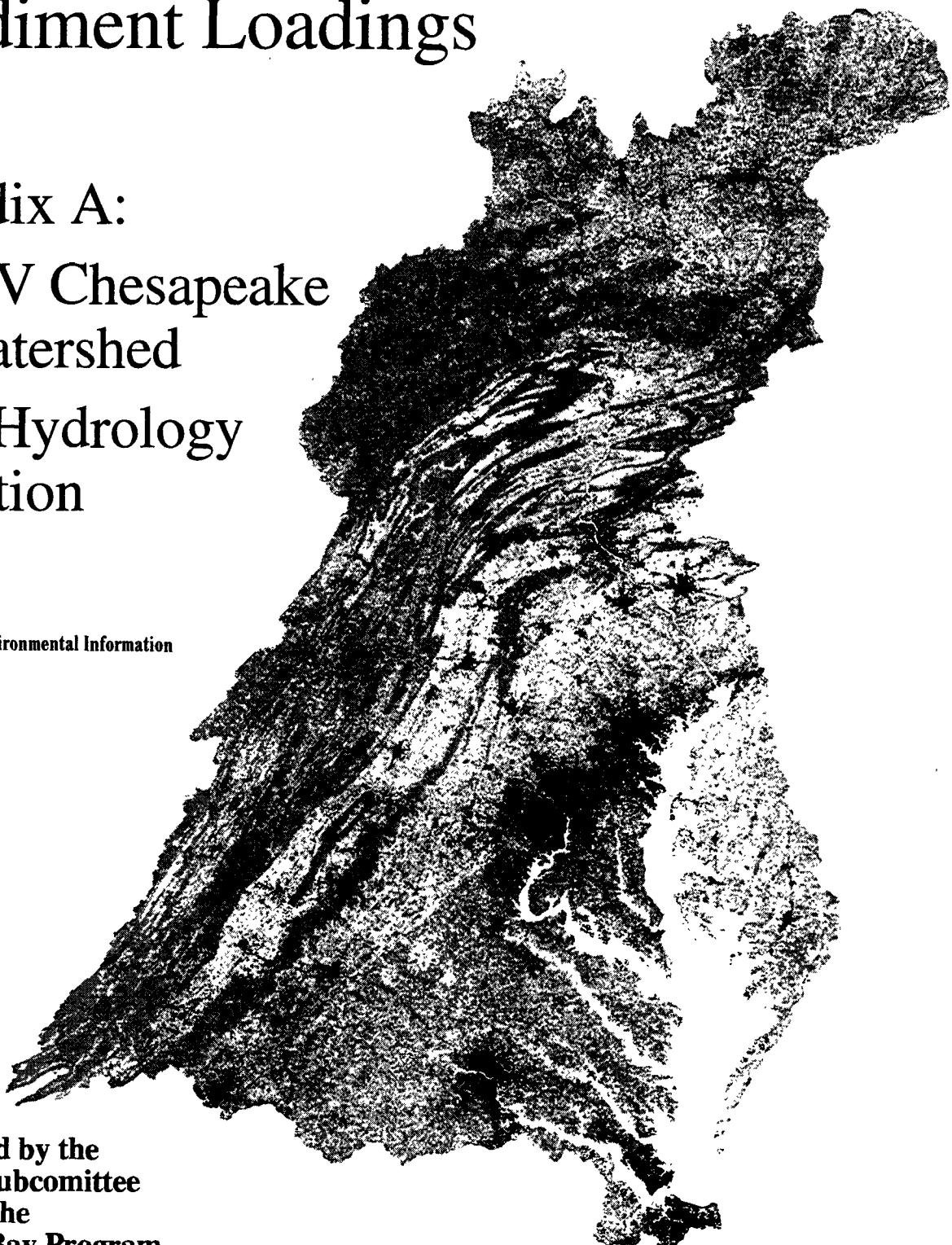


# Chesapeake Bay Watershed Model Application & Calculation of Nutrient & Sediment Loadings

## Appendix A: Phase IV Chesapeake Bay Watershed Model Hydrology Calibration Results

EPA Report Collection  
Regional Center for Environmental Information  
U.S. EPA Region III  
Philadelphia, PA 19103



Prepared by the  
Modeling Subcommittee  
of the  
Chesapeake Bay Program

EPA 903-R-98-004  
CBP/TRS 196/98

February 1998



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## **CHESAPEAKE BAY WATERSHED MODEL APPLICATION AND CALCULATION OF NUTRIENT AND SEDIMENT LOADINGS**

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### **Appendix A: Phase IV Chesapeake Bay Watershed Model Hydrology Calibration Results**

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A Report of the  
Chesapeake Bay Program  
Modeling Subcommittee  
Annapolis, MD

February 1998



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## **Principal Authors**

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## **LIST OF PHASE IV WATERSHED MODEL REFERENCE APPENDICES**

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- Appendix A Phase IV Chesapeake Bay Watershed Model Hydrology Calibration Results
- Appendix B Phase IV Chesapeake Bay Watershed Model Water Quality Calibration
- Appendix C Phase IV Chesapeake Bay Watershed Model Nonpoint Source Simulation
- Appendix D Phase IV Chesapeake Bay Watershed Model Precipitation and Meteorological Data Development and Atmospheric Nutrient Deposition
- Appendix E Phase IV Chesapeake Bay Watershed Land Use & Model Linkages to the Airshed & Estuarine Models
- Appendix F Phase IV Chesapeake Bay Watershed Model Point Source Loads and Water Supply Diversions
- Appendix G Observed Water Quality Data Used for Calibration, A Simulation of Regression Loads, and a Confirmation Scenario of the Phase IV Chesapeake Bay Watershed Model
- Appendix H Development of BMP Input Parameters To Track Nutrient Reduction Goals with the Phase IV Chesapeake Bay Watershed Model

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## Acknowledgments

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This is to acknowledge the substantial contribution of the United States Geological Survey offices of Virginia, Maryland, Pennsylvania, and West Virginia for their timely processing of seemingly endless data requests. The scientists, engineers, and managers of the Modeling Subcommittee and the Model Evaluation Group are acknowledged for their guidance and review. This document and other Chesapeake Bay Program modeling documents can be found on the Modeling Subcommittee web page:

<http://www.chesapeakebay.net/bayprogram/committ/mdsc/model.htm>

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## APPENDIX SUMMARY

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Appendix A documents in detail the Phase IV Watershed Model hydrology calibration. The results are presented as plots and statistical tables that compare the simulated and observed flows for the 8 years of calibration (1984-1991) for 17 flow calibration stations of the Chesapeake Bay. Specifically, this appendix includes the following plots: (1) Observed and Simulated Flows; (2) Actual Error of the Flow; (3) Observed and Simulated Cumulative Flows; (4) Actual Error versus Percentile Sample Population; (5) Paired Frequency Distribution of Simulated and Observed Data versus Percentile of Population; and (6) Scatter Plot and Regression of Simulated versus Observed with Ideal Line. The appendix also contains the following statistical tables: (1) Comparison of Annual Total Observed and Simulated Flows; (2) Comparison of Daily and Average Monthly Total Flow Observed and Simulated Regressions; and (3) Average Seasonal Regressions. Regression statistics include r-squared, intercept, and slope statistics for the entire data set, on an annual basis, on a seasonal basis..

The daily observed and simulated flow plots generally show good to excellent agreement between the model and data. The differences are mainly attributable to storm events and high-flow, snow-melt events of the spring freshet.

The observed and simulated cumulative flows vs. time show both under and over estimation relative to the observed flow, but no particular bias for any of these stations.

The actual error plots generally display a flat curve around 0 cubic feet per second (cfs) and a sigmoidal shape indicating the errors are normally distributed. A sigmoidal plot centered on 50% of the population indicates a lack of bias in the simulation.

The frequency distribution of paired simulated and observed flow plotted against percentile of sample population show good agreement, with the greatest differences between simulated and observed during very high flows (95th percentile or higher) or very low flows (5th percentile or lower). Note that in the scatter plots the ideal line is drawn (slope = 1, intercept = 0) as a point of reference for the flow data and that the flow regression statistics are displayed. As a point of comparison, the tabular regression statistics are for the log flow regression and the regression statistics displayed on the scatter plot are for untransformed flow data.

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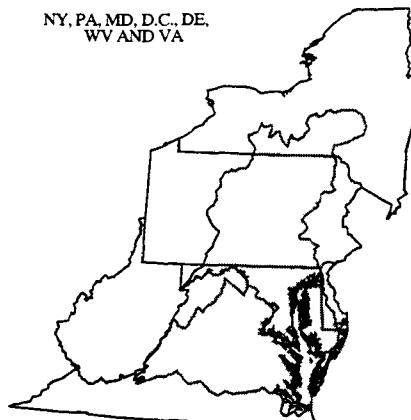
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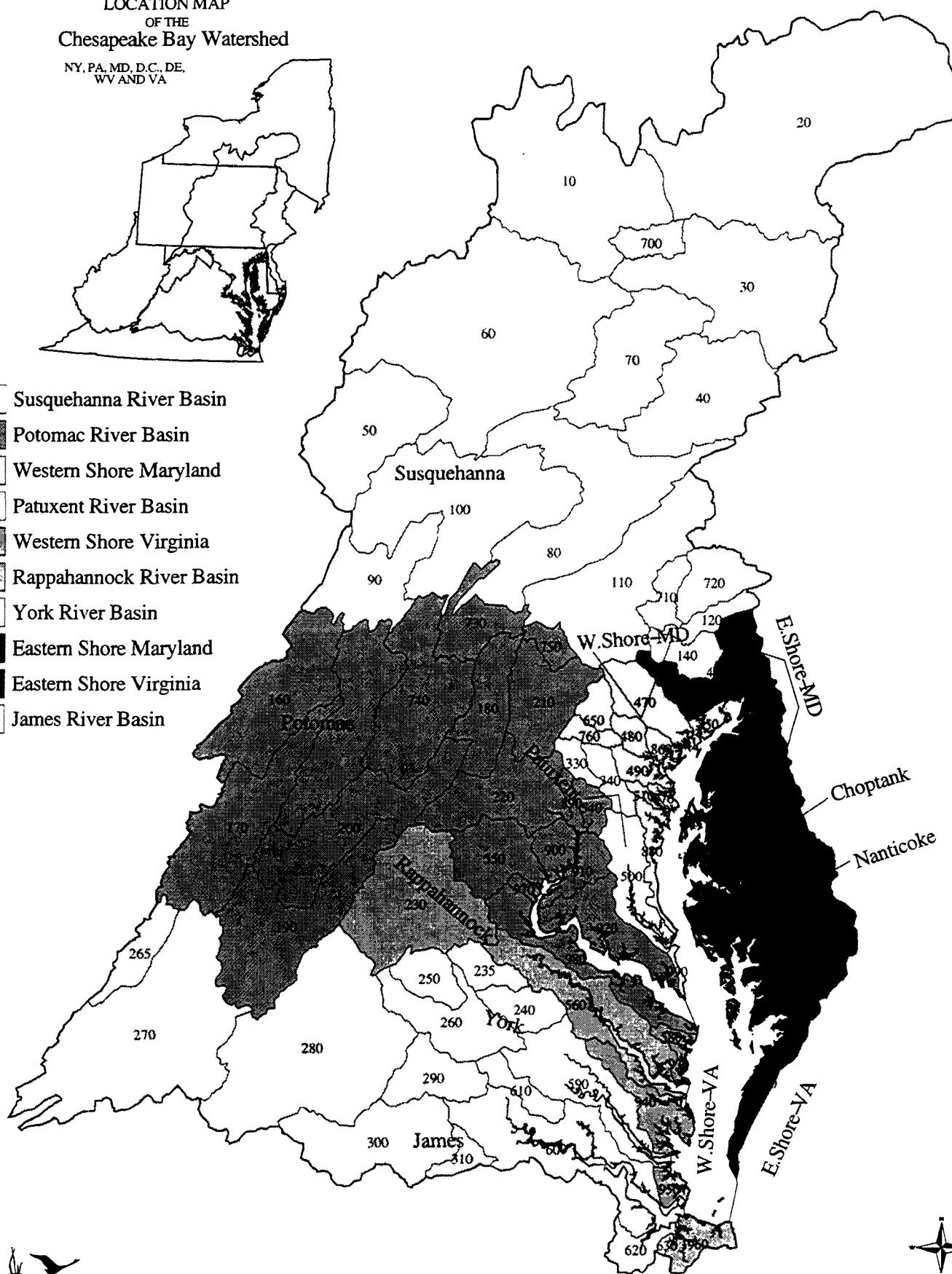
# Major Basins of the Chesapeake Bay Watershed

LOCATION MAP  
OF THE  
Chesapeake Bay Watershed

NY, PA, MD, D.C., DE,  
WV AND VA



- Susquehanna River Basin
- Potomac River Basin
- Western Shore Maryland
- Patuxent River Basin
- Western Shore Virginia
- Rappahannock River Basin
- York River Basin
- Eastern Shore Maryland
- Eastern Shore Virginia
- James River Basin



**Table A**  
**Characteristics of Stations Used in Hydrology Calibration**

Phase IV Model Segment	Station No.	Location	Latitude	Longitude	Drainage Area (mi <sup>2</sup> )	Gauge (ft. above NGVD)	Average Discharge
40	1540500	Montour County, PA, on right bank 200 ft upstream from Mill Street bridge on State Highway 54 at Danville and 0.8 mi upstream from Mahoning Creek.	40°57'29"	76°37'10"	11220	431.29	89 years, 15,270 cfs, 18.48 in/yr as 1988.*
70	1553500	Northumberland County, PA, at downstream side of left abutment of Market Street bridge on State Highway 45 at Lewisburg, 0.2 mi downstream from Buffalo Creek and 7.4 mi upstream from mouth.	40°58'05"	76°52'25"	6847	428.20. 10/20/87 - 9/30/88, nonrecord-	62 years, 757 cfs, 23.21 in/yr as 1991.*
100	1567000	Perry County, PA, on right bank at downstream side of bridge on State Highway 34 at Newport and 1,000 ft upstream from Little Buffalo Creek.	40°28'42"	77°07'46"	3354	363.93	89 years, 4,280 cfs, 17.37 in/yr as 1988.
710	1570500	Dauphin County, PA, on east bank of City Island, 60 ft downstream from Market Street bridge in Harrisburg, 3,670 ft upstream from sanitary dam, and 1.7 mi upstream from Paxton Creek.	40°15'17"	76°53'11"	24100	290.01	98 years, 34,220 cfs, 19.28 in/yr as 1988.

Phase IV Model Segment	Station No.	Location	Latitude	Longitude	Drainage Area (mi <sup>2</sup> )	Gauge (ft. above NGVD)	Average Discharge
175	1613000	Washington County, MD, on left bank, 0.2 mi downstream from Little Tonoloway Creek, 0.5 mi downstream from bridge on US Highway 522 at Hancock, 1.1 mi upstream from Tonoloway Creek (formerly called Great or Big Tonoloway Creek), and at mile 239.	39°41'49"	78°10'39"	4073	383.68	56 years, 4,154 cfs, 13.85 in/yr as 1988.
140	1578310	Harford County, MD, on downstream side of Conowingo Dam, 1.0 mi southwest of Conowingo, and 9.9 mi upstream from mouth.	39°39'31"	76°10'28"	27100	5.00	19 years, 41,870 cfs, 20.98 in/yr as 1986.
220	1646580	Arlington County, DC, under right downstream side of bridge on Virginia State Highway 123, and at river mile 115.9.	38°55'46"	77°07'02"	11570	N/A	N/A
200	1636500	Jefferson County, WV, on left bank 0.4 mi downstream from Cattail Run, 1.0 mi upstream from Millville, 5.0 mi upstream from Harpers Ferry, and at mile 5.0.	39°16'55"	77°47'22"	3040	293.00	71 years, 2699 cfs, 12.06 in/yr as 1986.
780	1487000	Bridgeville, DE, on left bank at downstream side of highway bridge, 800 ft downstream from Gum Branch, 2.5 mi southeast of Bridgeville, and 50.5 mi upstream from mouth.	38°43'42"	75°33'44"	75	13.64	45 years, 89.8 cfs, 16.17 in/yr as of 1988.

Phase IV Model Segment	Station No.	Location	Latitude	Longitude	Drainage Area (mi <sup>2</sup> )	Gauge (ft. above NGVD)	Average Discharge
280	2035000	Goochland County, VA, on left bank, 200 ft downstream from bridge at State Highway 45 between Pemberton and Cartersville, 1.8 mi downstream from Willis River and at mile 156.4.	37°40'15"	78°05'10"	6257	163.90	89 years, 7,087 cfs, 15.38 in/yr as 1988.
760	1589000	Baltimore County, on left bank at downstream side of highway bridge at Hollofield, 0.3 mi downstream from Dogwood Run, 3.0 mi north of Ellicott City and 28 mi upstream from mouth.	39°18'36"	76°47'34"	285	187.70	N/A
310	2041650	Chesterfield County, VA, on left bank at upstream side of bridge on State Highway 600, 0.2 mi south of Matoca, 2.0 mi upstream from Rohoic Creek, 2.8 mi downstream from Lake Chesdin, 3.5 mi west of Petersburg, and at mile 15.9.	37°13'28"	77°28'32"	1344	68.30	18 years, 1,476 cfs, 14.91 in/yr as 1987. (minimum, 41 cfs, Oct. 4, 1981.)
230	1668000	Spotsylvania County, VA, on right bank 1.6 mi upstream from dam of Virginia Power, 2.2 mi downstream from Motts Run, and 3.8 mi upstream from Frederickburg.	38°19'20"	77°31'05"	1596	55.18	80 years, 1,660 cfs, 14.12 in/yr as 1988.
240	1674500	King and Queen County, VA, on left bank 0.4 mi upstream from bridge on State Highway 628, 2.4 mi north of Beulahville, and 2.7 mi downstream from Maracossic Creek.	37°53'16"	77°09'48"	601	12.43	46 years, 591 cfs, 13.35 in/yr as 1987.

Phase IV Model Segment	Station No.	Location	Latitude	Longitude	Drainage Area (mi <sup>2</sup> )	Gauge (ft. above NGVD)	Average Discharge
260	1673000	Hanover County, VA, on right bank 100 ft downstream from bridge on State Highway 614, 0.3 mi upstream from Mechumps Creek, 2.0 mi east of Hanover, and 7.0 mi upstream from Millpond Creek.	37°46'03"	77°19'57"	1081	14.72	46 years, 1,006 cfs, 12.64 in/yr as 1988.
340	1594440	Anne Arundel County, MD, on left bank 45 ft upstream from bridge on U.S. Highway 50, 3.0 mi west of Bowie City Hall, 3.1 mi downstream from mouth of Little Patuxent River, 4.2 mi northwest of Davidsonville, and 60 mi upstream from mouth.	38°57'21"	76°41'36"	348	13.10	11 years, 362 cfs, 14.13 in/yr as 1988.
770	1491000	Caroline County, MD, on left bank at Highway bridge, 0.1 mi upstream from Gravelly Branch, 2.0 mi northeast of Greensboro, and 60 mi upstream from mouth..	38°59'50"	75°47'09"	113	3.51	41 years, 130 cfs, 15.62 in/yr as 1989.

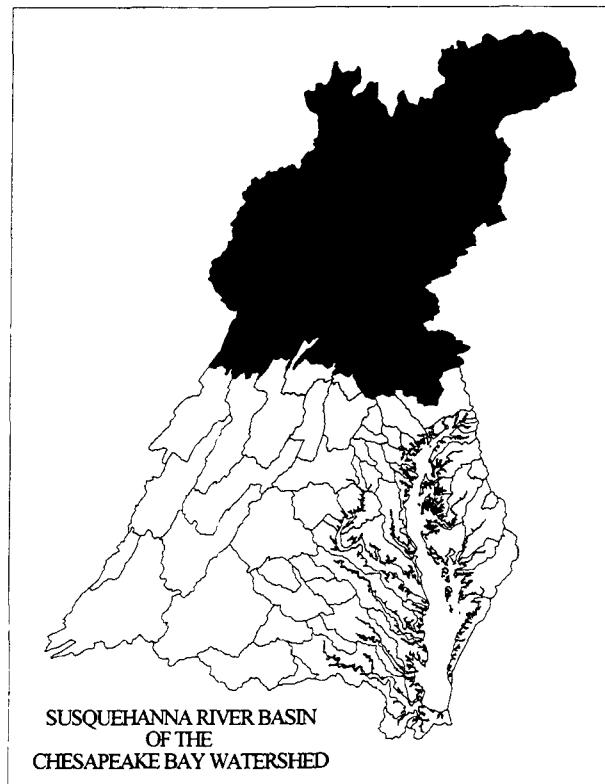
\*: Datum of gauge, above National Geodetic Vertical Datum of 1929; Water-stage recorder, if not otherwise indicated.

# Monitoring Stations

## Chesapeake Bay Watershed

### Phase IV Model Segments:

#### Susquehanna River Basin



**A.1.1 EAST BRANCH SUSQUEHANNA RIVER NEAR DANVILLE, PA AT  
SEGMENT 40 (1540500)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

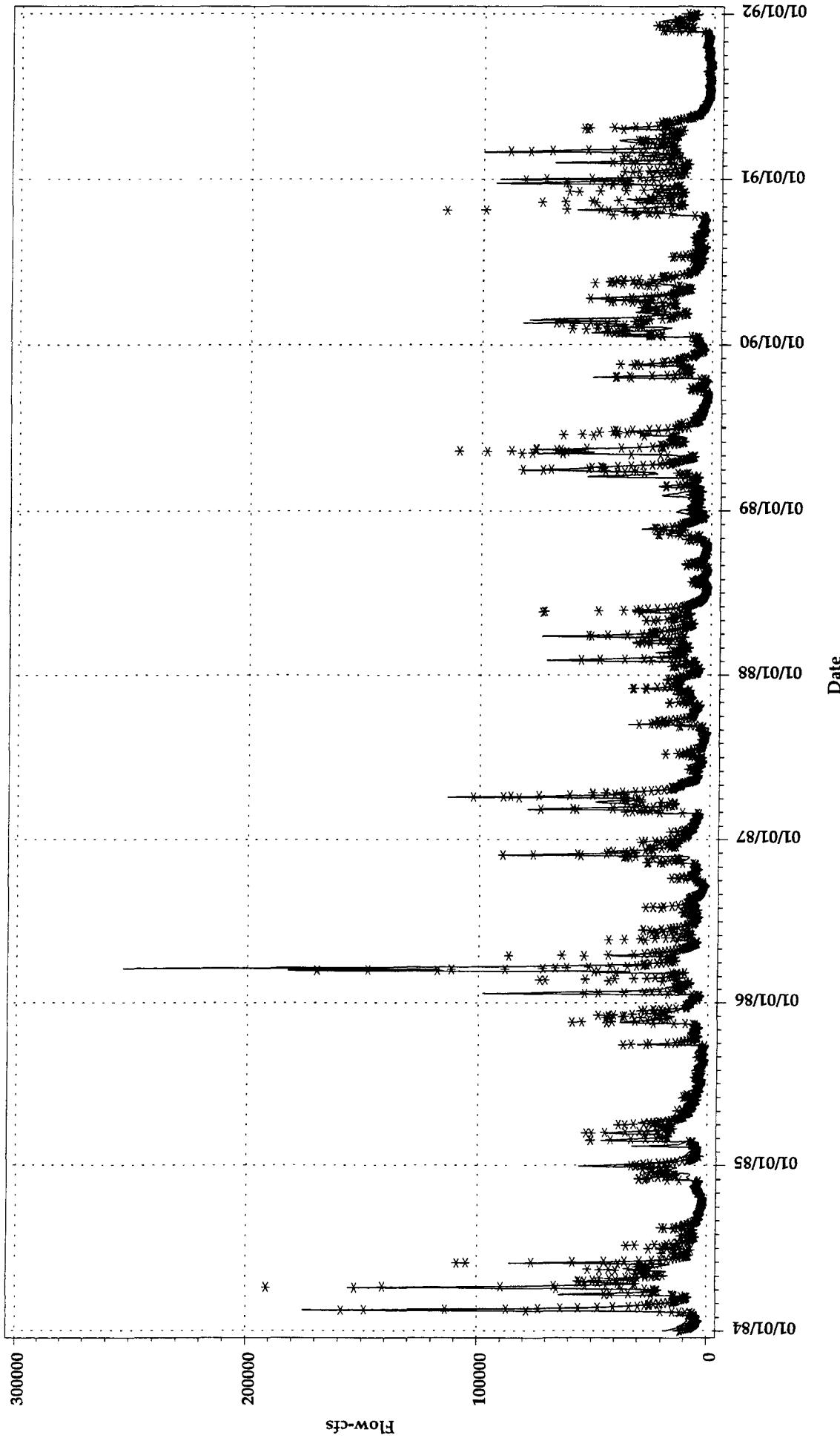
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# East Branch Susquehanna River at Segment 40 Observed and Simulated versus Time

## Flow-cfs

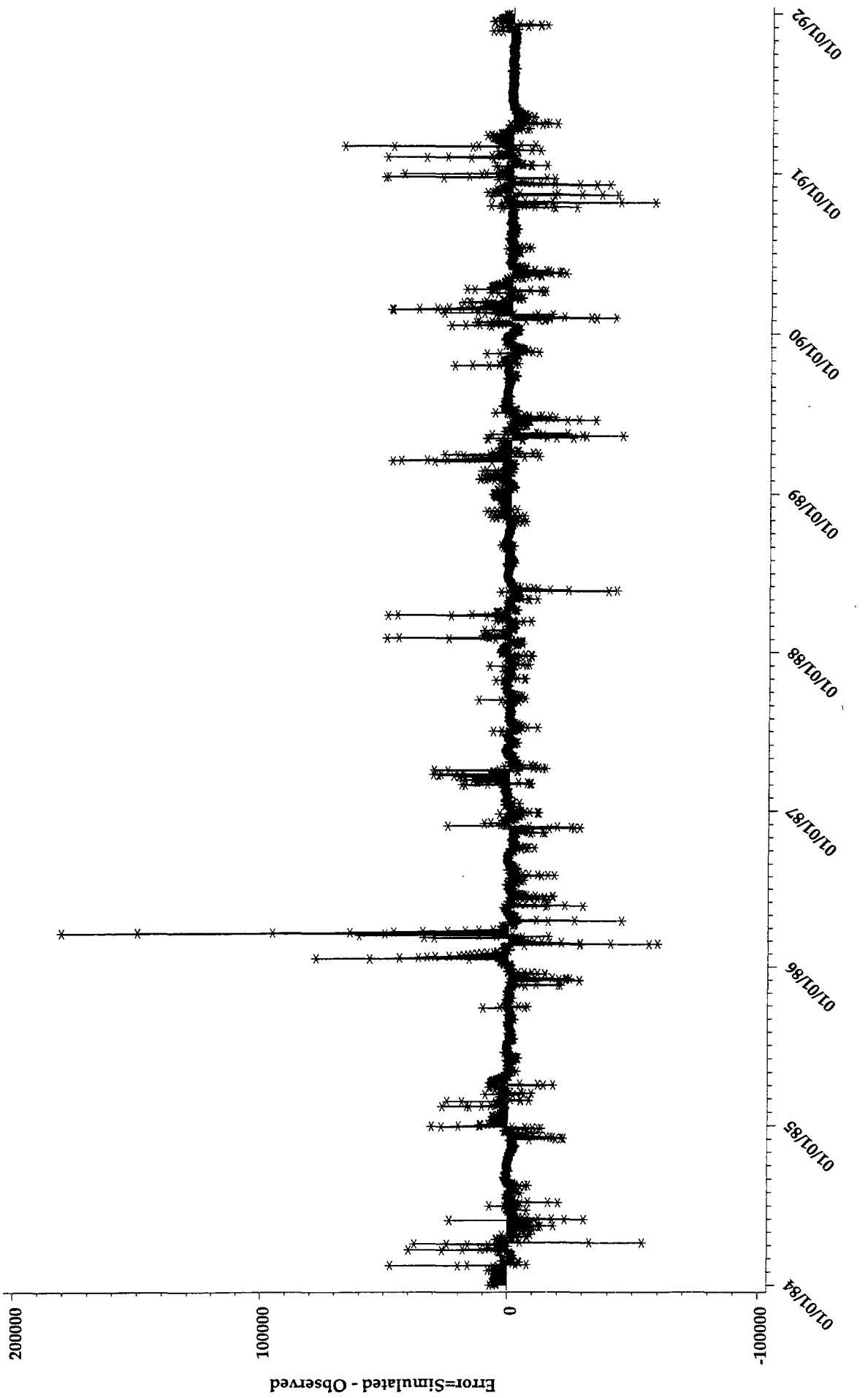
(\*=Observed, -=Simulated)



# East Branch Susquehanna River at Segment 40

## Actual Error versus Time

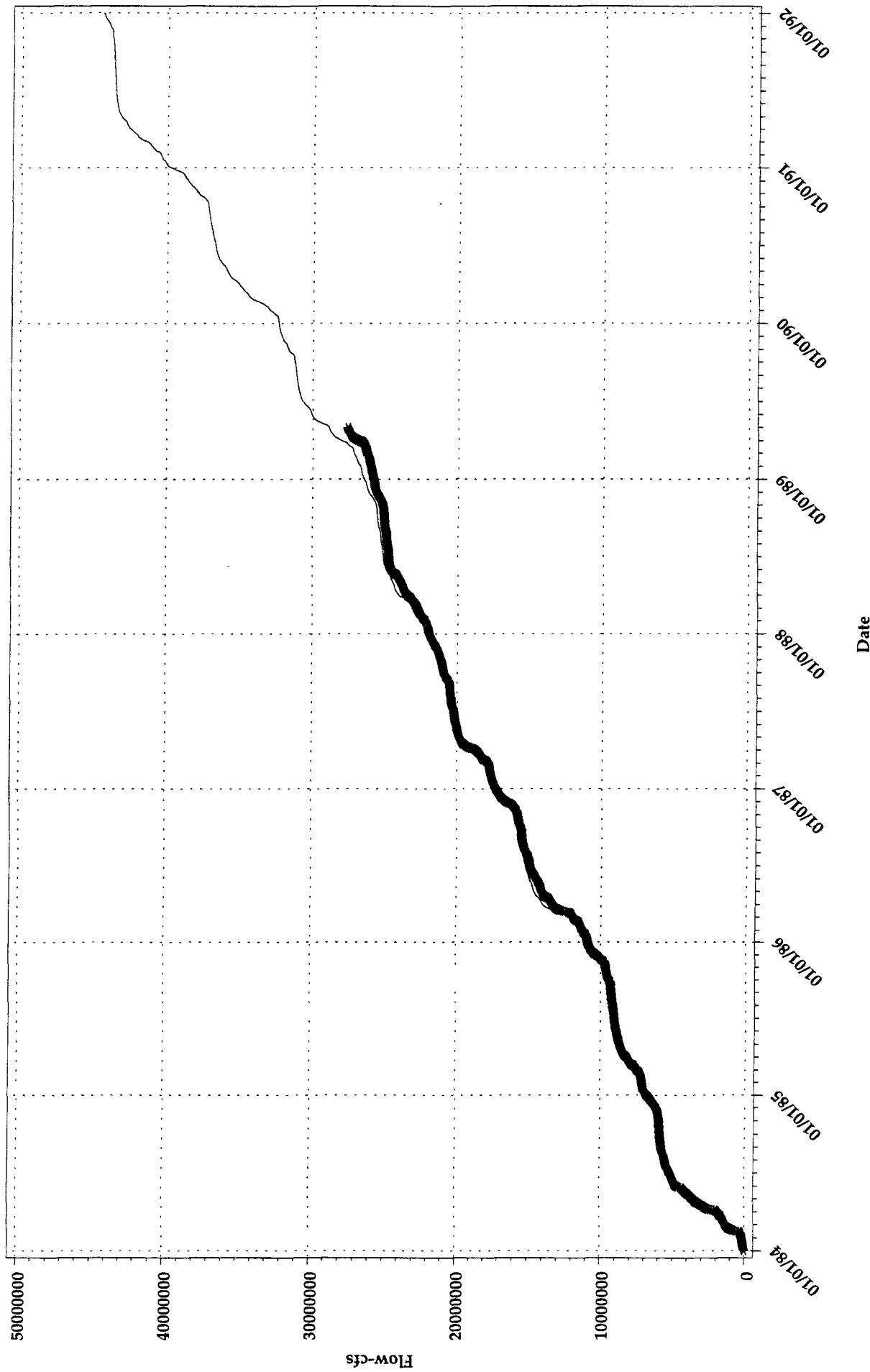
### Flow-cfs



# East Branch Susquehanna River at Segment 40

## Observed and Simulated Cumulative Flows versus Time

Flow-cfs  
(\* = Observed, \_ = Simulated)

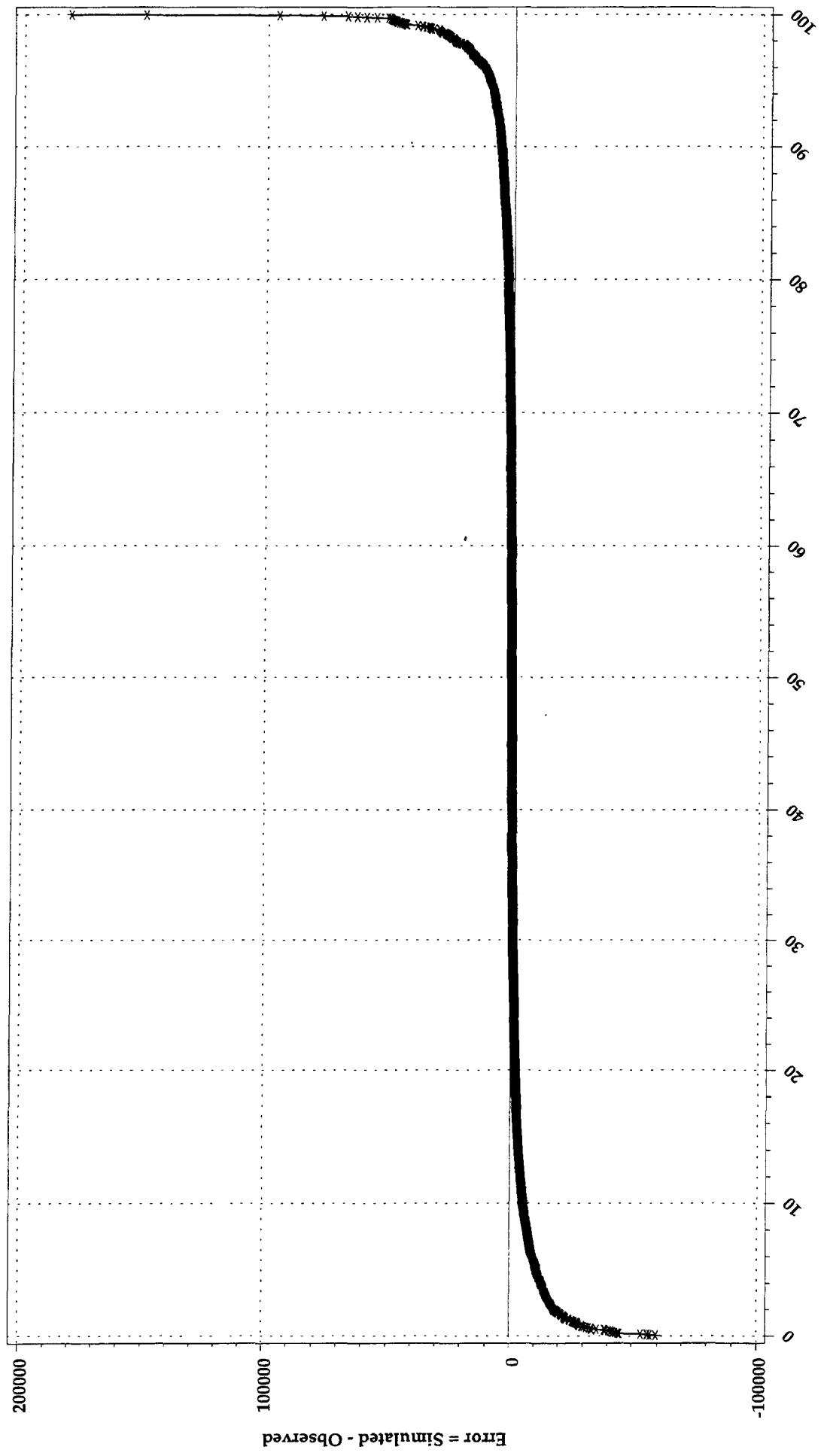


# East Branch Susquehanna River at Segment 40

## Actual error versus Percentile Sample Population

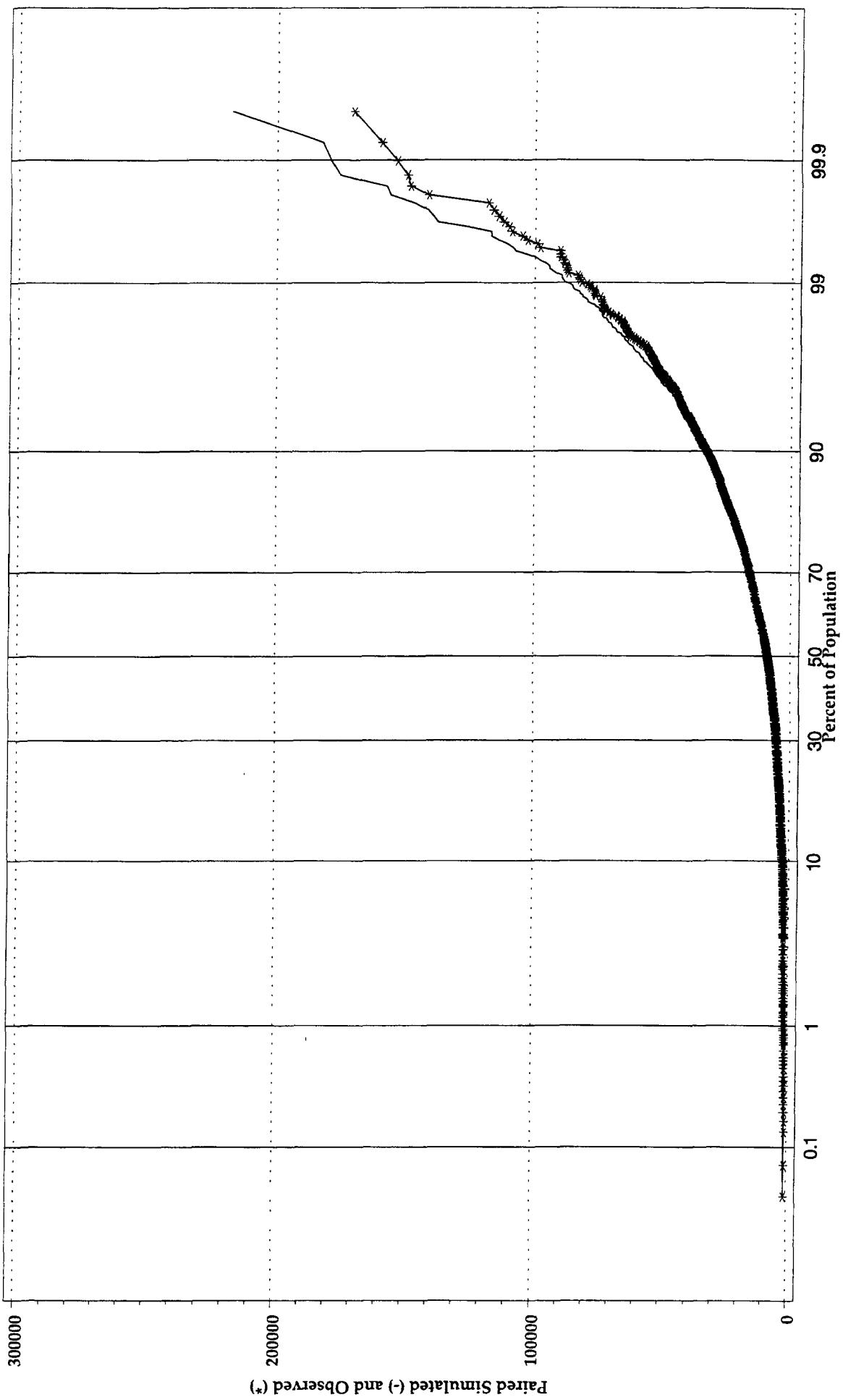
### Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# East Branch Susquehanna River at Segment 40

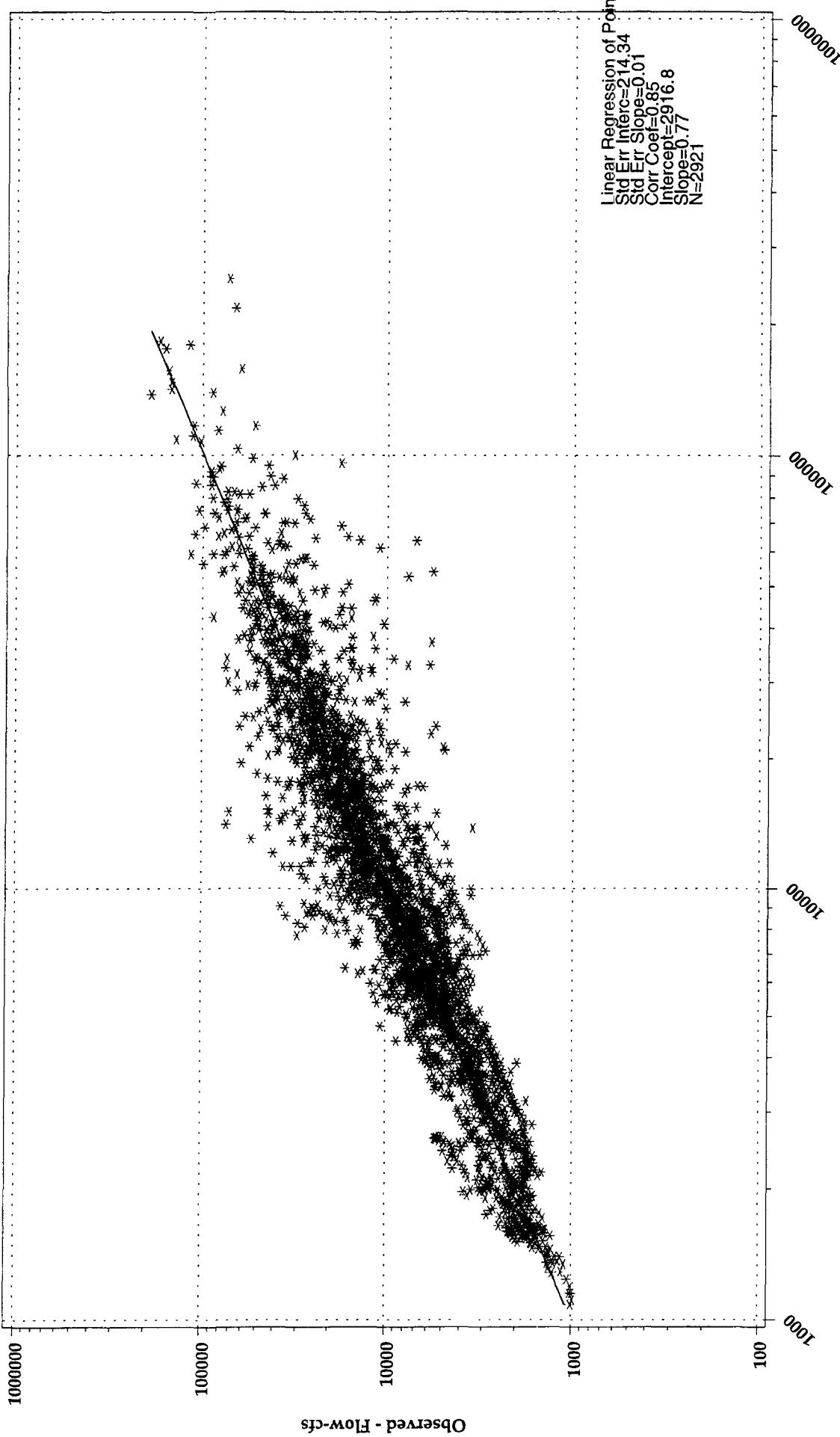
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population



# East Branch Susquehanna River at Segment 40

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION**  
**EAST BRANCH SUSQUEHANNA RIVER, PA (Segments 10, 20, 700, 30, and 40)**

Table A.1.1.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	Simulated Flow
Year	(inches)*	(inches)**
1984	22.64	20.94
1985	13.59	13.16
1986	21.02	20.93
1987	15.59	16.27
1988	12.87	14.08
1989	18.10	18.91
1990	23.93	23.50
1991	14.62	15.46
Mean	17.80	17.91

\* Observed flow from Susquehanna River near Danville, PA

\*\* Simulated outflow from RCH 40

Table A.1.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

Year	Average Daily			Average Monthly		
	m	b	r2	m	b	r2
1984	0.92	0.36	0.86	0.91	11.80	0.88
1985	0.90	0.40	0.85	0.90	11.98	0.88
1986	0.81	0.80	0.73	0.82	23.50	0.84
1987	0.94	0.22	0.90	0.94	6.65	0.96
1988	1.03	-0.18	0.88	1.08	-11.61	0.93
1989	1.08	-0.40	0.85	1.07	-11.86	0.90
1990	0.93	0.27	0.85	0.98	2.41	0.96
1991	0.94	0.20	0.96	0.97	3.66	0.98
1984-1991	0.94	0.21	0.86	0.96	4.57	0.92

Table A.1.1.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2									
1984	1.23	-1.14	0.96	0.87	0.61	0.82	1.14	-0.52	0.94	0.98	0.24	0.83
1985	1.00	-0.22	0.76	0.91	0.35	0.91	0.79	0.79	0.69	1.20	-0.71	0.91
1986	0.61	1.55	0.32	0.76	1.02	0.77	1.63	-2.27	0.89	0.82	0.85	0.87
1987	0.97	0.03	0.56	0.91	0.34	0.86	1.04	-0.14	0.87	1.21	-0.87	0.79
1988	0.71	1.09	0.63	0.78	0.95	0.66	1.20	-0.82	0.93	0.93	0.15	0.85
1989	0.47	1.98	0.32	0.98	-0.02	0.69	1.35	-1.42	0.96	1.13	-0.56	0.89
1990	0.73	1.17	0.75	0.85	0.62	0.41	1.20	-0.75	0.88	0.97	0.15	0.82
1991	0.78	0.93	0.63	0.76	1.03	0.81	1.00	-0.02	0.89	0.85	0.56	0.94
1984-1991	0.78	1.01	0.69	0.90	0.46	0.77	0.80	0.74	0.89	0.90	0.37	0.85

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

## **A.1.2 WEST BRANCH SUSQUEHANNA RIVER AT LEWISBURG, PA SEGMENT 70 (1553500)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

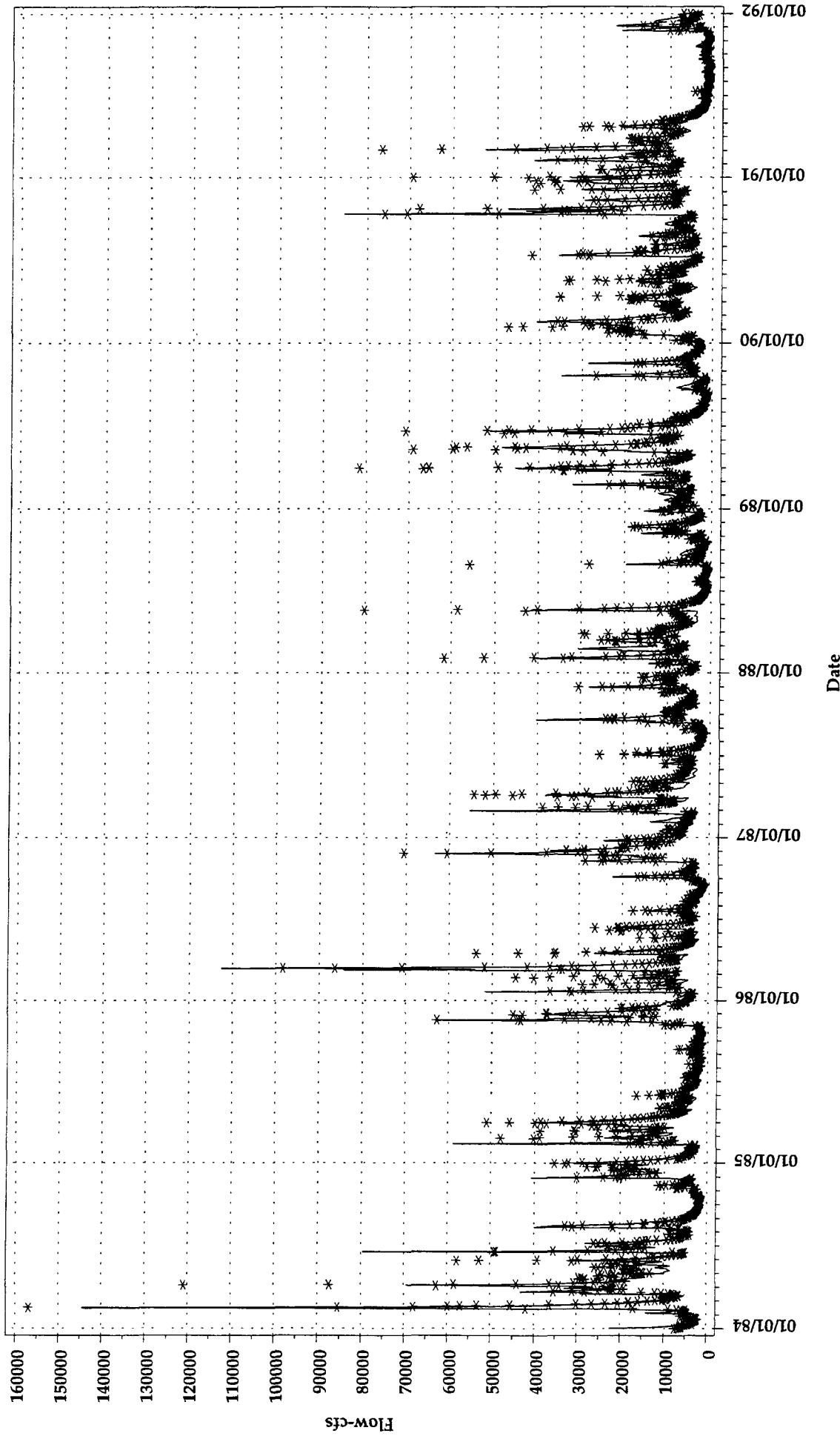
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# West Branch Susquehanna River at Segment 70 Observed and Simulated versus Time

## Flow-cfs

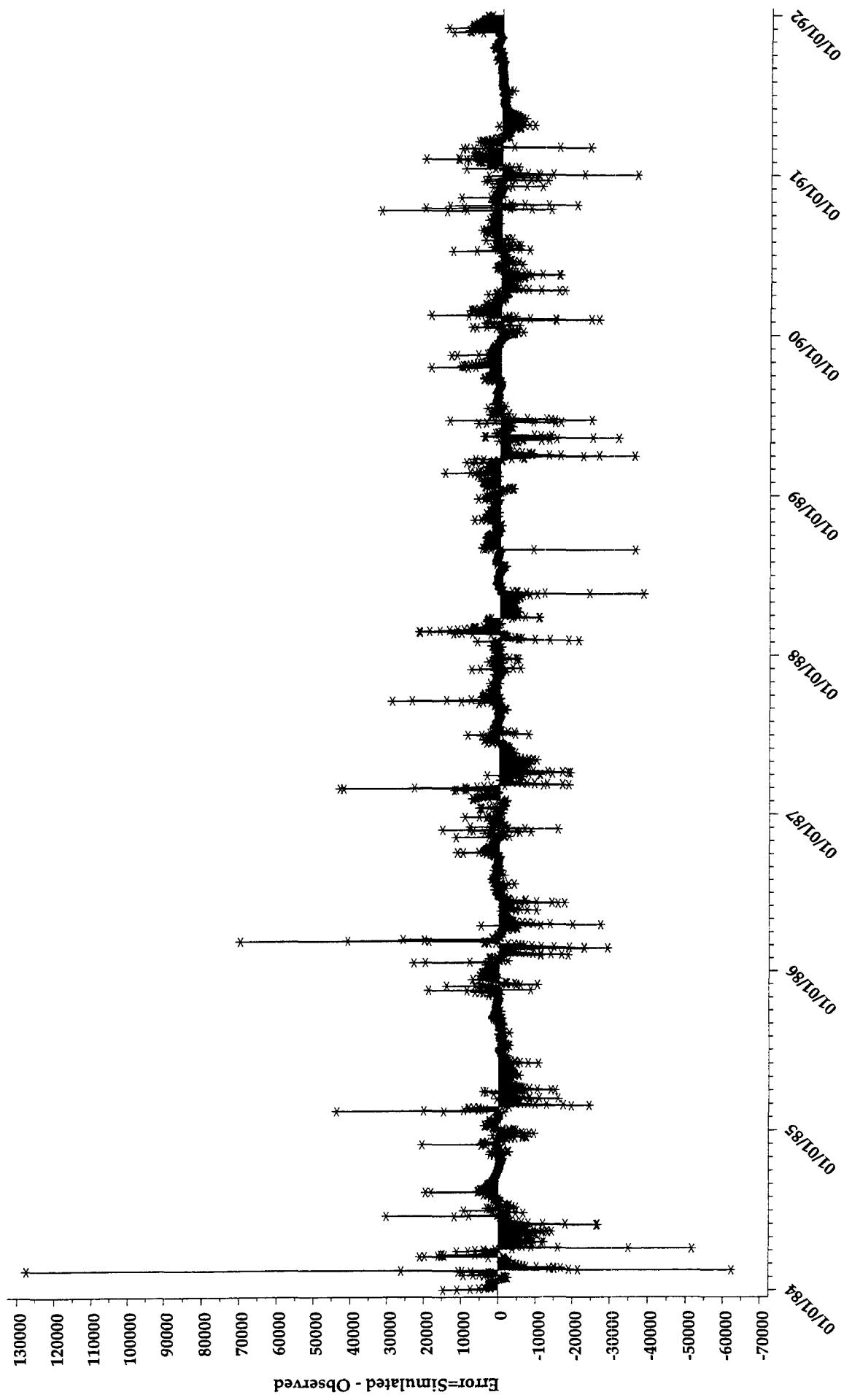
(\*=Observed, -=Simulated)



# West Branch Susquehanna River at Segment 70

## Actual Error versus Time

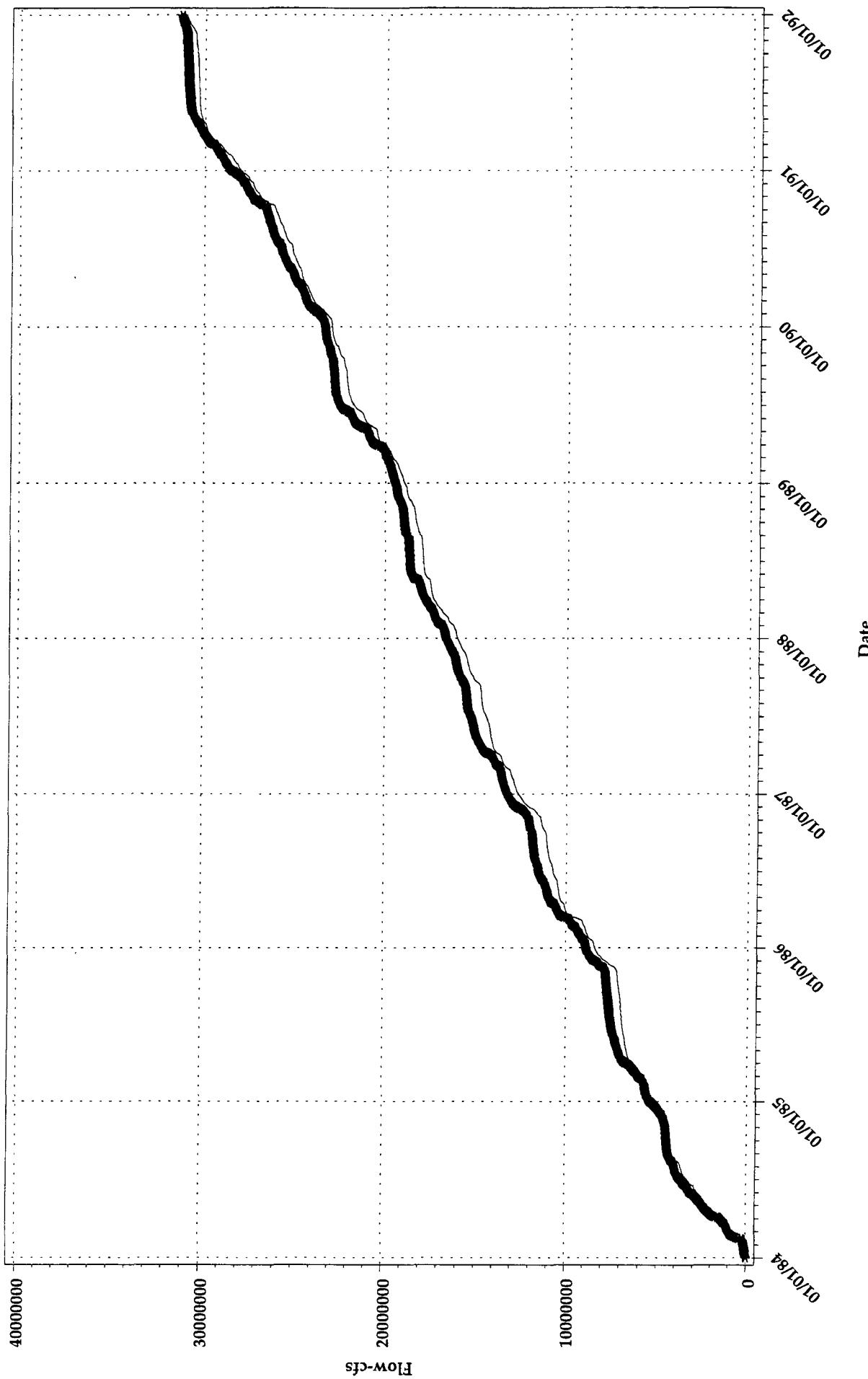
### Flow-cfs



# West Branch Susquehanna River at Segment 70

## Observed and Simulated Cumulative Flows versus Time

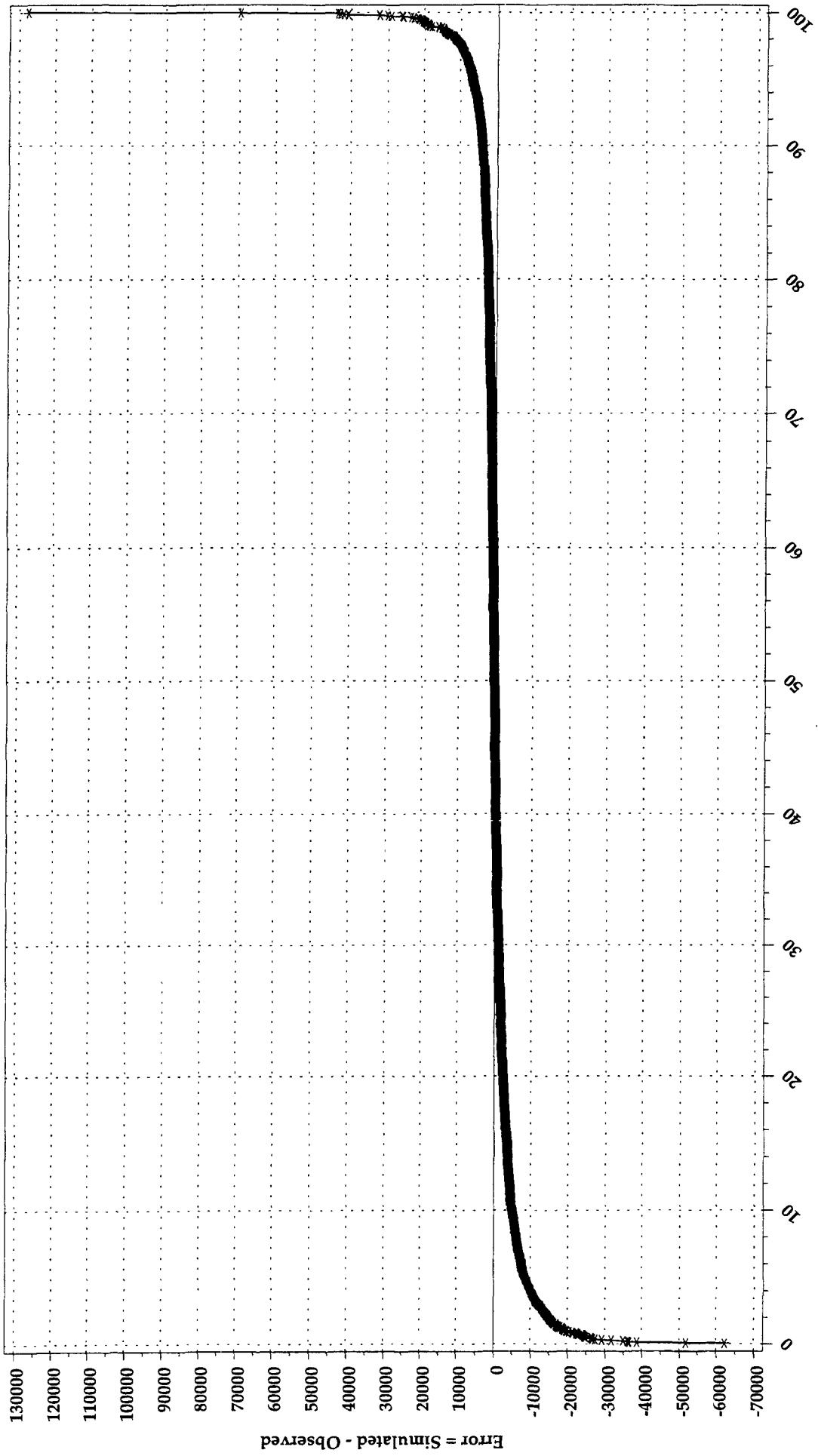
Flow-cfs  
(\* = Observed, \_ = Simulated)



