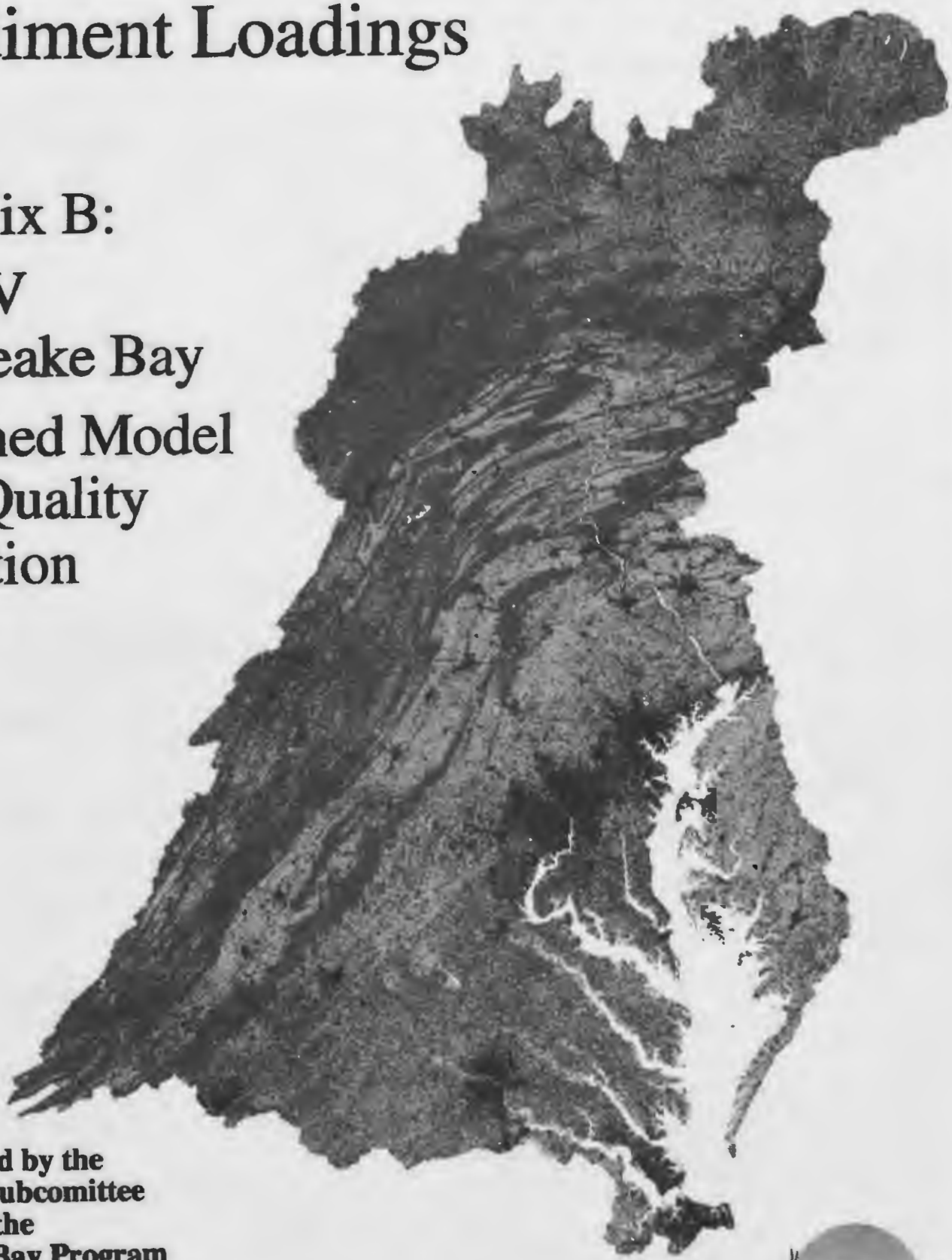
Chesapeake Bay Watershed Model Application & Calculation of Nutrient & Sediment Loadings



Appendix B:

Phase IV Chesapeake Bay Watershed Model Water Quality Calibration Results

Prepared by the Modeling Subcomittee of the Chesapeake Bay Program

EPA 903–R–98–003
CBP/TRS 196/98
February 1998

Chesapeake Bay Program

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

Appendix B: Phase IV Chesapeake Bay Watershed Model Water Quality Results

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

Chesapeake Bay Program

May 1998

Printed by the U.S. Environmental Protection Agency for the Chesapeake Bay Program

Principal Authors

Lewis C. Linker
United States Environmental Protection Agency
Chesapeake Bay Program Office
Annapolis, MD

Gary W. Shenk
United States Environmental Protection Agency
Chesapeake Bay Program Office
Annapolis, MD

Dr. Ping Wang
Maryland Department of Natural Resources
Chesapeake Bay Program Office
Annapolis, MD

Jennifer M. Storrick
Chesapeake Research Consortium
Chesapeake Bay Program Office
Annapolis, MD

Modeling Subcommittee Members

James R. Collier
Chairman, Modeling Subcommittee
Program Manager
Water Resources Management Division
Washington, DC

Dr. Joseph Bachman
US Geological Survey
Towson, MD

Mark Bennett
Department of Soil and Water Conservation
Richmond, VA

Dr. Peter Bergstrom
Chesapeake Bay Field Office
US Fish & Wildlife Service
Annapolis, MD

Dr. Arthur Butt
Chesapeake Bay Office
VA Department of Environmental Quality
Richmond, VA

Brian Hazelwood
Metropolitan Washington Council of Governments
Washington, DC

Dr. Albert Y. Kuo
VA Institute of Marine Science
Gloucester Point, VA

Lewis C. Linker
Coordinator, Modeling Subcommittee
US EPA Chesapeake Bay Program Office
Annapolis, MD

Dr. Robert Magnien
MD Department of Natural Resources
Assessment Administration
Annapolis, MD

Dr. Ross Mandel
Interstate Commission on the Potomac River Basin
Rockville, MD

Dr. Bruce Parker
National Oceanic and Atmospheric Administration/NOS/OES33
Coastal & Estuarine Oceanography
Silver Spring, MD

Kenn Pattison
PA Dept. of Environmental Protection
Bureau of Water Quality Protection
Harrisburg, PA

Ron Santos
US Army Corps of Engineers
Baltimore, MD

Dr. Tom Stockton
MD Dept. of Environmental Resources
Watershed Modeling & Analysis
Annapolis, MD

Paul Welle
USDA Soil Conservation Service
Northeast National Technical Center
Chester, PA

Dr. Alan Lumb
Hydrologic Analysis Support Section
USGS National Center
Reston, VA

Acknowledgments

The writers would like to acknowledge the efforts of several people who contributed substantially to the compilation of this appendix. We would like to thank the United States Geological Survey representatives from the states of West Virginia, Virginia, Pennsylvania and Maryland for the timely processing of our data requests. Finally, the authors would like to express their appreciation to the scientists and engineers of the Modeling Subcommittee and the Model Evaluation Group for their guidance and review of this document. 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

Appendix Summary

Appendix B documents the water quality calibration of the Phase IV Watershed Model. Simulated and observed concentrations are compared for 8 years of calibration (1984-1991) at 15 water quality stations. Calibration data is shown for temperature, dissolved oxygen, total suspended sediment, total phosphorus, organic and particulate phosphorus, phosphate, total nitrogen, nitrate, total ammonia, and organic nitrogen.

