocotaligo. S02 intake is directly on the Pocotaligo River. Please review and revise as needed. After review, it was decided to keep these sources aggregated with the withdrawal on the Pocotaligo, given the very small tributary sizes and the proximity to the Pocotaligo River.

4. IR: Carolina Plantation (16IR080S01): Sourcewater for intake is incorrectly designated as Black Creek. The Sourcewater should be the mainstem Pee Dee. This correction was made.

5. IR: Dargan (16IR015S01 and S02): S02 may not be directly connected to Back Swamp and appears to be on Louthers Lake, an oxbow lake that has lost connection with the Pee Dee except for high flow events perhaps. SCDNR is not sure what to recommend here, but request CDM Smith to review. Be sure to update the S01 registration limit to 5.5 MGM and S02 limit to 5MGM. Aggregated limit is 10.5 MGM (model has 6 MGM). Dargan source S02 was left as a withdrawal from Back Swamp for now. This can be revisited. Neither representation would necessarily be accurate in SWAM, since it appears on an (typically) unconnected ox-bow lake to the Mainstem; however, there are ultimately not likely to be any significant river basin planning or permitting implications of one approach over the other.

6. IR: Haley (Bear - 14IR016S01, S02, S04, S12), Haley (Deep - 14IR016S05, S06, S07) and IR: Haley (Ox - 14IR016S02, 14IR016S13) are inactive and should be removed. These have been removed.

7. IR: Hinson (34IR002S01, S02): S02 is on Gulley Branch, which appears to be a tributary to Cottingham Creek which then drains to Three Creeks. S01 is on a small tributary (or canal perhaps) off Hagins Prong. Please review and revise (add appropriate tributaries) as needed. The tributaries Cottingham and Gully were added and the IR: Hinson withdrawal locations were adjusted accordingly.

8. IR: Irwin (45IR002S01) appears to be on a small tributary or canal off Pudding Swamp. User may be okay as is, but SCDNR request CDM Smith to review. Registration limit also should be updated to 4.81 MGM. Updated permit limit. Left withdrawal location as Pudding Swamp given small size of the tributary and proximity to Pudding Swamp.

9. IR: Rogers (16IR016S01): Intake S02 is inactive – remove reference. Update registration limit for S01 to 90.4 MGM. Removed S02 and updated registration limit.

10. IR: The Sod Farm (26IR025S01) is inactive and should be removed. Removed.

11. Check: IR: Sugar Hill (16IR012S01, S02) and IR: Chapman (16IR030S01, S01) – The SWAM model has these users on Boggy Swamp (N), which may be the same as Little Boggy Swamp. SCDNR requests CDM Smith to ensure that the headwater flows and SBFFs reflect Little Boggy Swamp watershed and not the Boggy Swamp watershed (see StreamStats). Also, length of Little Boggy Swamp should be approximately 4 miles (model has 2.9 miles as reach length) - most upstream intake is located approximately four miles from confluence with Black Creek. In addition, StreamStats indicates that Sugar Hill, S02, intake may be on Boggy Swamp and not Little Boggy Swamp. Please review and revise as needed. Boggy Swamp and Little Boggy Swamp were reconfigured and the IR: withdrawals were adjusted.

12. IR: Tolson (31IR008S01, S03): S03, also on the Lynches River needs to be added to the model. Registration limit is 5 MGM and is just upstream of RM 84. IR: Tolson S03 was added. Combined permit limit is 12 MGM.

13. IR: Turf Connections (13IR008S03) – Active intake is now S03, with registration limit of 6 MGM and source water as Westfield Creek, RM 2.3. Remove references to S01 and S02. Updated.

**Other Water Use Objects:**

1. Hanson Aggregates, Brewer Facility (13IN002) – This permit is in the current DHEC database but is not represented in the model. It also appears to have reported water use for some years from 2013-2018. There may have been a reason it was originally excluded (maybe because there was no reported water use during the baseline period) but couldn't find any documentation stating why it was not included. This user was added and recent withdrawal information was used to develop baseline water use.

2. IN: Westrock is assumed to be Rocktenn – Florence CP LLC (21IN001) in DHEC permit database. Please verify and check if there was a name change associated with this user. In addition, IN: Westrock (21IN001S01, 21IN001G02-03) has two groundwater wells listed which were not found in current SCDHEC water use database. Though the groundwater use in the model is a very small fraction of total water used by the industry, please verify whether the groundwater wells are active and remove references to groundwater use if appropriate. Per DHEC, groundwater wells were re-registered as water supply (WS) wells. Demands were updated and left in model.

14. GC: White Plains is on a higher order tributary than Fork Creek. Consider adding in higher order tributary. After review, it was decided to leave this source assigned to Fork Creek, given the very small tributary size and the proximity to the Fork Creek.

3. Remove IN: Galey and Lord. This permit is inactive. Removed.

4. IN: Martek (45IN001) is listed as DSM Nutritional Products, LLC in current SCDHEC water use database. Please verify with SCDHEC if there was a recent company name change. Left as IN: Martek, which appears to be the parent company.

5. IN: McCall Farms (21IN008) has an additional intake (G04) with reported water use from 2014-2018. Be sure to include withdrawal volumes (potentially impacts discharges) in new baseline water use. G04 was included in the total groundwater withdrawal.

6. IN: IP (International Paper Georgetown, 22IN006S01) – Update surface water Permit limit from 10,000 MGM to 2003.5 MGM. Also, the groundwater wells (22IN006G02-03) may no longer be used. Please verify and update baseline water use and source waters as appropriate. Updated.

7. MI: Hanson Aggregates (Jefferson, 13MI003S01) – Intake is listed as the Lynches River but is on small un-named tributary to the Lynches. For accurate representation, consider adding in the tributary and updating the user object appropriately. An new tributary called “Unnamed Trib (Lynches)” was added and the MI: source was moved.

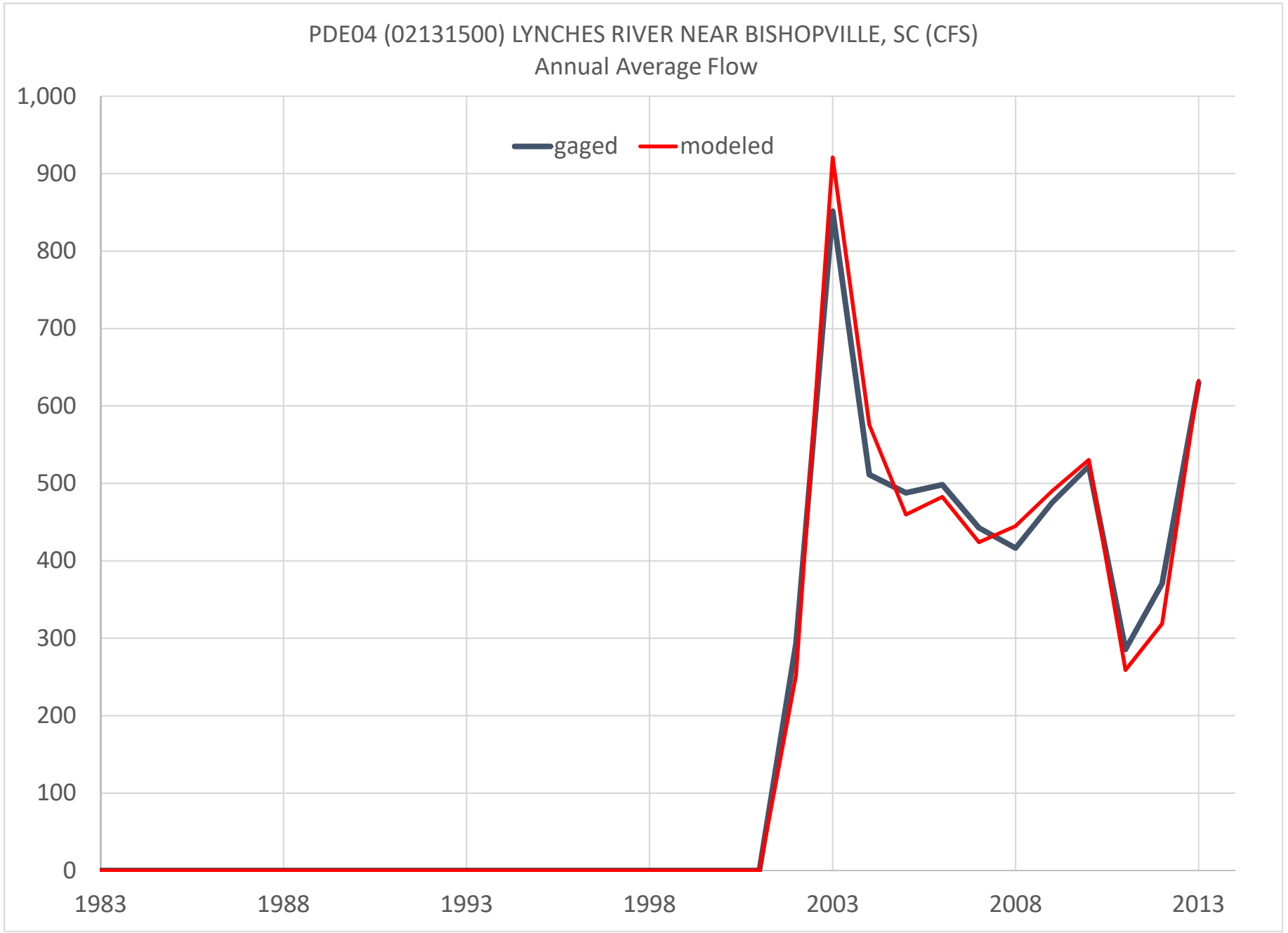
# 2020 Pee Dee SWAM Model Updates

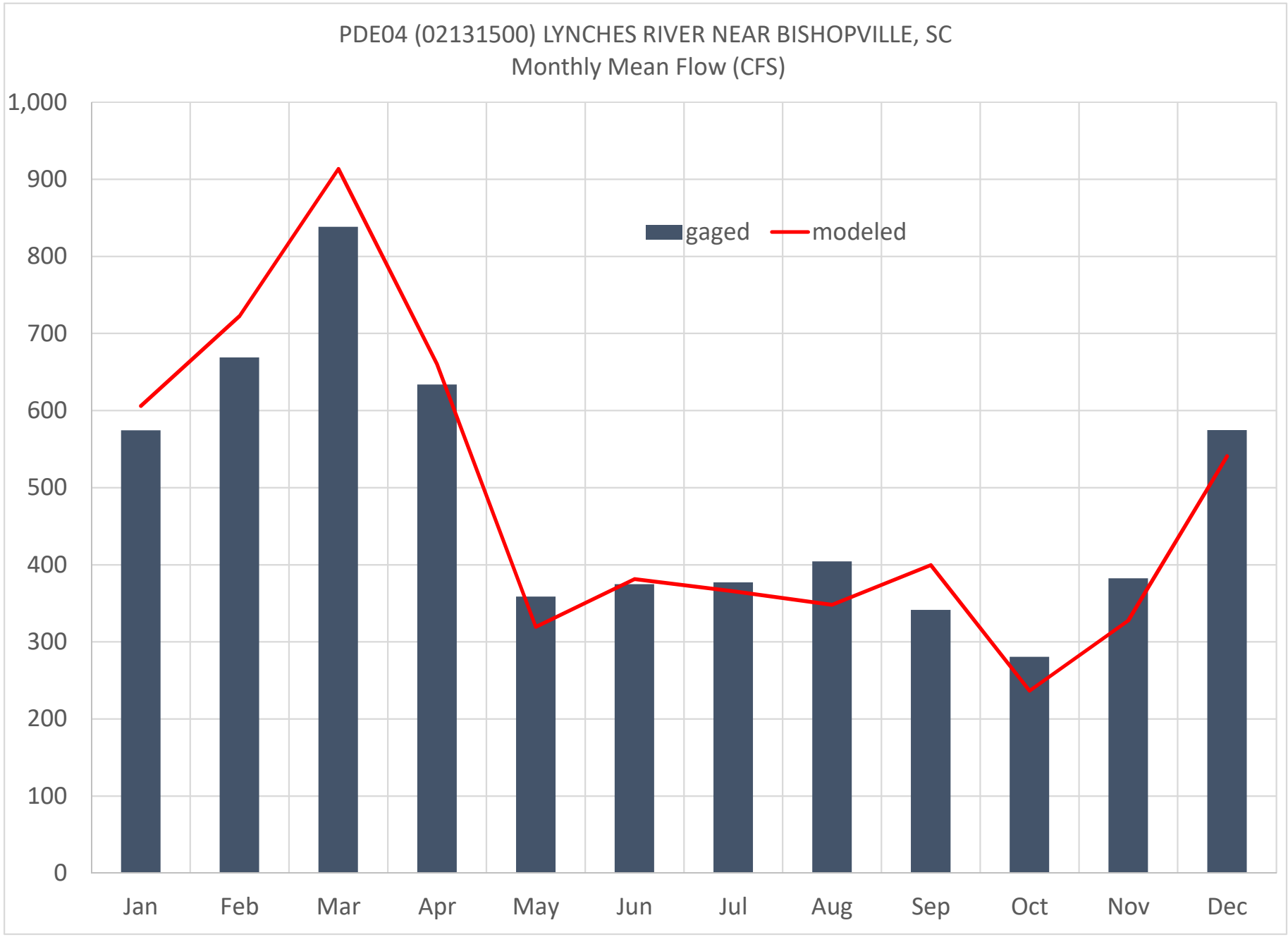
## Attachment C

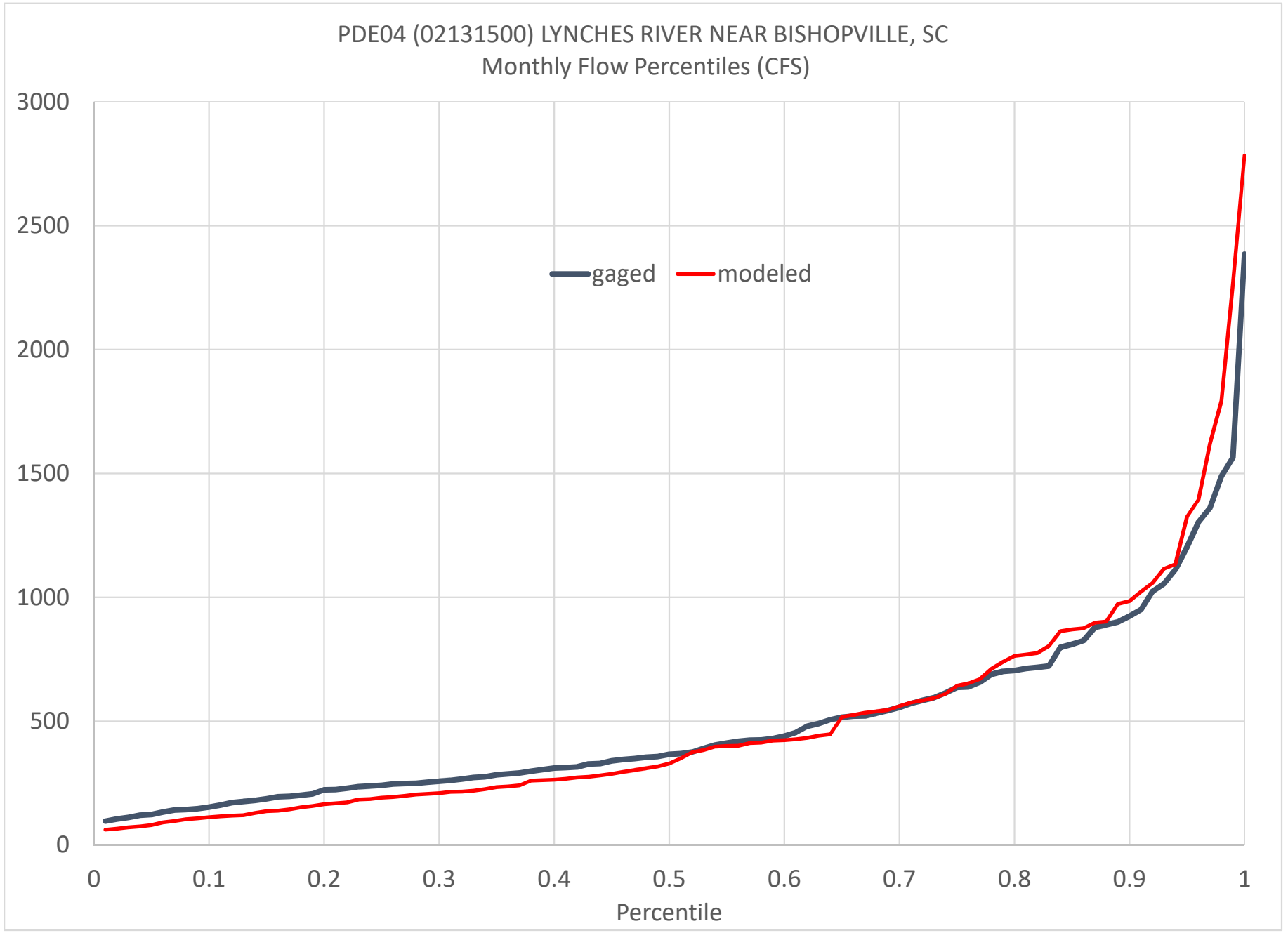
## Validation Results

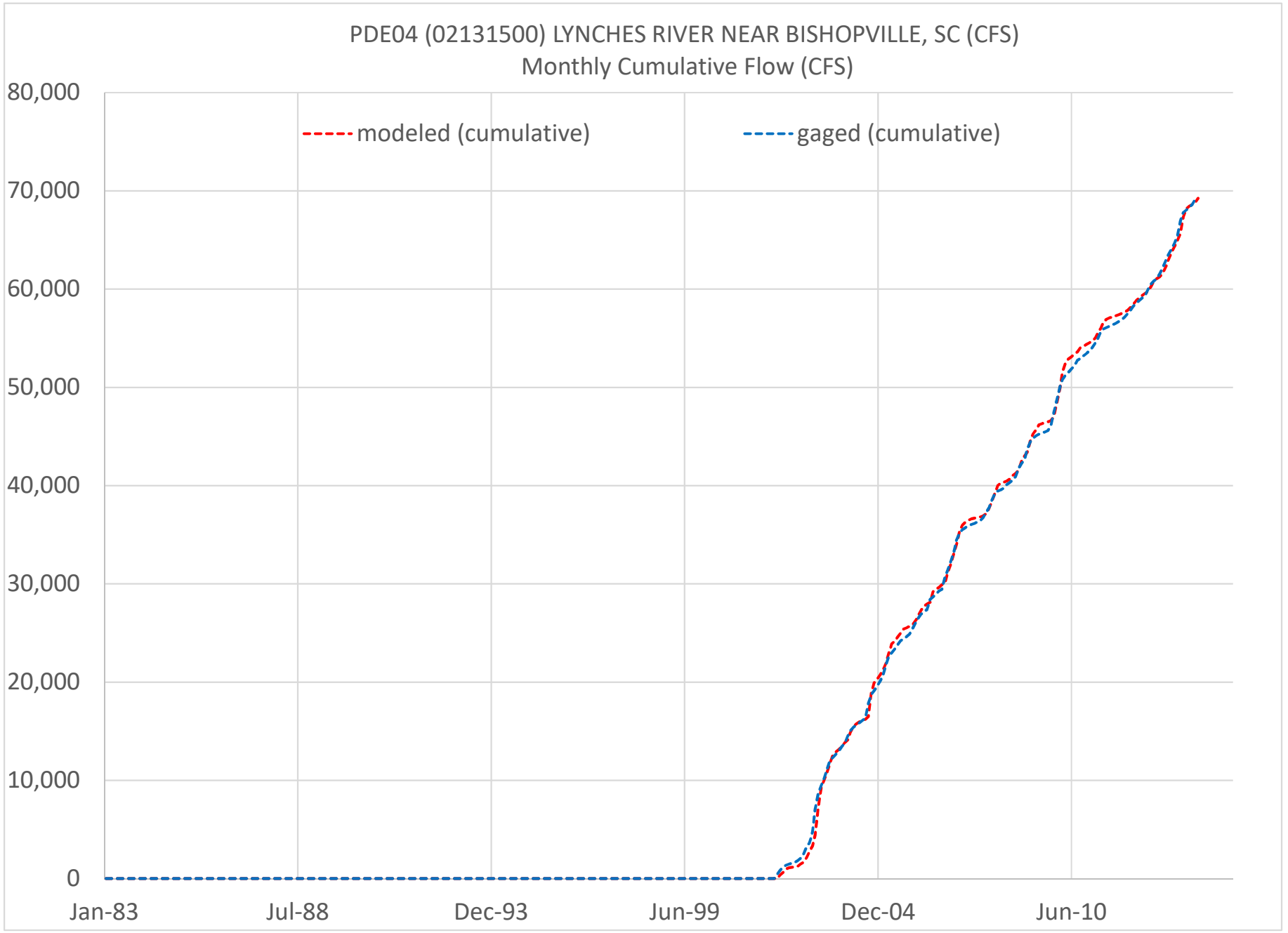
# Attachment C

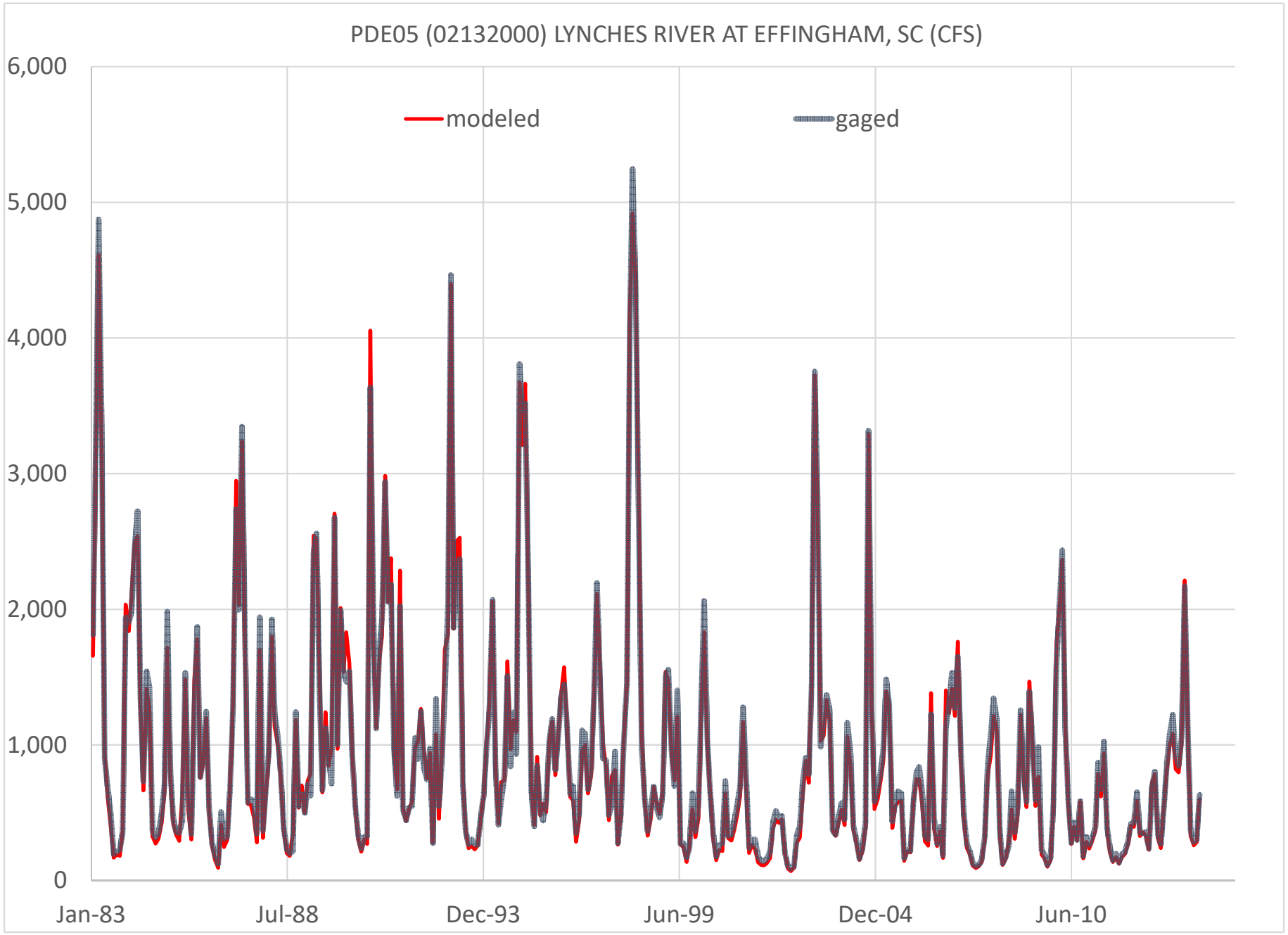
# Monthly Validation Results

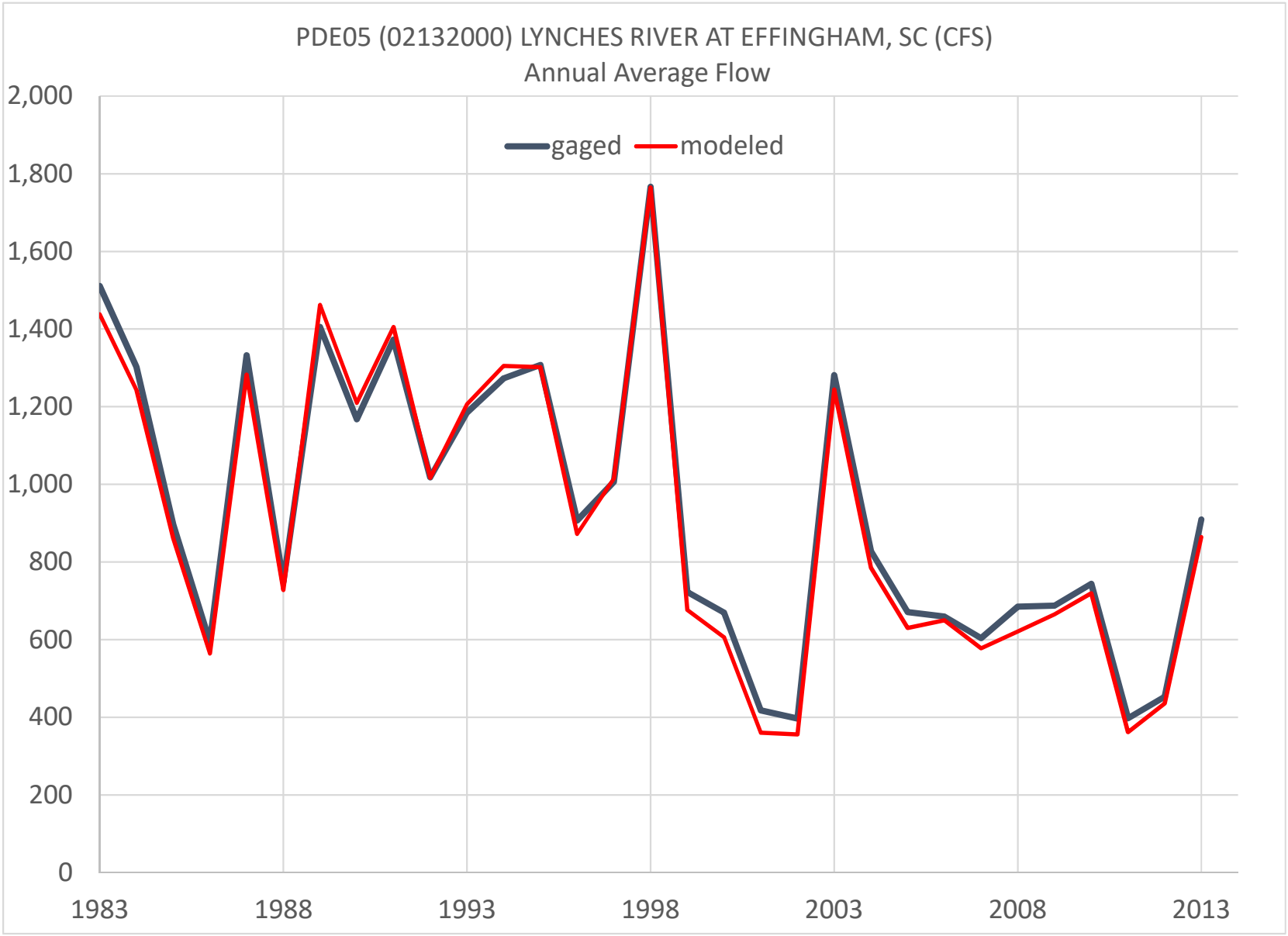

PDE04 (02131500) LYNCHES RIVER NEAR BISHOPVILLE, SC (CFS)
Annual Average Flow
gaged
modeled
1,000
900
800
700
600
500
400
300
200
100
0
1983
1988
1993
1998
2003
2008
2013

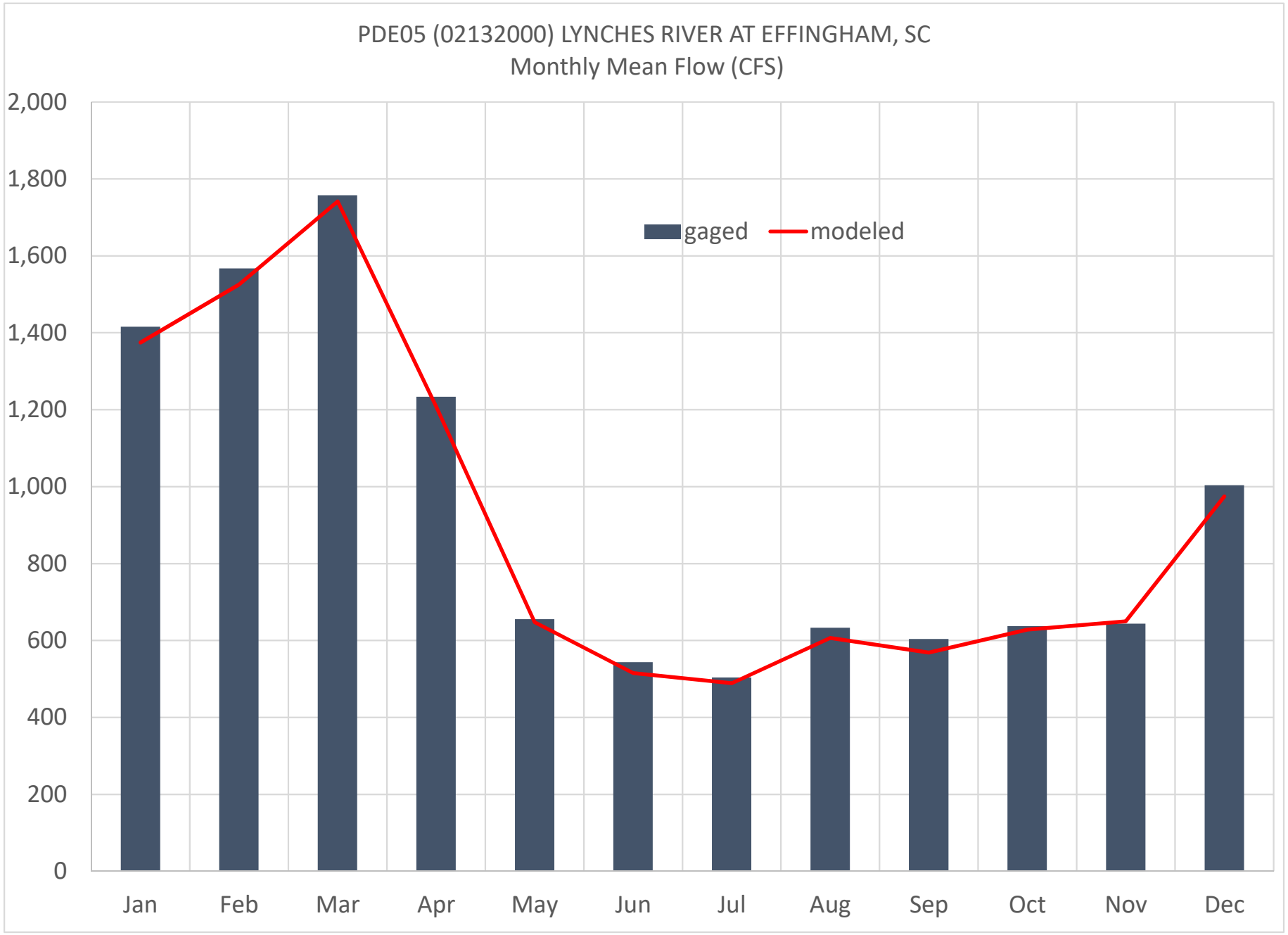

PDE04 (02131500) LYNCHES RIVER NEAR BISHOPVILLE, SC
Monthly Mean Flow (CFS)
1,000
900
800
700
600
500
400
300
200
100
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

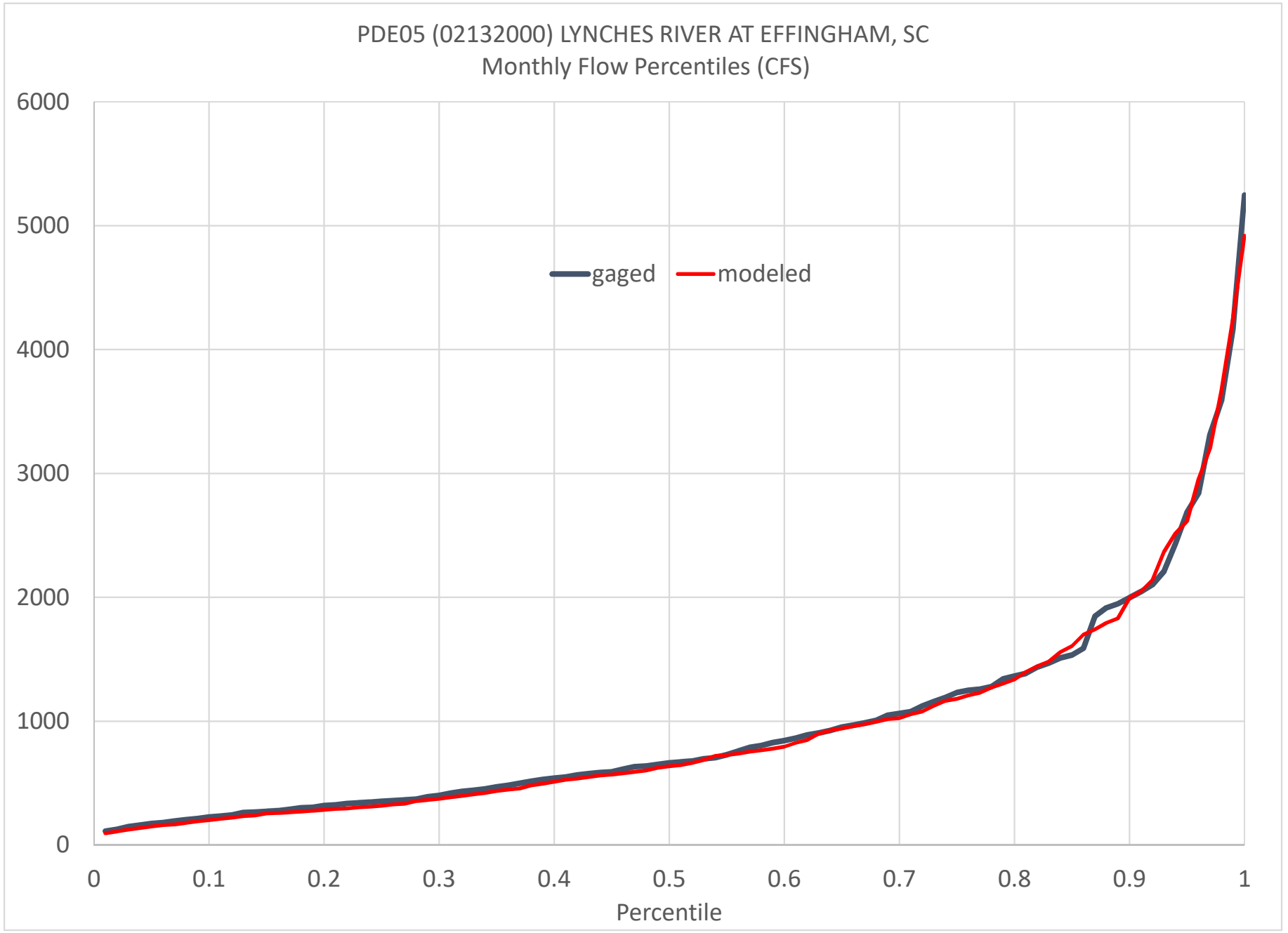

PDE04 (02131500) LYNCHES RIVER NEAR BISHOPVILLE, SC
Monthly Flow Percentiles (CFS)
3000
2500
2000
1500
1000
500
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

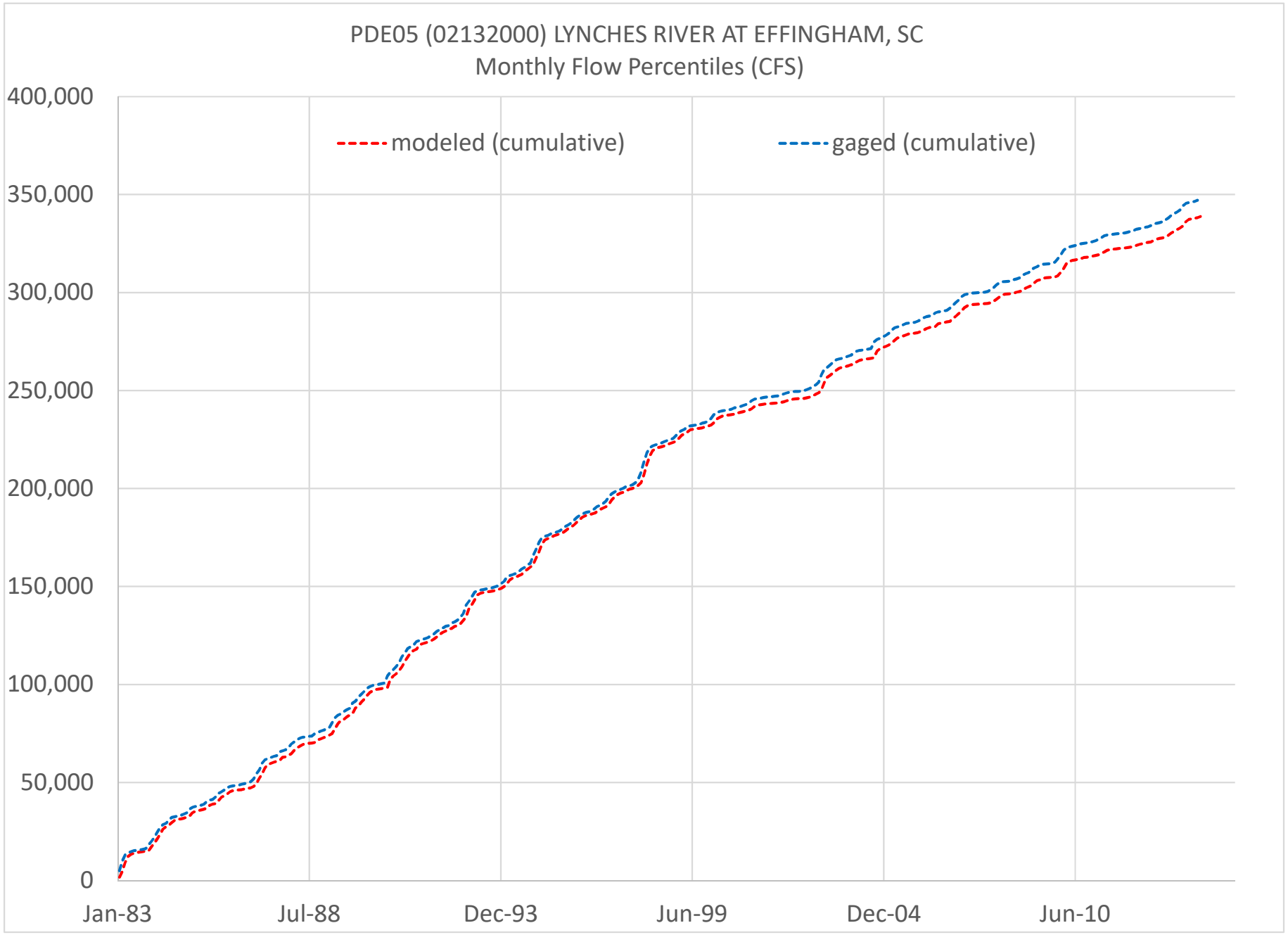

PDE04 (02131500) LYNCHES RIVER NEAR BISHOPVILLE, SC (CFS)
Monthly Cumulative Flow (CFS)
modeled (cumulative)
gaged (cumulative)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