# West Branch Susquehanna River at Segment 70

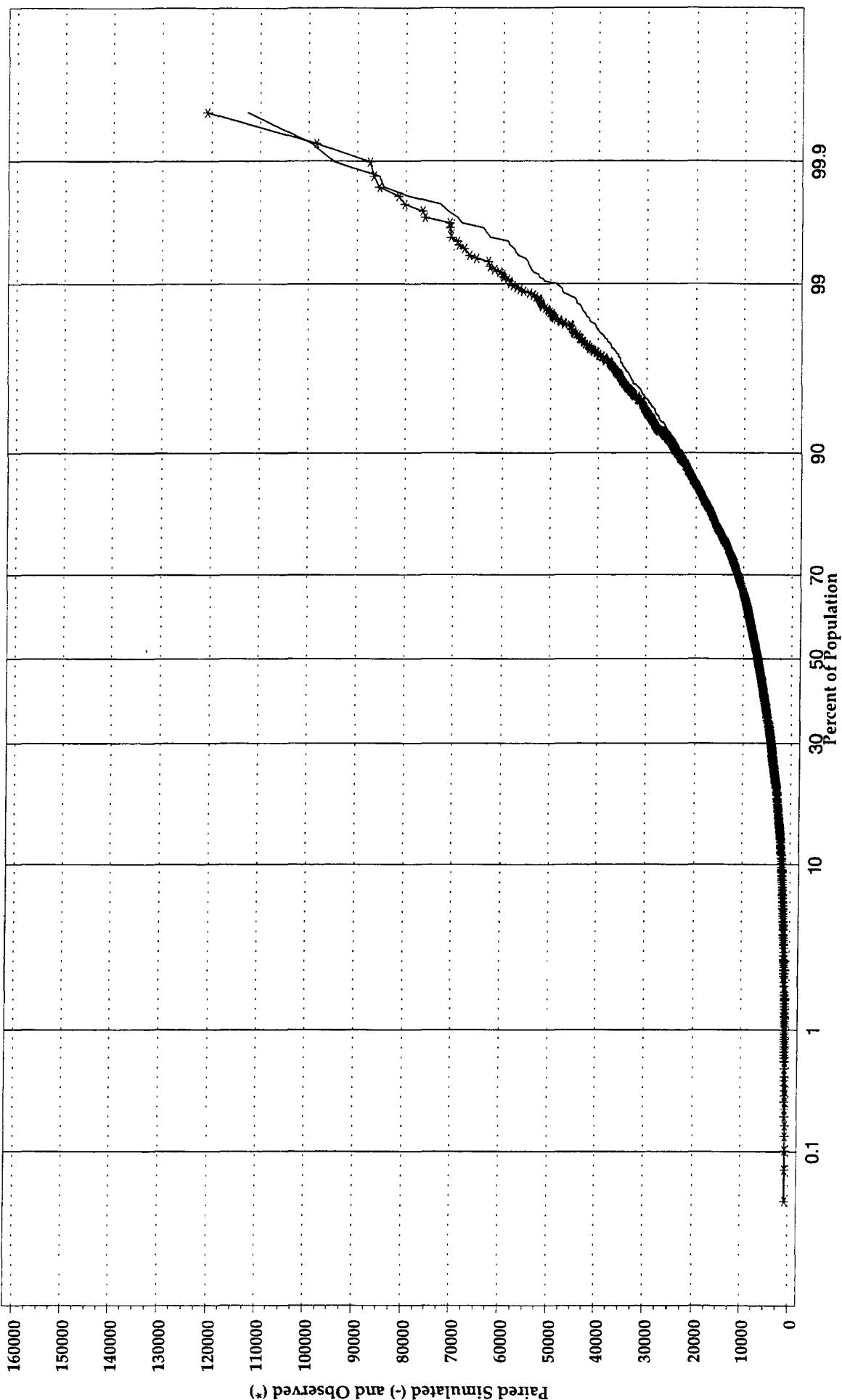
## Actual error versus Percentile Sample Population Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# West Branch Susquehanna River at Segment 70

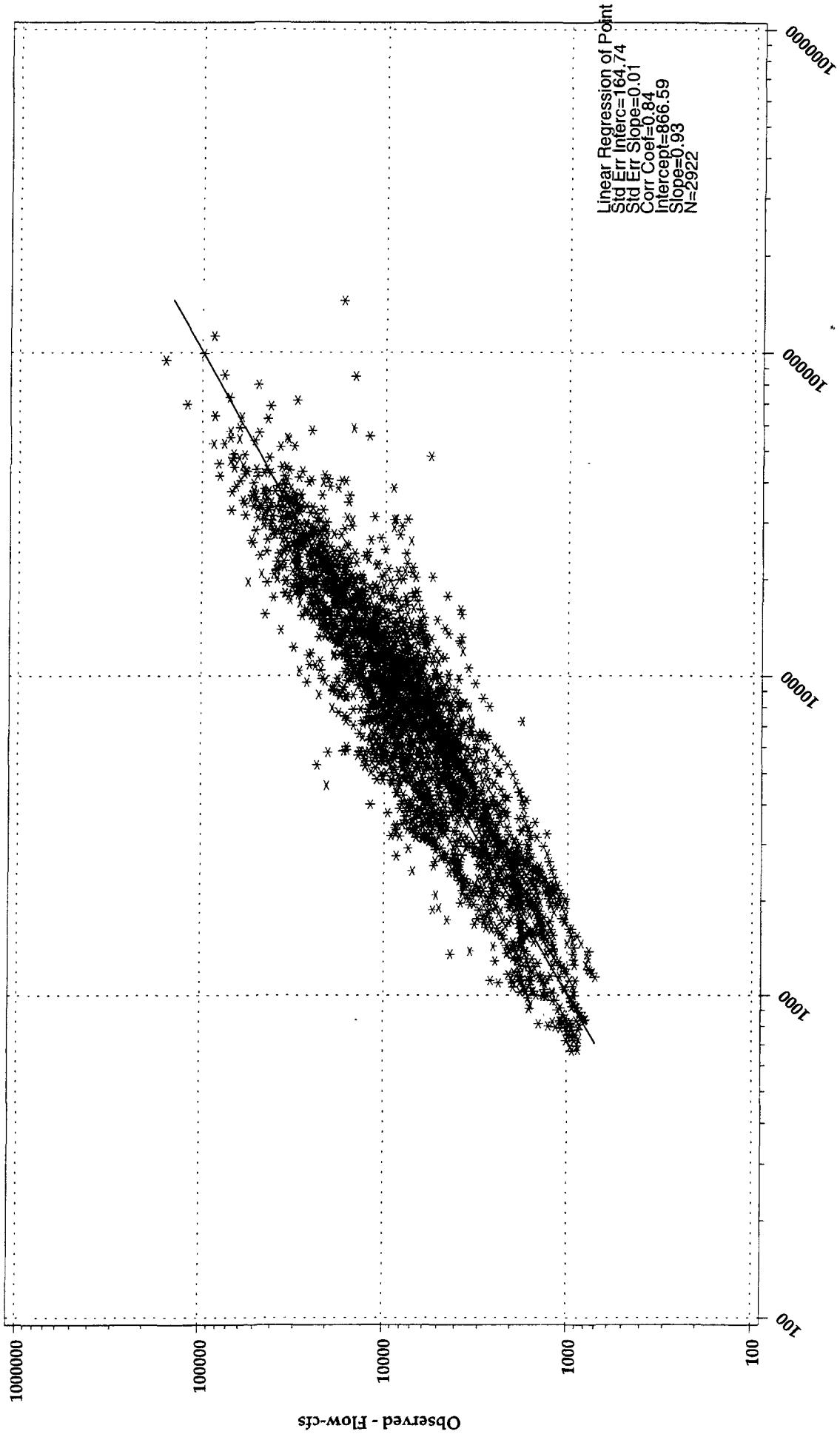
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population



# West Branch Susquehanna River at Segment 70

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
WEST BRANCH SUSQUEHANNA RIVER, PA (Segments 50, 60, and 70)**

Table A.1.2.1 Comparison of Annual Total Observed and Simulated flows..

	<b>Observed Flow</b>	<b>Simulated Flow</b>
<b>Year</b>	(inches)*	(inches)**
1984	29.02	26.75
1985	19.23	17.55
1986	23.83	22.66
1987	18.38	17.94
1988	15.26	15.46
1989	21.34	21.35
1990	27.52	26.47
1991	15.22	16.16
Mean	21.23	20.54

\* Observed flow from West Branch Susquehanna River at Lewisburg, PA

\*\* Simulated outflow from RCH 70

Table A.1.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r2</b>	<b>m</b>	<b>b</b>	<b>r2</b>
1984	0.86	0.54	0.84	0.00	3.90	0.00
1985	0.94	0.18	0.86	1.00	-0.05	0.88
1986	0.84	0.61	0.78	0.84	0.63	0.78
1987	0.76	0.91	0.63	0.99	0.02	0.99
1988	0.81	0.77	0.79	0.83	0.68	0.81
1989	0.81	0.80	0.88	0.75	1.04	0.90
1990	0.89	0.43	0.77	0.90	0.41	0.75
1991	0.99	0.07	0.85	1.00	0.02	0.87
1984-1991	0.86	0.54	0.80	0.79	0.83	0.75

Table A.1.2.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2									
1984	0.98	-0.04	0.75	0.66	1.52	0.55	1.06	-0.29	0.89	0.95	0.23	0.95
1985	0.91	0.31	0.79	0.85	0.74	0.96	0.98	0.18	0.64	1.01	-0.14	0.97
1986	0.95	0.23	0.44	0.73	1.18	0.82	1.10	-0.38	0.80	1.14	-0.65	0.93
1987	0.08	3.46	0.00	0.69	1.41	0.74	0.85	0.49	0.84	1.03	-0.19	0.82
1988	0.79	0.76	0.61	0.62	1.62	0.66	0.91	0.19	0.82	1.07	-0.44	0.90
1989	0.72	1.00	0.64	1.05	-0.16	0.85	1.12	-0.54	0.95	0.82	0.51	0.79
1990	0.66	1.42	0.74	0.76	1.00	0.52	0.90	0.38	0.78	1.09	-0.40	0.90
1991	0.95	0.18	0.53	0.70	1.28	0.87	0.69	1.04	0.46	0.85	0.30	0.91
1984-1991	0.75	1.05	0.63	1.02	-0.19	0.77	0.95	0.22	0.87	0.87	0.59	0.90

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

### **A.1.3 JUNIATA RIVER AT NEWPORT, PA AT SEGMENT 100 (1567000)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

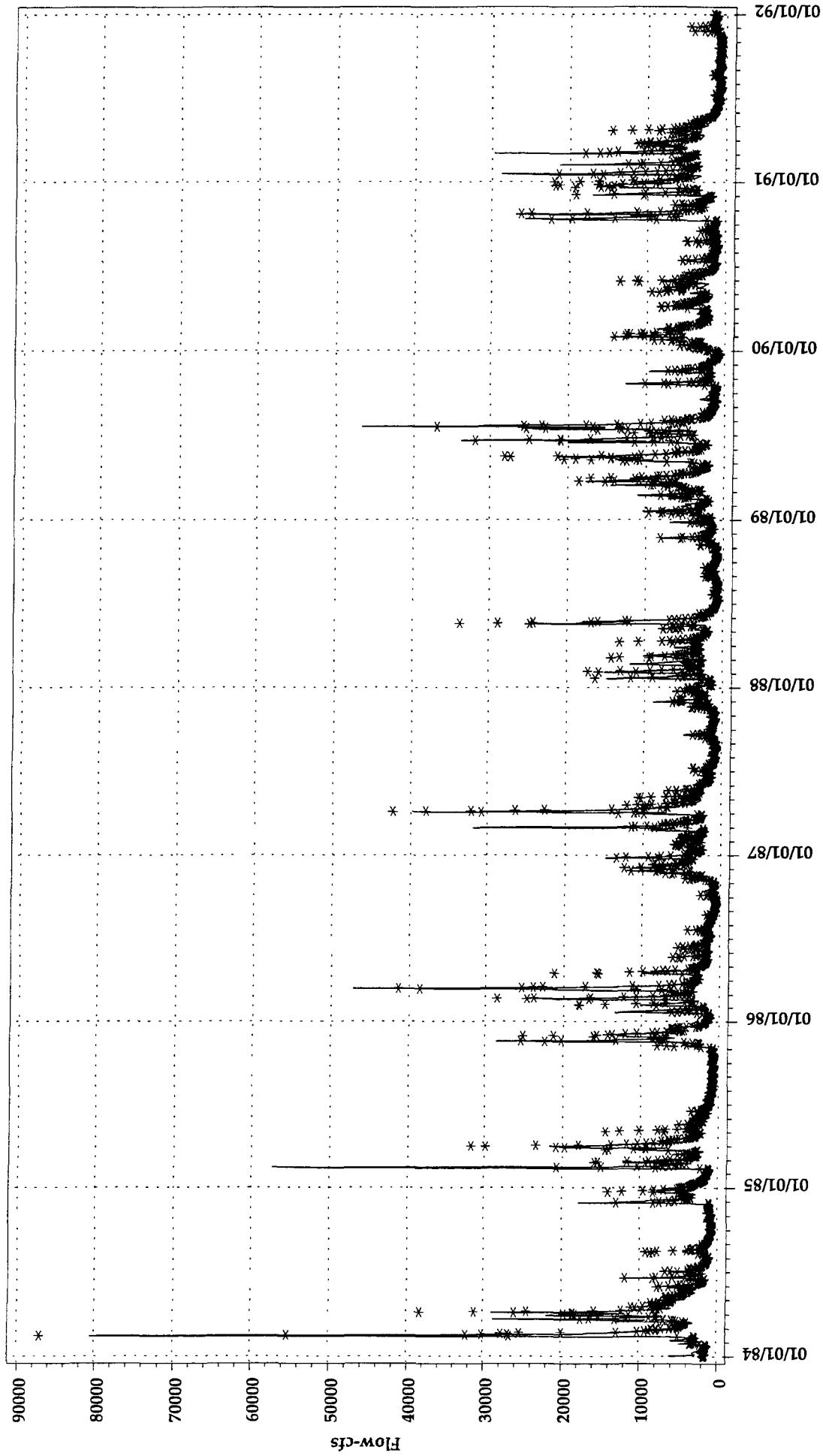
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Juniata River at Segment 100 Observed and Simulated versus Time Flow-cfs

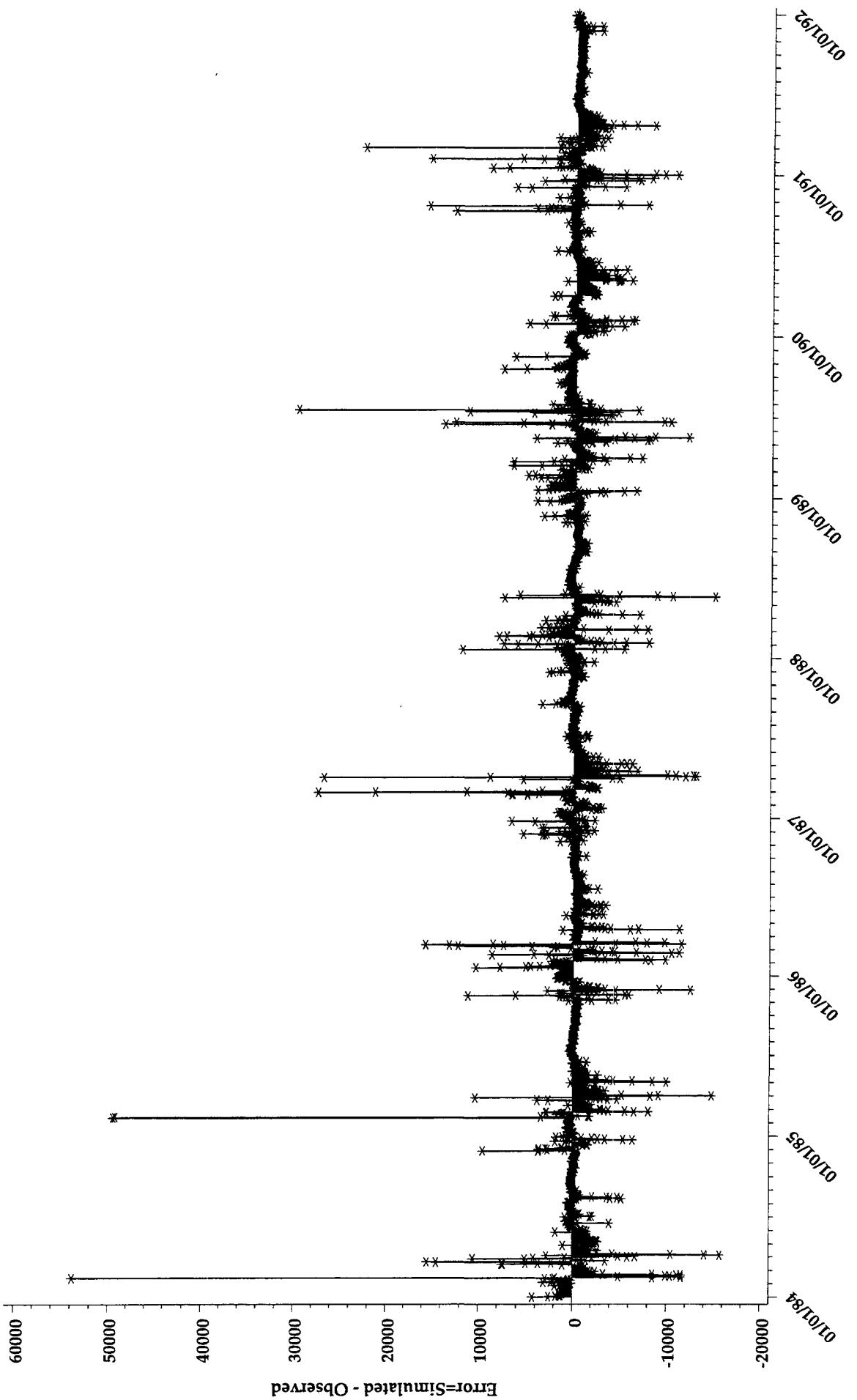
(\*=Observed, -=Simulated)



# Juniata River at Segment 100

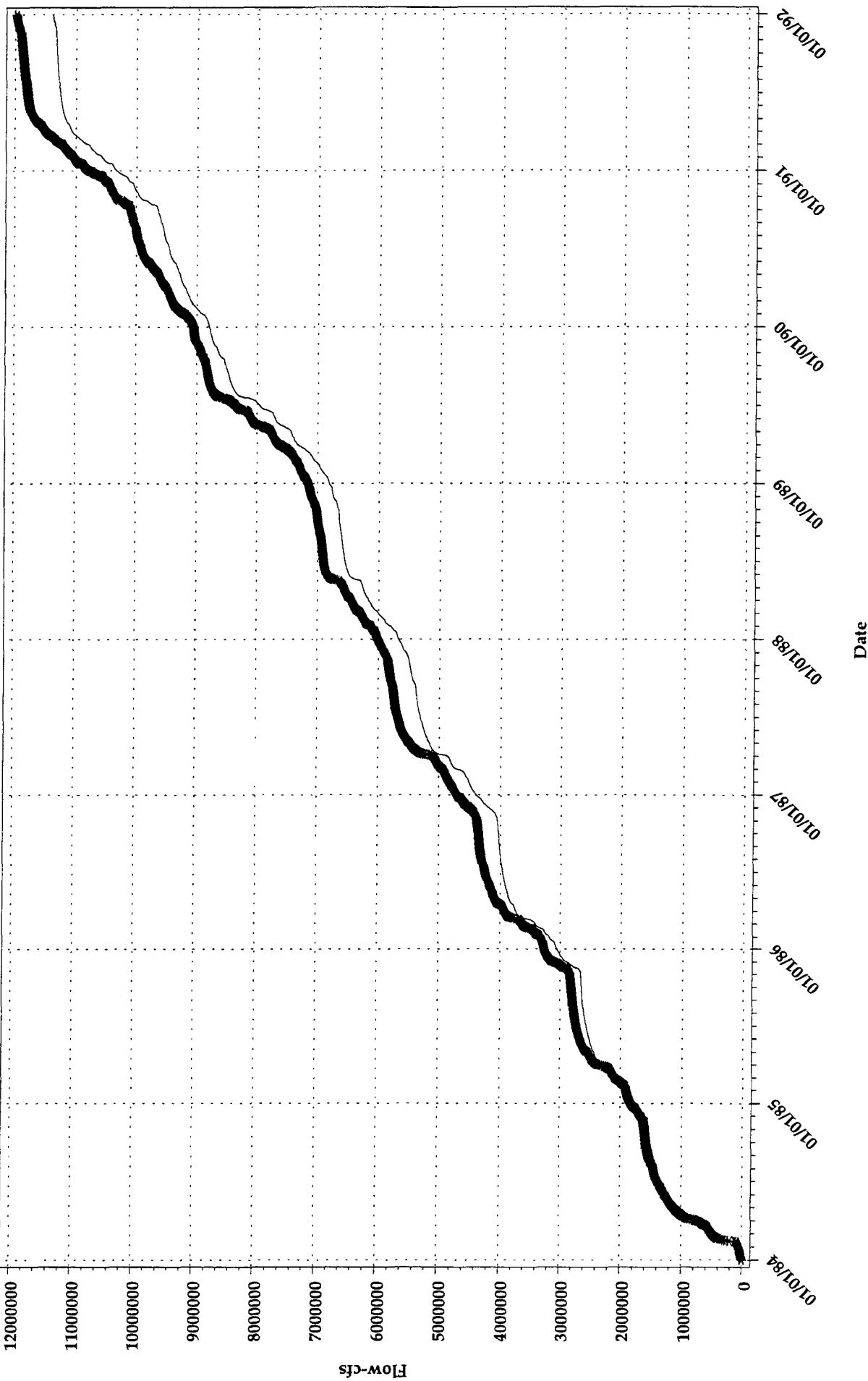
## Actual Error versus Time

### Flow-cfs



# Juniata River at Segment 100

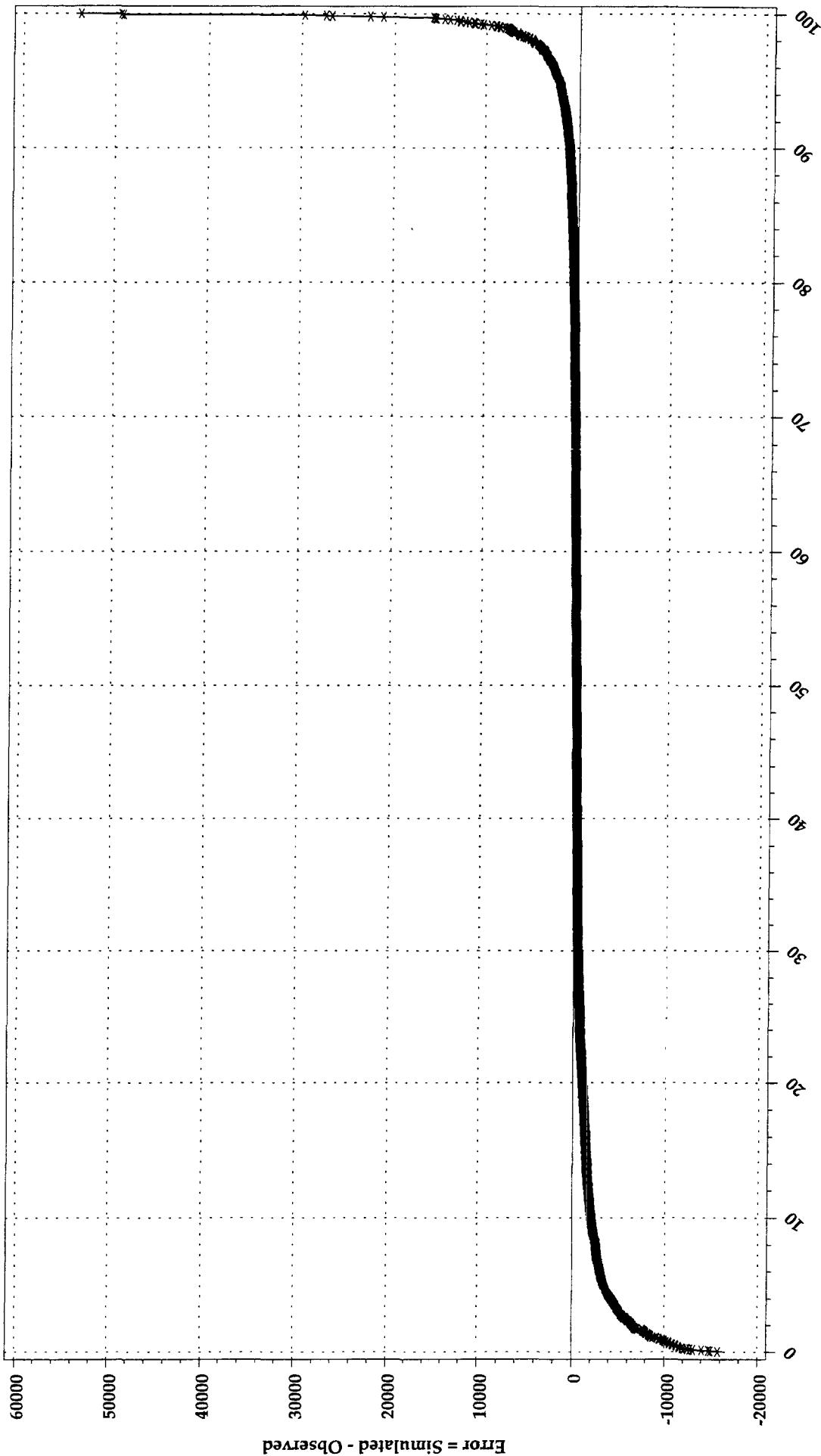
## Observed and Simulated Cumulative Flows versus Time



# Juniata River at Segment 100

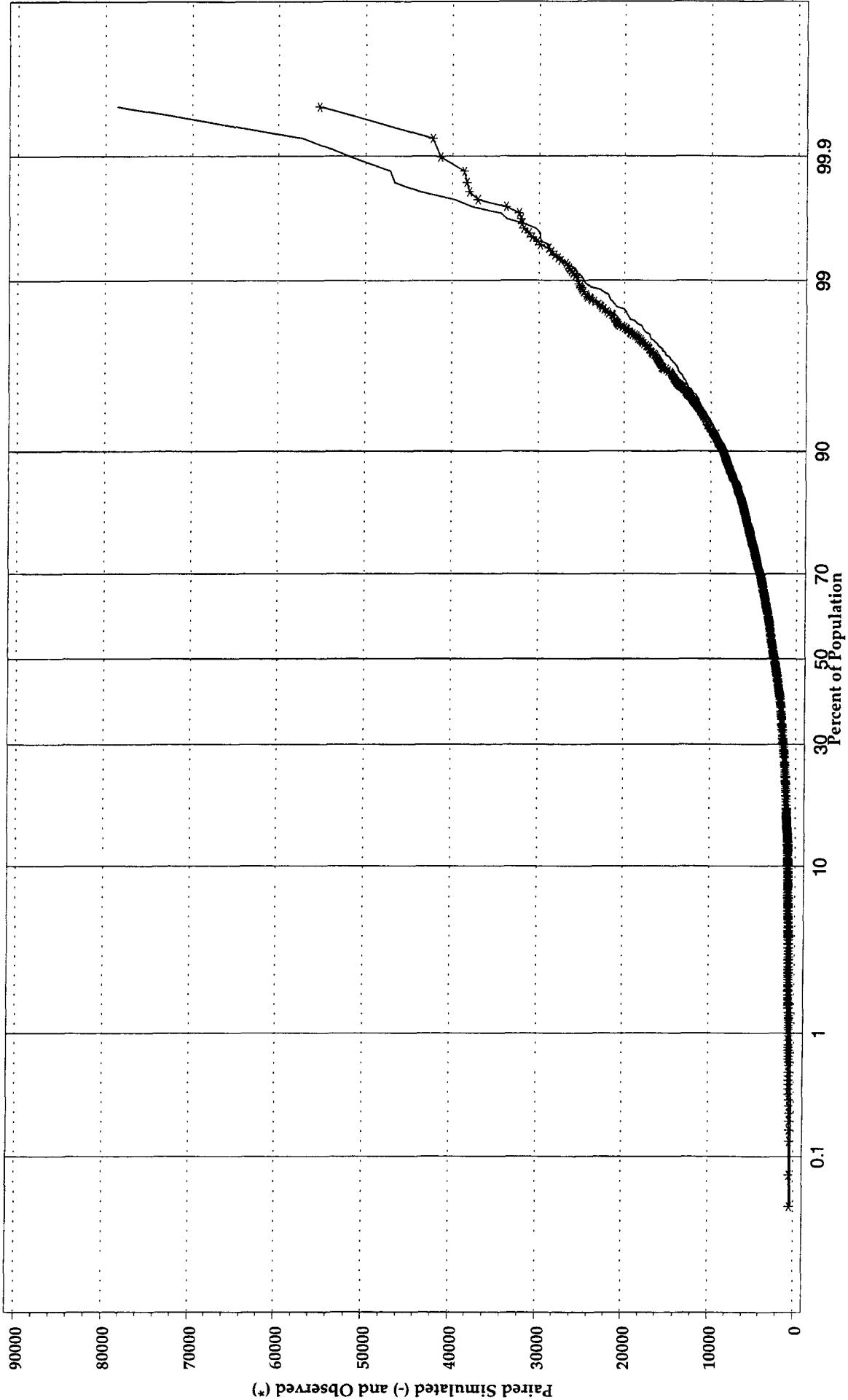
## Actual error versus Percentile Sample Population Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# Juniata River at Segment 100

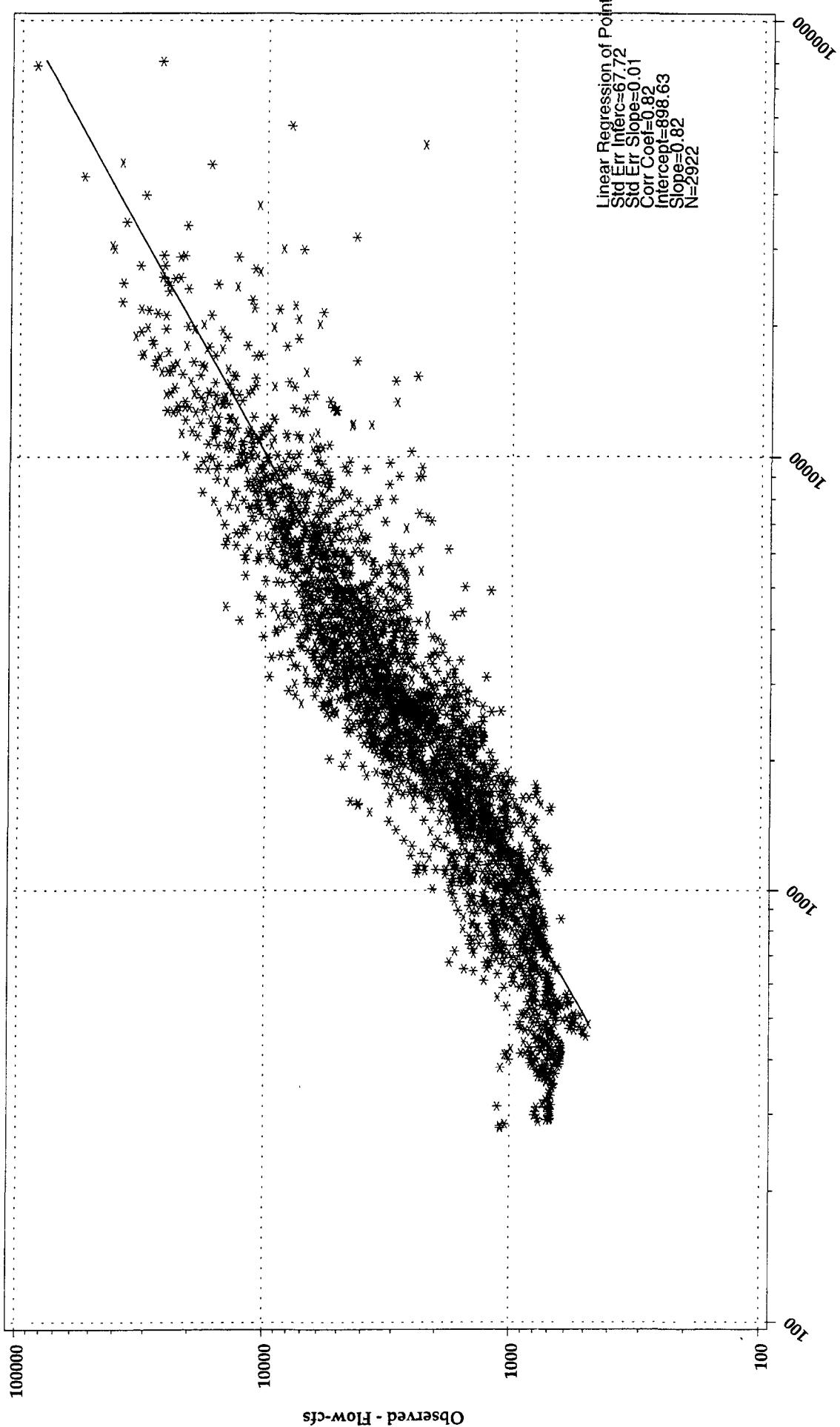
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population



# Juniata River at Segment 100

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
JUNIATA RIVER, PA (Segments 90 and 100)**

Table A.1.3.1 Comparison of Annual Total Observed and Simulated flows.

	<b>Observed Flow</b>	<b>Simulated Flow</b>
<b>Year</b>	(inches)*	(inches)**
1984	20.44	19.44
1985	15.84	14.39
1986	16.03	14.91
1987	14.40	14.02
1988	12.68	12.52
1989	20.98	22.00
1990	18.93	16.94
1991	13.57	11.81
Mean	16.61	15.75

\* Observed flow from Juniata River near Newport, PA  
 \*\* Simulated outflow from RCH 100

Table A.1.3.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r2</b>	<b>m</b>	<b>b</b>	<b>r2</b>
1984	0.88	0.38	0.88	0.92	0.27	0.94
1985	0.97	0.05	0.86	1.03	-0.17	0.91
1986	1.00	-0.05	0.85	1.08	-0.34	0.90
1987	0.84	0.55	0.79	0.99	0.01	1.00
1988	0.93	0.24	0.79	1.00	-0.02	0.87
1989	0.77	0.88	0.86	0.73	1.00	0.95
1990	0.82	0.60	0.80	0.81	0.63	0.82
1991	1.12	-0.53	0.92	1.16	-0.66	0.95
1984-1991	0.92	0.27	0.84	0.97	0.09	0.92

Table A.1.3.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	1.19	-0.79	0.80	0.72	1.12	0.71	1.25	-0.84	0.92	0.90	0.34	0.90
1985	0.77	0.73	0.63	0.93	0.40	0.81	0.83	0.55	0.83	0.81	0.72	0.92
1986	1.18	-0.75	0.70	0.86	0.56	0.79	1.26	-0.59	0.87	0.89	0.38	0.95
1987	-0.04	3.68	-0.01	0.78	0.90	0.74	0.82	0.55	0.71	1.09	-0.33	0.91
1988	0.85	0.44	0.54	0.89	0.43	0.72	0.71	0.88	0.45	0.67	1.09	0.87
1989	0.65	1.19	0.42	1.02	-0.02	0.87	1.11	-0.47	0.90	1.04	-0.26	0.80
1990	0.79	0.83	0.63	0.80	0.81	0.34	1.20	-0.66	0.88	0.98	0.05	0.87
1991	0.70	1.14	0.60	0.77	0.95	0.80	0.46	1.66	0.51	0.55	1.48	0.78
1984-1991	0.69	1.19	0.62	0.90	0.26	0.76	0.96	0.09	0.83	1.08	-0.30	0.87

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

#### **A.1.4 LOWER SUSQUEHANNA RIVER AT HARRISBURG, PA SEGMENT 710 (1570500)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

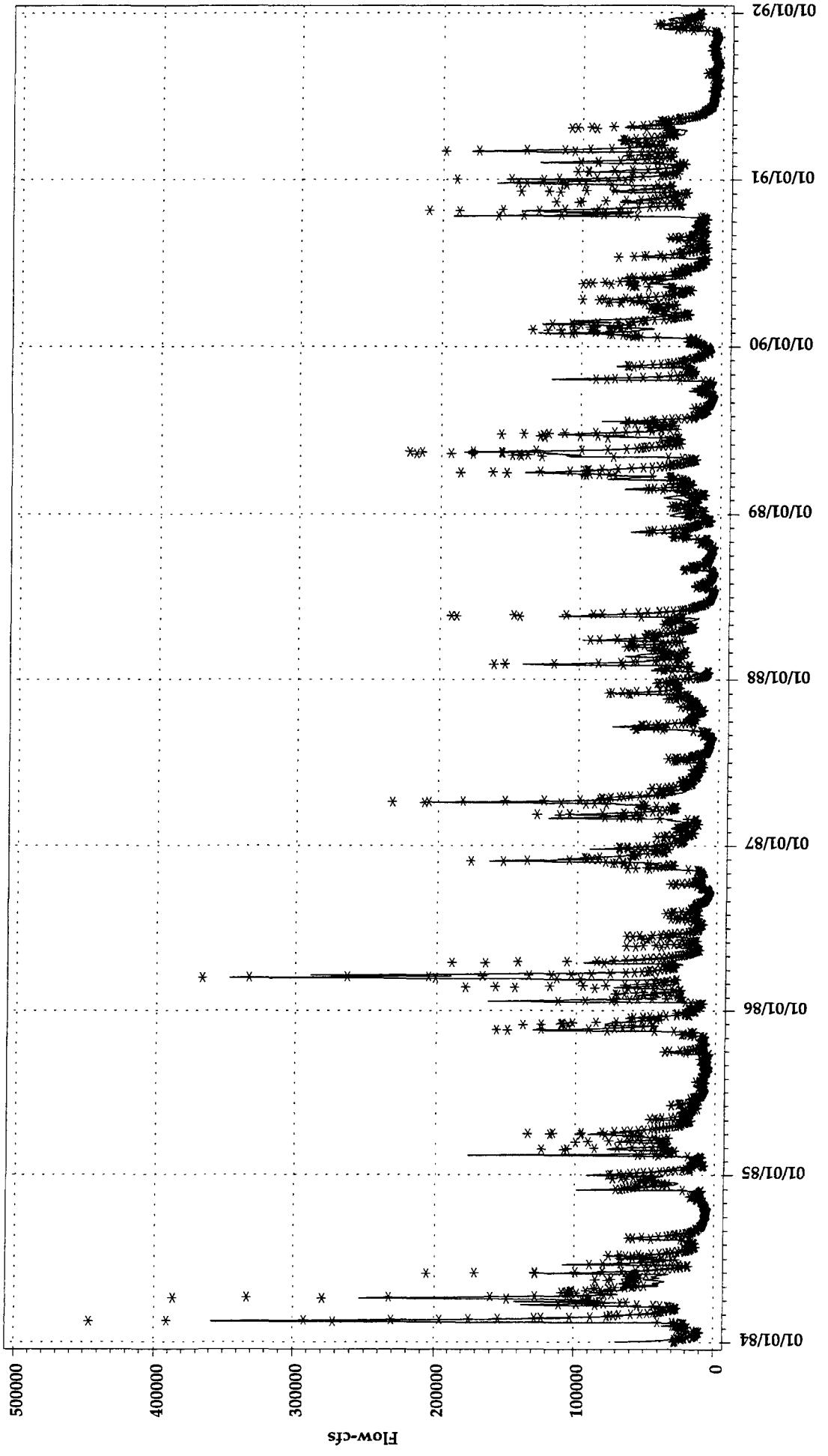
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Lower Susquehanna River at Segment 710 Observed and Simulated versus Time

Flow-cfs

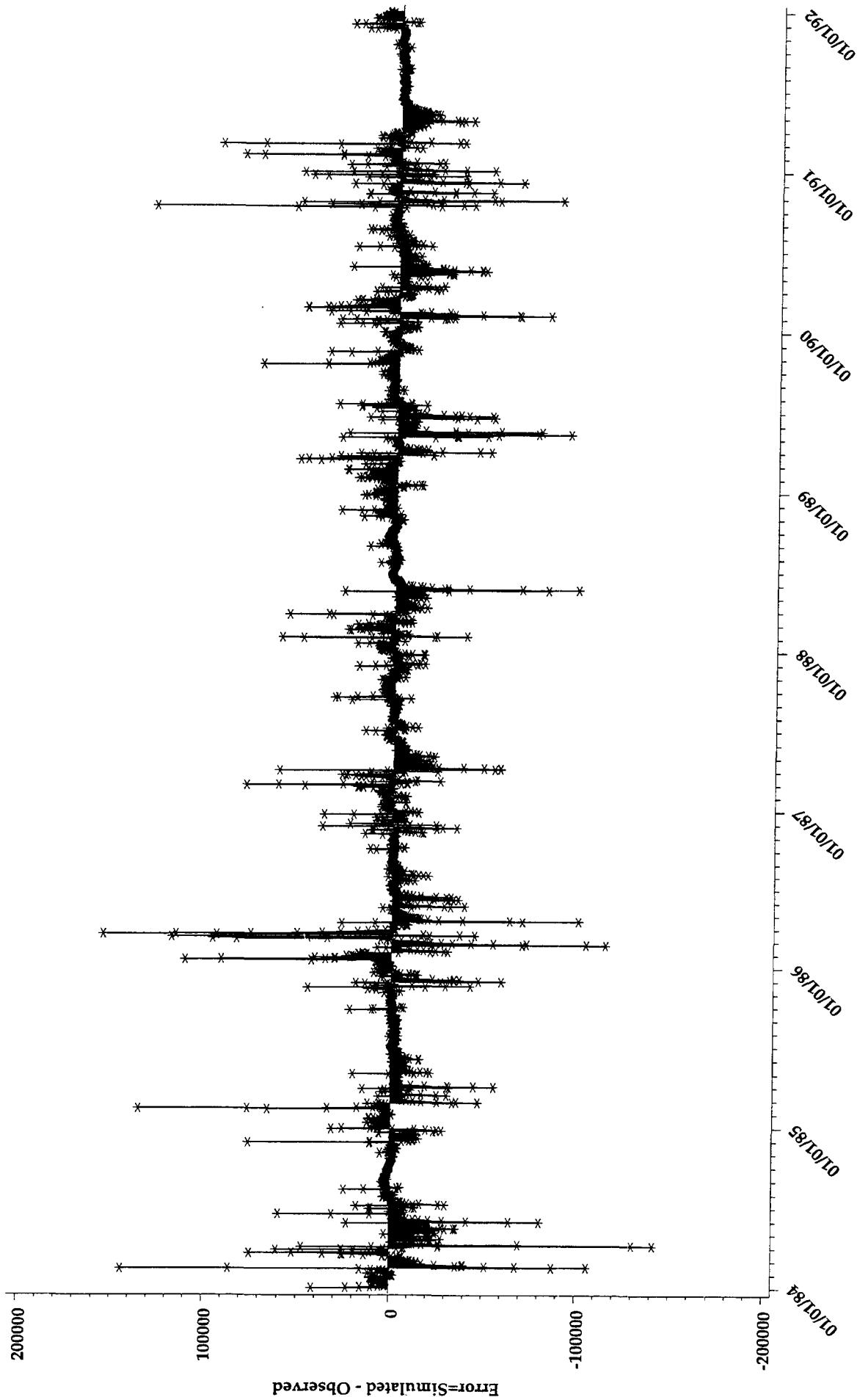
(\*=Observed, -=Simulated)



# Lower Susquehanna River at Segment 710

## Actual Error versus Time

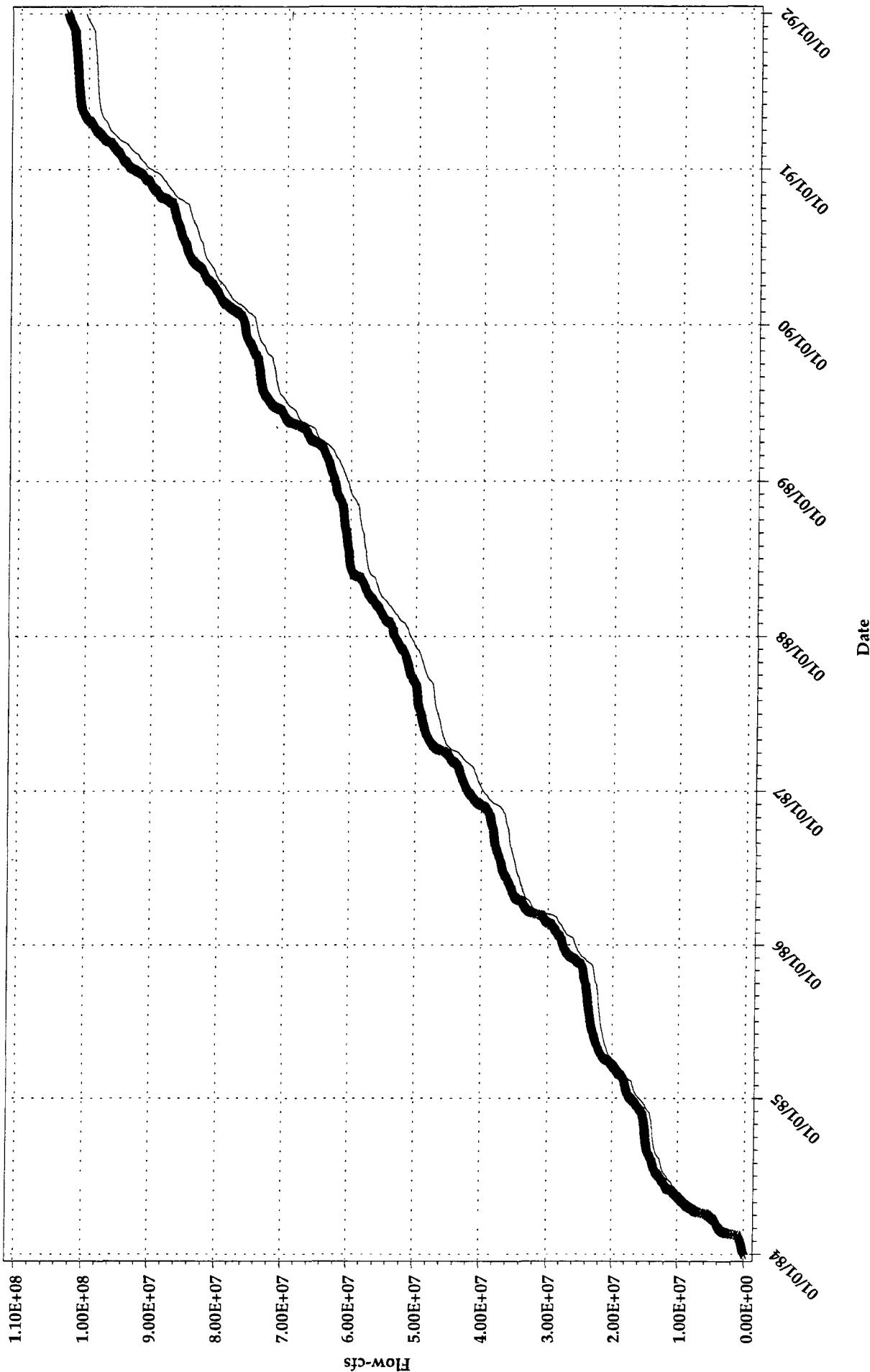
### Flow-cfs



# Lower Susquehanna River at Segment 710

## Observed and Simulated Cumulative Flows versus Time

Flow-cfs  
(\* = Observed, - = Simulated)

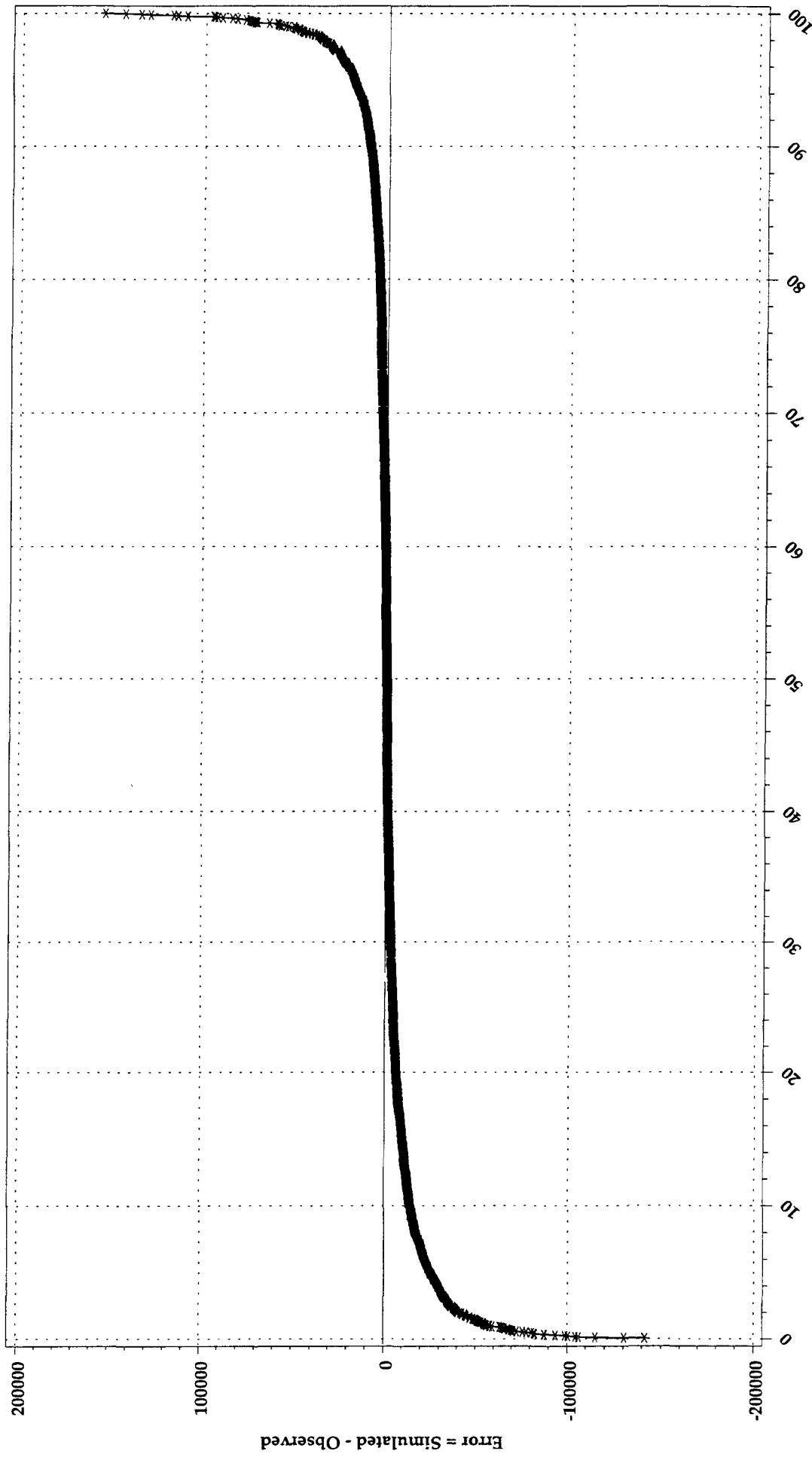


# Lower Susquehanna River at Segment 710

## Actual error versus Percentile Sample Population

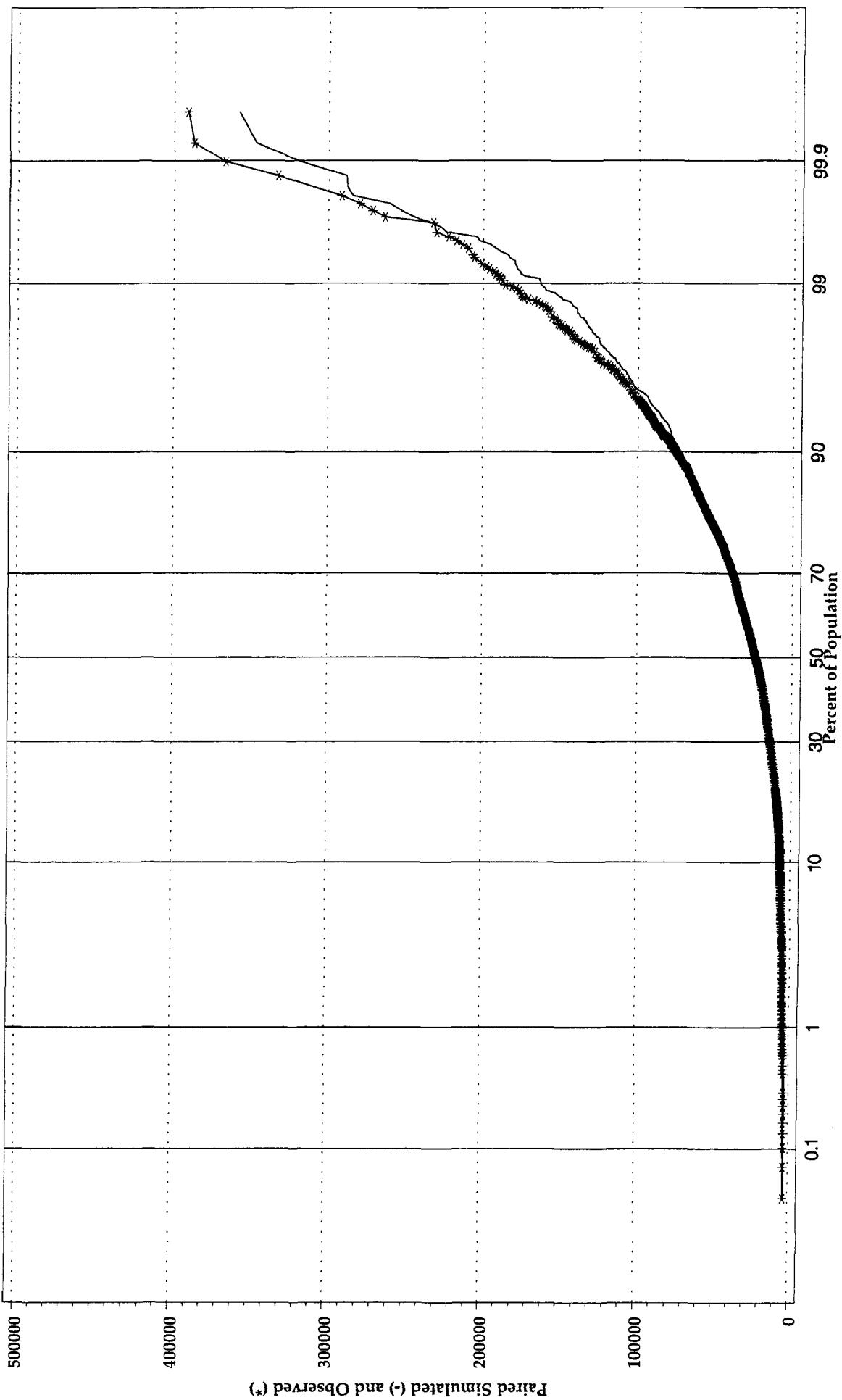
### Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# Lower Susquehanna River at Segment 710

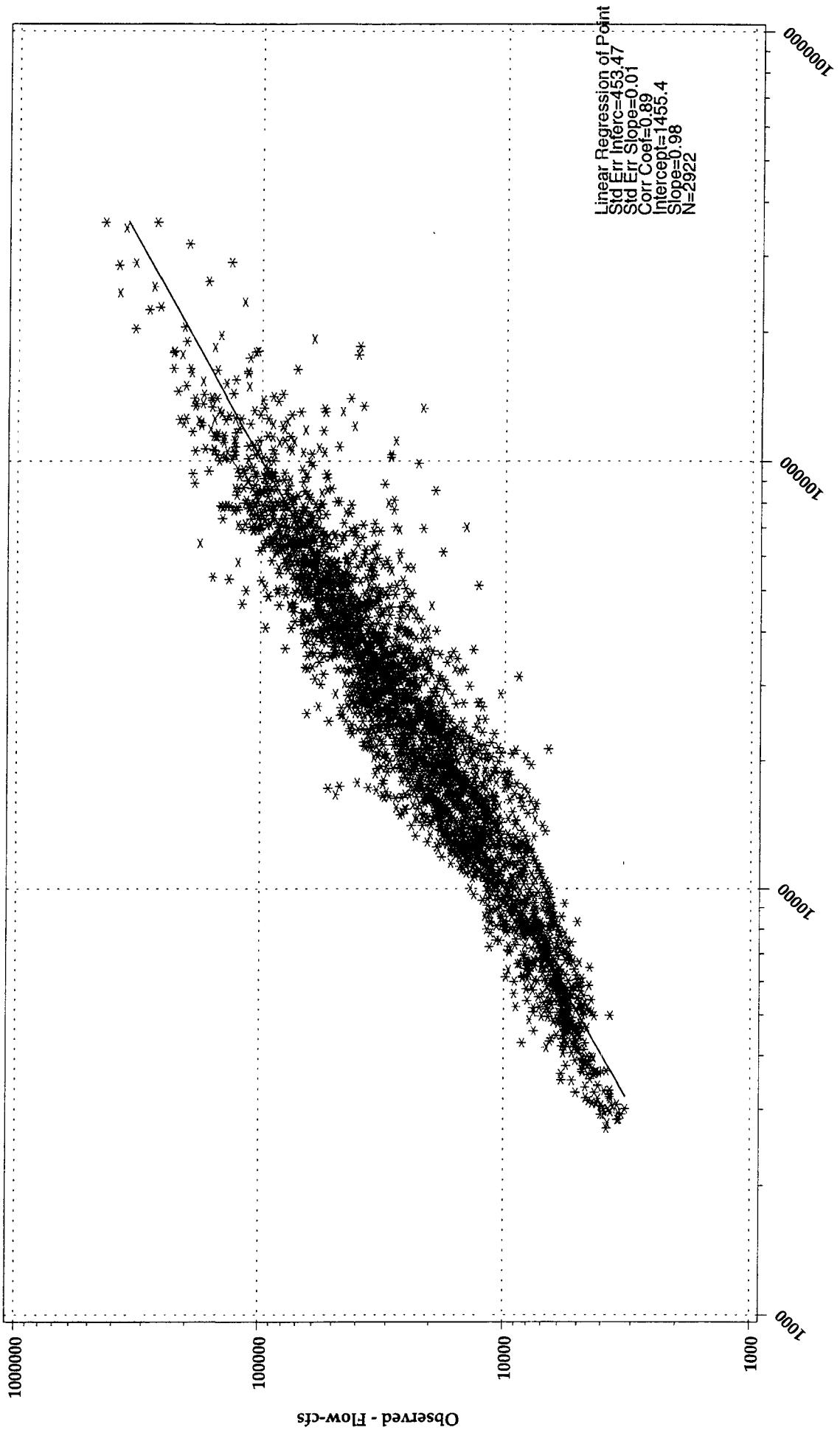
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population



# Lower Susquehanna River at Segment 710

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
LOWER SUSQUEHANNA RIVER, PA (Segments 10, 20, 30, 40, 50, 60,  
70, 80, 90, and 100)**

Table A.1.4.1 Comparison of Annual Total Observed and Simulated flows.