The following plots are completed for each constituent: (1) observed and simulated concentrations; (2) observed and simulated loads (temperature loads are not calculated); (3) scatter plot and regression of simulated versus observed concentrations; (4) observed and simulated actual error of paired data (simulated concentration - observed concentration); (5) frequency distribution of paired simulated and observed data, i.e. coincident observed and simulated concentrations, and; (6) frequency distribution of all simulated and observed data.

The daily observed and simulated concentration plots generally show good to excellent agreement between the model and data for temperature, dissolved oxygen, and total suspended sediment and fair to good agreement on other water quality constituents. Generally, as the number of water quality observations at a station increases the calibration improves.

The simulated and observed load plots are developed from the observed mean daily flow and concentration compared to model estimated loads. Overall the load comparisons range from fair to excellent depending in different cases on the simulation of flow or the simulation of concentration.

Scatter plots of observed and simulated concentrations are shown with the ideal line (slope of 1, intercept of zero) drawn to assist interpretation of the plots with changing x and y axis scales. The actual regression line slope, intercept, correlation coefficient, standard error of the slope, standard error of the intercept, and the number of observations are shown in the plot legend.

The actual error plot is calculated as the difference of the simulated and observed concentrations plotted against time and is useful for indicating calibration bias and the actual magnitude of errors. The two frequency distribution plots are useful for examining the differences between the observed and simulated concentrations with respect to concentration magnitude and frequency of occurrence. Generally, calibration is best in the central area of the data and calibration performance is least in the tails, particularly the 10th and 90th percentiles.

List of Phase IV Watershed Model Reference Appendices

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

Table of Contents

Principal Authors ..... *ii*

Modeling Subcommittee Members ..... *iii*

Acknowledgments ..... *iv*

Appendix Summary ..... *v*

List of Phase IV Watershed Model Reference Appendices ..... *vi*

Table of Contents ..... *vii*

List of Figures ..... *ix*

List of Tables ..... *x*

B.1.0 Susquehanna River *1*

B.1.1 East Branch Susquehanna River near Danville, PA at Segment 40 (Monitoring Station: 1540500) (Above Fall Line Basin Segments: 10, 20, 700, 30, and 40) 3

B.1.2 West Branch Susquehanna River near Lewisburg, PA at Segment 70 (Monitoring Station: 1553500) (Above Fall Line Basin Segments: 50, 60, and 70) 45

B.1.3 Juniata River at Newport, PA near Segment 100 (Monitoring Station: 1567000) (Above Fall Line Basin Segments: 90 and 100) 87

B.1.4 Lower Susquehanna River at Harrisburg, PA Segment 110 (Monitoring Station: 1576000) (Above Fall Line Basin Segments: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 700 and 710) 129

B.1.5 Susquehanna River near Conowingo, MD At Segment 140 (Monitoring Station: 1578310) (Above Fall Line Basin Segments: 120, 140, and 720) 167

B.2.0 Patuxent River *209*

B.2.1 Patuxent River near Bowie, MD at Segment 340 (Monitoring Station: 1594440) (Above Fall Line Basin Segments: 330, 340, 500, and 900) 211

B.3.0 Potomac River *253*

B.3.1 Mid Potomac River near Shepardstown, WV at Segment 740 (Monitoring Station: 1613000) (Above Fall Line Basin Segments: 160, 170, 175, 730, and 740) 255

B.3.2 Shenandoah River near Millville, WV at Segment 200 (Monitoring Station: 1636500) (Above Fall Line Basin Segments: 190 and 200) 297

B.3.3 Lower Potomac River at Chain Bridge near Washington, DC at Segment 220 (Monitoring Station: 1646580) (Above Fall Line Basin Segments: 160, 170, 175, 180, 190, 200, 210, 220, 730, 740, and 750) 339

B.4.0 Rappahannock River Basin *381*

B.4.1 Rappahannock River near Fredericksburg, VA at Segment 230 (Monitoring Station: 1668000) (Above Fall Line Basin Segments: 230) 383

B.5.0 York River Basin 425

B.5.1 Mattaponi River near Beulahville, VA at Segment 240 (Monitoring Station: 1674500) (Above Fall Line Basin Segments: 235 and 240) 427

B.5.2 Pamunkey River near Hanover, VA at Segment 260 (Monitoring Station: 1673000) (Above Fall Line Basin Segments: 250 and 260) 469

B.6.0 James River Basin 511

B.6.1 James River at Cartersville, VA at Segment 280 (Monitoring Station: 2035000) (Above Fall Line Basin Segments: 265, 270, 280, and 290) 513

B.6.2 Appomattox River at Matoaca, VA at Segment 310 (Monitoring Station: 2041650) (Above Fall Line Basin Segments: 300 and 310) 555

B.7.0 Choptank River Basin 597

B.7.1 Choptank River near Greensboro, MD at Segment 770 (Monitoring Station: 1491000) (Above Fall Line Basin Segments: 770) 599

List of Figures

Figure		Page
B.0	Major Basins of the Chesapeake Bay Watershed	xi
B.1	Monitoring Stations in the Susquehanna River Basin	2
B.2	Monitoring Stations in the Patuxent River Basin	210
B.3	Monitoring Stations in the Potomac River Basin	254
B.4	Monitoring Stations in the Rappahannock River Basin	382
B.5	Monitoring Stations in the York River Basin	426
B.6	Monitoring Stations in the James River Basin	512
B.7	Monitoring Stations in the Choptank River Basin	598