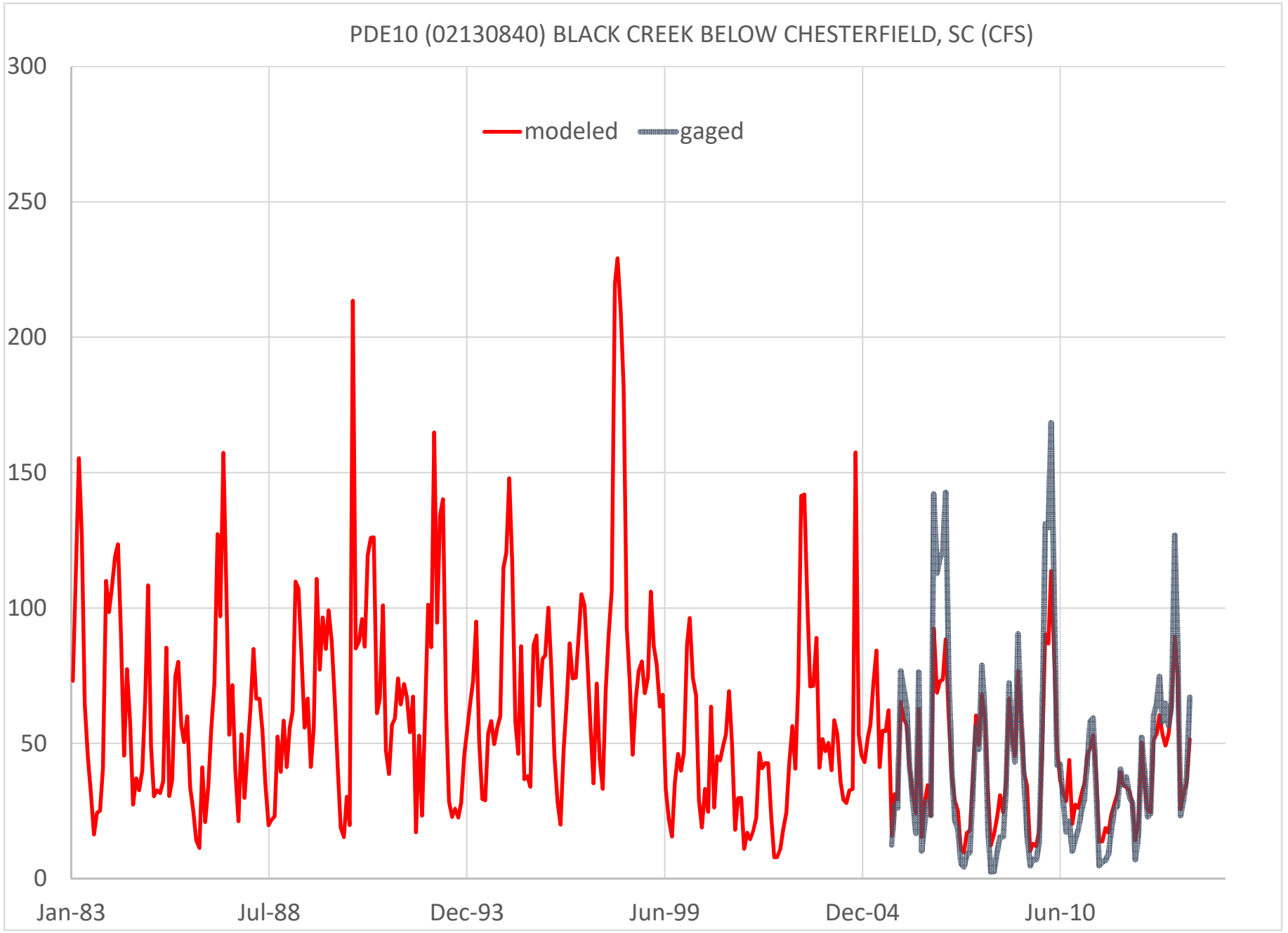

PDE05 (02132000) LYNCHES RIVER AT EFFINGHAM, SC (CFS)
modeled
gaged
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

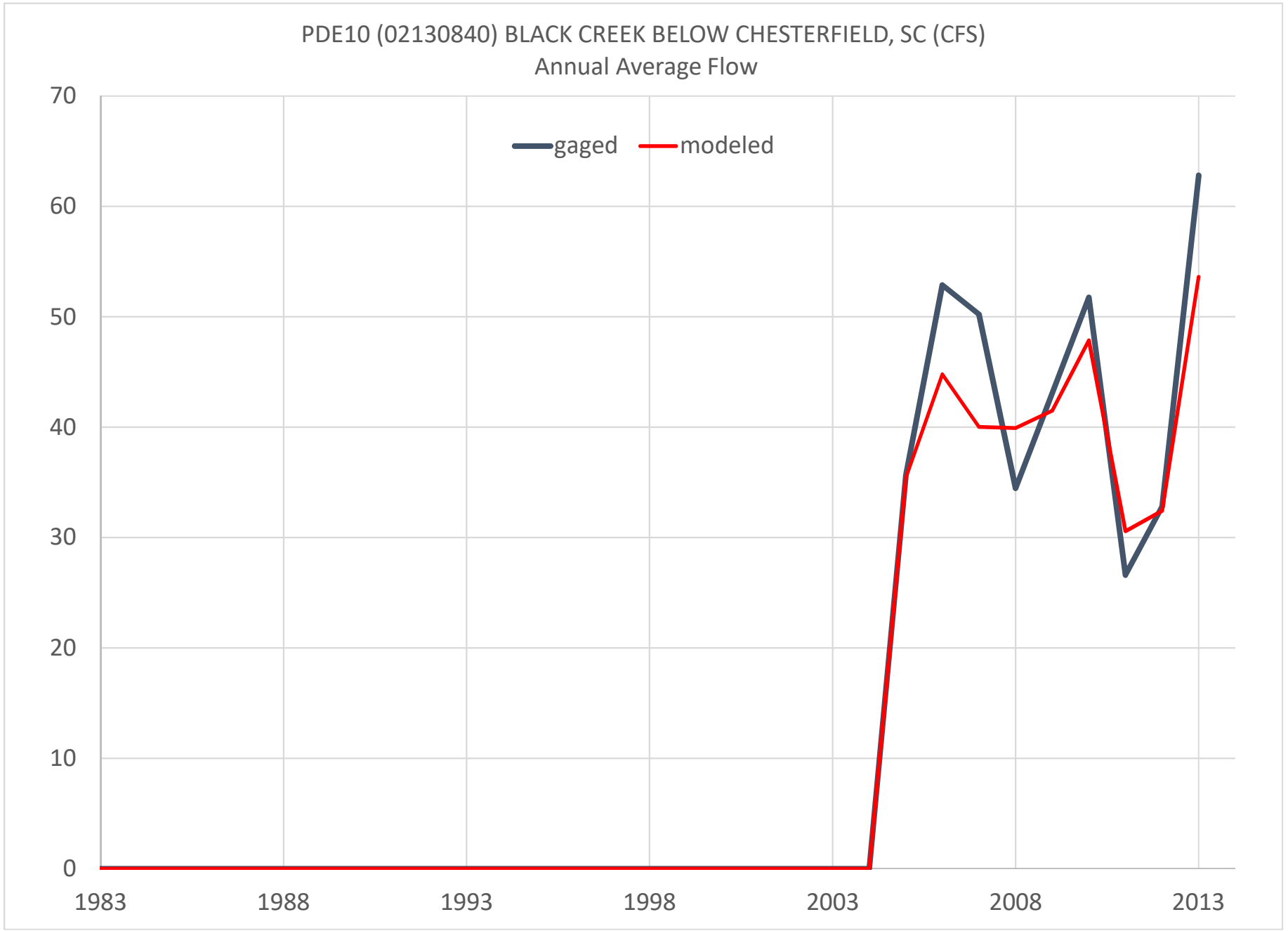

PDE05 (02132000) LYNCHES RIVER AT EFFINGHAM, SC (CFS)
Annual Average Flow
gaged
modeled
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1983
1988
1993
1998
2003
2008
2013

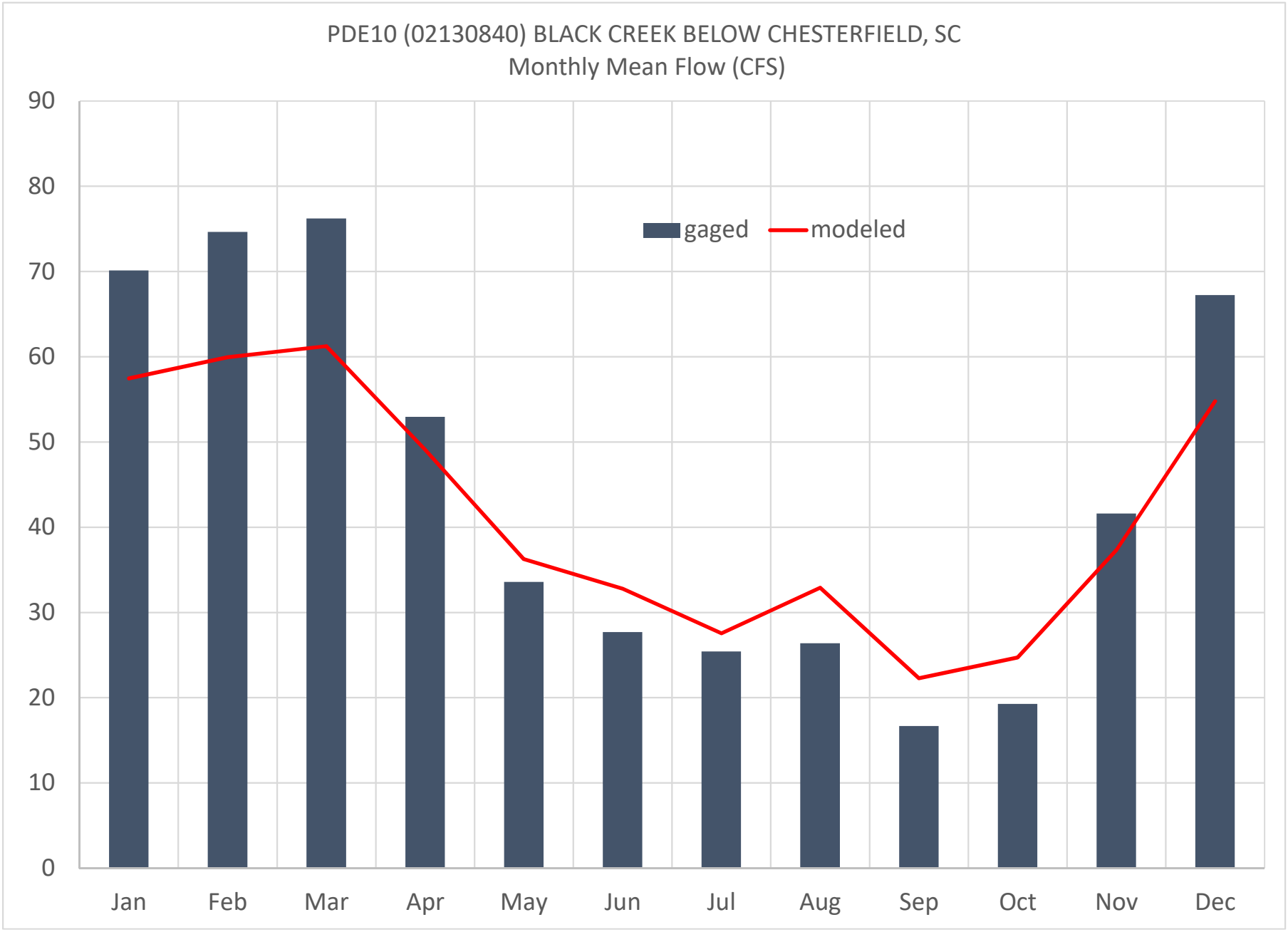

PDE05 (02132000) LYNCHES RIVER AT EFFINGHAM, SC
Monthly Mean Flow (CFS)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

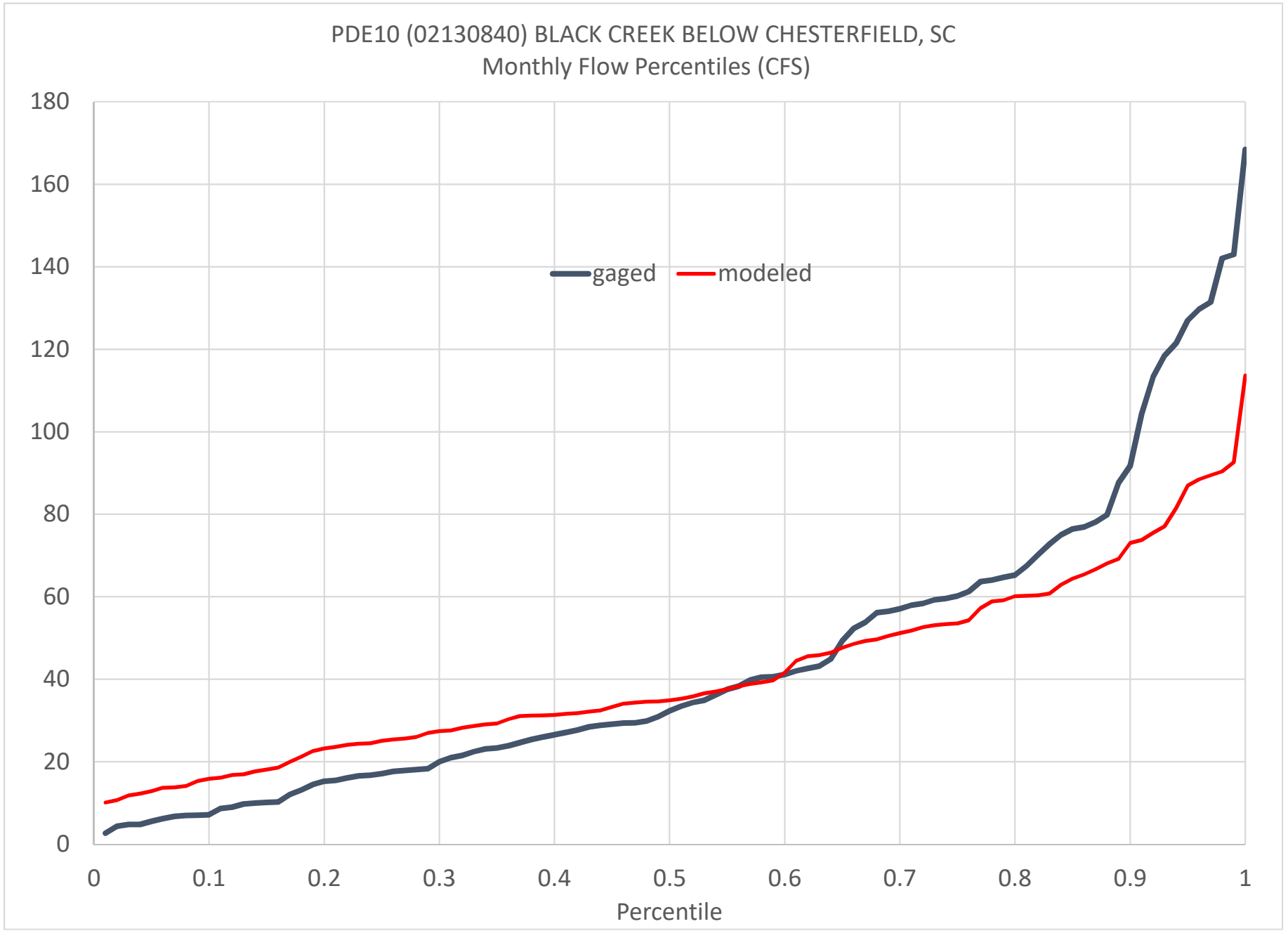

PDE05 (02132000) LYNCHES RIVER AT EFFINGHAM, SC
Monthly Flow Percentiles (CFS)
6000
5000
4000
3000
2000
1000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

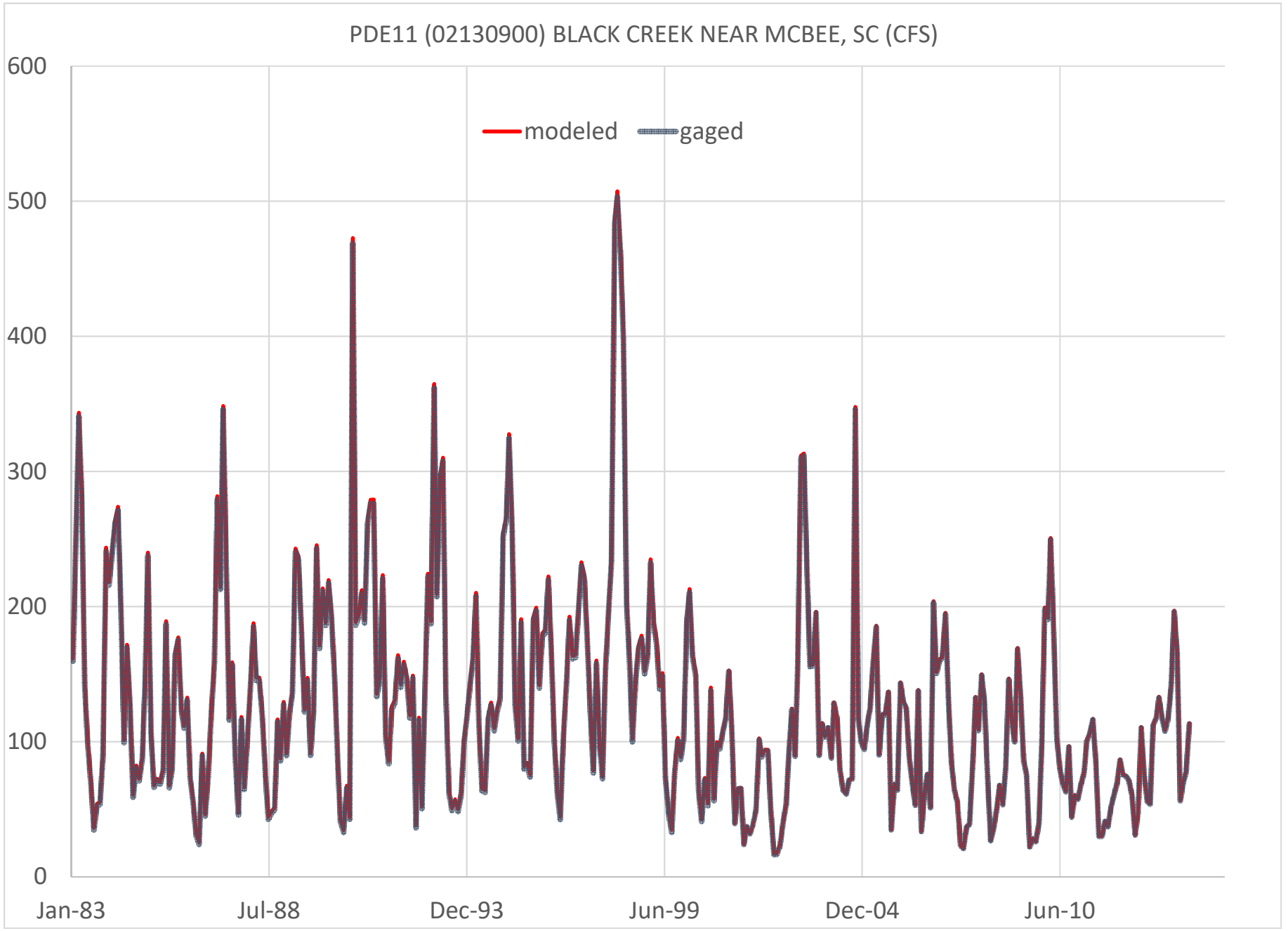

PDE05 (02132000) LYNCHES RIVER AT EFFINGHAM, SC
Monthly Flow Percentiles (CFS)
modeled (cumulative)
gaged (cumulative)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

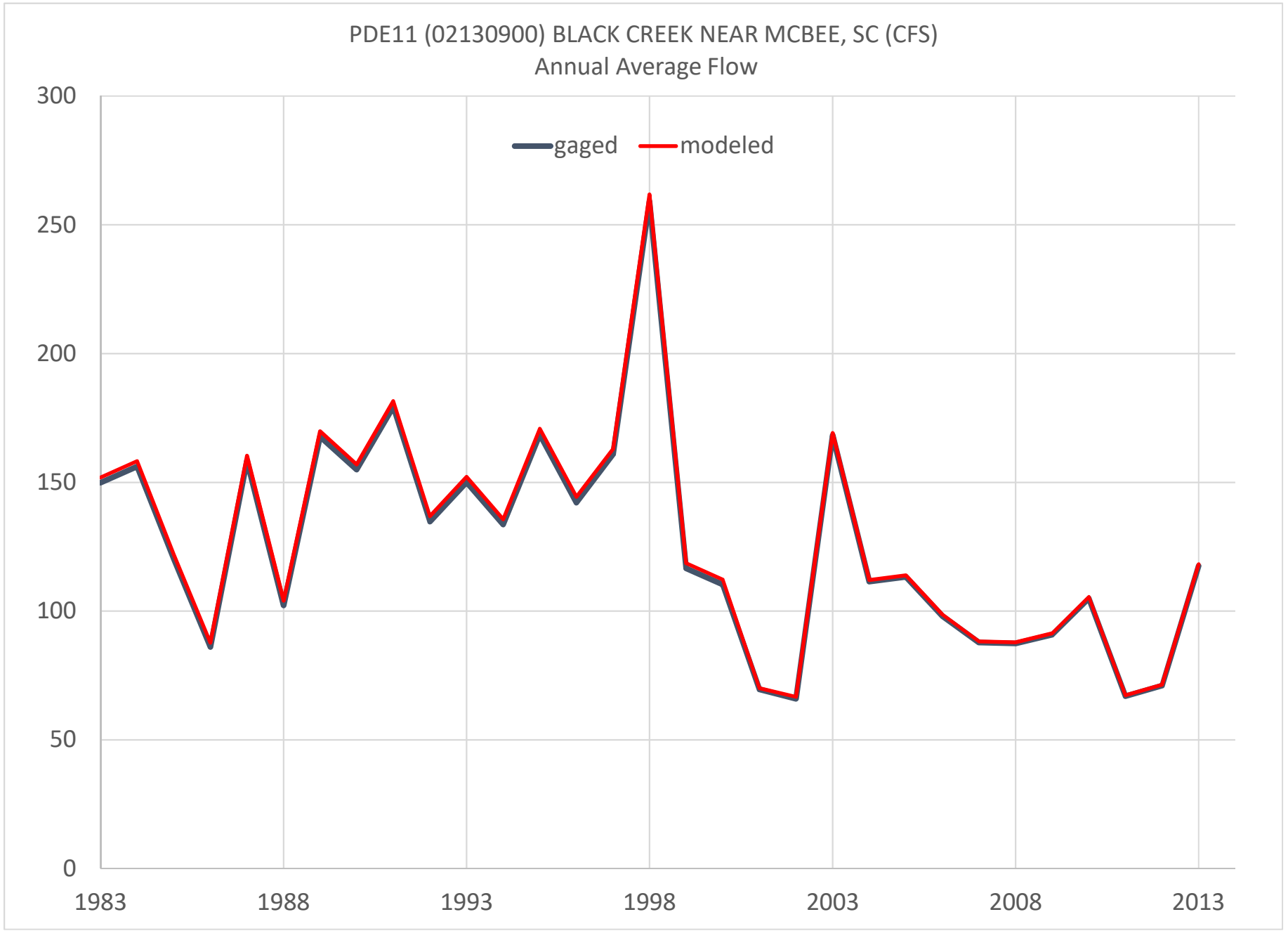

PDE10 (02130840) BLACK CREEK BELOW CHESTERFIELD, SC (CFS)
modeled
gaged
300
250
200
150
100
50
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

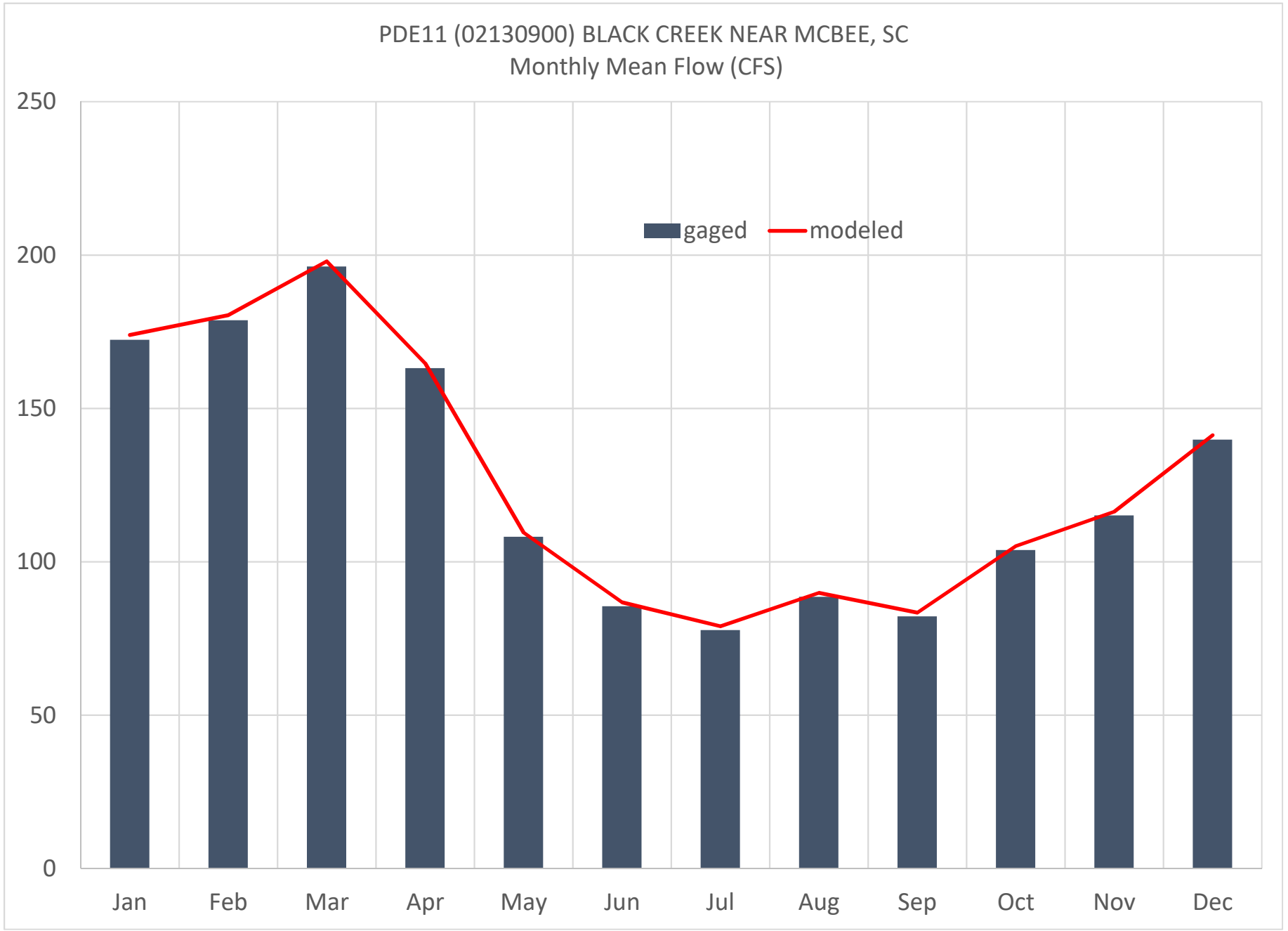

PDE10 (02130840) BLACK CREEK BELOW CHESTERFIELD, SC (CFS)
Annual Average Flow
gaged
modeled
70
60
50
40
30
20
10
0
1983
1988
1993
1998
2003
2008
2013

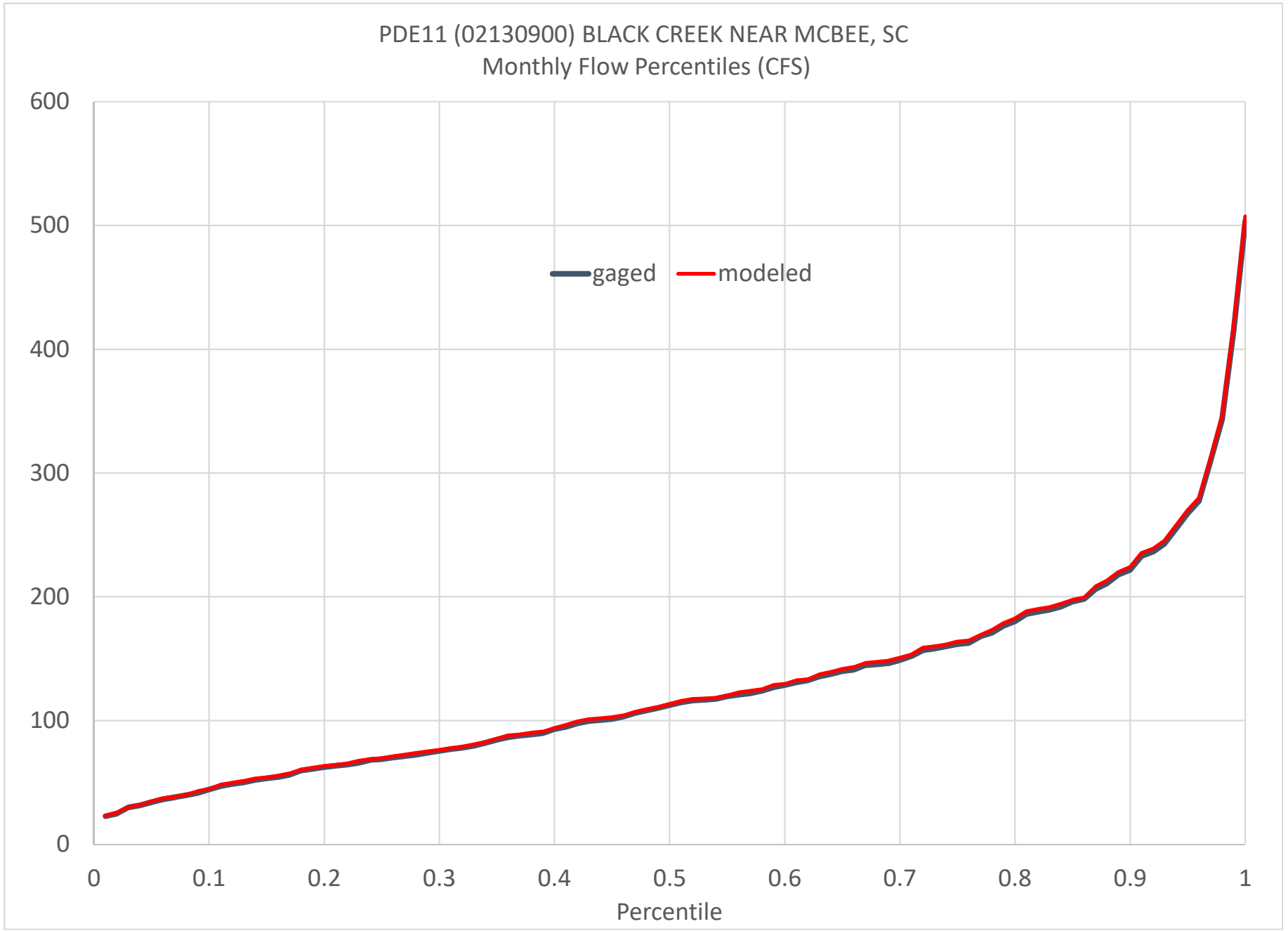

PDE10 (02130840) BLACK CREEK BELOW CHESTERFIELD, SC
Monthly Mean Flow (CFS)
90
80
70
60
50
40
30
20
10
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

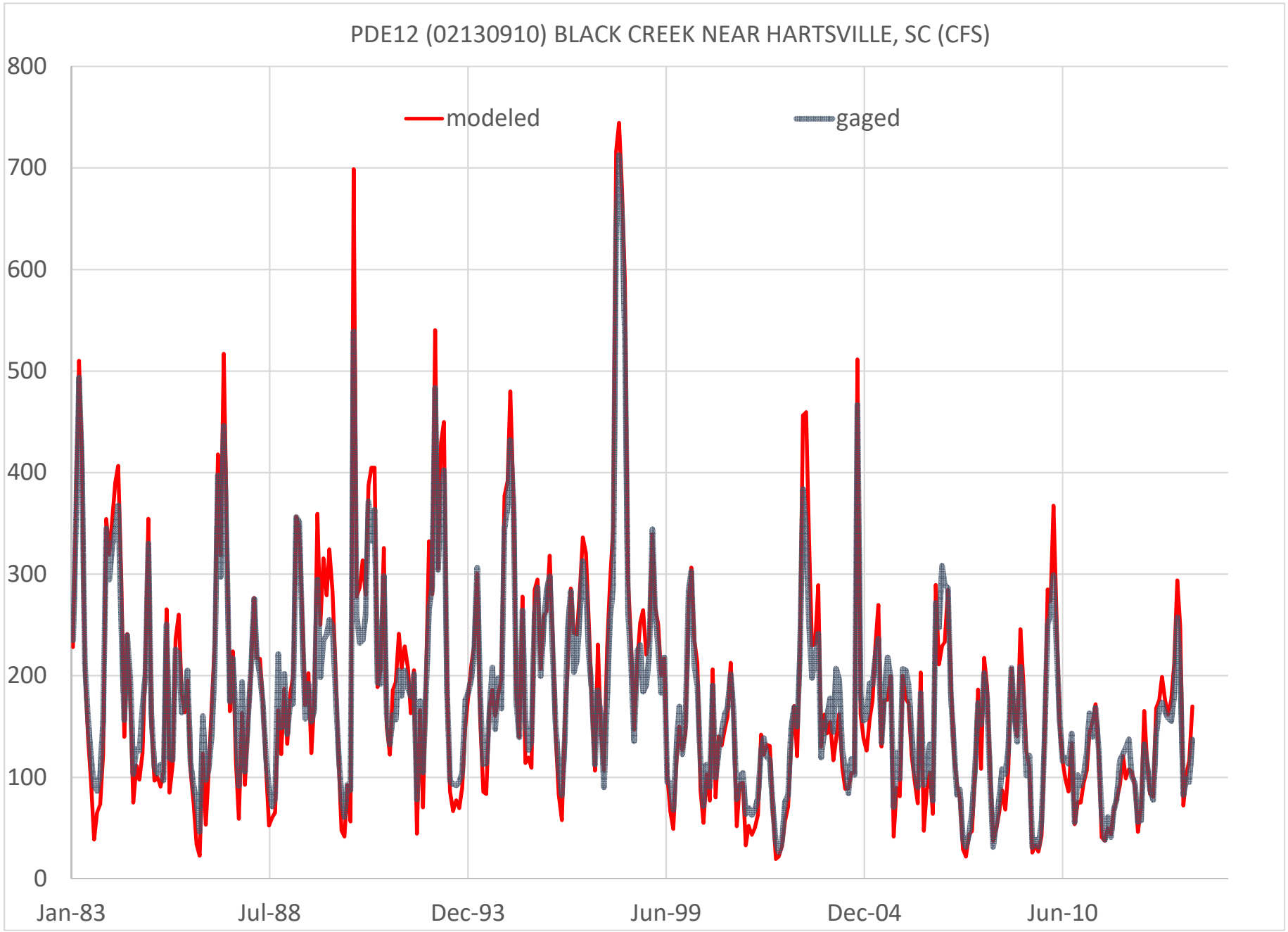

PDE10 (02130840) BLACK CREEK BELOW CHESTERFIELD, SC
Monthly Flow Percentiles (CFS)
180
160
140
120
100
80
60
40
20
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

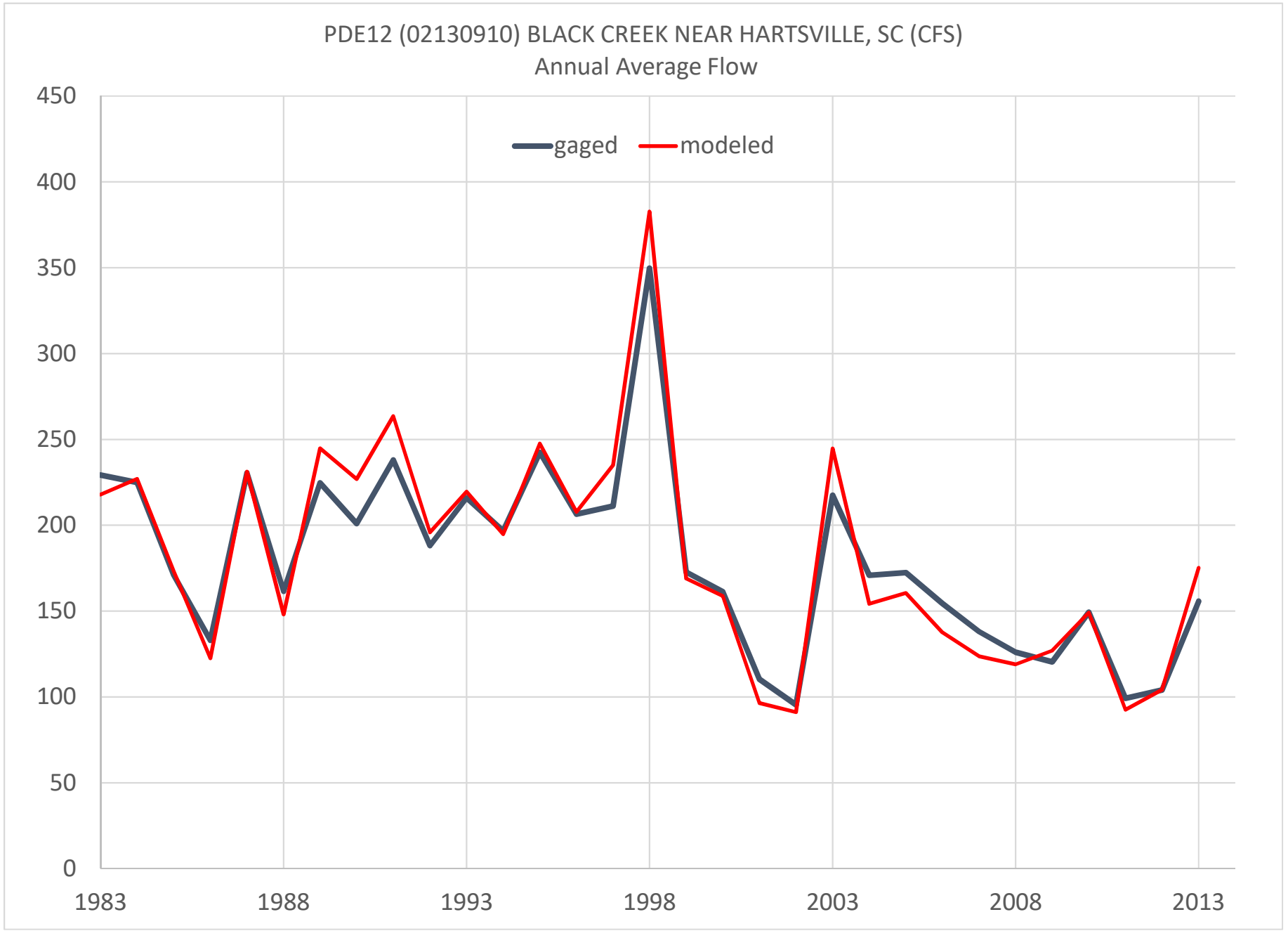

PDE11 (02130900) BLACK CREEK NEAR MCBEE, SC (CFS)
modeled
gaged
600
500
400
300
200
100
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