	<b>Observed Flow</b>	<b>Simulated Flow</b>
<b>Year</b>	(inches)*	(inches)**
1984	23.6	24.5
1985	14.81	15.31
1986	19.96	21.49
1987	15.58	17.17
1988	13.02	14.91
1989	18.92	21.49
1990	23.33	24.62
1991	13.97	15.52
Mean	17.90	19.38

\* Observed flow Susquehanna River at Harrisburg, PA

\*\* Simulated outflow from RCH 710

Table A.1.4.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r2</b>	<b>m</b>	<b>b</b>	<b>r2</b>
1984	0.90	0.46	0.91	0.90	0.43	0.96
1985	0.97	0.13	0.89	1.05	-0.26	0.95
1986	0.91	0.37	0.84	0.99	0.03	0.91
1987	0.92	0.35	0.88	1.00	0.00	1.00
1988	0.85	0.70	0.88	0.88	0.55	0.91
1989	0.80	0.96	0.90	0.78	1.05	0.94
1990	0.85	0.70	0.81	0.90	0.47	0.92
1991	1.05	-0.25	0.95	1.07	-0.33	0.97
1984-1991	0.91	0.43	0.88	0.95	0.24	0.95

Table A.1.4.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.83	0.86	0.88	0.87	0.55	0.71	0.83	0.75	0.92	0.94	0.20	0.92
1985	0.81	0.96	0.76	0.98	0.04	0.90	0.81	0.69	0.75	0.89	0.50	0.94
1986	0.56	2.02	0.52	1.03	-0.16	0.81	0.67	1.32	0.88	0.95	0.21	0.94
1987	0.54	2.06	0.34	0.99	0.00	0.79	0.97	0.13	0.91	0.66	1.55	0.98
1988	0.65	1.70	0.70	0.89	0.45	0.68	0.86	0.62	0.87	0.97	0.22	0.89
1989	0.52	2.20	0.44	0.77	1.10	0.85	0.79	0.93	0.96	0.85	0.73	0.86
1990	0.95	0.22	0.77	0.49	2.32	0.41	0.75	1.09	0.75	0.80	0.95	0.82
1991	0.70	1.45	0.66	1.13	-0.70	0.83	0.94	0.16	0.84	1.22	-0.84	0.95
1984-1991	0.74	1.25	0.75	0.93	0.27	0.78	0.93	0.28	0.90	0.93	0.34	0.91

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

## **A.1.5 SUSQUEHANNA RIVER AT CONOWINGO, MD AT SEGMENT 140 (1578310)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

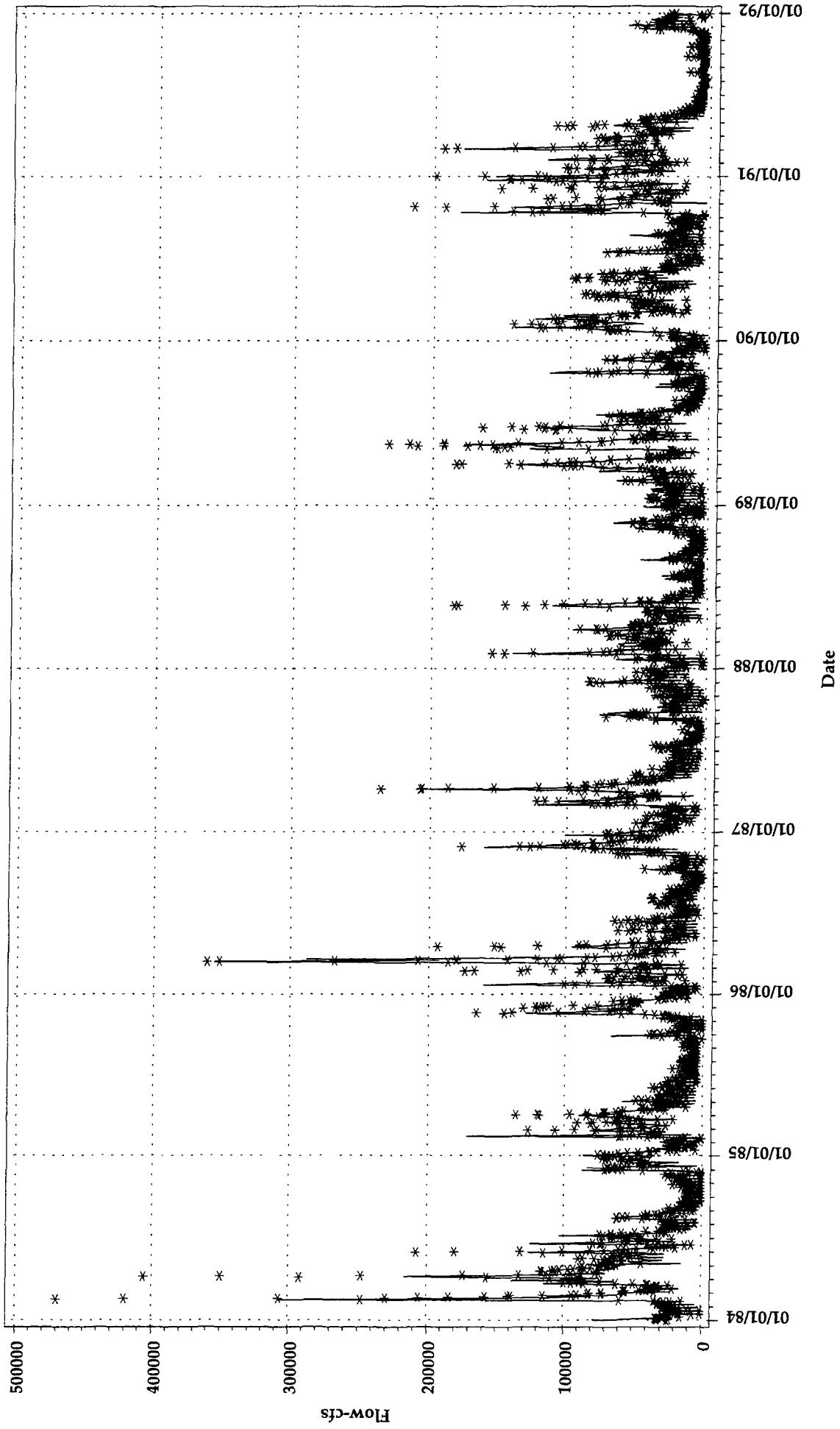
Average Seasonal Regressions for 1984-1991

# Susquehanna River at Conowingo at Segment 140

## Observed and Simulated versus Time

### Flow-cfs

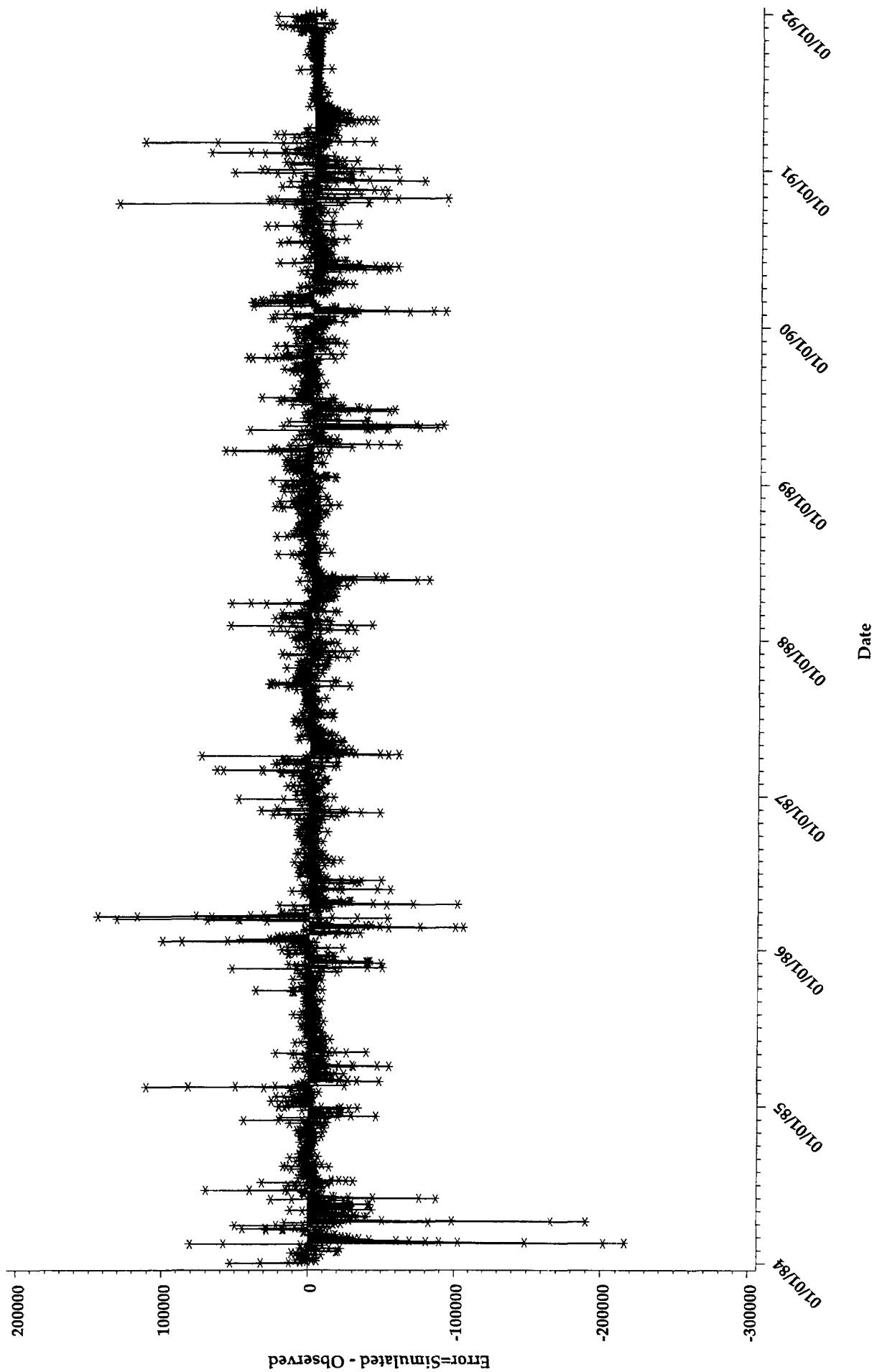
(\*=Observed, -=Simulated)



# Susquehanna River at Conowingo at Segment 140

## Actual Error versus Time

### Flow-cfs

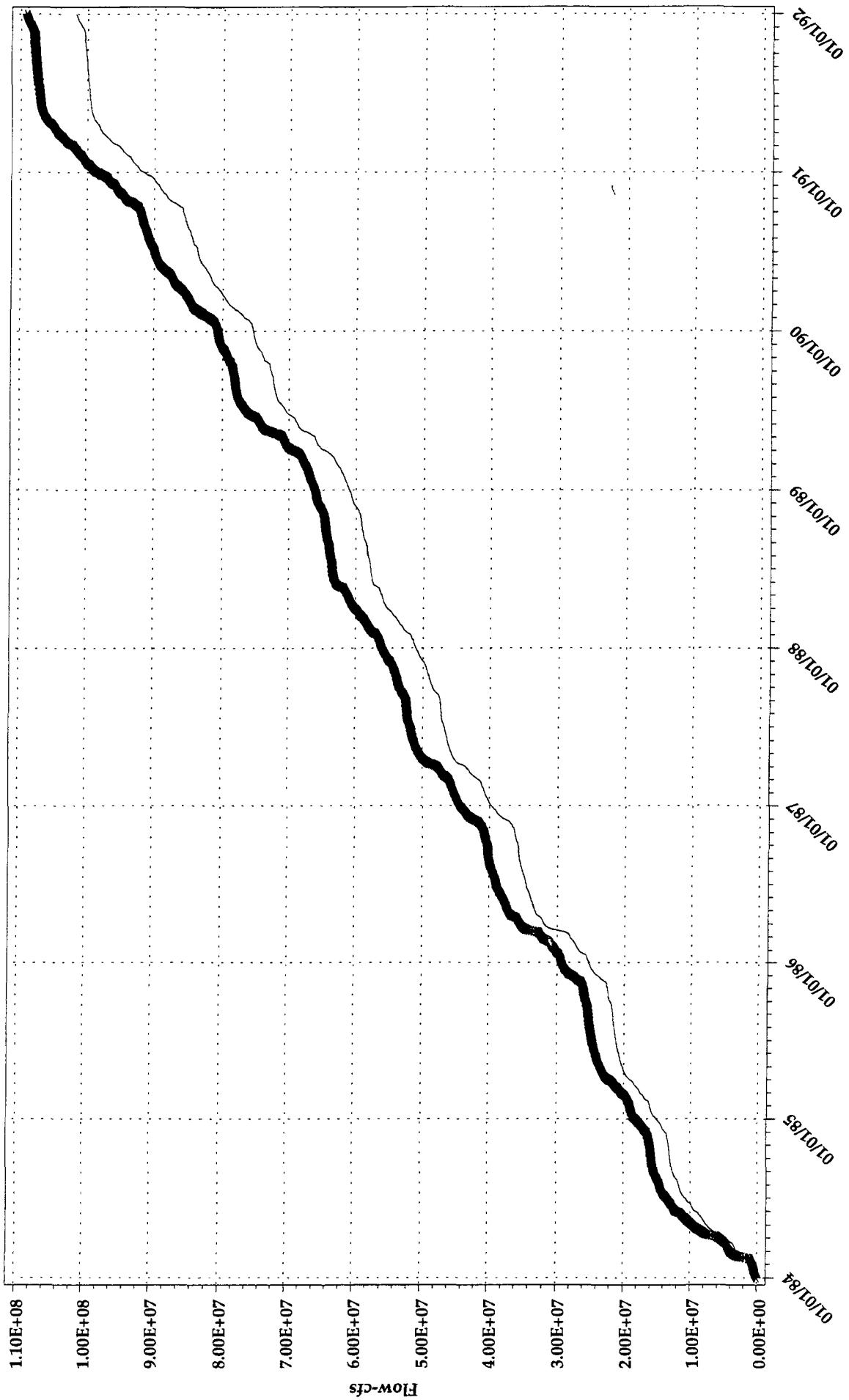


# Susquehanna River at Conowingo at Segment 140

## Observed and Simulated Cumulative Flows versus Time

Flow-cfs

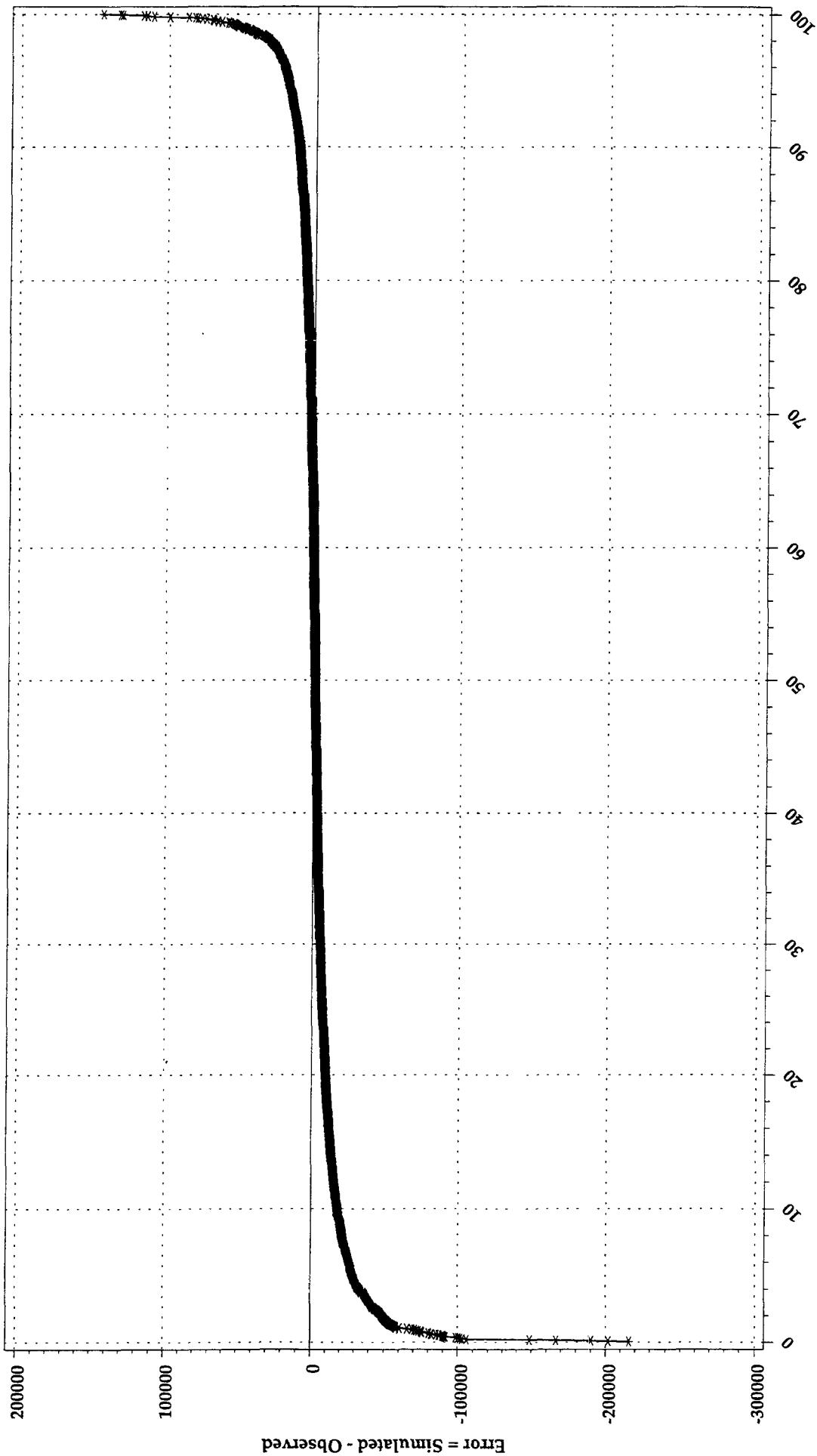
(\* = Observed, - = Simulated)



# Susquehanna River at Conowingo at Segment 140

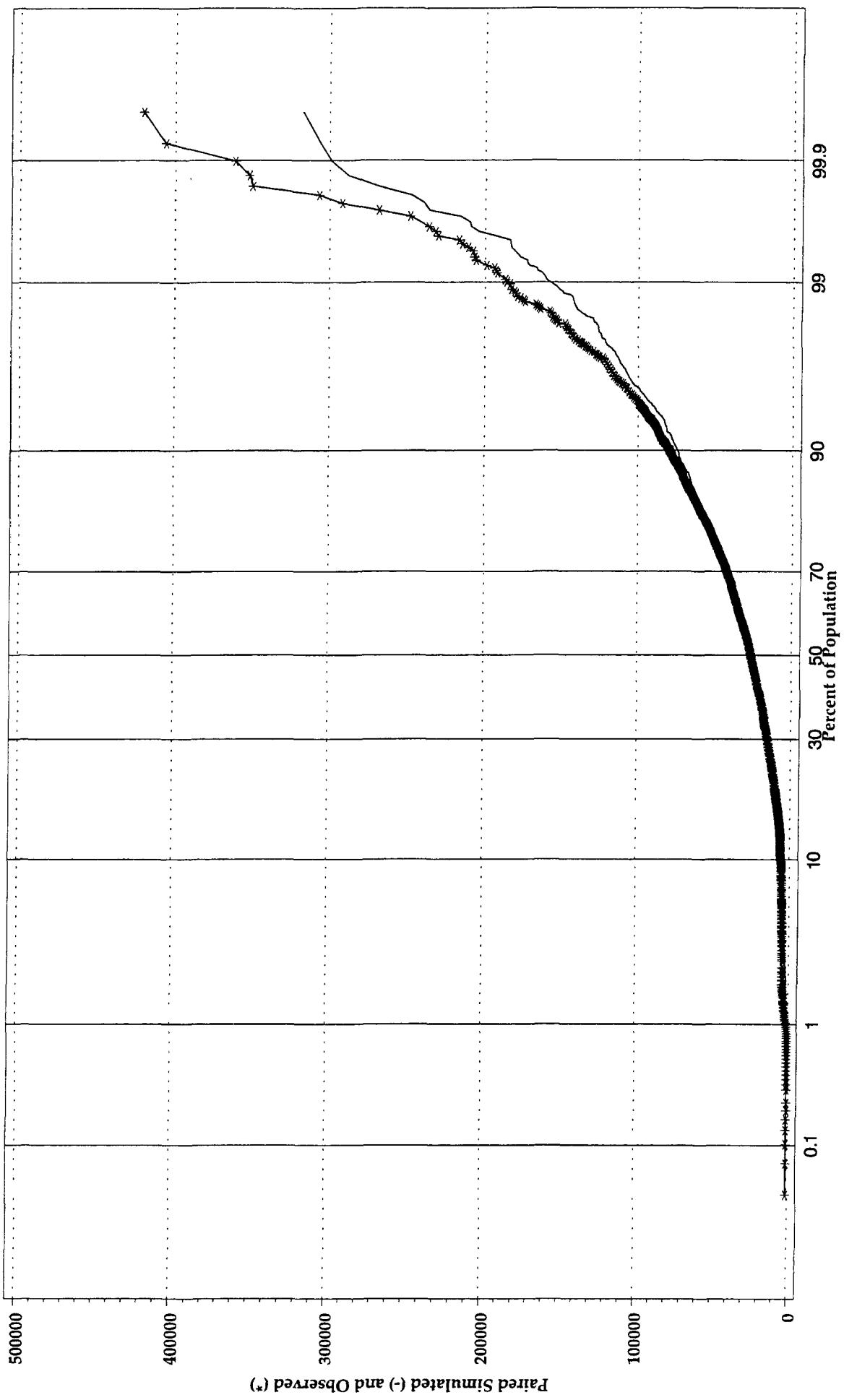
## Actual error versus Percentile Sample Population Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# Susquehanna River at Conowingo at Segment 140

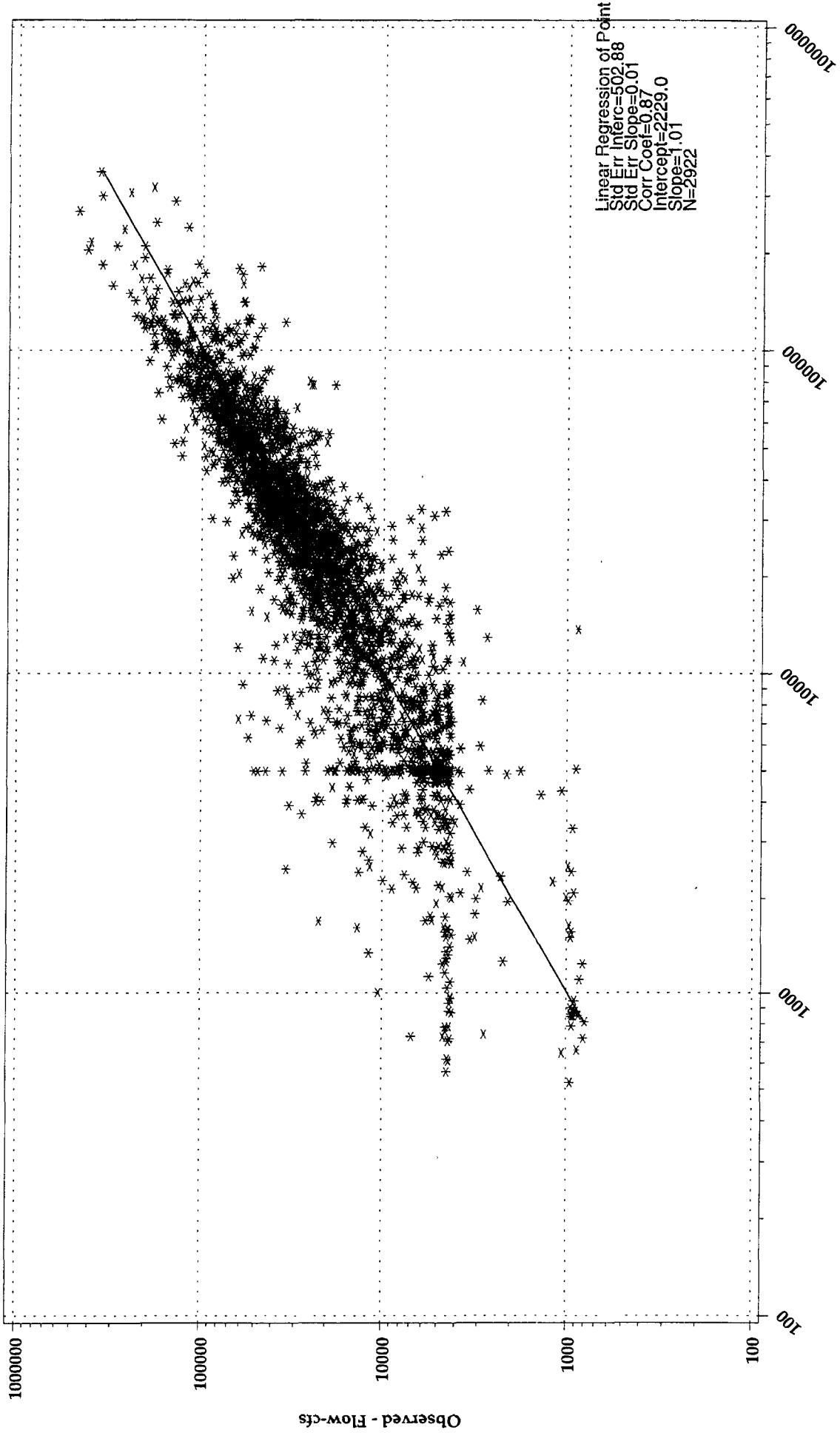
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population



# Susquehanna River at Conowingo at Segment 140

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
CONOWINGO RESERVOIR, MD (Segments 10, 20 , 30, 40, 50, 60, 70,  
80, 90, 100, 110, 120, 140, 710, and 720)**

Table A.1.5.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	Simulated Flow
Year	(inches)*	(inches)**
1984	25.01	20.53
1985	15.27	13.83
1986	20.66	19.53
1987	16.16	15.77
1988	13.64	13.53
1989	19.97	19.59
1990	24.21	22.27
1991	14.86	14.08
Mean	18.72	17.39

\* Observed flow from Susquehanna River at Conowingo, MD

\*\* Simulated outflow from RCH 140

Table A.1.5.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

Year	Average Daily			Average Monthly		
	m	b	r2	m	b	r2
1984	0.51	2.19	0.32	0.91	0.36	0.96
1985	0.91	0.37	0.82	1.02	-0.12	0.93
1986	0.95	0.16	0.77	1.02	-0.18	0.93
1987	0.93	0.27	0.81	0.93	0.28	0.92
1988	0.92	0.35	0.71	0.93	0.29	0.91
1989	0.86	0.63	0.75	0.84	0.72	0.94
1990	0.96	0.12	0.72	0.98	-0.03	0.93
1991	1.05	-0.28	0.85	1.12	-0.58	0.97
1984-1991	0.89	0.48	0.72	0.99	0.02	0.94

Table A.1.5.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.84	0.80	0.70	0.80	1.07	0.71	1.01	-0.02	0.89	0.91	0.45	0.81
1985	0.92	0.26	0.78	0.70	1.46	0.72	0.84	0.72	0.59	0.94	0.33	0.86
1986	0.77	1.08	0.56	0.70	1.45	0.73	0.79	0.99	0.49	0.80	0.95	0.89
1987	0.66	1.47	0.53	0.68	1.53	0.77	0.82	0.77	0.79	0.74	1.14	0.55
1988	0.88	0.48	0.66	0.53	2.21	0.52	0.76	0.97	0.67	0.57	1.78	0.64
1989	0.87	0.46	0.43	0.91	0.44	0.74	0.98	0.09	0.85	0.64	1.54	0.67
1990	0.59	1.97	0.78	0.42	2.71	0.28	0.57	1.91	0.55	0.80	0.98	0.74
1991	0.87	0.63	0.67	0.65	1.68	0.77	0.41	2.23	0.36	0.54	1.88	0.68
1984-1991	0.78	1.02	0.68	0.99	-0.03	0.68	0.93	0.23	0.76	1.00	-0.03	0.74

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

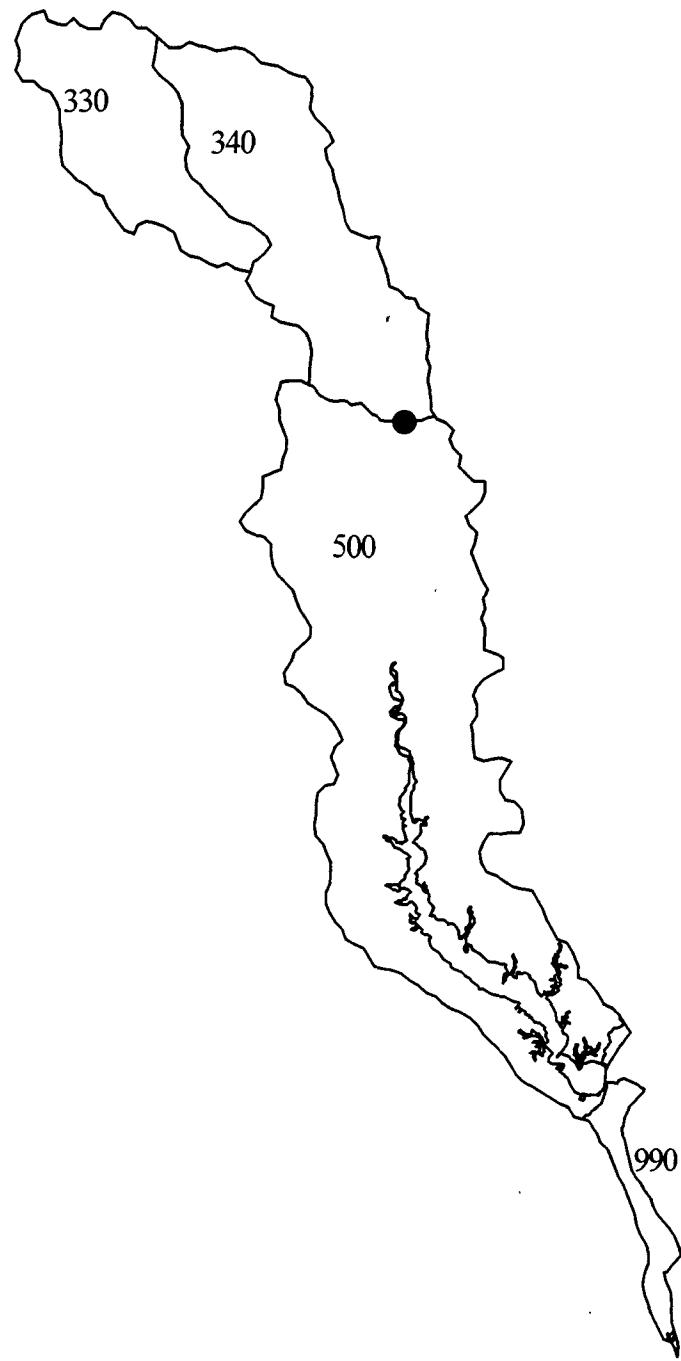
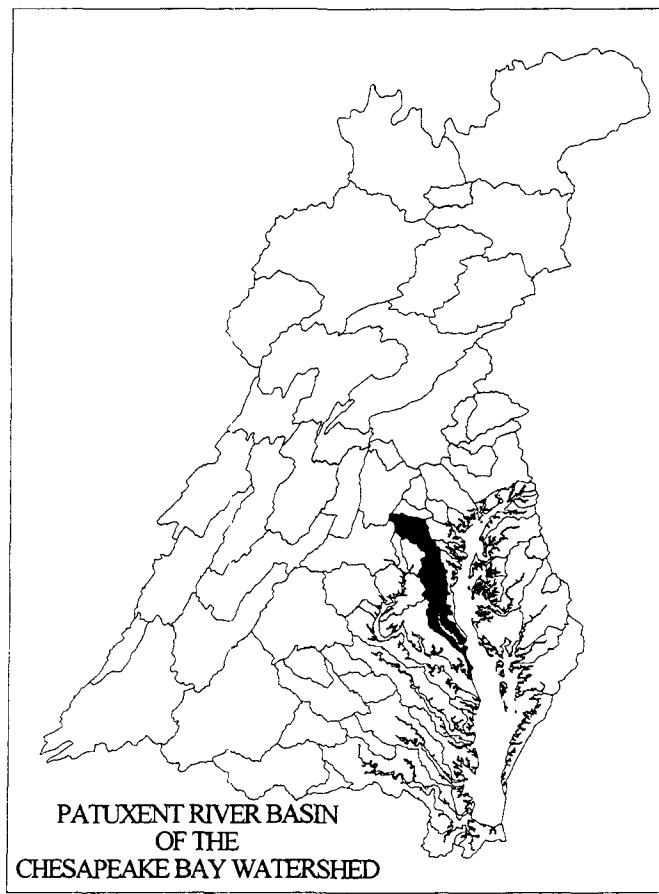
Season 4 is from Julian day 271 to 365.

# Monitoring Stations

## Chesapeake Bay Watershed

### Phase IV Model Segments:

#### Patuxent River Basin



## **A.2.1 PATUXENT RIVER AT BOWIE, MD AT SEGMENT 340 (1594440)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

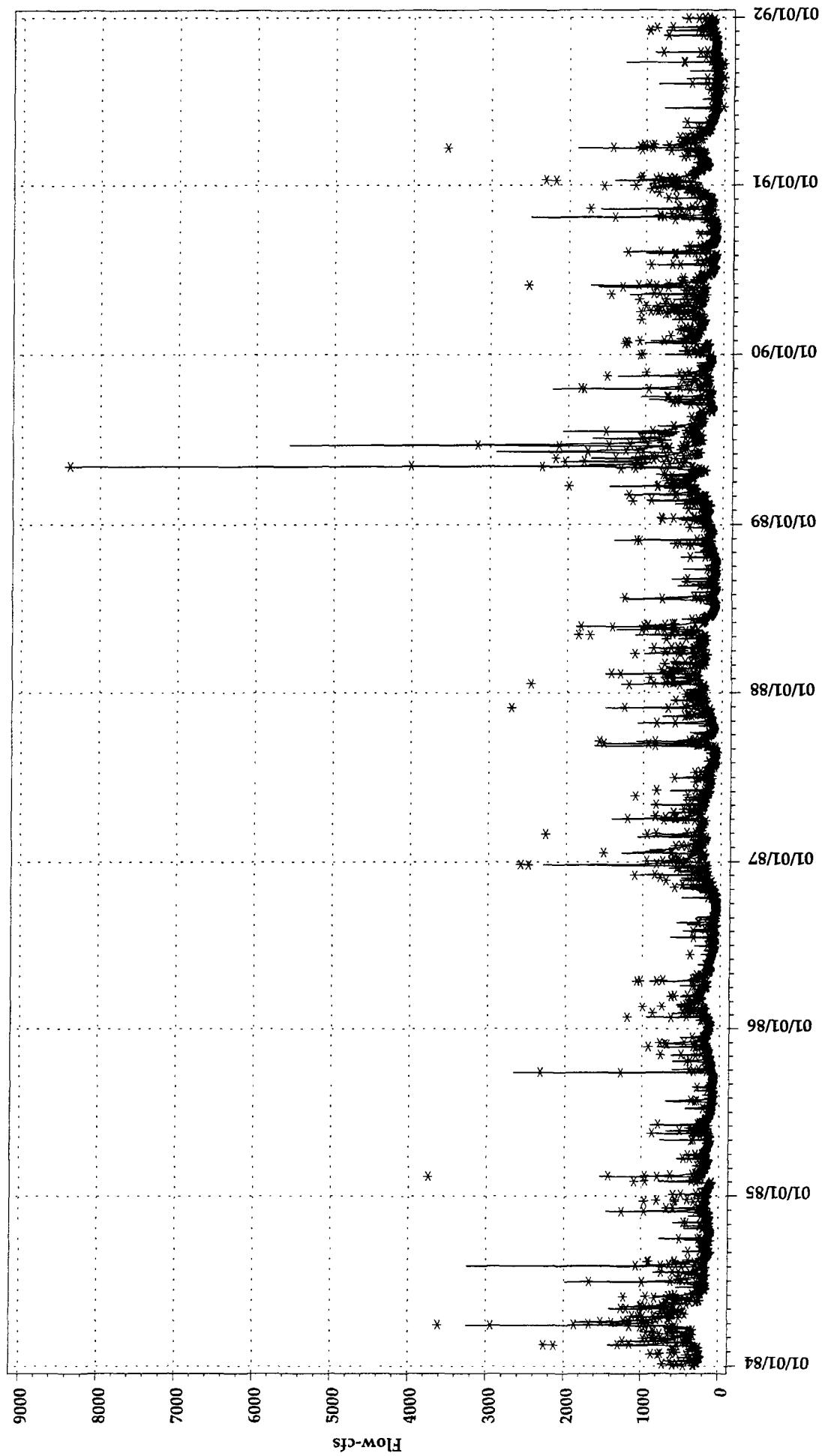
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Patuxent River at Segment 340 Observed and Simulated versus Time

## Flow-cfs

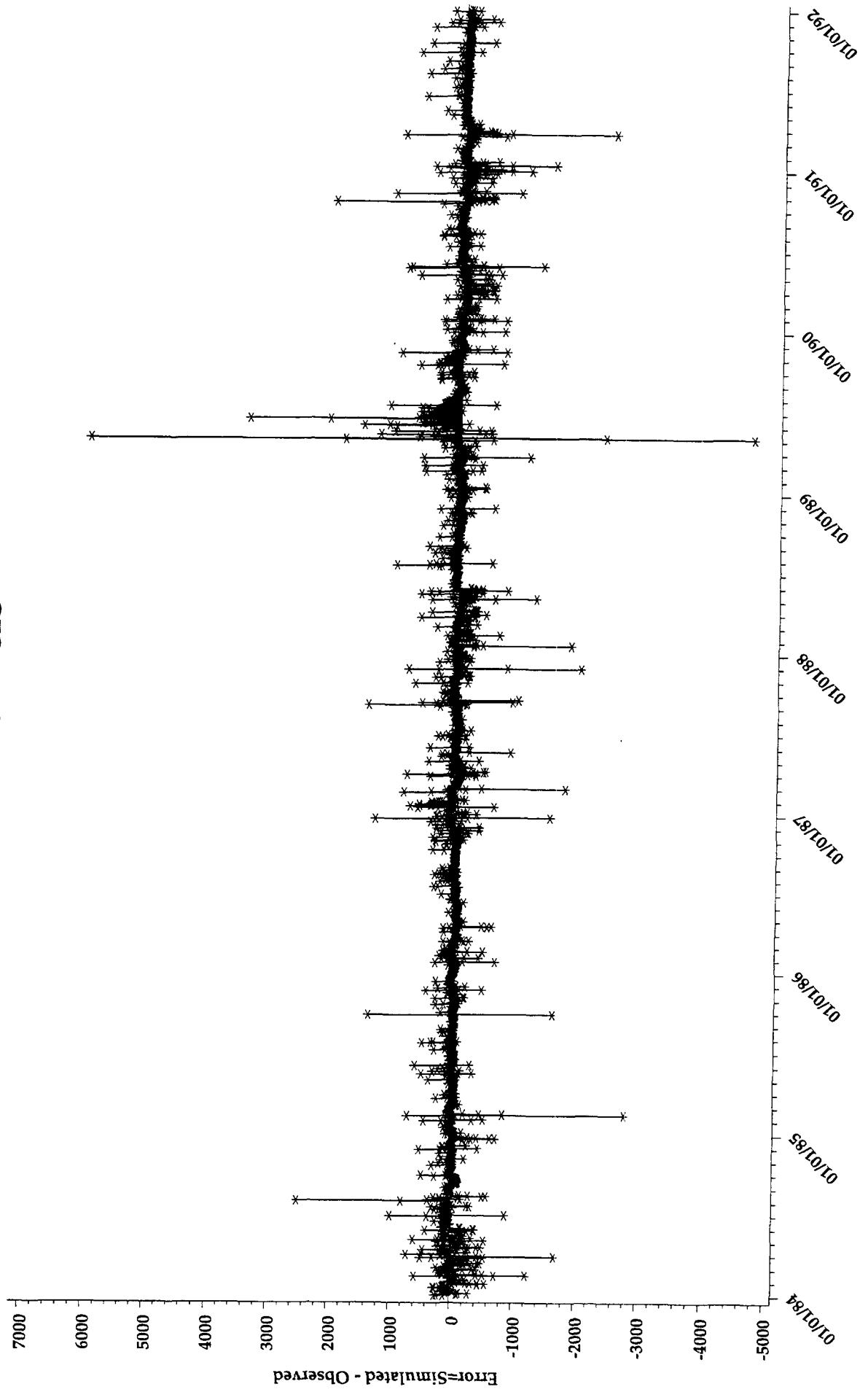
(\*=Observed, -=Simulated)



# Patuxent River at Segment 340

## Actual Error versus Time

### Flow-cfs



# Patuxent River at Segment 340

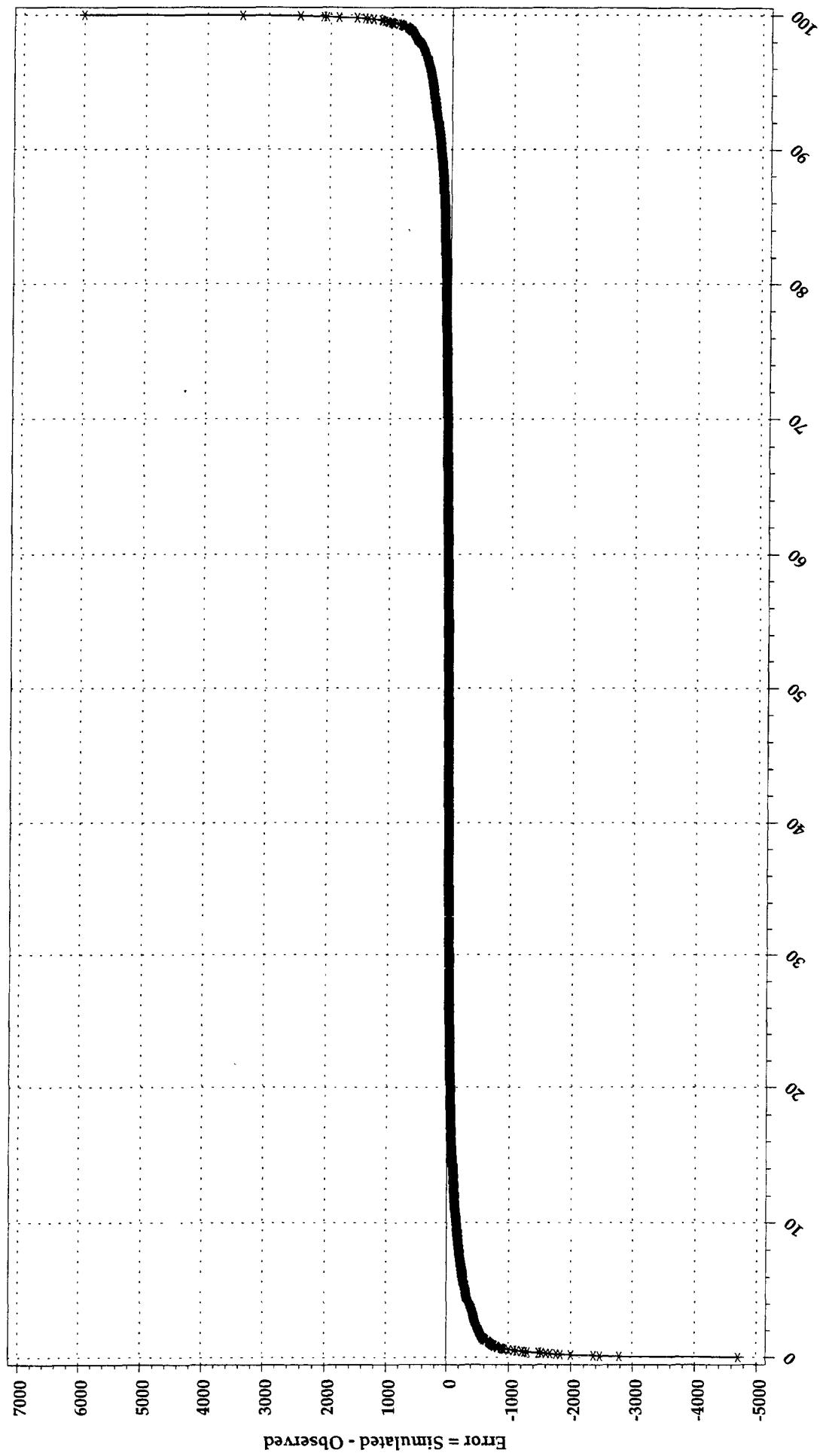
## Observed and Simulated Cumulative Flows versus Time

Flow-cfs  
(\* = Observed, - = Simulated)



# Patuxent River at Segment 340 Actual error versus Percentile Sample Population Flow-cfs

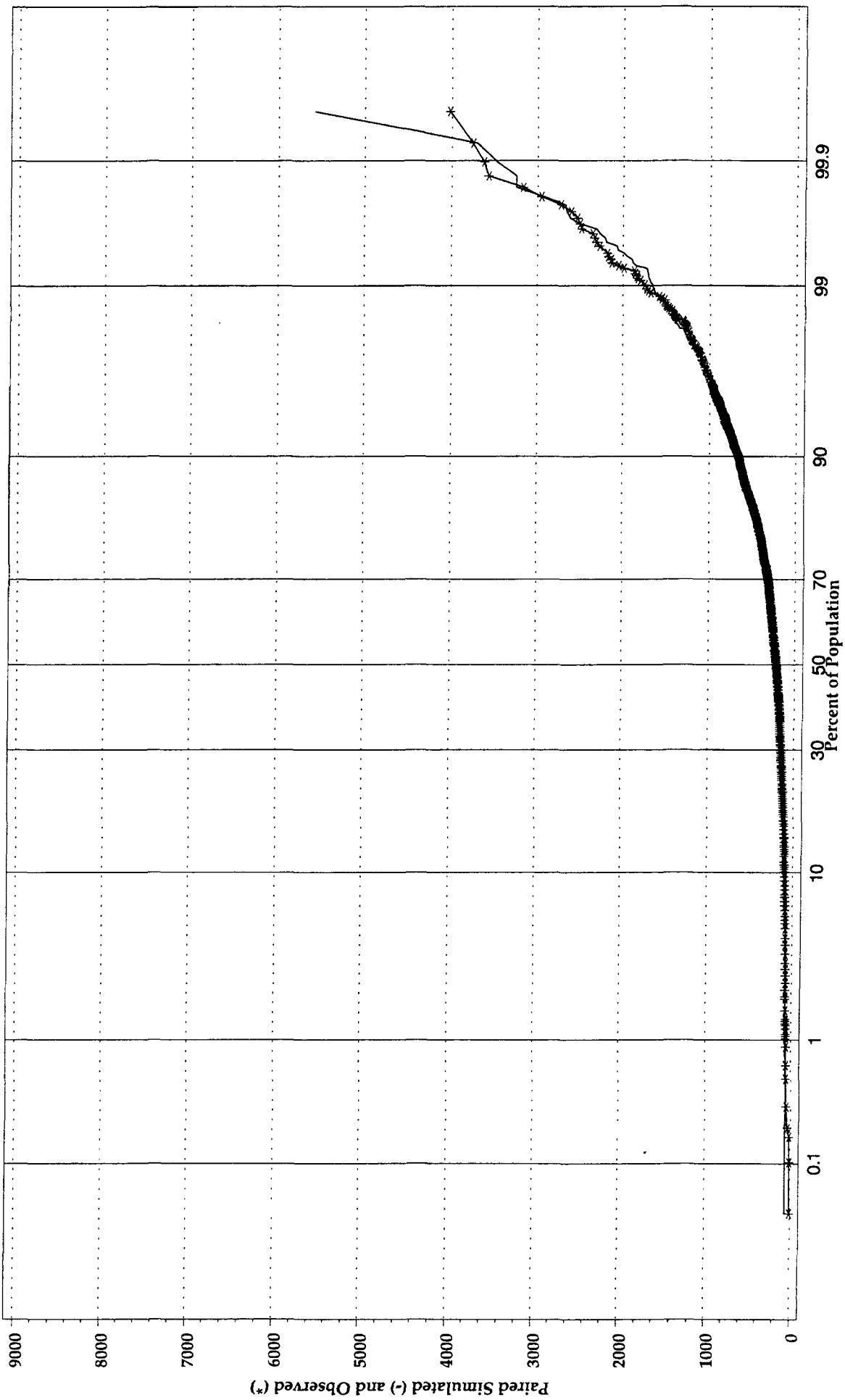
Frequency Distribution - All Simulated and Observed Data



# Patuxent River at Segment 340

## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

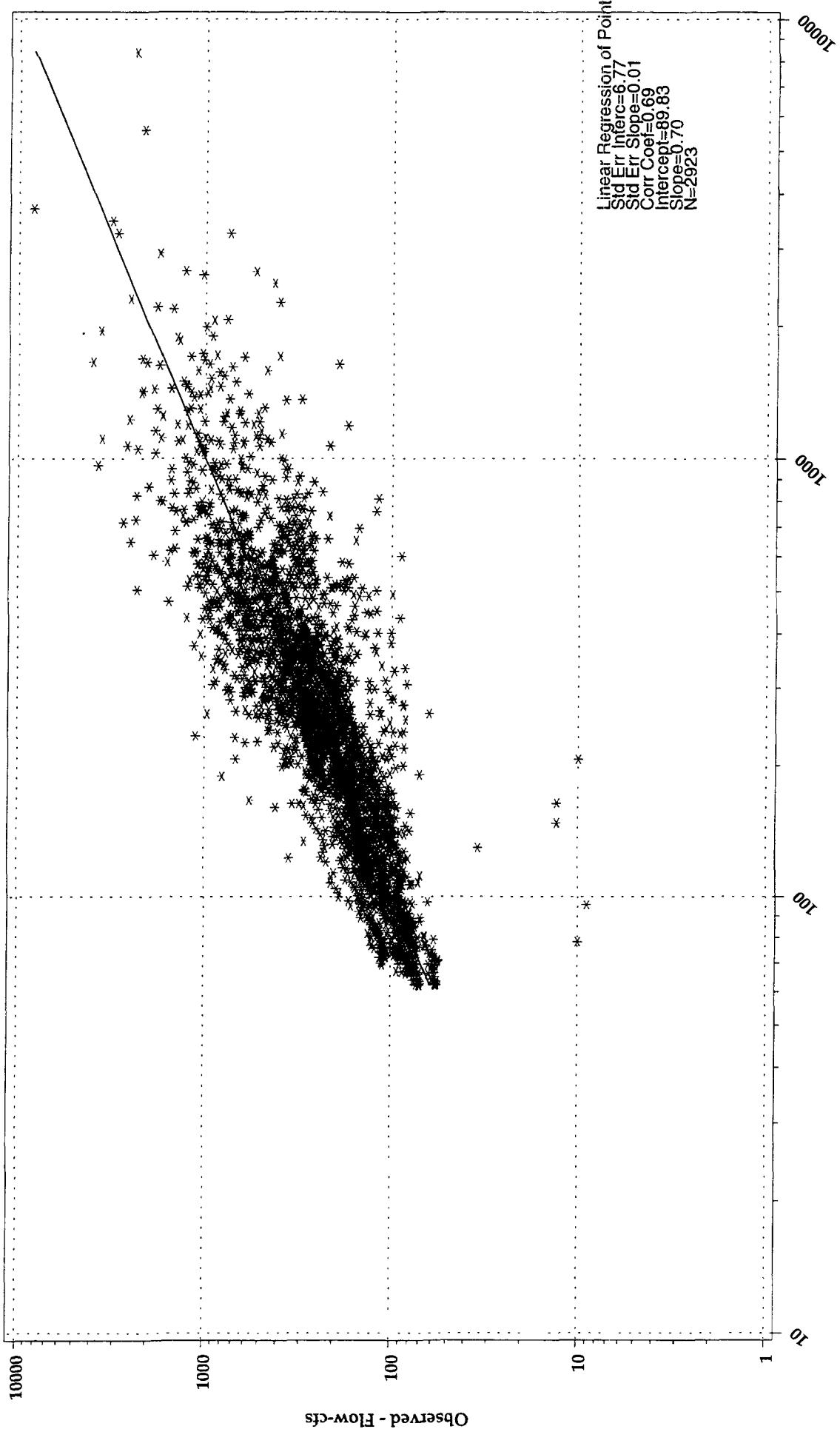
### Flow-cfs



# Patuxent River at Segment 340

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
PATUXENT RIVER, MD (Segments 330 and 340)**

A.2.1.1 Comparison of Annual Total Observed and Simulated flows.

	<b>Observed Flow</b>	<b>Simulated Flow</b>
<b>Year</b>	(inches)*	(inches)**
1984	17.12	16.82
1985	8.41	9.13
1986	8.42	8.77
1987	11.39	12.73
1988	11.93	12.14
1989	18.57	24.4
1990	14.59	13.24
1991	10.64	9.38
Mean	12.63	13.33

\*Observed flow at Patuxent River near Bowie, MD

\*\*Simulated outflow from RCH 340

Table A.2.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r<sup>2</sup></b>	<b>m</b>	<b>b</b>	<b>r<sup>2</sup></b>
1984	0.80	0.51	0.70	0.92	0.21	0.92
1985	0.89	0.29	0.71	0.94	0.16	0.88
1986	0.79	0.49	0.63	0.96	0.12	0.88
1987	0.81	0.49	0.64	0.91	0.26	0.83
1988	0.73	0.68	0.70	0.69	0.75	0.87
1989	0.86	0.48	0.71	1.14	-0.24	0.89
1990	0.67	0.78	0.66	0.62	0.92	0.84
1991	0.72	0.60	0.67	0.79	0.45	0.93
1984-1991	0.78	0.54	0.68	0.91	0.24	0.87

Table A.2.1.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.85	0.40	0.42	0.79	0.62	0.55	0.66	0.81	0.52	0.68	0.74	0.48
1985	1.19	-0.49	0.75	0.62	0.86	0.67	0.60	0.82	0.69	0.82	0.37	0.70
1986	0.75	0.56	0.28	0.83	0.45	0.73	0.46	1.04	0.45	0.80	0.38	0.74
1987	0.65	0.79	0.31	0.79	0.53	0.38	0.76	0.50	0.67	0.91	0.15	0.50
1988	1.07	-0.16	0.67	0.80	0.57	0.57	0.78	0.35	0.63	0.79	0.45	0.71
1989	0.80	0.46	0.53	0.83	0.42	0.61	0.75	0.50	0.76	0.85	0.26	0.62
1990	0.93	0.23	0.55	0.81	0.59	0.57	1.03	-0.15	0.80	0.84	0.44	0.57
1991	1.03	0.00	0.62	1.10	-0.16	0.75	0.42	1.12	0.16	0.57	0.98	0.26
1984-1991	0.57	1.11	0.53	0.84	0.39	0.73	0.94	0.22	0.72	0.82	0.44	0.62

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

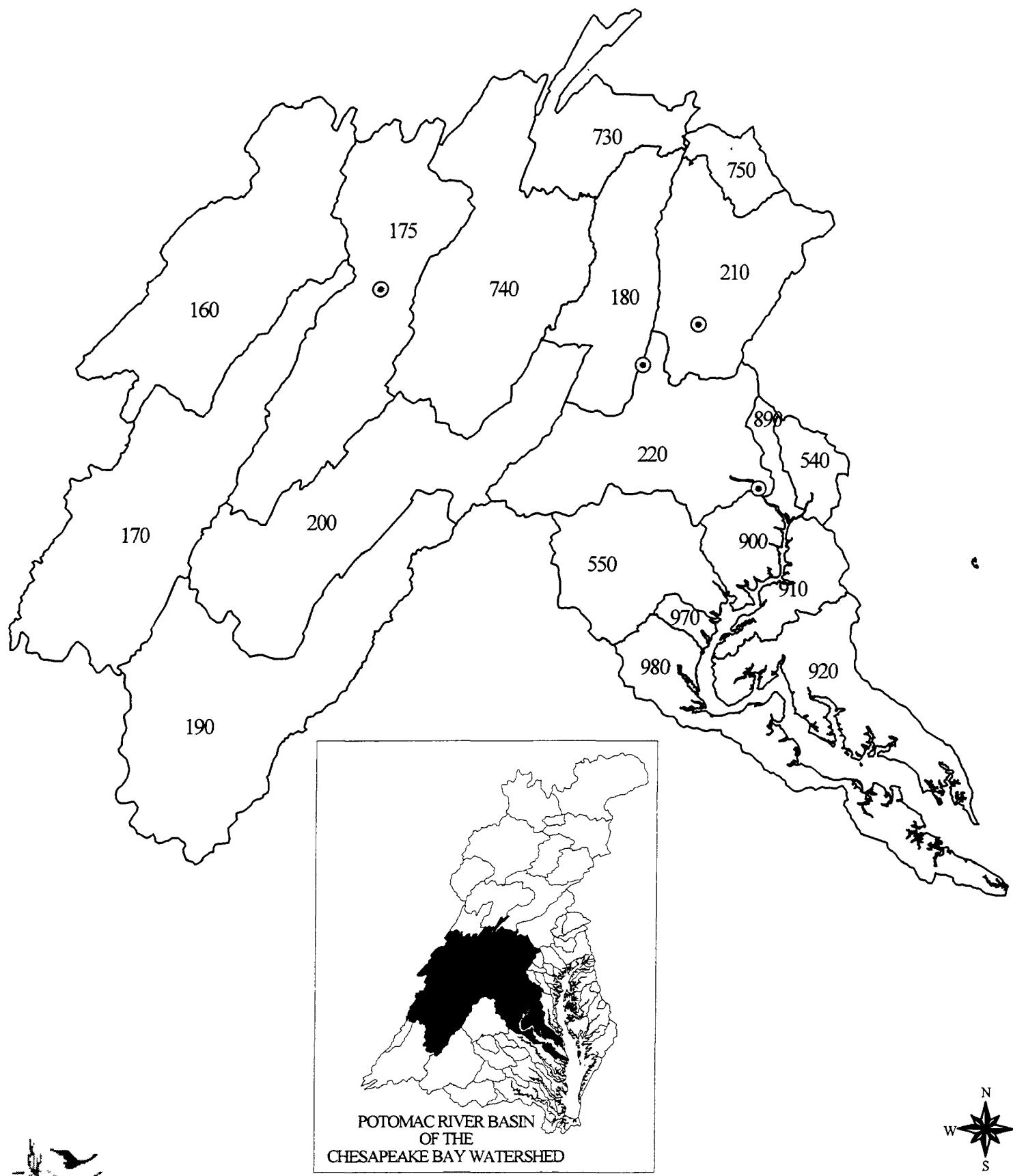
Season 4 is from Julian day 271 to 365.