List of Tables

Table

Page

B.0 Table of Phase IV Watershed Model Segments by Basin.....xii

B.1 Characteristics of Stations used in Hydrology Calibration.....xiii

Major Basins of the Chesapeake Bay Watershed

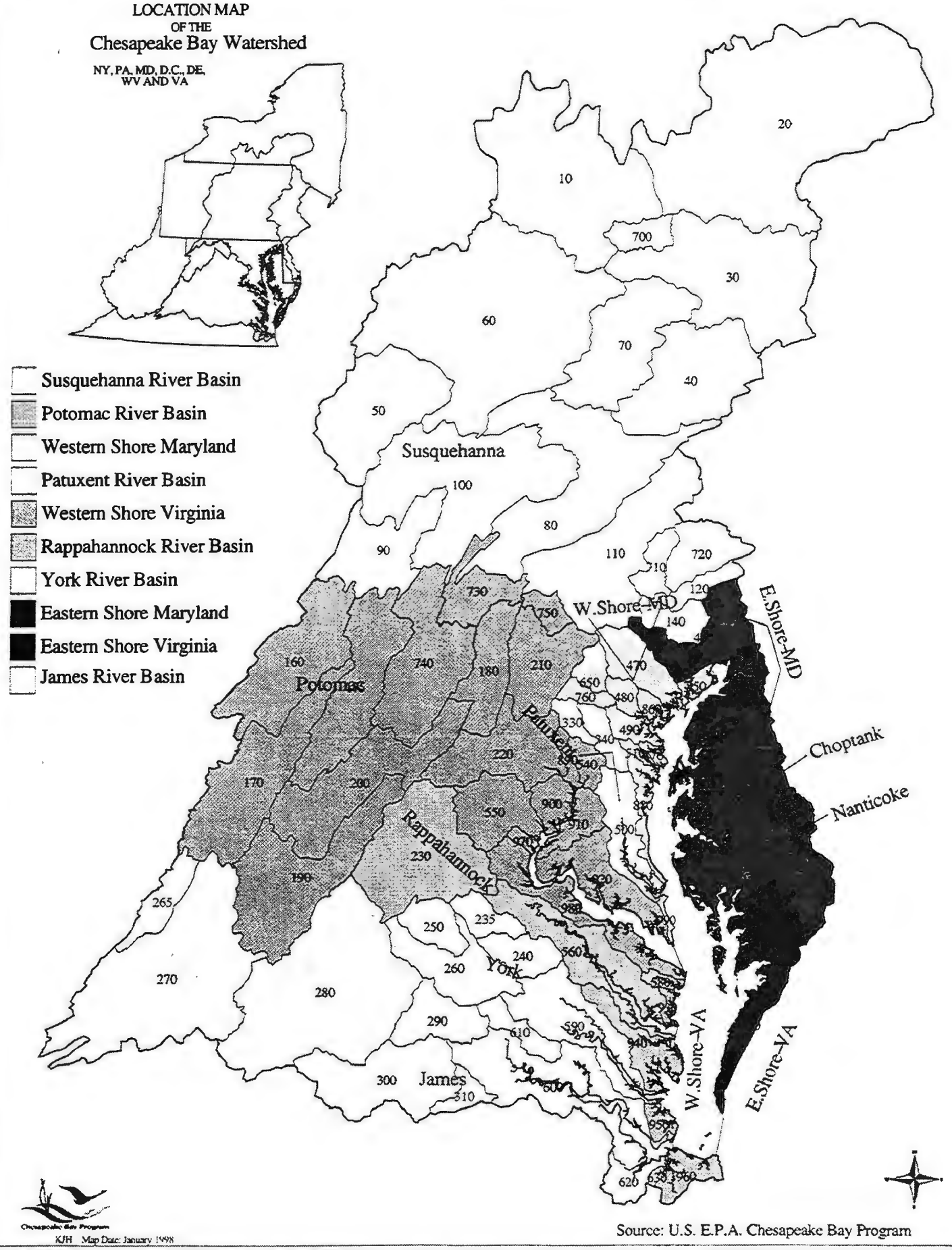


Table B.0

PHASE IV CHESAPEAKE BAY MODEL SEGMENTS BY BASIN

SUSQUEHANNA RIVER BASIN:
AFL -- 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 140, 700, 720

POTOMAC RIVER BASIN:
AFL - 160, 170, 175, 180, 190, 200, 210, 220, 730, 740, 750
BFL - 540, 550, 890, 900, 910, 920, 970, 980

JAMES RIVER BASIN:
AFL - 265, 270, 280, 290, 300, 310
BFL - 600, 610, 620, 630

RAPPAHANNOCK RIVER BASIN:
AFL - 230
BFL - 560

PATUXENT RIVER BASIN:
AFL - 330, 340
BFL - 500, 990

YORK RIVER BASIN:
AFL - 235, 240, 250, 260
BFL - 590

WESTERN SHORE MARYLAND:
AFL - 650, 760
BFL - 470, 480, 490, 510, 850, 860, 870, 880

EASTERN SHORE MARYLAND:
BFL - 370, 380, 390, 400, 410, 420, 430, 450, 770, 780, 800, 820, 830, 840

WESTERN SHORE VIRGINIA:
BFL - 580, 930, 940, 950, 960

EASTERN SHORE VIRGINIA:
BFL -- 440

Table B.1
Characteristics of Stations Used in Hydrology Calibration

Phase IV Model Segment	Station No.	Location	Latitude	Longitude	Drainage Area (mi^2)	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 Creak.	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, nonrecording gauge at same site and datum.	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	1576000	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^2)	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^2)	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 Matoaca, 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 Fredericksburg.	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^2)	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.

B.1.0 Susquehanna River

Basin Segments:

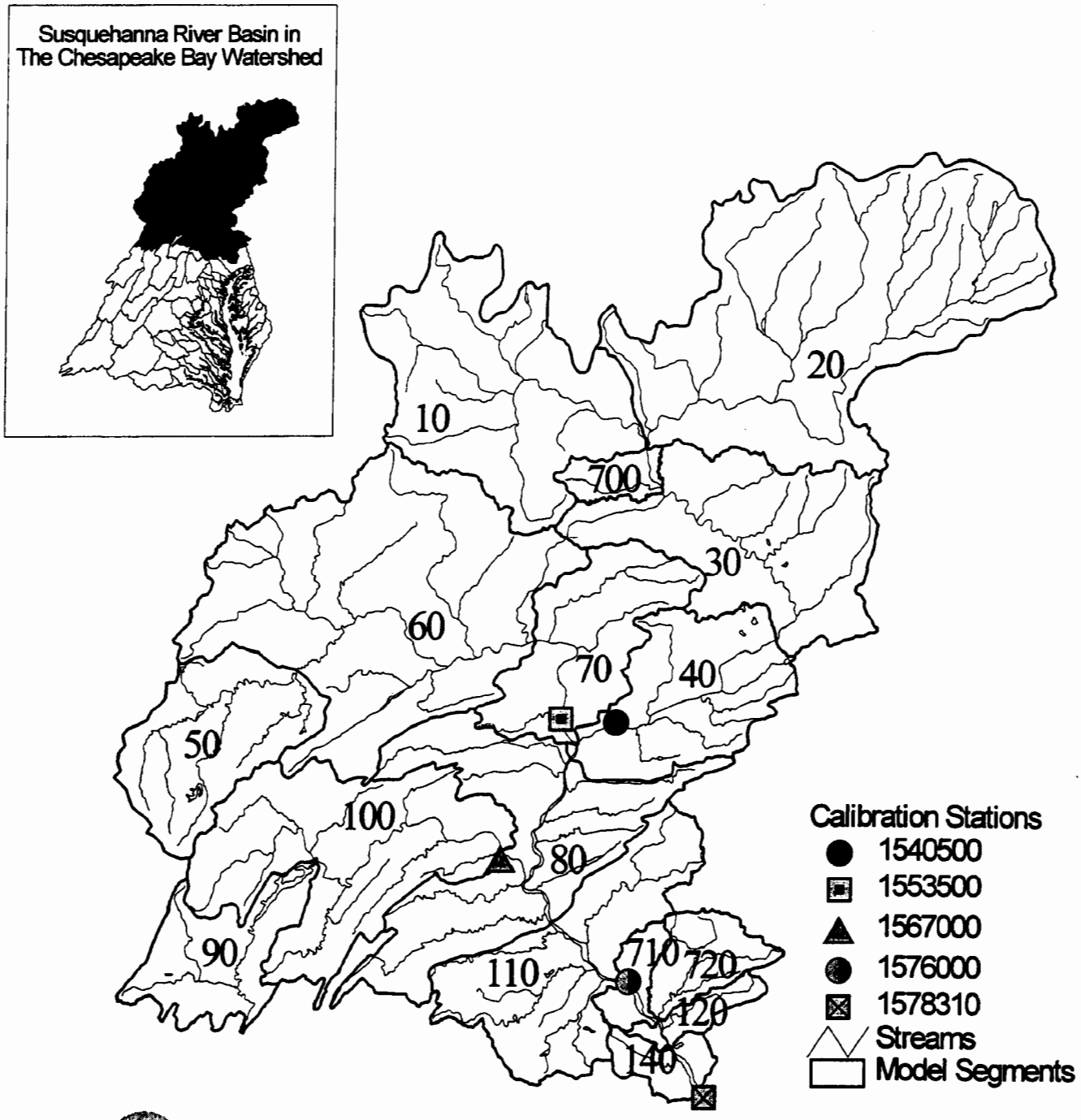
Above Fall Line Basin Segments: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 110, 120, 140, 700, 710, and 720