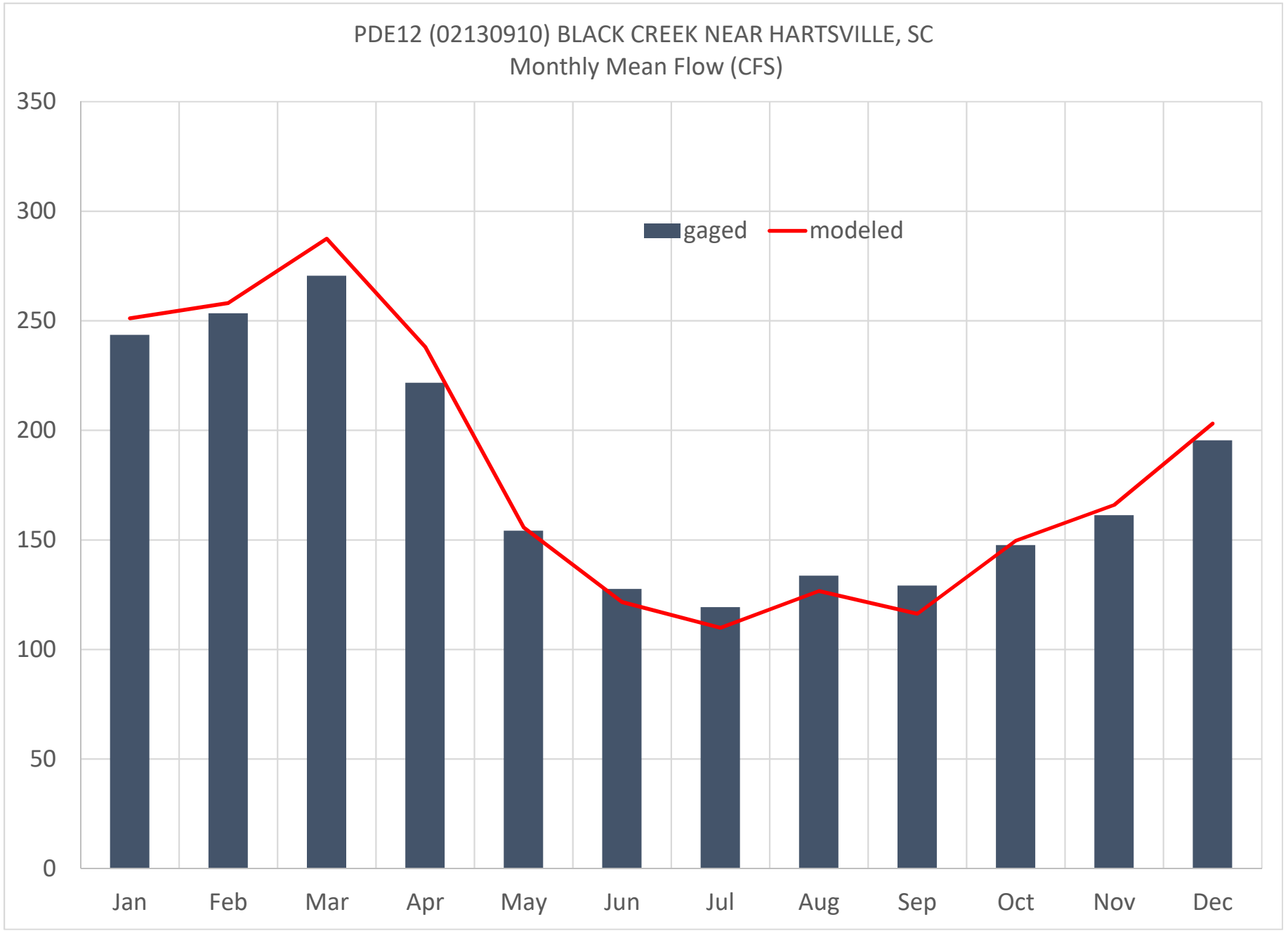

PDE11 (02130900) BLACK CREEK NEAR MCBEE, SC (CFS)
Annual Average Flow
gaged
modeled
300
250
200
150
100
50
0
1983
1988
1993
1998
2003
2008
2013

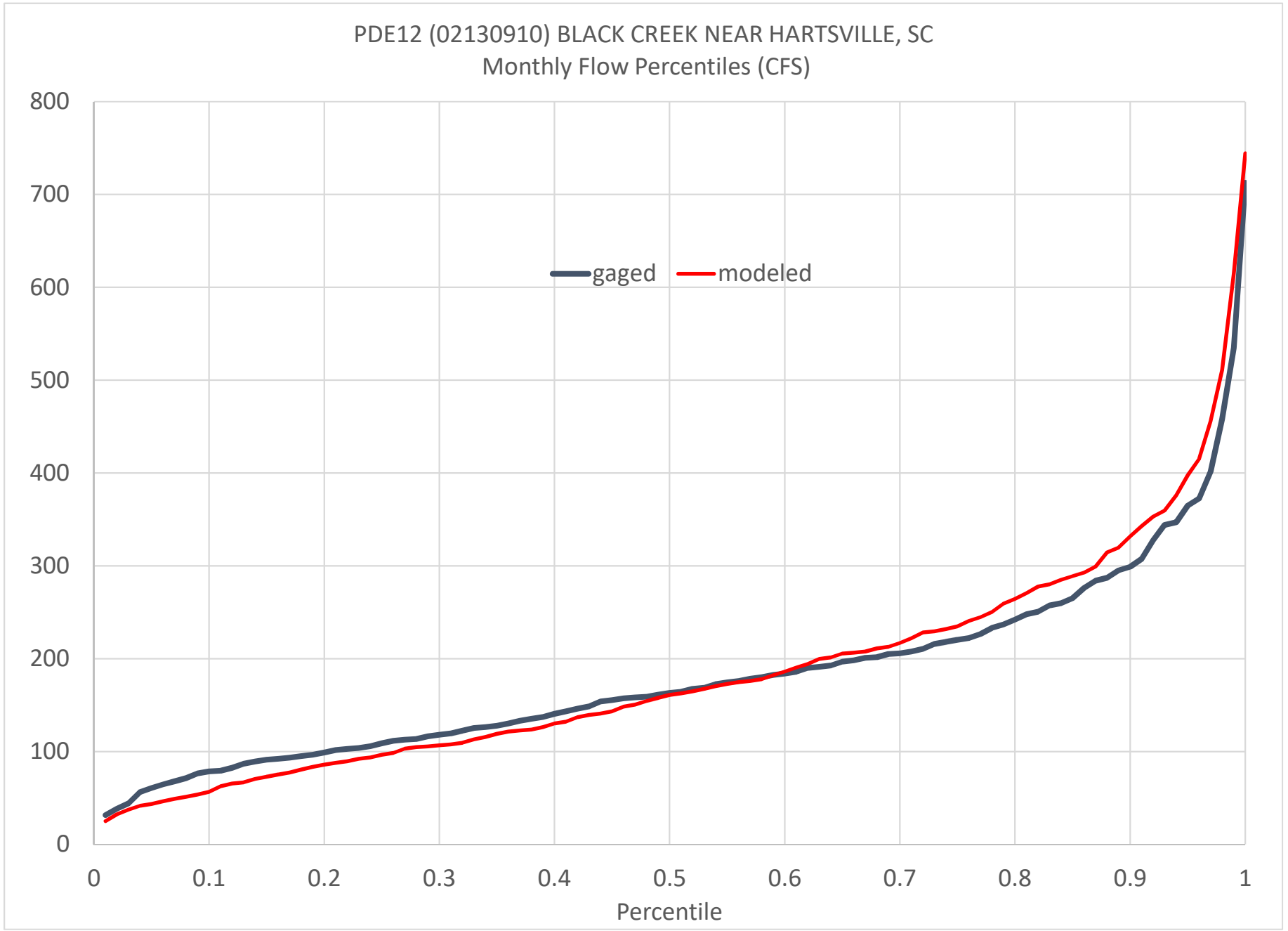

PDE11 (02130900) BLACK CREEK NEAR MCBEE, SC
Monthly Mean Flow (CFS)
250
200
150
100
50
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

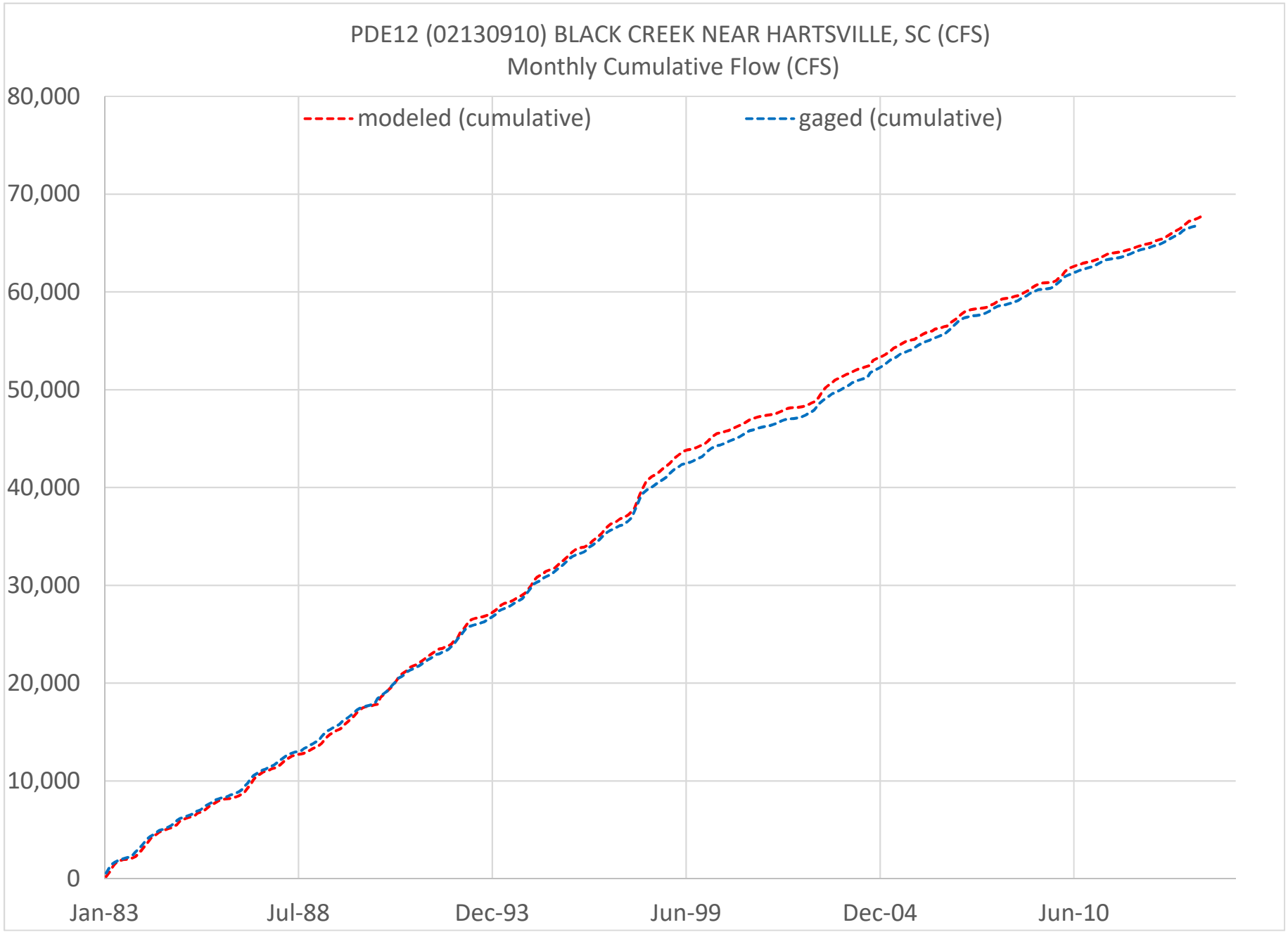

PDE11 (02130900) BLACK CREEK NEAR MCBEE, SC
Monthly Flow Percentiles (CFS)
600
500
400
300
200
100
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

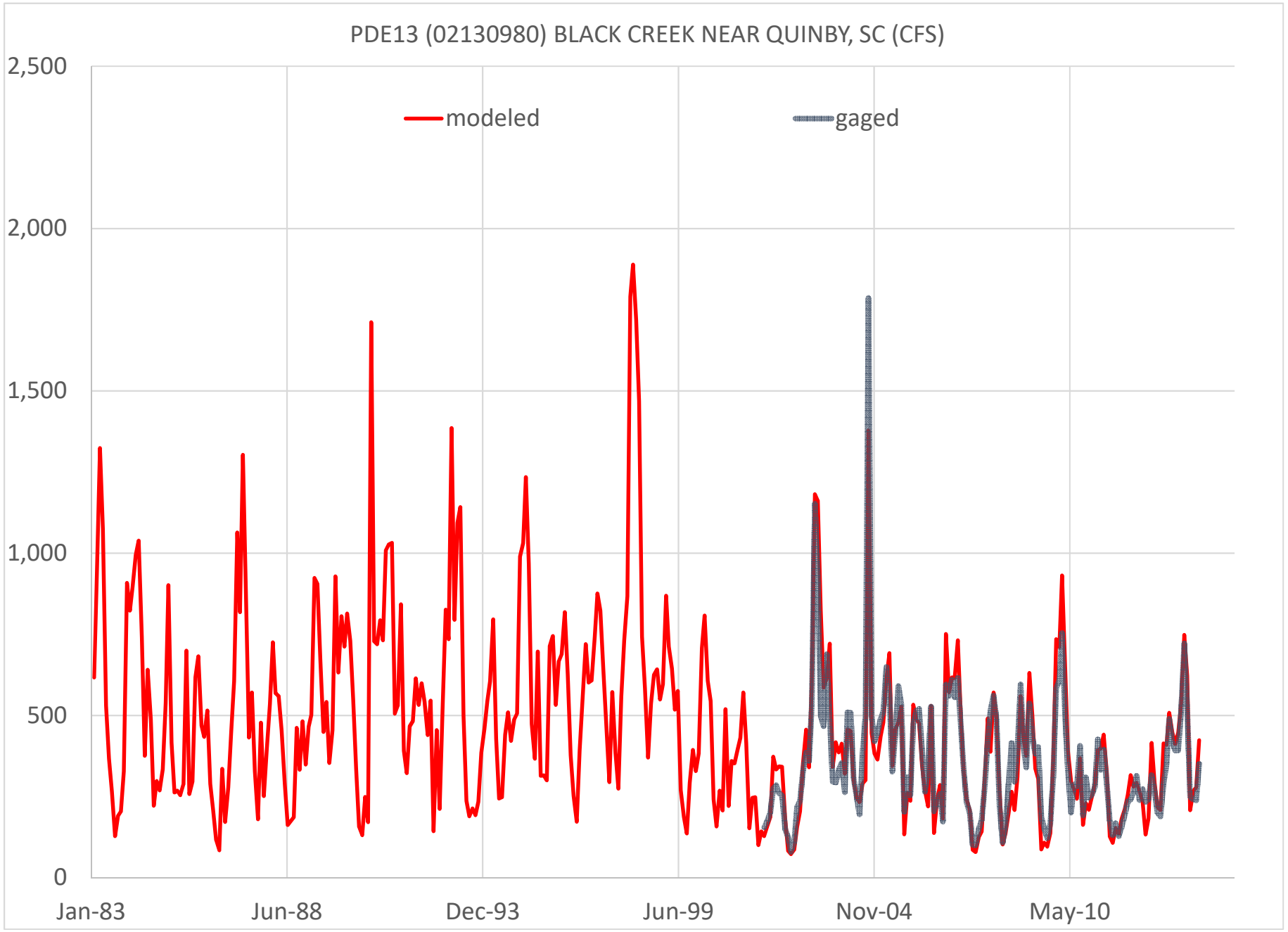

PDE12 (02130910) BLACK CREEK NEAR HARTSVILLE, SC (CFS)
modeled
gaged
800
700
600
500
400
300
200
100
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

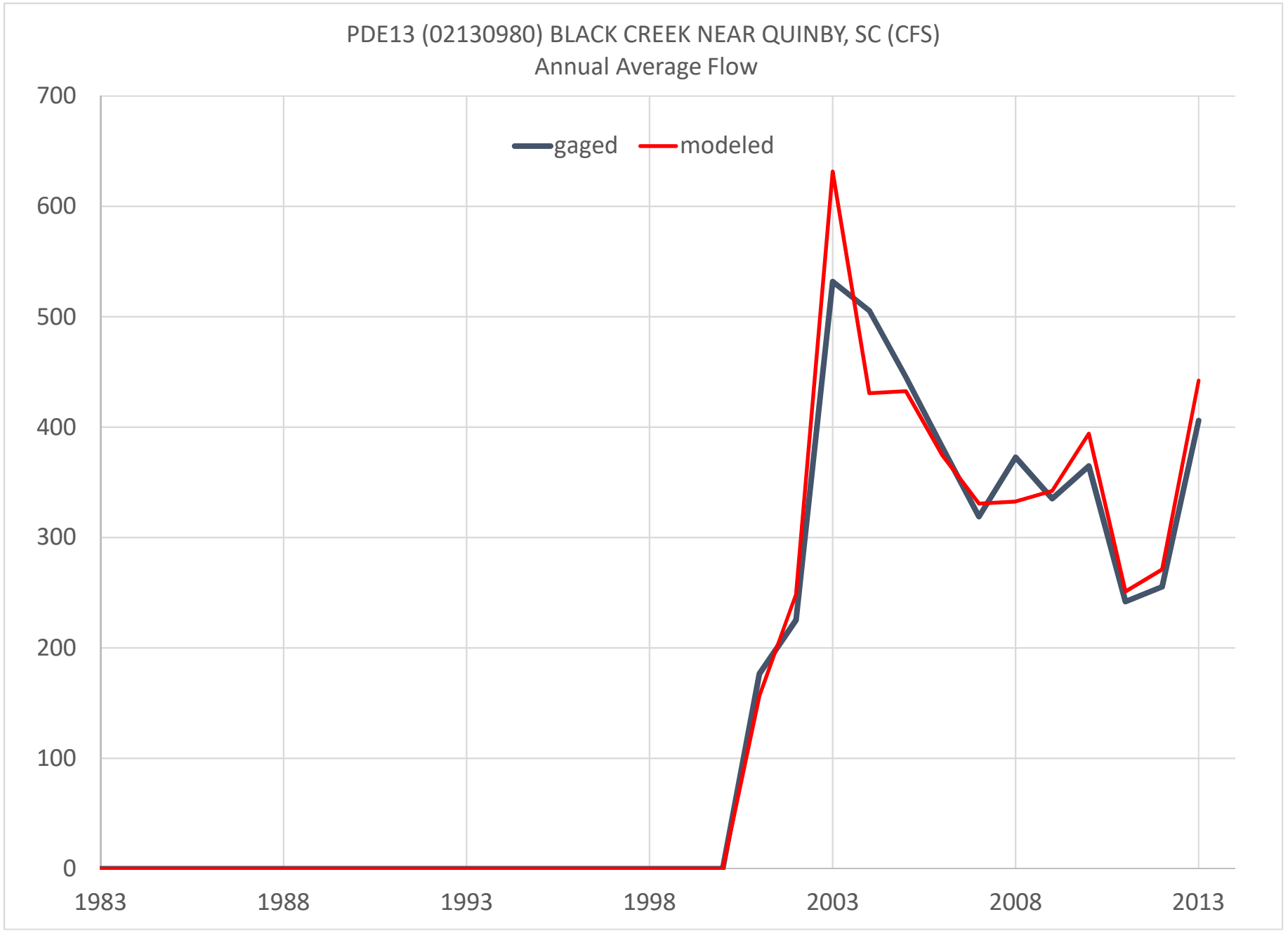

PDE12 (02130910) BLACK CREEK NEAR HARTSVILLE, SC (CFS)
Annual Average Flow
gaged
modeled
450
400
350
300
250
200
150
100
50
0
1983
1988
1993
1998
2003
2008
2013

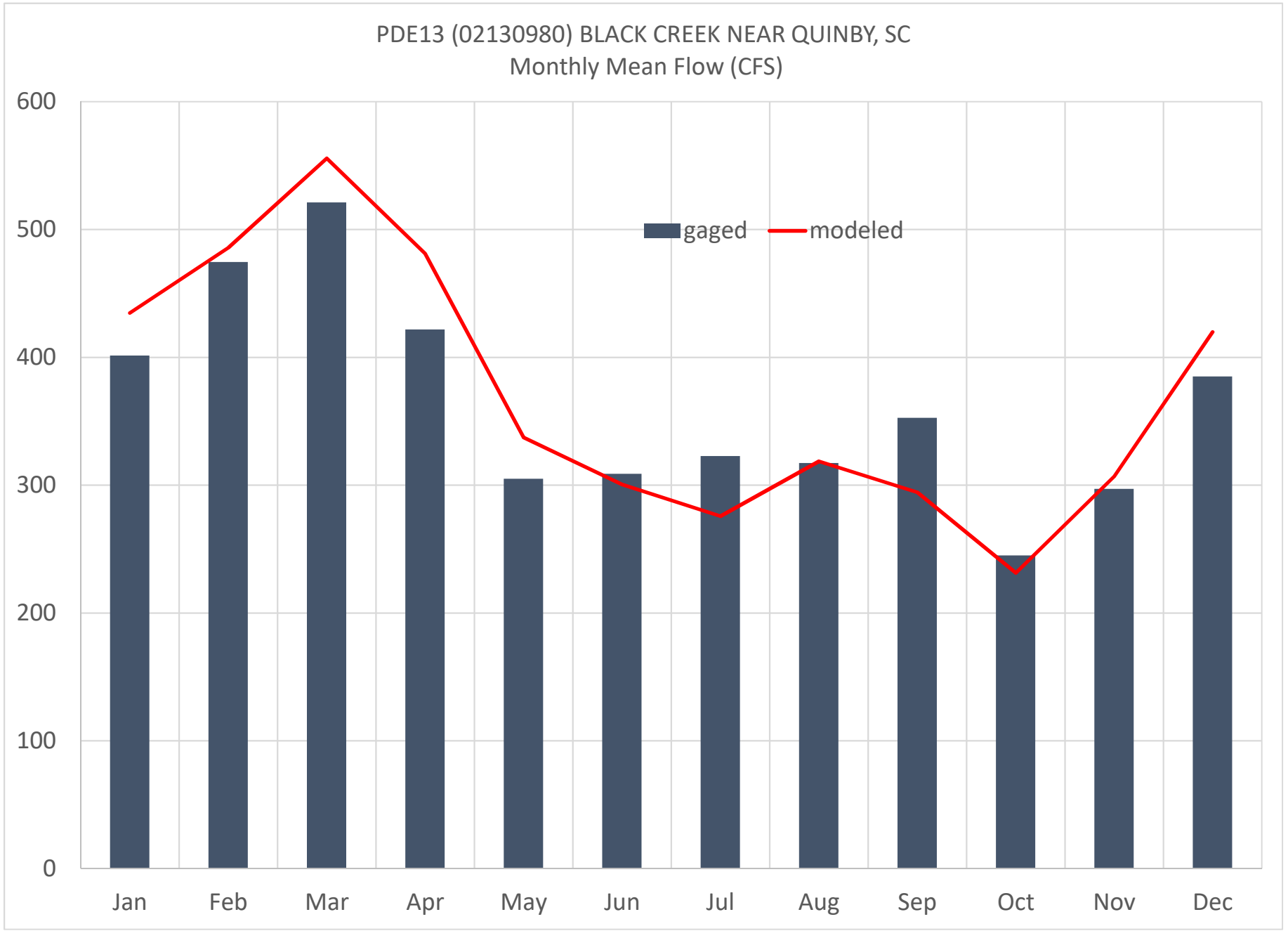

PDE12 (02130910) BLACK CREEK NEAR HARTSVILLE, SC
Monthly Mean Flow (CFS)
350
300
250
200
150
100
50
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

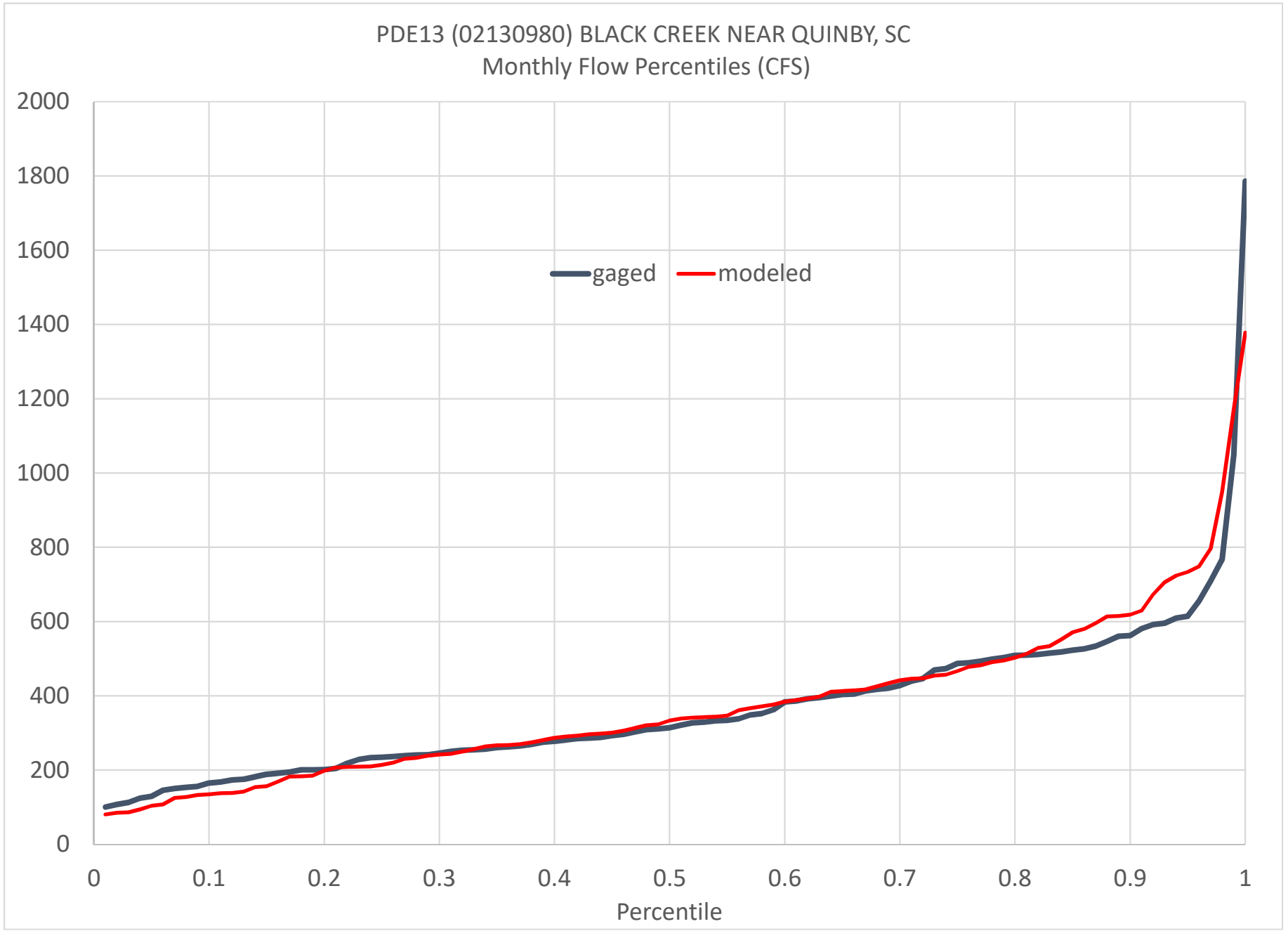

PDE12 (02130910) BLACK CREEK NEAR HARTSVILLE, SC
Monthly Flow Percentiles (CFS)
800
700
600
500
400
300
200
100
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

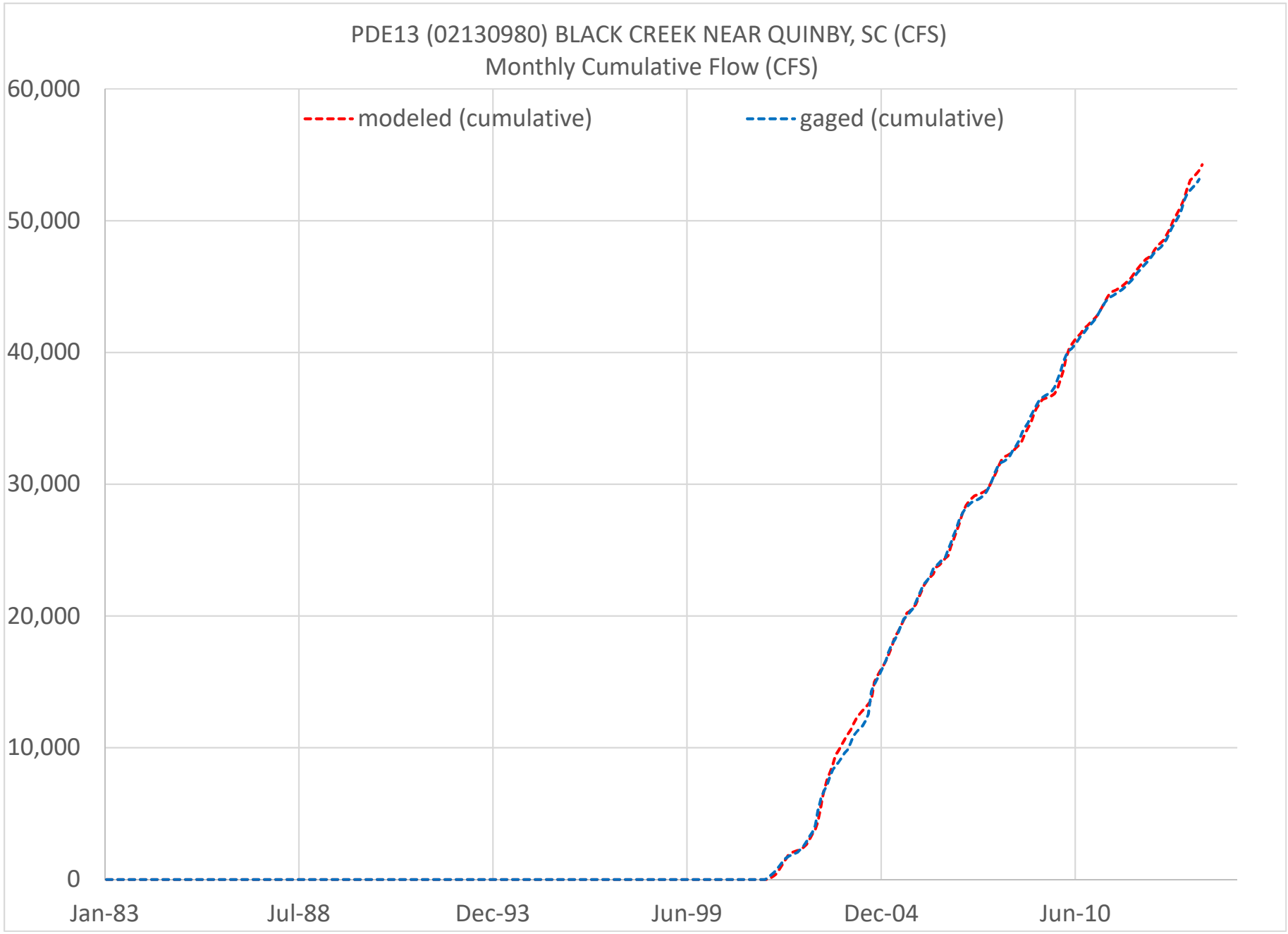

PDE12 (02130910) BLACK CREEK NEAR HARTSVILLE, SC (CFS)
Monthly Cumulative Flow (CFS)
modeled (cumulative)
gaged (cumulative)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

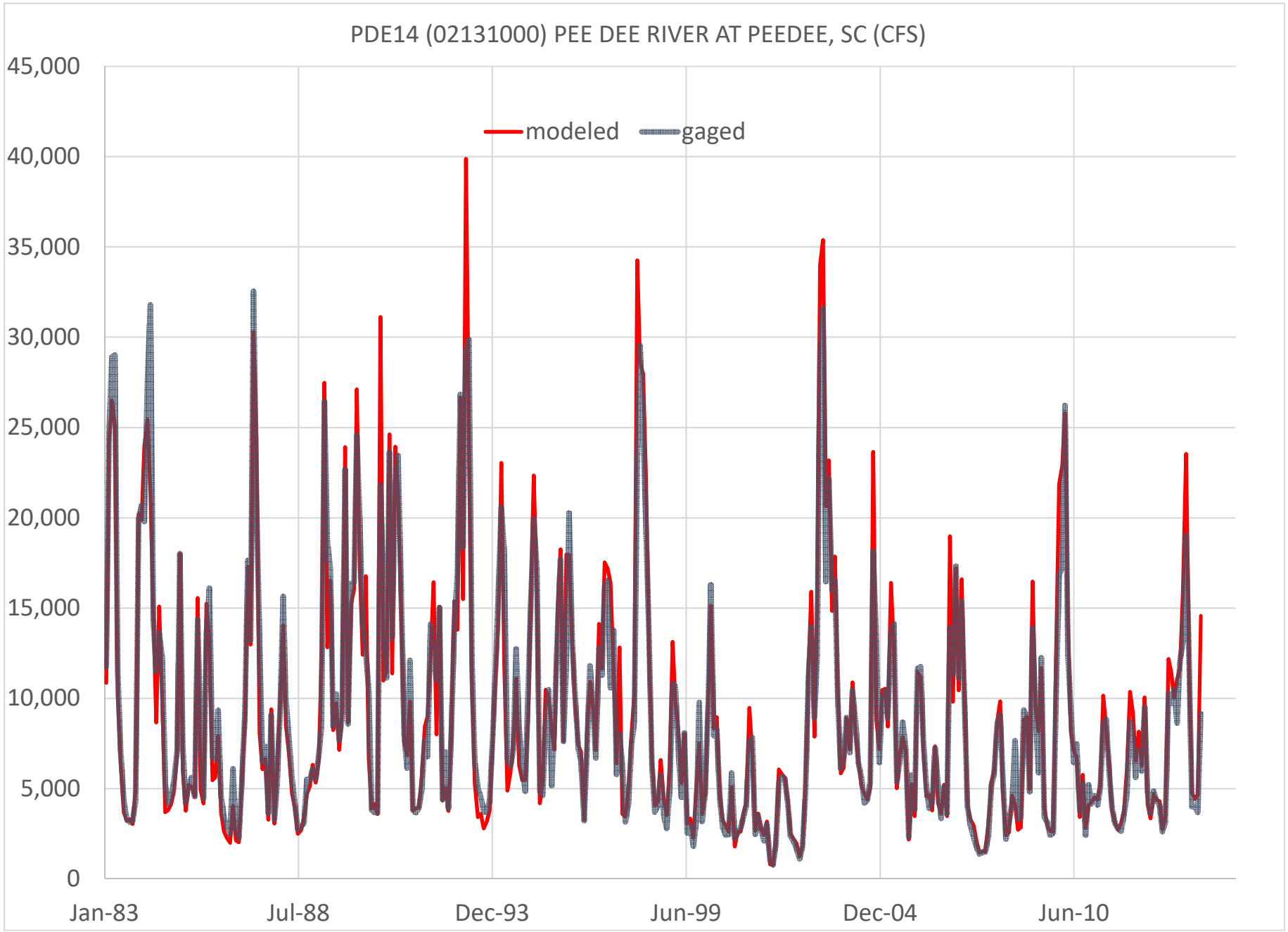

PDE13 (02130980) BLACK CREEK NEAR QUINBY, SC (CFS)
modeled
gaged
2,500
2,000
1,500
1,000
500
0
Jan-83
Jun-88
Dec-93
Jun-99
Nov-04
May-10

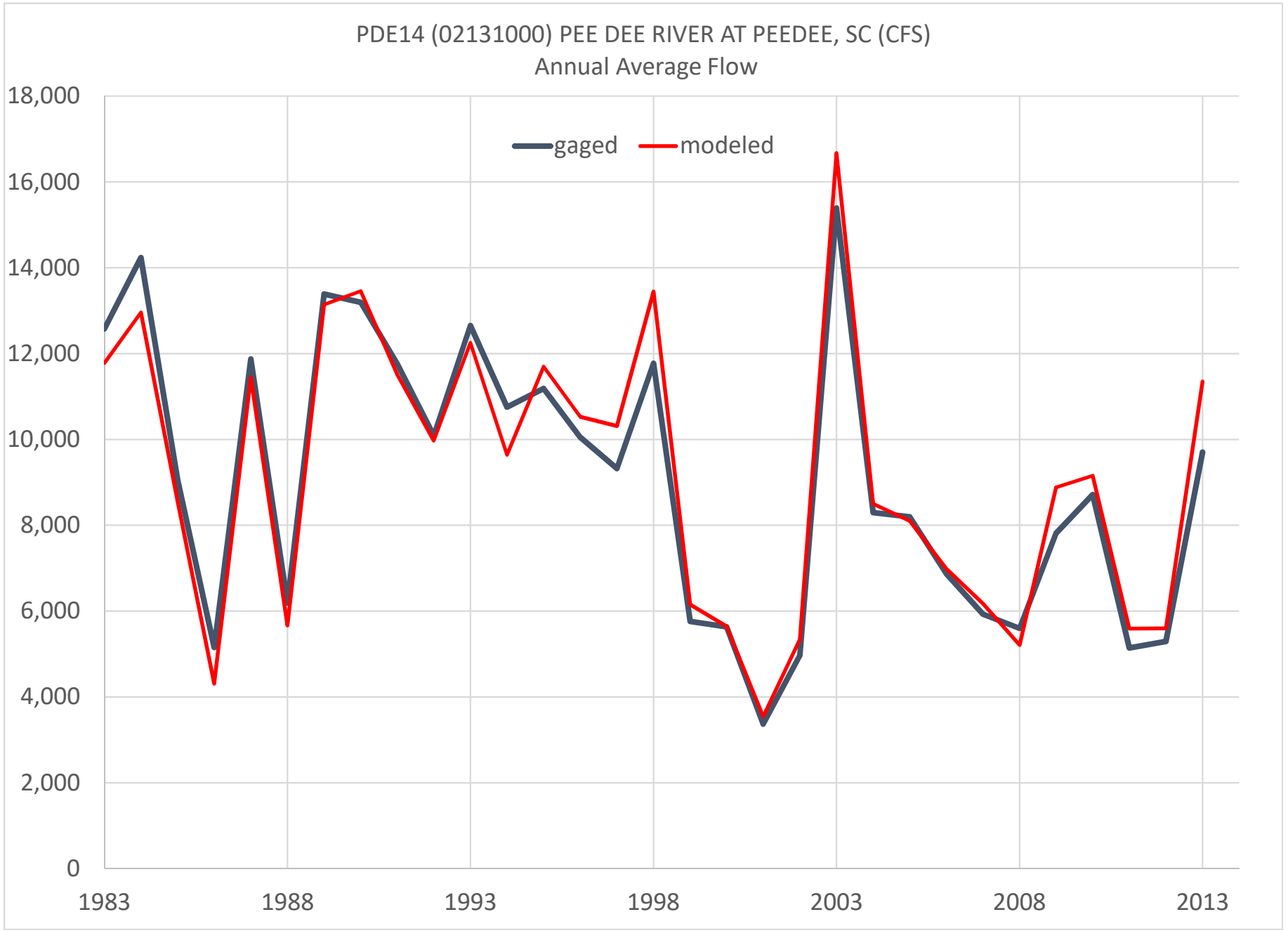

PDE13 (02130980) BLACK CREEK NEAR QUINBY, SC (CFS)
Annual Average Flow
gaged
modeled
700
600
500
400
300
200
100
0
1983
1988
1993
1998
2003
2008
2013

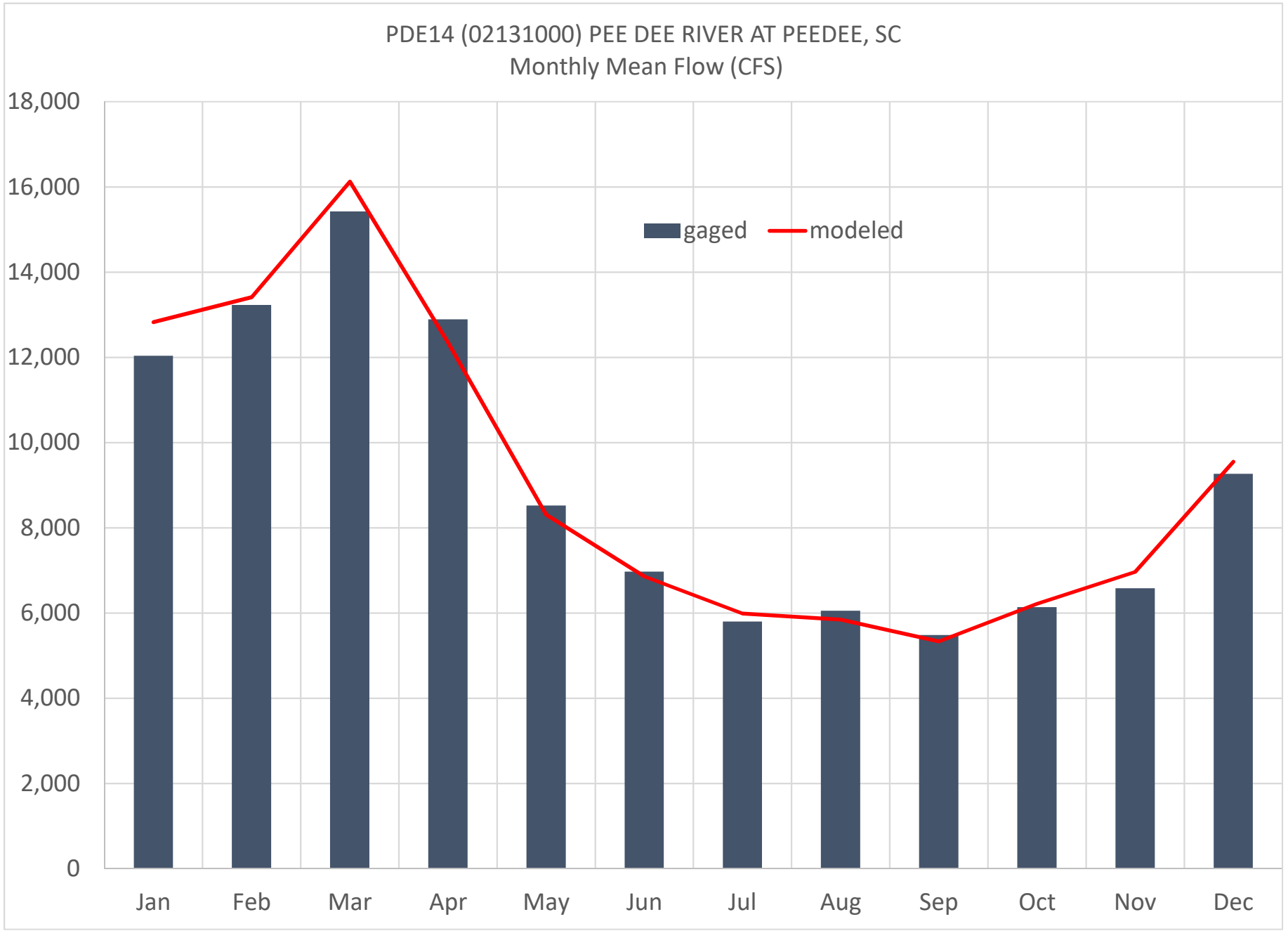

PDE13 (02130980) BLACK CREEK NEAR QUINBY, SC
Monthly Mean Flow (CFS)
600
500
400
300
200
100
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