# Monitoring Stations

## Chesapeake Bay Watershed

### Phase IV Model Segments:

#### Potomac River Basin



### **A.3.1 UPPER POTOMAC RIVER AT HANCOCK, MD AT SEGMENT 175 (1613000)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

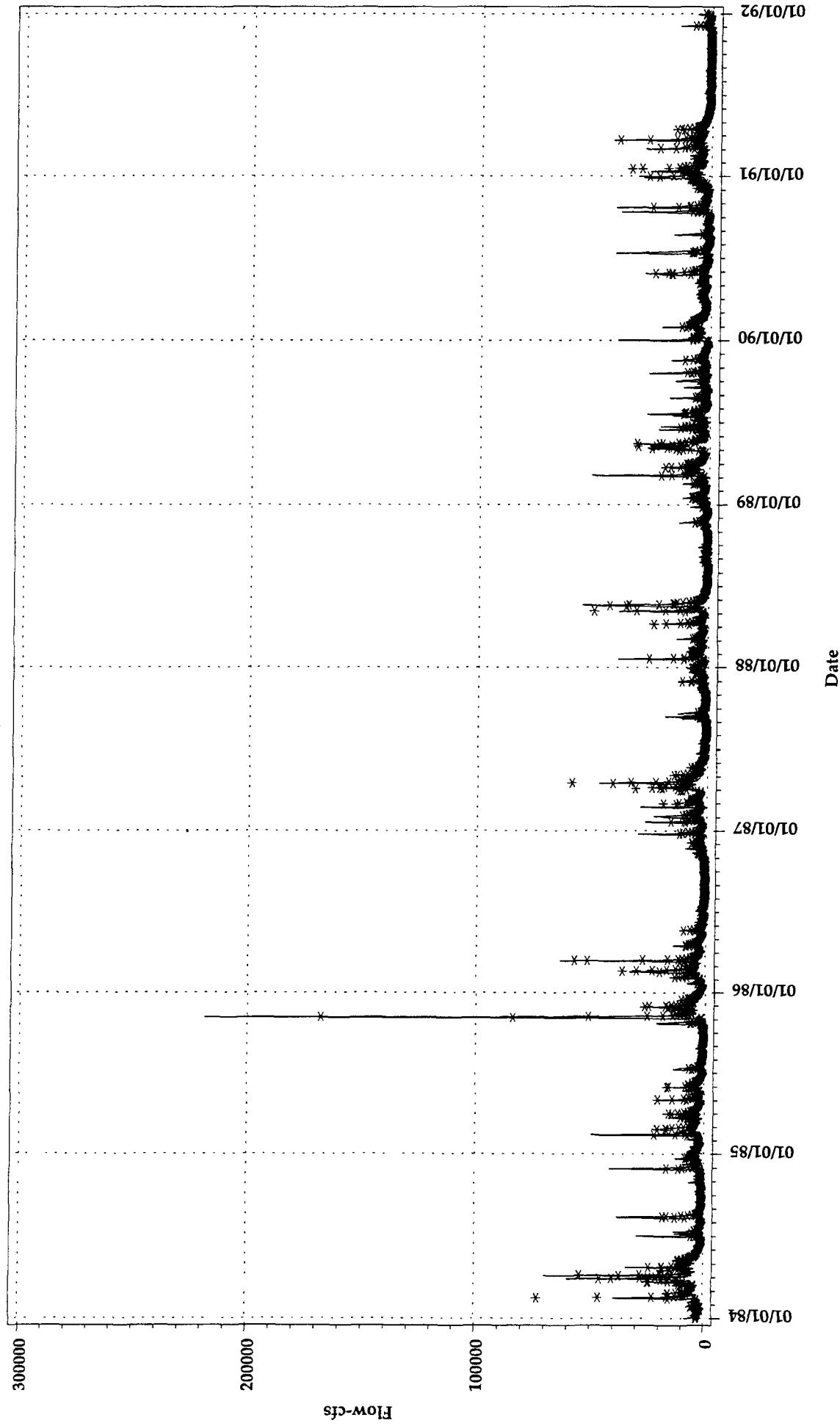
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Upper Potomac River at Segment 175 Observed and Simulated versus Time

## Flow-cfs

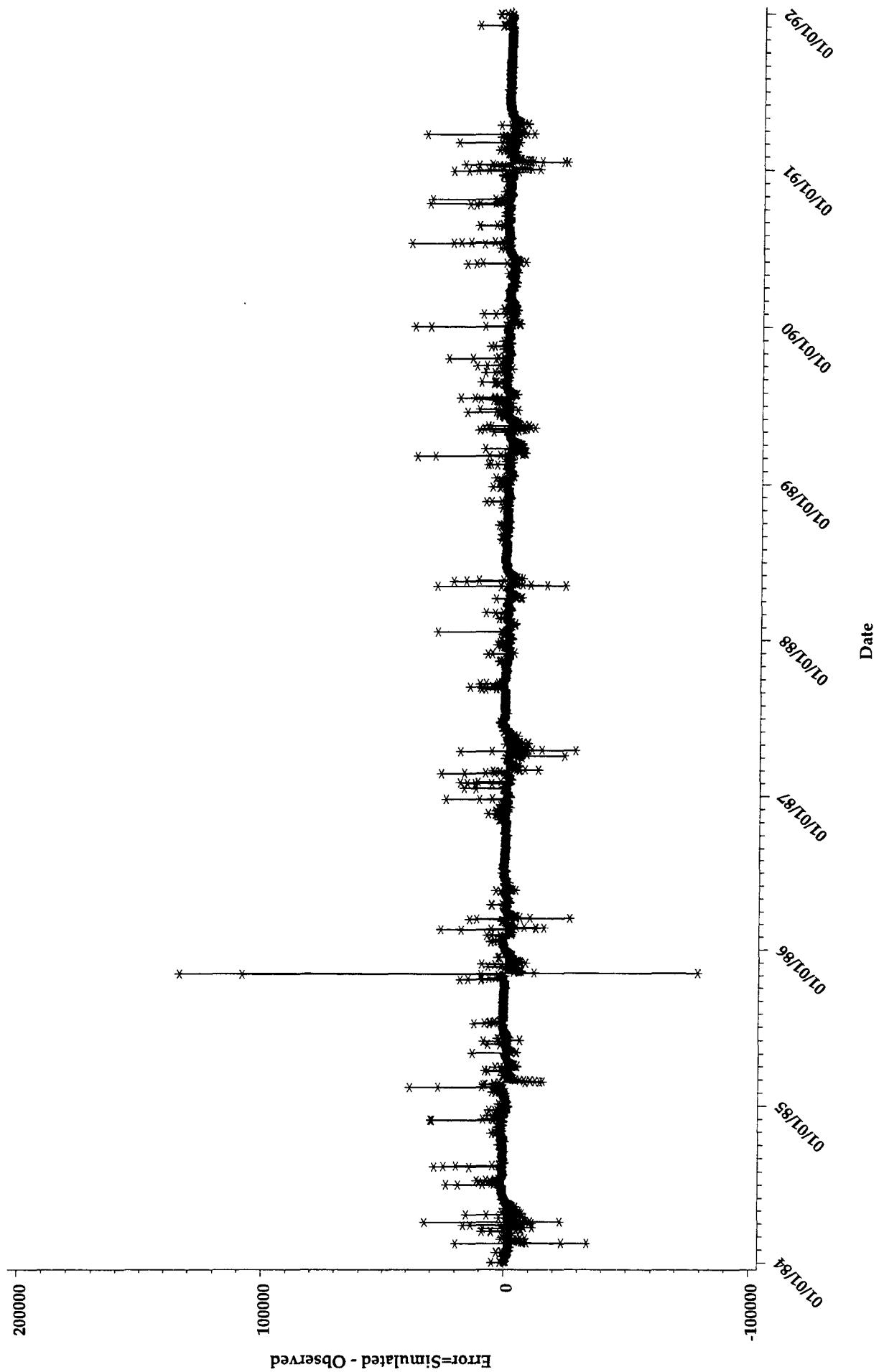
(\*=Observed, -=Simulated)



# Upper Potomac River at Segment 175

## Actual Error versus Time

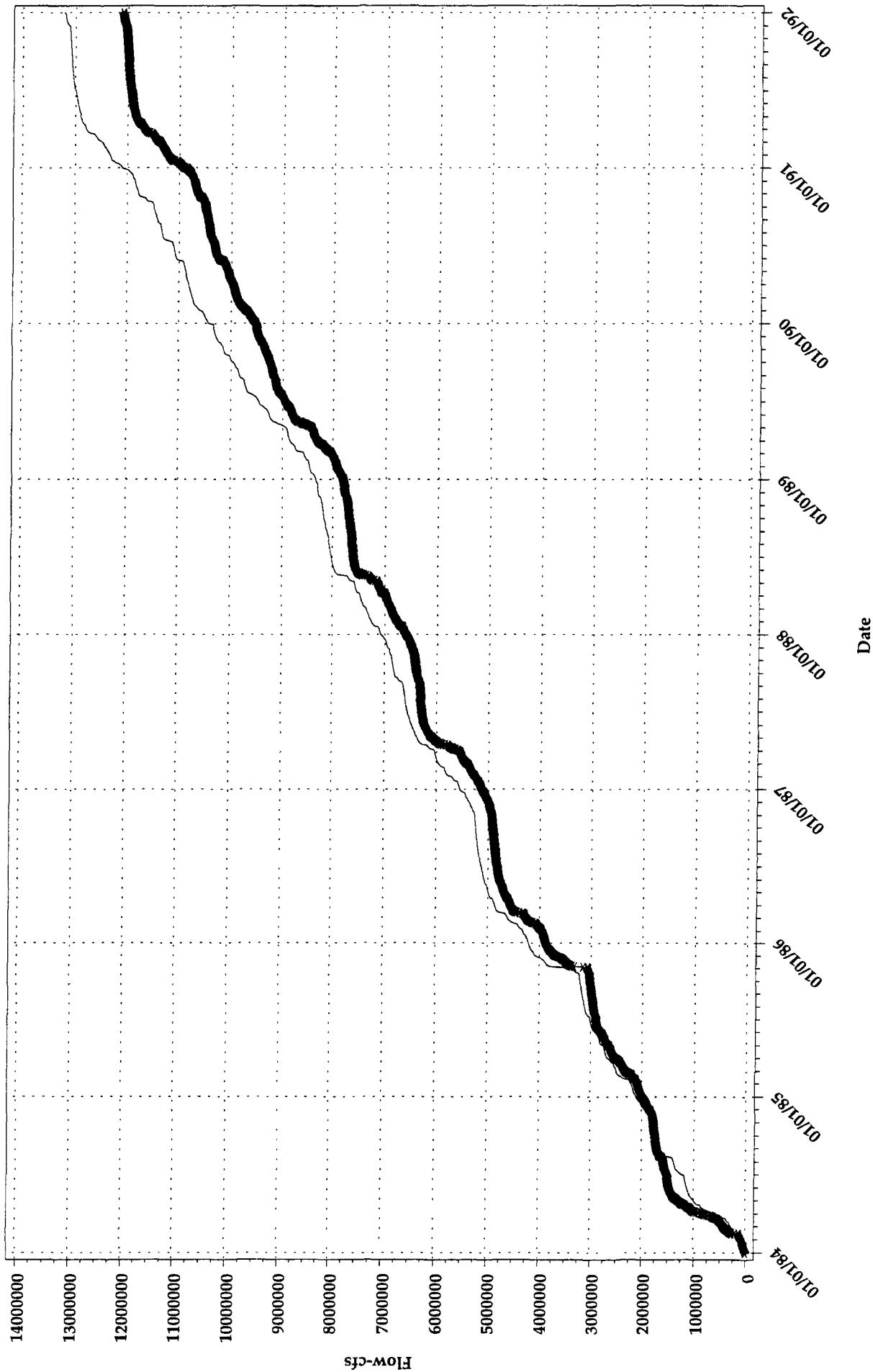
### Flow-cfs



# Upper Potomac River at Segment 175

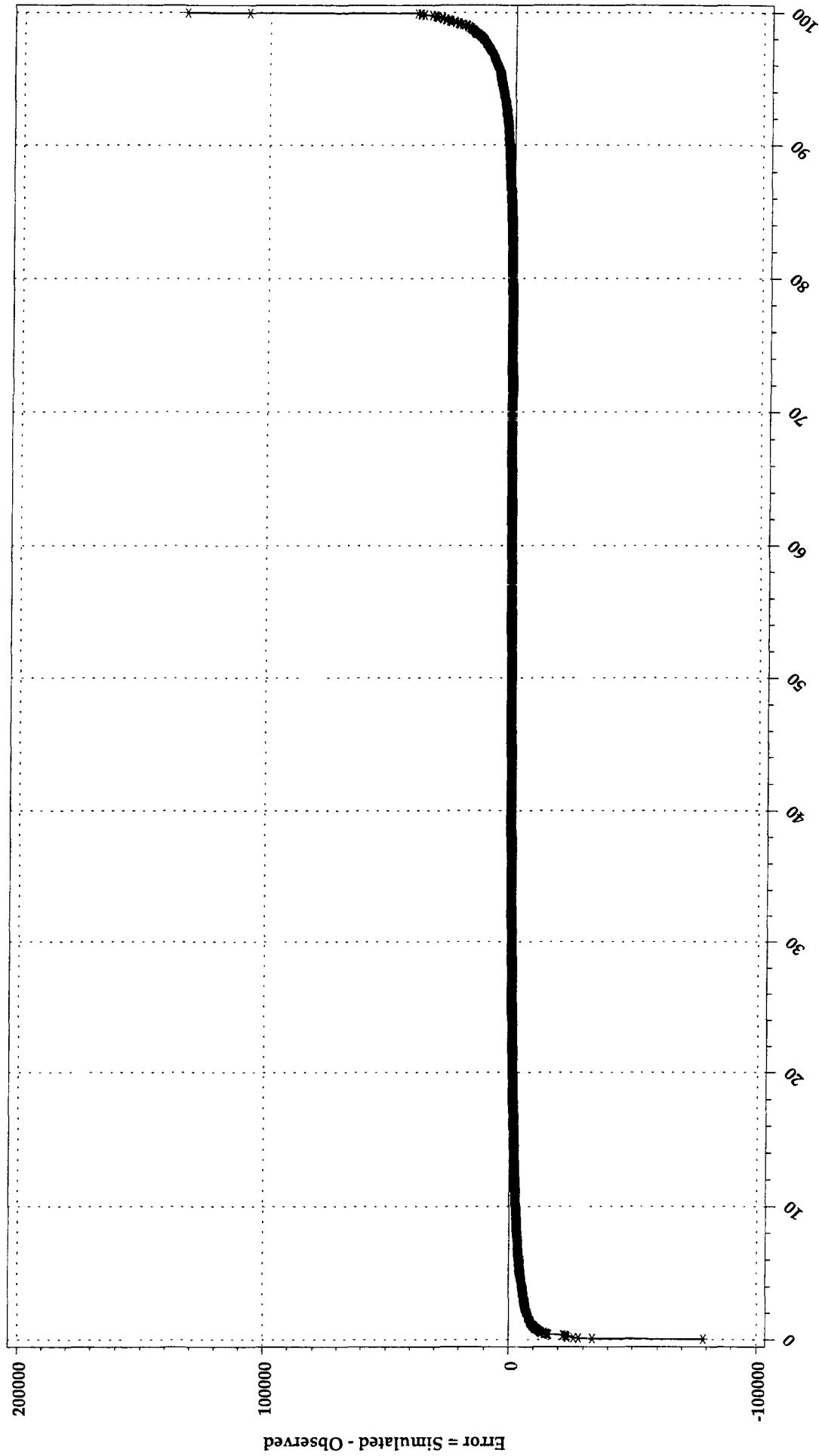
## Observed and Simulated Cumulative Flows versus Time

(\* = Observed, \_ = Simulated)



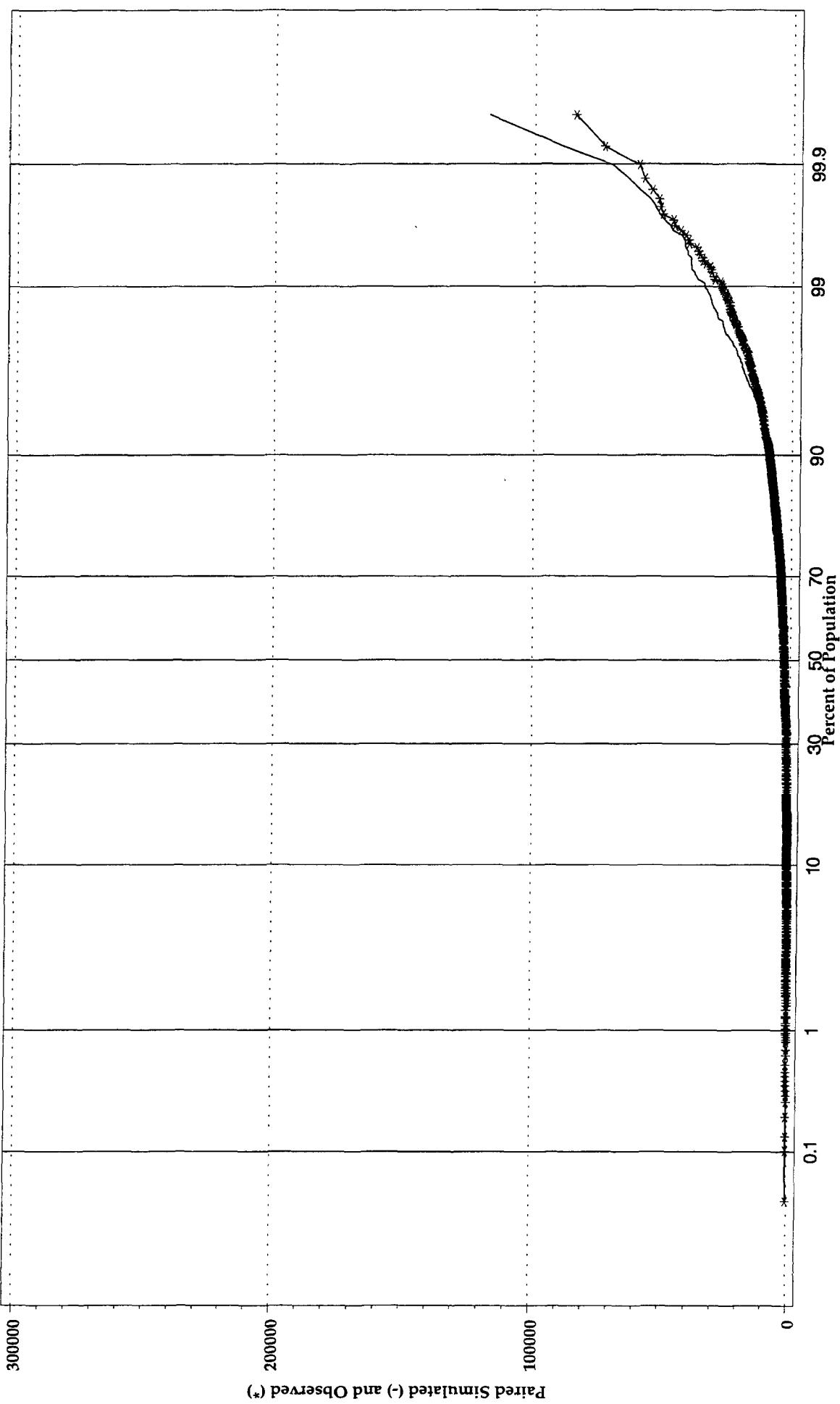
# Upper Potomac River at Segment 175 Actual error versus Percentile Sample Population Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# Upper Potomac River at Segment 175

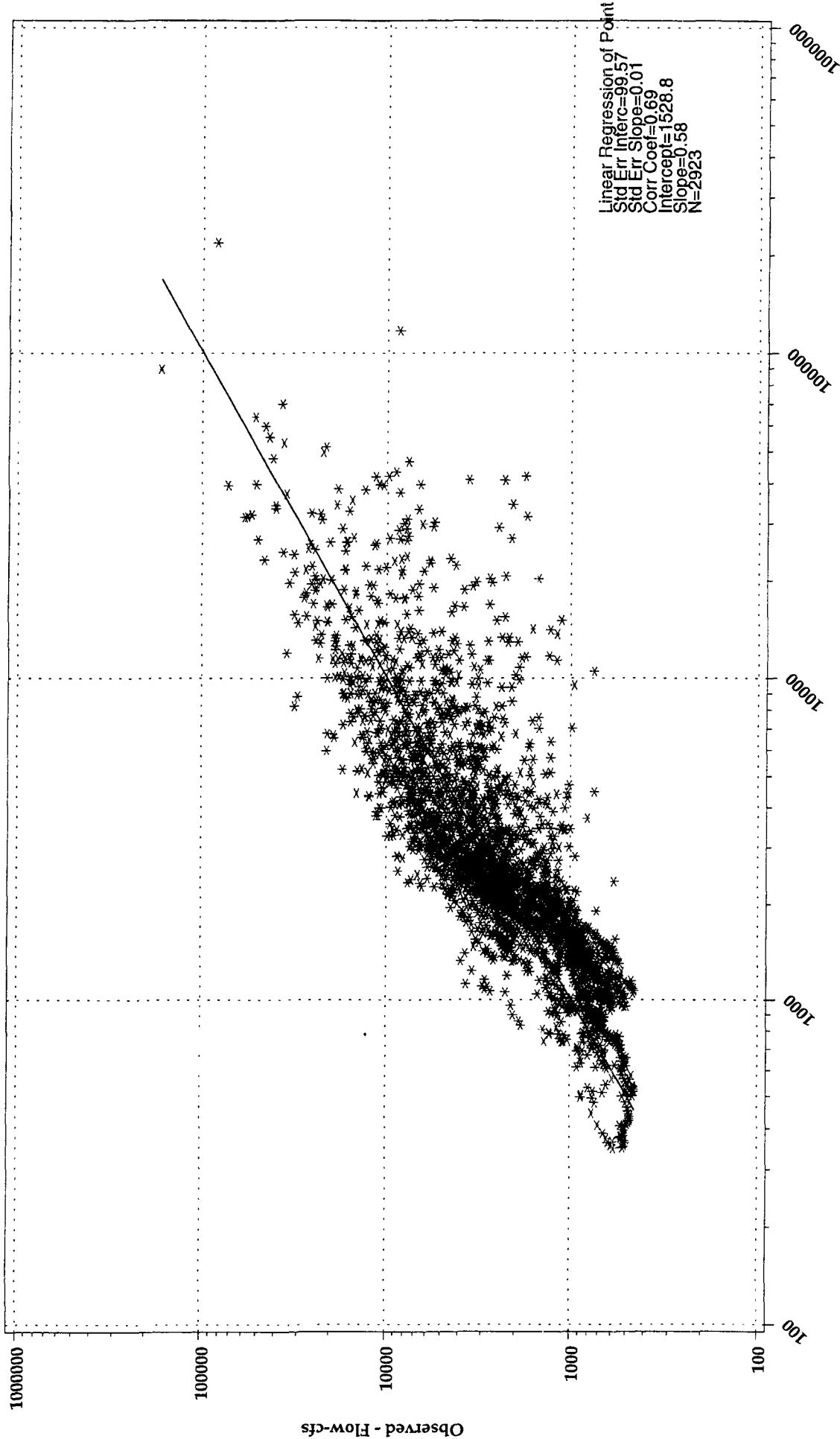
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population



# Upper Potomac River at Segment 175

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
UPPER POTOMAC RIVER, MD (Segments 160, 170 and 175)**

Table A.3.1.1 Comparison of Annual Total Observed and Simulated flows.

	<b>Observed Flow</b>	<b>Simulated Flow</b>
<b>Year</b>	(inches)*	(inches)**
1984	18.19	18.69
1985	17.3	18.67
1986	11.35	11.48
1987	13.47	13.26
1988	11.07	11.04
1989	15.59	18.5
1990	12.33	14.83
1991	11.08	9.97
Mean	13.80	14.56

\*Observed flow at Upper Potomac River at Hancock, MD

\*\*Simulated outflow from RCH 175

Table A.3.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r2</b>	<b>m</b>	<b>b</b>	<b>r2</b>
1984	0.66	1.25	0.59	0.51	1.76	0.70
1985	0.74	0.97	0.69	0.70	1.09	0.86
1986	0.82	0.65	0.80	0.85	0.58	0.94
1987	0.56	1.59	0.57	0.54	1.63	0.78
1988	0.72	1.00	0.74	0.63	1.27	0.90
1989	0.74	0.98	0.50	0.62	1.41	0.65
1990	0.82	0.64	0.52	0.58	1.47	0.48
1991	0.82	0.59	0.82	0.84	0.53	0.94
1984-1991	0.74	0.96	0.65	0.71	1.03	0.82

Table A.3.1.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2									
1984	0.92	0.47	0.80	0.85	0.62	0.72	0.83	0.33	0.80	0.89	0.18	0.68
1985	0.69	1.05	0.44	0.88	0.51	0.71	1.07	-0.42	0.82	0.98	0.02	0.83
1986	1.10	-0.47	0.64	1.03	-0.10	0.86	0.70	0.86	0.59	0.72	0.92	0.84
1987	0.42	2.00	0.31	1.03	0.06	0.79	0.91	0.04	0.83	1.03	-0.19	0.74
1988	0.90	0.32	0.64	0.91	0.38	0.82	1.15	-0.65	0.62	0.78	0.66	0.76
1989	0.73	0.94	0.49	0.81	0.78	0.70	0.86	0.33	0.68	0.55	1.46	0.47
1990	0.34	2.48	0.25	0.57	1.56	0.48	0.72	0.79	0.56	0.78	0.66	0.75
1991	0.72	0.09	0.39	0.89	0.43	0.75	0.53	1.32	0.59	0.61	1.24	0.79
1984-1991	0.74	0.92	0.45	0.89	0.30	0.73	0.87	0.61	0.71	0.95	0.25	0.74

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

**A.3.2 SHENANDOAH RIVER AT MILLVILLE, WV AT SEGMENT 200  
(1636500)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

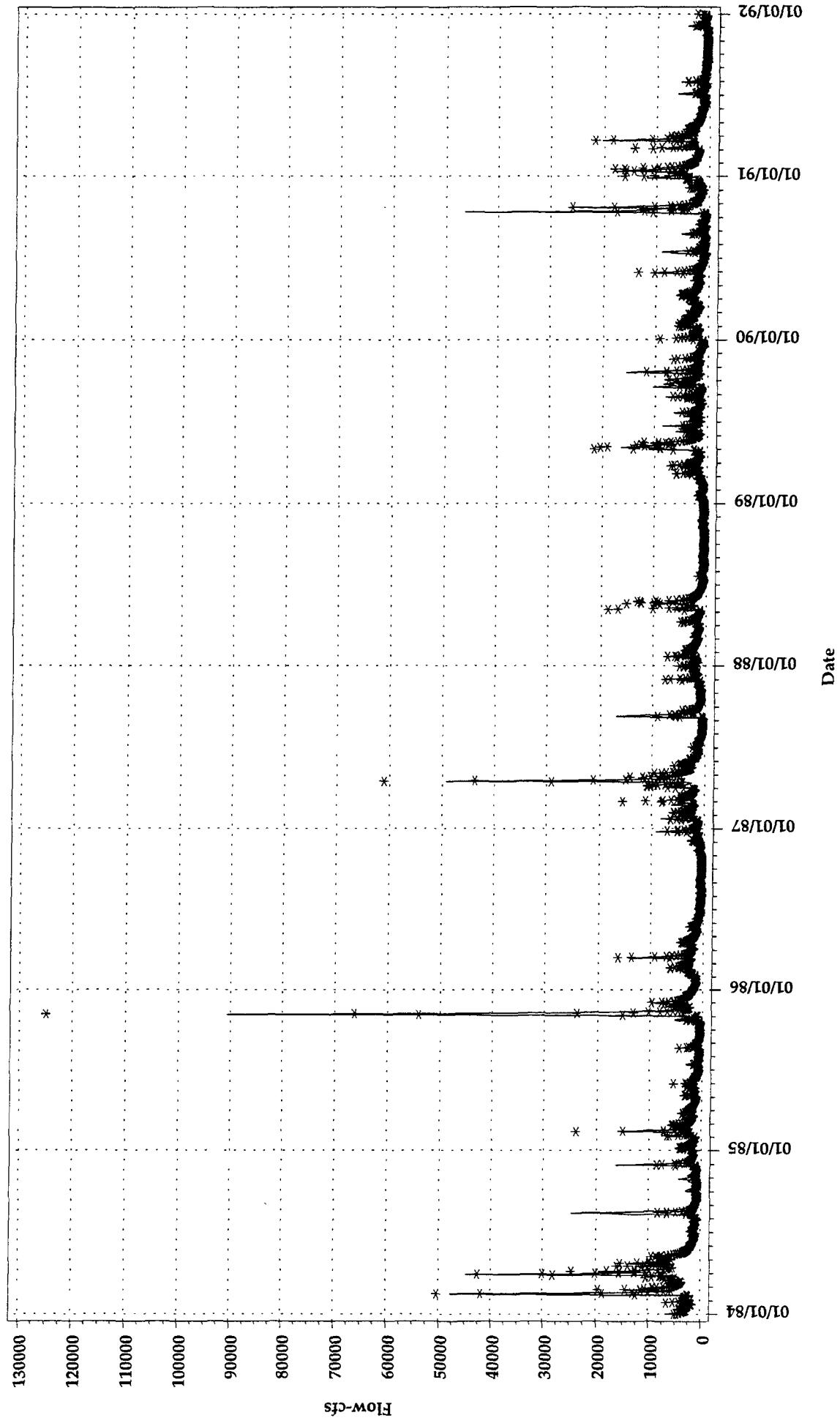
Average Seasonal Regressions for 1984-1991



# Shenandoah River at Segment 200 Observed and Simulated versus Time

## Flow-cfs

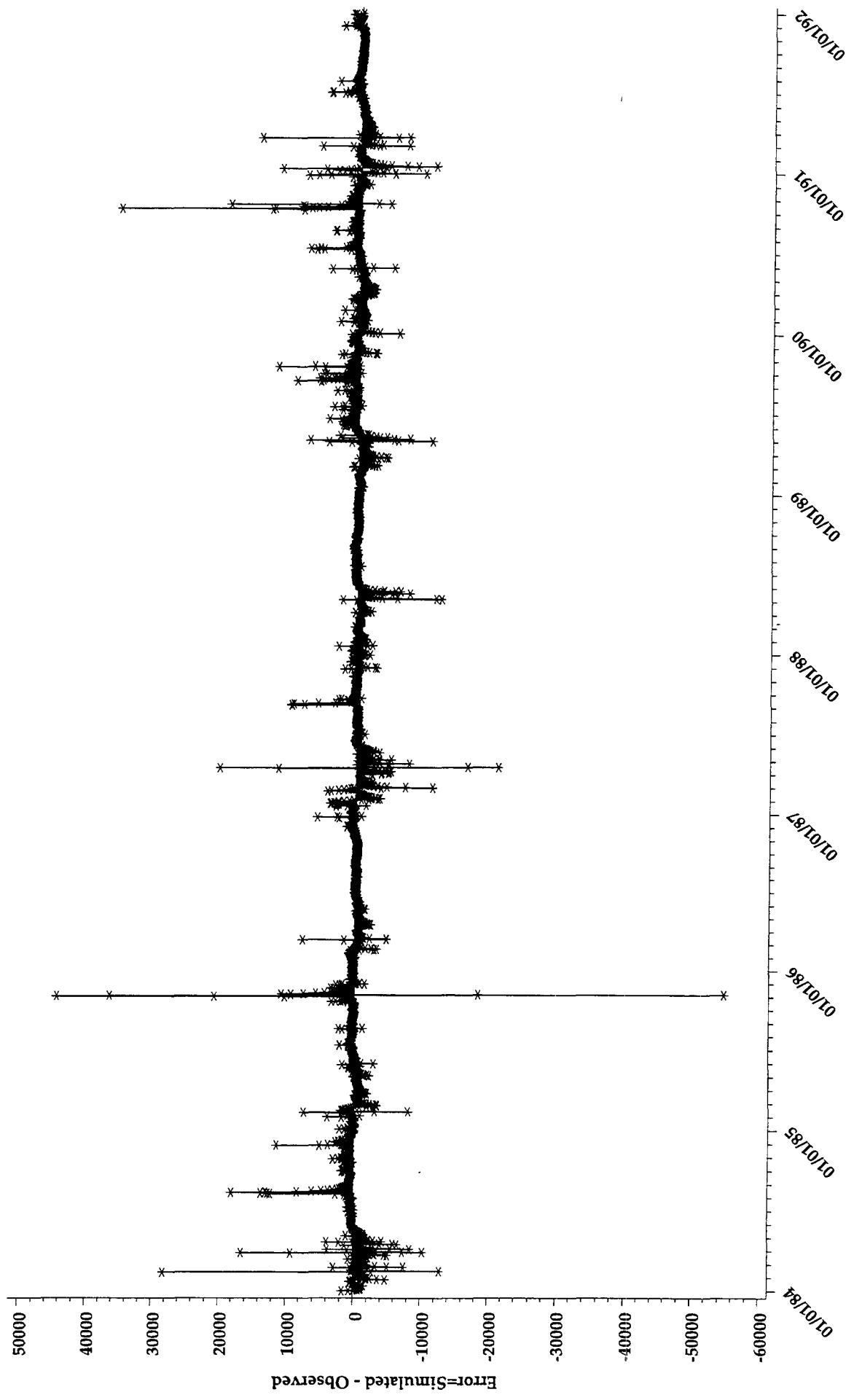
(\*=Observed, -=Simulated)



# Shenandoah River at Segment 200

## Actual Error versus Time

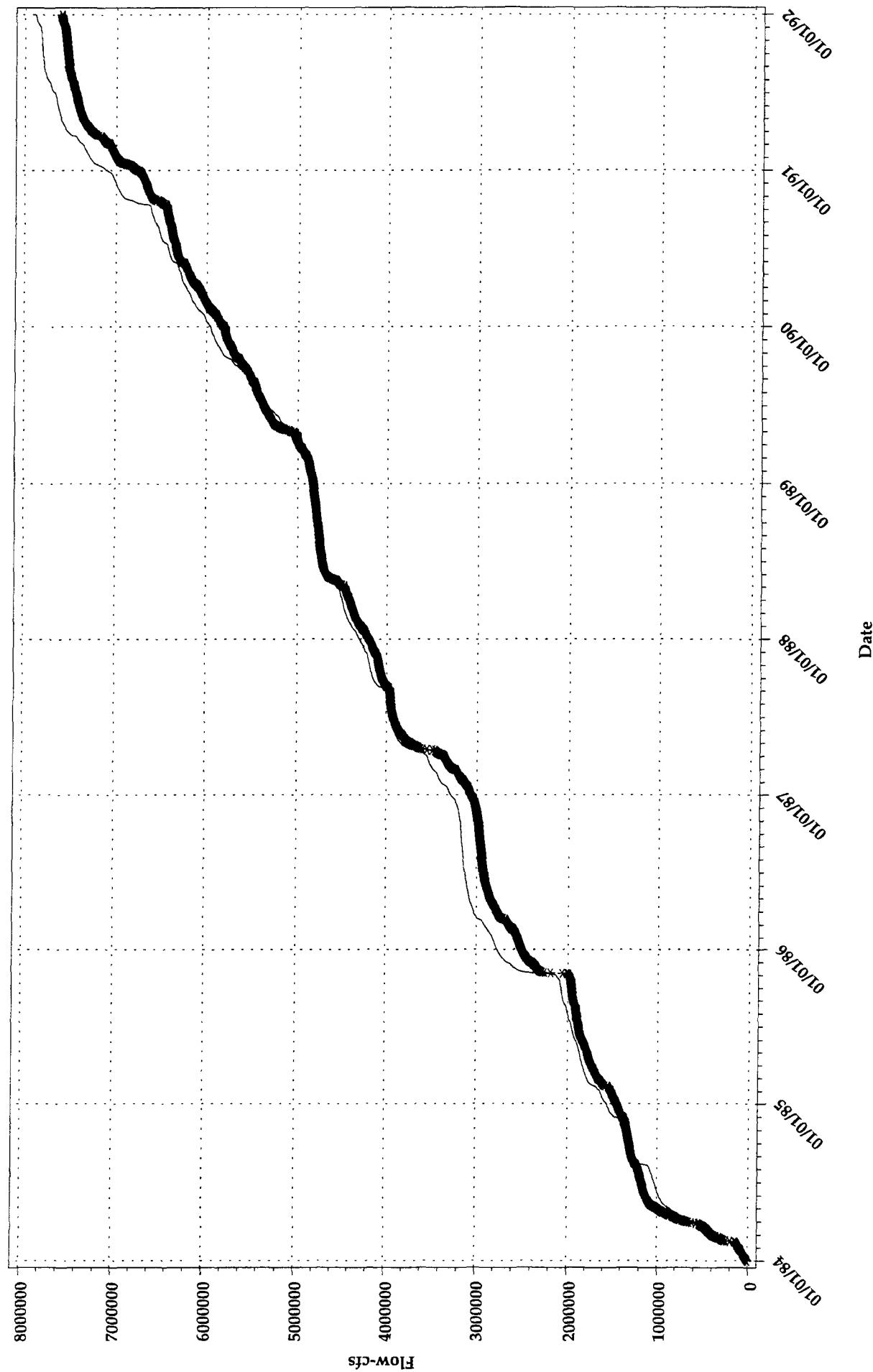
### Flow-cfs



# Shenandoah River at Segment 200

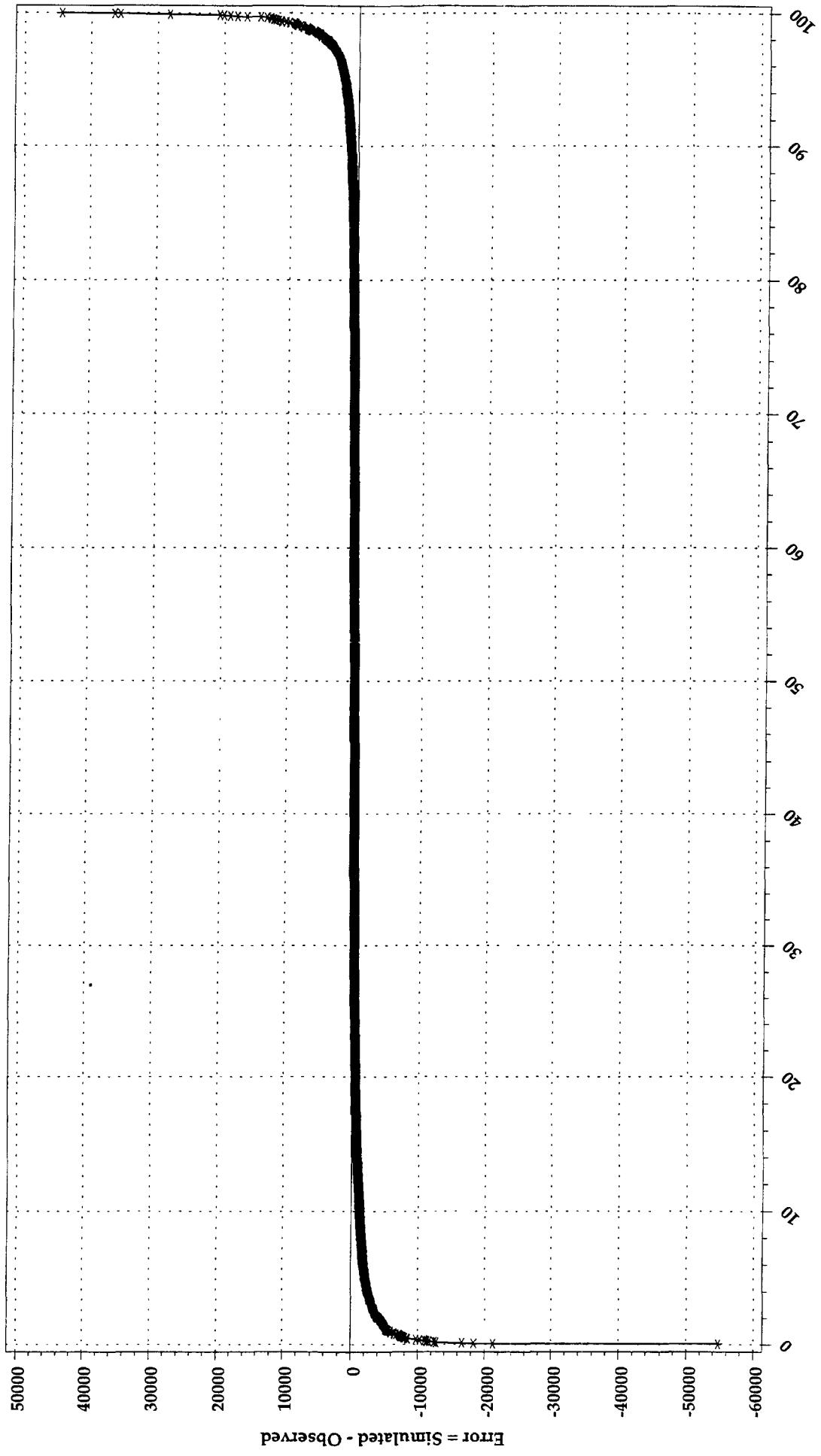
## Observed and Simulated Cumulative Flows versus Time

Flow-cfs  
(\* = Observed, - = Simulated)



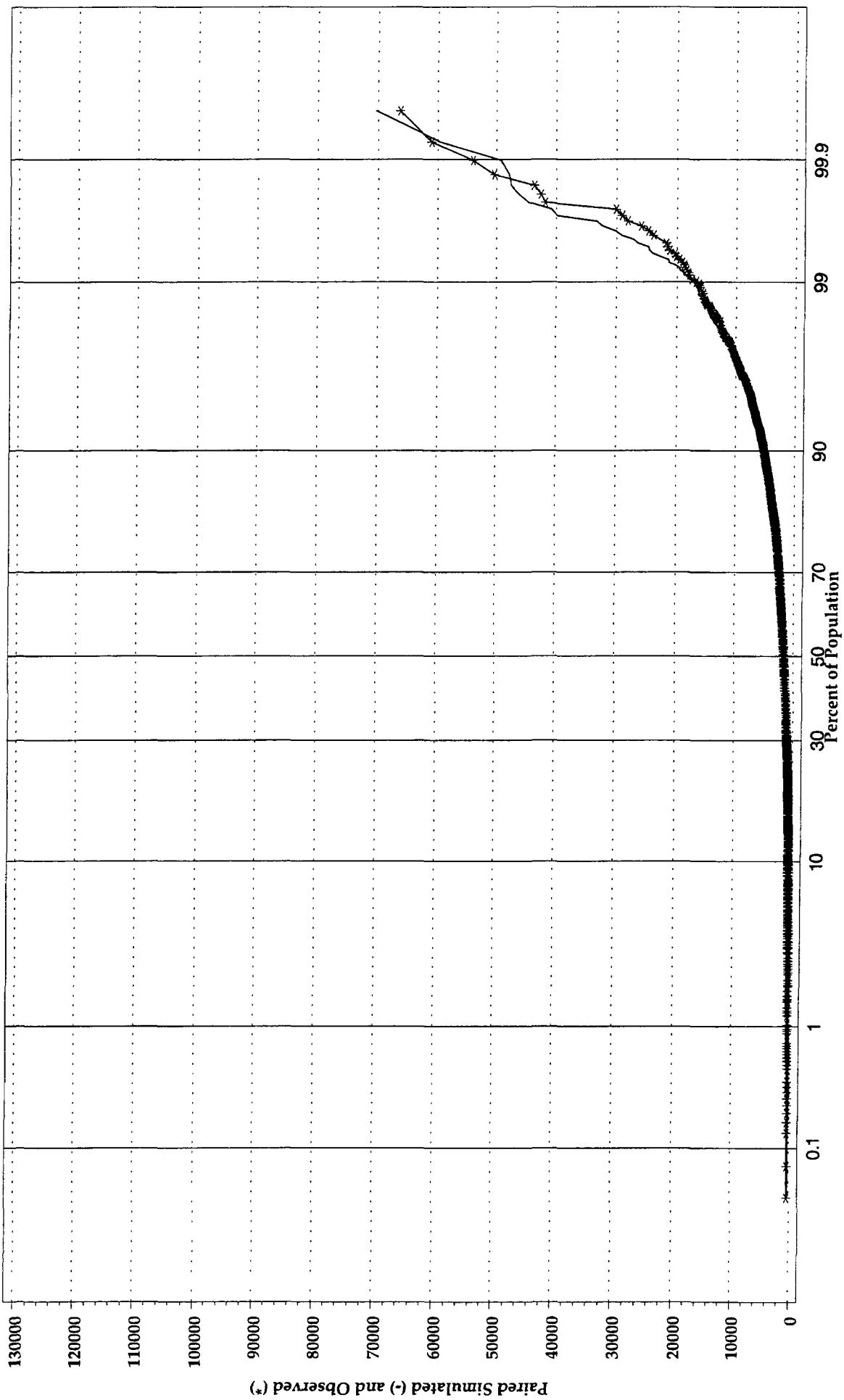
# Shenandoah River at Segment 200 Actual error versus Percentile Sample Population Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# Shenandoah River at Segment 200

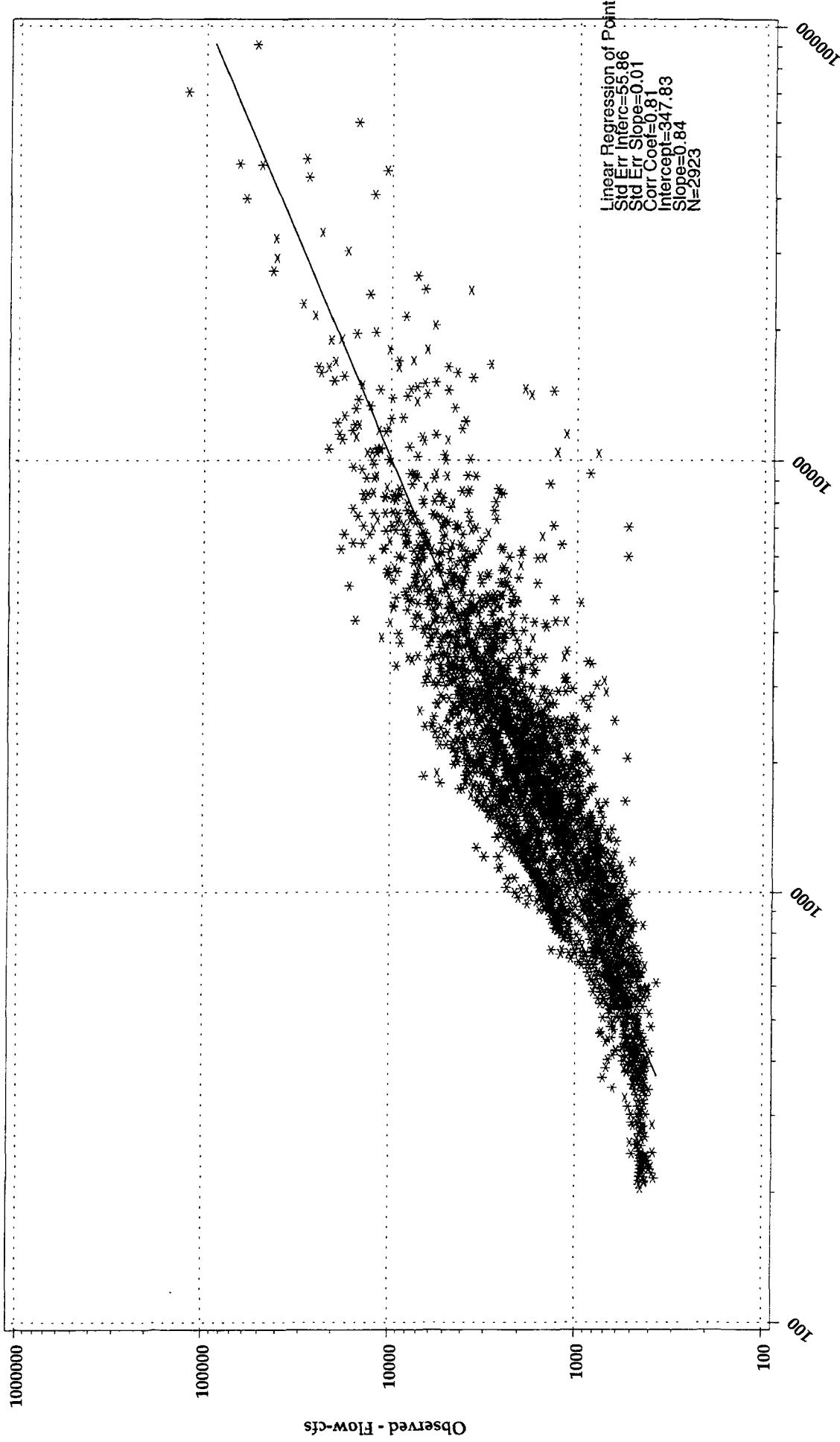
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population



# Shenandoah River at Segment 200

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
SHENANDOAH RIVER, VA (Segments 190 and 200)**

Table A.3.2.1 Comparison of Annual Total Observed and Simulated flows.

	<b>Observed Flow</b>	<b>Simulated Flow</b>
<b>Year</b>	(inches)*	(inches)**
1984	17.73	19.25
1985	12.93	14.55
1986	6.88	7.00
1987	13.88	12.18
1988	7.69	6.78
1989	11.96	13.20
1990	11.52	13.86
1991	10.45	10.09
Mean	11.63	12.11

\* Observed flow at Shenandoah River at Millville, WV

\*\* Simulated outflow from RCH 200

Table A.3.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r2</b>	<b>m</b>	<b>b</b>	<b>r2</b>
1984	0.72	1.05	0.74	0.60	1.44	0.82
1985	0.84	0.58	0.76	0.88	0.44	0.80
1986	0.98	0.05	0.87	1.01	-0.05	0.91
1987	0.82	0.55	0.76	0.98	0.67	0.87
1988	0.72	0.87	0.88	0.72	0.89	0.92
1989	0.90	0.38	0.66	1.06	-0.15	0.72
1990	0.71	1.03	0.58	0.49	1.76	0.44
1991	0.94	0.17	0.83	0.95	0.12	0.87
1984-1991	0.83	0.59	0.76	0.87	0.44	0.81

Table A.3.2.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2									
1984	0.68	1.31	0.81	0.89	0.49	0.83	0.64	0.96	0.73	0.90	0.05	0.61
1985	0.91	0.27	0.64	1.06	-0.14	0.41	1.10	-0.52	0.60	1.04	-0.29	0.81
1986	1.56	-1.98	0.78	0.97	0.18	0.84	1.00	-0.11	0.71	0.83	0.45	0.92
1987	0.44	1.87	0.20	0.88	0.63	0.78	0.95	0.04	0.80	1.25	-0.82	0.86
1988	1.06	-0.17	0.65	1.31	-0.89	0.90	1.68	-2.26	0.83	0.73	0.67	0.47
1989	1.30	-0.81	0.67	0.82	0.78	0.84	0.75	0.71	0.56	0.96	-0.02	0.65
1990	0.81	0.69	0.53	0.71	1.05	0.48	0.85	0.29	0.48	0.86	0.34	0.74
1991	1.09	0.28	0.65	0.96	0.20	0.80	0.80	0.44	0.74	0.67	0.88	0.83
1984-1991	0.84	0.54	0.76	0.95	0.05	0.86	1.02	0.04	0.76	1.10	-0.22	0.85

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

### **A.3.3 LOWER POTOMAC RIVER AT CHAIN BRIDGE NEAR WASHINGTON DC AT SEGMENT 220 (1646500)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

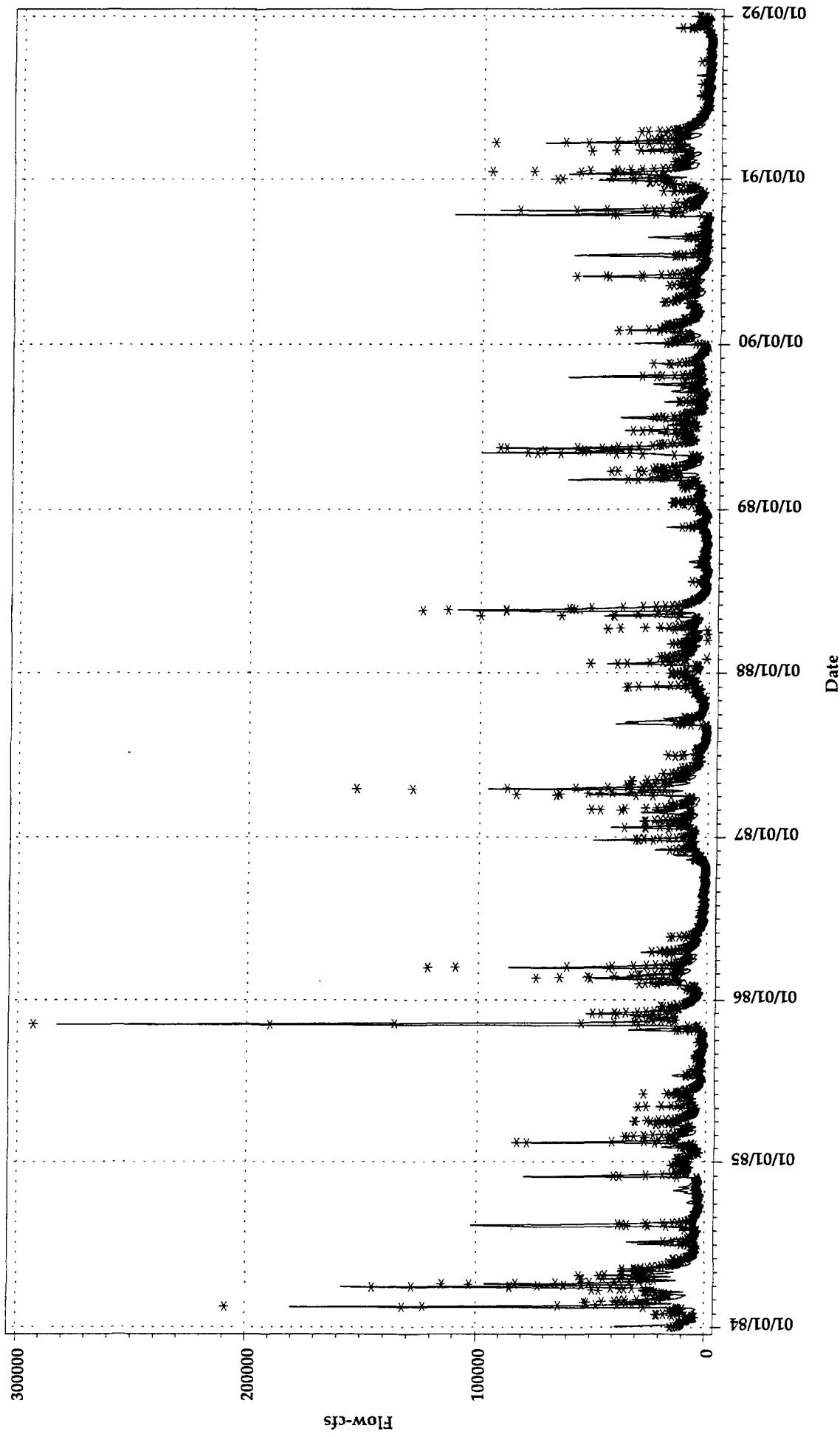
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Lower Potomac River at Segment 220 Observed and Simulated versus Time

## Flow-cfs

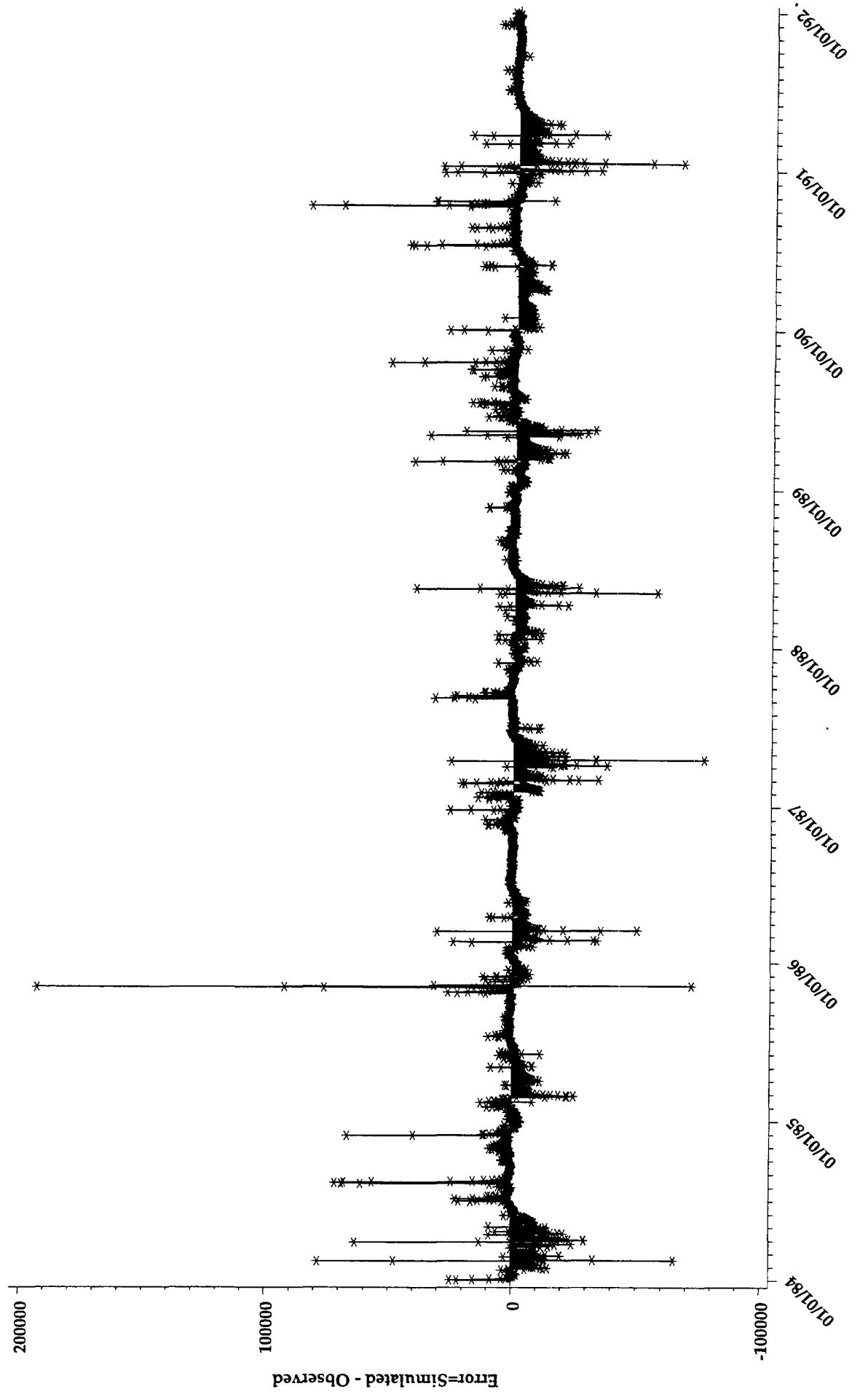
(\*=Observed, -=Simulated)