Section Contents:

B.1.0 Monitoring Stations in the Susquehanna River Basin (Figure B.1.0)
B.1.1 East Branch Susquehanna River (Monitoring Station: 1540500)
B.1.2 West Branch Susquehanna River (Monitoring Station: 1553500)
B.1.3 Juniata River (Monitoring Station: 1567000)
B.1.4 Lower Susquehanna River (Monitoring Station: 1576000)
B.1.5 Susquehanna River at Conowingo Dam (Monitoring Station: 1578310)

Figure B.1

Monitoring Stations in the Susquehanna River Basin



Chesapeake Bay Program

Map Date: April 1998

Source: USGS and USEPA Chesapeake Bay Program

B.1.1 East Branch Susquehanna River near Danville, PA at Segment 40 (Monitoring Station: 1540500) (Above Fall Line Basin Segments: 10, 20, 700, 30, and 40)

Section Summary:

The East Branch Susquehanna basin is largely rural in character and influenced by agricultural loads as well as loads from several cities including Binghamton, Scranton, and Wilkes Barre. An unusual feature of the East Branch Susquehanna is the decreasing population in the basin over the 1984-1995 simulation period. This is the only Chesapeake Bay basin with a decreasing population.

The East Branch Susquehanna basin above the gaged site covers an area of 11,522 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 59% forest land, 7% cropland, 27% other agricultural areas, 6% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario, estimated total nitrogen delivered to the gage decreased from 47.9 million pounds in 1985 to 46.7 million pounds in 1996. Total phosphorus loads over the same time period decreased from 2.1 million pounds to 1.6 million pounds. In general, point source loads above the gage site are low. In 1996, the total nitrogen point source load was 12% of the total load and the total phosphorus point source load was 29% of the total load. Estimated septic system total nitrogen loads increased 6%, from 1.35 million pounds in 1985 to 1.44 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 7%, and other agricultural loads (primarily pasture and manure loads) by 7%. Total phosphorus decreased for these land uses by 10% and 24% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 5% for total nitrogen and 5% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

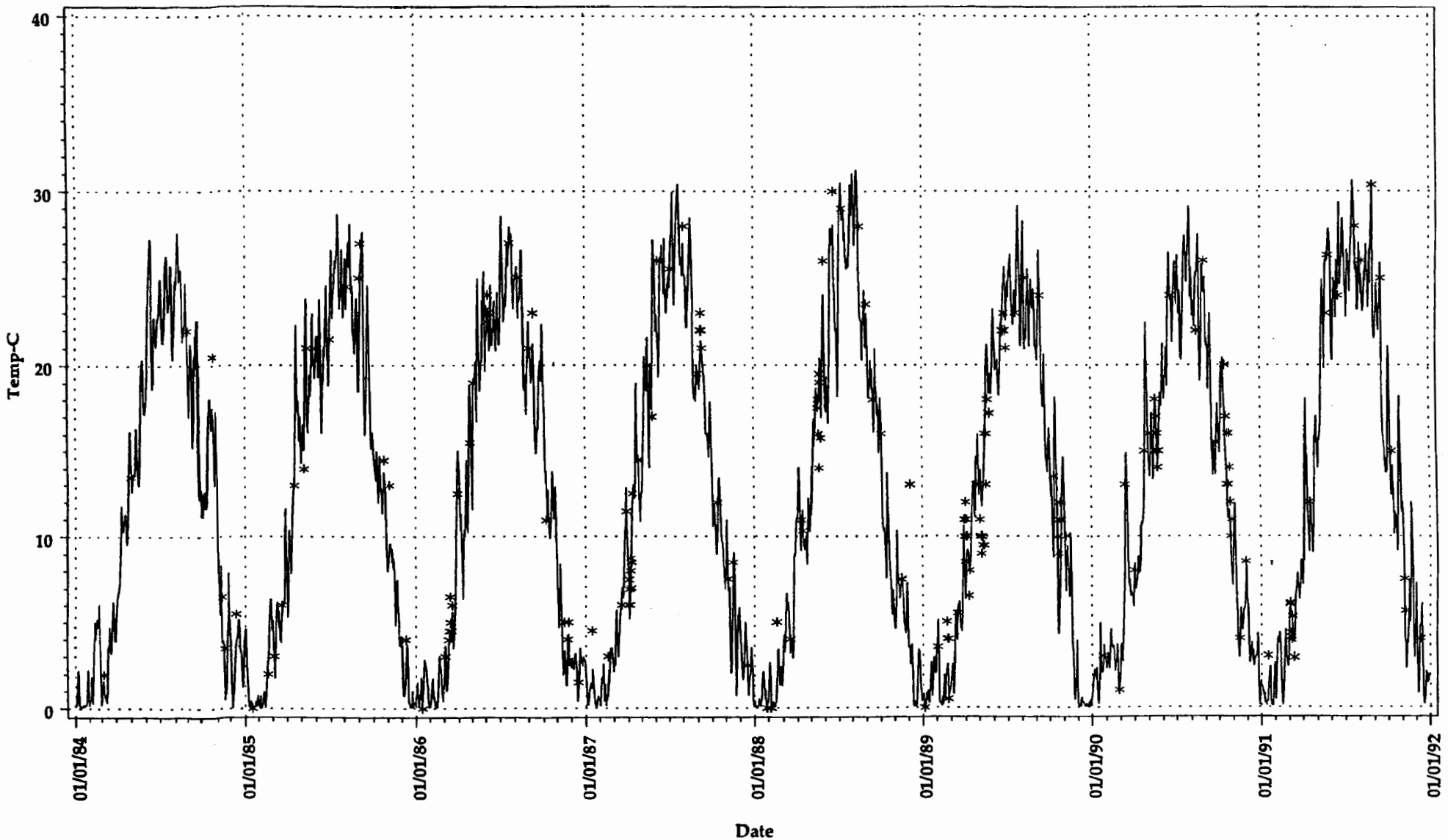
Observed and Simulated Loads versus Date -- Temperature