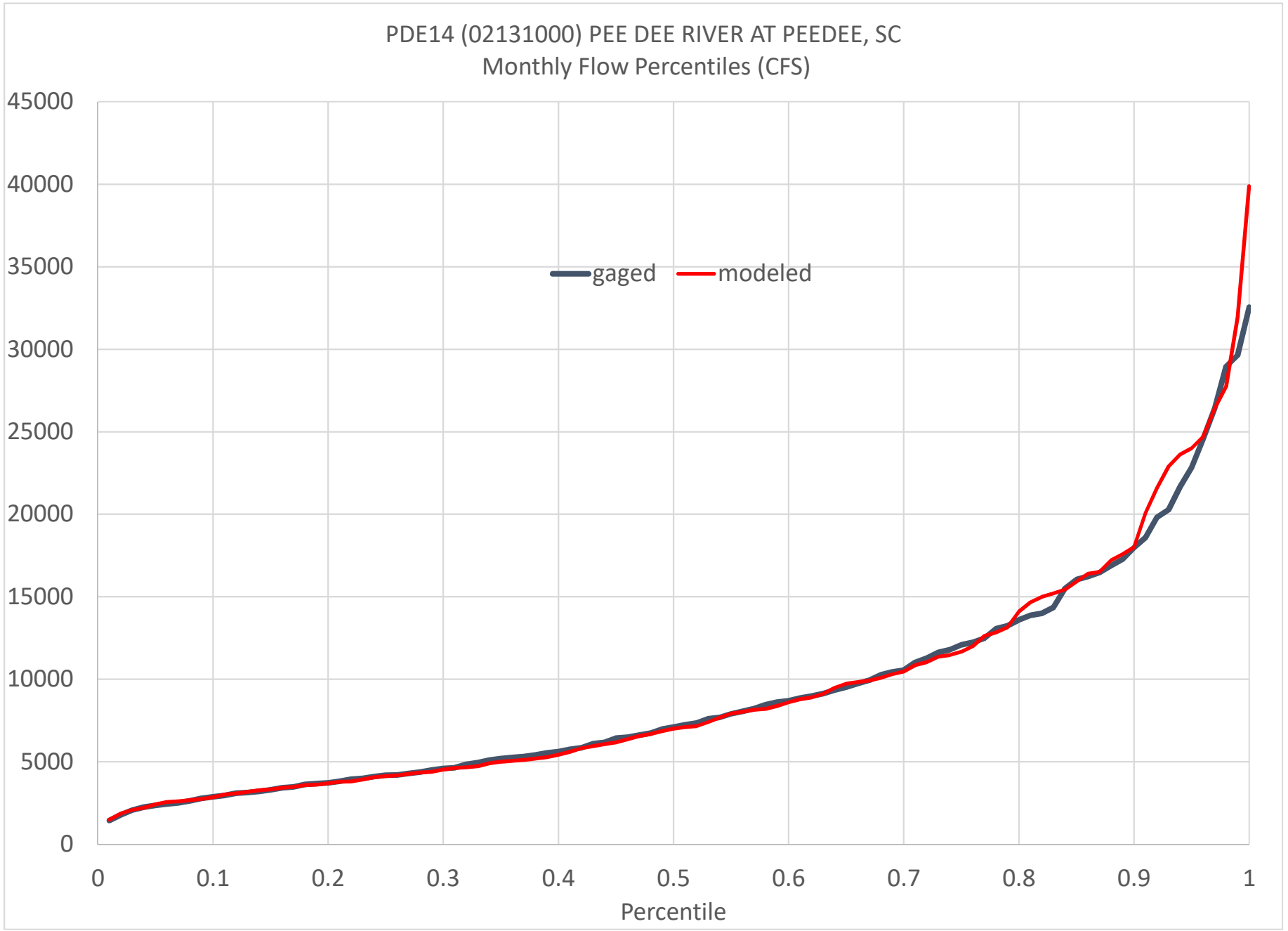

PDE13 (02130980) BLACK CREEK NEAR QUINBY, SC
Monthly Flow Percentiles (CFS)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

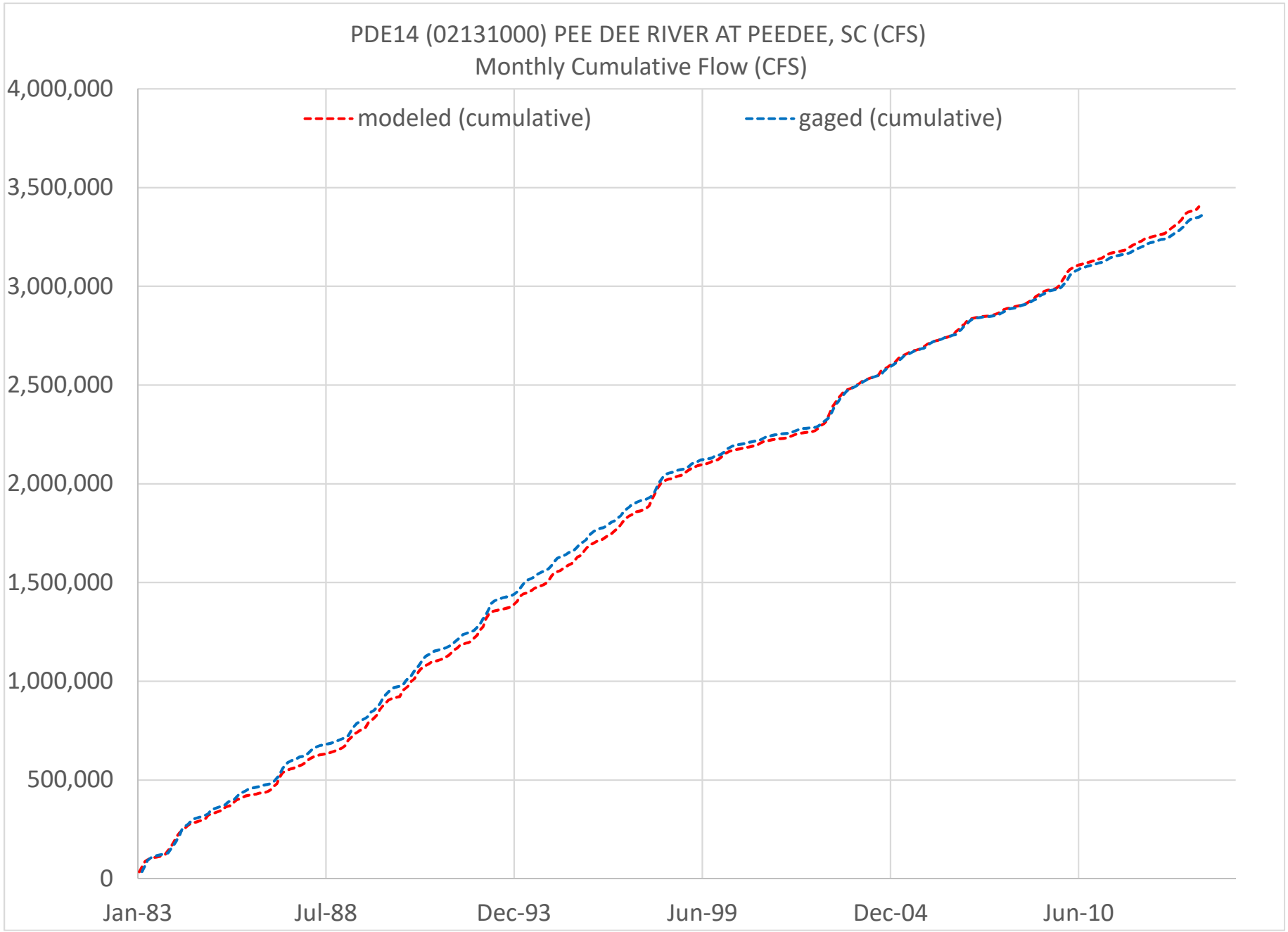

PDE13 (02130980) BLACK CREEK NEAR QUINBY, SC (CFS)
Monthly Cumulative Flow (CFS)
modeled (cumulative)
gaged (cumulative)
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

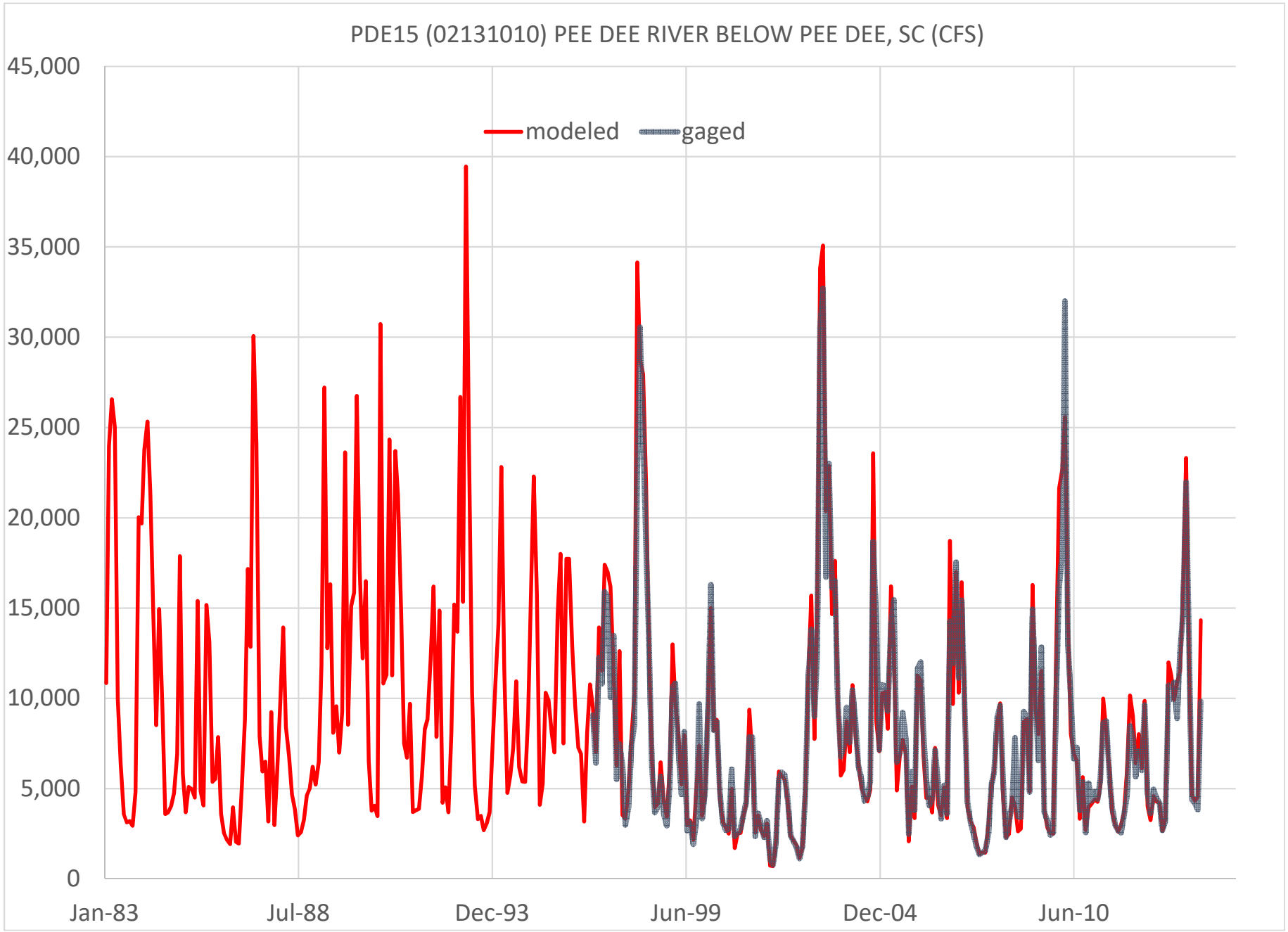

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC (CFS)
modeled
gaged
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

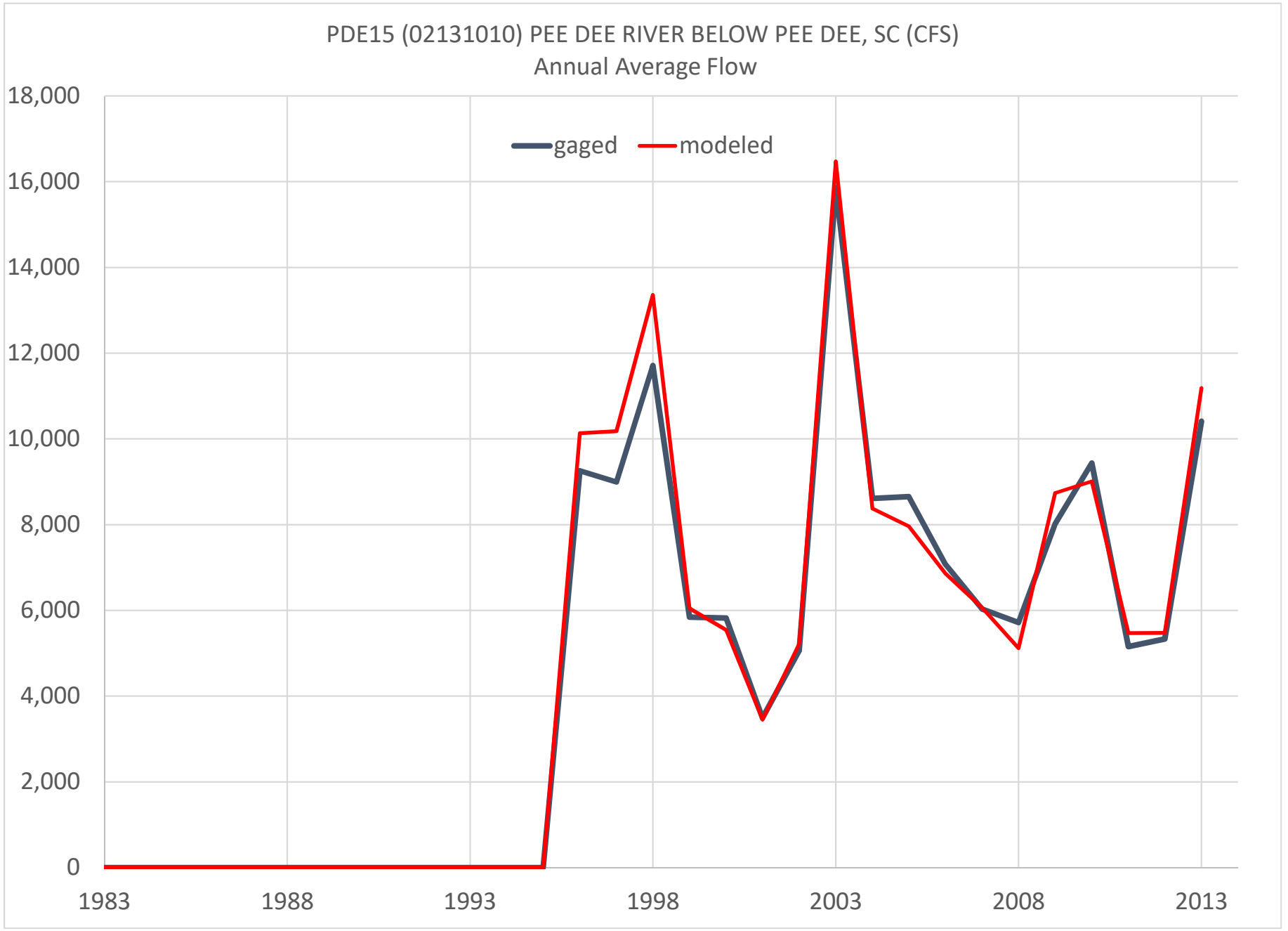

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC (CFS)
Annual Average Flow
gaged
modeled
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1983
1988
1993
1998
2003
2008
2013

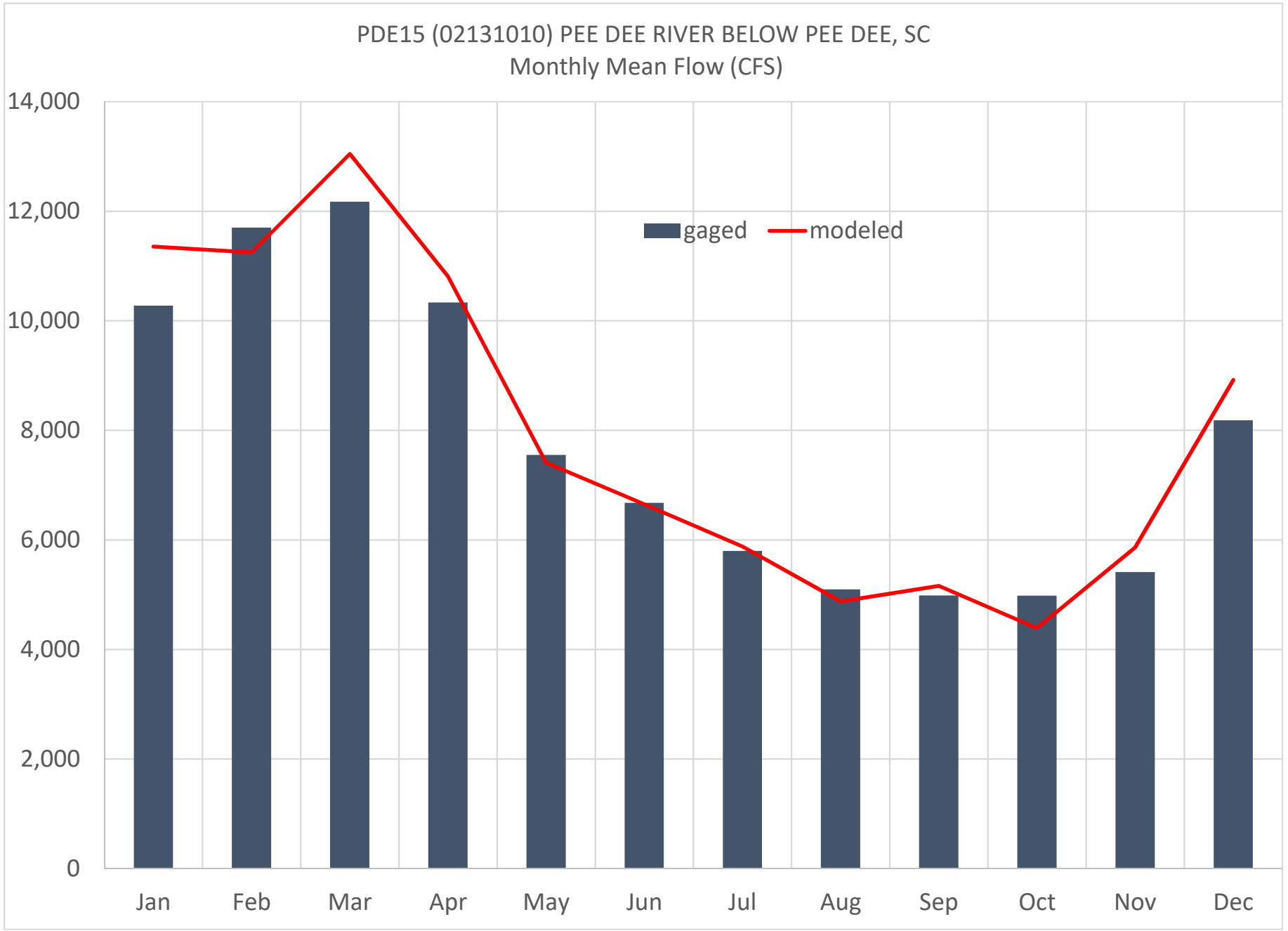

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC
Monthly Mean Flow (CFS)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

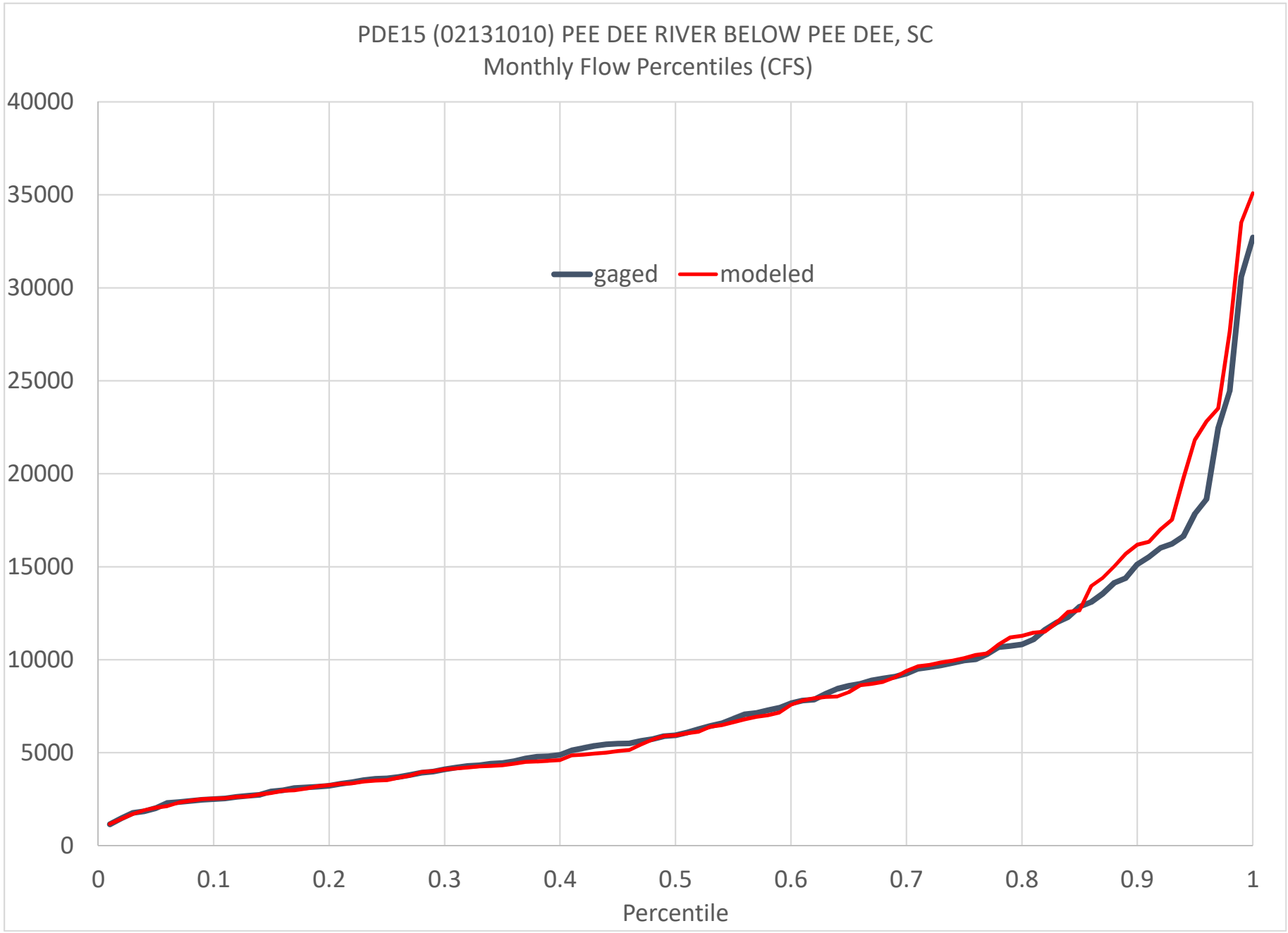

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC
Monthly Flow Percentiles (CFS)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

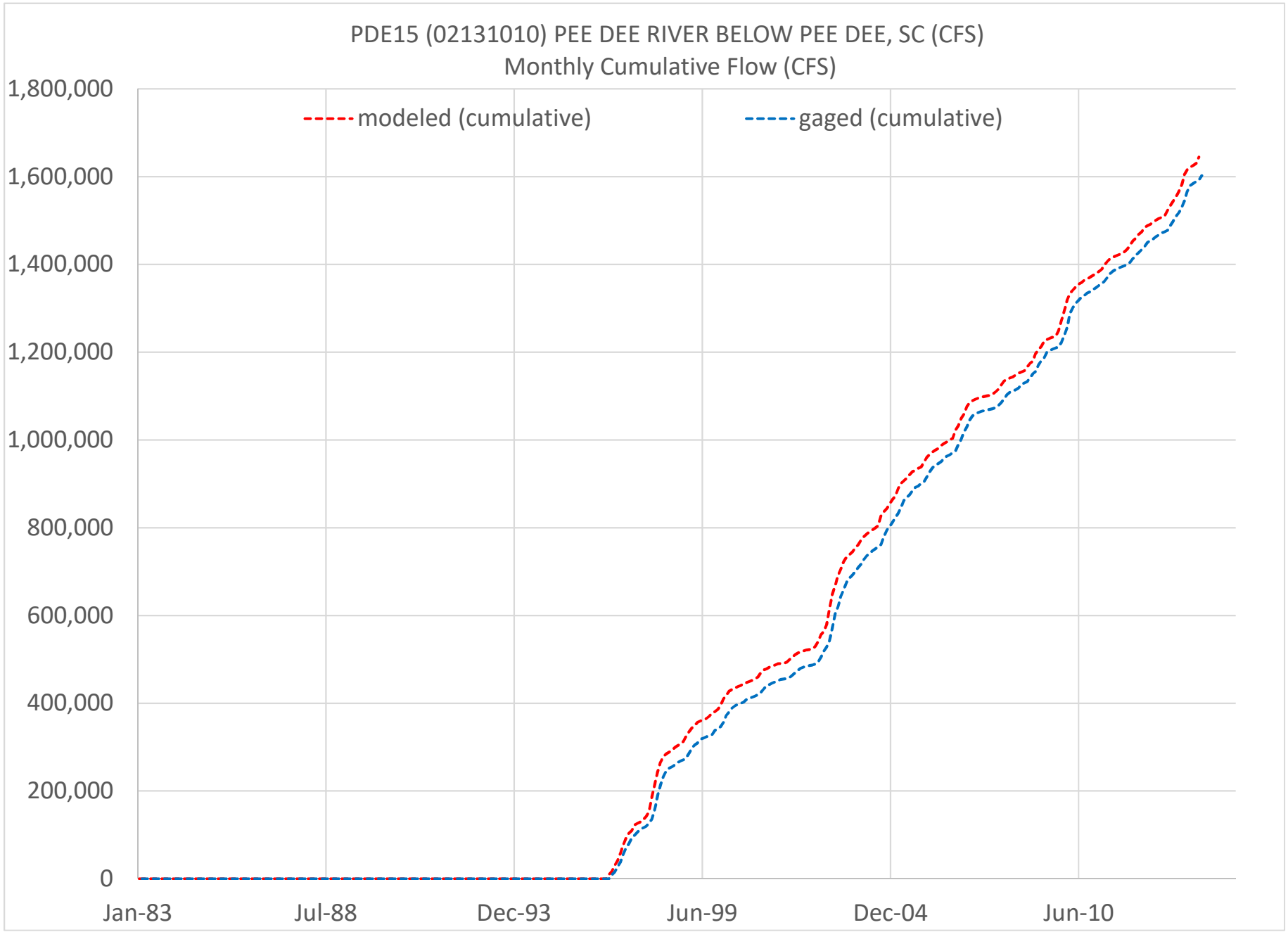

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC (CFS)
Monthly Cumulative Flow (CFS)
modeled (cumulative)
gaged (cumulative)
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

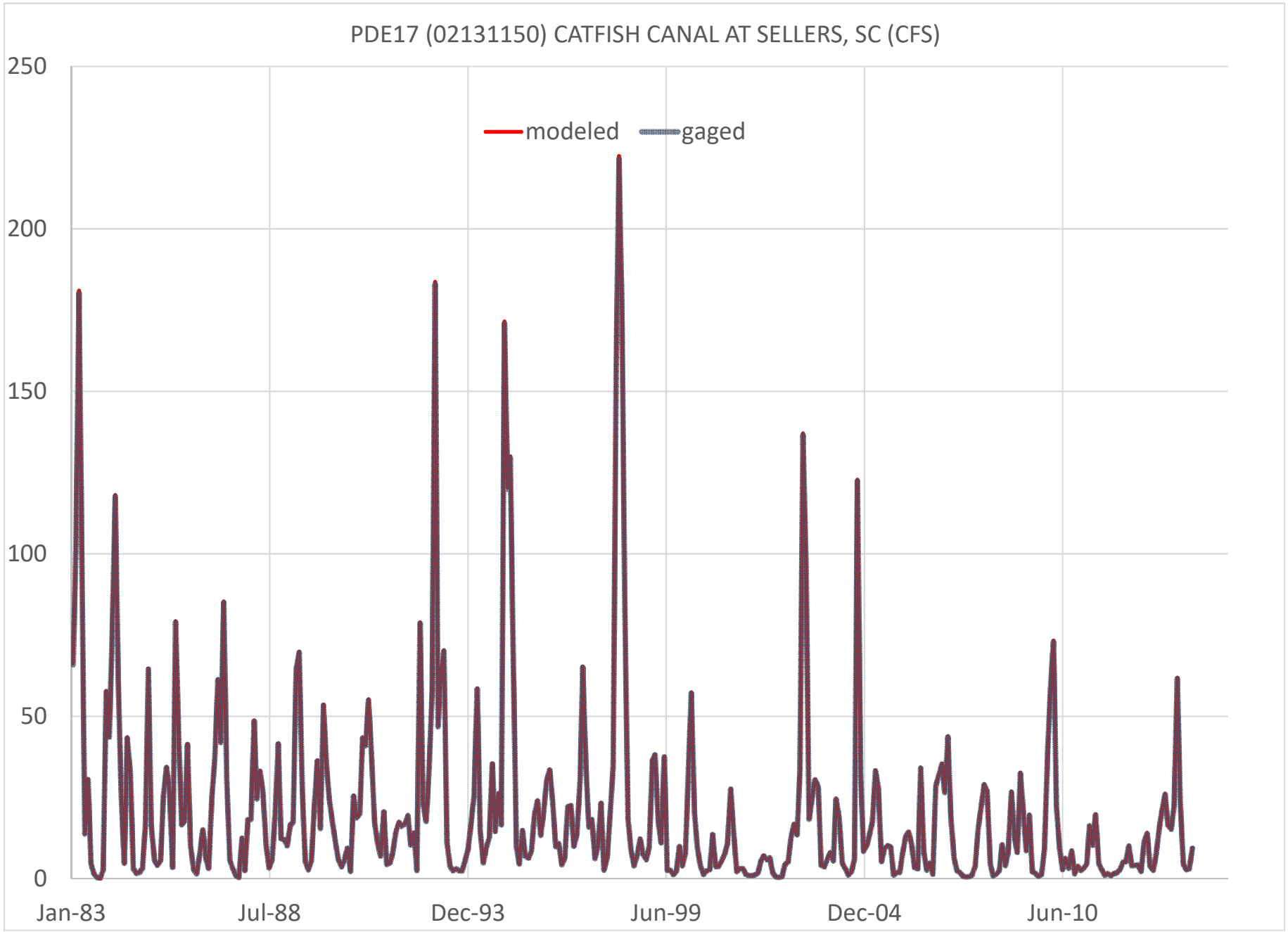

PDE15 (02131010) PEE DEE RIVER BELOW PEE DEE, SC (CFS)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
modeled
gaged
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

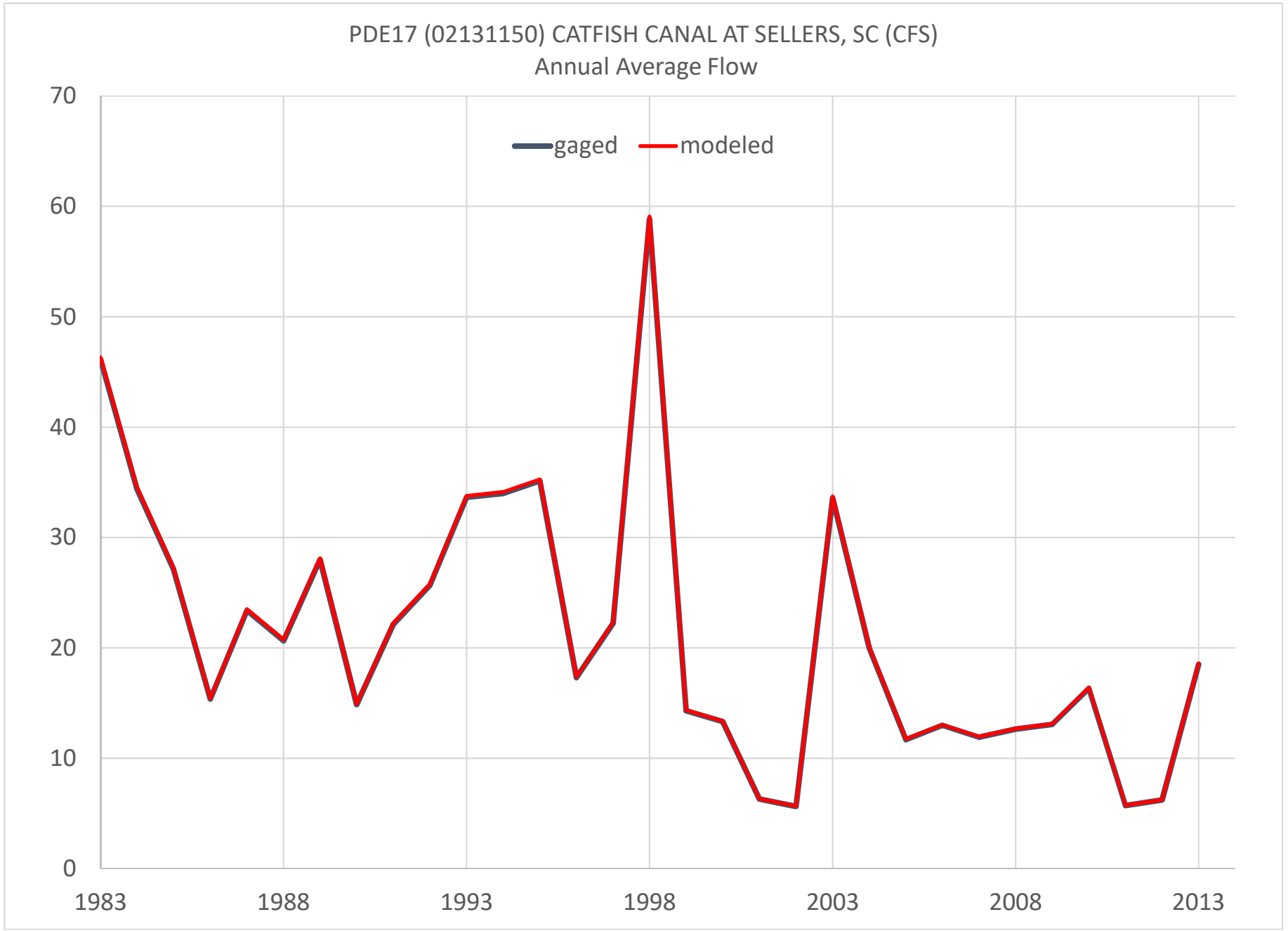

PDE15 (02131010) PEE DEE RIVER BELOW PEE DEE, SC (CFS)
Annual Average Flow
gaged
modeled
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1983
1988
1993
1998
2003
2008
2013

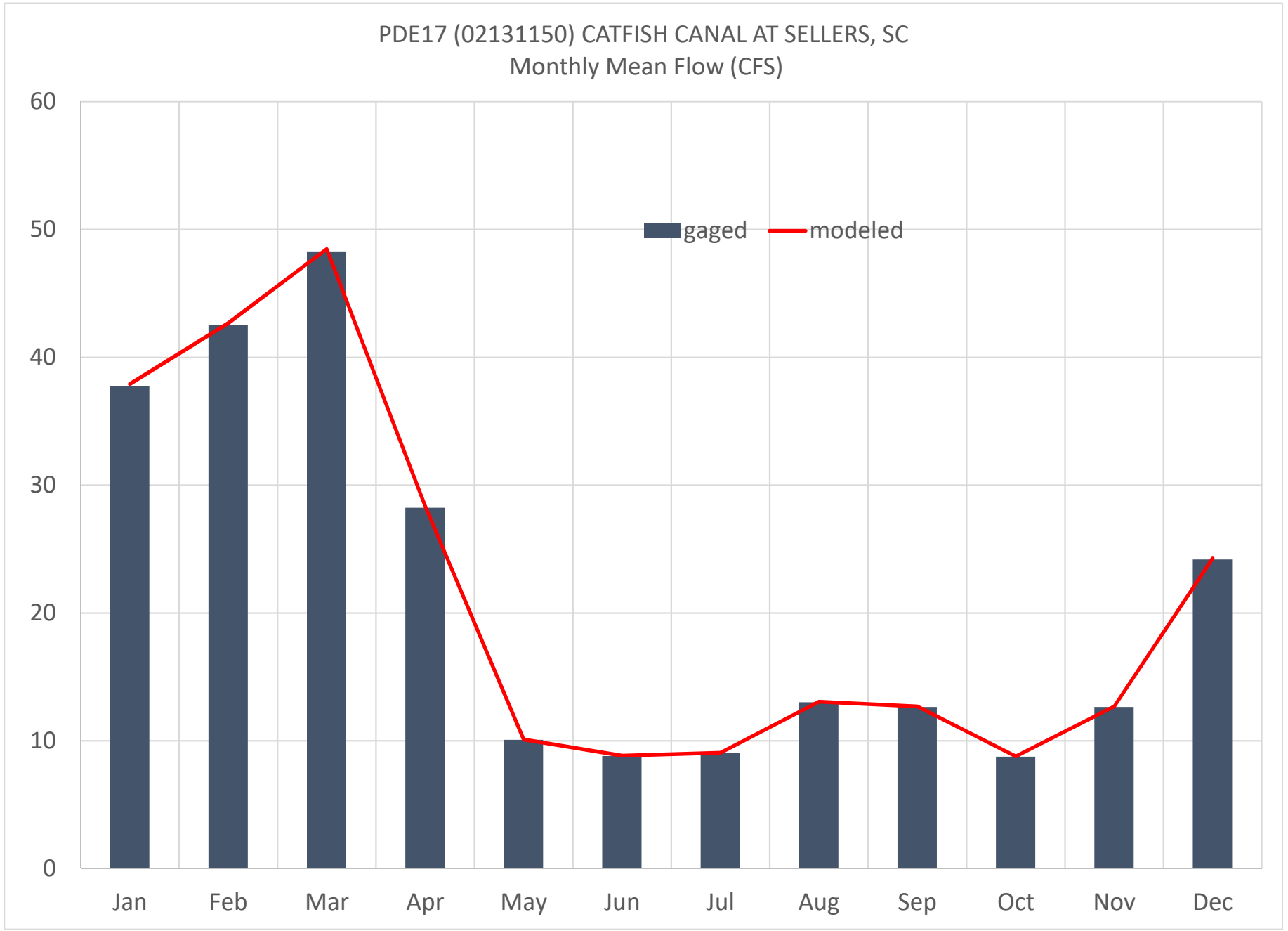

PDE15 (02131010) PEE DEE RIVER BELOW PEE DEE, SC
Monthly Mean Flow (CFS)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