# Lower Potomac River at Segment 220

## Actual Error versus Time

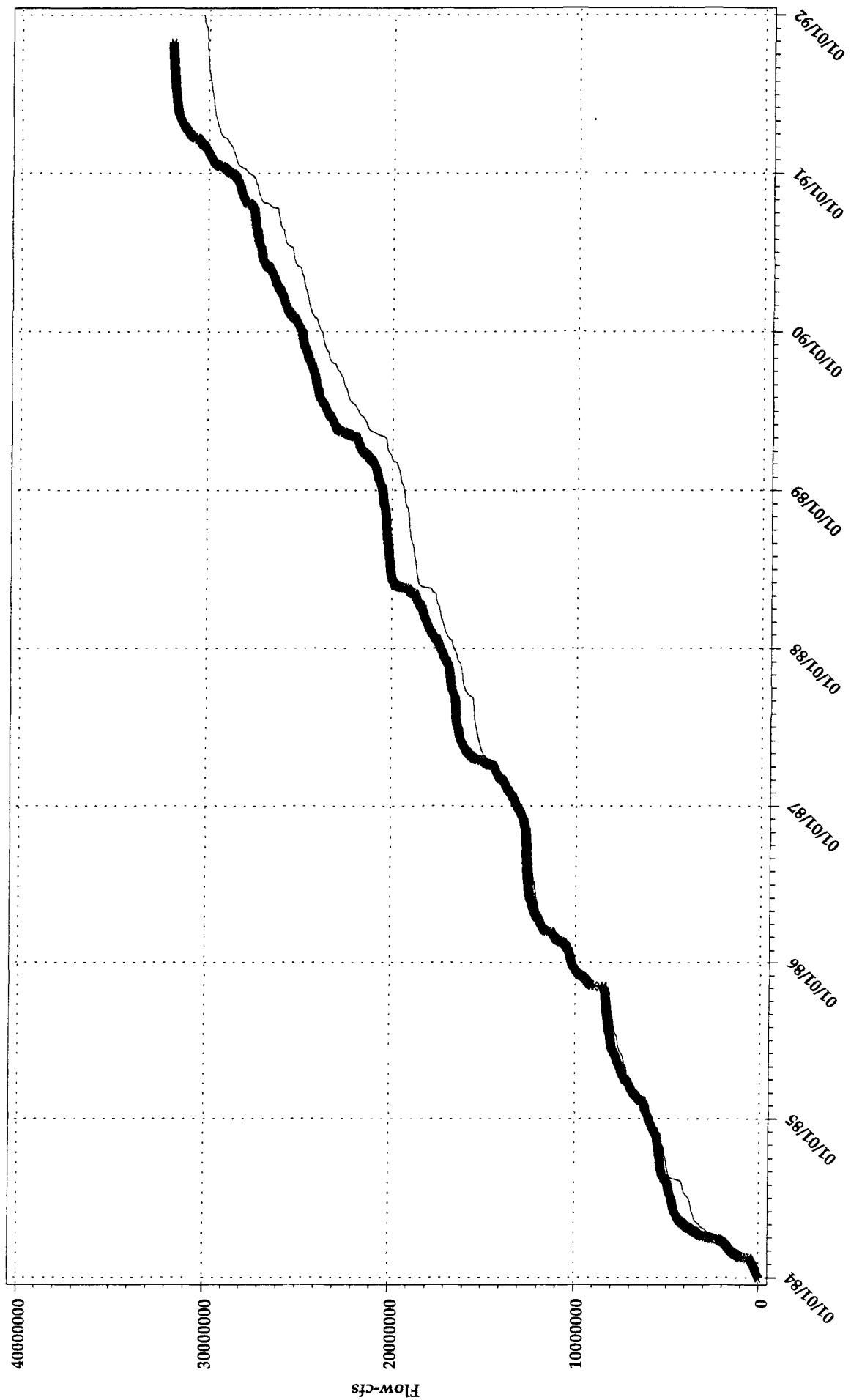
### Flow-cfs



# Lower Potomac River at Segment 220

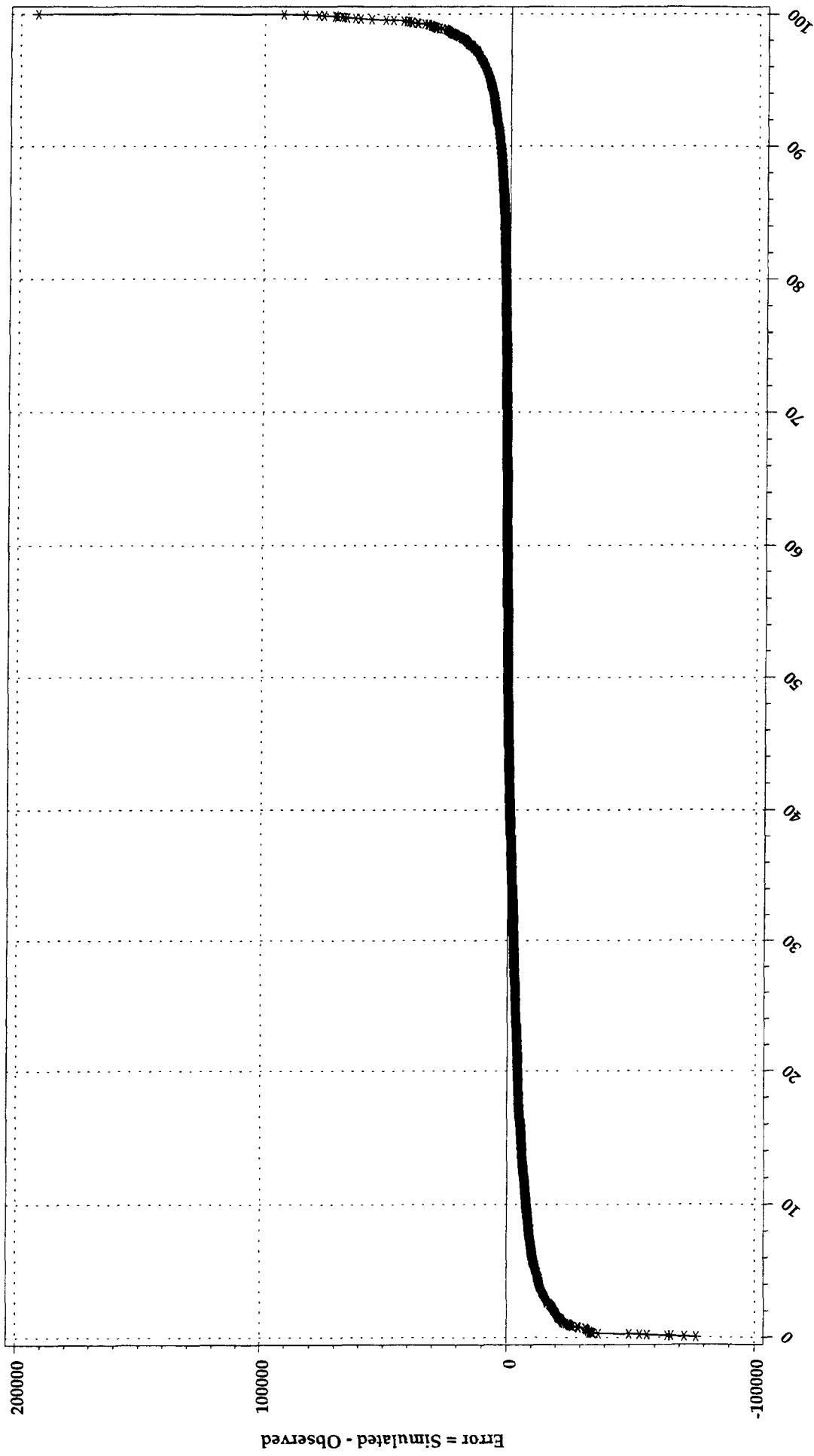
## Observed and Simulated Cumulative Flows versus Time

Flow-cfs  
(\* = Observed, - = Simulated)



# Lower Potomac River at Segment 220 Actual error versus Percentile Sample Population Flow-cfs

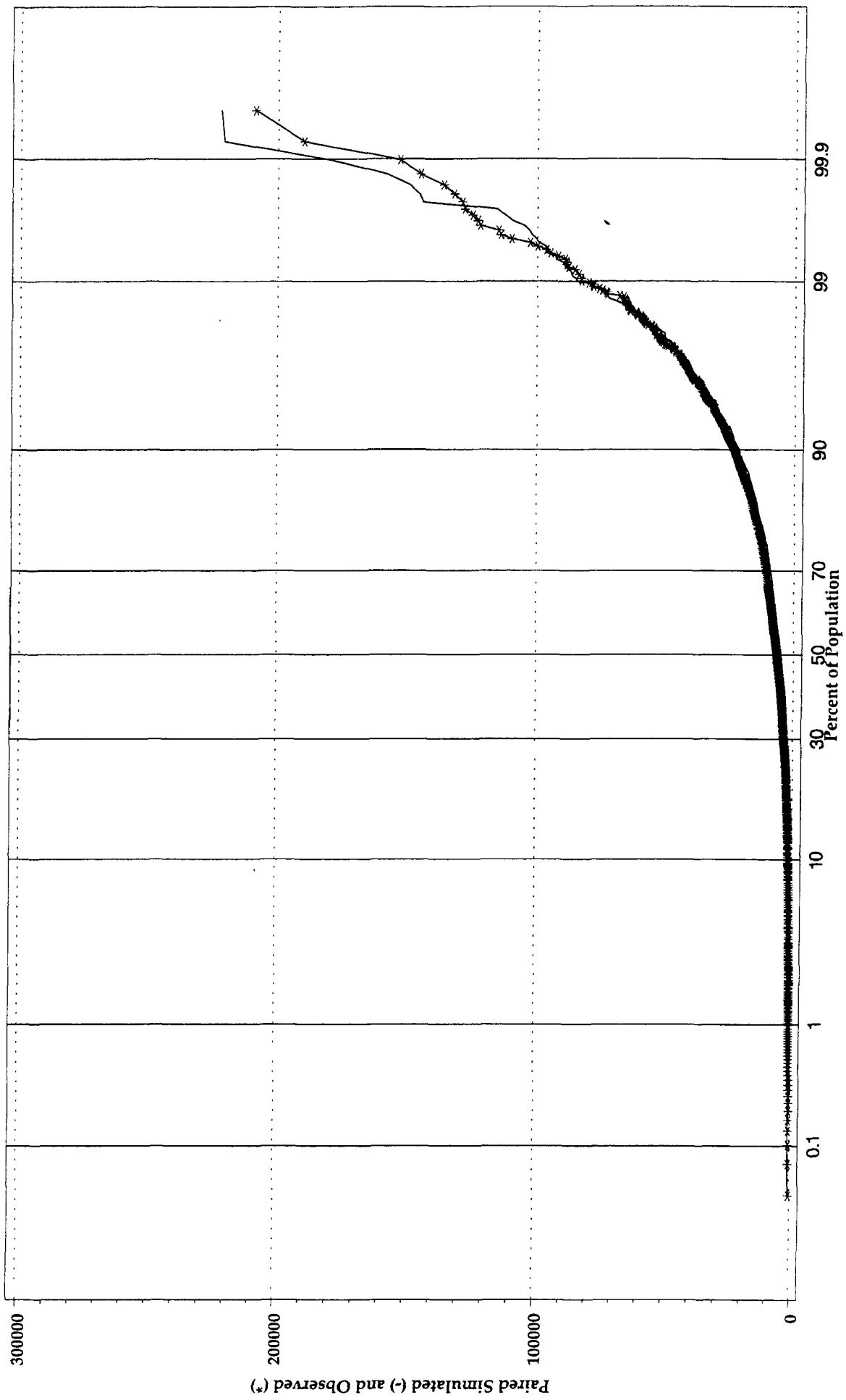
Frequency Distribution - All Simulated and Observed Data



# Lower Potomac River at Segment 220

## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

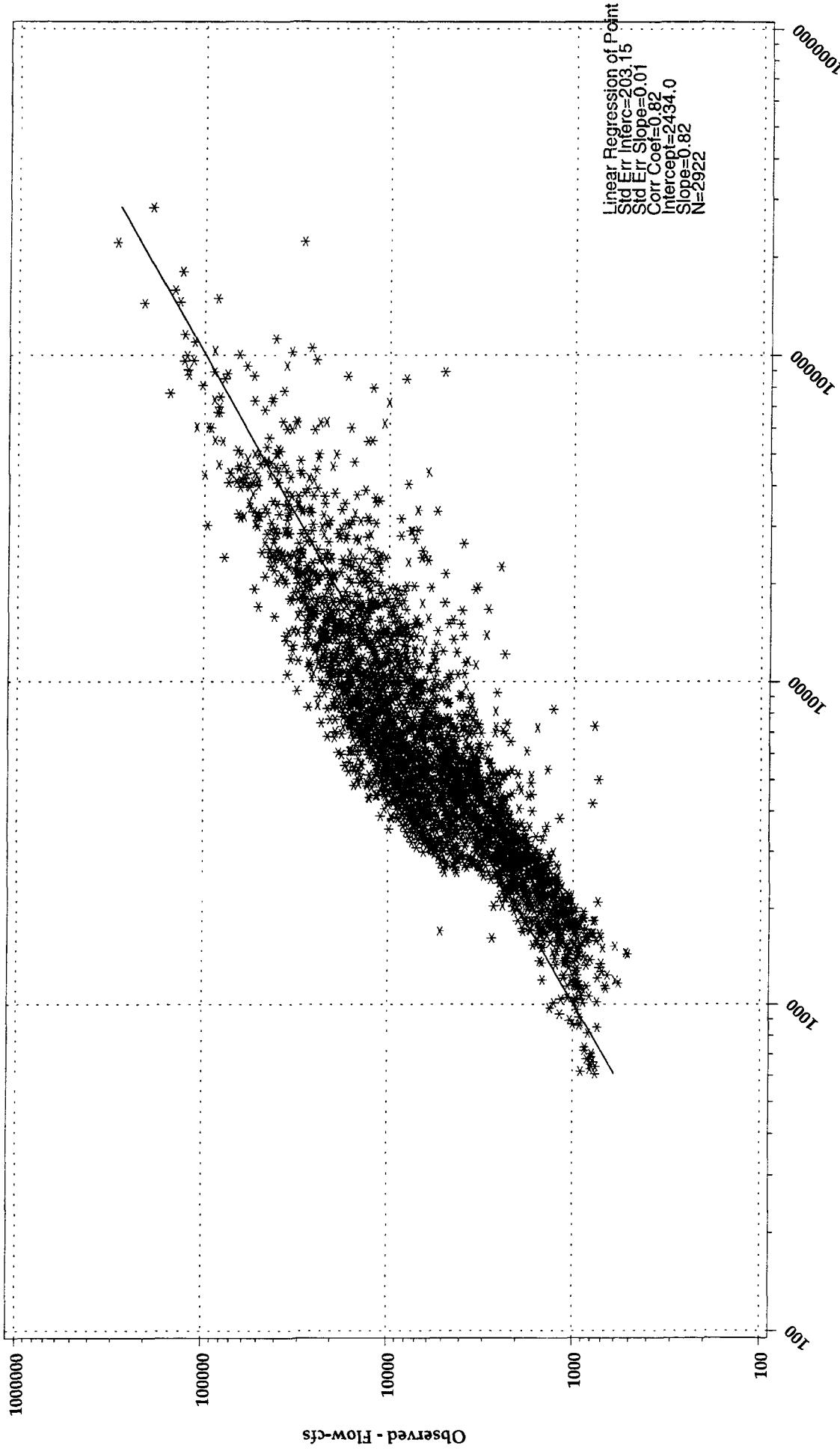
Flow-cfs



# Lower Potomac River at Segment 220

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
LOWER POTOMAC RIVER (Segments 180, 210 and 220)**

Table A.3.3.1 Comparison of Annual Total Observed and Simulated flows.

<b>Year</b>	<b>Observed Flow</b>	<b>Simulated Flow</b>
	(inches)*	(inches)**
1984	19.38	19.41
1985	13.58	14.22
1986	9.55	8.76
1987	13.47	11.38
1988	10.26	8.85
1989	14.04	14.40
1990	12.27	12.83
1991	10.89	8.22
Mean	12.93	12.26

\* Observed flow at Potomac River at Chain Bridge near Washington, D.C.  
\*\* Simulated outflow from RCH 220

Table A.3.3.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r<sup>2</sup></b>	<b>m</b>	<b>b</b>	<b>r<sup>2</sup></b>
1984	0.76	0.98	0.70	0.61	1.58	0.82
1985	0.78	0.87	0.74	0.72	1.07	0.77
1986	0.77	0.86	0.87	0.74	0.96	0.92
1987	0.68	1.21	0.72	0.98	0.05	0.99
1988	0.68	1.20	0.78	0.63	1.38	0.00
1989	0.78	0.88	0.63	0.67	1.31	0.00
1990	0.74	1.01	0.56	0.39	2.35	0.00
1991	0.66	1.22	0.80	0.25	2.77	0.00
1984-1991	0.73	1.03	0.73	0.62	1.43	0.44

Table A.3.3.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2									
1984	1.37	-1.89	0.88	1.91	-1.03	0.89	1.32	-1.06	0.82	0.84	0.77	0.69
1985	0.79	0.82	0.69	0.93	0.07	0.65	0.78	0.90	0.83	0.86	0.66	0.81
1986	0.82	0.70	0.90	1.08	-0.50	0.90	0.54	1.63	0.72	0.99	0.18	0.93
1987	0.89	0.44	0.39	1.04	-0.47	0.89	0.82	0.78	0.77	0.83	0.79	0.99
1988	0.20	3.08	0.22	0.86	0.41	0.75	0.48	1.91	0.61	1.04	-0.02	0.84
1989	0.84	0.54	0.69	1.16	-0.86	0.83	0.81	0.84	0.68	0.98	0.23	0.74
1990	0.65	1.33	0.26	0.95	-0.04	0.58	0.86	0.64	0.66	0.90	0.47	0.72
1991	0.91	0.17	0.69	1.00	-0.19	0.87	0.54	1.68	0.46	0.60	1.35	0.56
1984-1991	0.79	0.78	0.65	1.00	-0.18	0.83	0.83	0.76	0.79	0.94	0.32	0.86

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

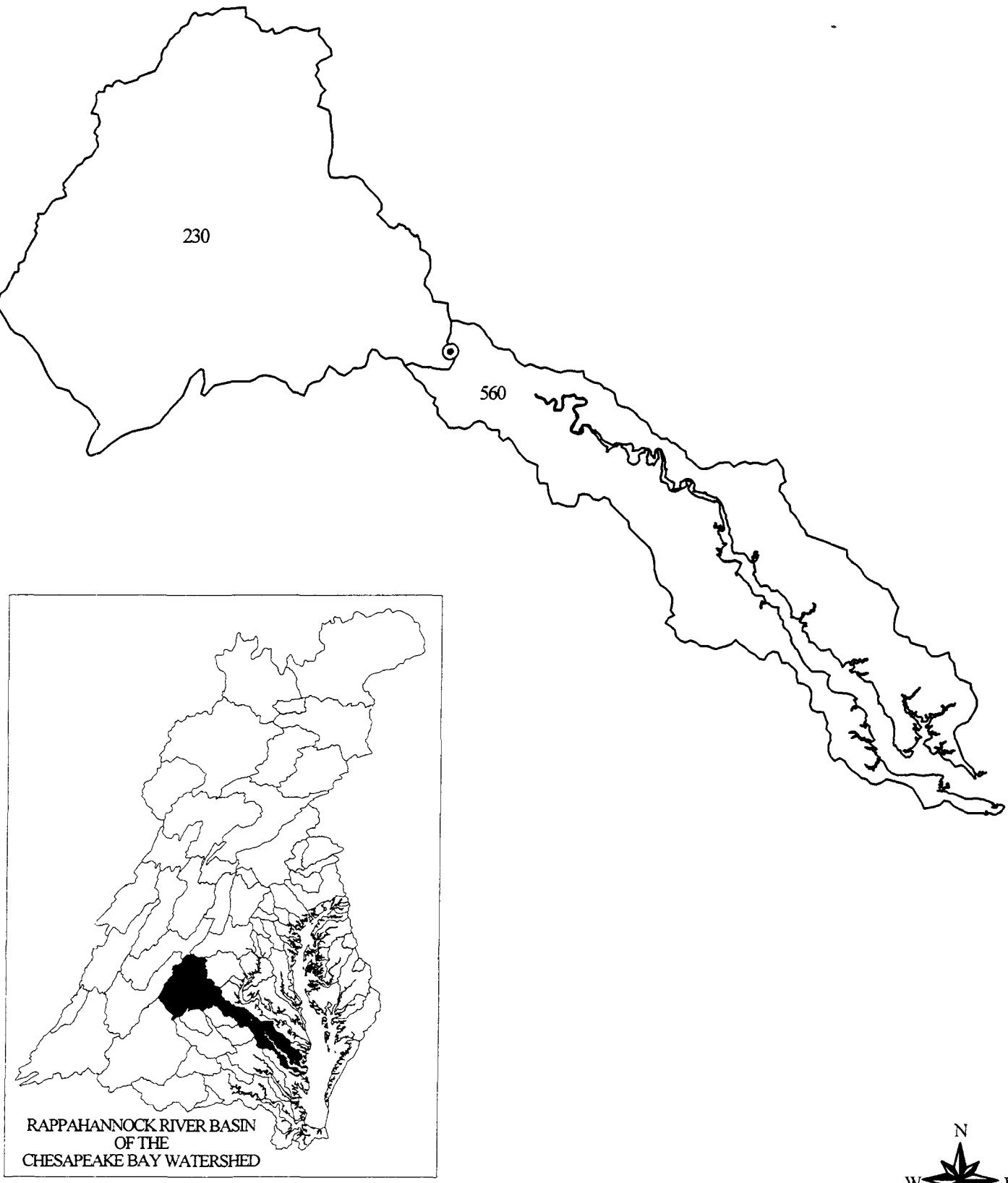
Season 4 is from Julian day 271 to 365.

# Monitoring Stations

## Chesapeake Bay Watershed

### Phase IV Model Segments:

#### Rappahannock River Basin



#### **A.4 RAPPAHANNOCK RIVER NEAR FREDERICKSBURG, VA AT SEGMENT 230 (1668000)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

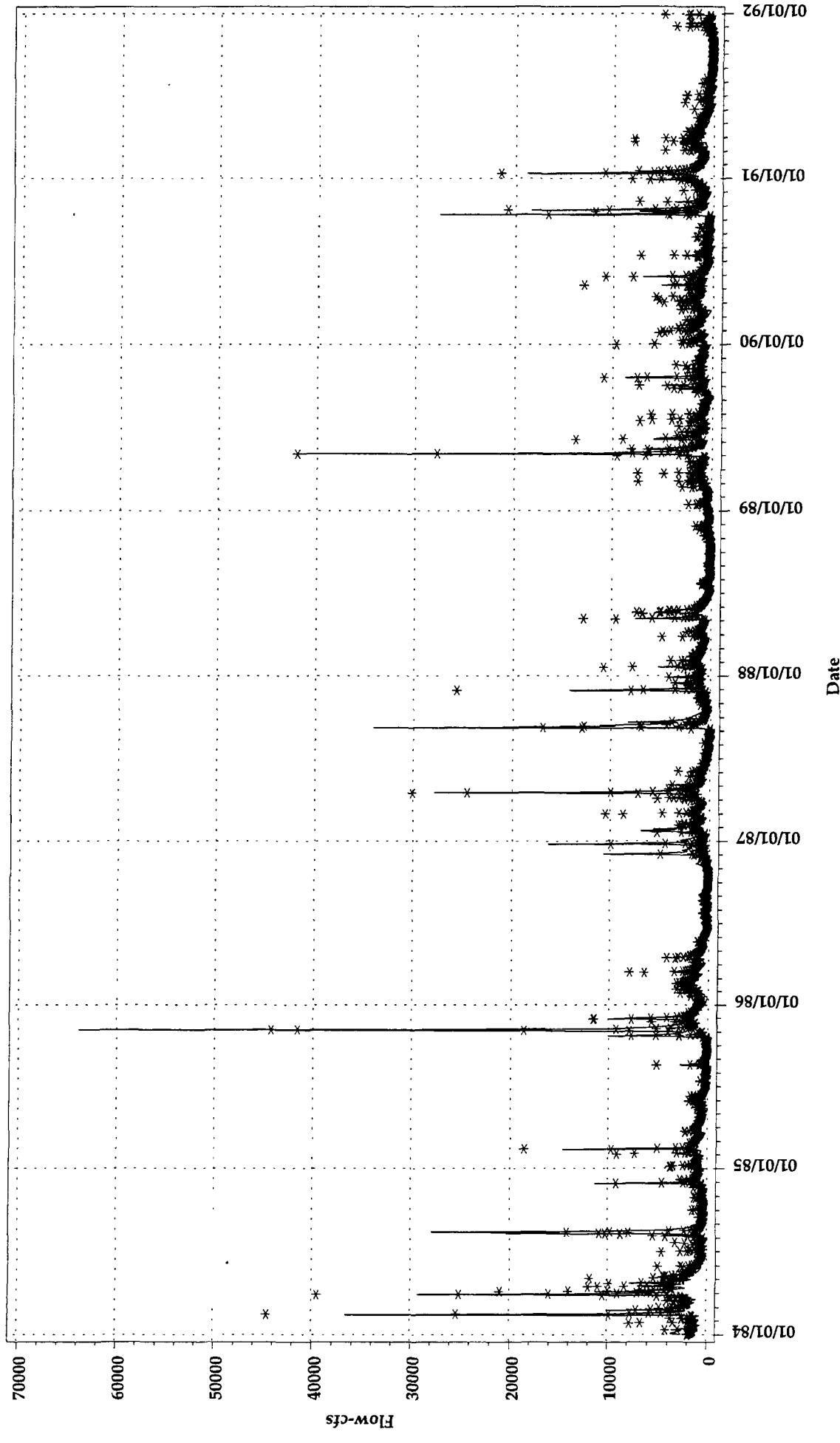
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Rappahannock River at Segment 230 Observed and Simulated versus Time

## Flow-cfs

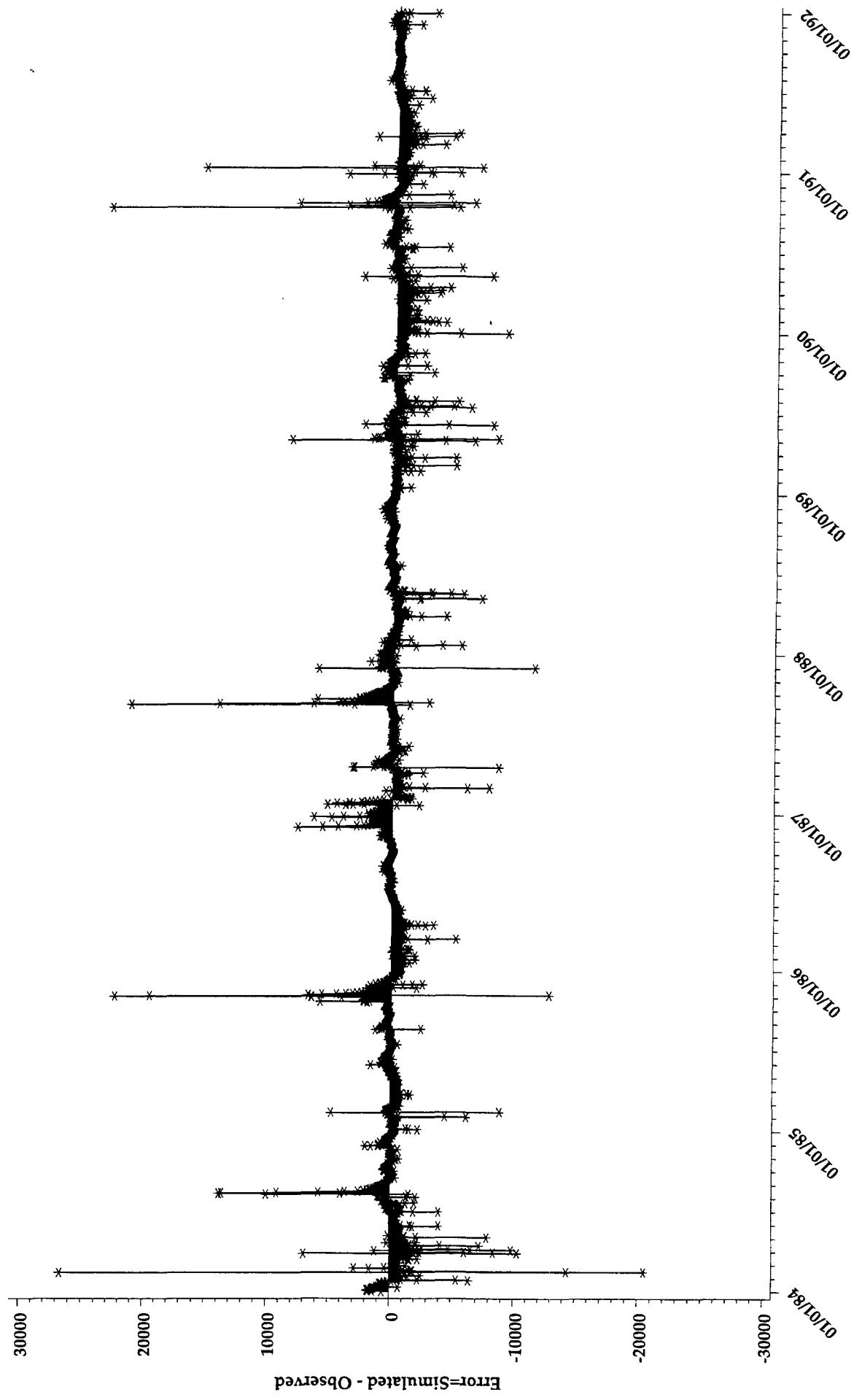
(\*=Observed, -=Simulated)



# Rappahannock River at Segment 230

## Actual Error versus Time

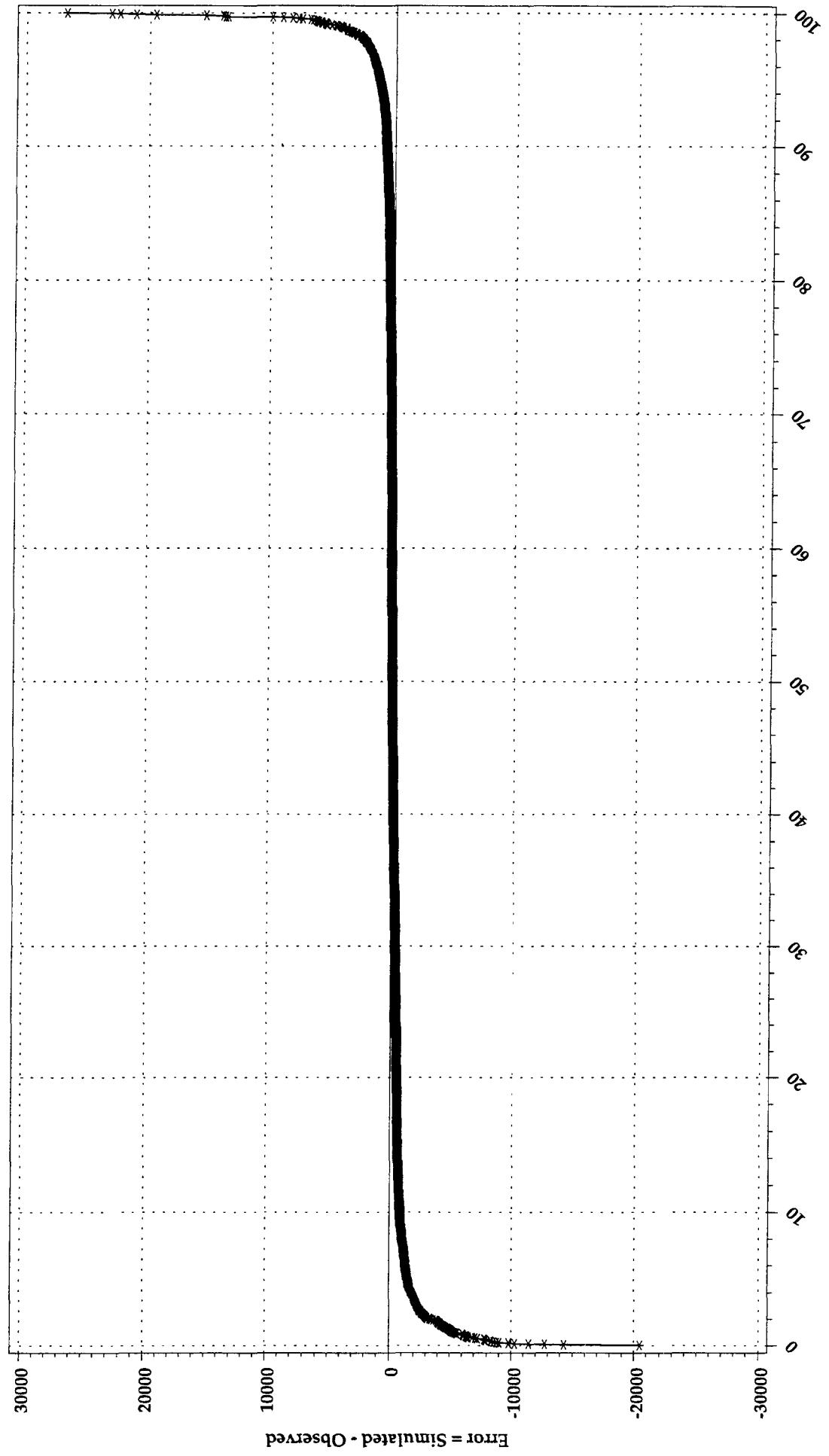
### Flow-cfs





# Rappahannock River at Segment 230 Actual error versus Percentile Sample Population Flow-cfs

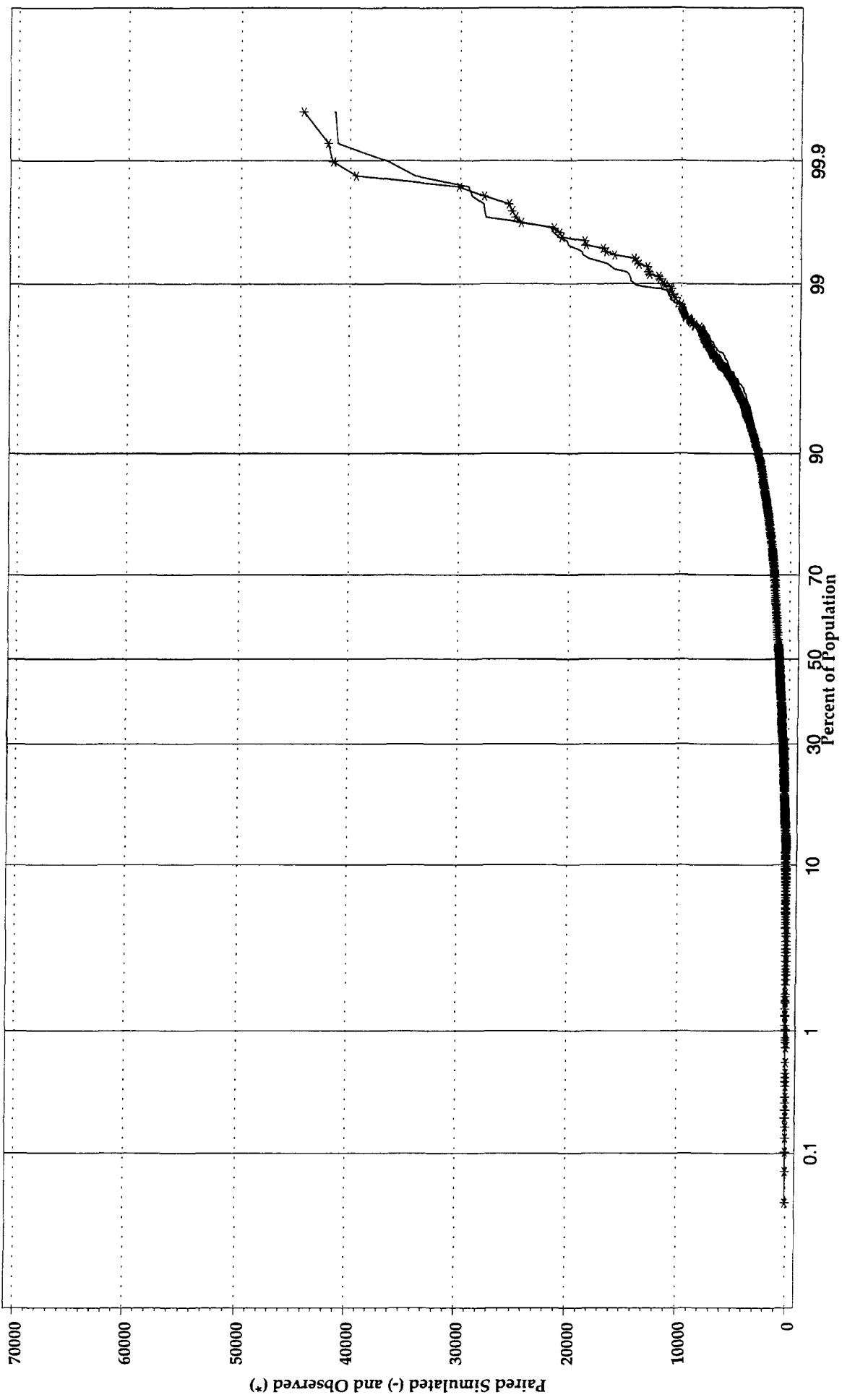
Frequency Distribution - All Simulated and Observed Data



# Rappahannock River at Segment 230

## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

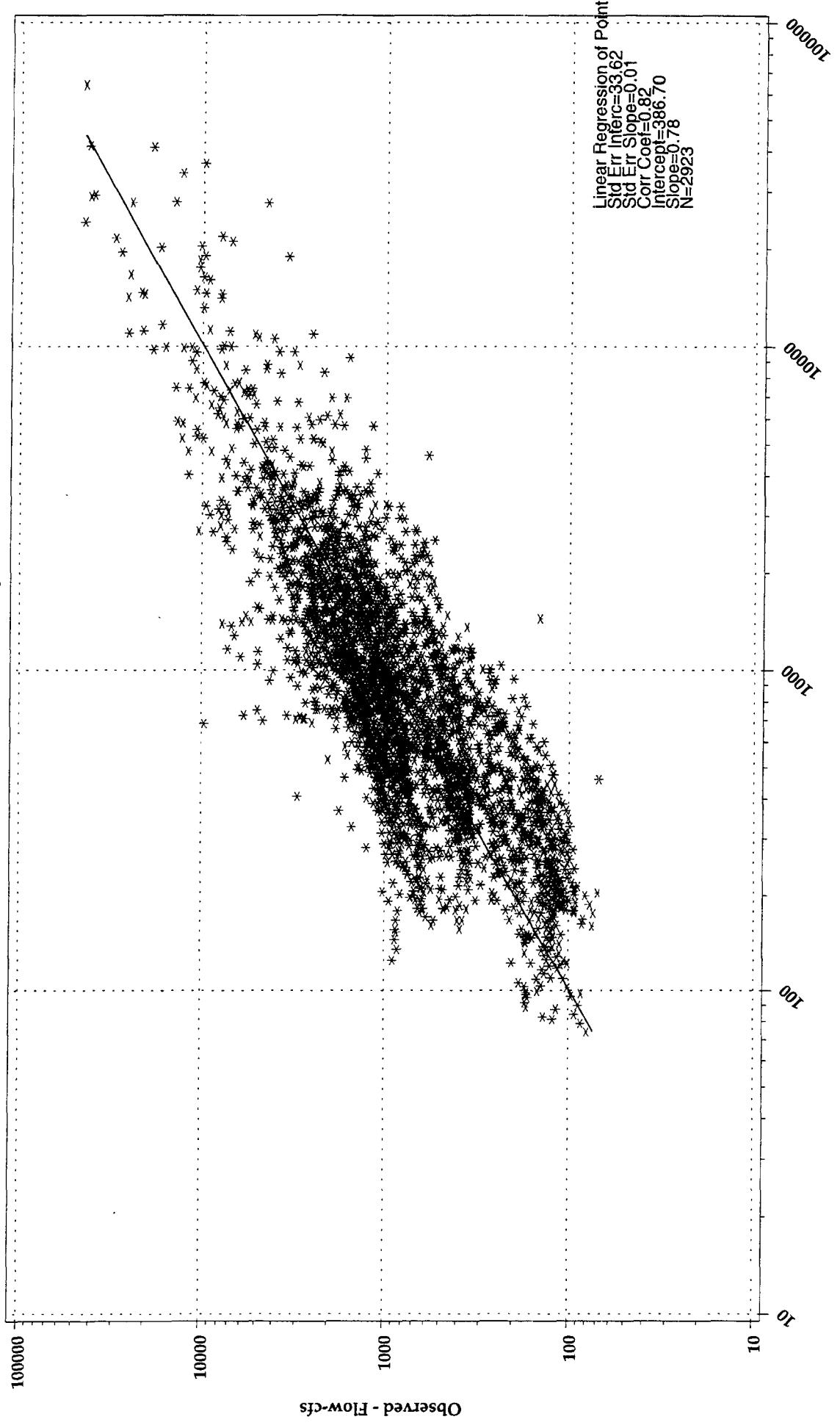
### Flow-cfs



# Rappahannock River at Segment 230

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION**  
**RAPPAHANNOCK RIVER, VA (Segments 230)**

Table A.4.1.1 Comparison of Annual Total Observed and Simulated flows.

Year	Observed Flow (inches)*	Simulated Flow (inches)**
1984	21.77	19.77
1985	13.05	15.07
1986	7.48	7.64
1987	13.43	16.53
1988	8.31	8.21
1989	15.36	13.04
1990	15.51	12.60
1991	10.04	7.74
Mean	13.12	12.58

\* Observed flow at Rappahannock River near Fredericksburg, VA

\*\* Simulated outflow from RCH 230

Table A.4.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

Year	Average Daily			Average Monthly		
	m	b	r2	m	b	r2
1984	0.85	0.44	0.72	0.85	0.43	0.79
1985	0.72	0.85	0.63	0.66	1.03	0.58
1986	0.57	1.20	0.41	0.53	1.31	0.39
1987	0.87	0.47	0.77	0.90	0.38	0.78
1988	0.59	1.24	0.65	0.54	1.37	0.70
1989	0.89	0.27	0.73	1.18	-0.62	0.86
1990	0.55	1.30	0.44	0.06	2.87	0.10
1991	0.71	0.77	0.77	0.71	0.75	0.82
1984-1991	0.72	0.82	0.64	0.68	0.94	0.63

Table A.4.1.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.71	0.93	0.46	1.05	0.36	0.89	0.92	0.22	0.55	0.97	0.10	0.76
1985	0.99	-0.06	0.80	0.65	0.76	0.18	0.78	0.77	0.71	0.73	1.05	0.78
1986	1.82	-2.92	0.77	1.06	-0.51	0.84	0.27	1.94	0.05	1.19	-0.14	0.93
1987	0.32	2.23	0.08	1.01	-0.09	0.81	0.96	0.23	0.85	0.90	0.45	0.75
1988	0.62	1.24	0.58	1.02	-0.29	0.77	0.59	1.26	0.64	0.87	0.61	0.73
1989	0.67	0.87	0.80	0.90	0.28	0.80	0.80	0.51	0.61	1.06	0.27	0.61
1990	0.49	1.39	0.34	0.89	0.15	0.59	0.39	1.81	0.35	0.87	0.42	0.60
1991	1.32	-1.20	0.86	0.95	-0.13	0.78	0.60	1.03	0.54	0.81	0.59	0.83
1984-1991	0.82	0.47	0.51	1.04	-0.32	0.77	0.72	0.85	0.64	0.82	0.63	0.76

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

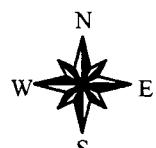
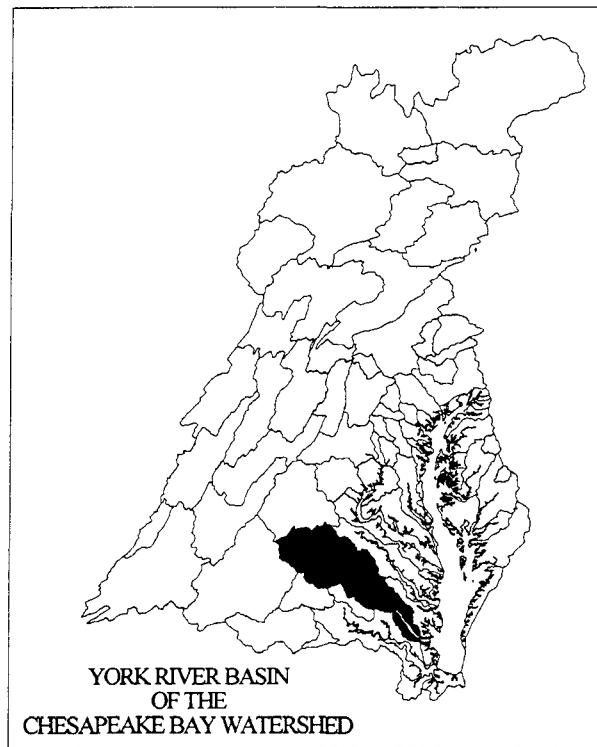
Season 4 is from Julian day 271 to 365.

# Monitoring Stations

## Chesapeake Bay Watershed

### Phase IV Model Segments:

#### York River Basin



## **A.5.1 MATTAPONI RIVER NEAR BEULAHVILLE, VA AT SEGMENT 240 (1674500)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

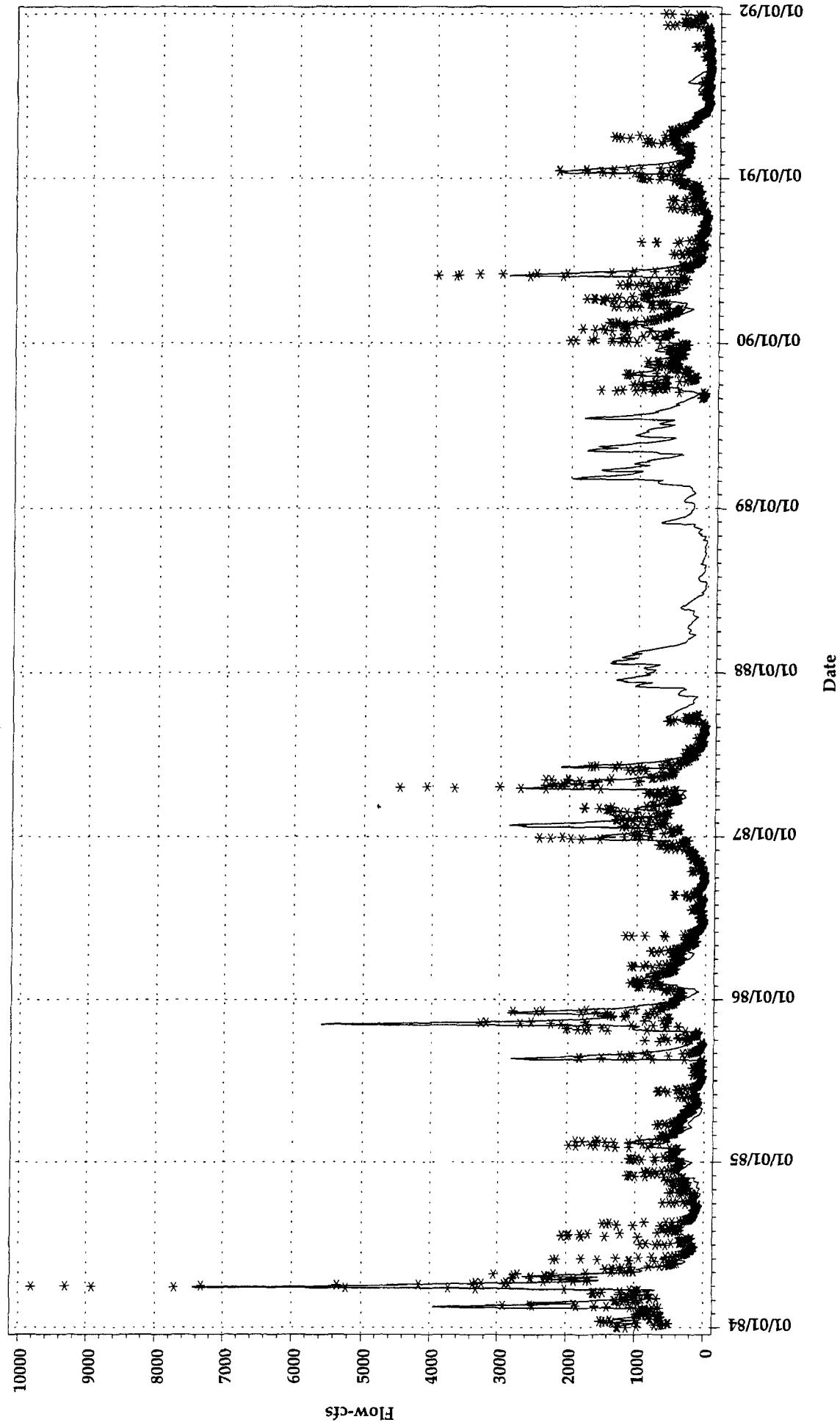
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Mattaponi River at Segment 240 Observed and Simulated versus Time

## Flow-cfs

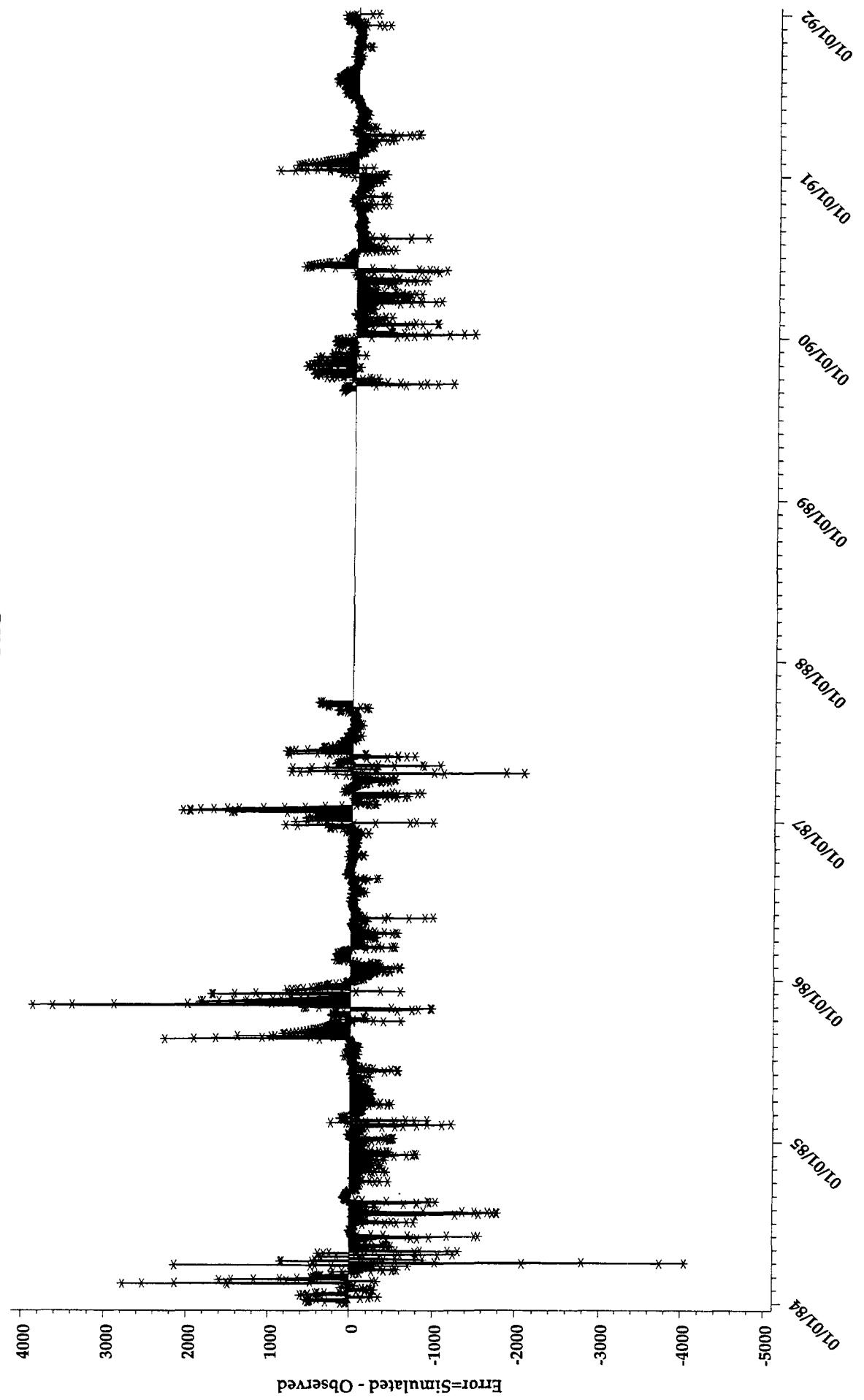
(\*=Observed, -=Simulated)



# Mattaponi River at Segment 240

## Actual Error versus Time

### Flow-cfs

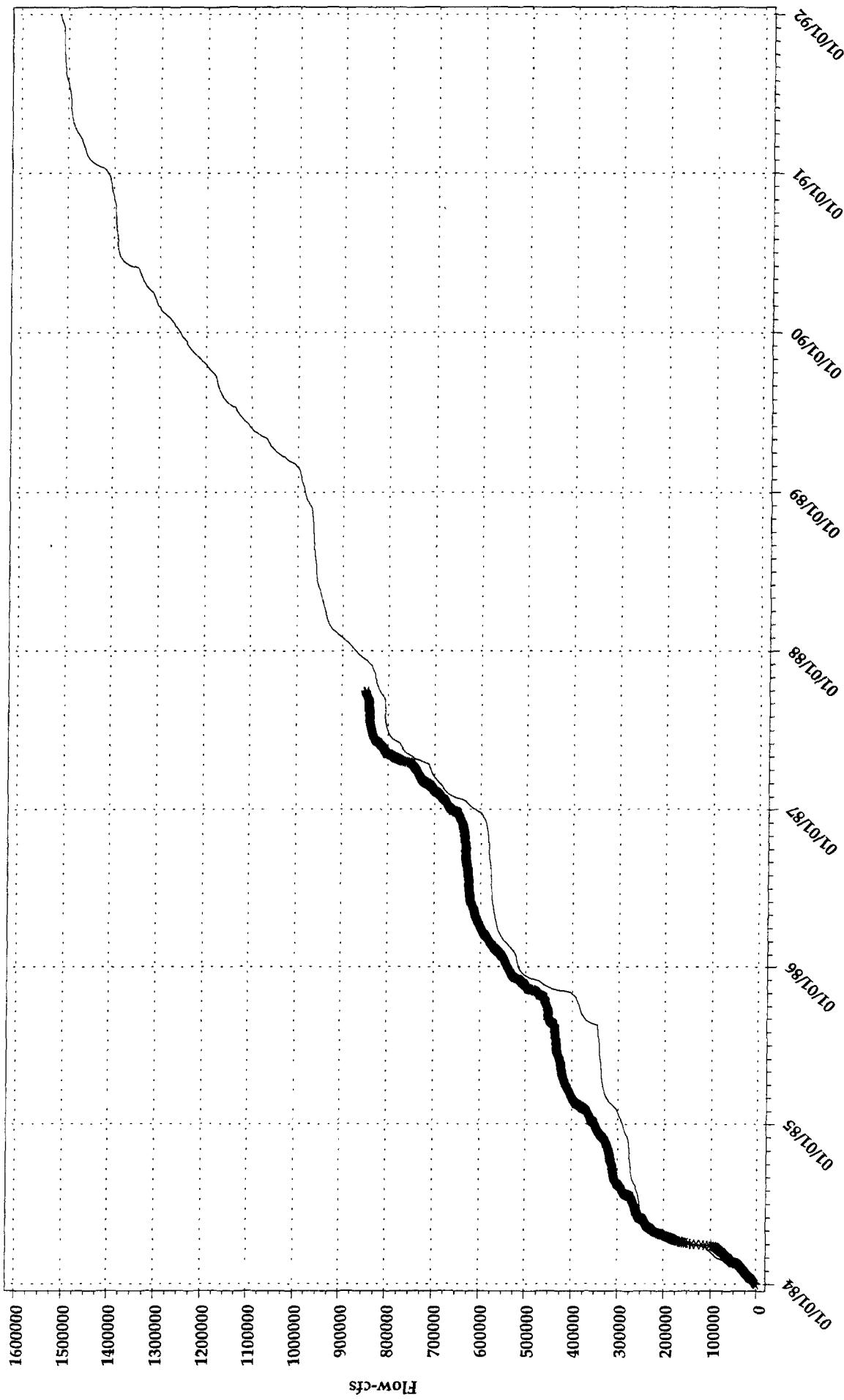


# Mattaponi River at Segment 240

## Observed and Simulated Cumulative Flows versus Time

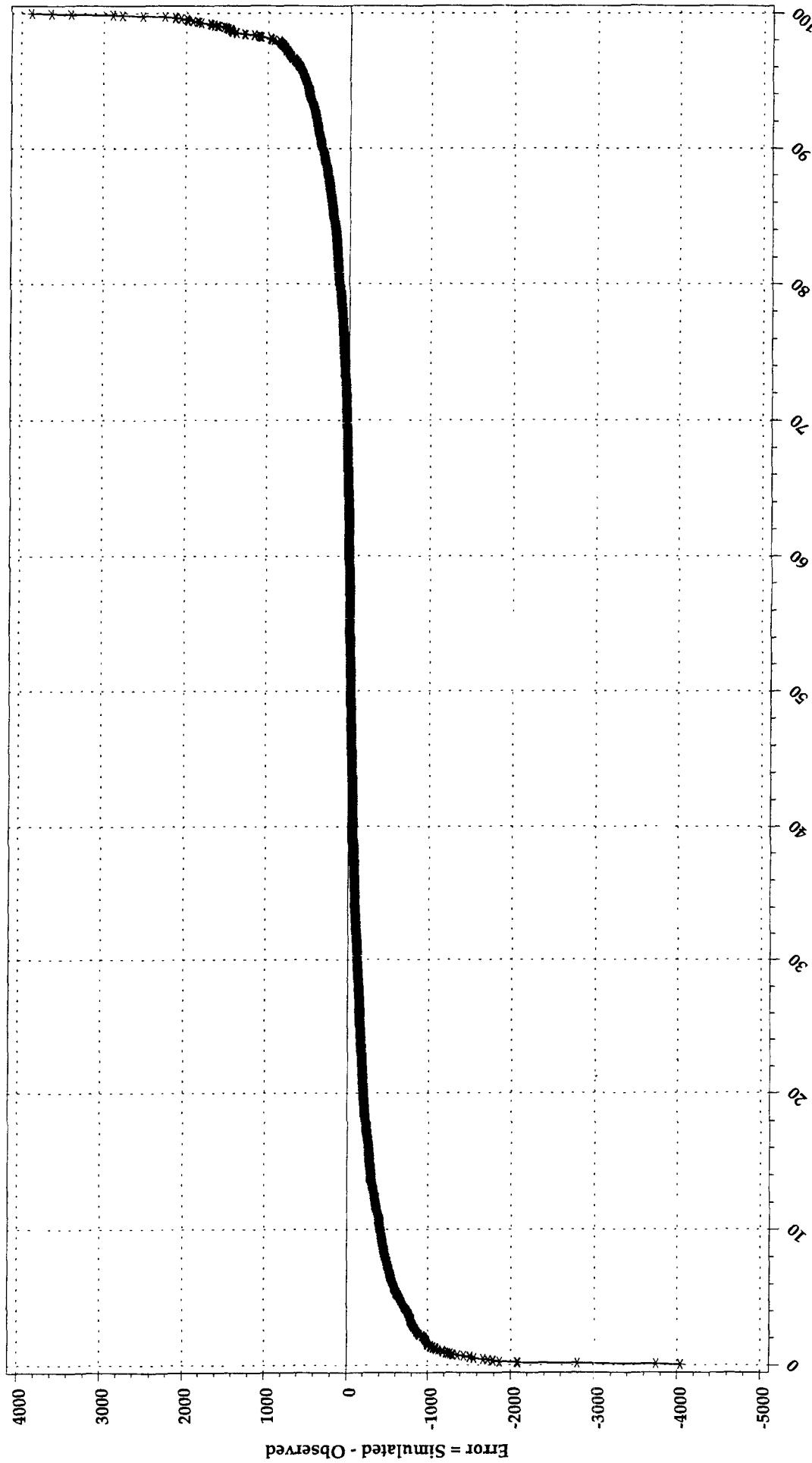
### Flow-cfs

(\* = Observed, - = Simulated)



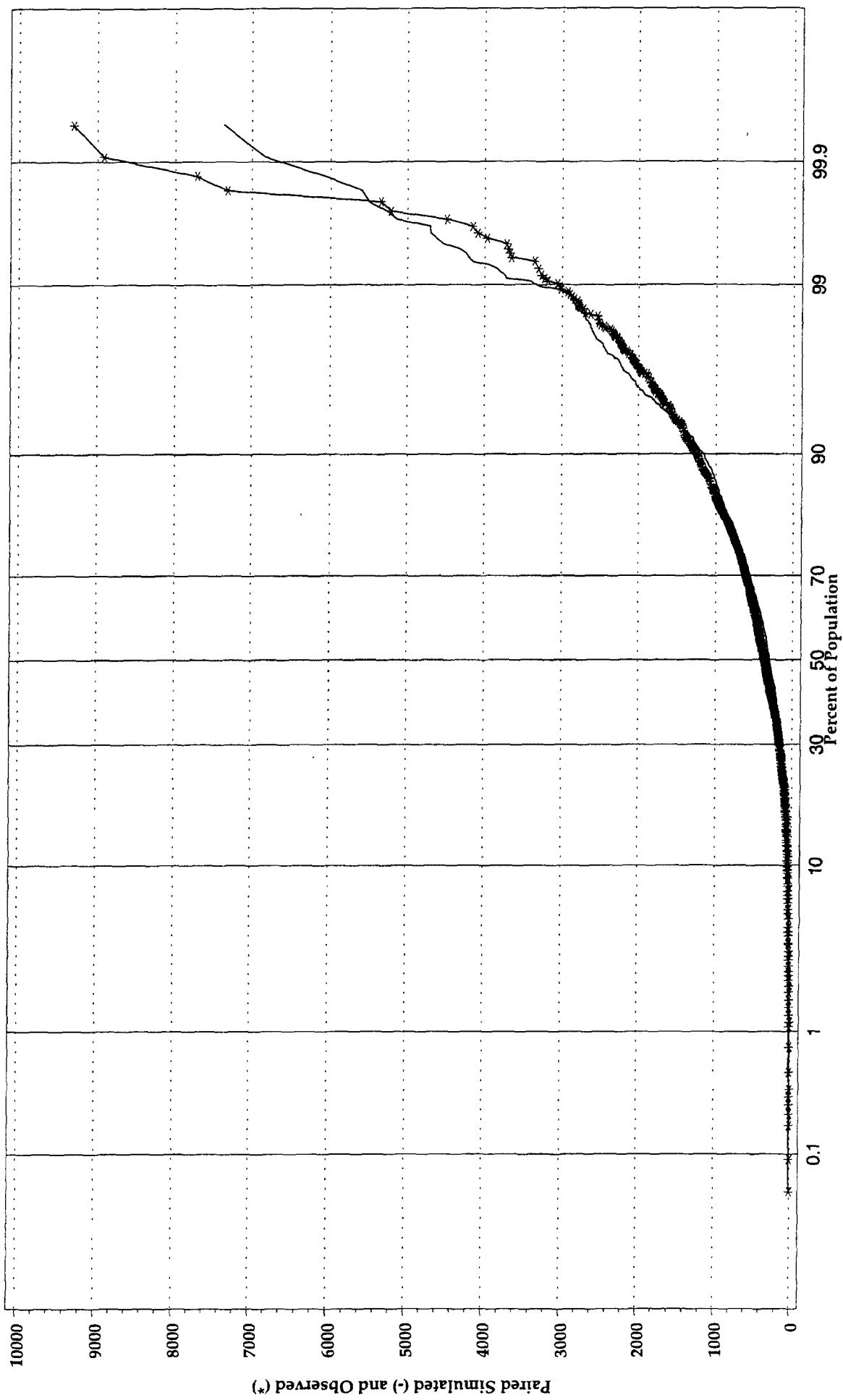
# Mattaponi River at Segment 240 Actuarial error versus Percentile Sample Population Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# Mattaponi River at Segment 240

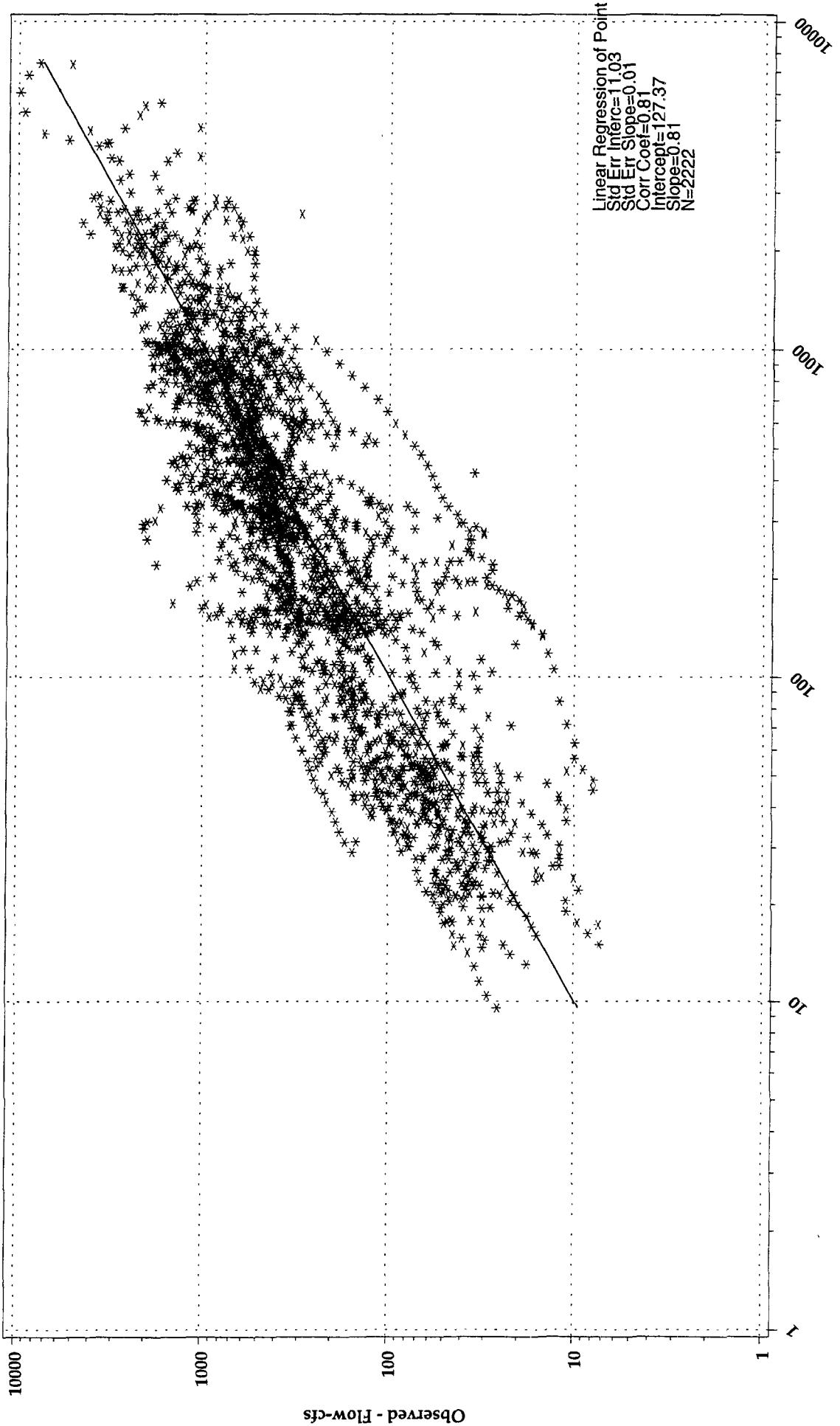
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population



# Mattaponi River at Segment 240

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION**  
**MATTAPONI RIVER, VA (Segments 235 and 240)**

Table A.5.1.1 Comparison of Annual Total Observed and Simulated flows.