East Branch Susquehanna River at Segment 40

Observed and Simulated versus Time

Temperature-C

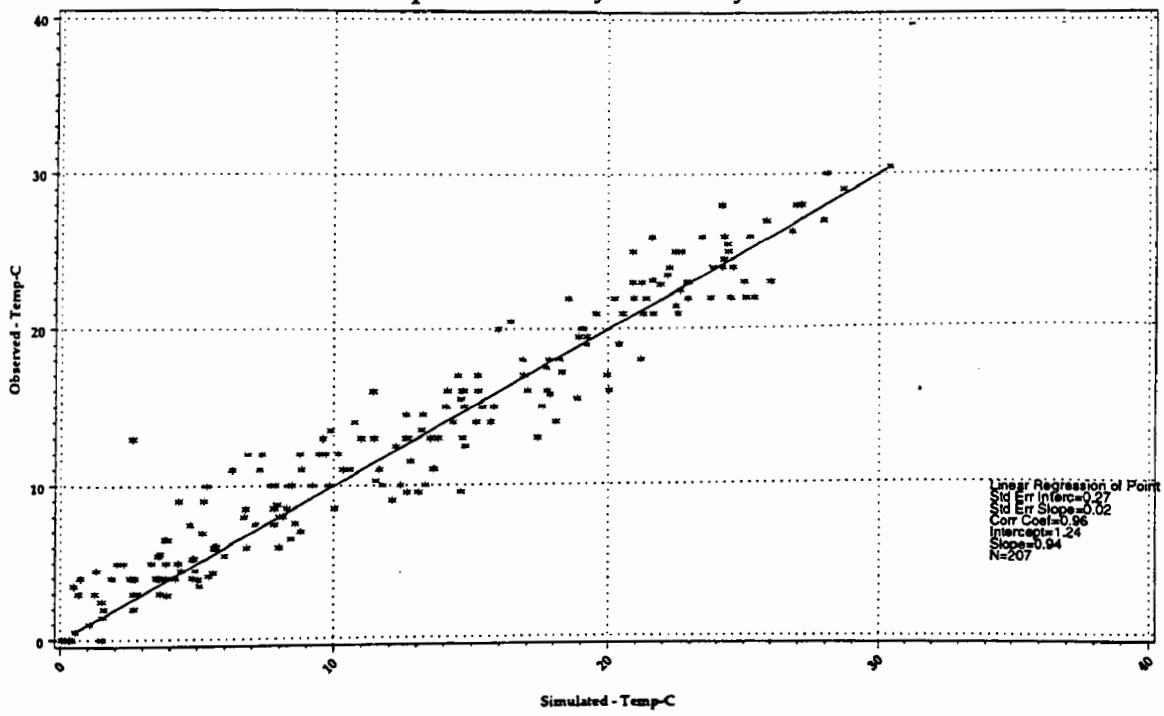
(*=Observed, -=Simulated)



(y21_plot1.sas datasetcse2trpe.p3.james.sas) plotcmd - cmdme)
(graph_e.drv 28JAN98 19:55)

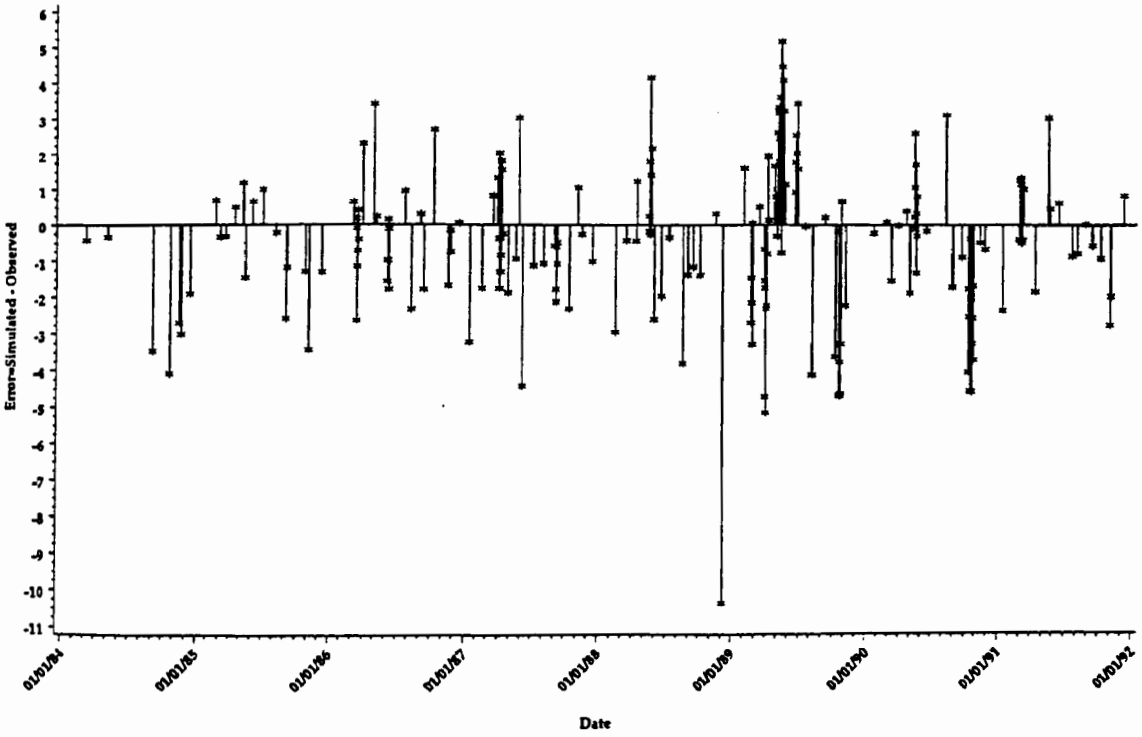
East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Temperature-C: 01JAN84 - 01JAN92