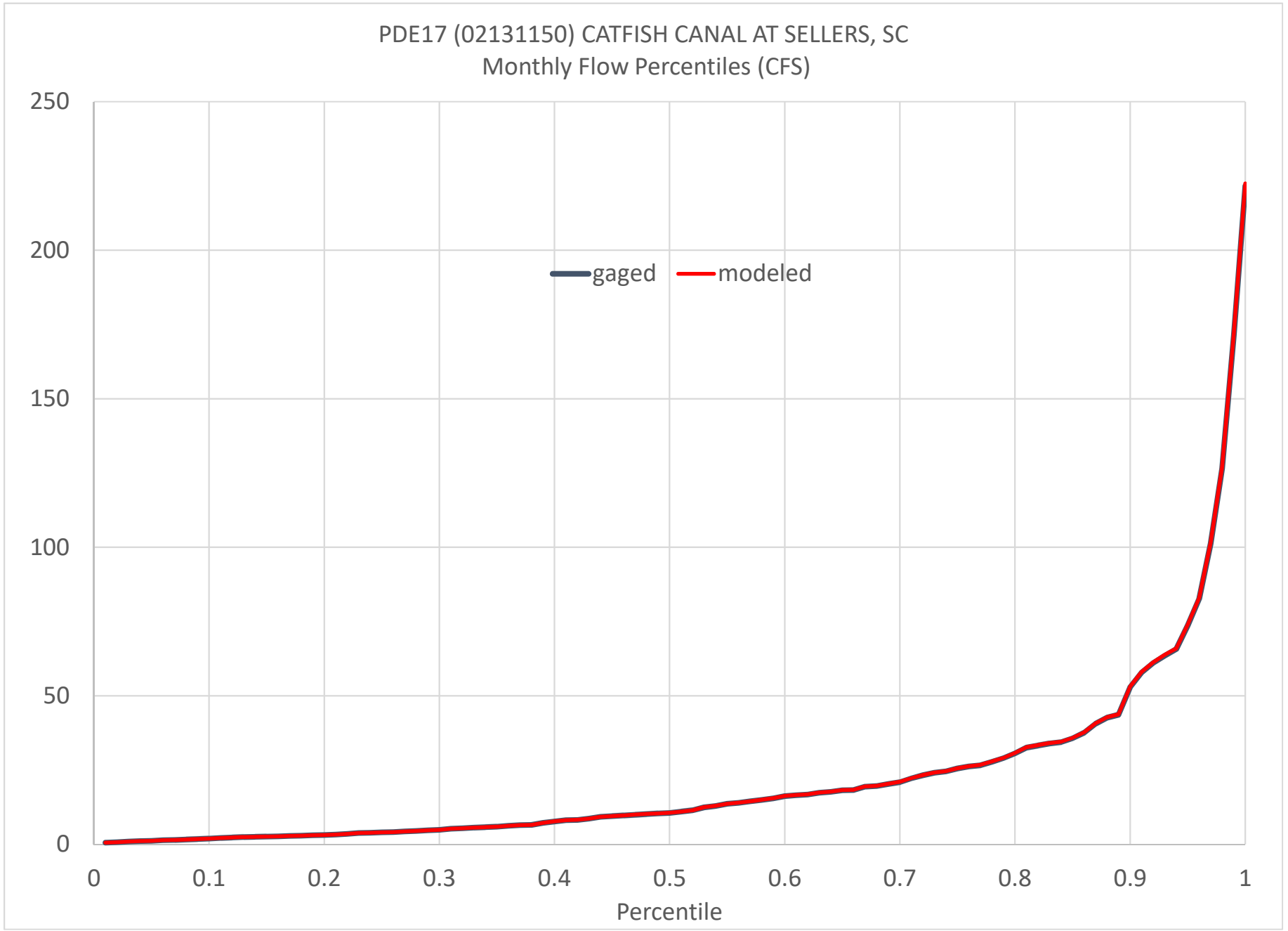

PDE15 (02131010) PEE DEE RIVER BELOW PEE DEE, SC
Monthly Flow Percentiles (CFS)
40000
35000
30000
25000
20000
15000
10000
5000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

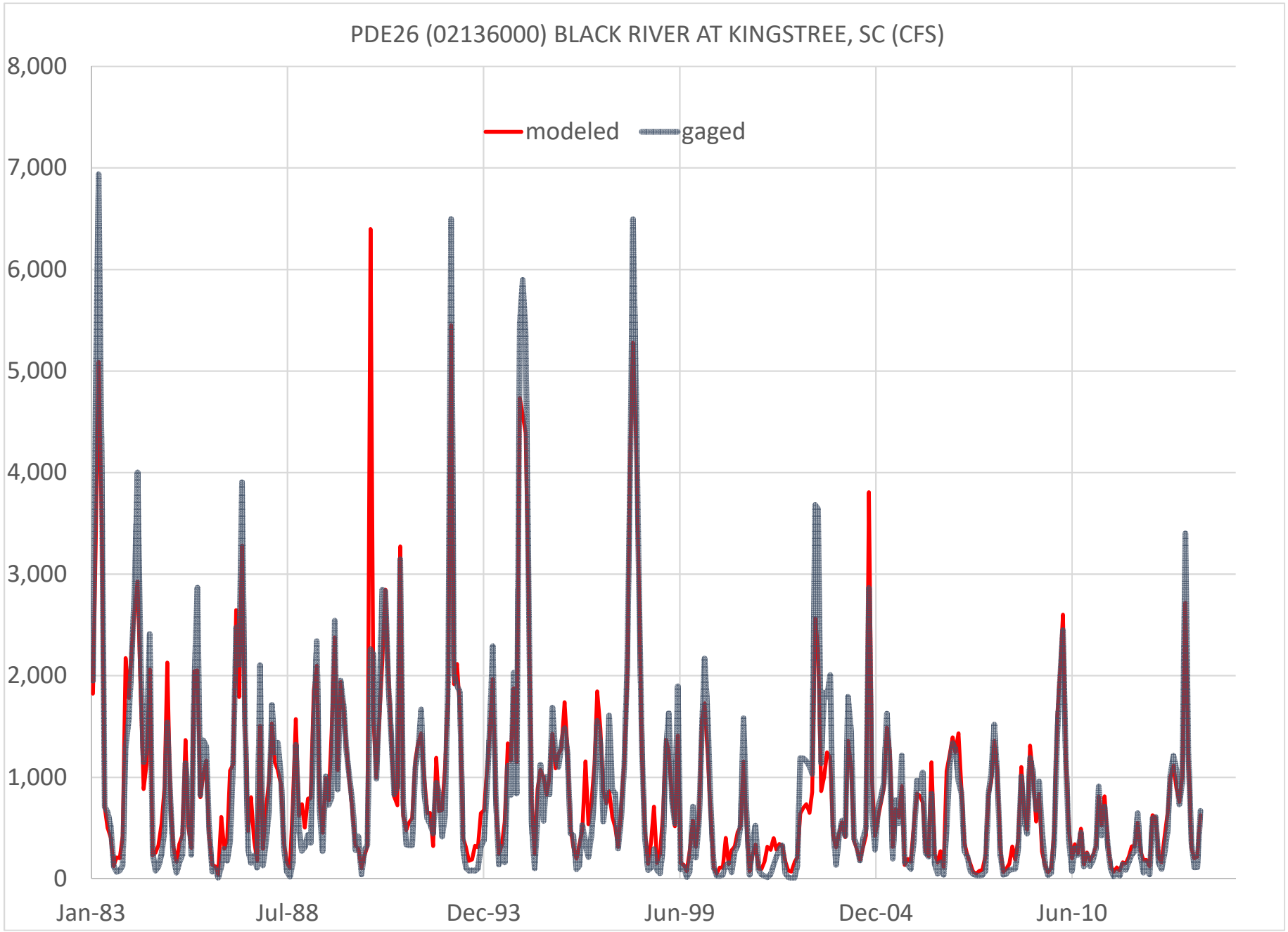

PDE15 (02131010) PEE DEE RIVER BELOW PEE DEE, SC (CFS)
Monthly Cumulative Flow (CFS)
modeled (cumulative)
gaged (cumulative)
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

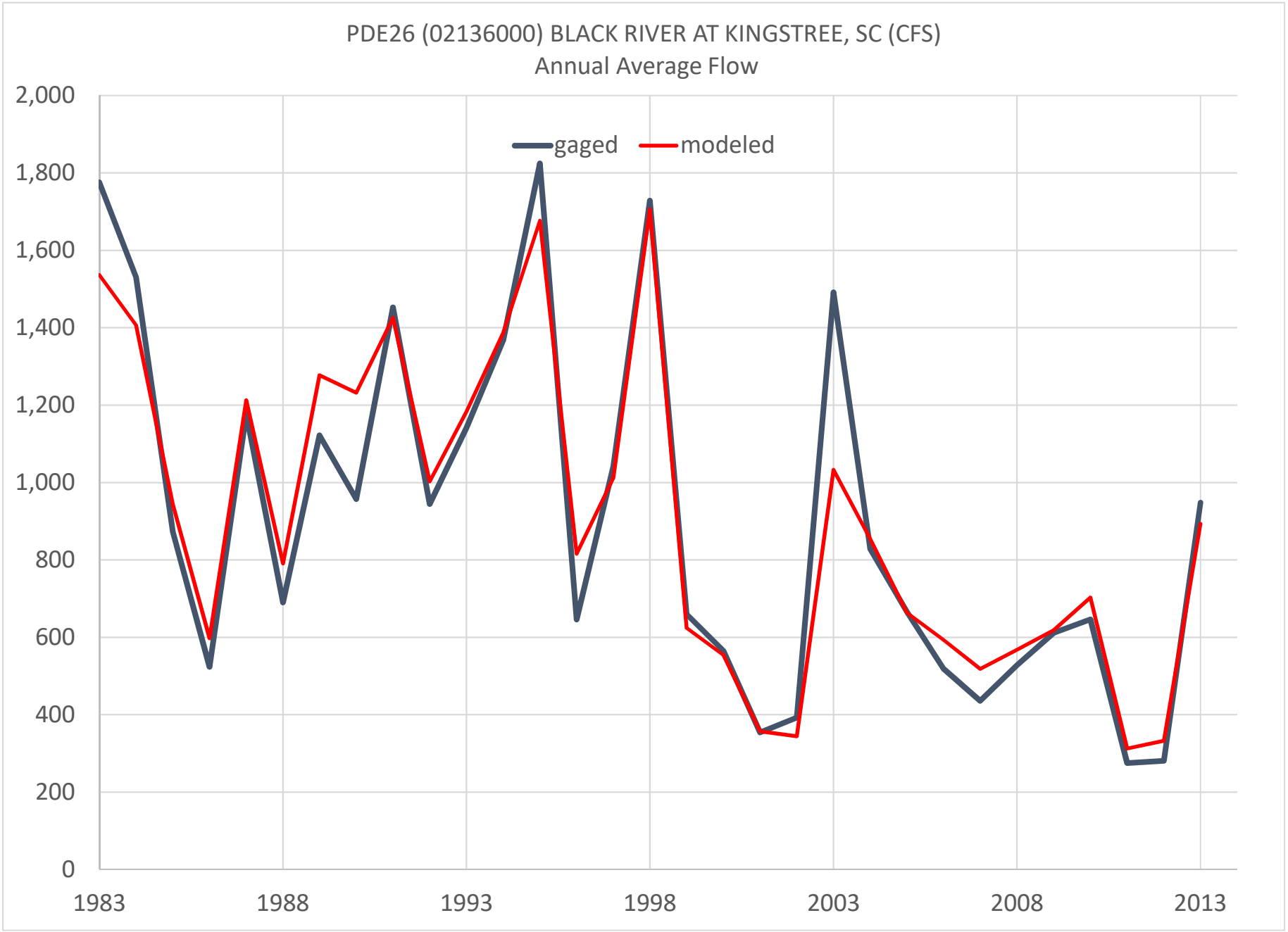

PDE17 (02131150) CATFISH CANAL AT SELLERS, SC (CFS)
250
200
150
100
50
0
modeled
gaged
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

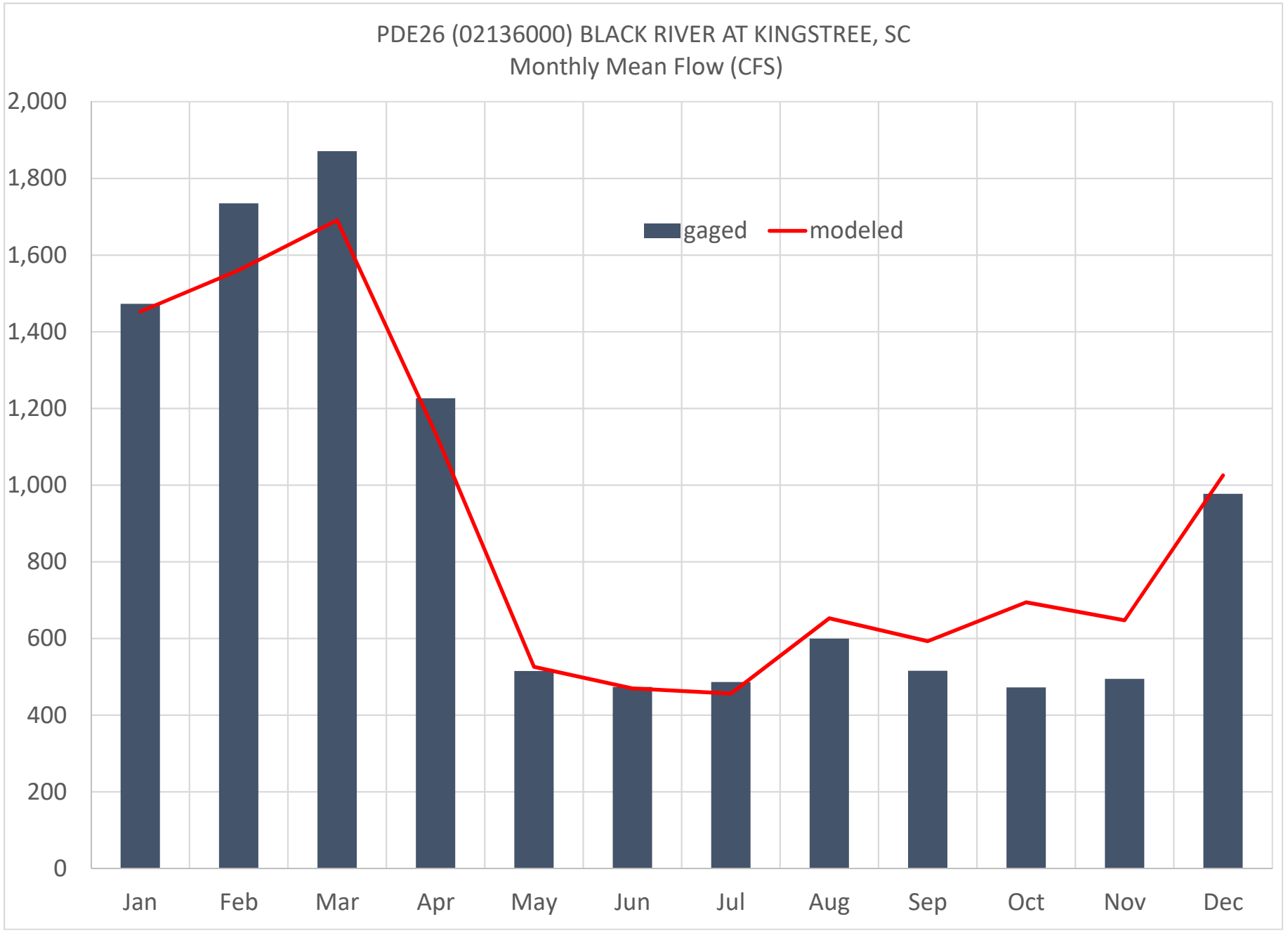

PDE17 (02131150) CATFISH CANAL AT SELLERS, SC (CFS)
Annual Average Flow
gaged
modeled
70
60
50
40
30
20
10
0
1983
1988
1993
1998
2003
2008
2013

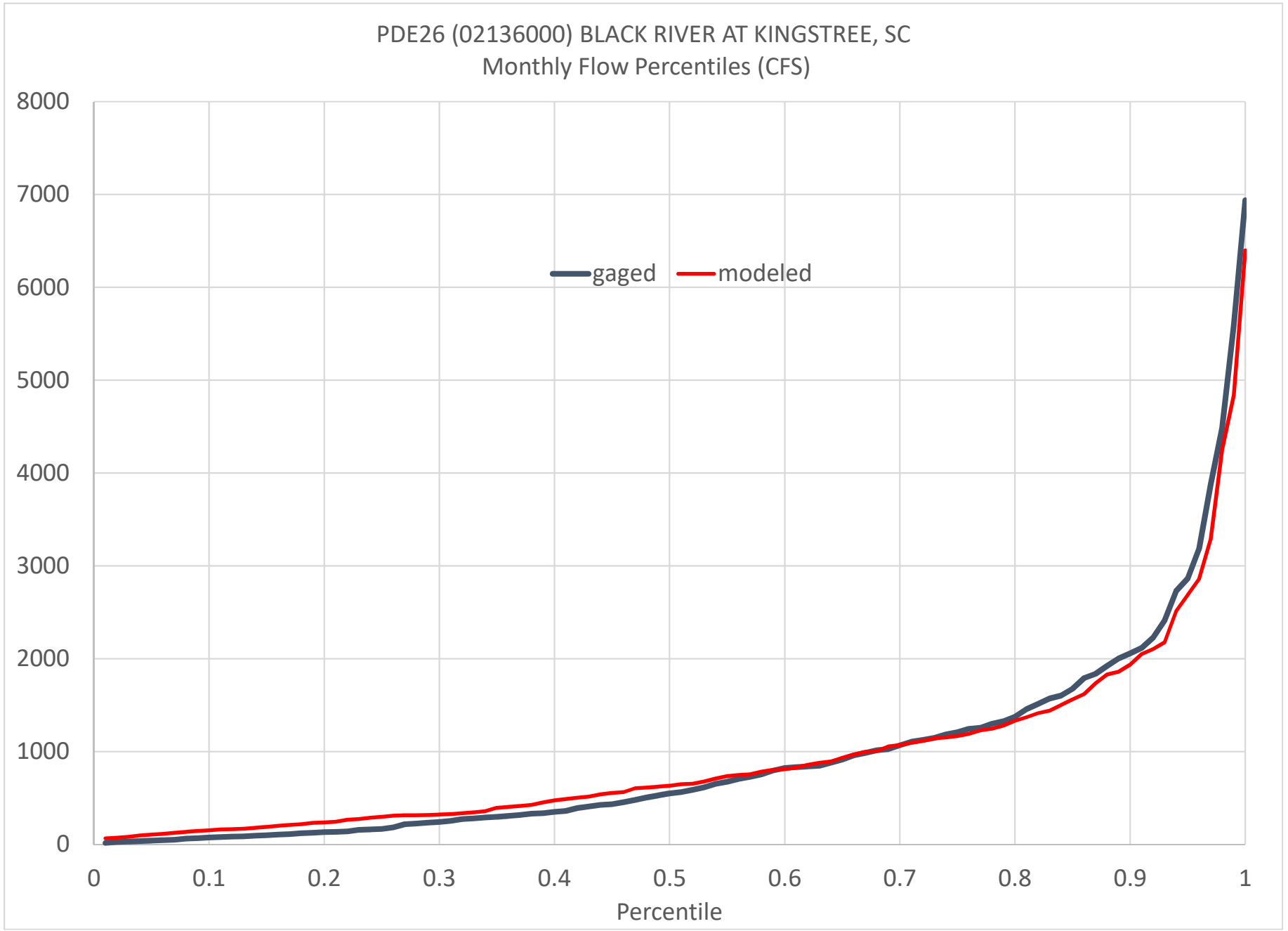

PDE17 (02131150) CATFISH CANAL AT SELLERS, SC
Monthly Mean Flow (CFS)
gaged
modeled
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

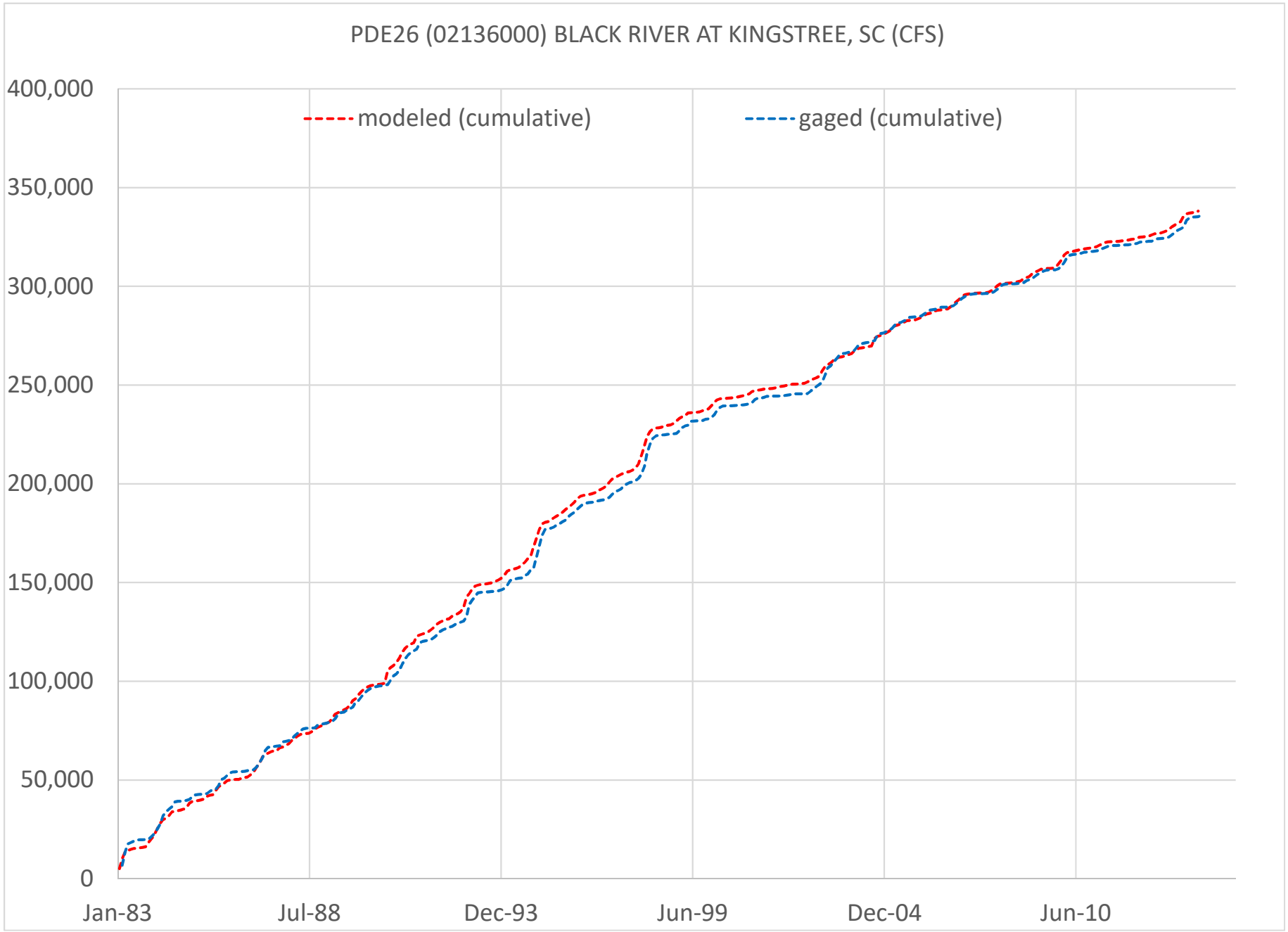

PDE17 (02131150) CATFISH CANAL AT SELLERS, SC
Monthly Flow Percentiles (CFS)
250
200
150
100
50
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

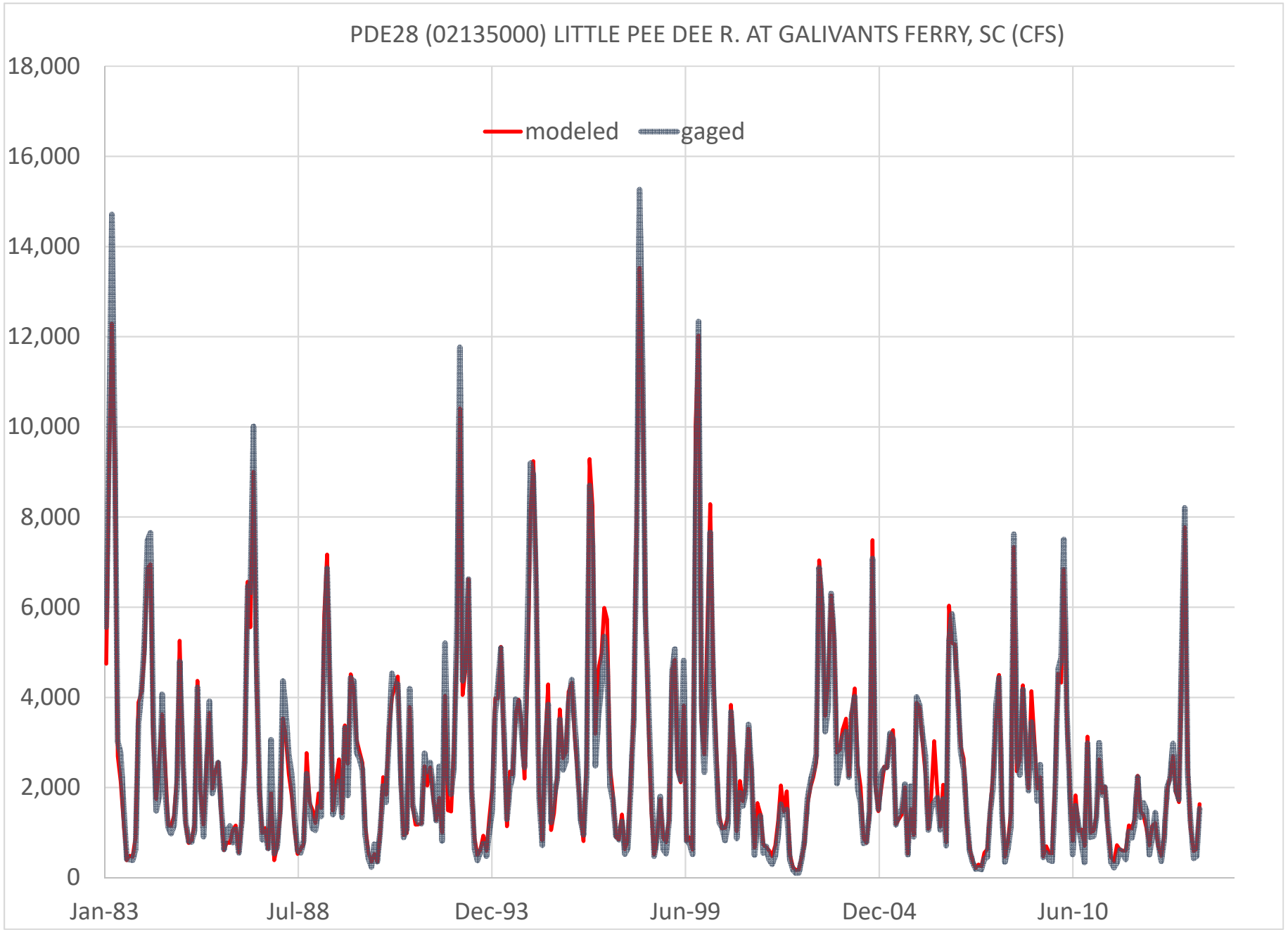

PDE26 (02136000) BLACK RIVER AT KINGSTREE, SC (CFS)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
modeled
gaged
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

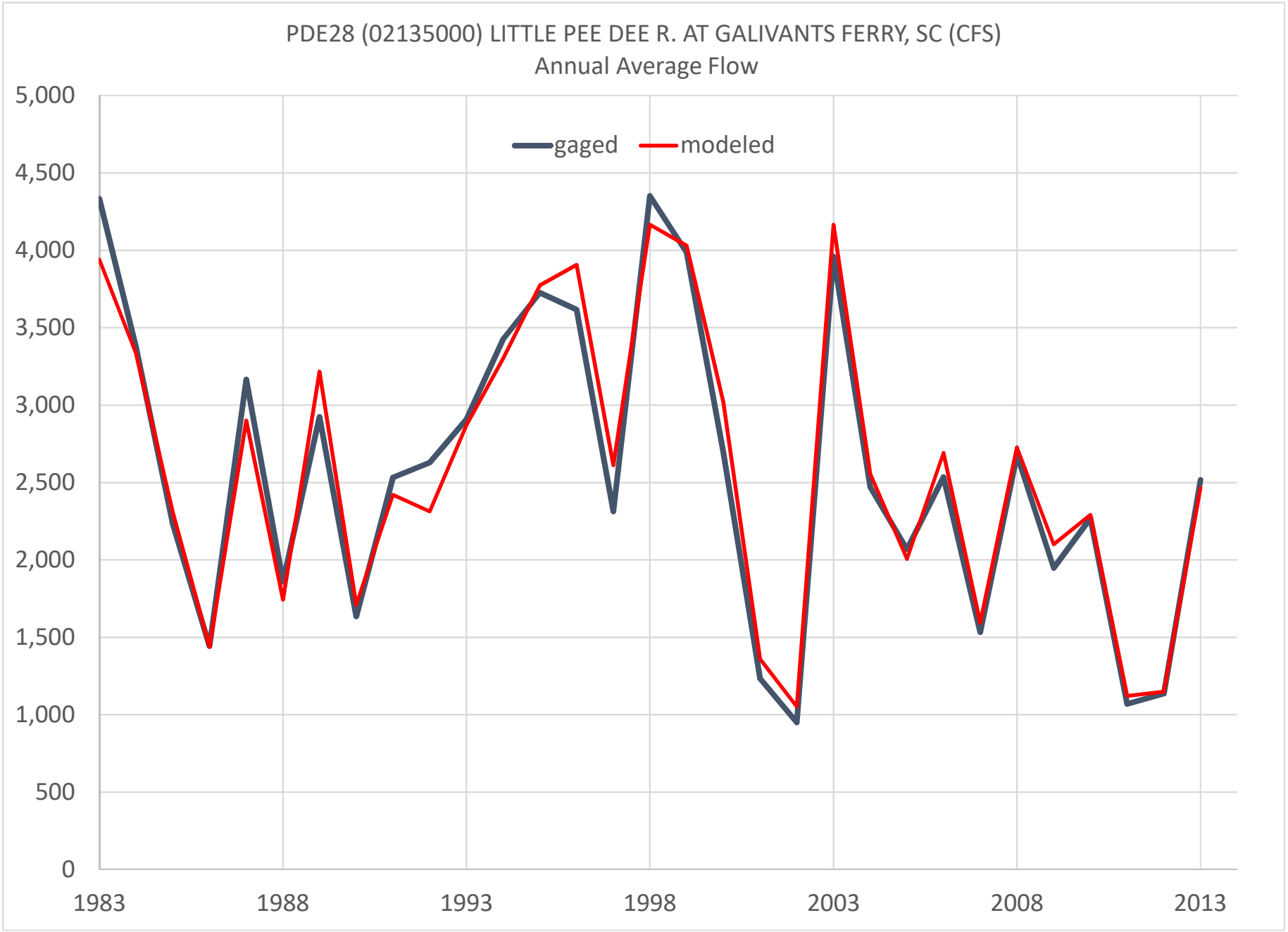

PDE26 (02136000) BLACK RIVER AT KINGSTREE, SC (CFS)
Annual Average Flow
gaged
modeled
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1983
1988
1993
1998
2003
2008
2013

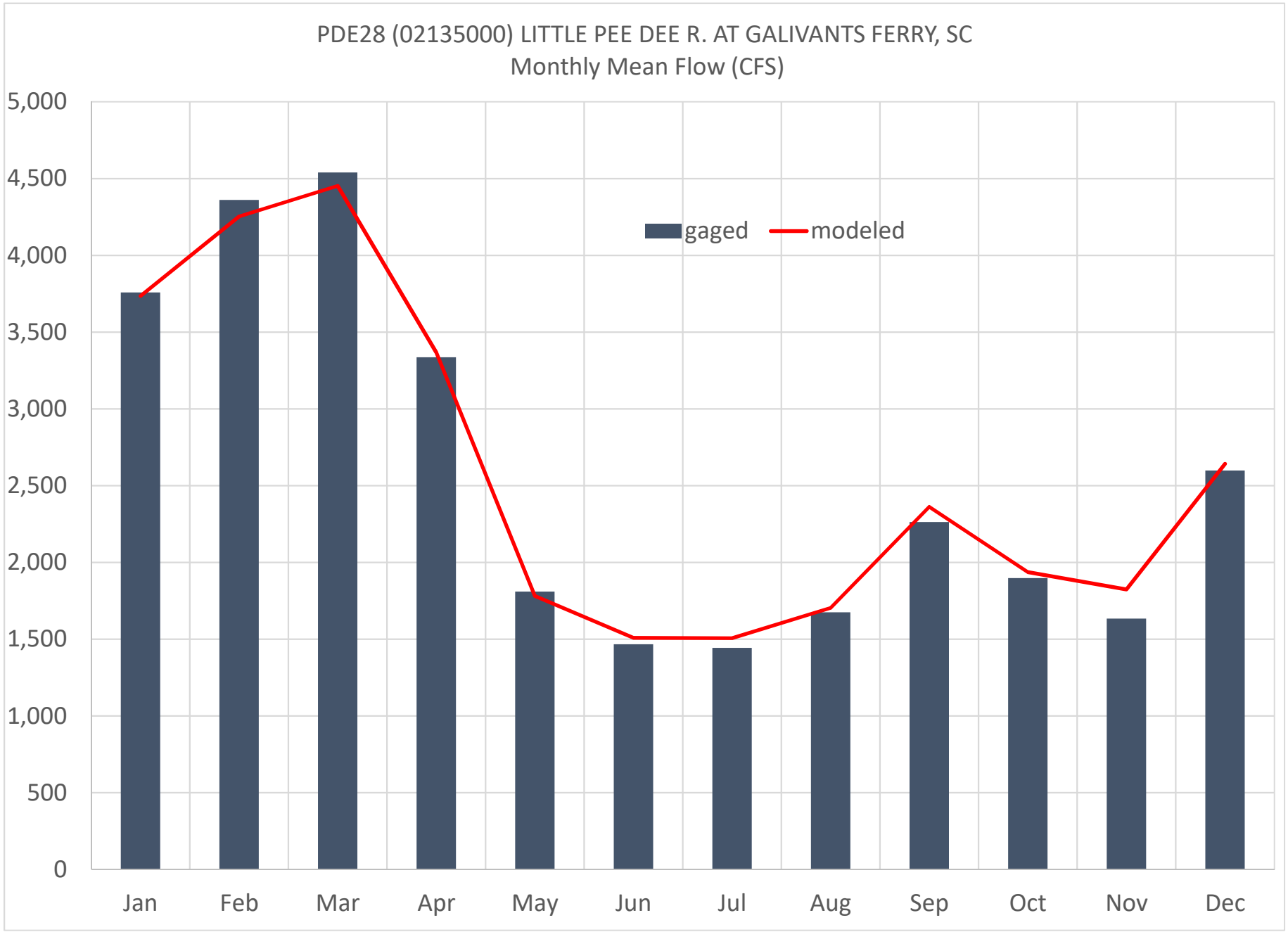

PDE26 (02136000) BLACK RIVER AT KINGSTREE, SC
Monthly Mean Flow (CFS)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

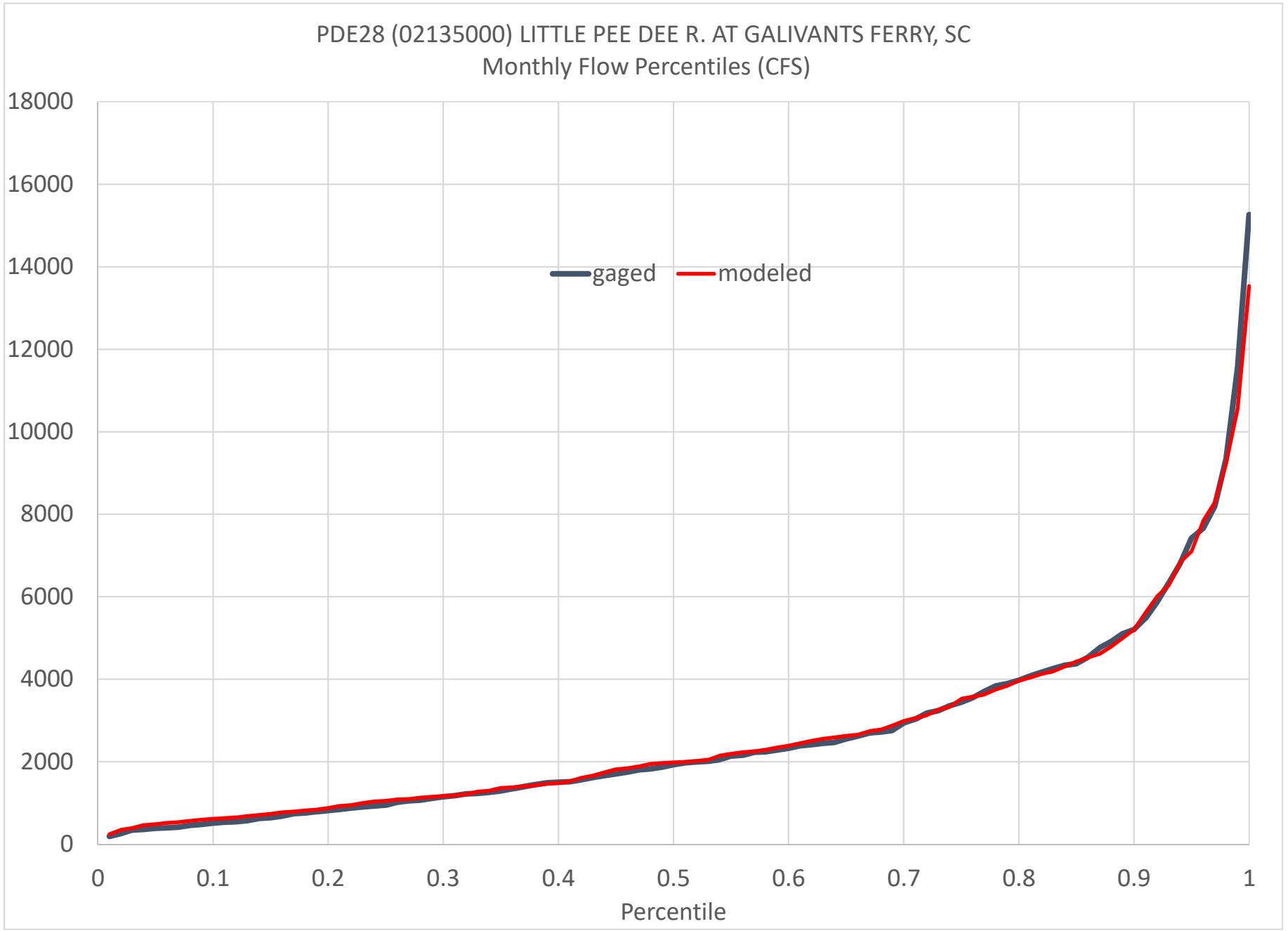

PDE26 (02136000) BLACK RIVER AT KINGSTREE, SC
Monthly Flow Percentiles (CFS)
8000
7000
6000
5000
4000
3000
2000
1000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