Year	Observed Flow (inches)*	Simulated Flow (inches)**
1984	21.65	18.21
1985	11.81	14.77
1986	7.57	6.52
1987	0.00	16.19
1988	0.00	7.65
1989	0.00	17.75
1990	13.59	10.76
1991	5.99	7.45
Mean	12.12	11.54+

\* Observed flow at Mattaponi River at Beulahville, VA

\*\* Simulated outflow from RCH 240

+ Using only 1984, 1985, 1986, 1990, and 1991 years.

Table A.5.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

Year	Average Daily			Average Monthly		
	m	b	r2	m	b	r2
1984	1.05	-0.28	0.76	1.23	-0.78	0.89
1985	0.83	0.42	0.56	0.89	0.27	0.57
1986	0.82	0.35	0.83	0.85	0.28	0.89
1987	0.94	0.22	0.80	1.01	0.02	0.99
1988	0.00	0.00	0.00	0.00	0.00	0.00
1989	1.05	0.01	0.99	1.06	0.00	1.00
1990	0.93	0.05	0.83	1.02	-0.18	0.92
1991	0.65	0.90	0.67	0.66	0.89	0.71
1984-1991	0.78	0.21	0.68	0.84	0.06	0.75

Table A.5.1.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	1.11	-0.23	0.49	0.99	-0.06	0.84	0.57	0.90	0.55	0.87	0.01	0.63
1985	0.68	0.78	0.65	1.16	-0.72	0.57	0.77	0.65	0.43	0.74	0.93	0.64
1986	1.51	1.60	0.62	0.67	0.70	0.46	0.73	0.51	0.56	0.94	0.16	0.92
1987	0.31	2.51	0.06	0.90	0.20	0.72	1.12	-0.17	0.80	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.02	0.97	0.37	1.87	0.33
1990	0.39	1.72	0.34	0.72	0.63	0.62	1.03	-0.16	0.74	0.94	0.02	0.77
1991	0.94	0.27	0.71	1.01	-0.15	0.89	0.65	1.04	0.27	0.79	0.49	0.75
1984-1991	0.84	0.44	0.41	1.09	-0.40	0.83	0.64	0.83	0.51	0.90	0.26	0.74

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

**A.5.2 PAMUNKEY RIVER NEAR HANOVER, VA AT SEGMENT 260  
(1673000)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

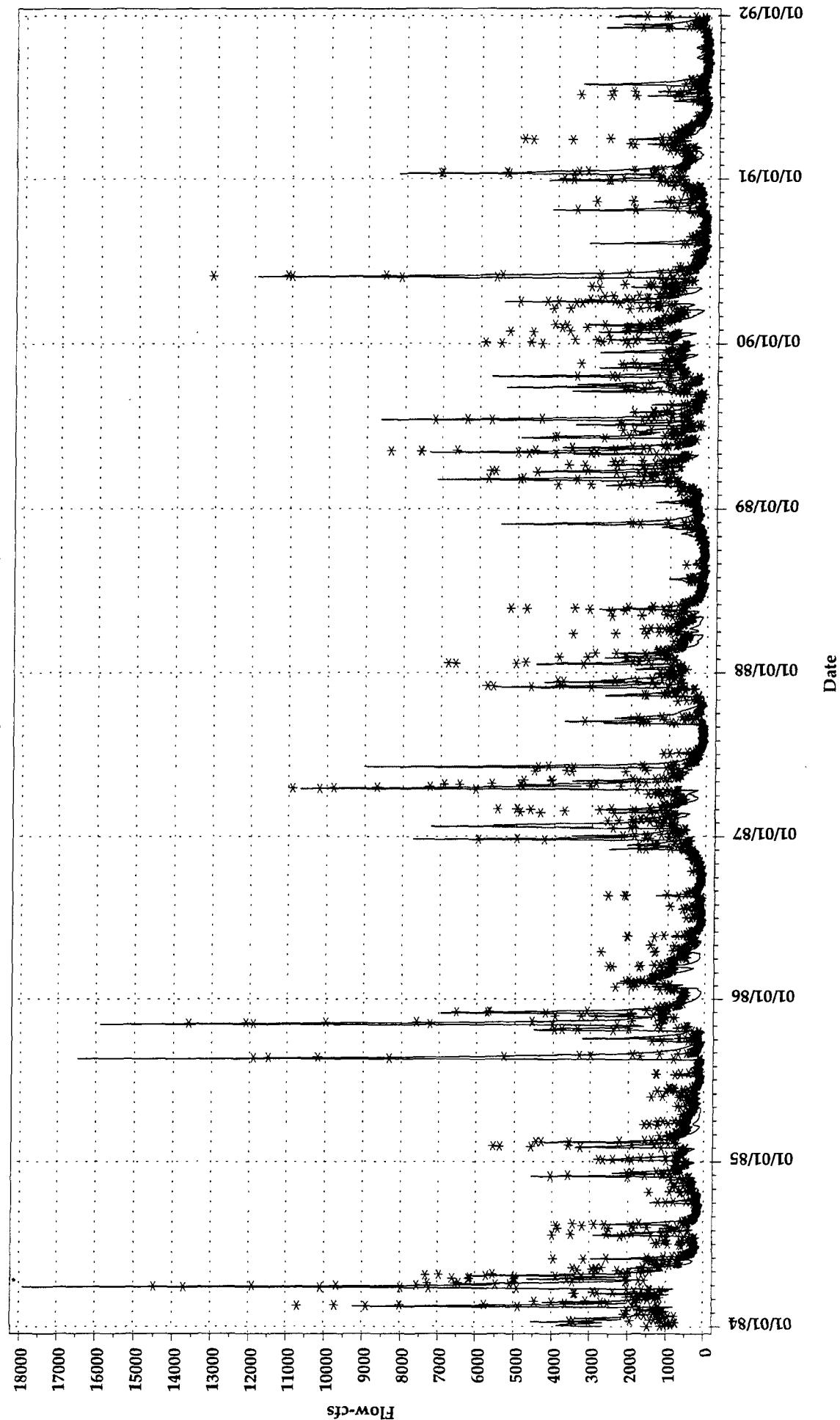
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Pamunkey River at Segment 260 Observed and Simulated versus Time

## Flow-cfs

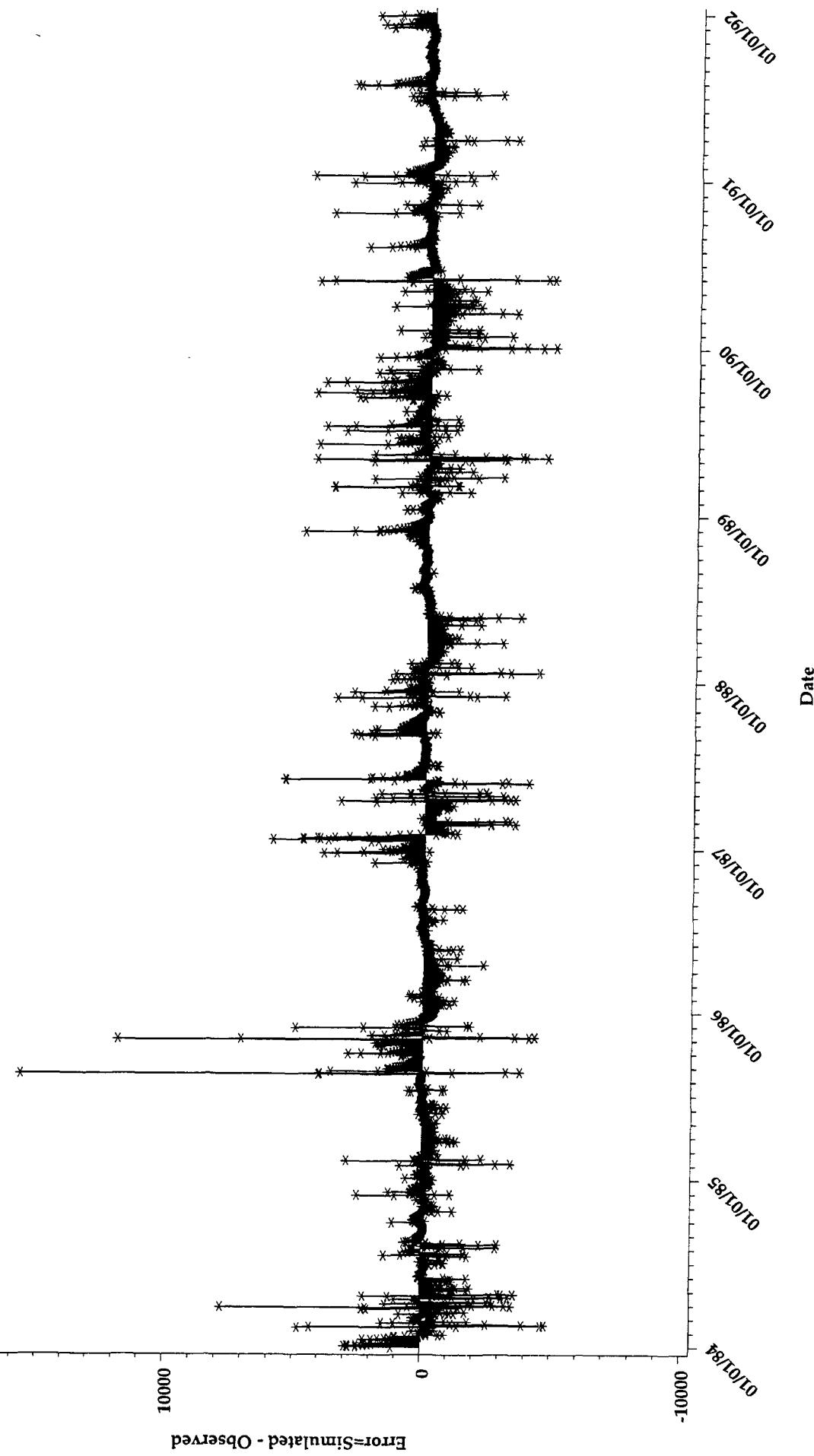
(\*=Observed, -=Simulated)



# Pamunkey River at Segment 260

## Actual Error versus Time

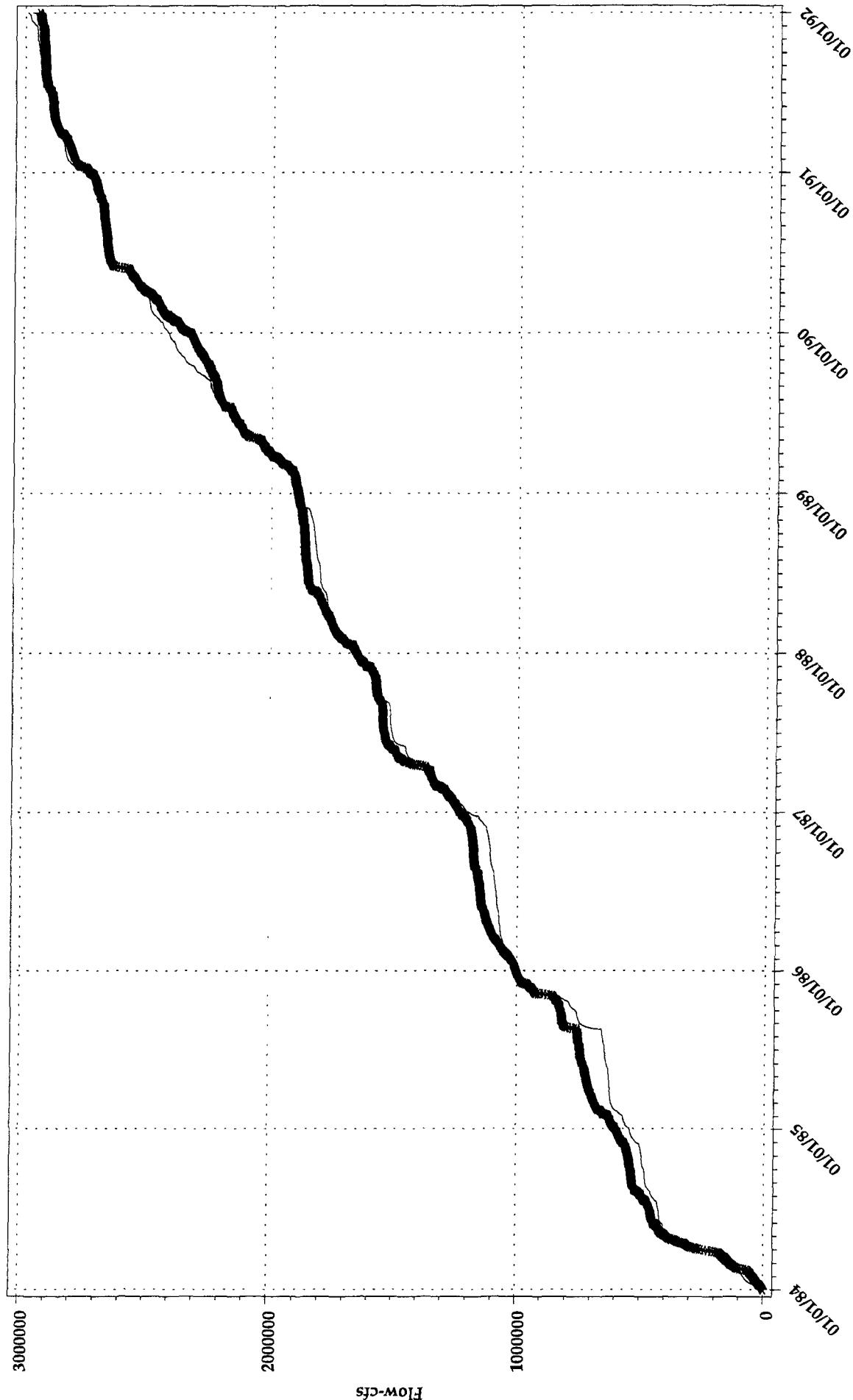
### Flow-cfs



# Pamunkey River at Segment 260

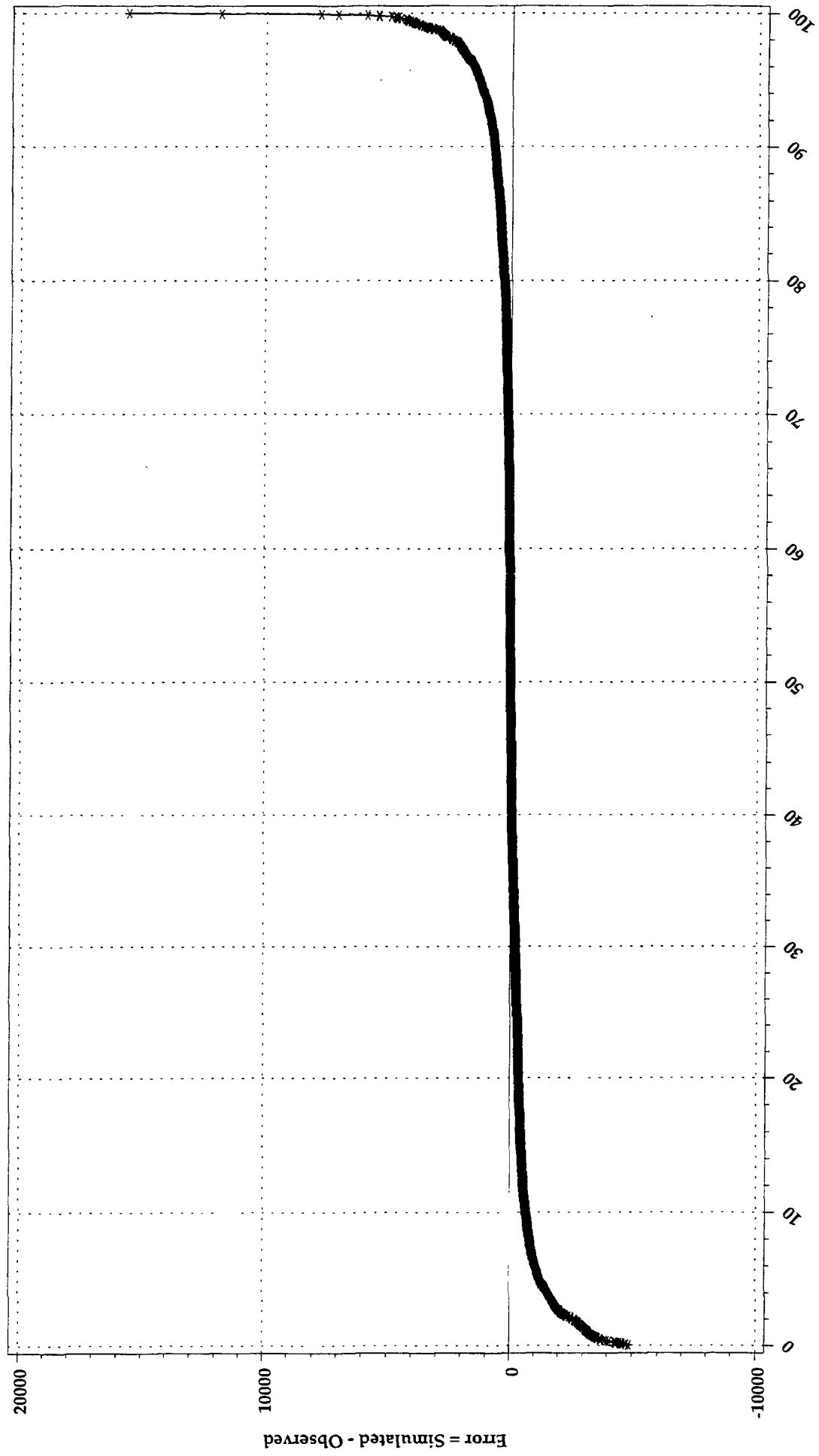
## Observed and Simulated Cumulative Flows versus Time

(\* = Observed, - = Simulated)



# Pamunkey River at Segment 260 Actual error versus Percentile Sample Population Flow-cfs

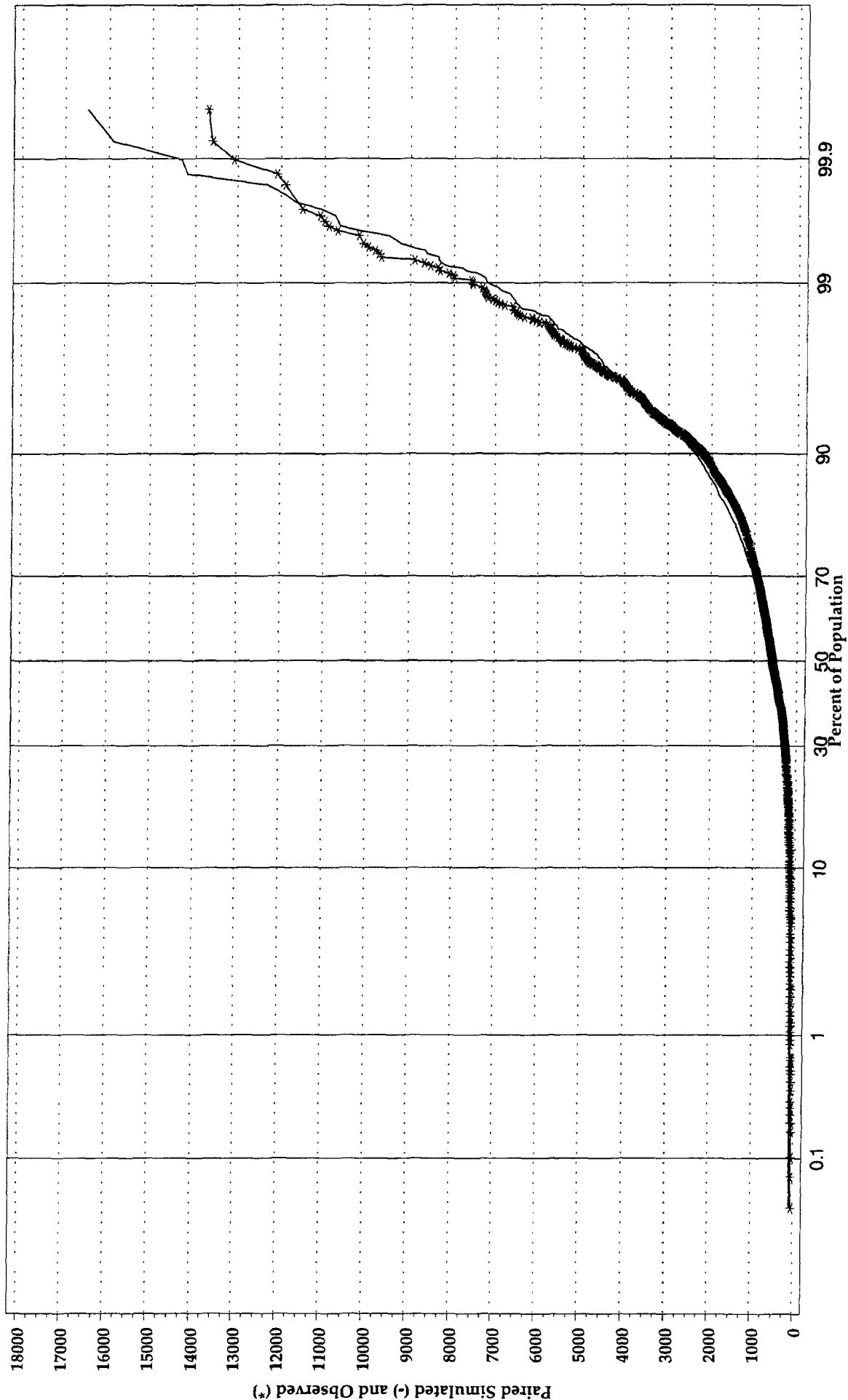
Frequency Distribution - All Simulated and Observed Data



# Pamunkey River at Segment 260

## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

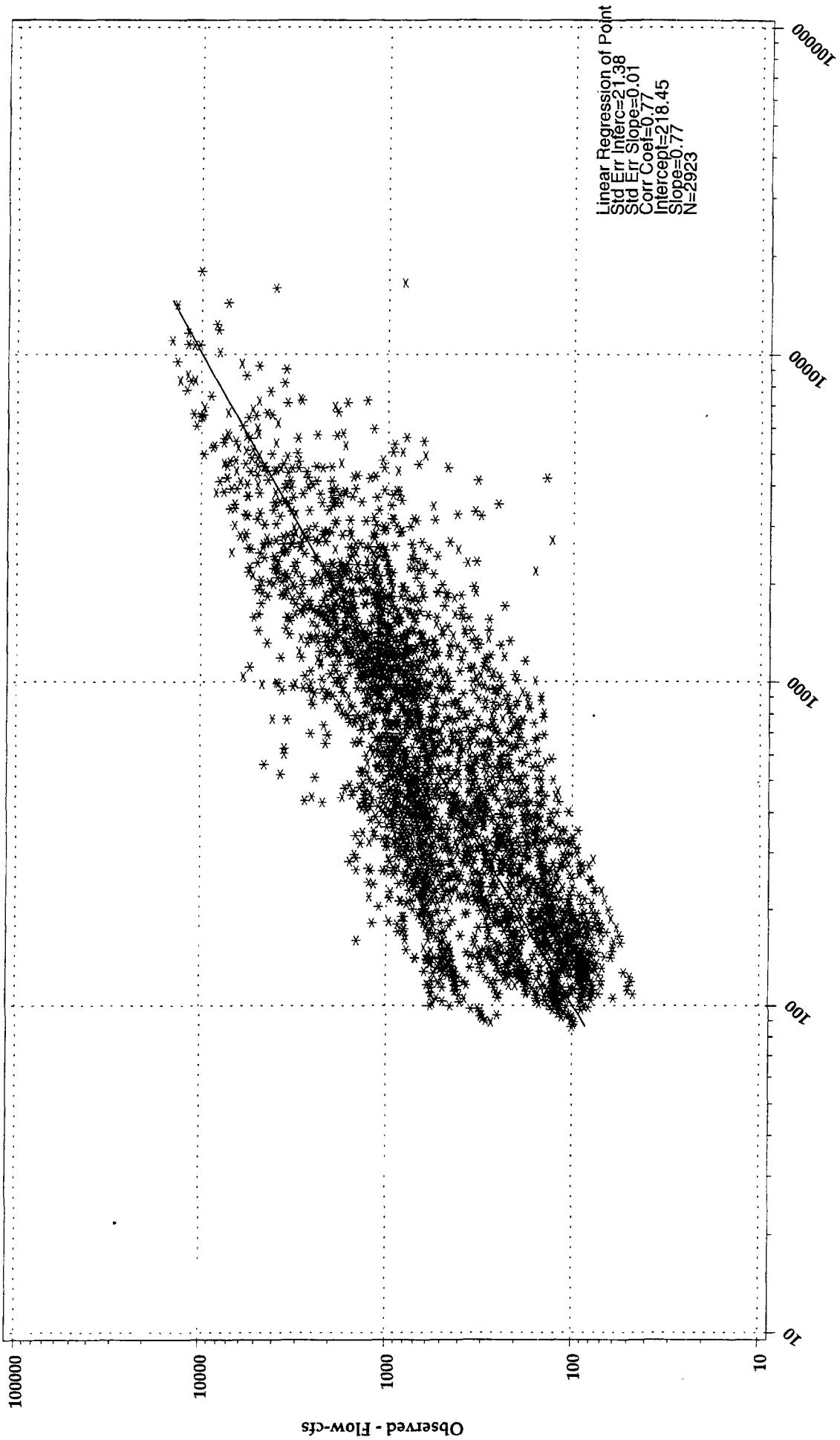
Flow-cfs



# Pamunkey River at Segment 260

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
PAMUNKEY RIVER, VA (Segments 250 and 260)**

Table A.5.2.1 Comparison of Annual Total Observed and Simulated flows.

	<b>Observed Flow</b>	<b>Simulated Flow</b>
<b>Year</b>	(inches)*	(inches)**
1984	20.59	18.55
1985	13.95	15.66
1986	7.80	6.35
1987	14.71	16.55
1988	8.17	7.39
1989	14.76	17.92
1990	14.17	11.44
1991	7.13	8.09
Mean	12.66	12.74

\* Observed flow at Pamunkey River at Hanover, VA

\*\* Simulated outflow from RCH 260

Table A.5.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r<sup>2</sup></b>	<b>m</b>	<b>b</b>	<b>r<sup>2</sup></b>
1984	0.92	0.20	0.78	0.98	0.01	0.91
1985	0.81	0.53	0.54	0.83	0.47	0.44
1986	0.68	0.76	0.50	0.66	0.81	0.49
1987	0.73	0.81	0.63	0.99	0.07	0.97
1988	0.55	1.21	0.45	0.44	1.48	0.39
1989	0.78	0.75	0.61	0.71	0.94	0.59
1990	0.65	0.96	0.65	0.54	1.28	0.75
1991	0.64	1.04	0.55	0.59	1.13	0.57
1984-1991	0.72	0.78	0.59	0.72	0.77	0.64

Table A.5.2.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.81	0.58	0.69	1.07	-0.37	0.79	0.86	0.30	0.76	0.89	0.29	0.64
1985	0.92	0.18	0.74	0.53	0.89	0.22	0.83	0.61	0.63	0.63	1.35	0.61
1986	2.11	-3.63	0.86	0.83	0.11	0.59	0.62	0.92	0.53	1.08	0.01	0.88
1987	0.32	2.19	0.05	1.00	0.19	0.69	0.98	0.29	0.79	0.67	1.47	0.88
1988	0.90	0.23	0.77	1.05	-0.56	0.78	0.56	1.17	0.41	1.17	-0.04	0.81
1989	0.91	0.28	0.75	0.82	0.56	0.69	0.85	0.63	0.65	0.57	1.41	0.23
1990	0.69	0.82	0.51	1.46	-0.73	0.69	0.84	0.57	0.73	0.72	0.85	0.62
1991	1.24	-0.76	0.75	0.95	-0.10	0.82	0.78	0.81	0.60	1.00	0.37	0.79
1984-1991	0.89	0.28	0.53	1.11	-0.60	0.77	0.81	0.62	0.66	0.80	0.71	0.70

Season 1 is from Julian day 1 to 60.

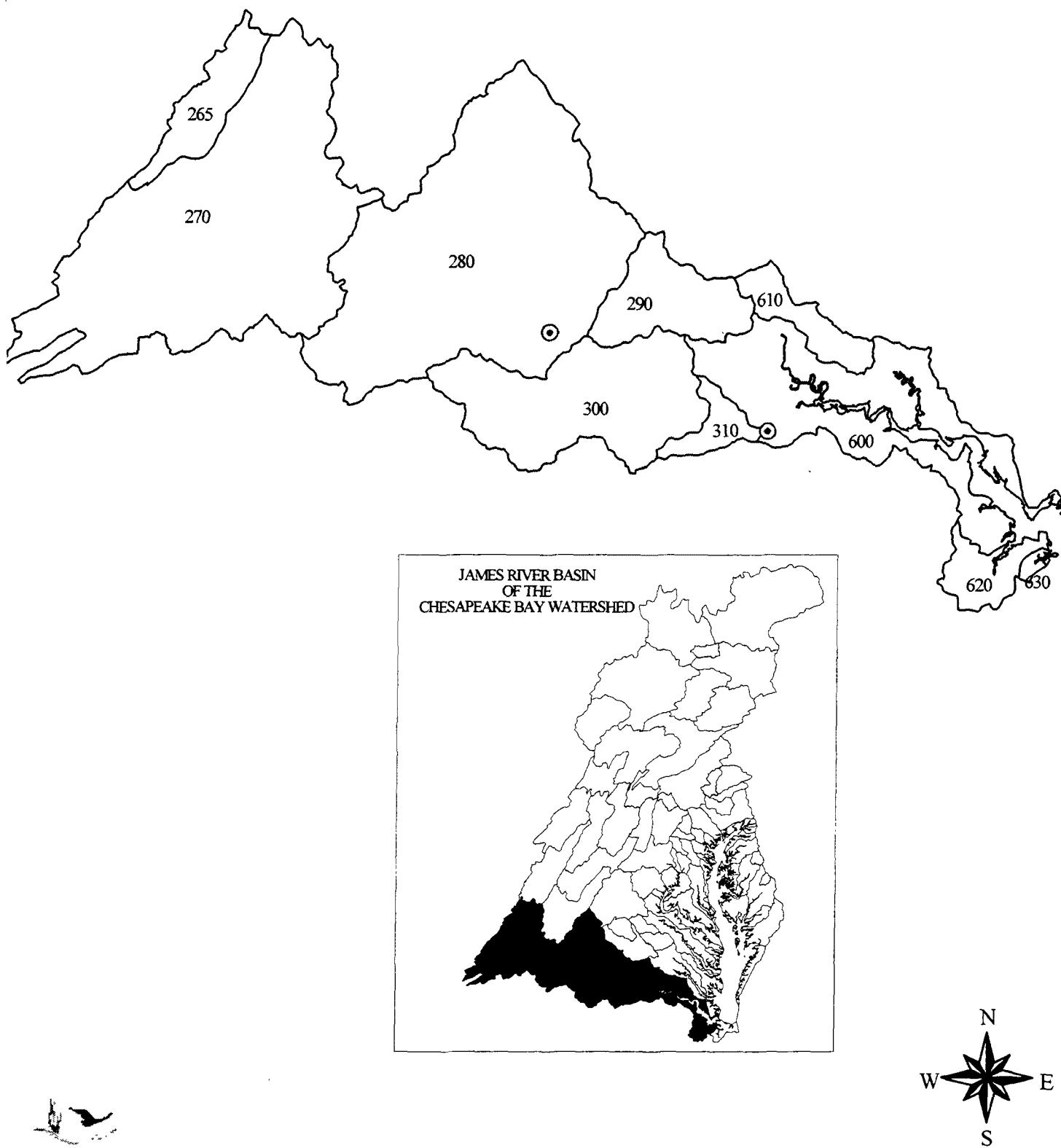
Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

# Monitoring Stations

## Chesapeake Bay Watershed Phase IV Model Segments: James River Basin



## **A.6.1 JAMES RIVER AT CARTERSVILLE, VA AT SEGMENT 280 (2035000)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

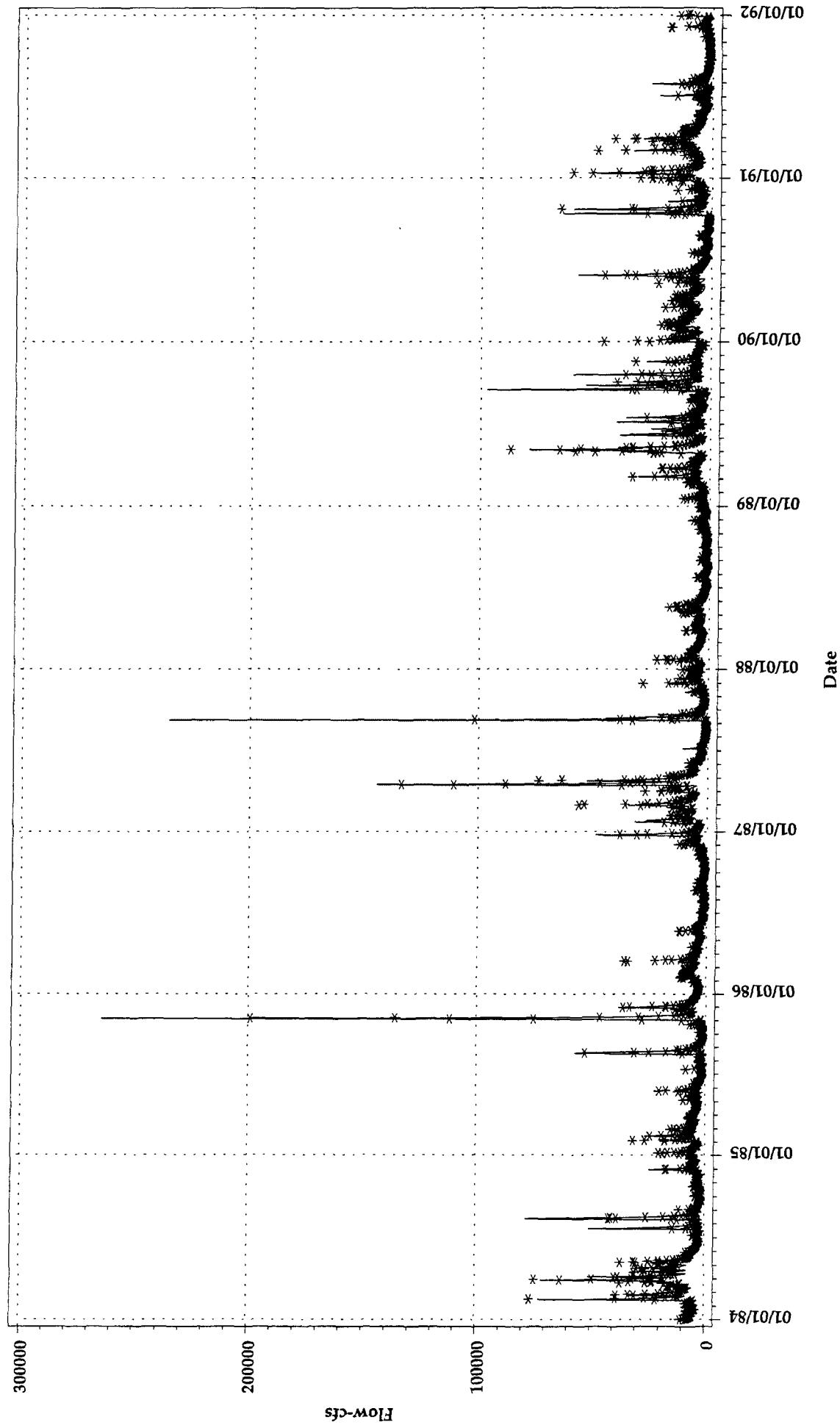
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# James River at Segment 280 Observed and Simulated versus Time

## Flow-cfs

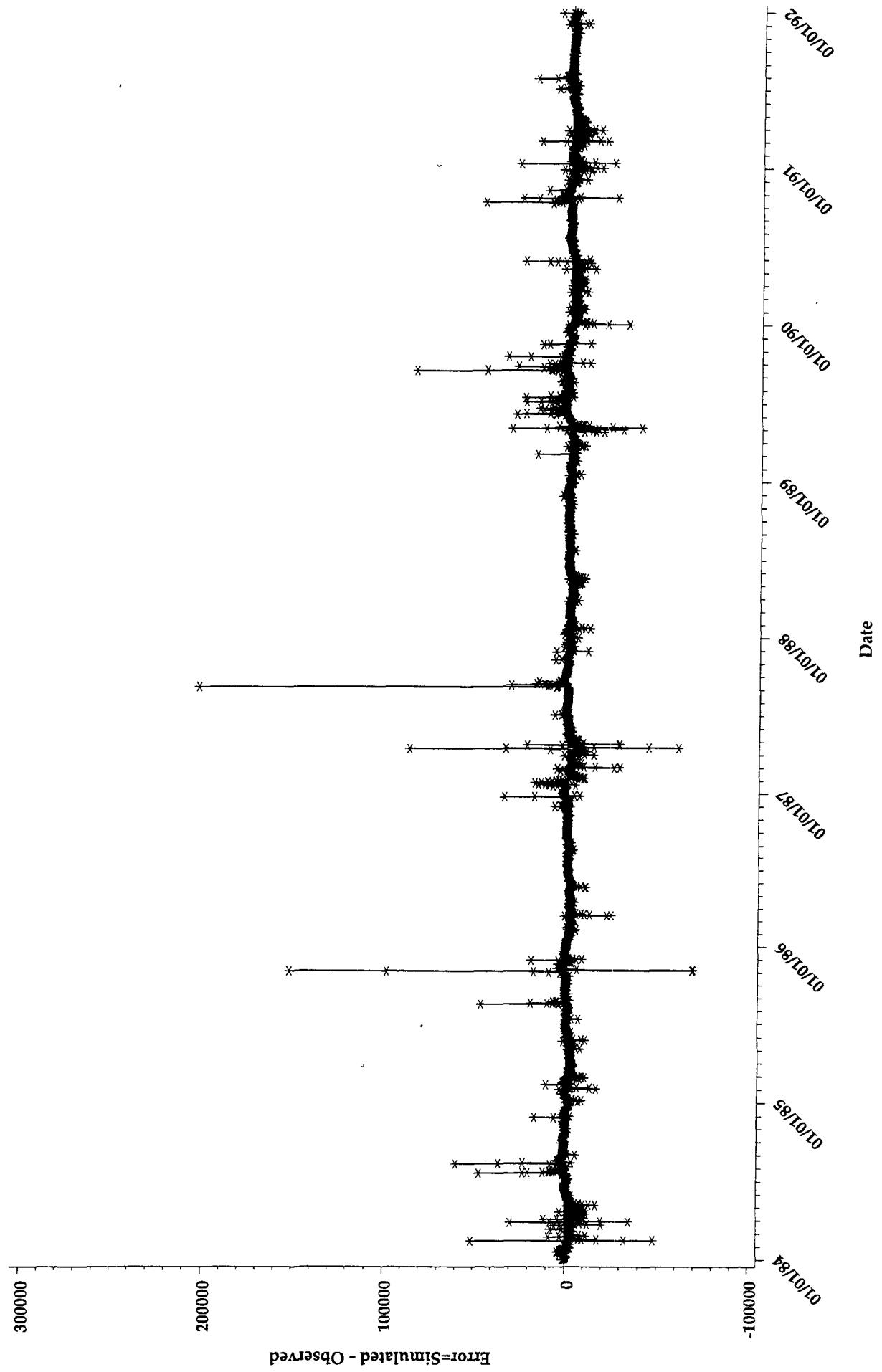
(\*=Observed, -=Simulated)



# James River at Segment 280

## Actual Error versus Time

### Flow-cfs

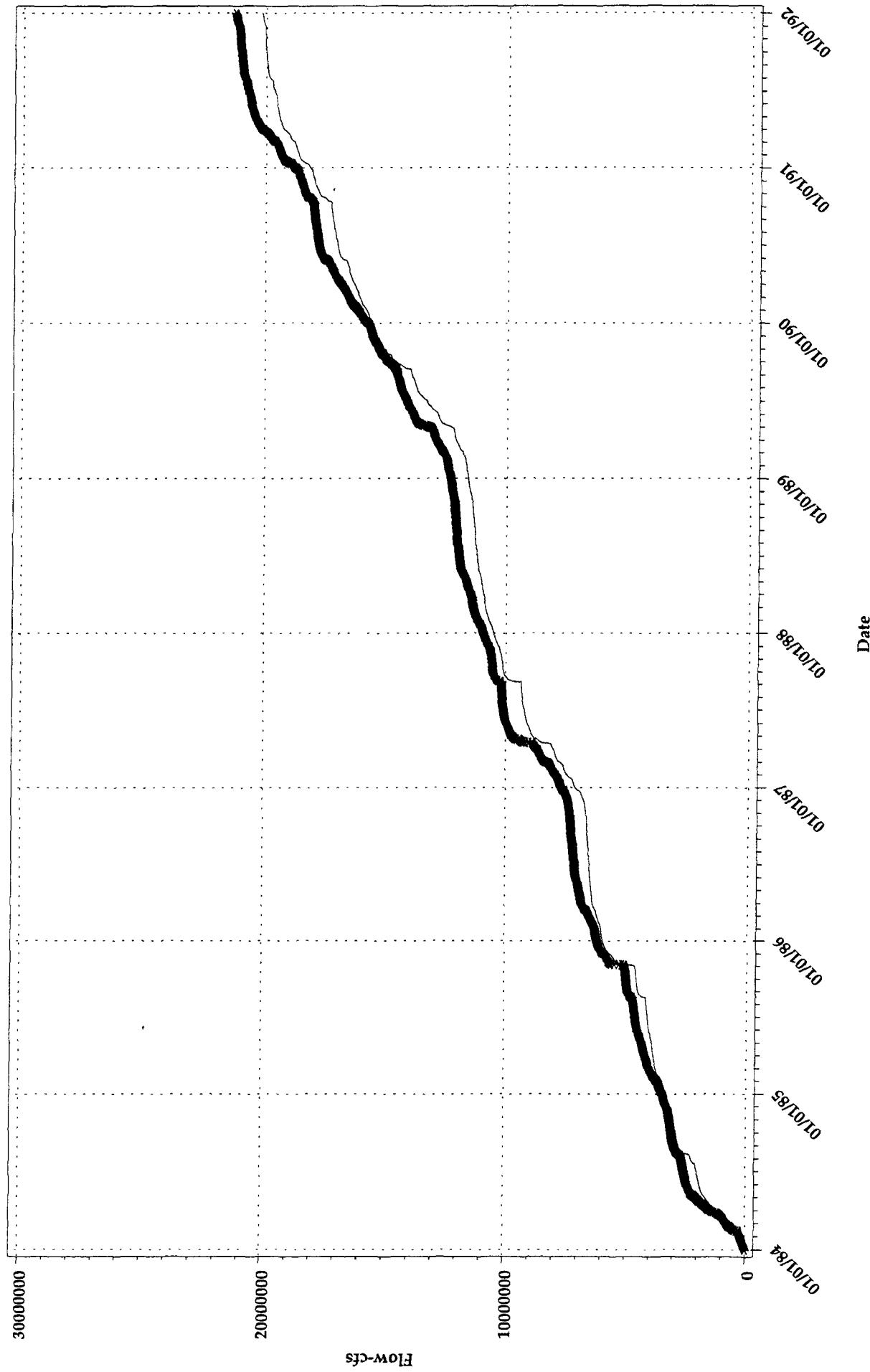


# James River at Segment 280

## Observed and Simulated Cumulative Flows versus Time

Flow-cfs

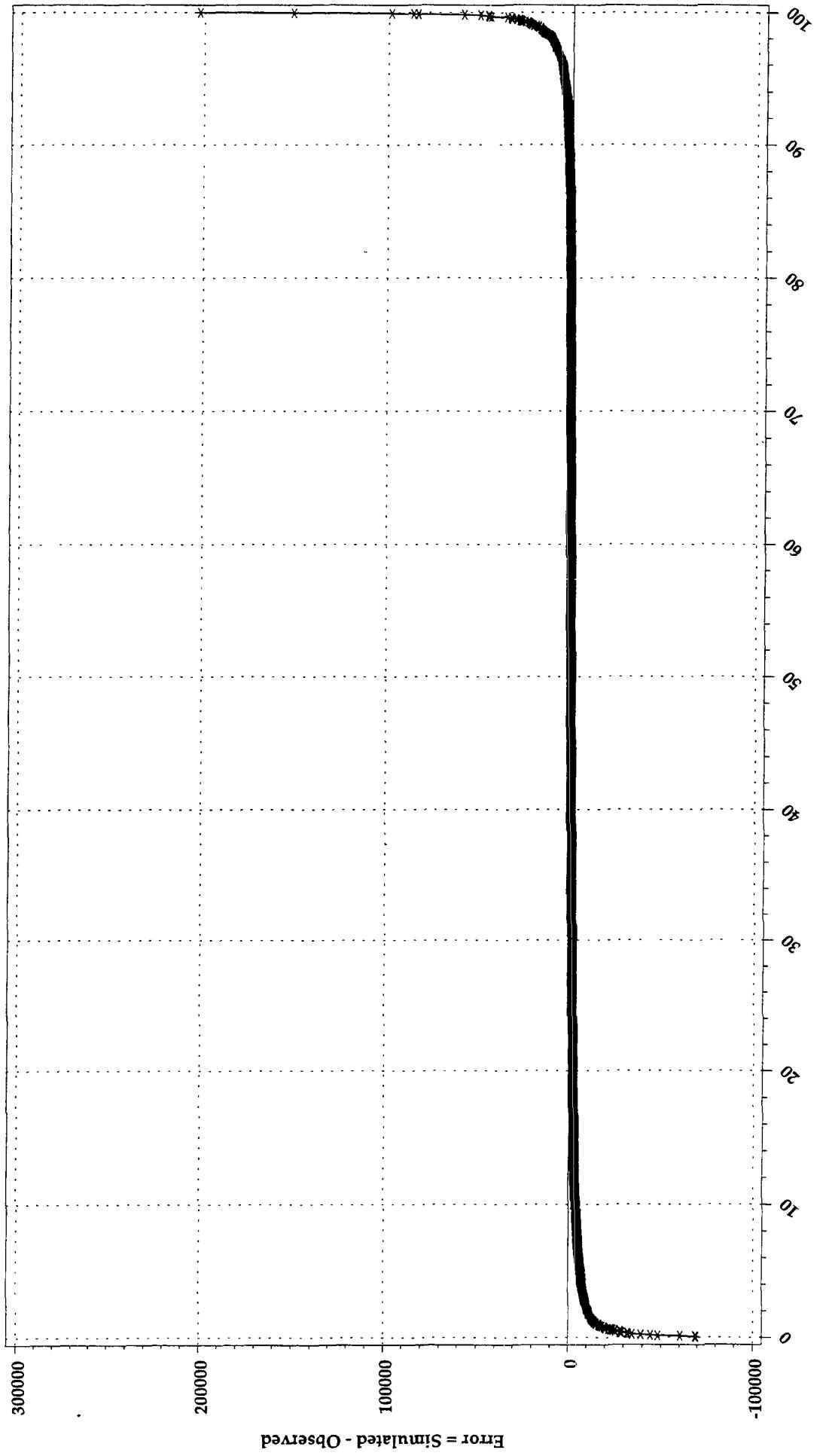
(\* = Observed, - = Simulated)



# James River at Segment 280

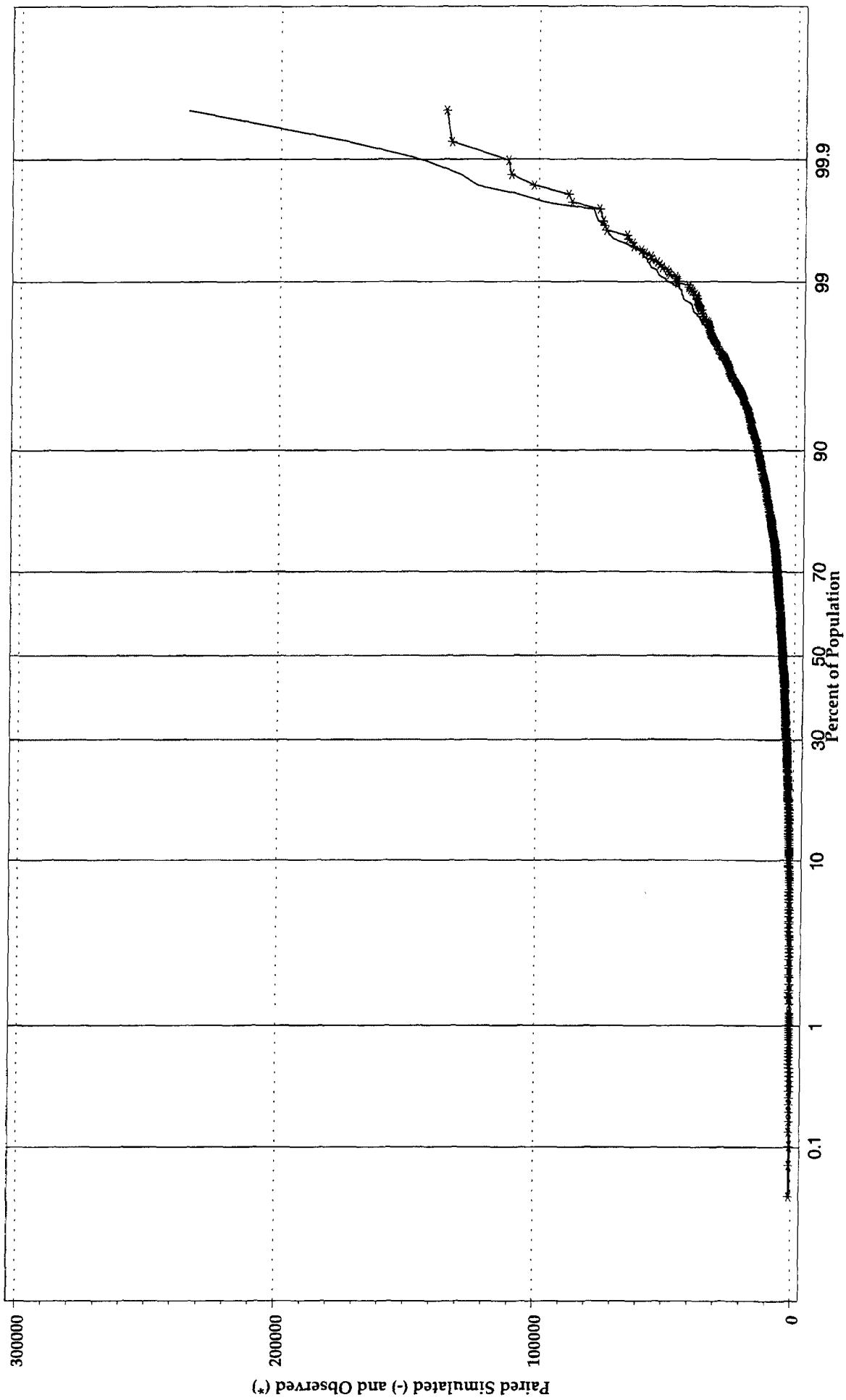
## Actual error versus Percentile Sample Population Flow-cfs

Frequency Distribution - All Simulated and Observed Data

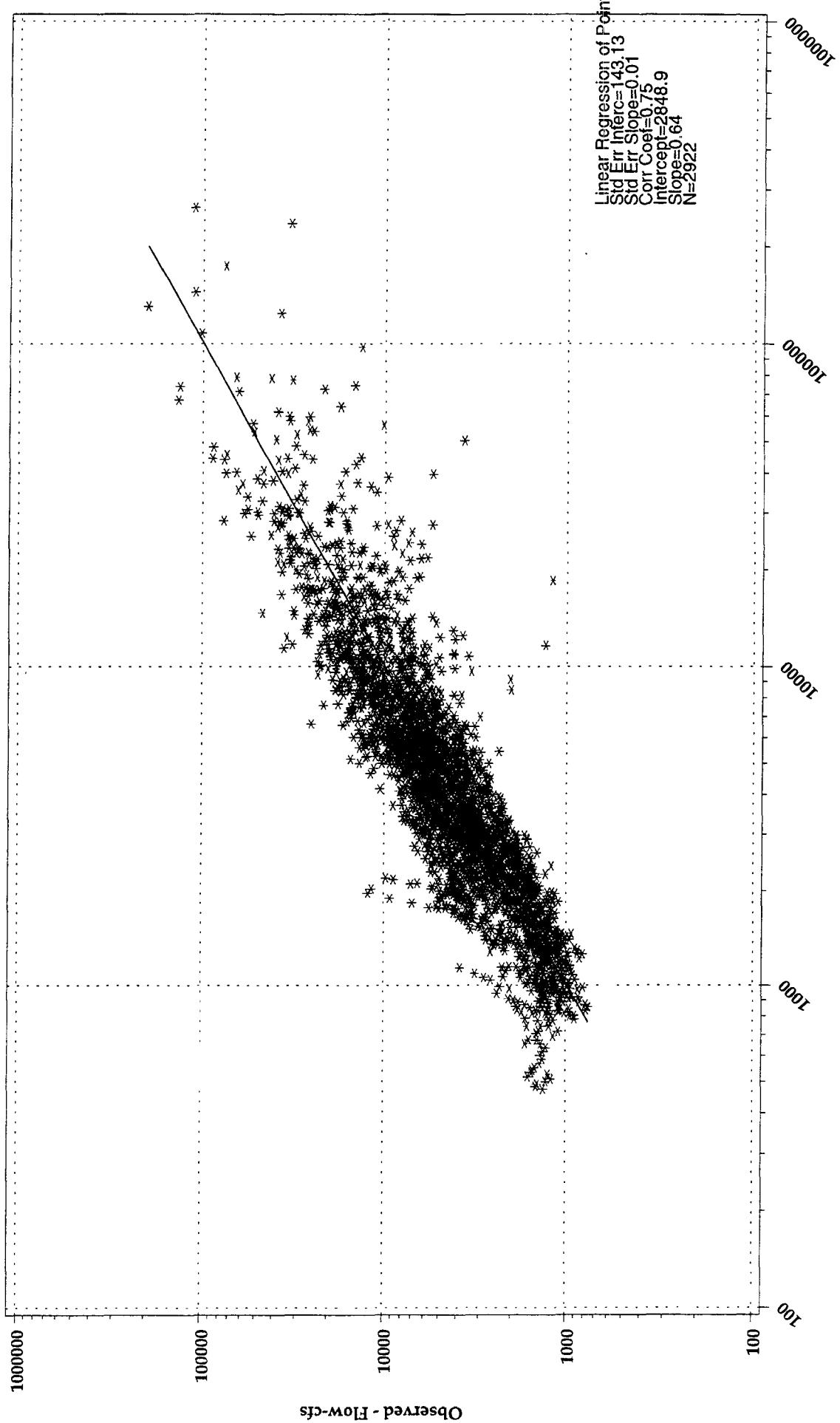


# James River at Segment 280

## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population Flow-cfs



# James River at Segment 280 Scatter Plot and Regression of Simulated versus Observed with Ideal Line Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION**  
**JAMES RIVER, VA (Segments 265, 270, 280 and 290)**

Table A.6.1.1 Comparison of Annual Total Observed and Simulated flows..