East Branch Susquehanna at Segment 40

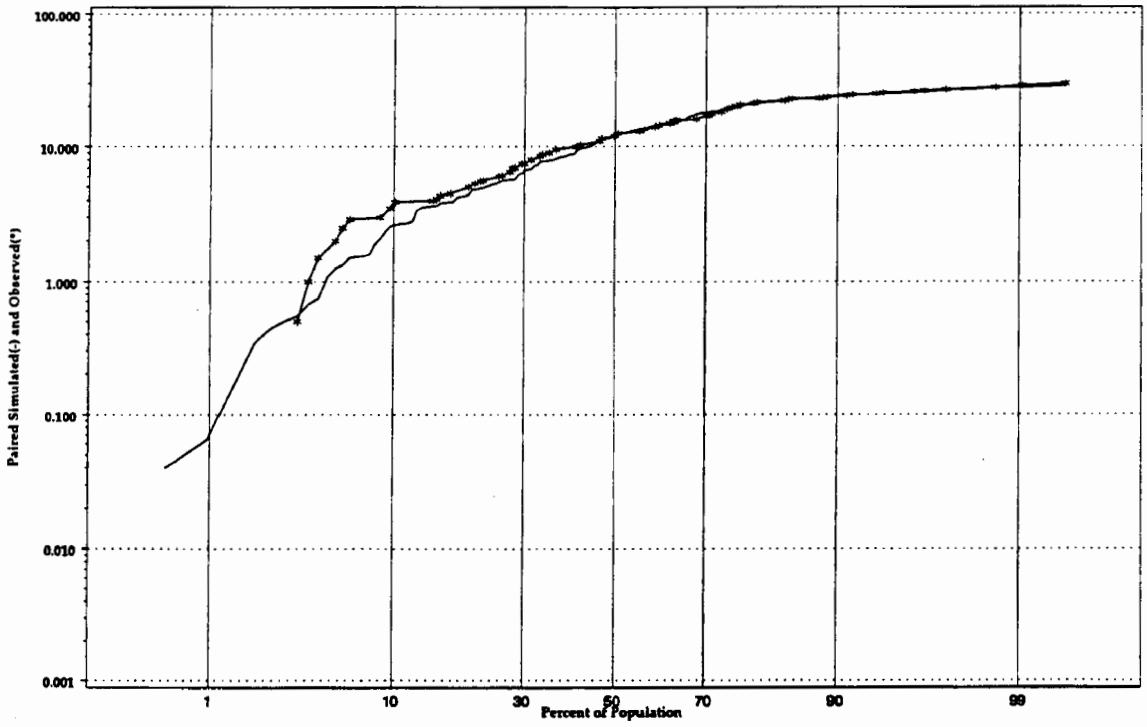
Actual Error versus Time
Temperature-C



East Branch Susquehanna at Segment 40

Temperature-C

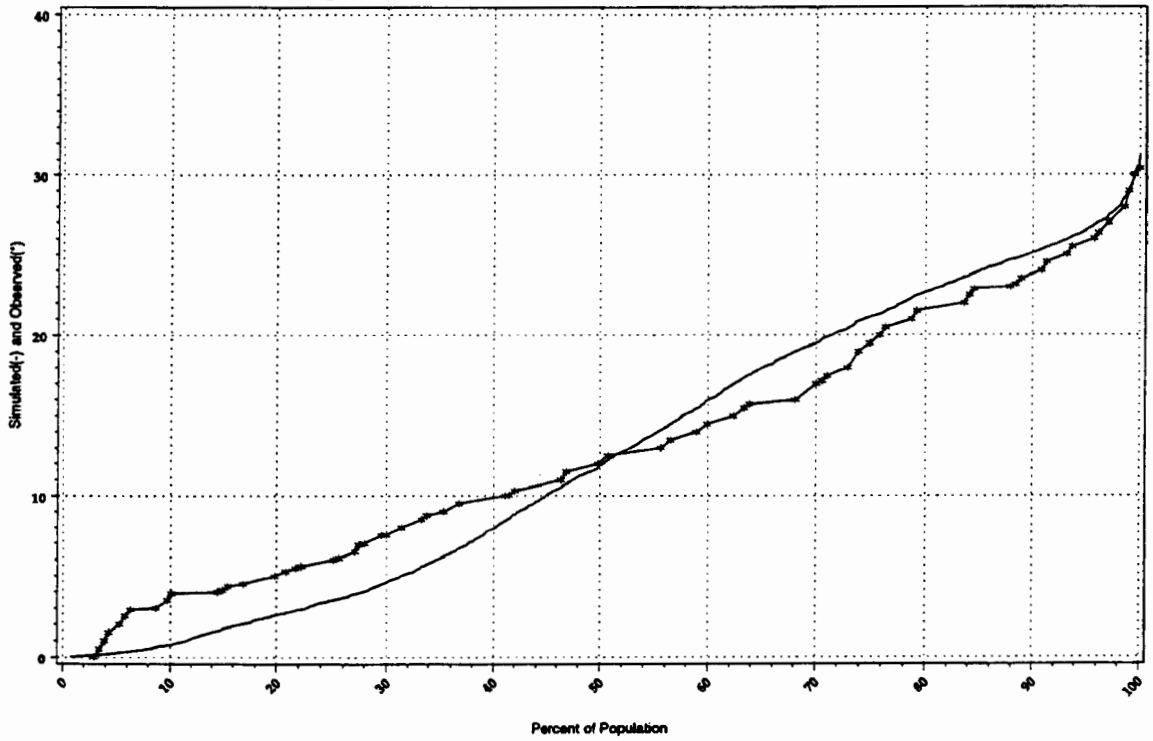
Frequency Distribution - PAIRED Simulated and Observed Data