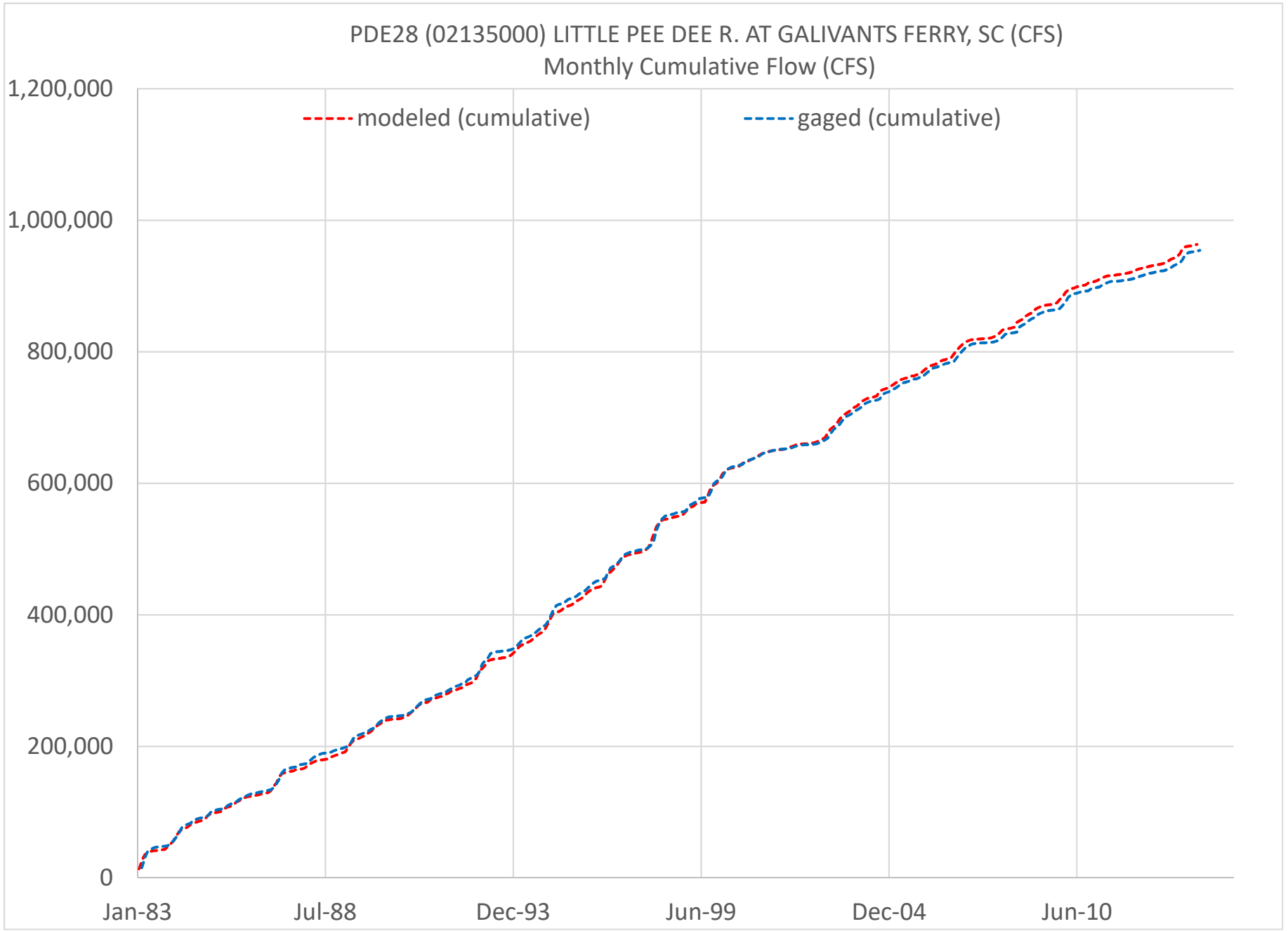

PDE26 (02136000) BLACK RIVER AT KINGSTREE, SC (CFS)
modeled (cumulative)
gaged (cumulative)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10


PDE28 (02135000) LITTLE PEE DEE R. AT GALIVANTS FERRY, SC (CFS)
modeled
gaged
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10


PDE28 (02135000) LITTLE PEE DEE R. AT GALIVANTS FERRY, SC (CFS)
Annual Average Flow
gaged
modeled
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1983
1988
1993
1998
2003
2008
2013

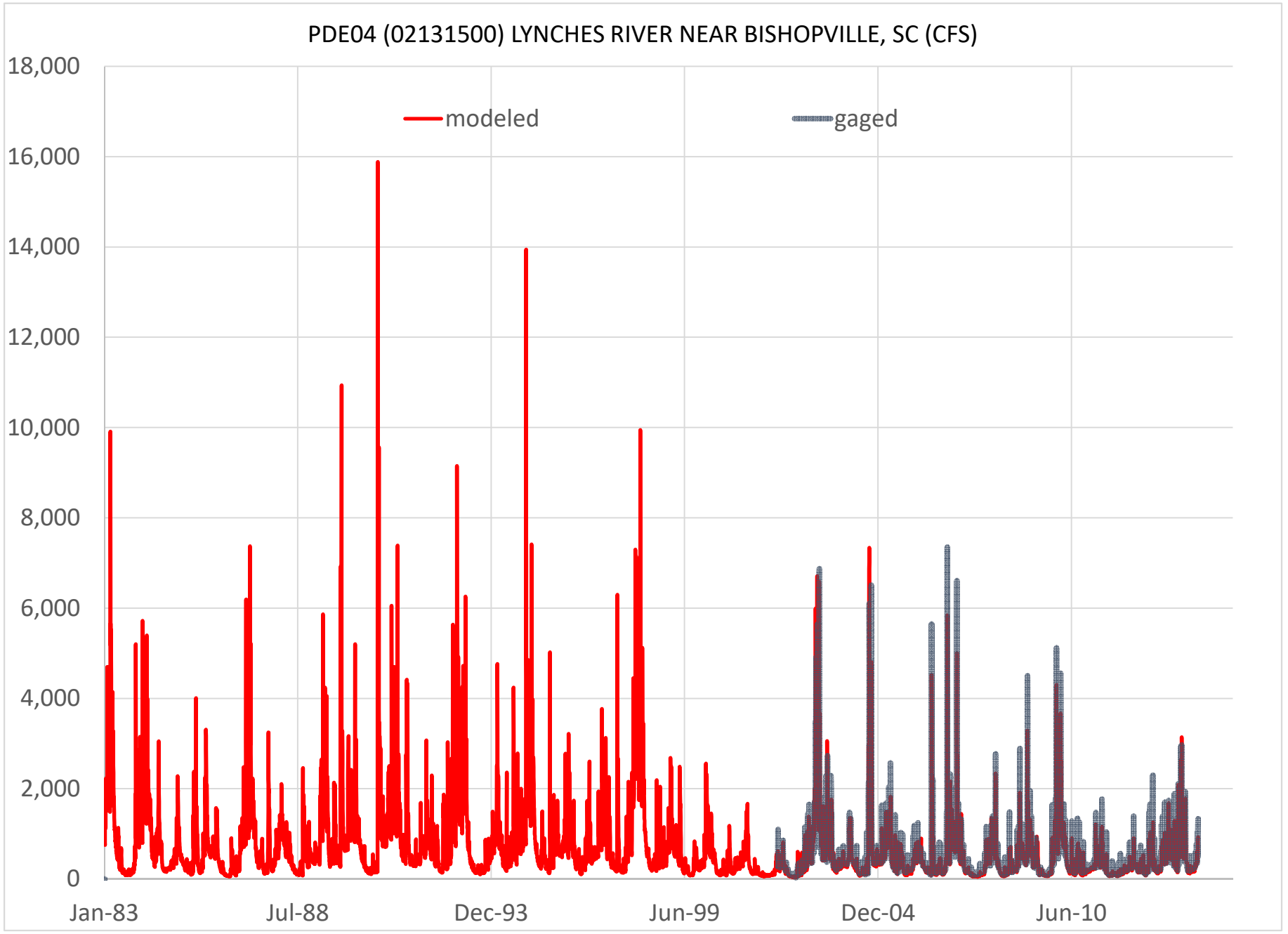

PDE28 (02135000) LITTLE PEE DEE R. AT GALIVANTS FERRY, SC
Monthly Mean Flow (CFS)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
gaged
modeled
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

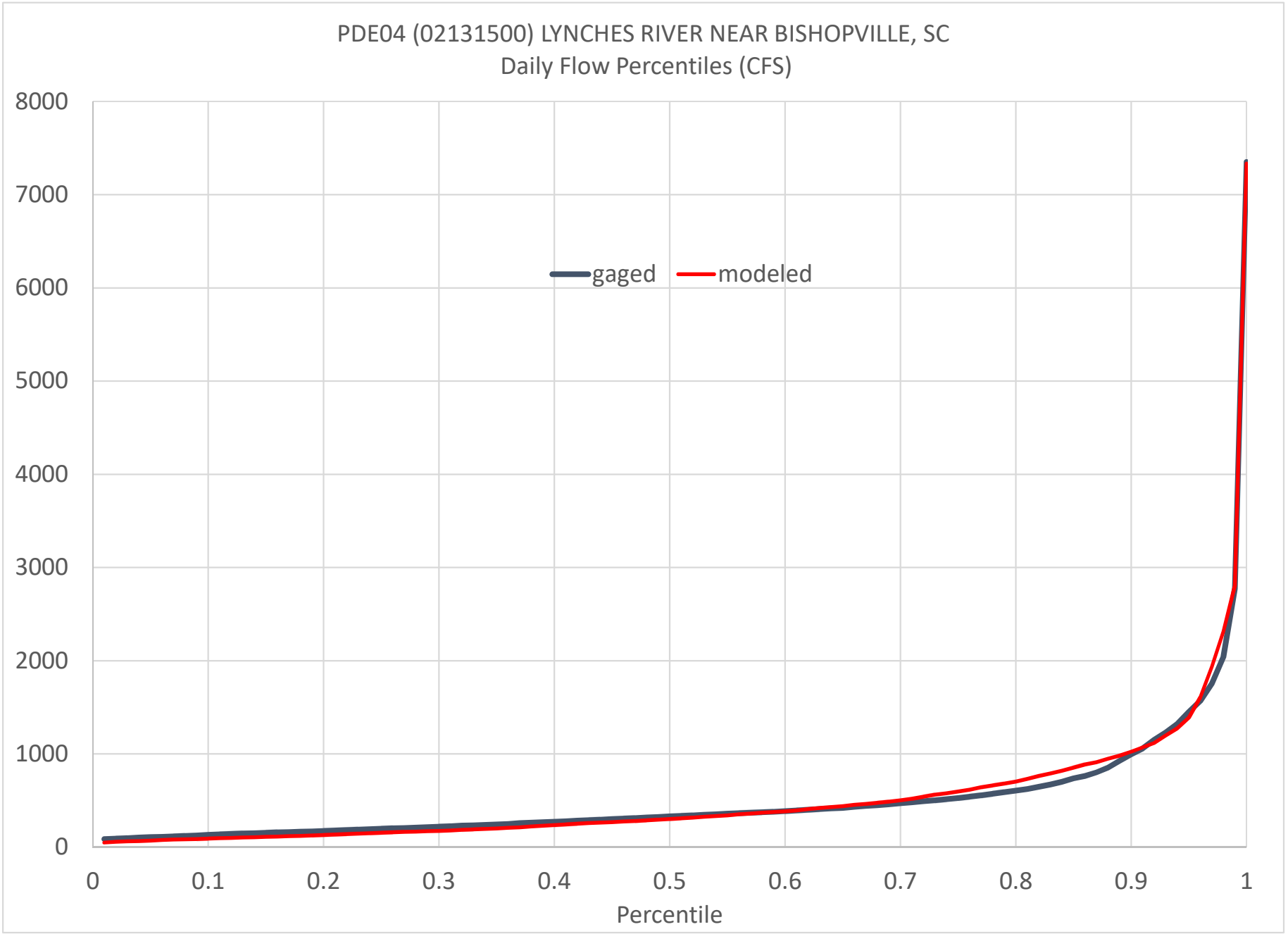

PDE28 (02135000) LITTLE PEE DEE R. AT GALIVANTS FERRY, SC
Monthly Flow Percentiles (CFS)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

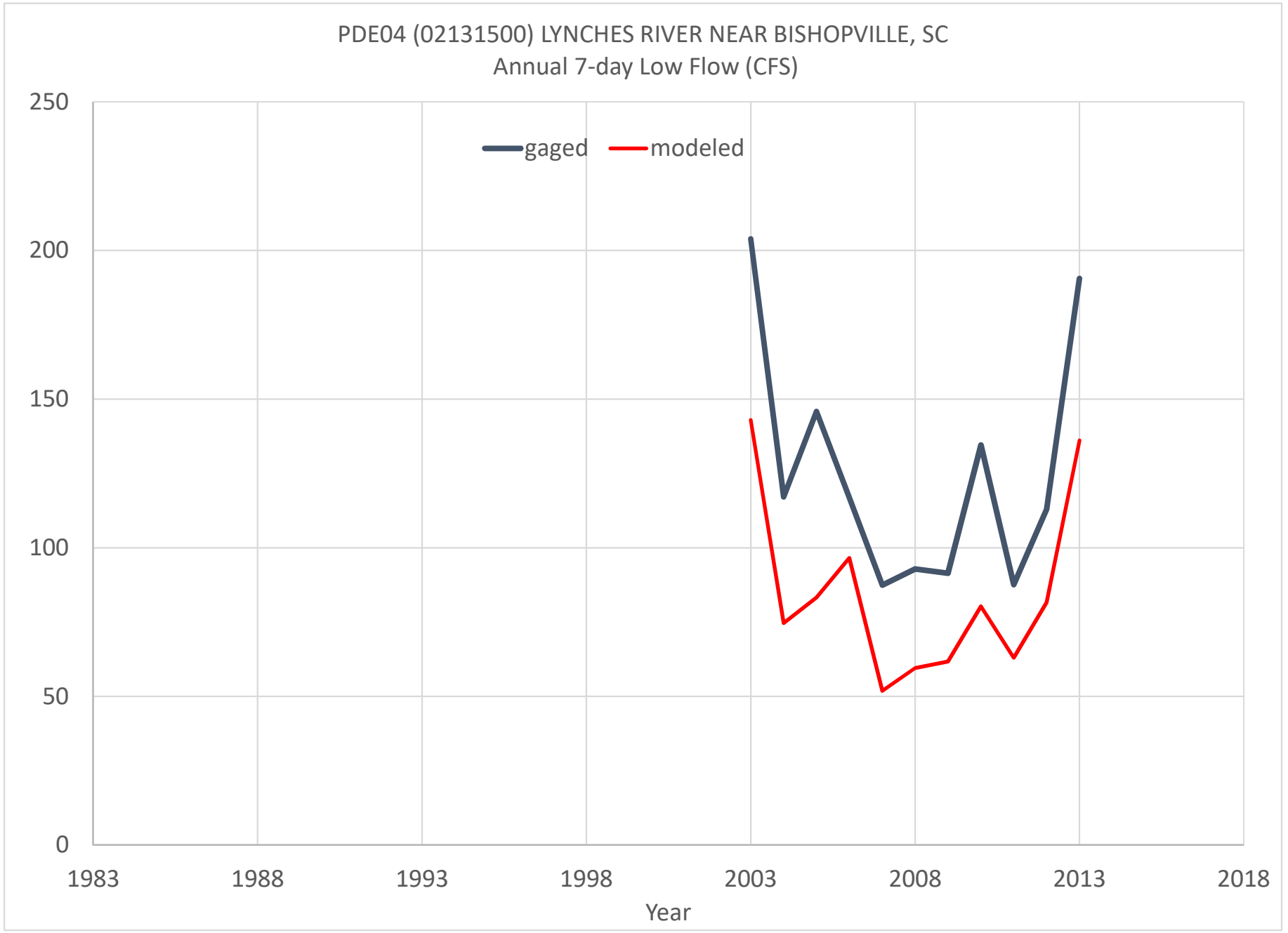

PDE28 (02135000) LITTLE PEE DEE R. AT GALIVANTS FERRY, SC (CFS)
Monthly Cumulative Flow (CFS)
modeled (cumulative)
gaged (cumulative)
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

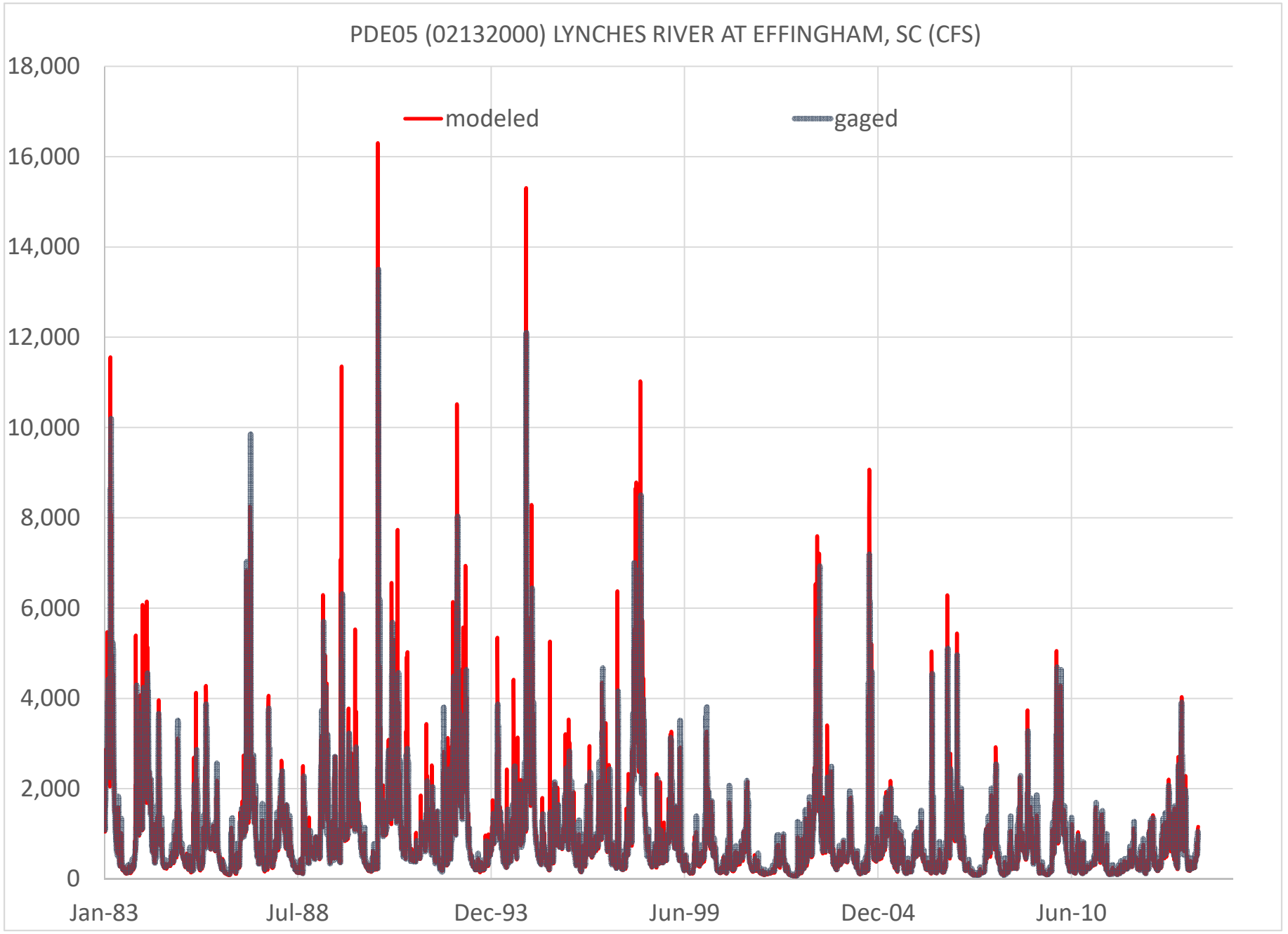
# Attachment C

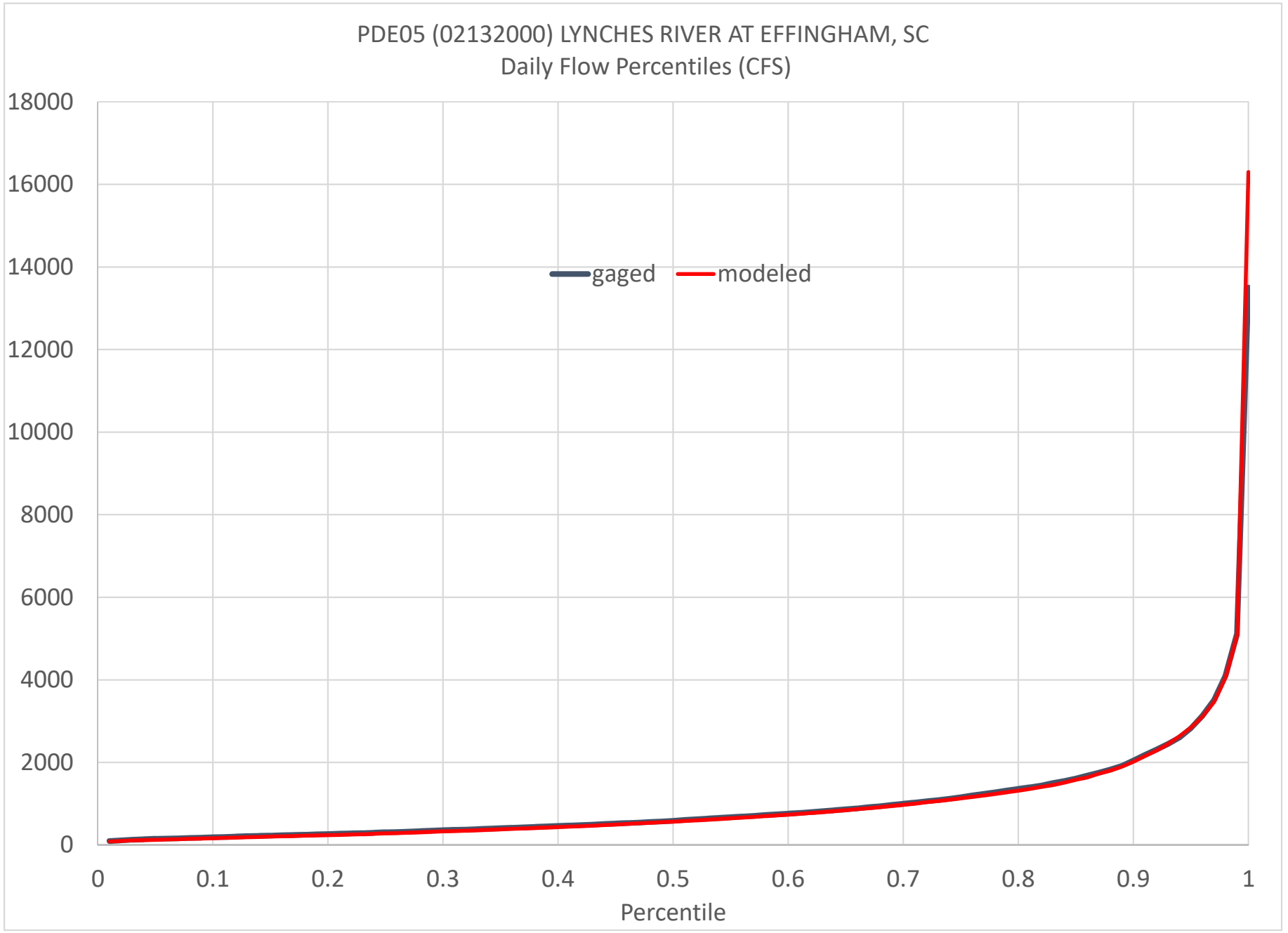
# Daily Validation Results

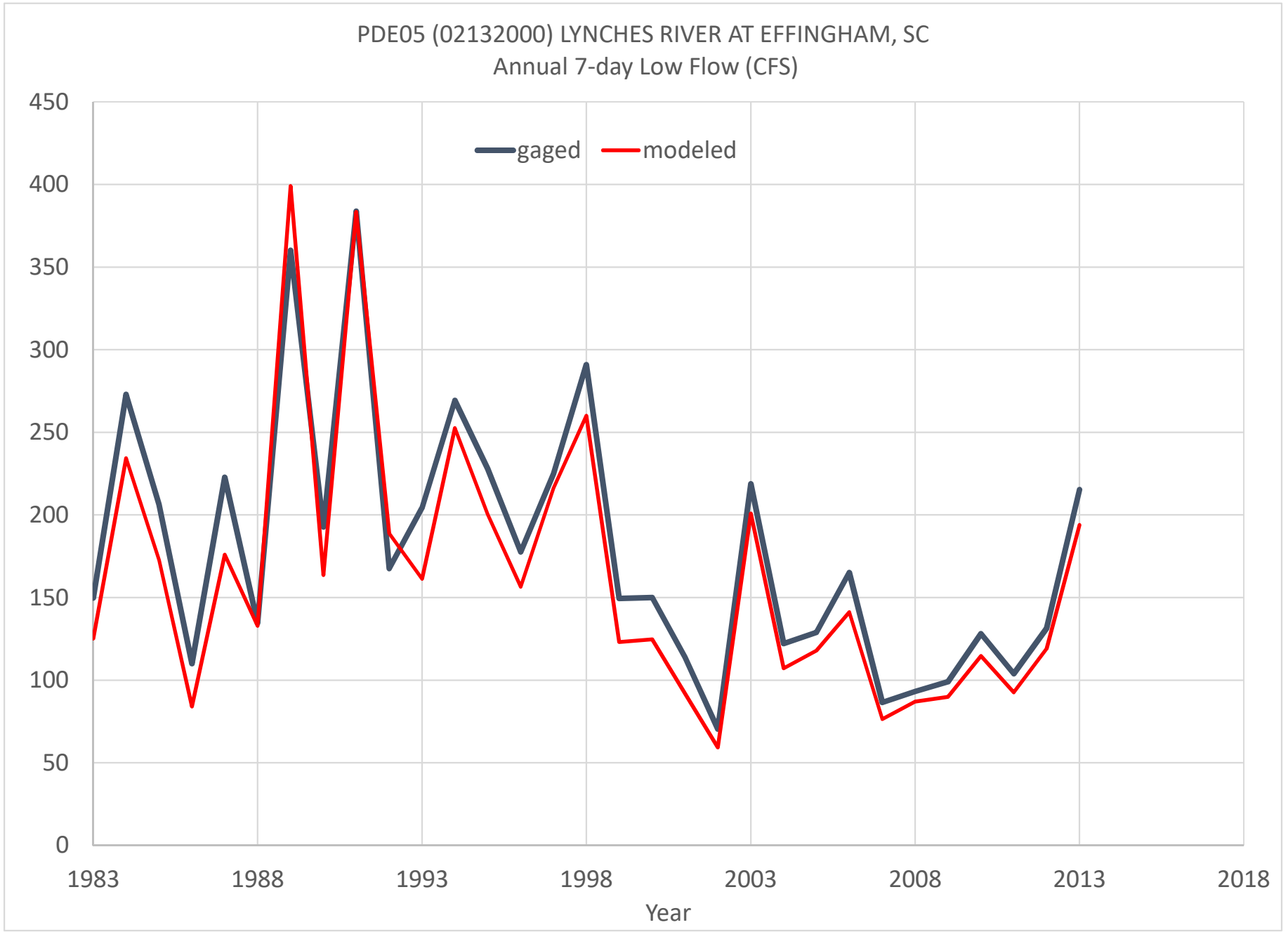

PDE04 (02131500) LYNCHES RIVER NEAR BISHOPVILLE, SC (CFS)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
modeled
gaged
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

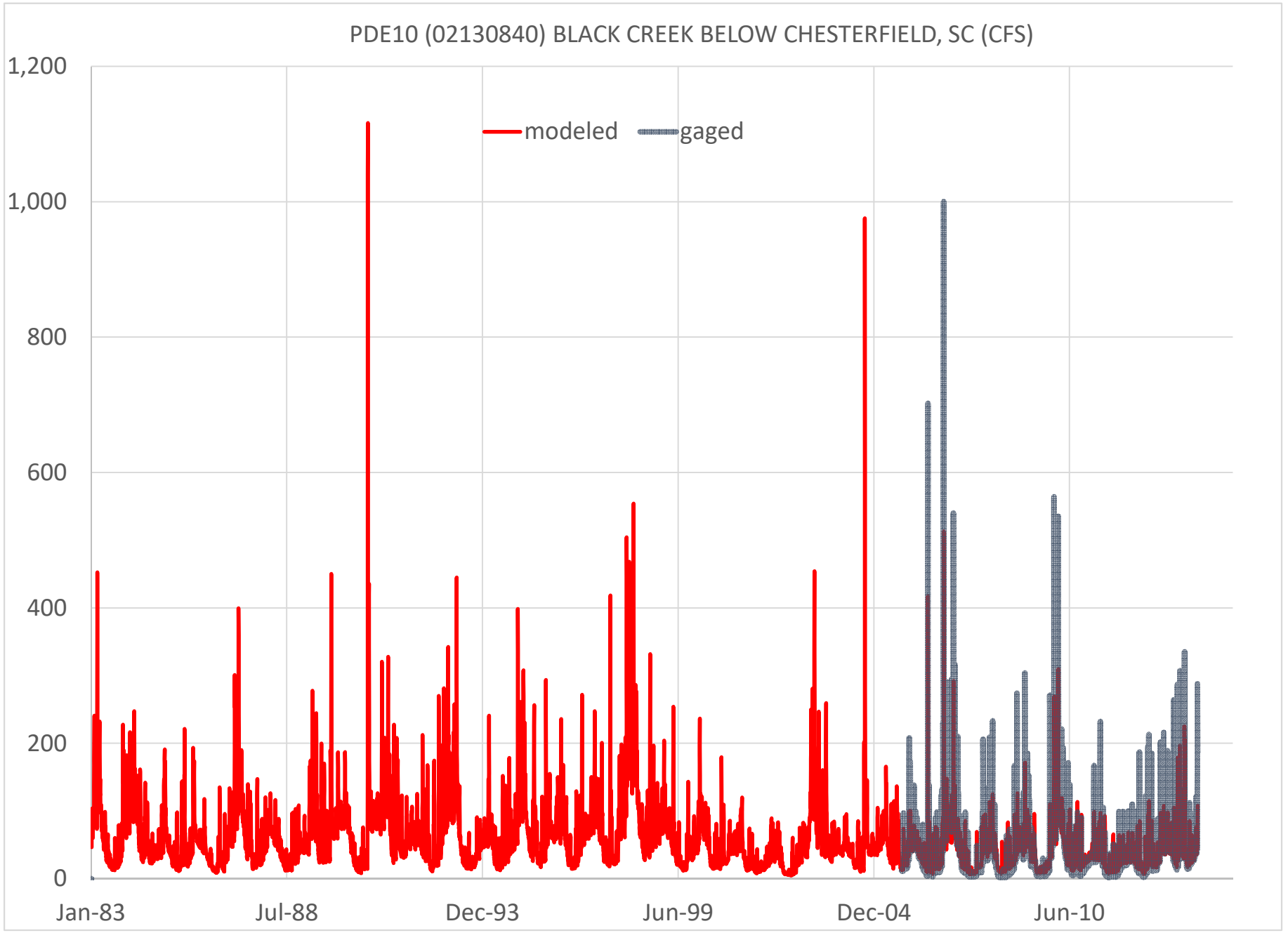

PDE04 (02131500) LYNCHES RIVER NEAR BISHOPVILLE, SC
Daily Flow Percentiles (CFS)
8000
7000
6000
5000
4000
3000
2000
1000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

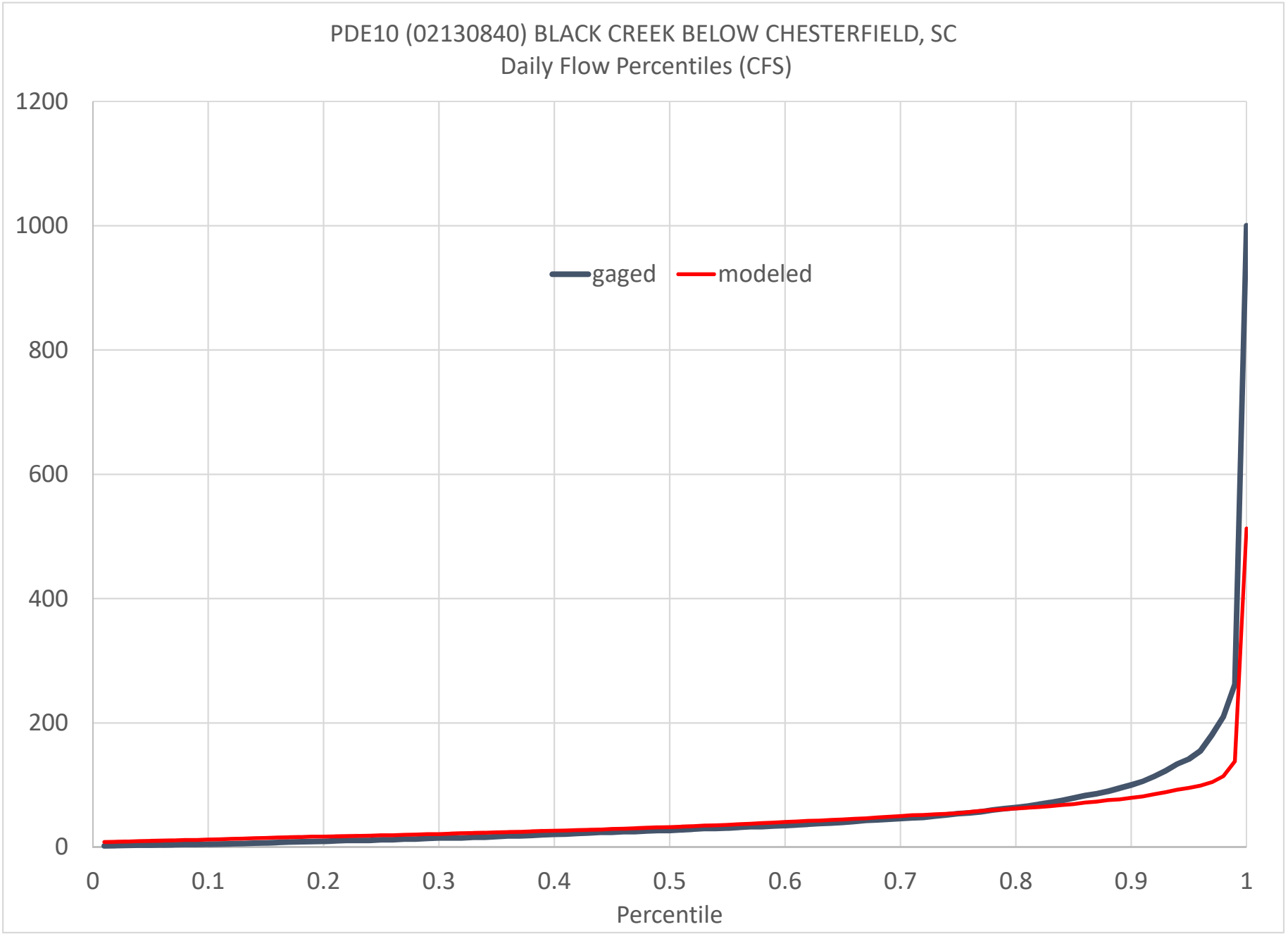

PDE04 (02131500) LYNCHES RIVER NEAR BISHOPVILLE, SC
Annual 7-day Low Flow (CFS)
gaged
modeled
250
200
150
100
50
0
1983
1988
1993
1998
2003
2008
2013
2018
Year

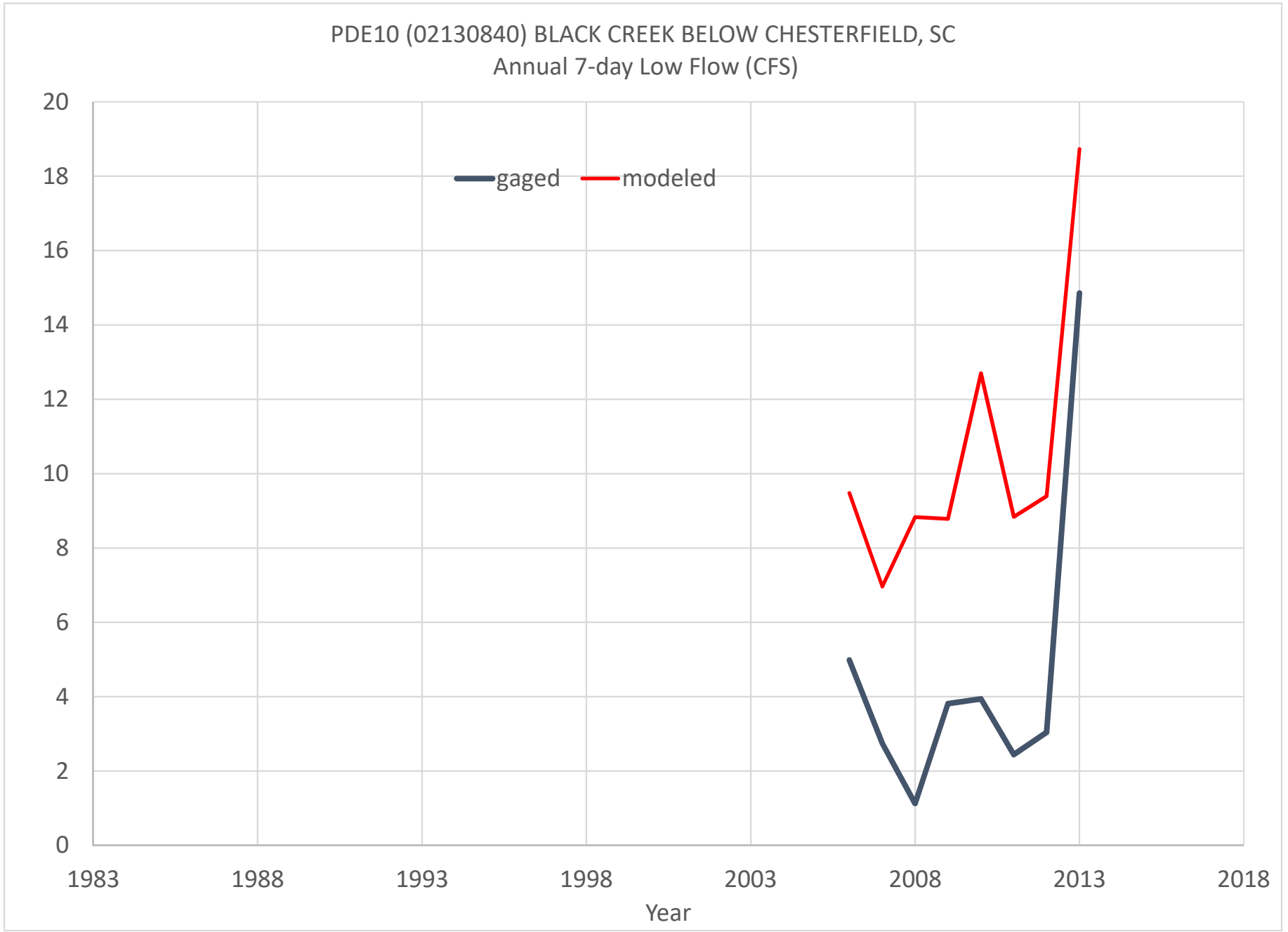

PDE05 (02132000) LYNCHES RIVER AT EFFINGHAM, SC (CFS)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
modeled
gaged
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

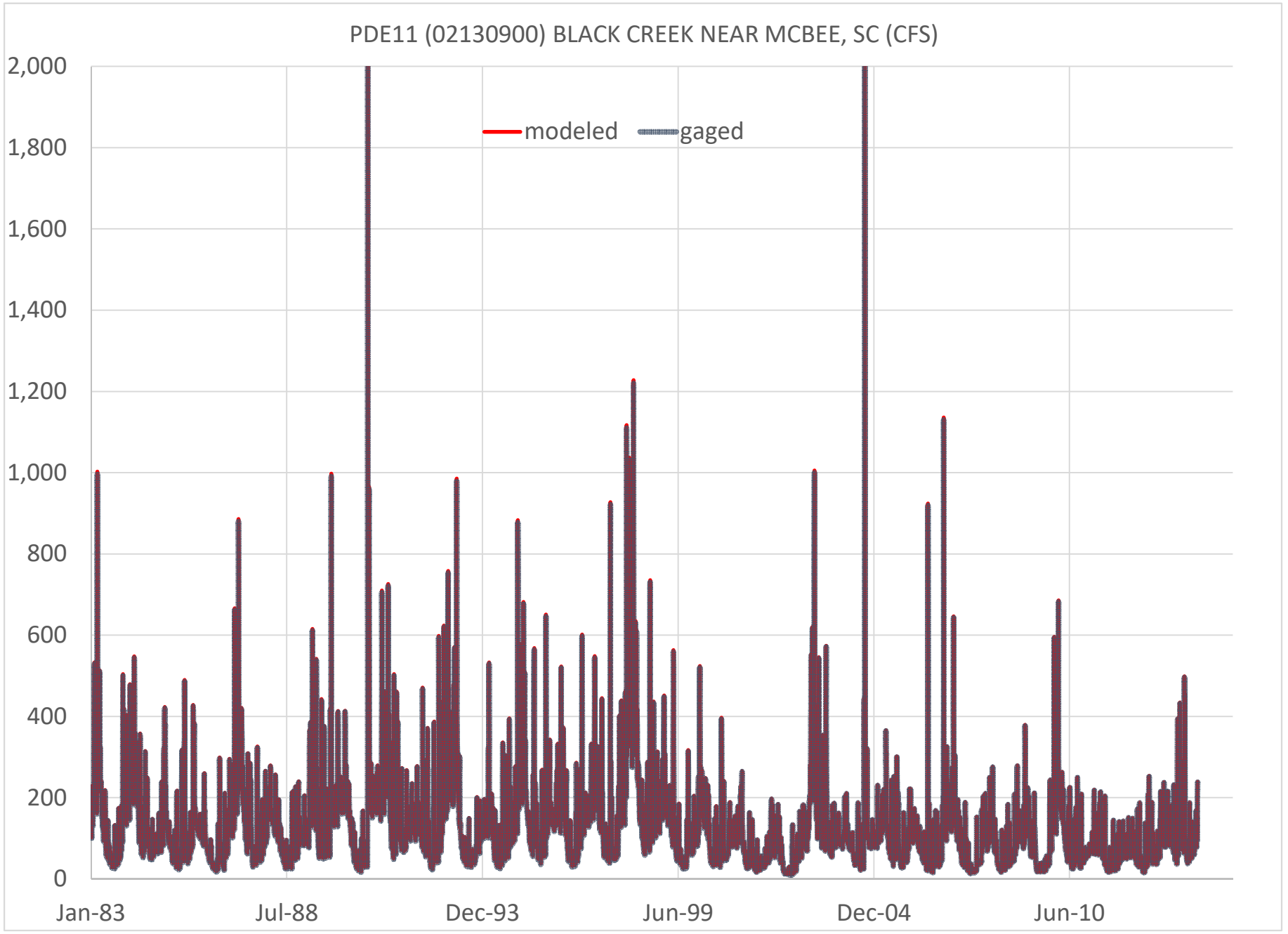

PDE05 (02132000) LYNCHES RIVER AT EFFINGHAM, SC
Daily Flow Percentiles (CFS)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