Year	Observed Flow (inches)*	Simulated Flow (inches)**
1984	20.52	19.50
1985	16.33	16.10
1986	9.10	7.22
1987	19.16	20.26
1988	8.18	6.63
1989	20.27	23.76
1990	18.18	15.66
1991	15.09	12.28
Mean	15.85	15.18

\* Observed flow at James River at Cartersville, VA

\*\* Simulated outflow from RCH 280

Table A.6.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

Year	Average Daily			Average Monthly		
	m	b	r2	m	b	r2
1984	0.79	0.78	0.77	0.72	1.06	0.90
1985	0.92	0.23	0.80	0.96	0.09	0.80
1986	0.86	0.37	0.80	0.94	0.10	0.85
1987	0.82	0.73	0.81	1.00	0.03	0.99
1988	0.66	1.13	0.76	0.68	1.06	0.82
1989	0.94	0.30	0.72	1.15	-0.52	0.71
1990	0.77	0.83	0.78	0.63	1.34	0.85
1991	1.01	-0.12	0.87	1.04	-0.24	0.91
1984-1991	0.85	0.53	0.79	0.89	0.37	0.86

Table A.6.1.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.93	0.16	0.82	0.94	0.13	0.81	1.05	-0.10	0.68	0.71	1.08	0.63
1985	0.68	1.20	0.71	0.88	0.20	0.67	0.99	0.02	0.81	0.95	0.26	0.95
1986	0.73	0.91	0.83	0.80	0.49	0.71	0.58	1.23	0.70	1.04	-0.10	0.92
1987	0.67	1.37	0.34	0.91	0.27	0.83	1.02	0.07	0.84	-0.62	5.89	0.10
1988	0.75	0.86	0.88	0.78	0.60	0.66	0.64	1.19	0.76	0.71	1.02	0.67
1989	0.78	0.72	0.88	0.88	0.42	0.84	1.06	-0.01	0.80	0.96	0.23	0.75
1990	0.83	0.56	0.72	1.22	-1.09	0.77	0.79	0.78	0.93	0.93	0.31	0.76
1991	0.88	0.42	0.83	0.99	-0.14	0.87	1.04	-0.13	0.84	1.26	-1.05	0.84
1984-1991	0.81	0.68	0.74	1.04	-0.36	0.85	1.09	-0.25	0.83	1.02	-0.04	0.85

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

**A.6.2 APPAMATTOX RIVER AT MATOACA, VA AT SEGMENT 310  
(2041650)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

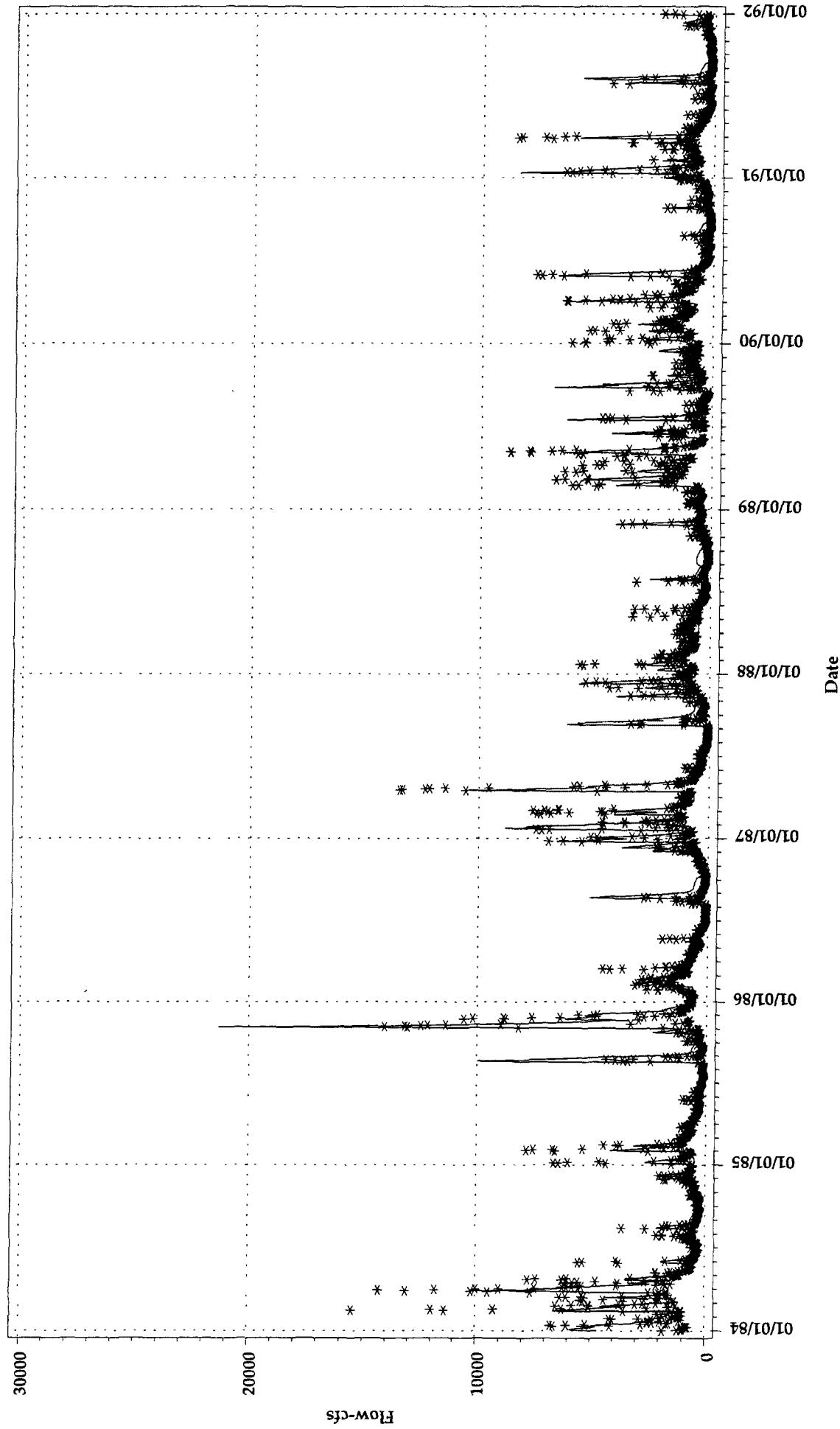
Average Seasonal Regressions for 1984-1991



# Appomattox River at Segment 310 Observed and Simulated versus Time

## Flow-cfs

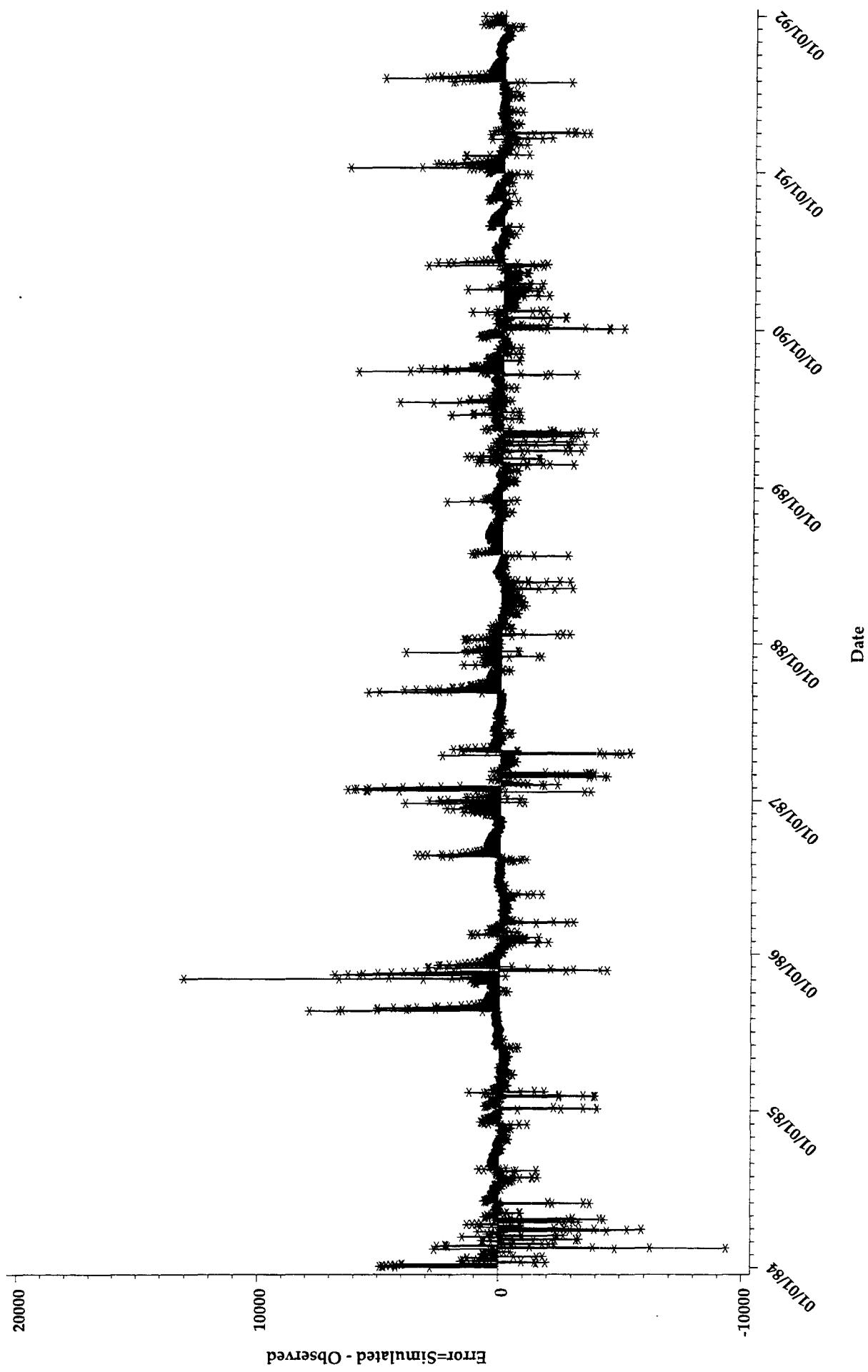
(\*=Observed, -=Simulated)



# Appomattox River at Segment 310

## Actual Error versus Time

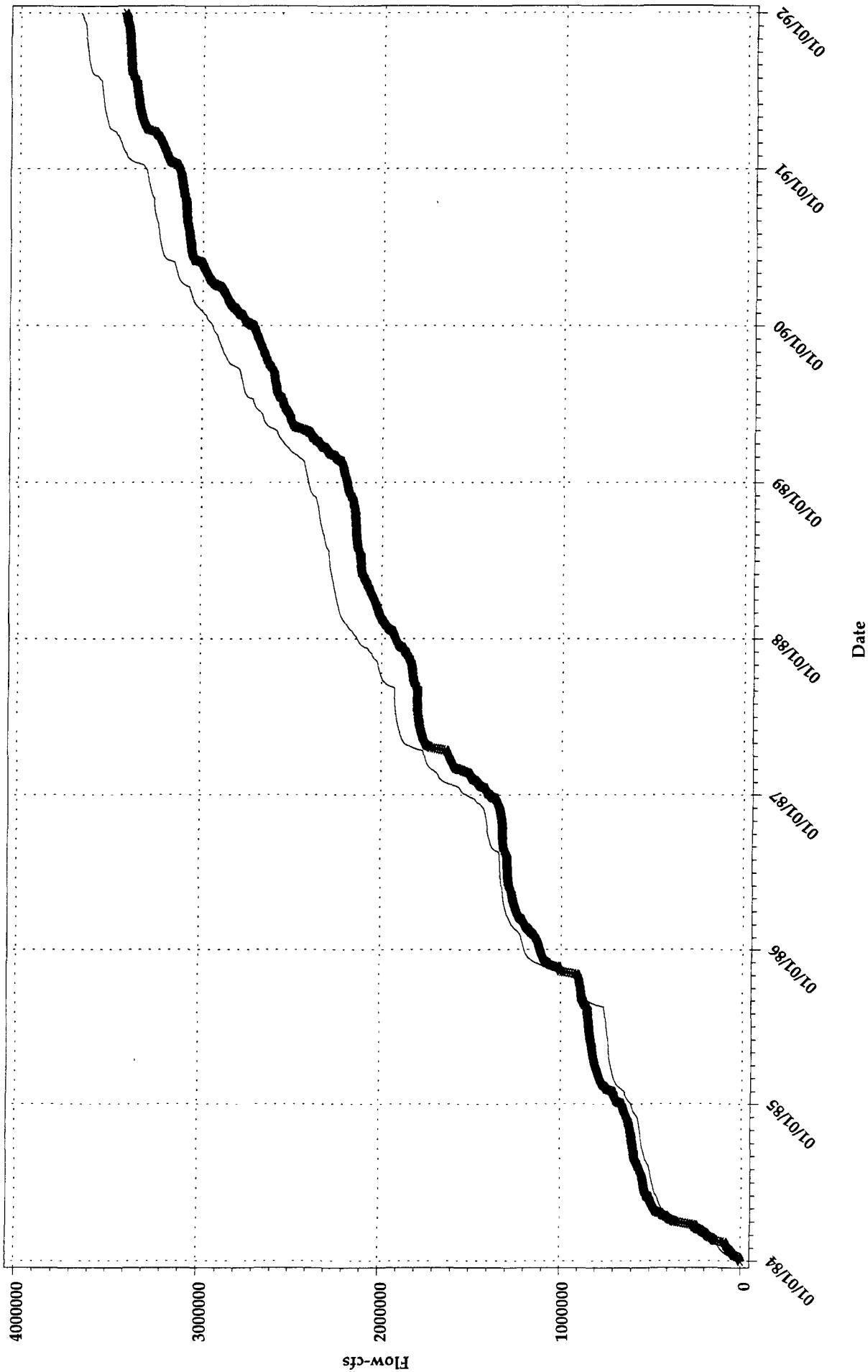
### Flow-cfs



# Appomattox River at Segment 310

## Observed and Simulated Cumulative Flows versus Time

Flow-cfs  
(\* = Observed, - = Simulated)

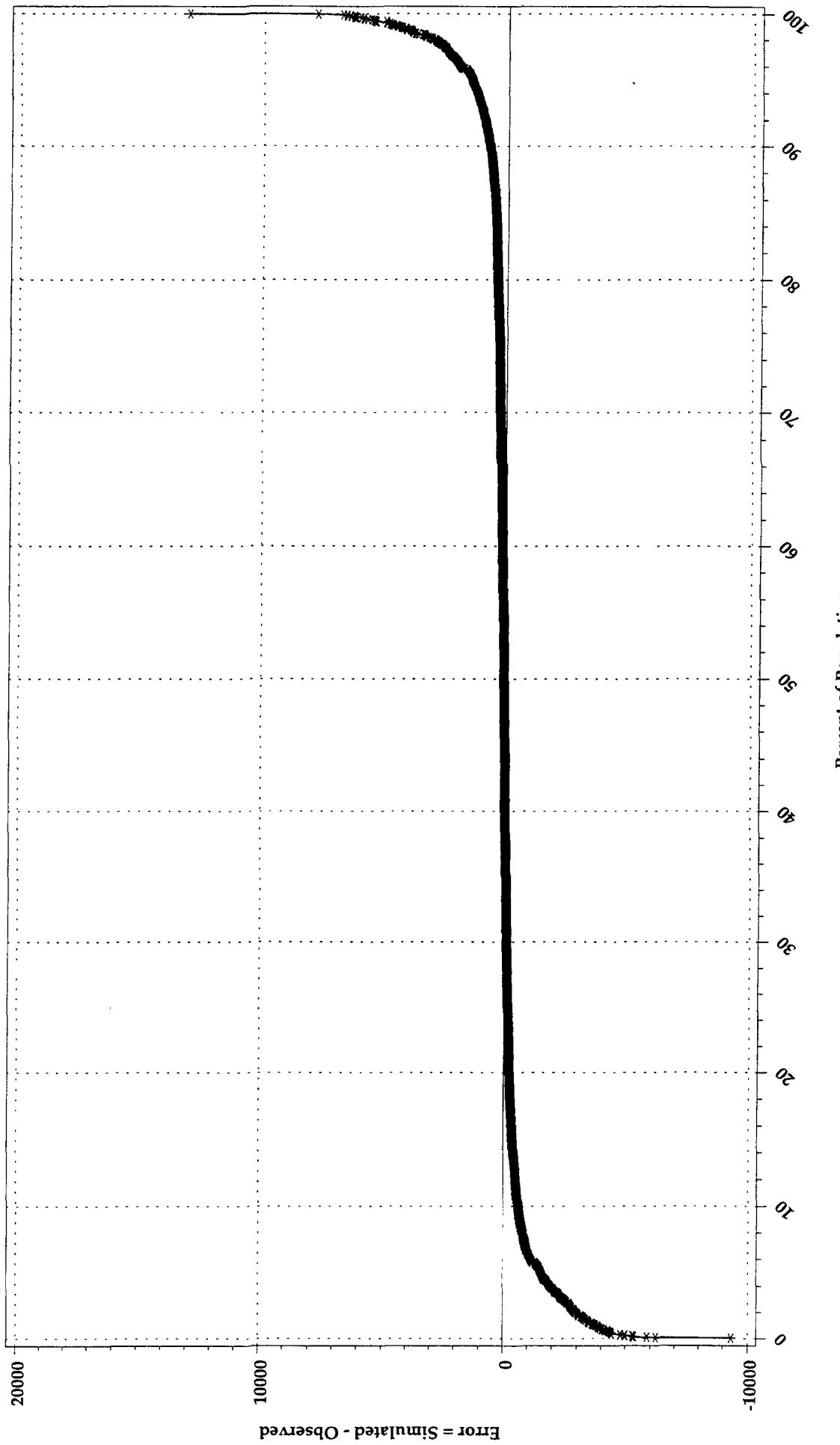


# Appomattox River at Segment 310

## Actual error versus Percentile Sample Population

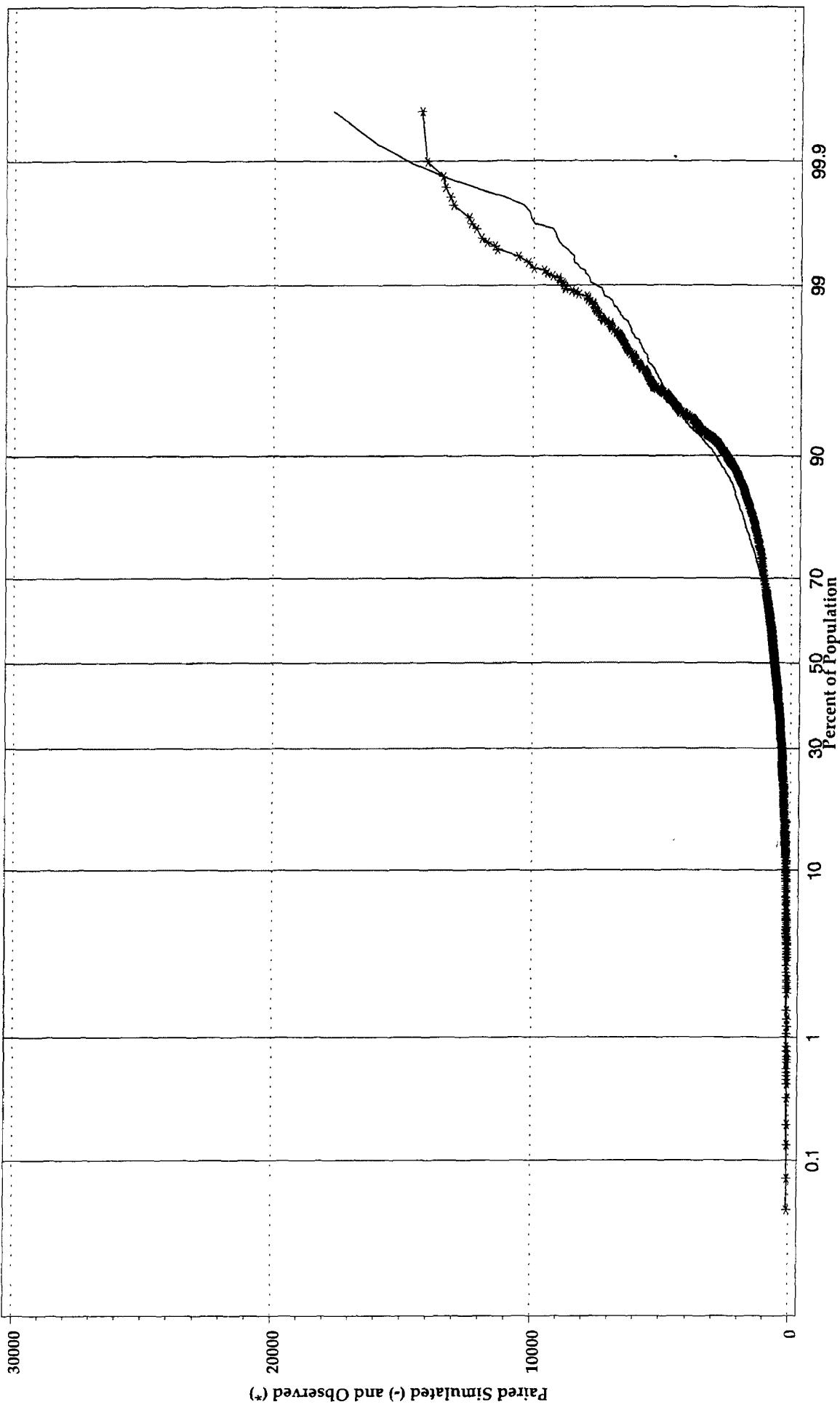
### Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# Appomattox River at Segment 310

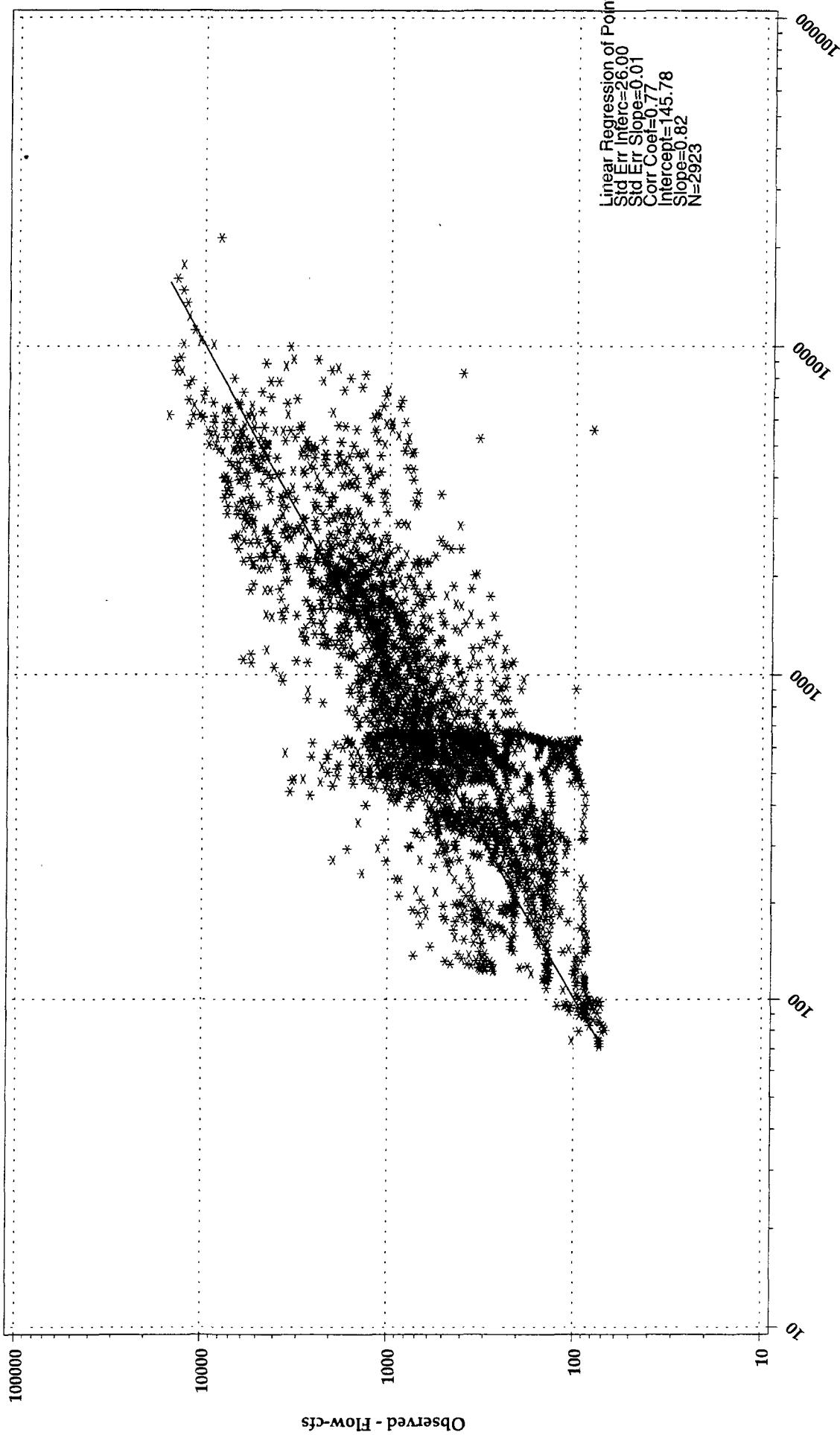
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population



# Appomattox River at Segment 310

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
APPOMATTOX RIVER, VA (Segments 300 and 310)**

Table A.6.2.1 Comparison of Annual Total Observed and Simulated flows.

<b>Year</b>	<b>Observed Flow</b>	<b>Simulated Flow</b>
	(inches)*	(inches)**
1984	18.16	18.03
1985	12.83	12.75
1986	7.68	7.63
1987	14.55	14.46
1988	7.42	7.36
1989	14.52	14.43
1990	11.37	11.29
1991	8.19	8.14
Mean	11.84	11.76

\* Observed flow at Appomattox River at Matoaca, VA

\*\* Simulated outflow from RCH 310

Table A.6.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r2</b>	<b>m</b>	<b>b</b>	<b>r2</b>
1984	0.77	0.75	0.76	0.90	0.35	0.89
1985	0.85	0.52	0.65	0.92	0.36	0.67
1986	0.65	1.03	0.52	0.67	0.99	0.58
1987	0.82	0.65	0.76	1.02	0.06	0.98
1988	0.35	1.89	0.27	0.29	2.04	0.24
1989	0.70	0.98	0.67	0.72	0.93	0.70
1990	0.64	1.09	0.67	0.58	1.25	0.77
1991	0.74	0.84	0.62	0.75	0.83	0.61
1984-1991	0.69	0.97	0.61	0.73	0.85	0.68

Table A.6.2.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.55	1.57	0.71	0.73	0.88	0.86	0.46	1.57	0.49	0.95	0.17	0.70
1985	0.62	1.21	0.81	1.31	-1.03	0.78	1.08	0.14	0.75	0.77	0.99	0.75
1986	0.84	0.40	0.54	0.90	0.10	0.64	0.89	0.50	0.52	0.78	0.94	0.78
1987	0.44	1.98	0.21	0.87	0.38	0.82	1.08	0.07	0.72	1.12	0.45	0.99
1988	1.04	-0.11	0.87	-0.02	2.79	0.01	0.12	2.42	0.02	0.57	1.34	0.64
1989	0.86	0.37	0.79	0.62	1.26	0.69	0.68	1.08	0.62	0.86	0.55	0.48
1990	0.44	1.76	0.34	1.07	0.38	0.80	0.70	0.98	0.55	0.74	0.80	0.54
1991	0.98	0.26	0.69	0.80	0.53	0.86	0.84	0.65	0.46	0.60	1.16	0.29
1984-1991	0.72	0.94	0.51	0.95	0.02	0.80	0.77	0.82	0.56	0.81	0.73	0.69

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

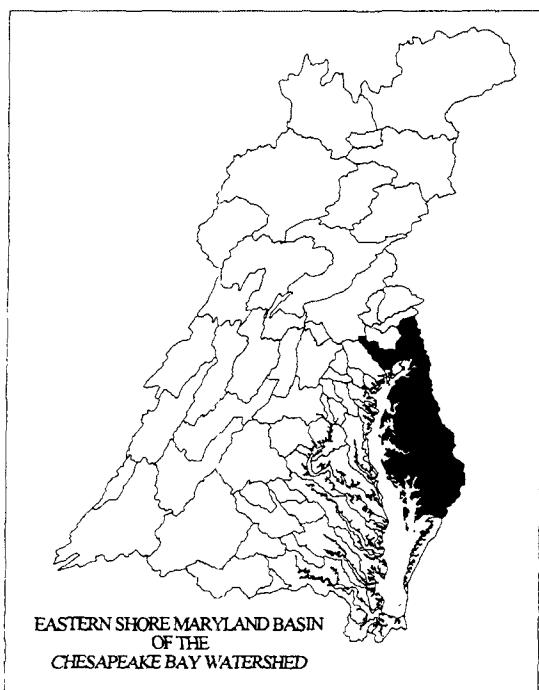
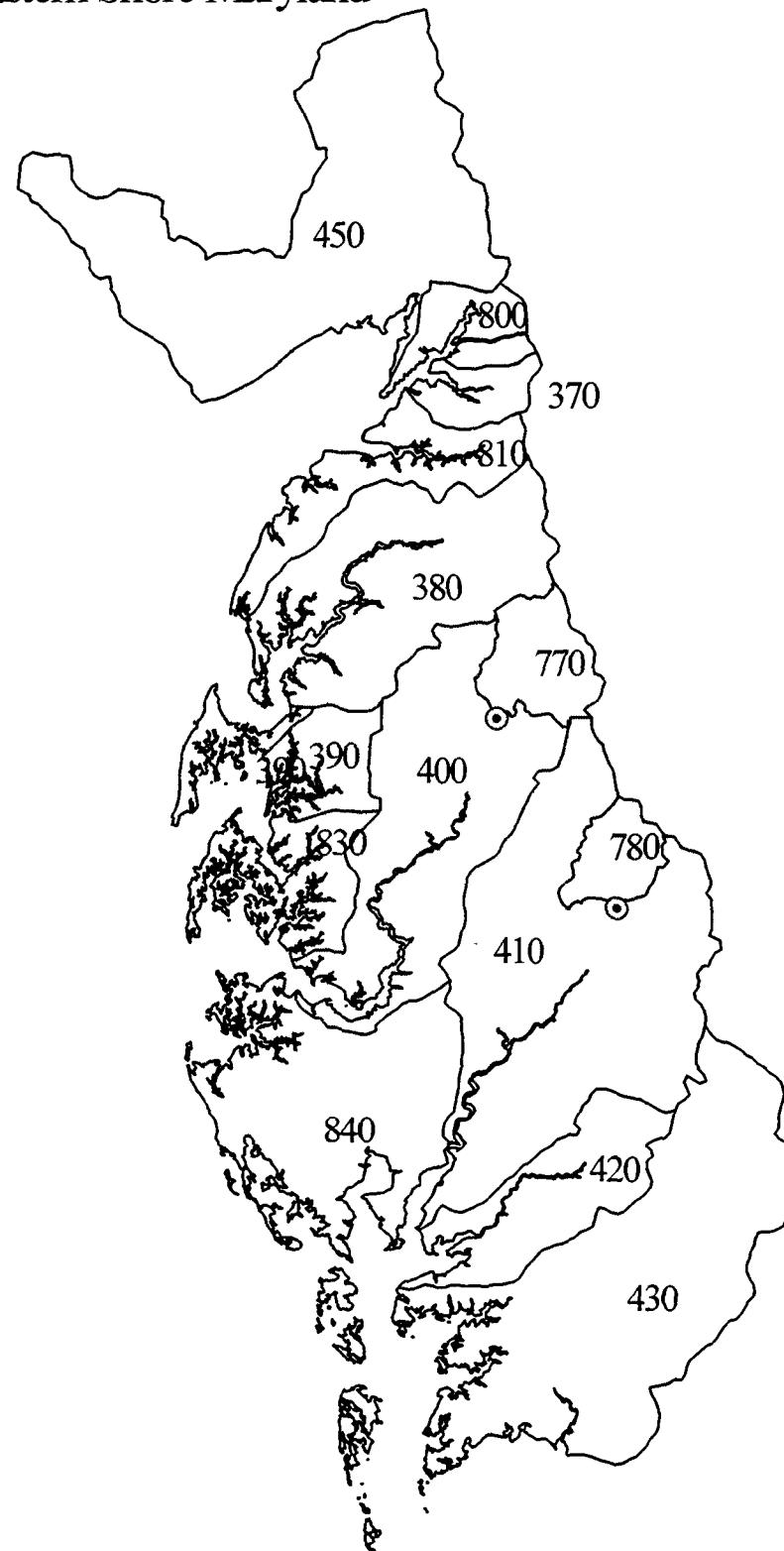
Season 4 is from Julian day 271 to 365.

# Monitoring Stations

## Chesapeake Bay Watershed

### Phase IV Model Segments:

#### Eastern Shore Maryland



## **A.7.0 NANTICOKE RIVER AT BRIDGEVILLE, DE AT SEGMENT 780 (1487000)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

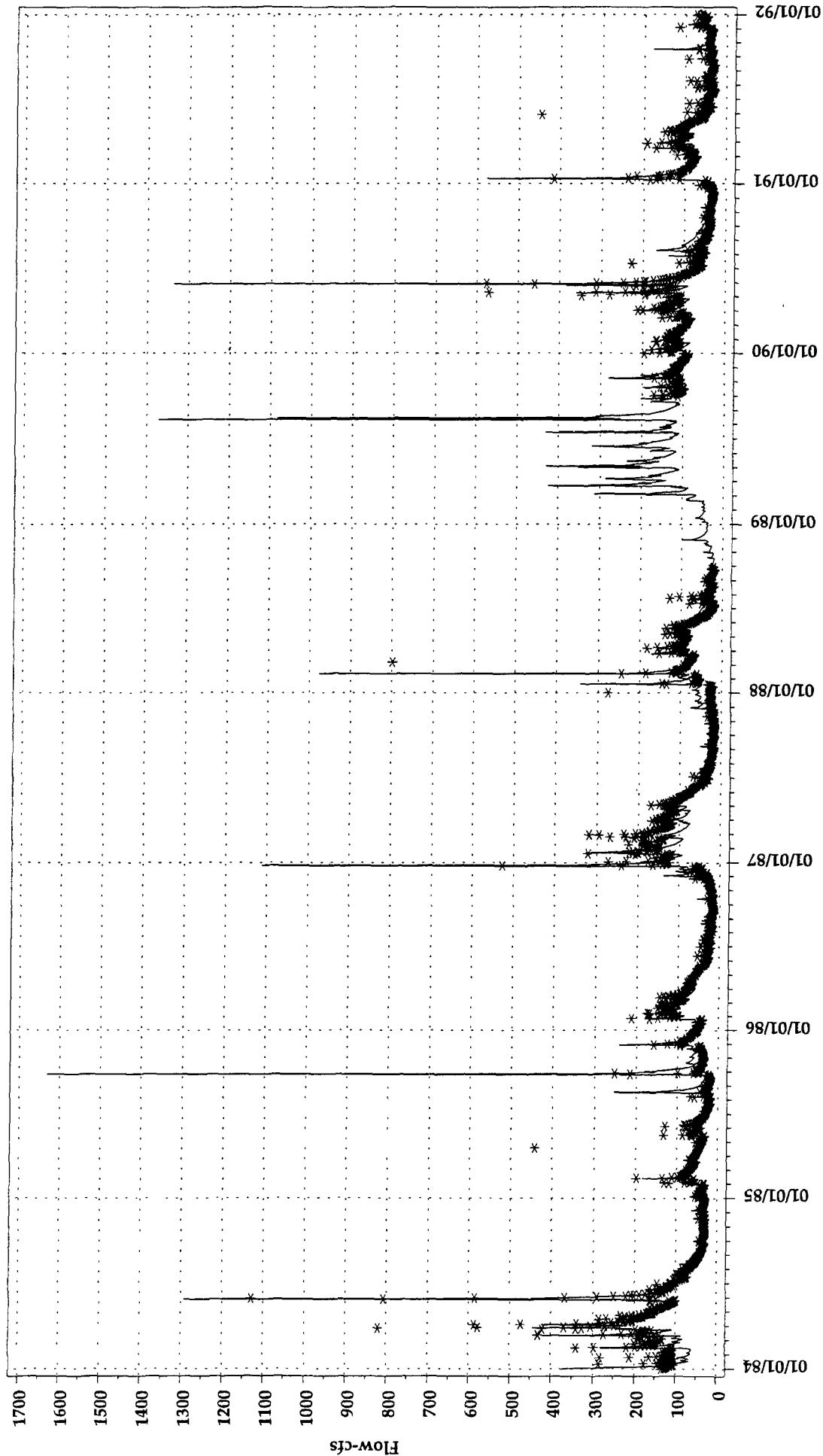
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Nanticoke River at Segment 780 Observed and Simulated versus Time

## Flow-cfs

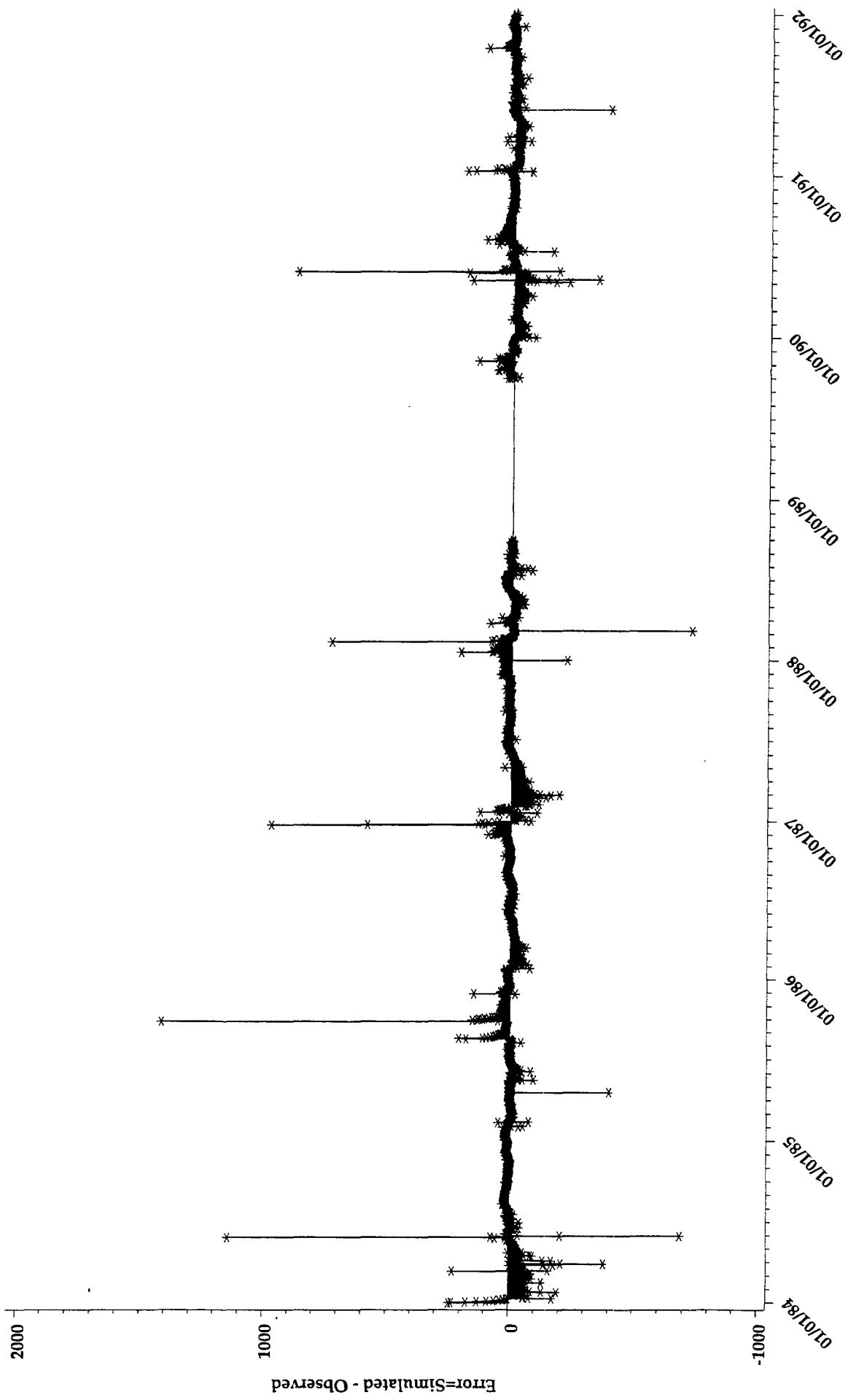
(\*=Observed, -=Simulated)



# Nanticoke River at Segment 780

## Actual Error versus Time

### Flow-cfs

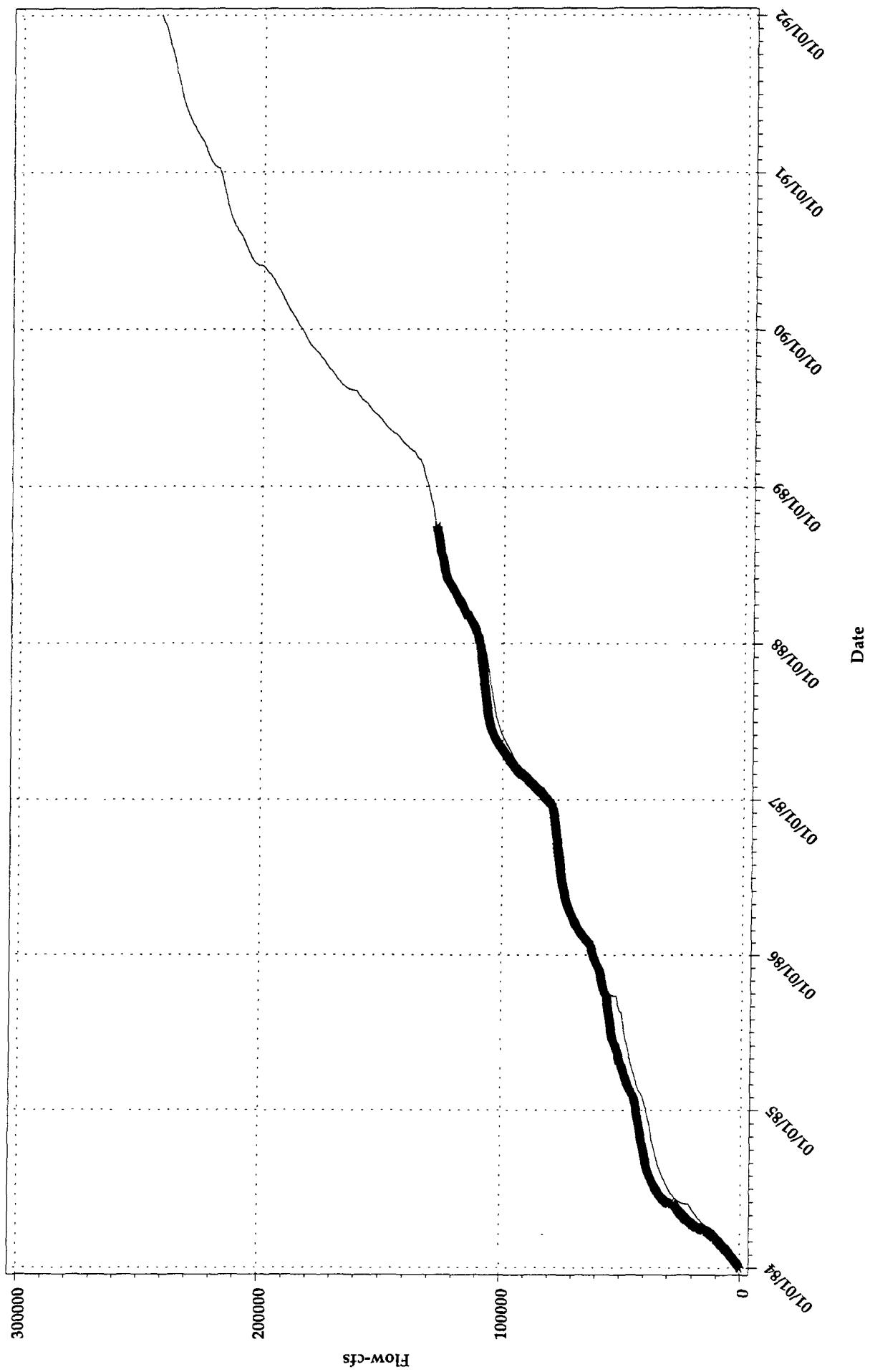


# Nanticoke River at Segment 780

## Observed and Simulated Cumulative Flows versus Time

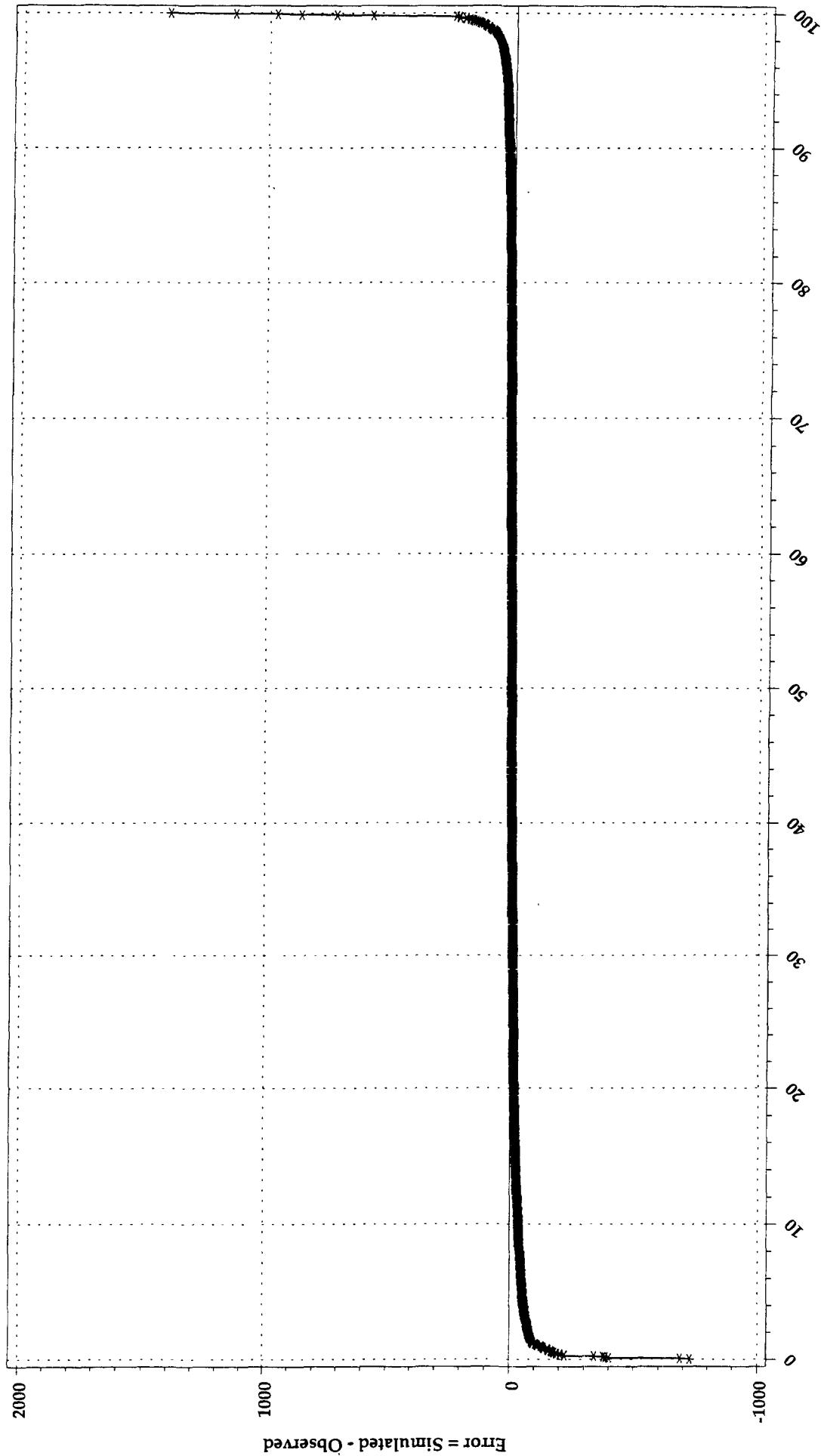
### Flow-cfs

(\* = Observed, - = Simulated)



# Nanticoke River at Segment 780 Actual error versus Percentile Sample Population Flow-cfs

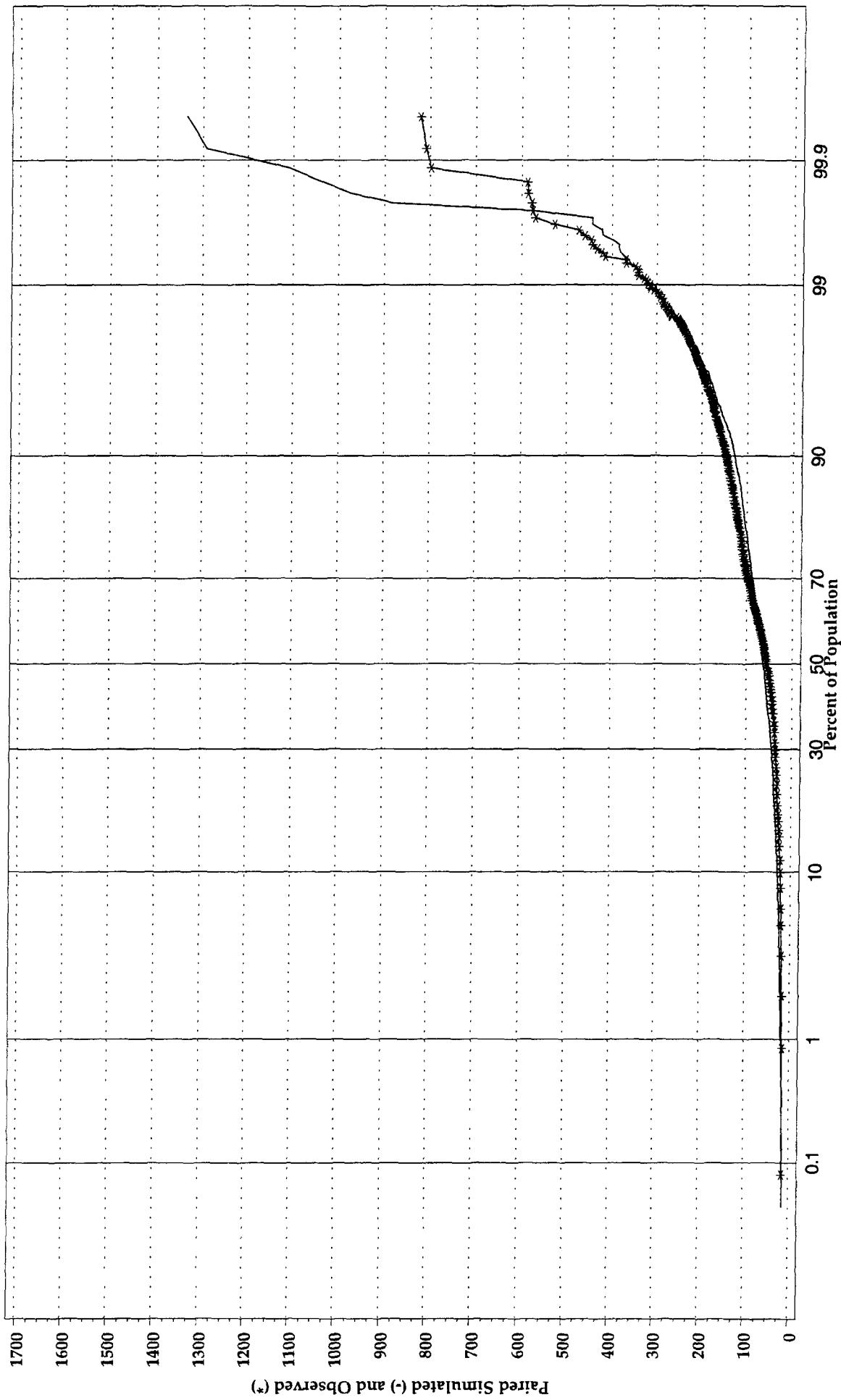
Frequency Distribution - All Simulated and Observed Data



# Nanticoke River at Segment 780

## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

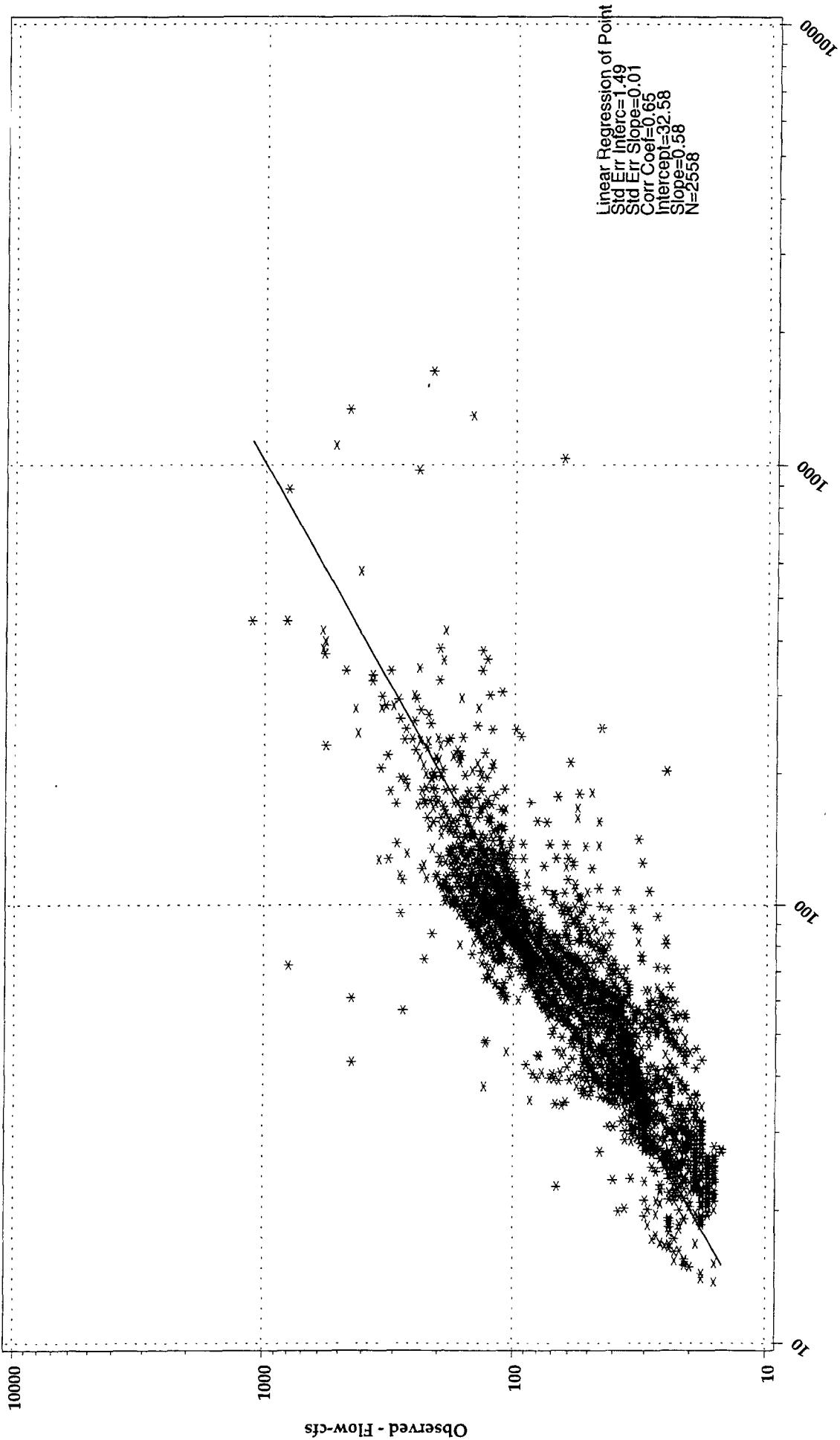


(y21\_plot1 sas datalist\re2 [bps p3 james sas] pp5opair)  
(graph\_a dvr 2&JUL97 19 37)

# Nanticoke River at Segment 780

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
NANTICOKE RIVER, VA (Segment 780)**

Table A.7.0.1 Comparison of Annual Total Observed and Simulated flows.