East Branch Susquehanna at Segment 40

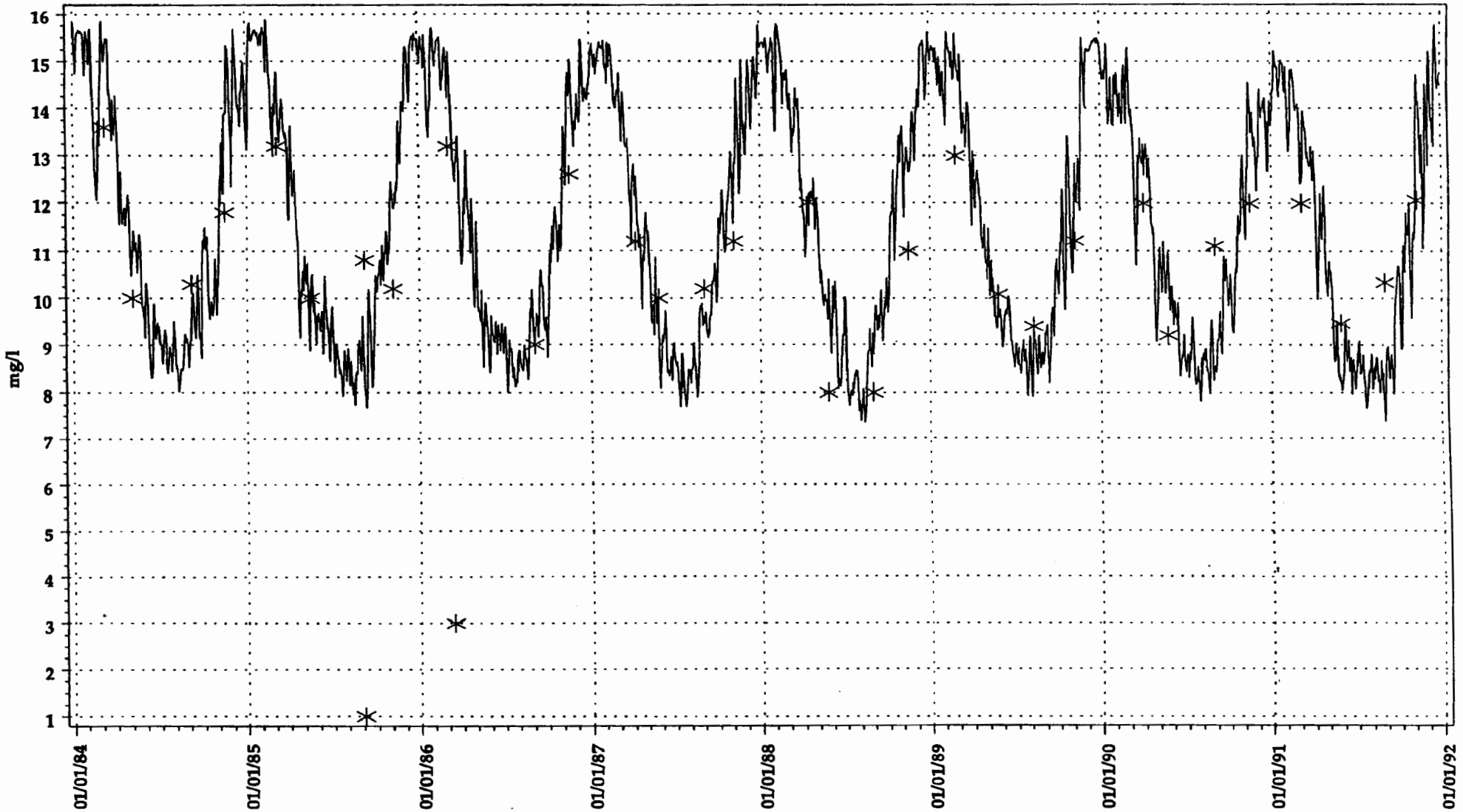
Temperature-C

Frequency Distribution - All Simulated and Observed Data

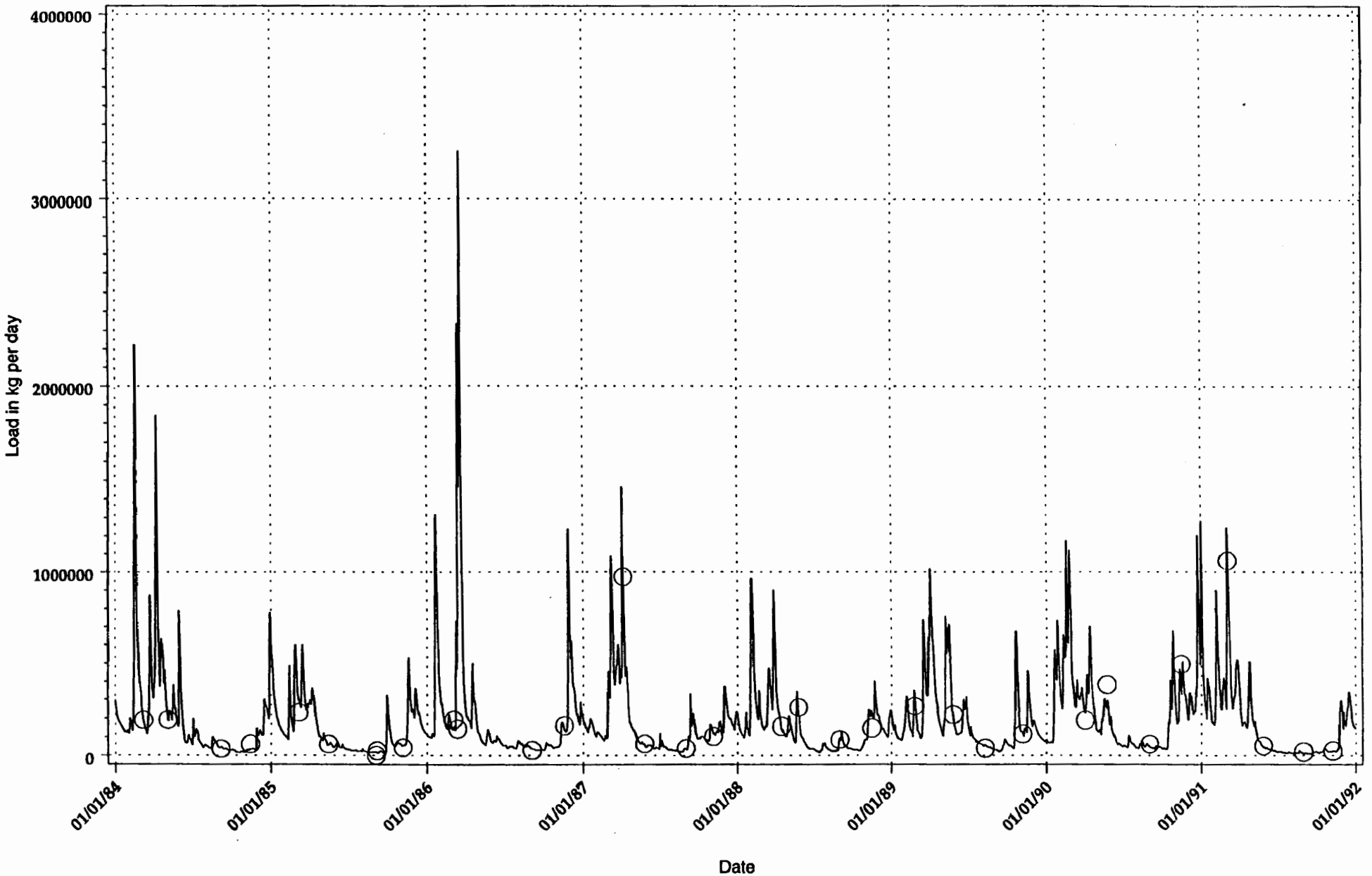


East Branch Susquehanna River at Segment 40
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



East Branch Susquehanna River at Segment 40
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)