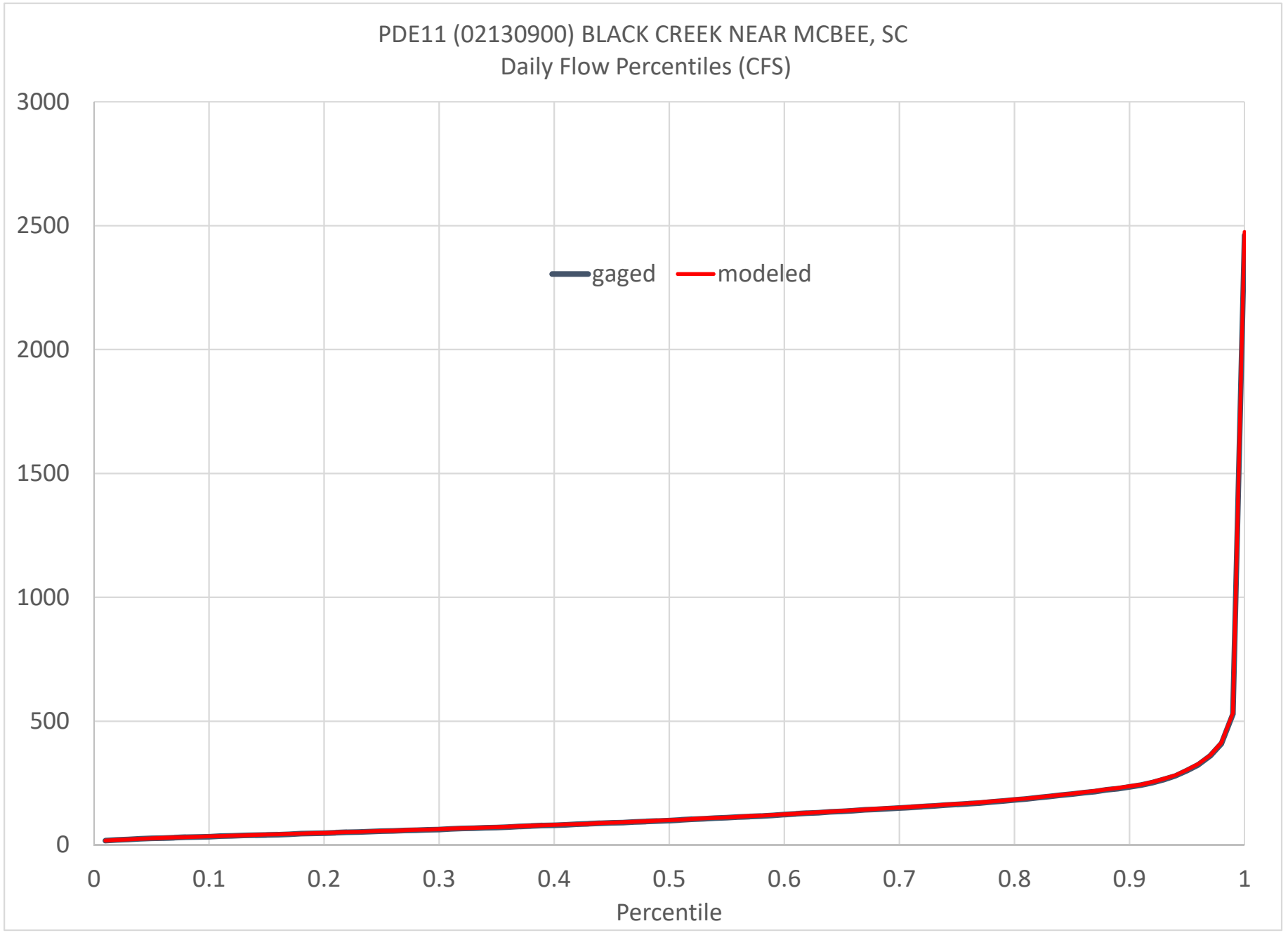

PDE05 (02132000) LYNCHES RIVER AT EFFINGHAM, SC
Annual 7-day Low Flow (CFS)
gaged
modeled
450
400
350
300
250
200
150
100
50
0
1983
1988
1993
1998
2003
2008
2013
2018
Year

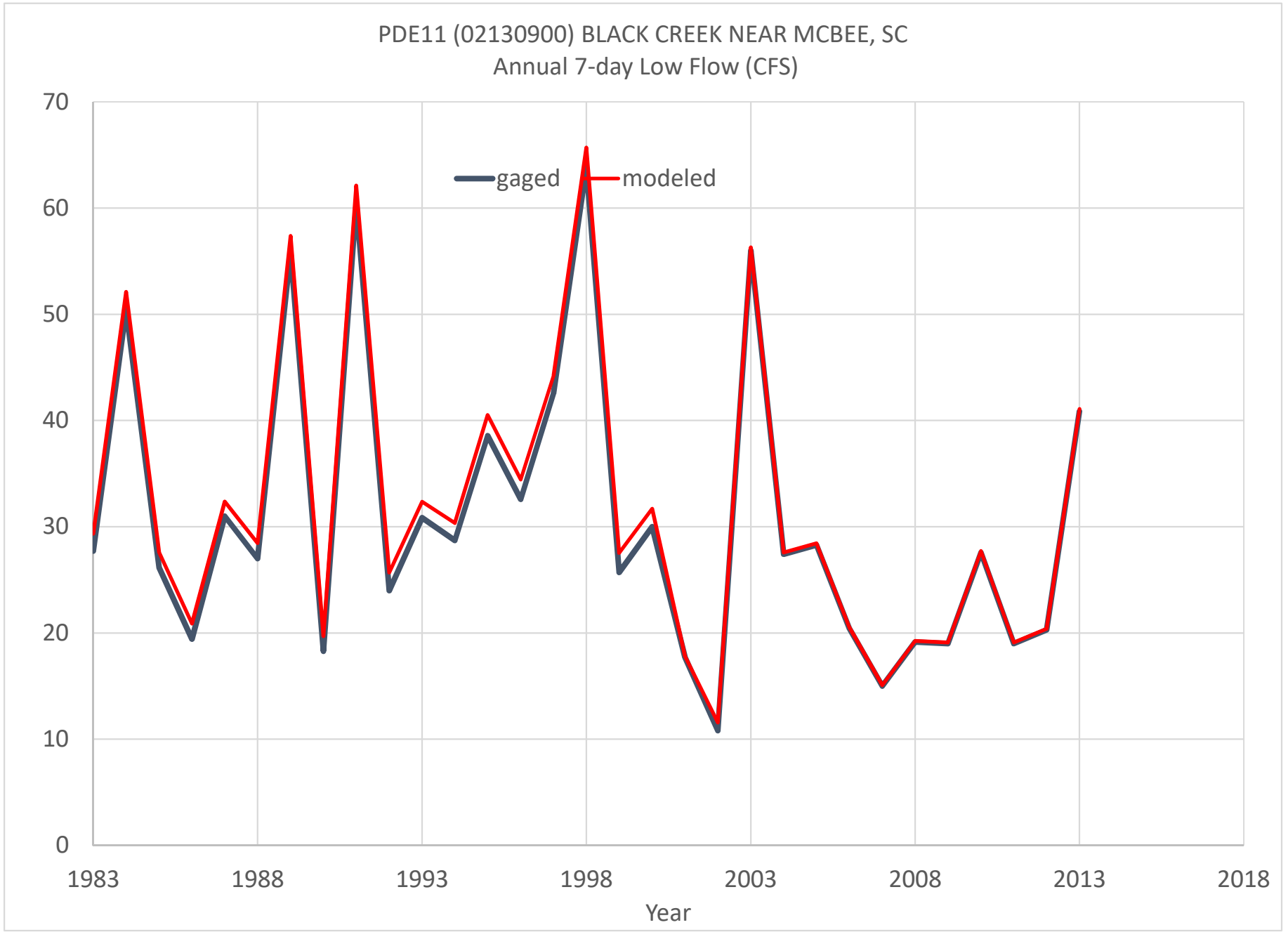

PDE10 (02130840) BLACK CREEK BELOW CHESTERFIELD, SC (CFS)
modeled
gaged
1,200
1,000
800
600
400
200
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

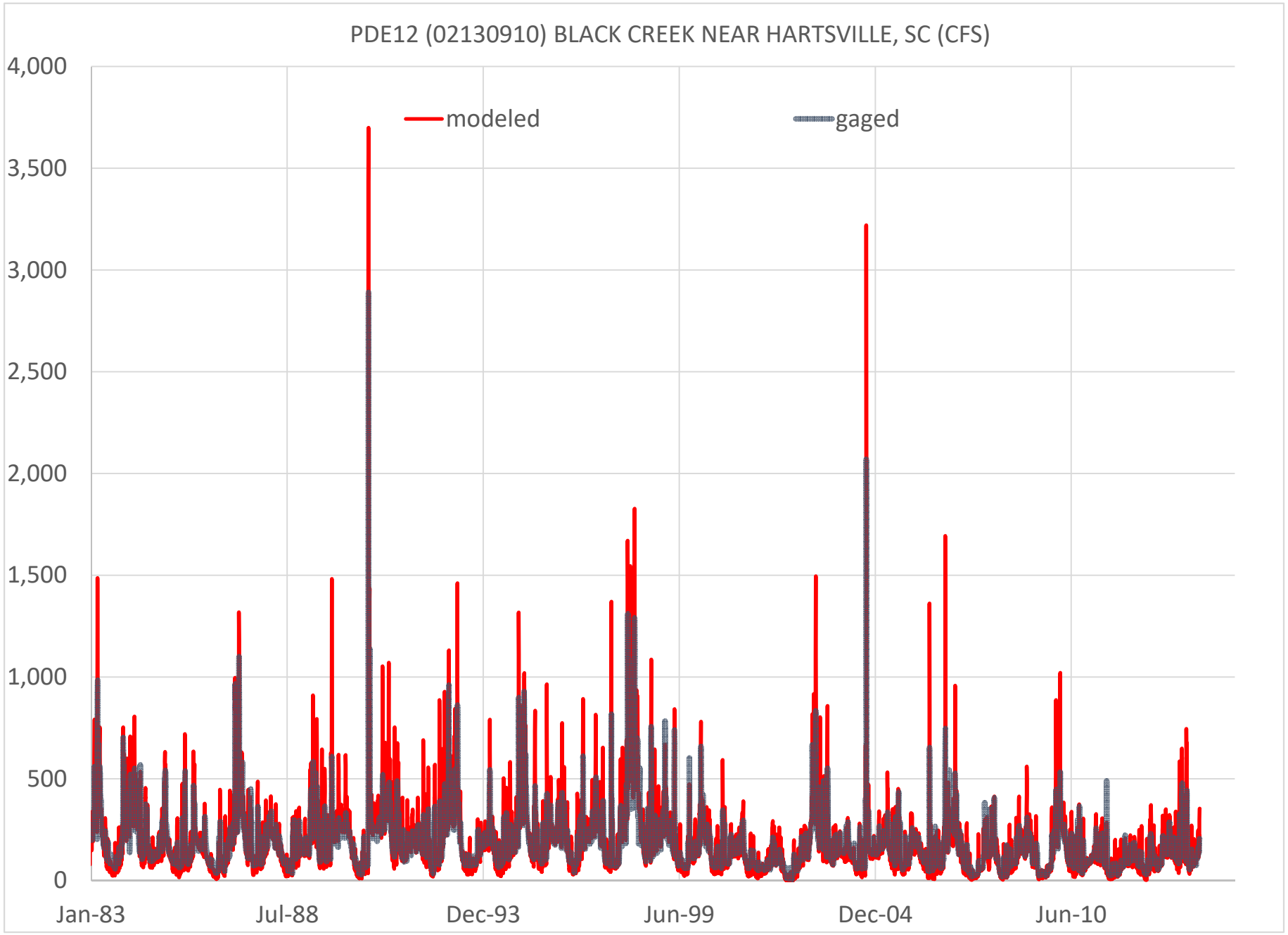

PDE10 (02130840) BLACK CREEK BELOW CHESTERFIELD, SC
Daily Flow Percentiles (CFS)
1200
1000
800
600
400
200
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

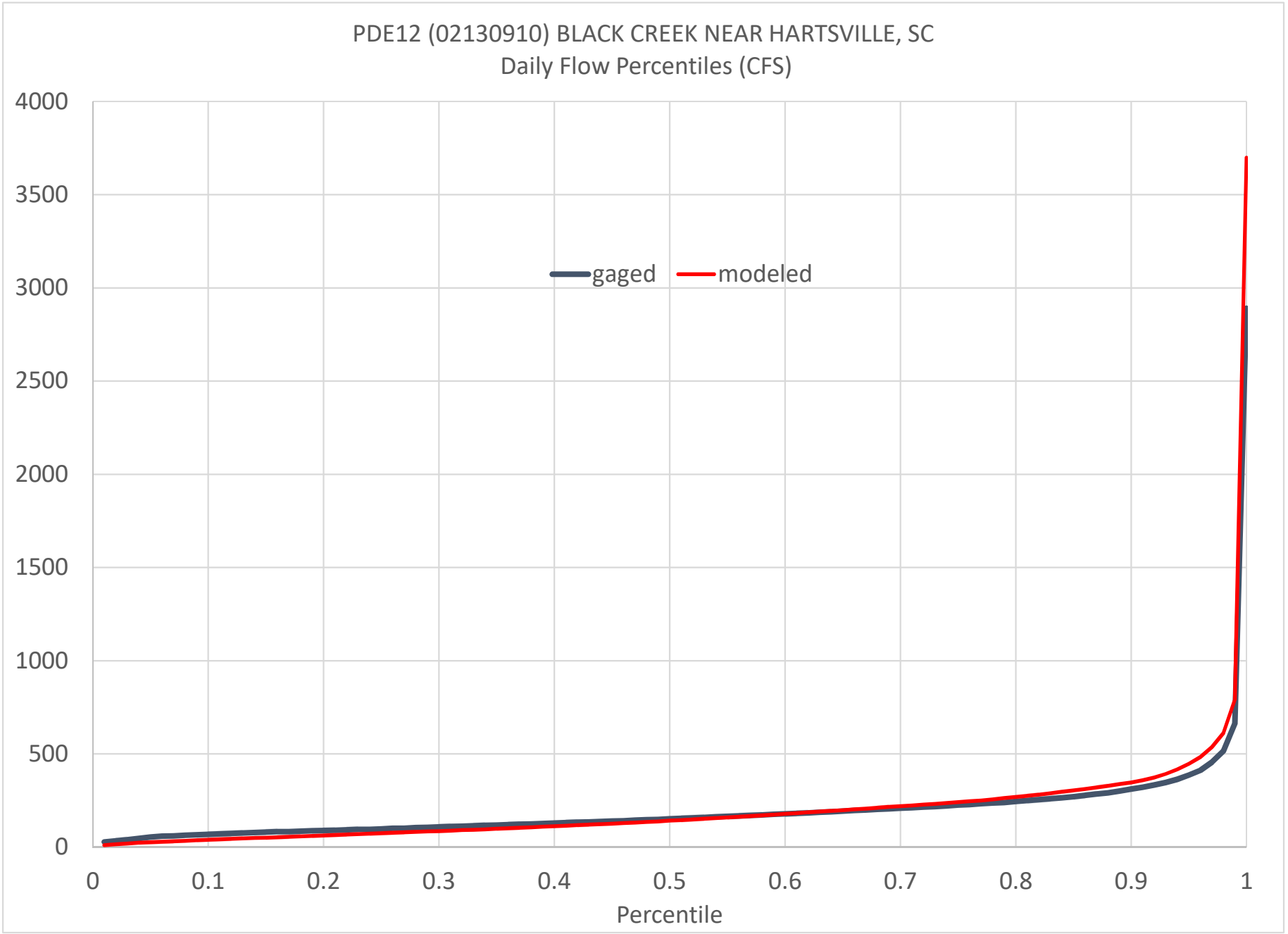

PDE10 (02130840) BLACK CREEK BELOW CHESTERFIELD, SC
Annual 7-day Low Flow (CFS)
gaged
modeled
20
18
16
14
12
10
8
6
4
2
0
1983
1988
1993
1998
2003
2008
2013
2018
Year

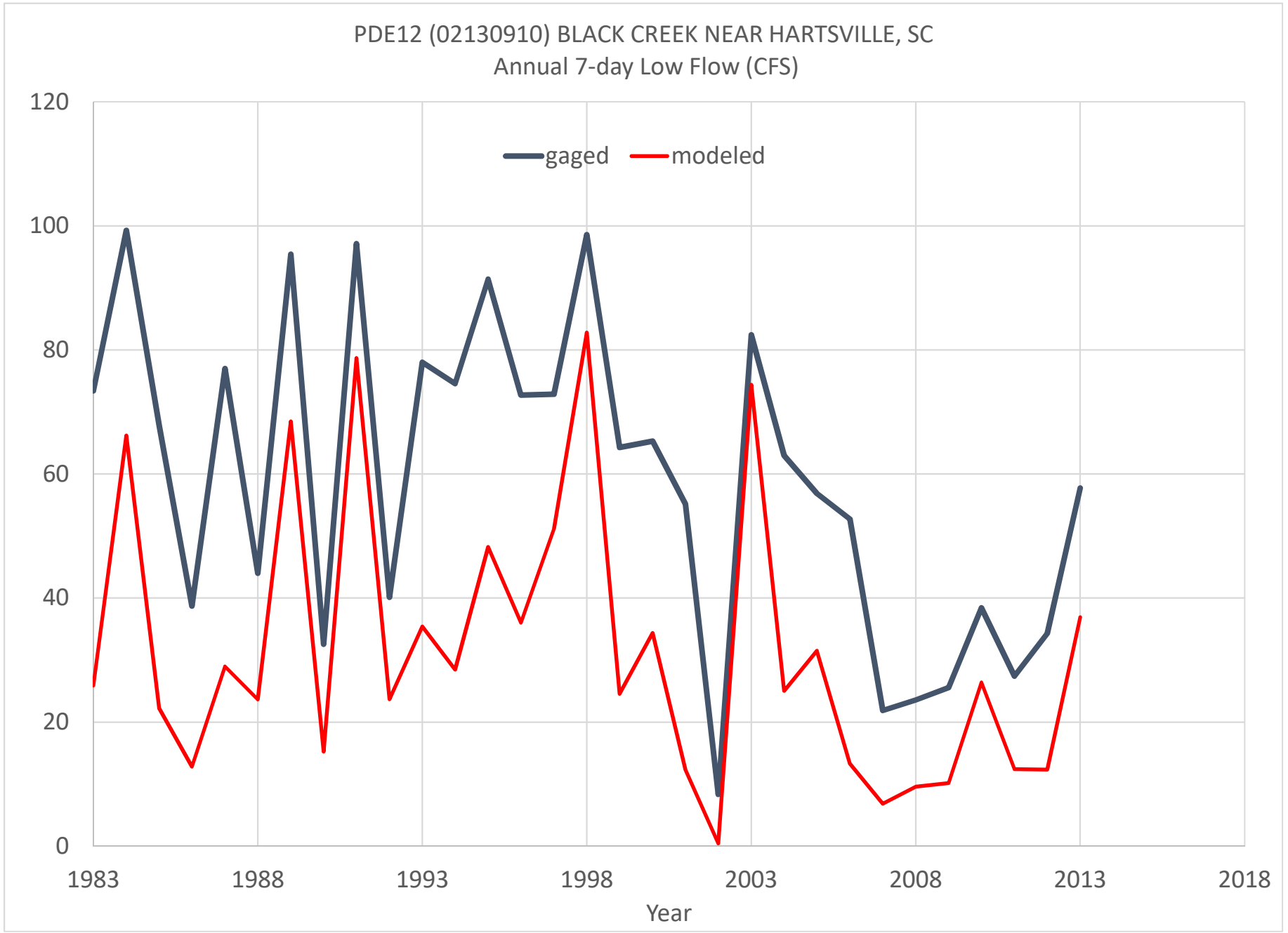

PDE11 (02130900) BLACK CREEK NEAR MCBEE, SC (CFS)
modeled
gaged
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

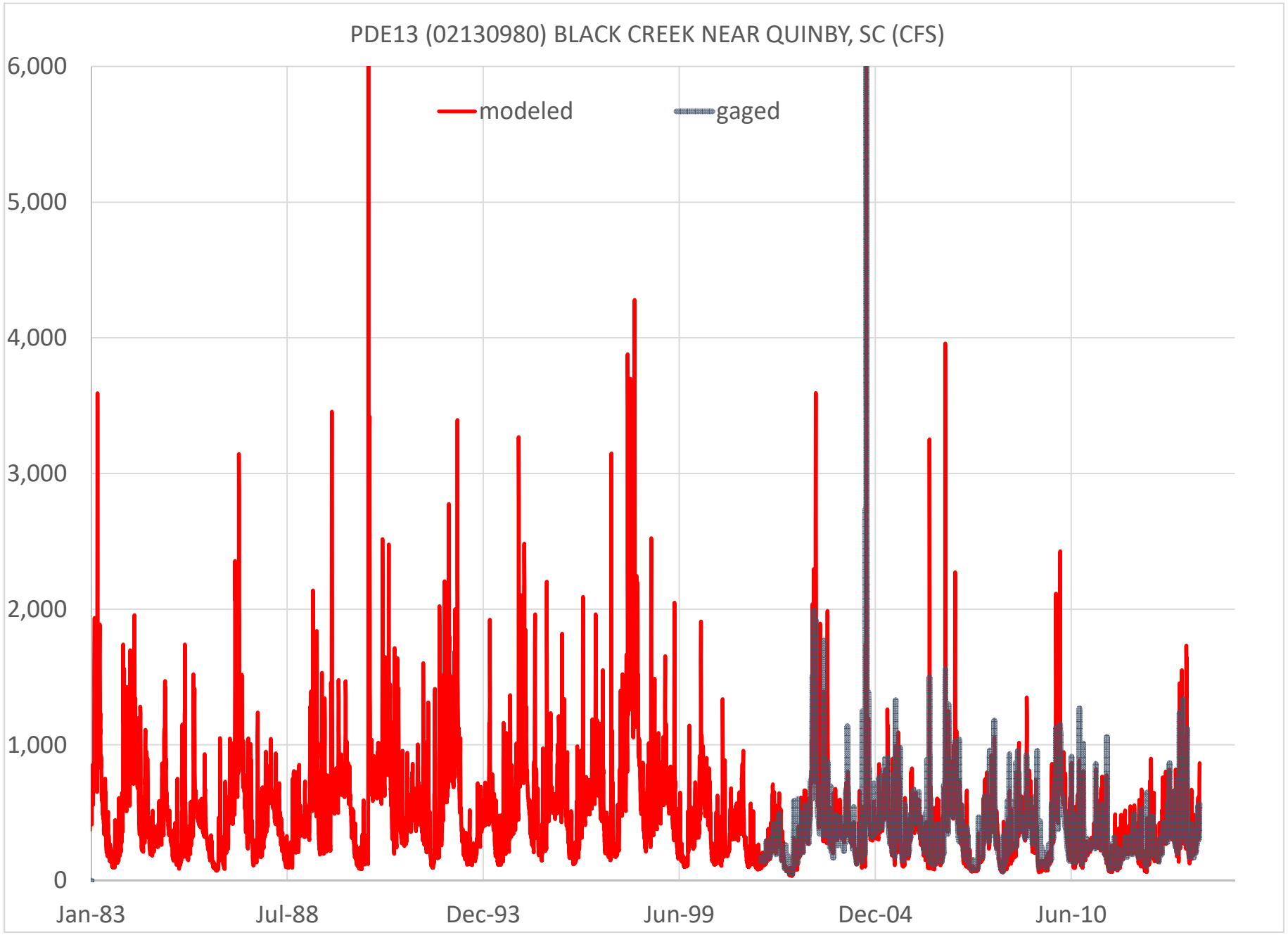

PDE11 (02130900) BLACK CREEK NEAR MCBEE, SC
Daily Flow Percentiles (CFS)
3000
2500
2000
1500
1000
500
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

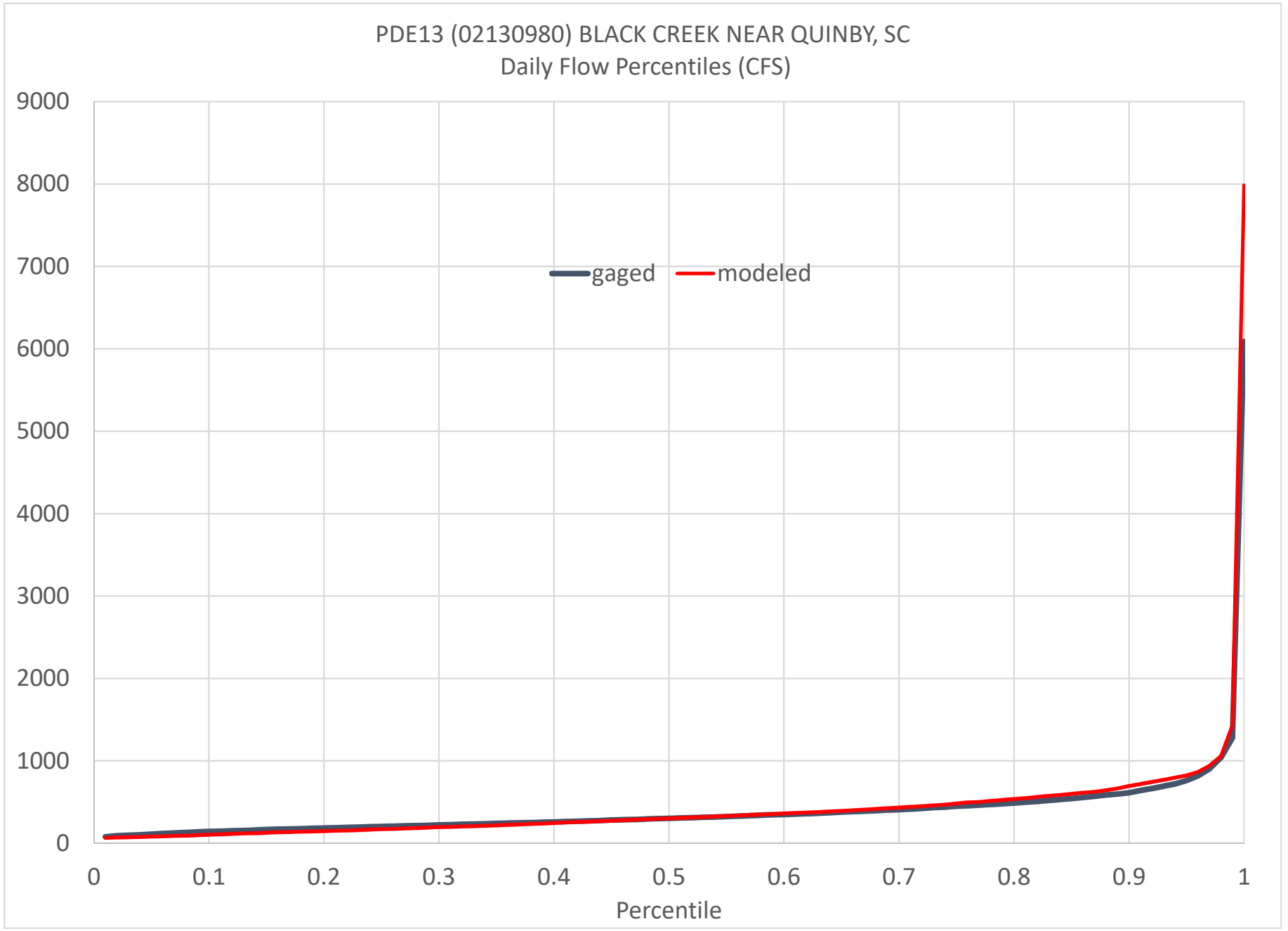

PDE11 (02130900) BLACK CREEK NEAR MCBEE, SC
Annual 7-day Low Flow (CFS)
gaged
modeled
70
60
50
40
30
20
10
0
1983
1988
1993
1998
2003
2008
2013
2018
Year

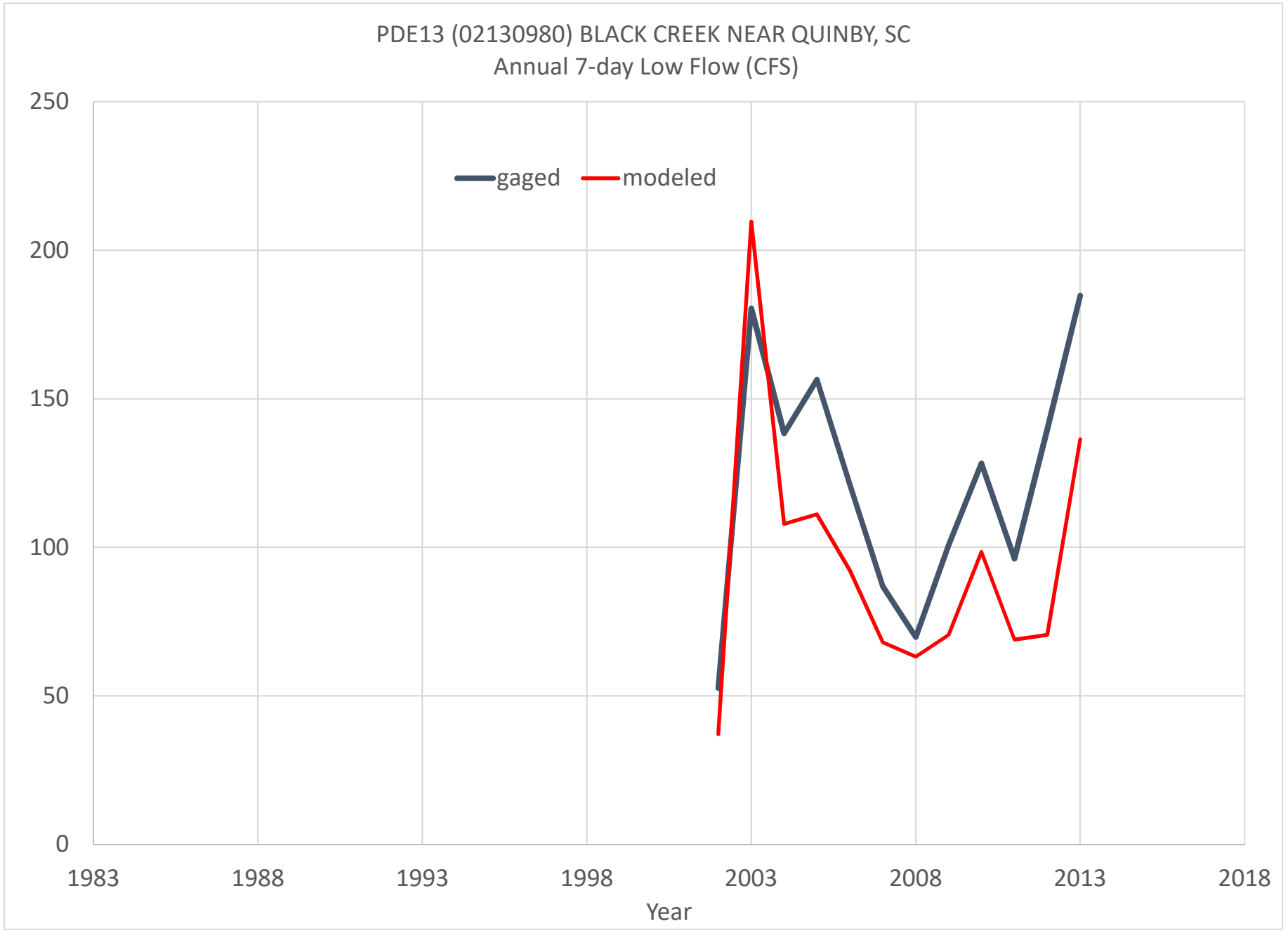

PDE12 (02130910) BLACK CREEK NEAR HARTSVILLE, SC (CFS)
modeled
gaged
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

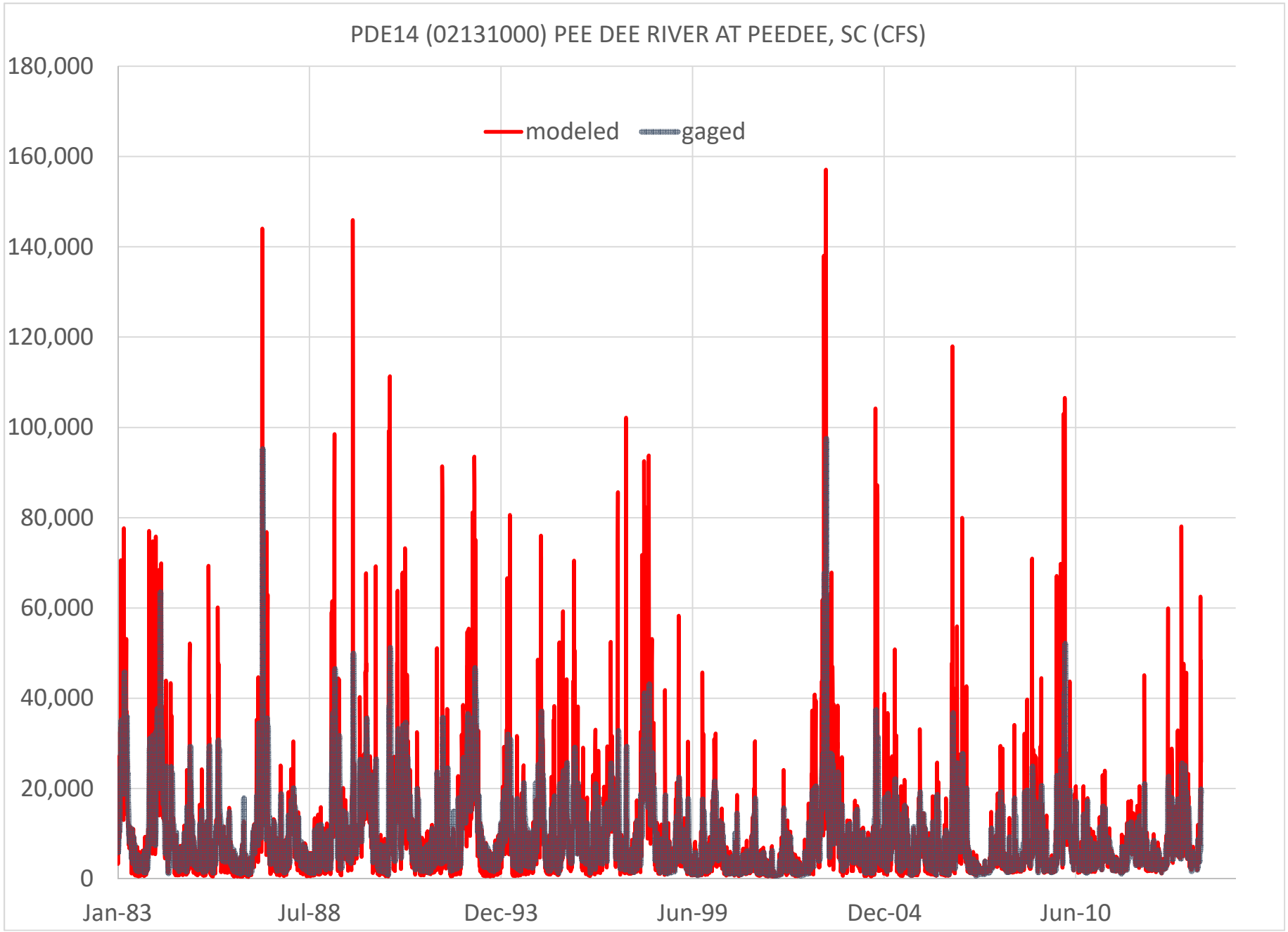

PDE12 (02130910) BLACK CREEK NEAR HARTSVILLE, SC
Daily Flow Percentiles (CFS)
4000
3500
3000
2500
2000
1500
1000
500
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

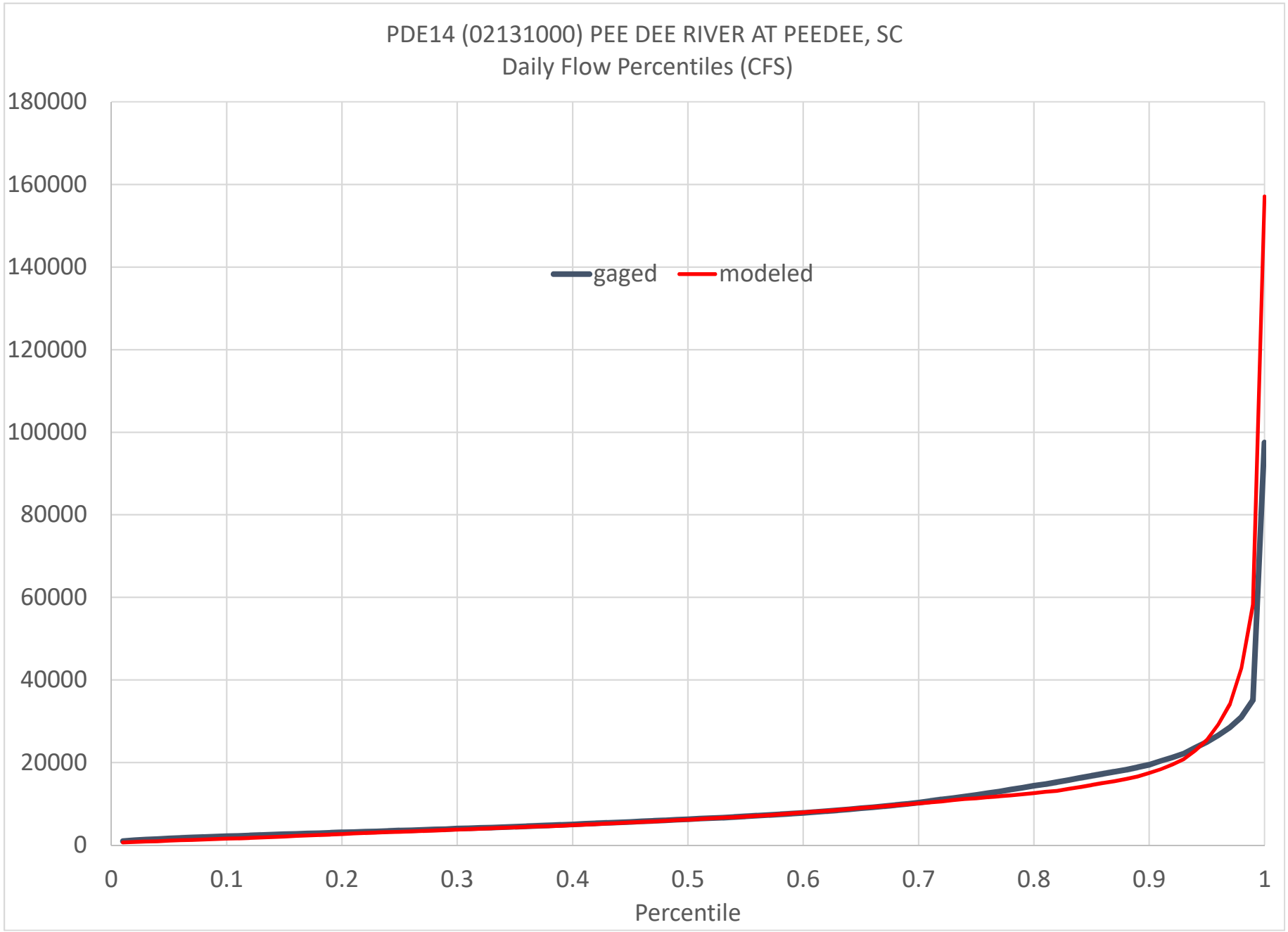

PDE12 (02130910) BLACK CREEK NEAR HARTSVILLE, SC
Annual 7-day Low Flow (CFS)
gaged
modeled
120
100
80
60
40
20
0
1983
1988
1993
1998
2003
2008
2013
2018
Year