	<b>Observed Flow</b>	<b>Simulated Flow</b>
<b>Year</b>	(inches)*	(inches)**
1984	21.49	19.43
1985	8.87	11.21
1986	9.55	10.41
1987	14.05	12.49
1988	10.15	11.53
1989	23.85	25.85
1990	16.83	16.65
1991	12.23	12.09
Mean	13.65	14.96

\* Observed flow at Nanticoke River at Matoaca, VA

\*\* Simulated outflow from RCH 780

Table A.7.0.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

<b>Year</b>	<b>Average Daily</b>			<b>Average Monthly</b>		
	<b>m</b>	<b>b</b>	<b>r2</b>	<b>m</b>	<b>b</b>	<b>r2</b>
1984	1.08	-0.15	0.84	1.21	-11.73	0.93
1985	0.57	0.67	0.37	0.58	19.98	0.24
1986	0.92	0.10	0.74	0.93	2.30	0.74
1987	1.37	-0.69	0.88	1.40	-22.45	0.88
1988	0.94	0.05	0.62	1.00	-2.05	0.74
1989	0.53	0.93	0.69	0.48	31.92	0.58
1990	1.14	-0.30	0.77	1.28	-16.84	0.83
1991	1.03	-0.05	0.79	1.06	-3.00	0.89
1984-1991	0.95	0.07	0.71	0.99	-0.23	0.73

Table A.7.0.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2									
1984	0.22	1.70	0.12	0.65	0.85	0.53	1.25	-0.54	0.96	0.46	0.79	0.64
1985	1.45	-0.88	0.83	0.72	0.54	0.15	0.33	0.96	0.18	0.67	0.45	0.44
1986	1.56	-1.04	0.93	1.40	-0.62	0.94	0.20	1.08	0.04	0.72	0.29	0.87
1987	0.33	1.53	0.19	1.01	0.12	0.44	1.10	-0.25	0.87	0.44	0.65	0.73
1988	0.94	-0.09	0.56	0.59	-0.85	0.19	0.79	0.25	0.42	1.91	-1.24	0.90
1989	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.53	0.93	0.69
1990	0.83	0.41	0.46	0.76	0.59	0.65	0.98	-0.08	0.58	0.67	0.46	0.67
1991	0.78	0.45	0.76	0.92	0.21	0.37	1.00	-0.01	0.58	0.66	0.51	0.66
1984-1991	0.55	0.88	0.57	0.81	0.30	0.76	0.83	0.34	0.72	0.91	0.26	0.81

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.

## **A.8.0 CHOPTANK RIVER NEAR GREENSBORO, MD AT SEGMENT 770(1491000)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

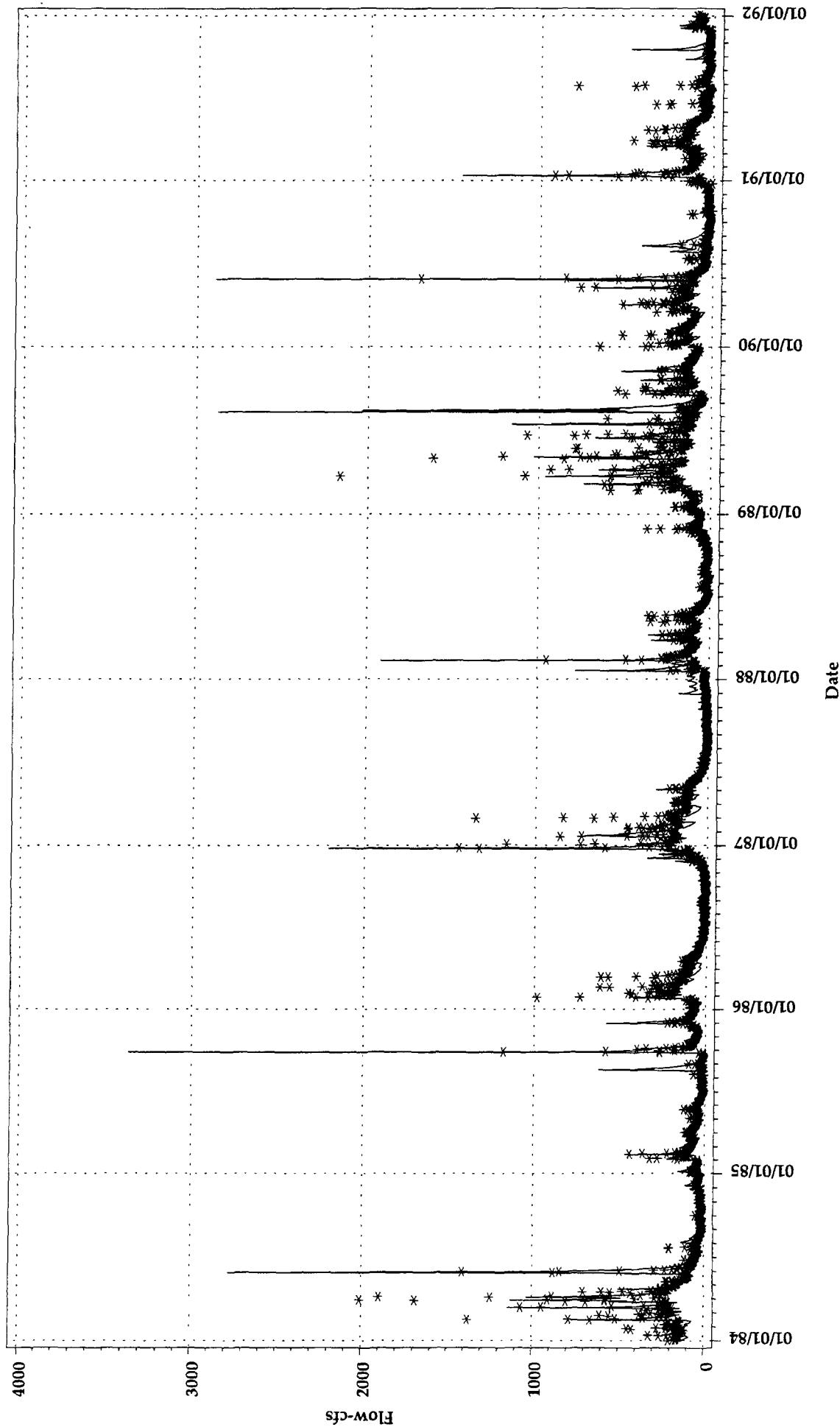
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Choptank River at Segment 770 Observed and Simulated versus Time

## Flow-cfs

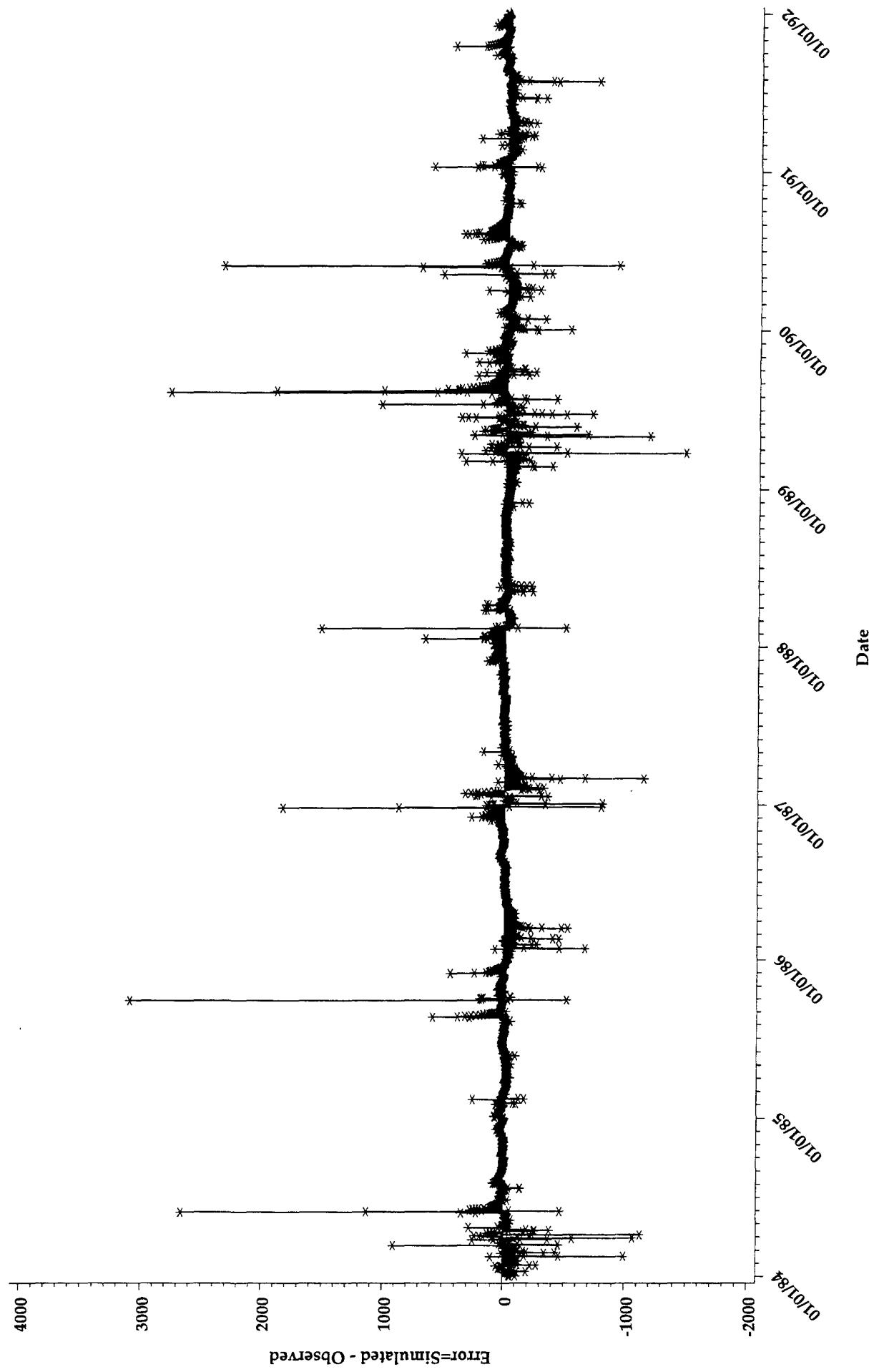
(\*=Observed, -=Simulated)



# Choptank River at Segment 770

## Actual Error versus Time

### Flow-cfs

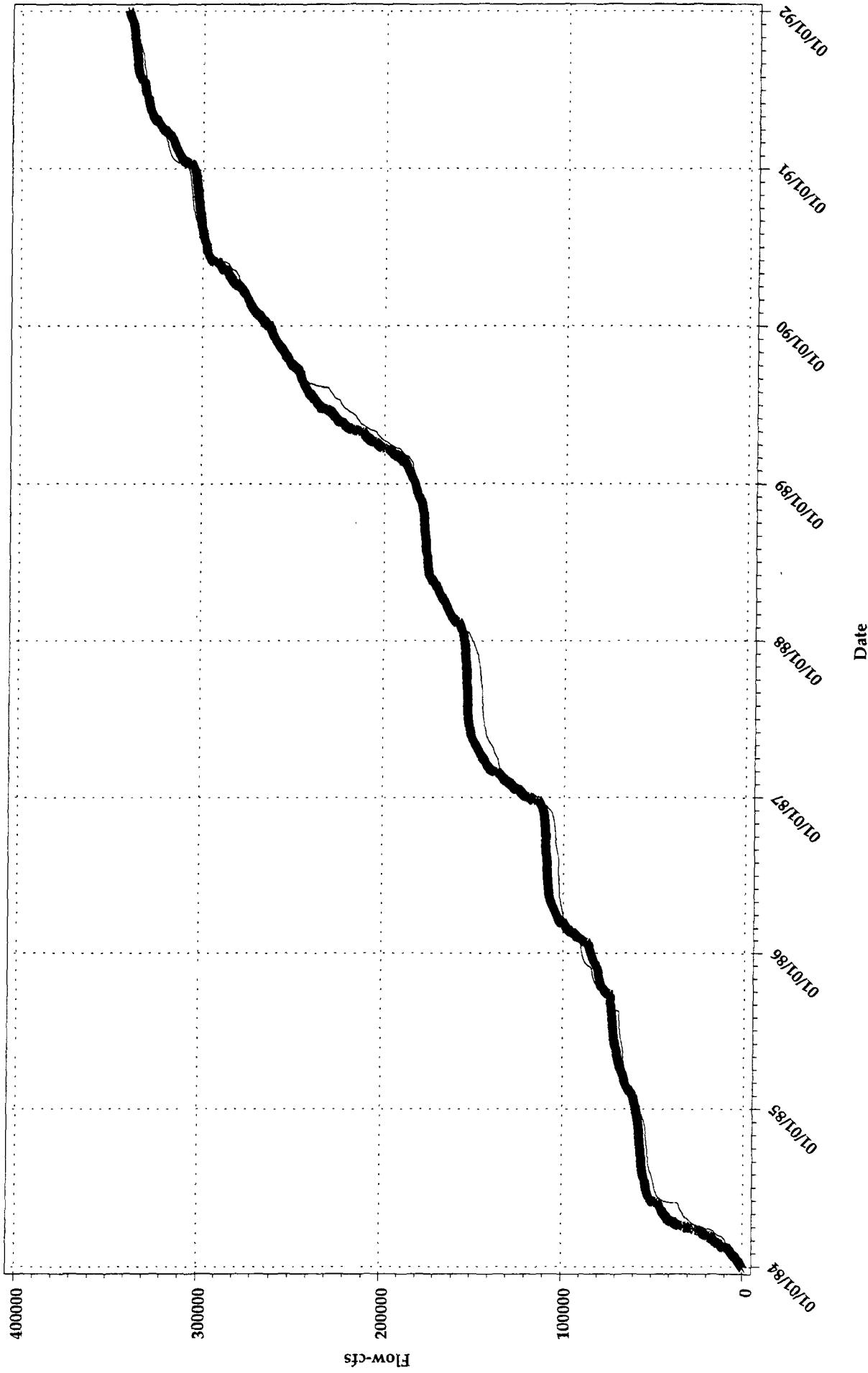


# Choptank River at Segment 770

## Observed and Simulated Cumulative Flows versus Time

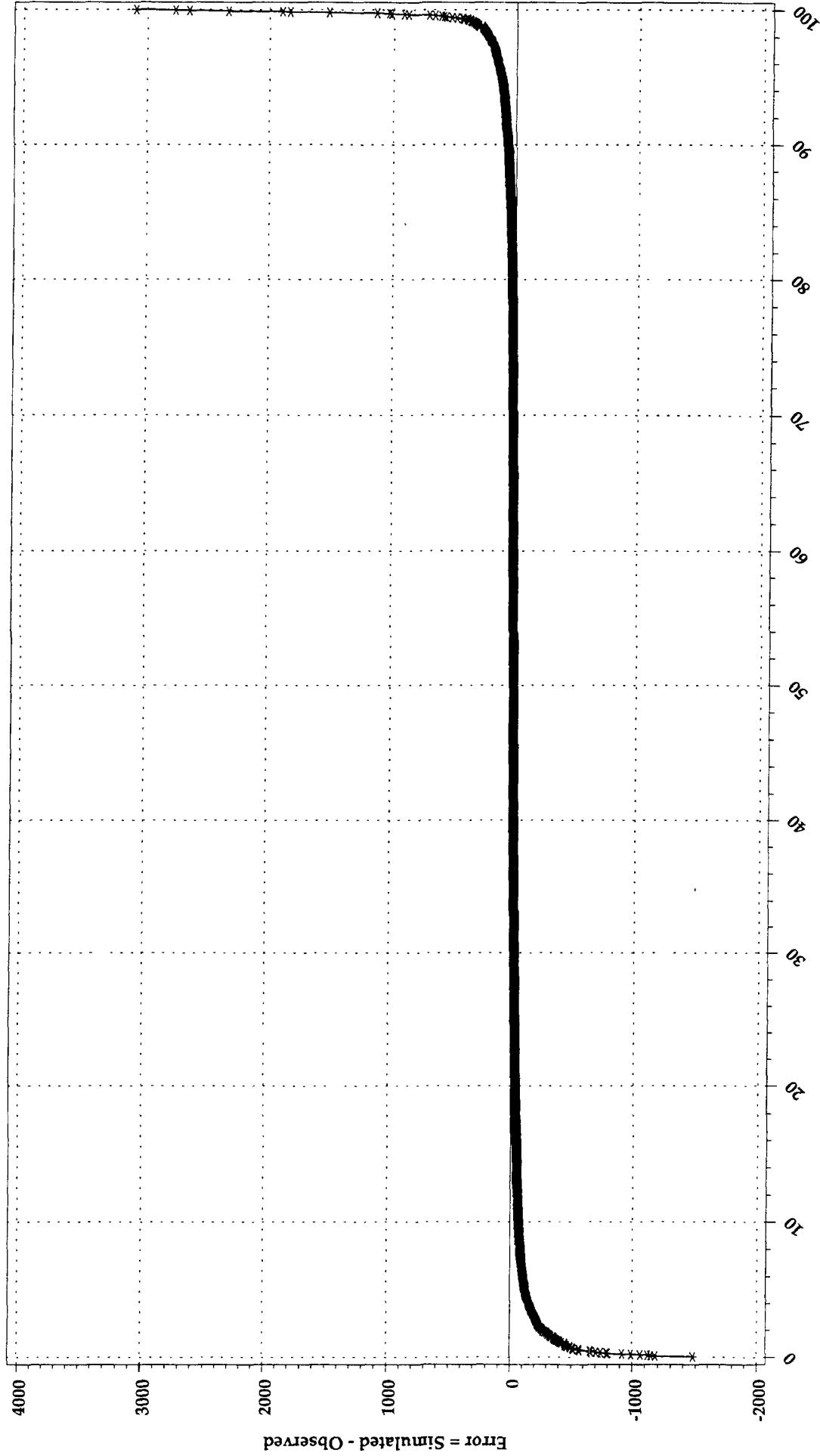
Flow-cfs

(\* = Observed, - = Simulated)



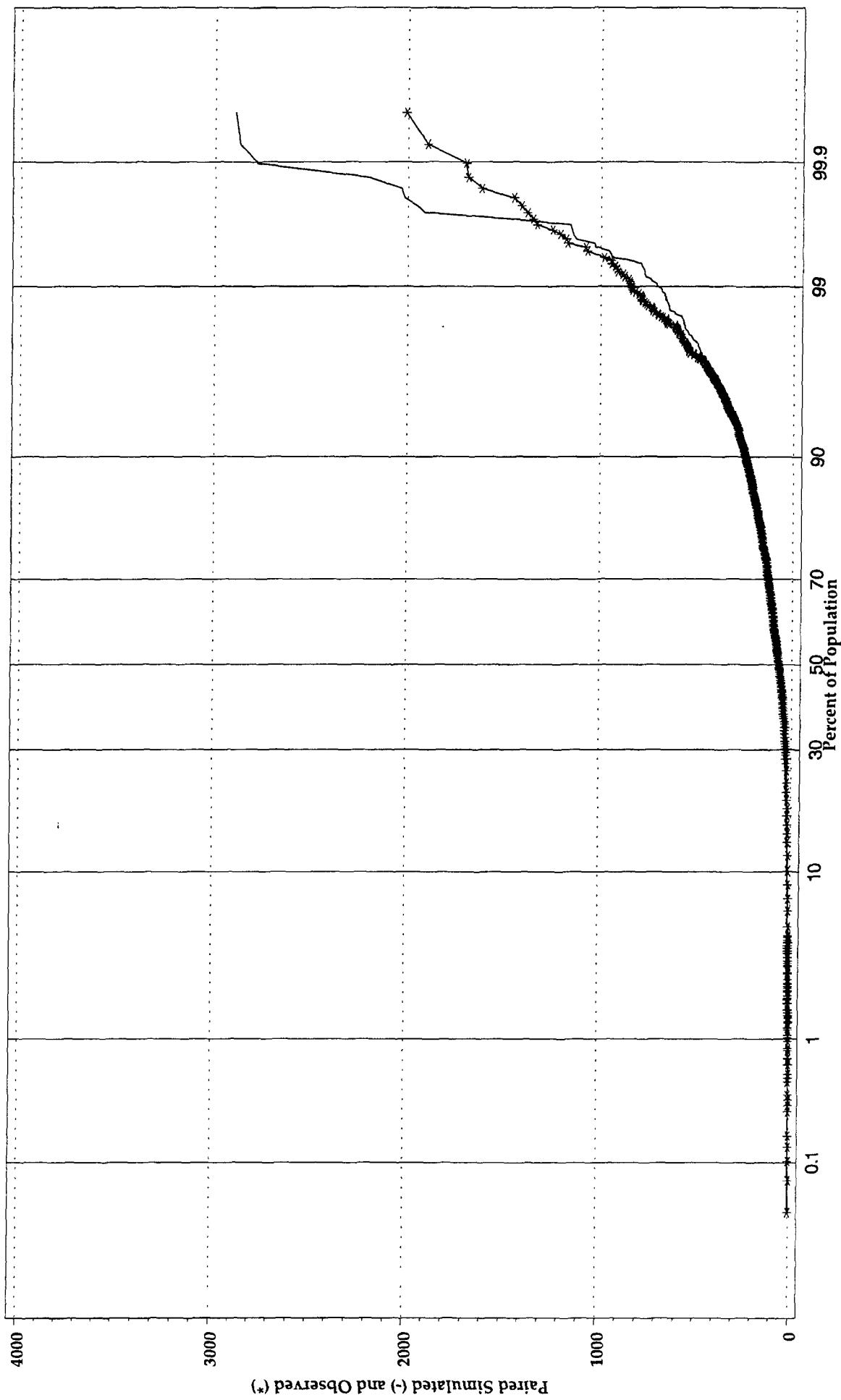
# Choptank River at Segment 770 Actual error versus Percentile Sample Population Flow-cfs

Frequency Distribution - All Simulated and Observed Data



# Choptank River at Segment 770

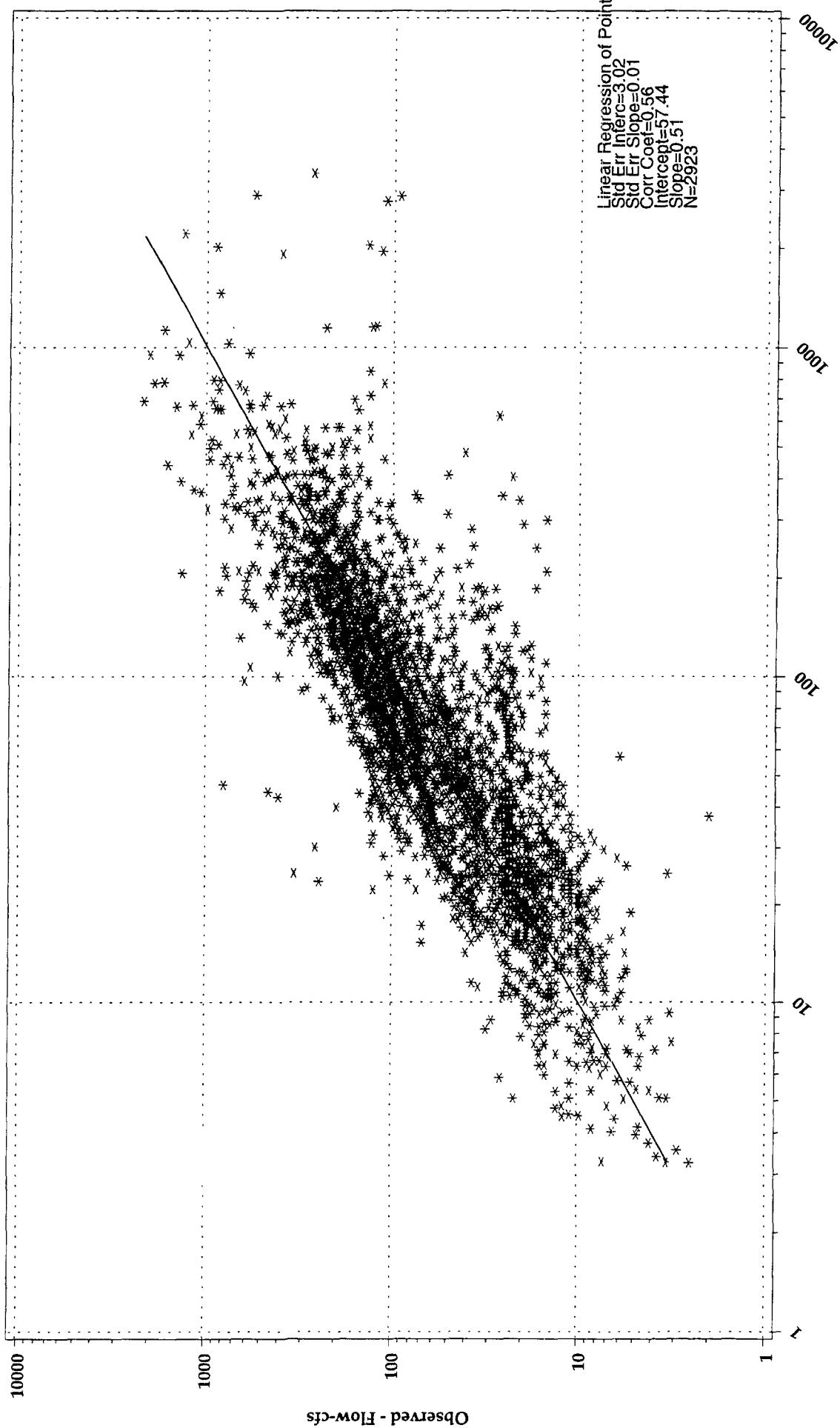
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population Flow-cfs



# Choptank River at Segment 770

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
CHOPTANK RIVER, MD (Segment 770)**

Table A.8.0.1 Comparison of Annual Total Observed and Simulated flows.

Year	Observed Flow (inches)*	Simulated Flow (inches)**
1984	19.52	18.81
1985	8.36	11.07
1986	11.07	9.80
1987	12.10	10.45
1988	9.19	10.27
1989	26.30	27.73
1990	13.78	14.52
1991	11.96	11.14
Mean	14.04	14.22

\* Observed flow at Choptank River near Greensboro, MD  
\*\* Simulated outflow from RCH 770

Table A.8.0.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

Year	Average Daily			Average Monthly		
	m	b	r2	m	b	r2
1984	0.82	0.37	0.82	0.83	0.35	0.91
1985	0.84	0.31	0.52	0.85	0.30	0.67
1986	0.75	0.36	0.64	0.75	0.36	0.69
1987	0.74	0.44	0.86	0.68	0.61	0.83
1988	0.85	0.28	0.75	0.91	0.17	0.81
1989	0.71	0.65	0.43	0.74	0.59	0.45
1990	0.67	0.66	0.57	0.69	0.62	0.67
1991	0.68	0.56	0.51	0.72	0.49	0.57
1984-1991	0.76	0.45	0.64	0.79	0.39	0.77

Table A.8.0.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2									
1984	0.86	0.49	0.58	0.70	0.75	0.53	0.82	0.18	0.81	0.58	0.55	0.73
1985	1.01	-0.21	0.76	0.60	0.83	0.74	0.24	0.96	0.19	0.77	0.39	0.77
1986	0.86	0.50	0.86	1.03	0.30	0.84	0.13	0.97	0.04	0.93	-0.15	0.90
1987	0.36	1.60	0.19	0.55	1.06	0.25	0.90	-0.03	0.72	0.45	0.48	0.70
1988	1.15	-0.63	0.54	0.55	0.98	0.48	0.99	0.01	0.64	1.20	-0.26	0.92
1989	0.87	0.46	0.84	0.77	0.62	0.47	0.42	1.20	0.17	0.63	0.77	0.67
1990	0.61	0.95	0.27	0.59	0.97	0.59	0.43	0.85	0.23	0.76	0.31	0.34
1991	0.63	0.84	0.79	0.87	0.40	0.79	0.64	0.69	0.14	0.61	0.44	0.47
1984-1991	0.62	0.75	0.47	1.05	-0.24	0.75	0.87	0.28	0.61	0.82	0.43	0.72

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

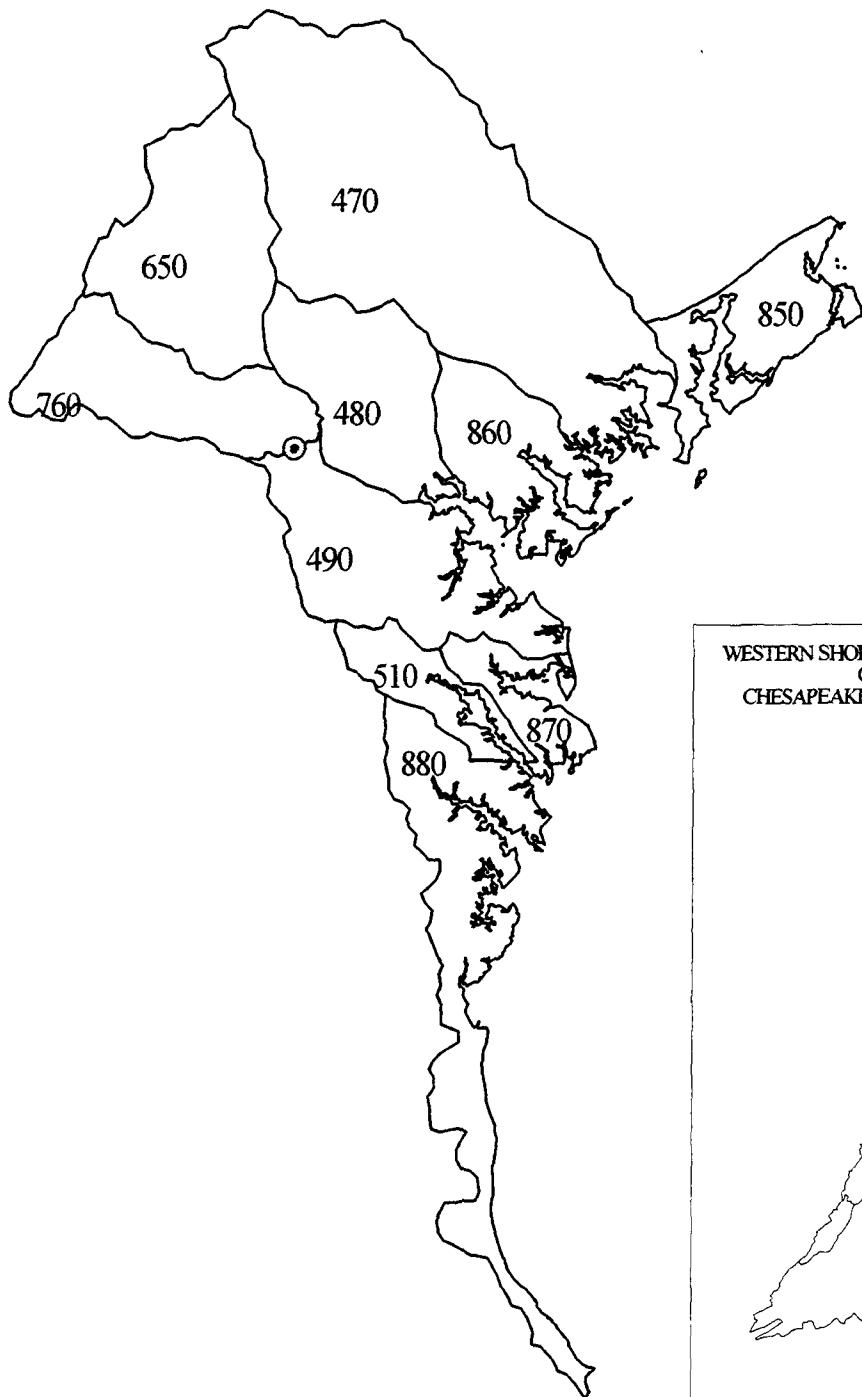
Season 4 is from Julian day 271 to 365.

# Monitoring Stations

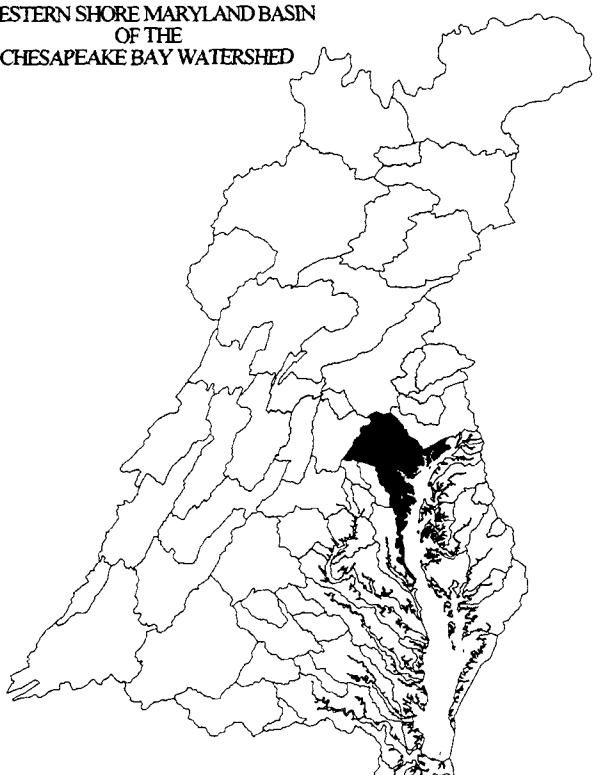
## Chesapeake Bay Watershed

### Phase IV Model Segments:

#### Western Shore Maryland Basin



WESTERN SHORE MARYLAND BASIN  
OF THE  
CHESAPEAKE BAY WATERSHED



## **A.9.0 PATAPSCO RIVER AT HOLLOWFIELD, MD AT SEGMENT 760(1589000)**

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Comparison of Annual Total Observed and Simulated

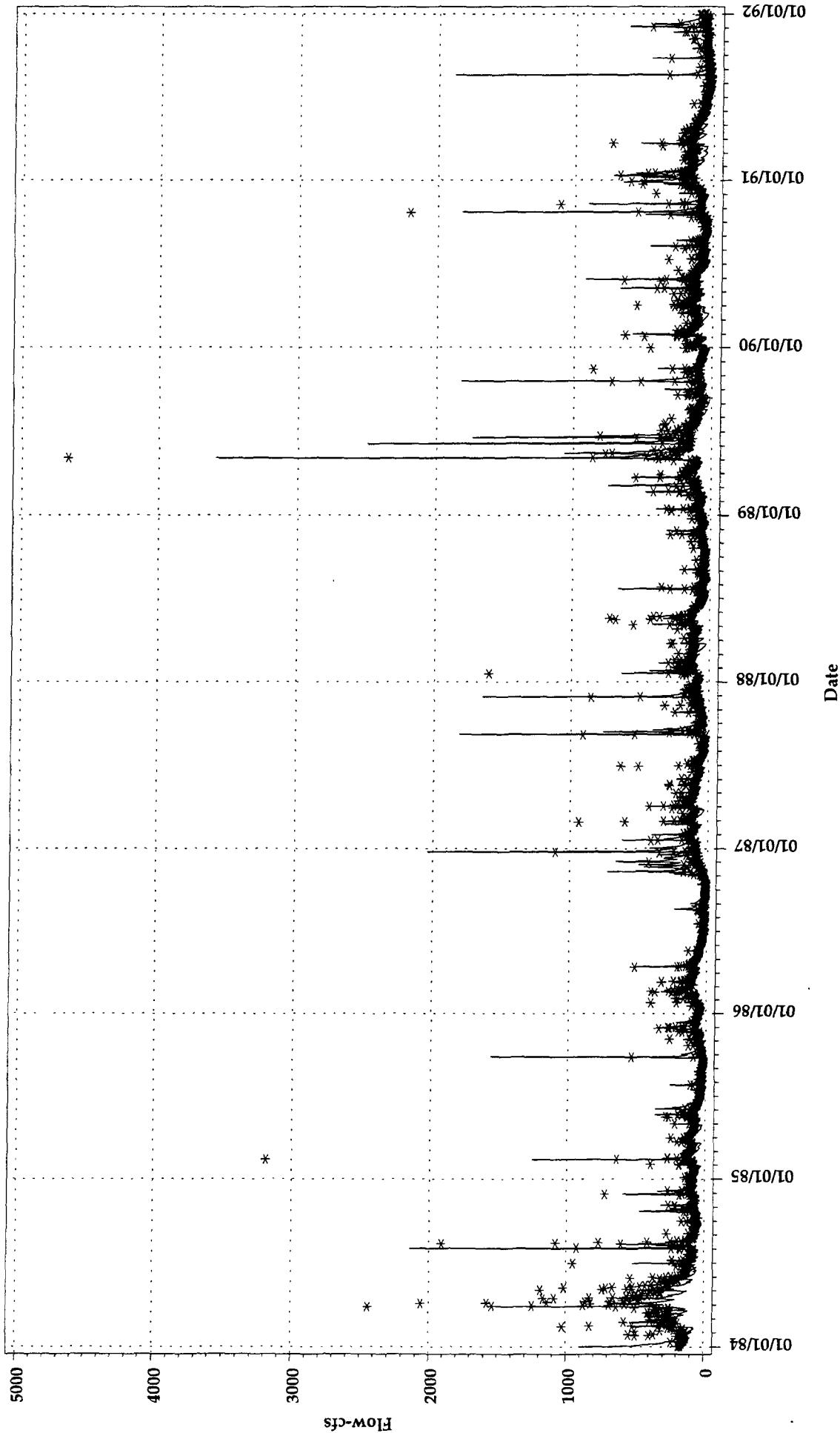
Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

# Patapsco River at Segment 760 Observed and Simulated versus Time

## Flow-cfs

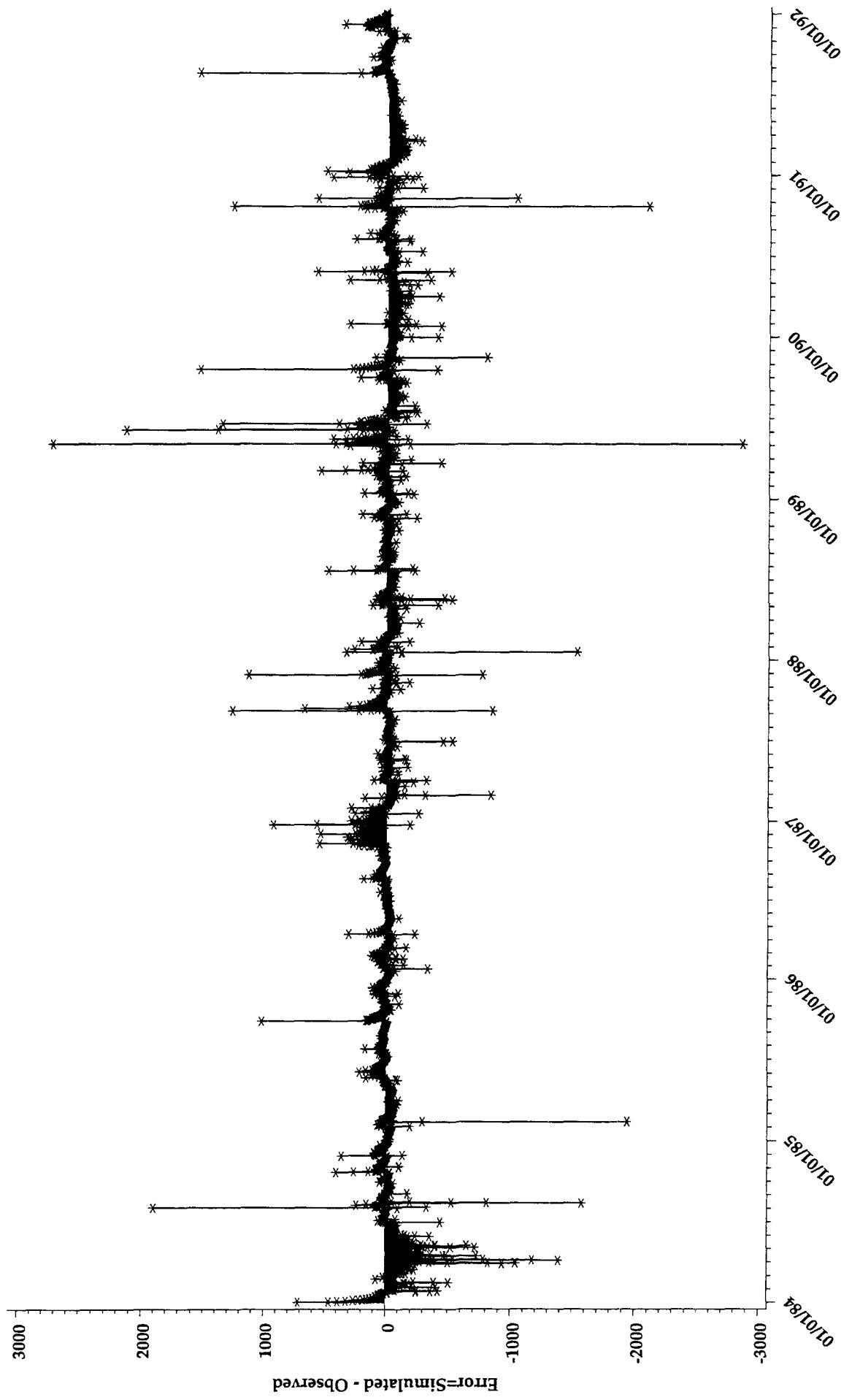
(\*=Observed, -=Simulated)



# Patapsco River at Segment 760

## Actual Error versus Time

### Flow-cfs

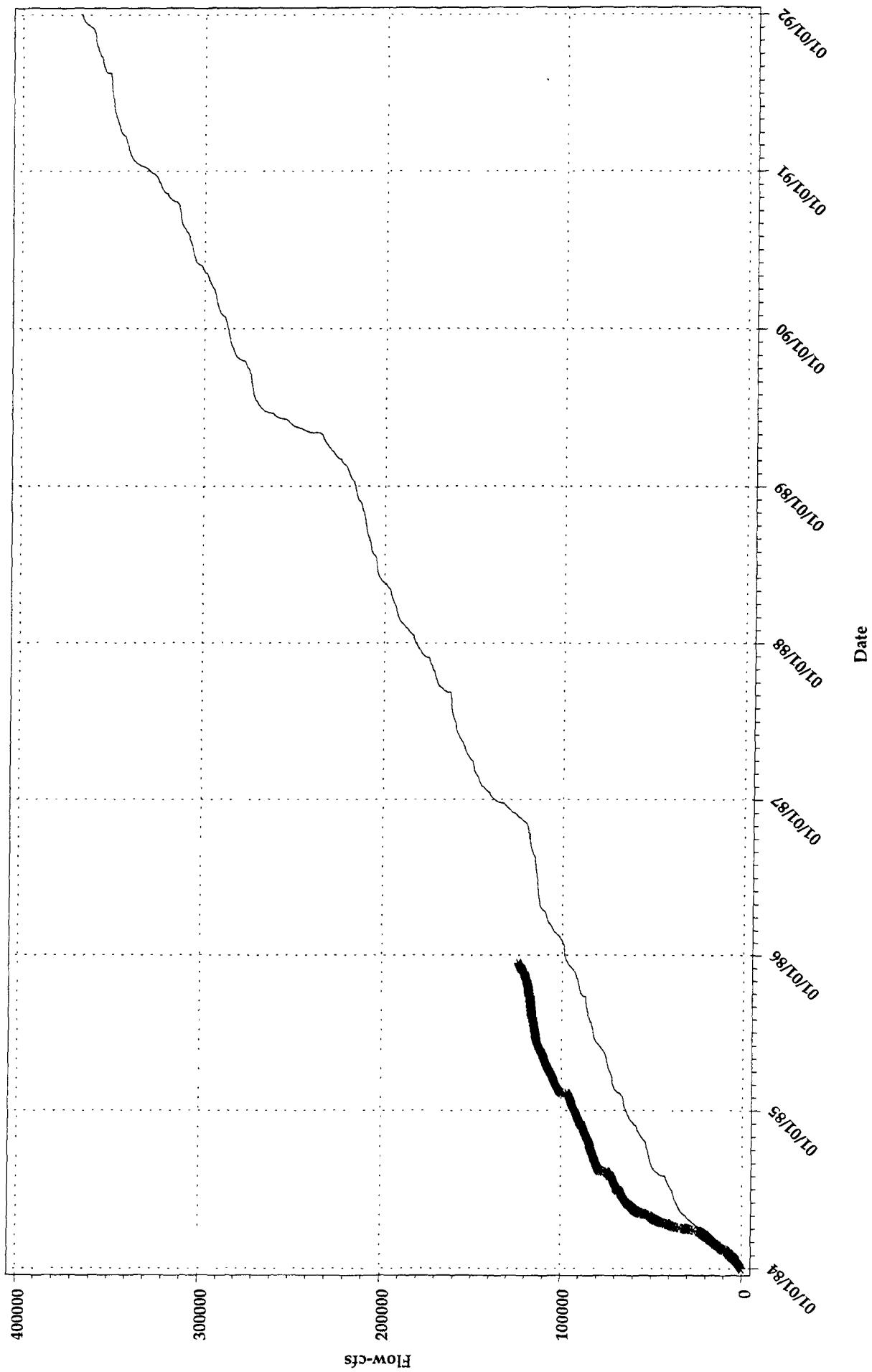


# Patapsco River at Segment 760

## Observed and Simulated Cumulative Flows versus Time

### Flow-cfs

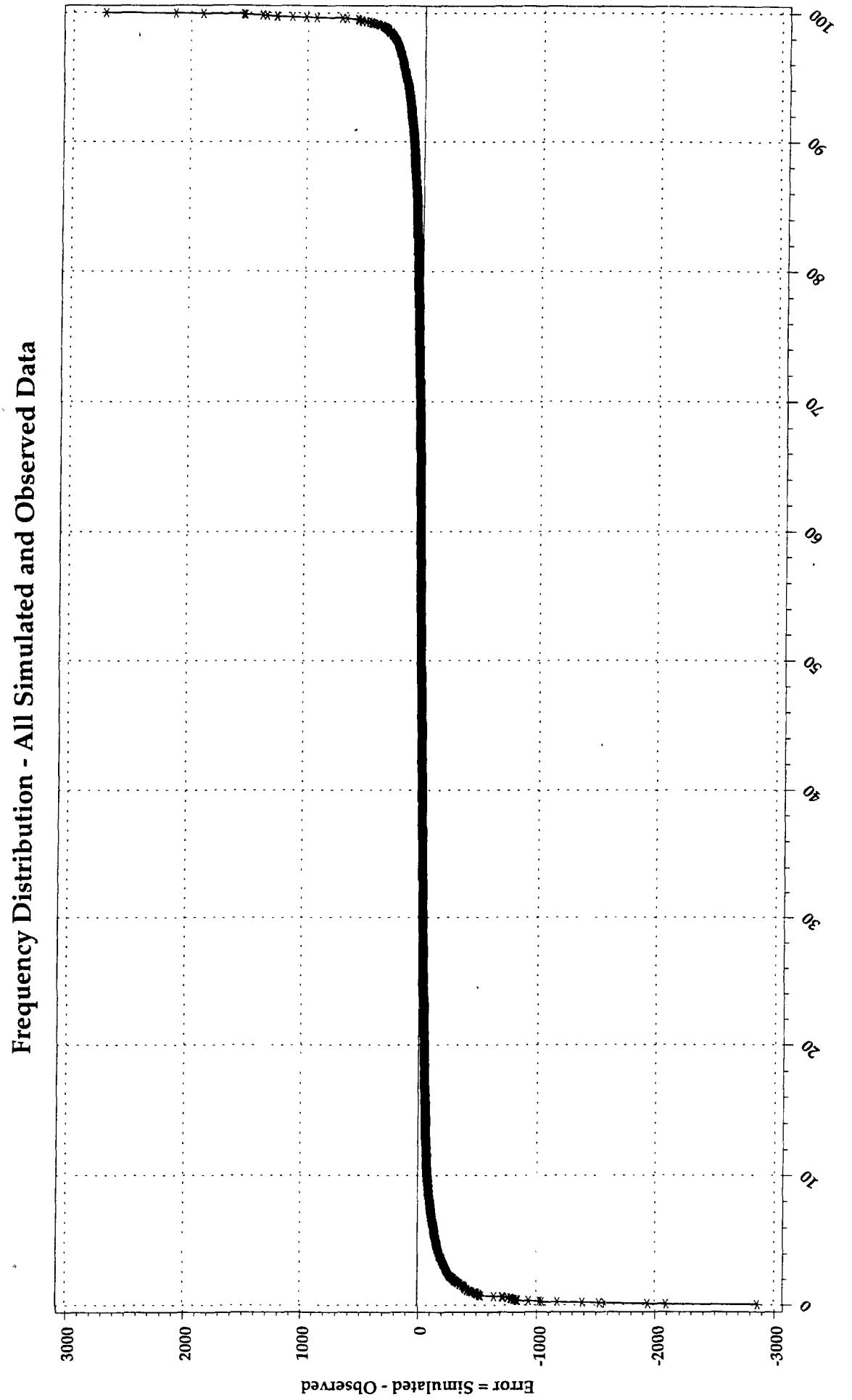
(\* = Observed, - = Simulated)



# Patapsco River at Segment 760

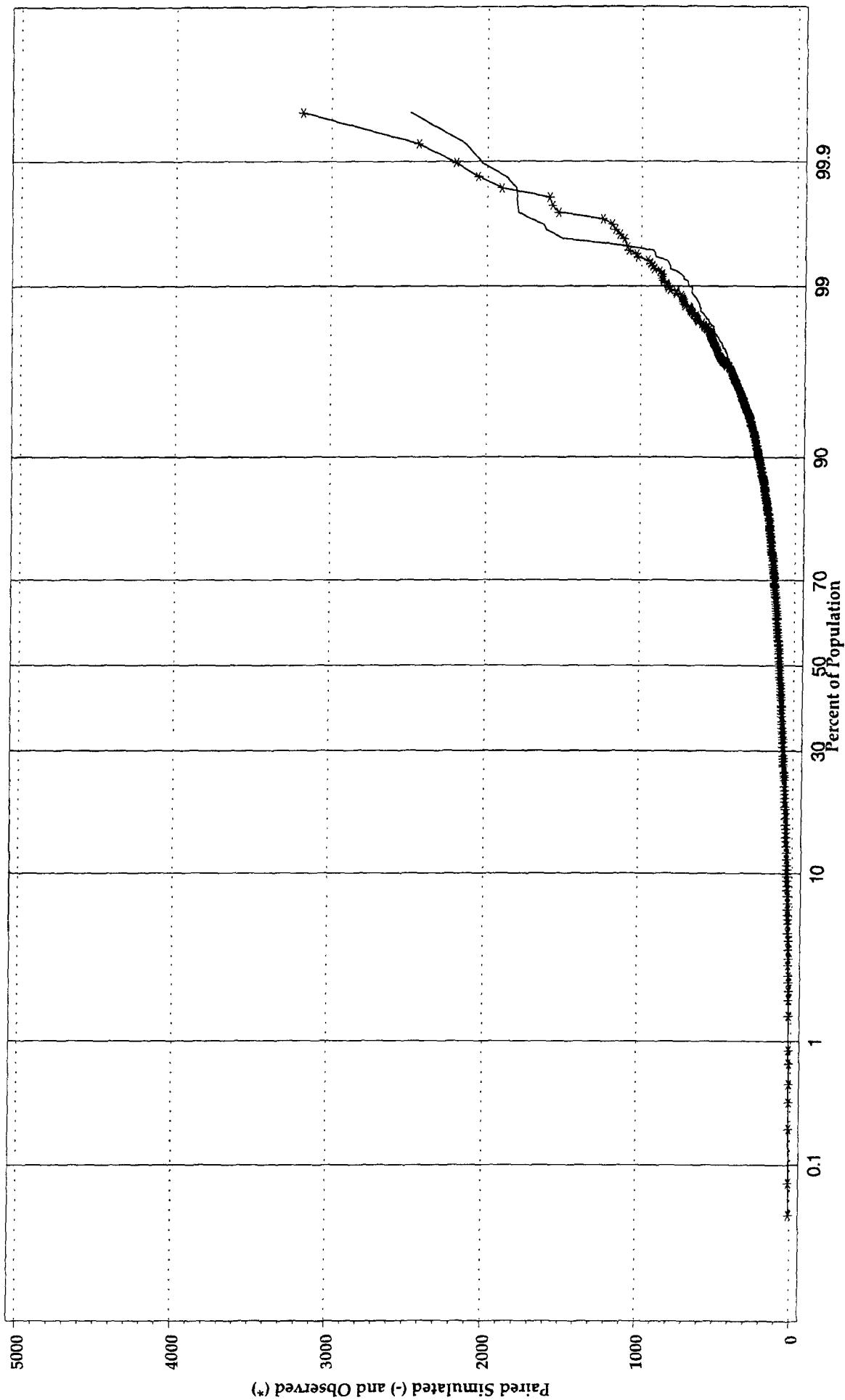
## Actual error versus Percentile Sample Population

### Flow-cfs



# Patapsco River at Segment 760

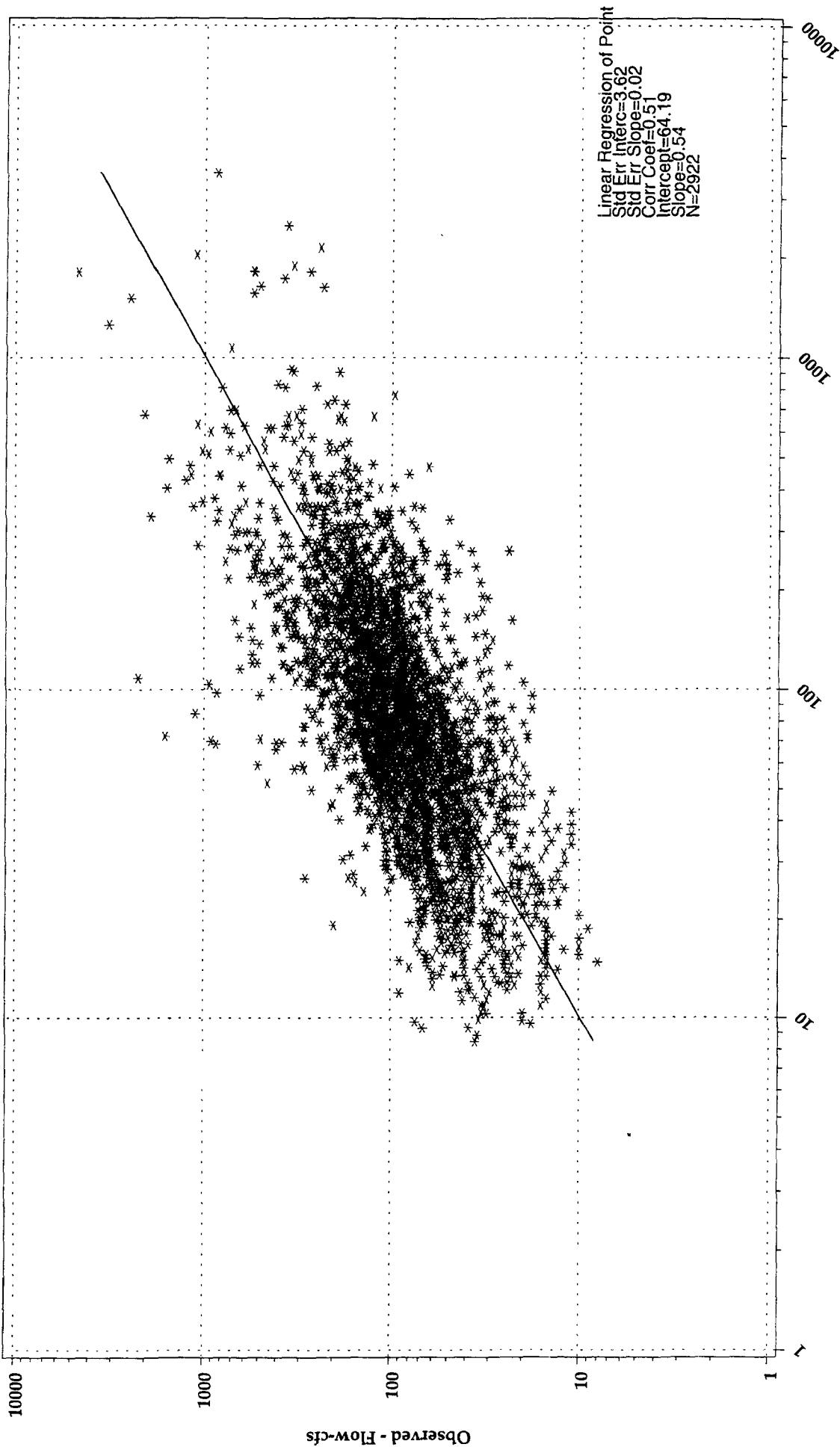
## Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population Flow-cfs



# Patapsco River at Segment 760

## Scatter Plot and Regression of Simulated versus Observed with Ideal Line

### Flow-cfs: 01JAN84 - 01JAN92



**CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION  
PATAPSCO RIVER, MD (Segment 760)**

Table 9.0.1 Comparison of Annual Total Observed and Simulated flows.

Year	Observed Flow (inches)*	Simulated Flow (inches)**
1984	27.48	19.15
1985	9.74	10.33
1986	8.07	12.00
1987	12.44	13.39
1988	11.86	10.12
1989	17.93	21.02
1990	15.58	13.11
1991	11.38	11.44
Mean	14.31	13.82

\* Observed flow at Patapsco River near

\*\* Simulated outflow from RCH 760

Table 9.0.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

Year	Average Daily			Average Monthly		
	m	b	r2	m	b	r2
1984	0.81	0.51	0.51	0.99	3.86	0.58
1985	0.67	0.57	0.47	0.71	15.02	0.27
1986	0.59	0.65	0.48	0.61	18.71	0.44
1987	0.47	1.06	0.42	0.43	34.70	0.48
1988	0.54	0.94	0.43	0.82	13.00	0.64
1989	0.44	1.20	0.51	0.47	35.00	0.74
1990	0.50	1.10	0.35	0.65	24.36	0.41
1991	0.53	0.94	0.39	0.52	29.00	0.31
1984-1991	0.57	0.87	0.45	0.65	21.71	0.48

Table A.9.0.3 Seasonal r-squared.

Year	Season 1			Season 2			Season 3			Season 4		
	m	b	r2									
1984	0.17	1.96	0.03	1.02	0.27	0.84	0.63	0.85	0.48	0.47	1.01	0.51
1985	0.76	0.60	0.73	0.33	1.41	0.41	0.65	0.43	0.84	0.66	0.50	0.42
1986	0.56	0.92	0.65	0.51	1.05	0.77	0.03	1.34	0.00	0.79	0.00	0.82
1987	0.24	1.58	0.08	0.38	1.37	0.32	0.45	1.05	0.48	0.56	0.80	0.36
1988	0.37	1.33	0.14	0.46	1.28	0.44	0.34	1.22	0.27	0.40	1.09	0.27
1989	0.62	0.77	0.52	0.66	0.71	0.58	0.36	1.42	0.64	0.32	1.39	0.24
1990	0.50	1.21	0.46	0.34	1.53	0.29	0.47	1.06	0.37	0.55	0.94	0.42
1991	0.25	1.71	0.35	0.65	0.95	0.73	0.23	1.27	0.12	0.35	1.13	0.32
1984-1991	0.82	0.33	0.41	0.92	0.00	0.56	0.79	0.33	0.44	0.73	0.60	0.39

Season 1 is from Julian day 1 to 60.

Season 2 is from Julian day 61 to 150.

Season 3 is from Julian day 151 to 270.

Season 4 is from Julian day 271 to 365.



## **Chesapeake Bay Program**

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