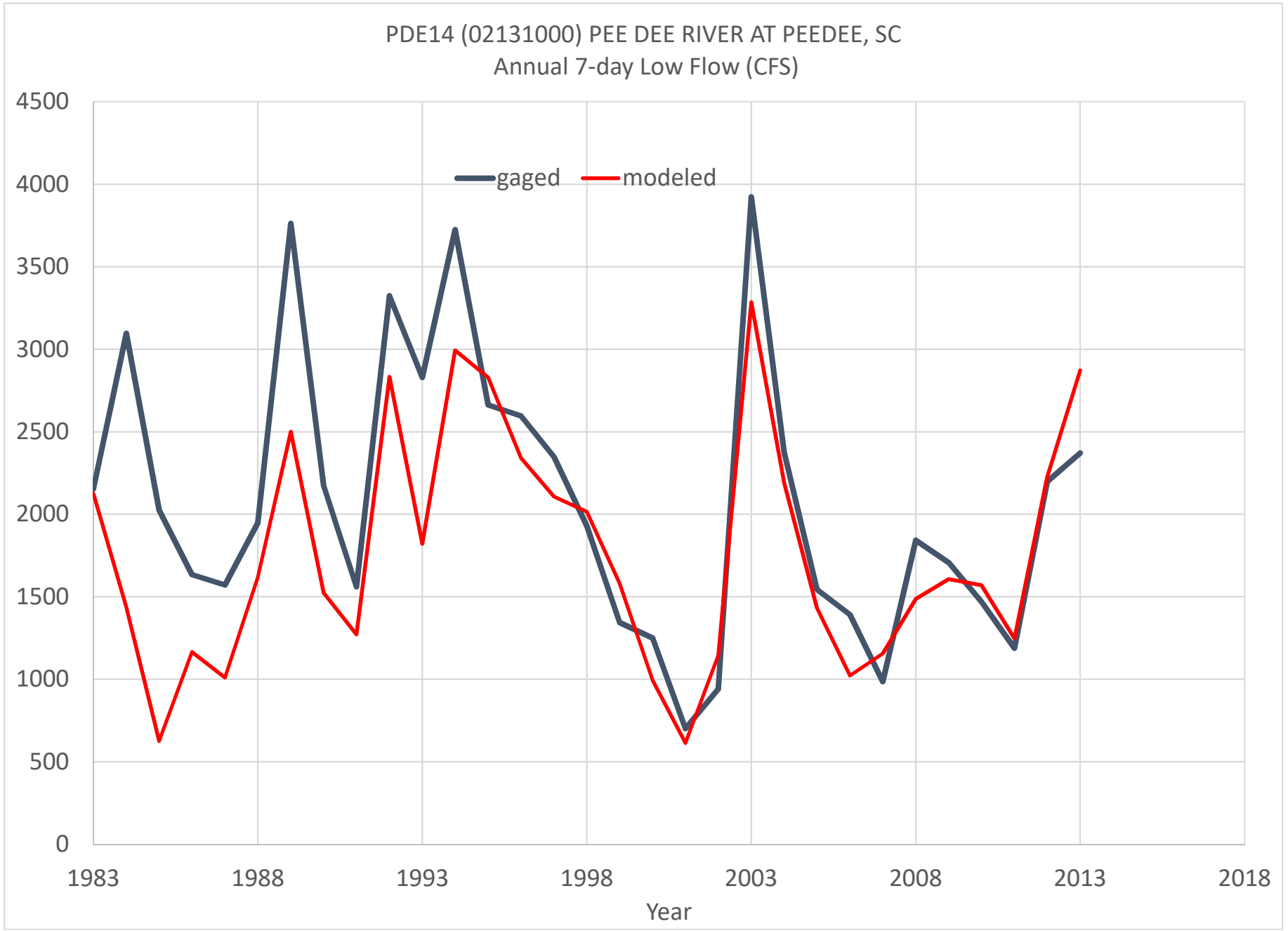

PDE13 (02130980) BLACK CREEK NEAR QUINBY, SC (CFS)
modeled
gaged
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

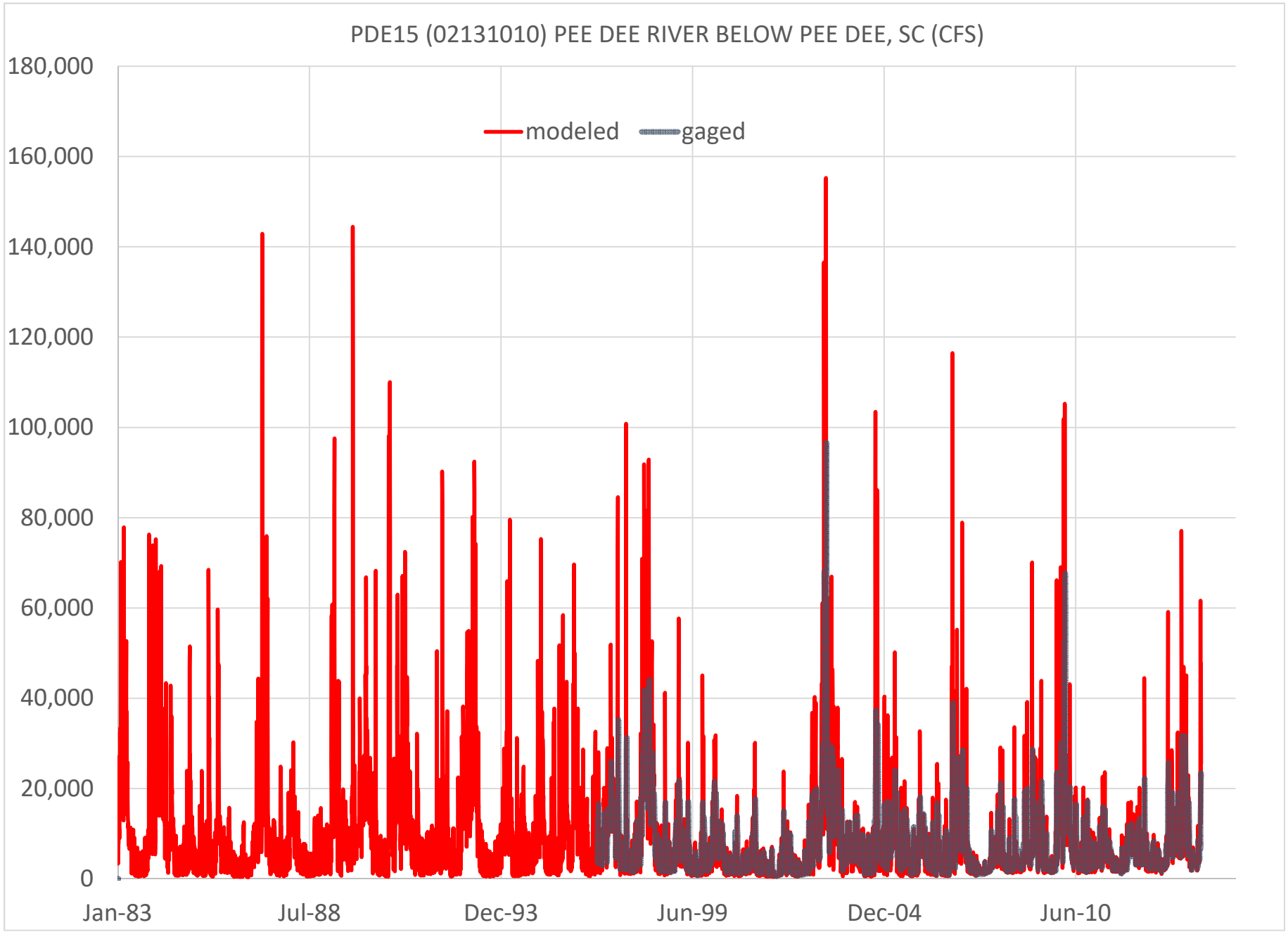

PDE13 (02130980) BLACK CREEK NEAR QUINBY, SC
Daily Flow Percentiles (CFS)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

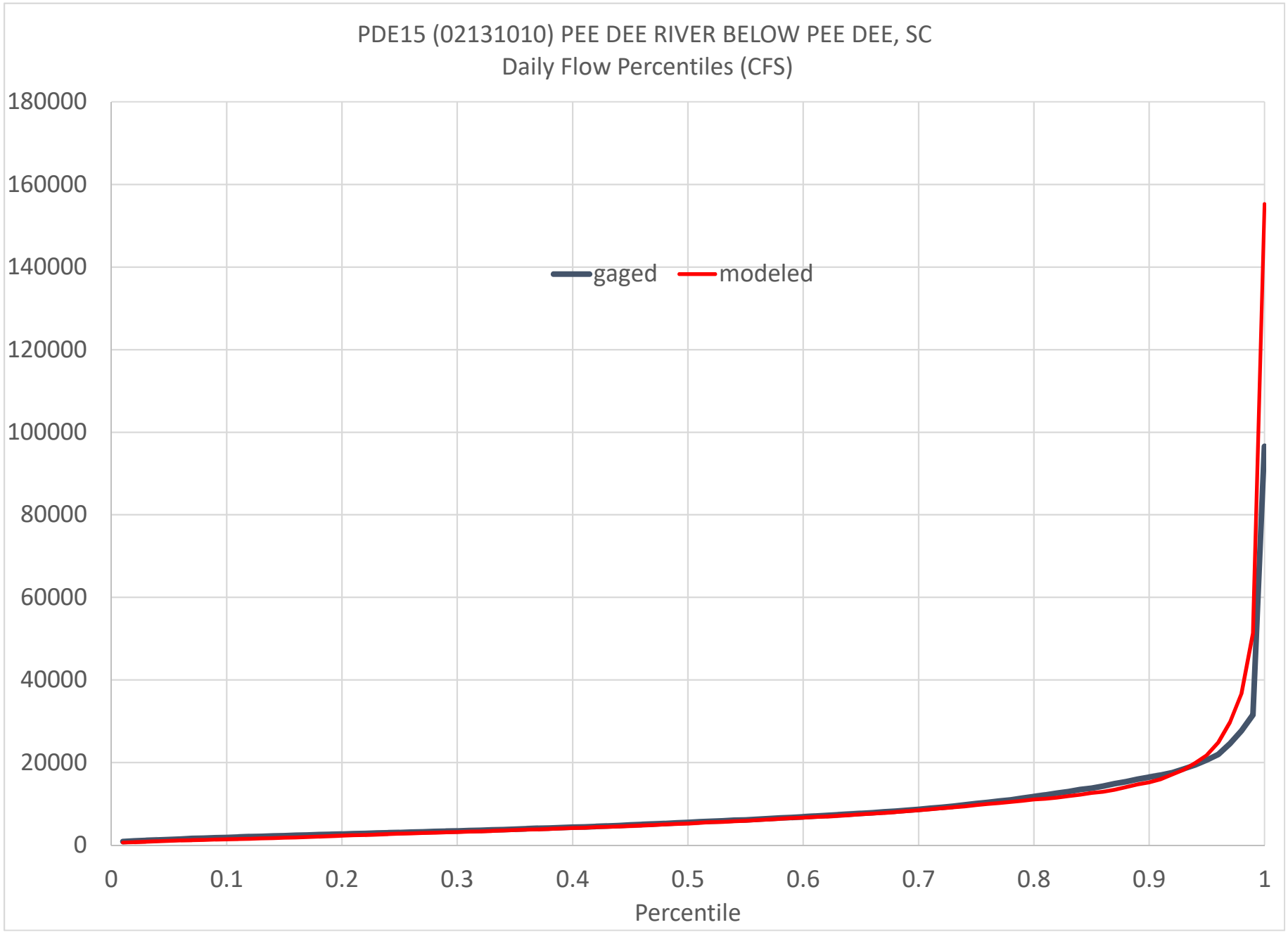

PDE13 (02130980) BLACK CREEK NEAR QUINBY, SC
Annual 7-day Low Flow (CFS)
250
200
150
100
50
0
gaged
modeled
1983
1988
1993
1998
2003
2008
2013
2018
Year

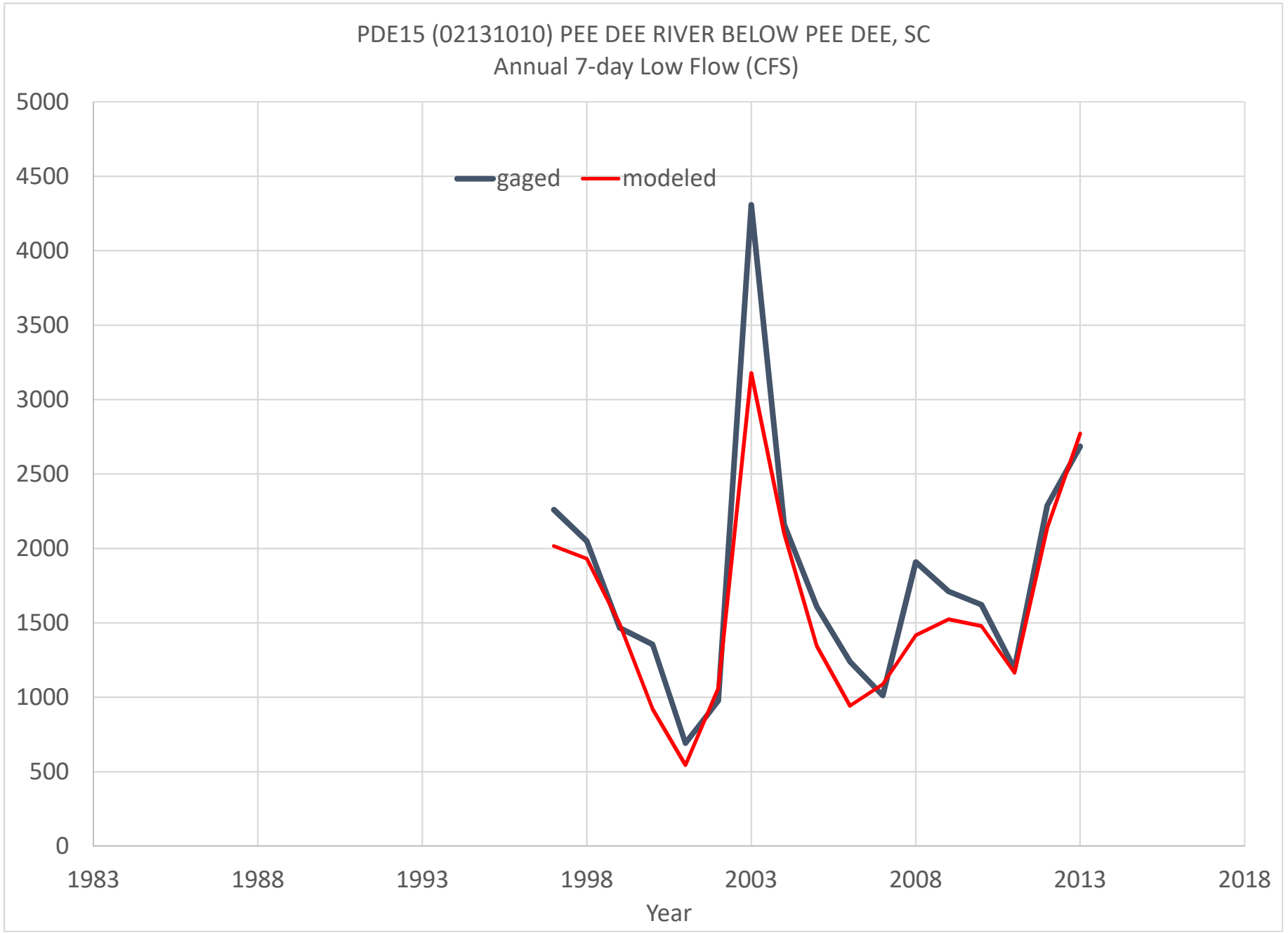

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC (CFS)
modeled
gaged
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

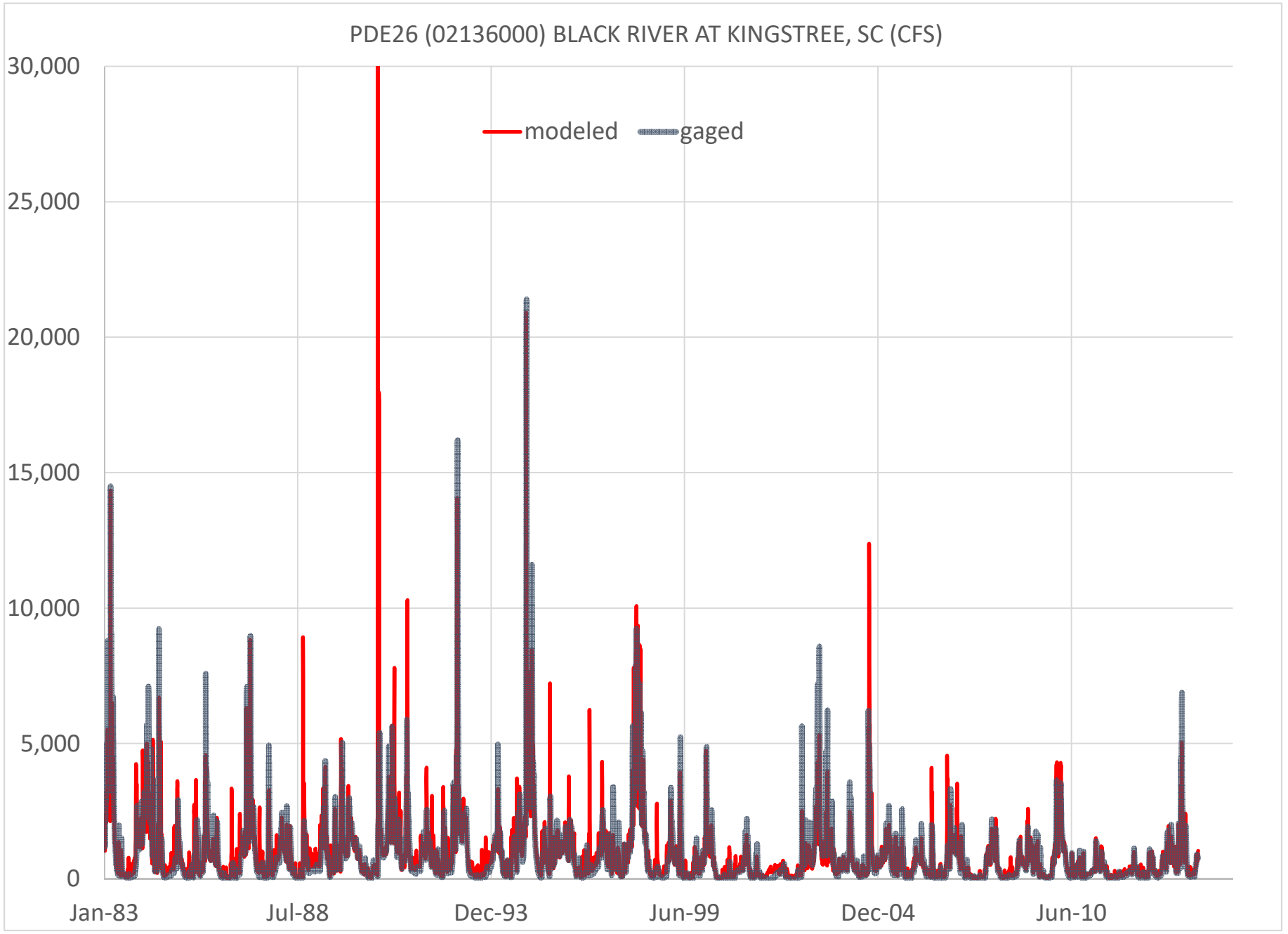

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC
Daily Flow Percentiles (CFS)
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

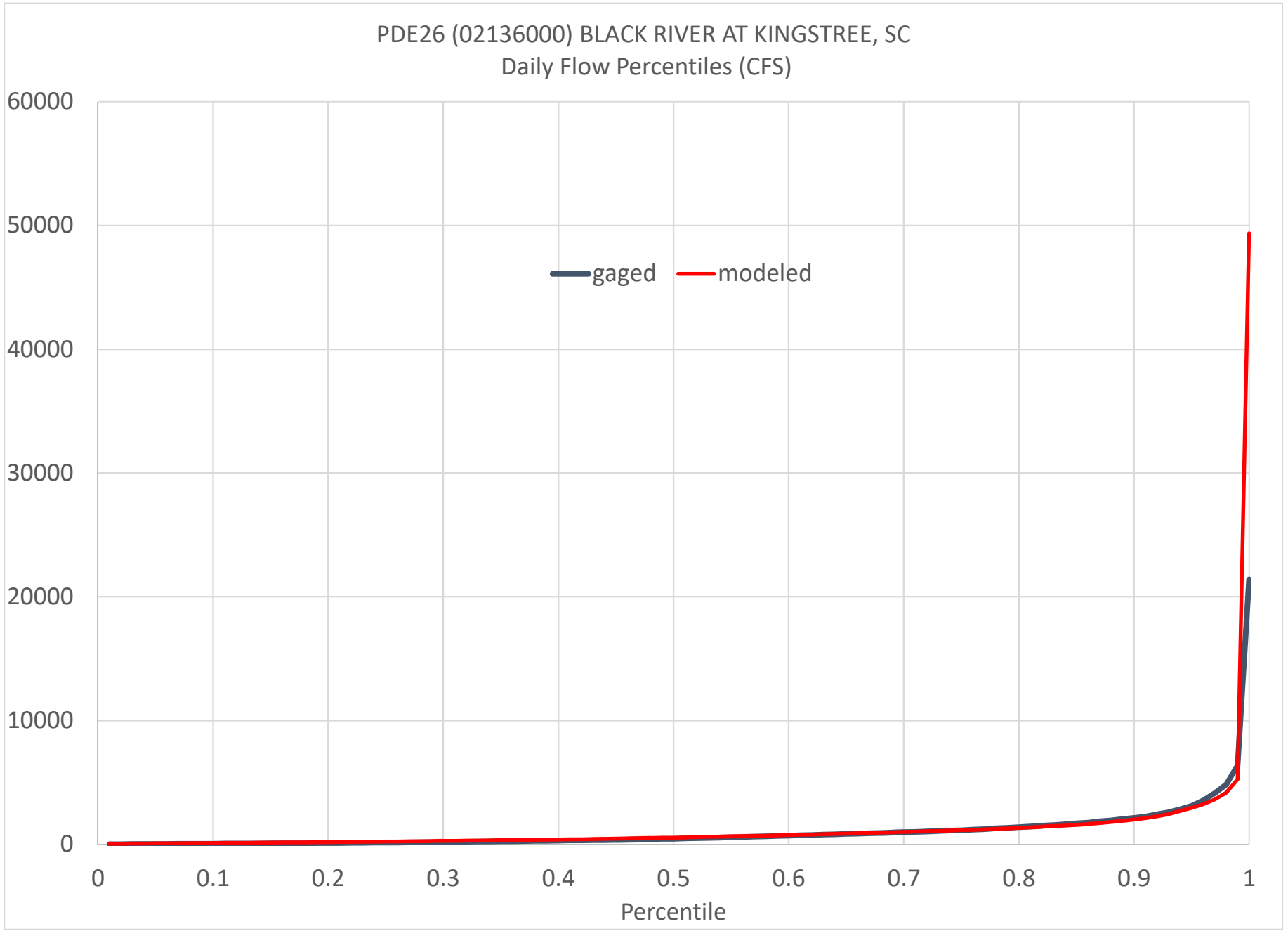

PDE14 (02131000) PEE DEE RIVER AT PEEDEE, SC
Annual 7-day Low Flow (CFS)
gaged
modeled
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1983
1988
1993
1998
2003
2008
2013
2018
Year

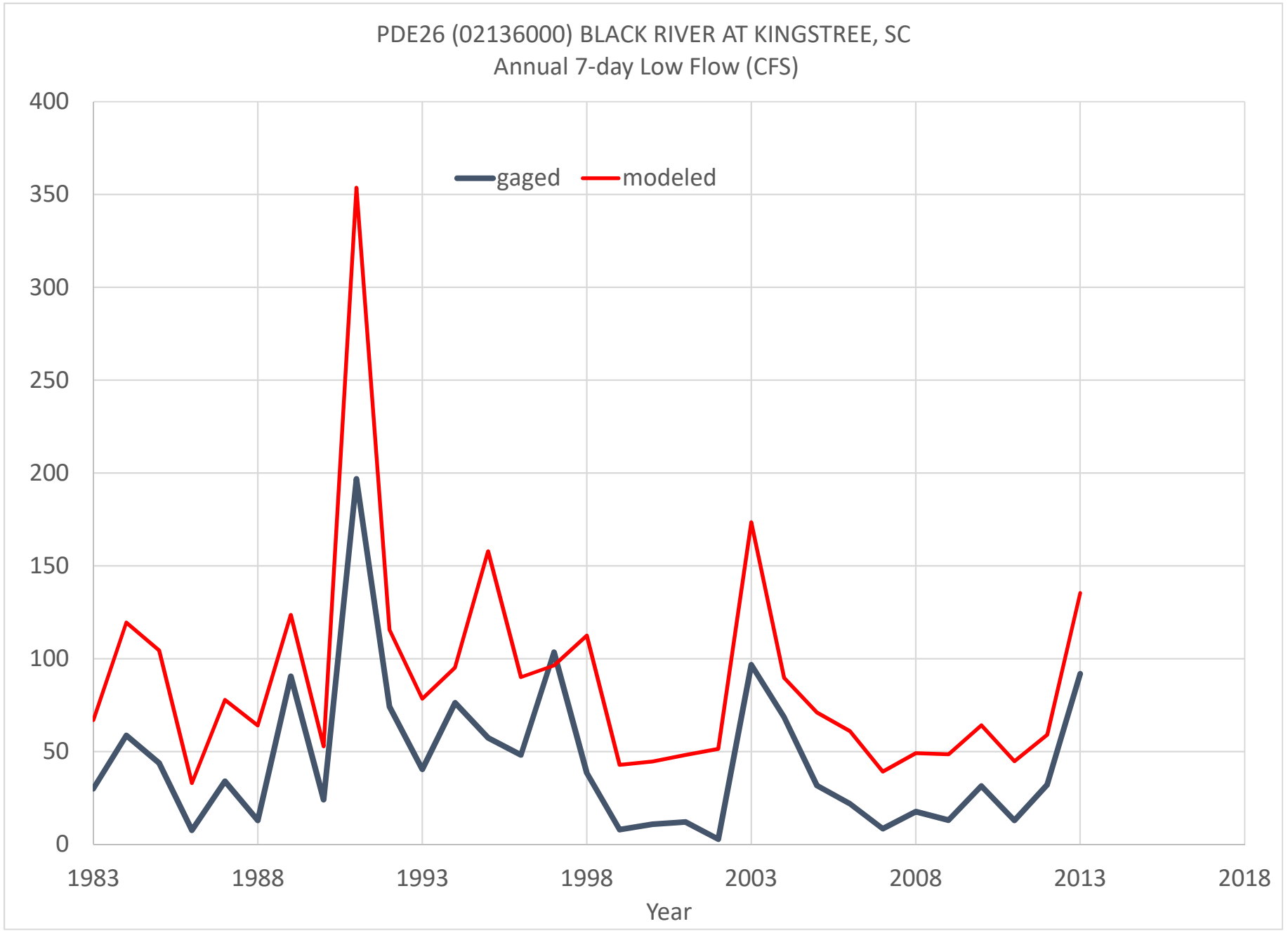

PDE15 (02131010) PEE DEE RIVER BELOW PEE DEE, SC (CFS)
modeled
gaged
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10

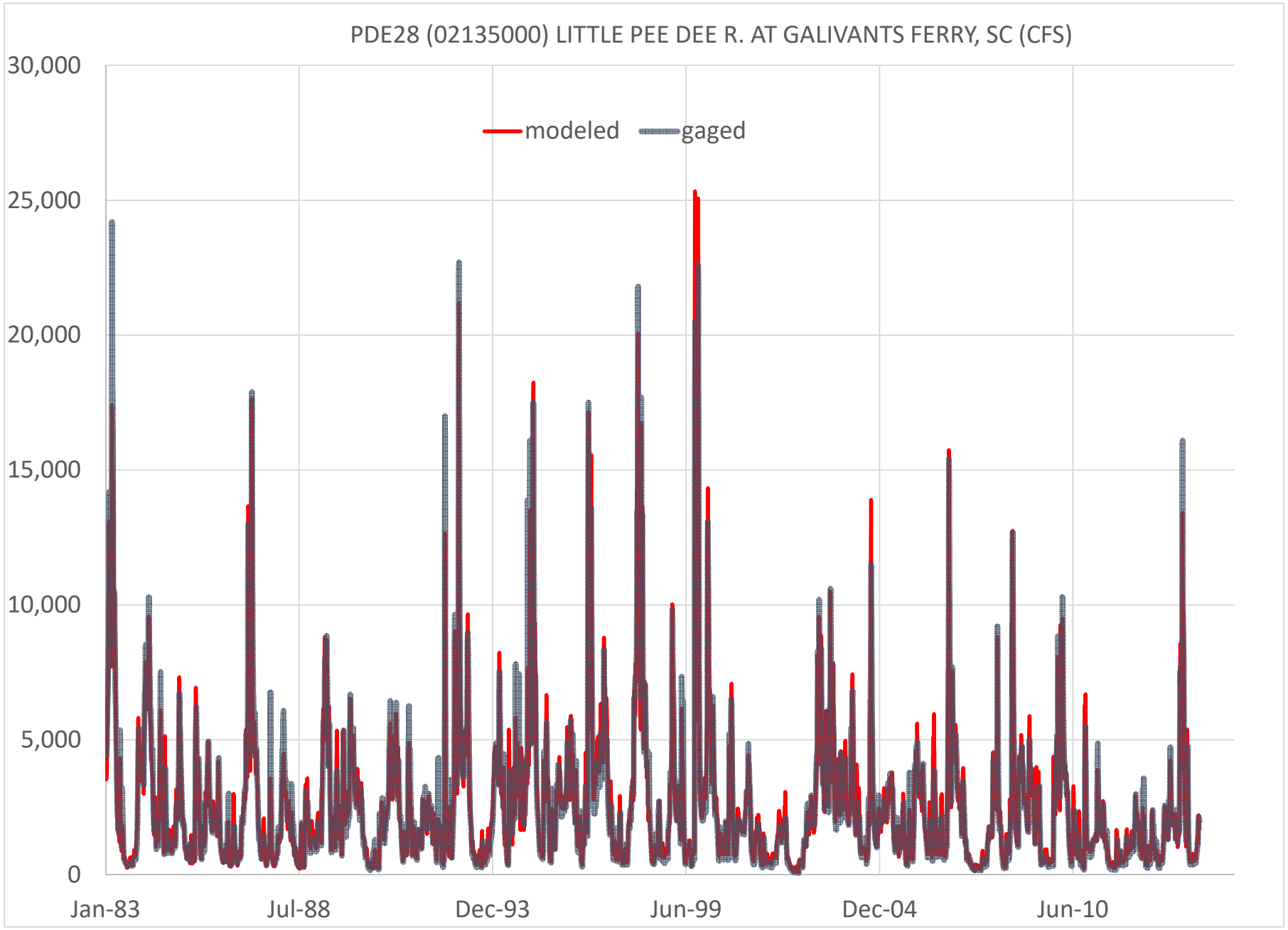

PDE15 (02131010) PEE DEE RIVER BELOW PEE DEE, SC
Daily Flow Percentiles (CFS)
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

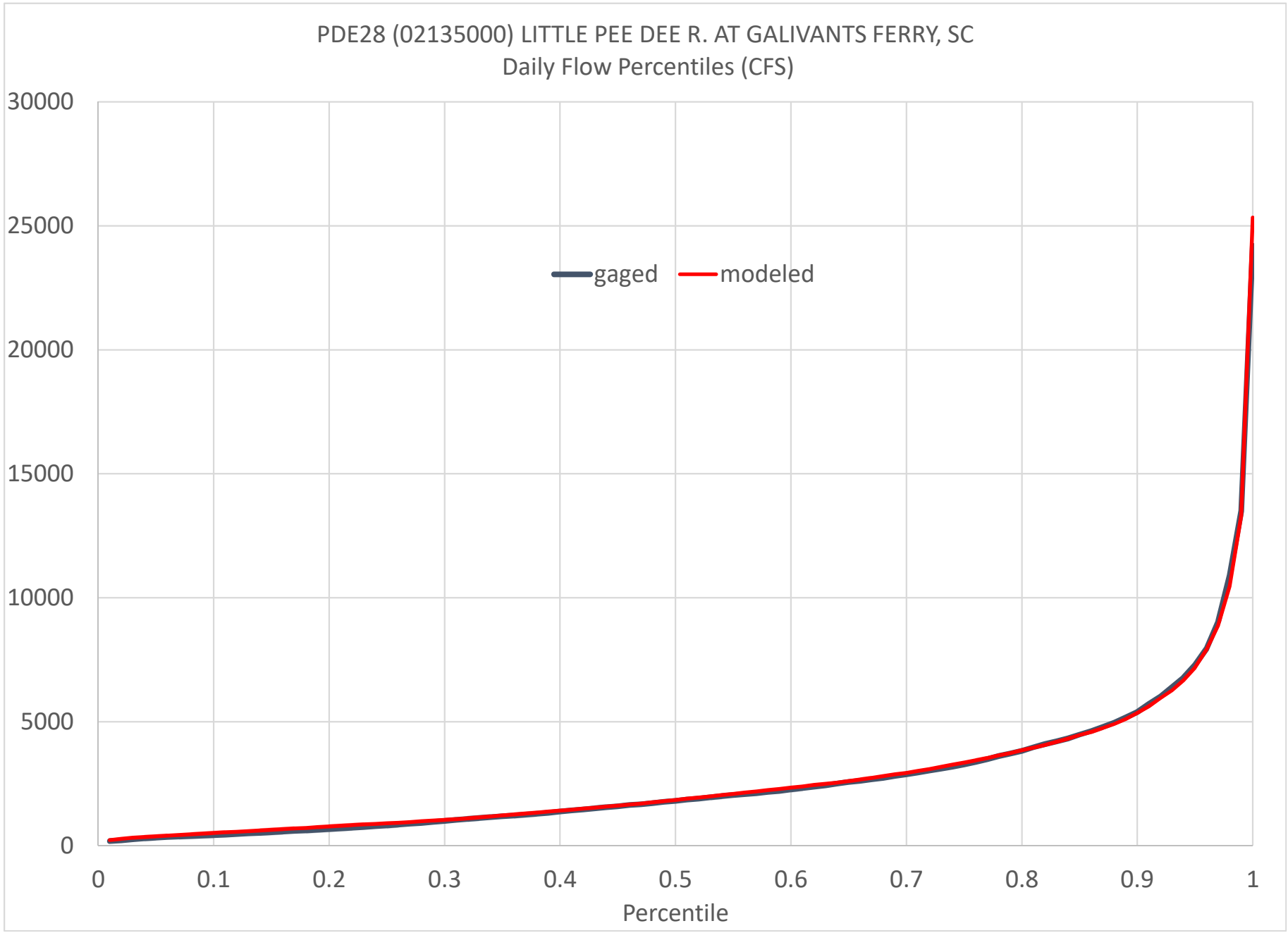

PDE15 (02131010) PEE DEE RIVER BELOW PEE DEE, SC
Annual 7-day Low Flow (CFS)
gaged
modeled
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1983
1988
1993
1998
2003
2008
2013
2018
Year

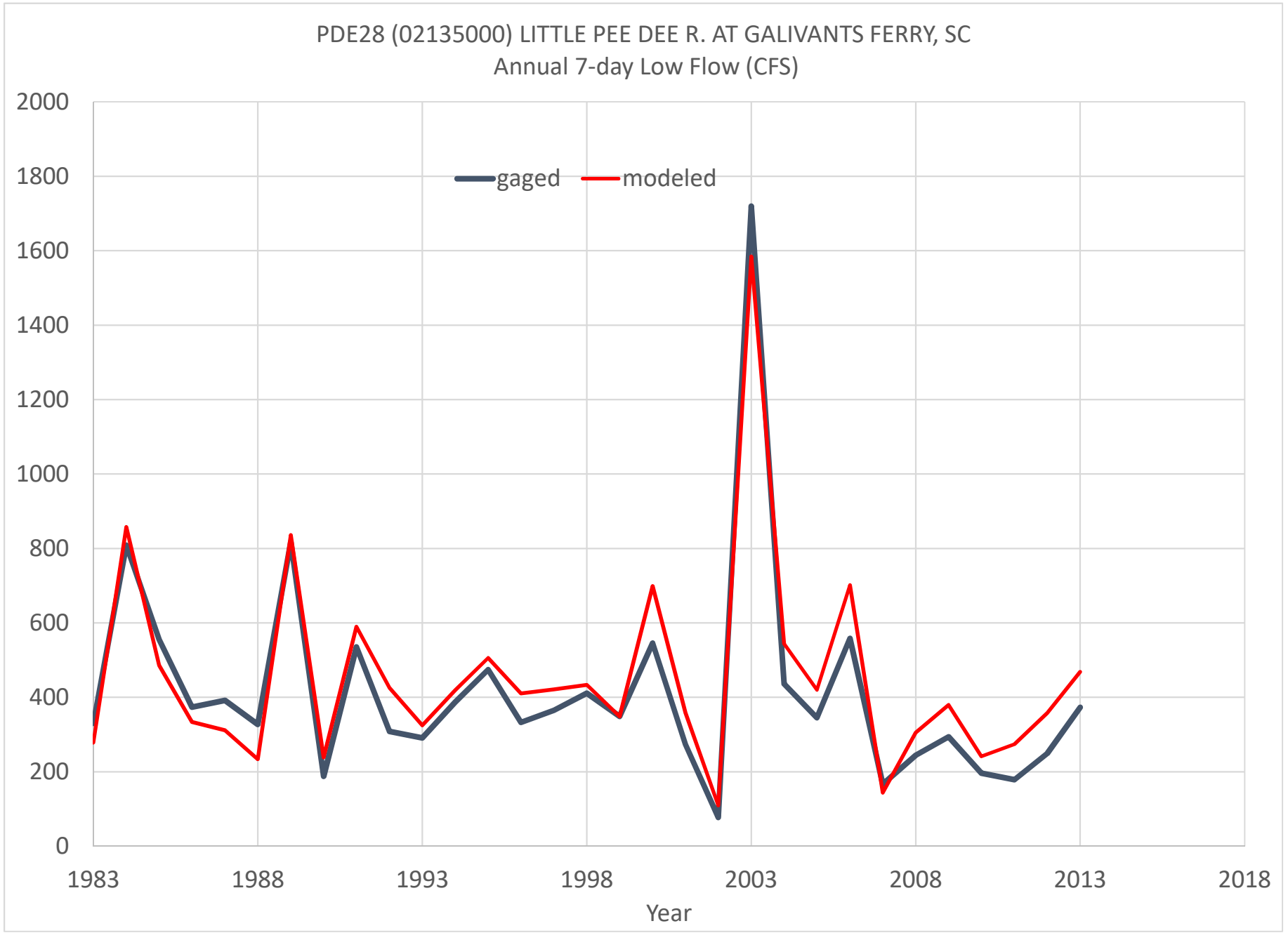

PDE26 (02136000) BLACK RIVER AT KINGSTREE, SC (CFS)
30,000
25,000
20,000
15,000
10,000
5,000
0
modeled
gaged
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10


PDE26 (02136000) BLACK RIVER AT KINGSTREE, SC
Daily Flow Percentiles (CFS)
60000
50000
40000
30000
20000
10000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile


PDE26 (02136000) BLACK RIVER AT KINGSTREE, SC
Annual 7-day Low Flow (CFS)
gaged
modeled
400
350
300
250
200
150
100
50
0
1983
1988
1993
1998
2003
2008
2013
2018
Year


PDE28 (02135000) LITTLE PEE DEE R. AT GALIVANTS FERRY, SC (CFS)
modeled
gaged
30,000
25,000
20,000
15,000
10,000
5,000
0
Jan-83
Jul-88
Dec-93
Jun-99
Dec-04
Jun-10


PDE28 (02135000) LITTLE PEE DEE R. AT GALIVANTS FERRY, SC
Daily Flow Percentiles (CFS)
30000
25000
20000
15000
10000
5000
0
gaged
modeled
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile


PDE28 (02135000) LITTLE PEE DEE R. AT GALIVANTS FERRY, SC
Annual 7-day Low Flow (CFS)
gaged
modeled
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1983
1988
1993
1998
2003
2008
2013
2018
Year