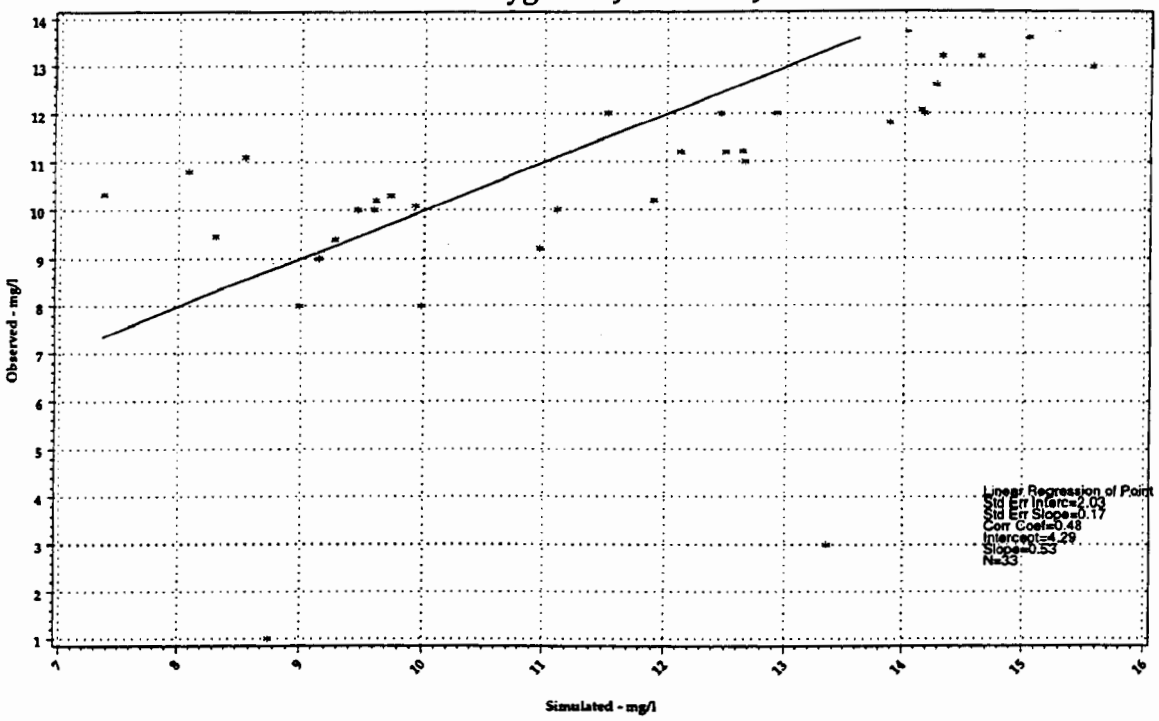


(y21_plot1.sas datastore2:[nps.p3.james.sas] lldfles)
(graph_a.drv 28JAN98 19:55.proc reg,model y=x)

East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

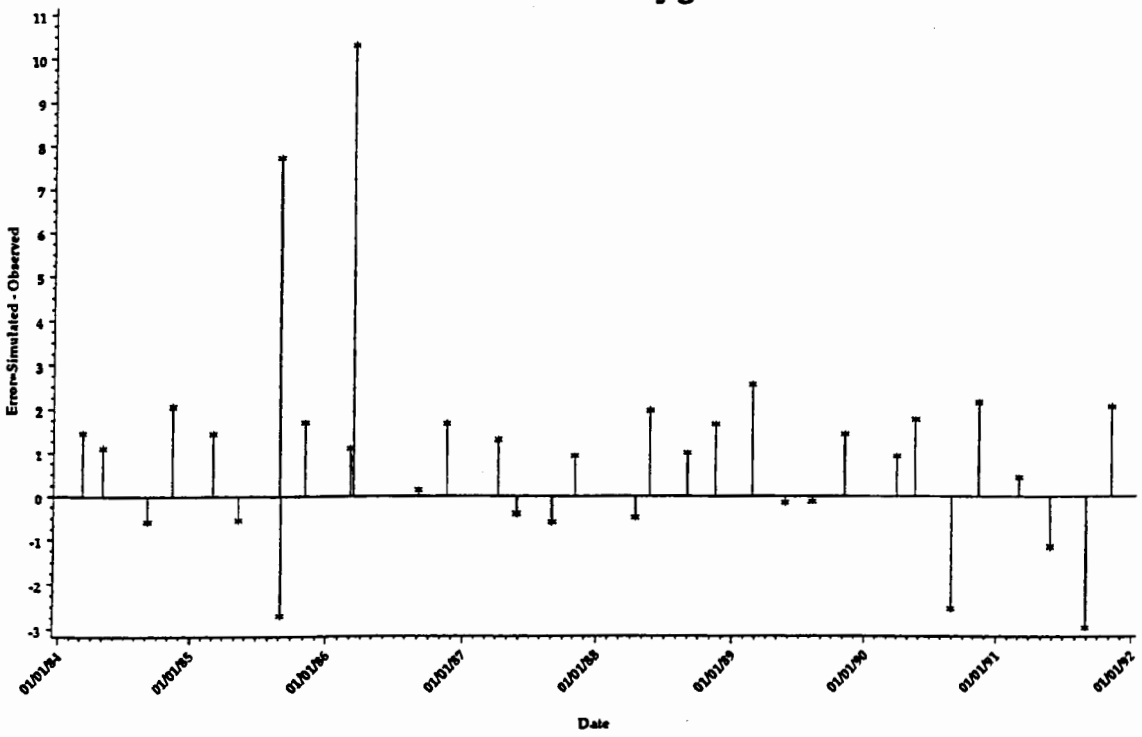
Dissolved Oxygen: 01JAN84 - 01JAN92



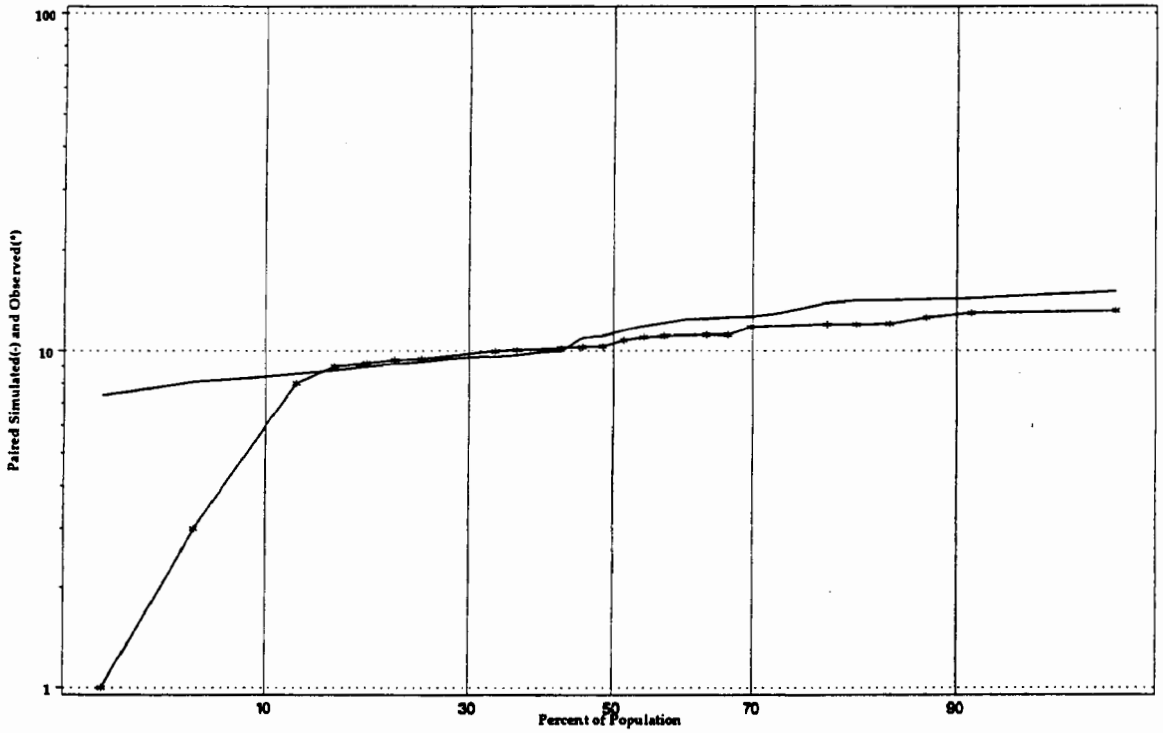
East Branch Susquehanna at Segment 40

Actual Error versus Time

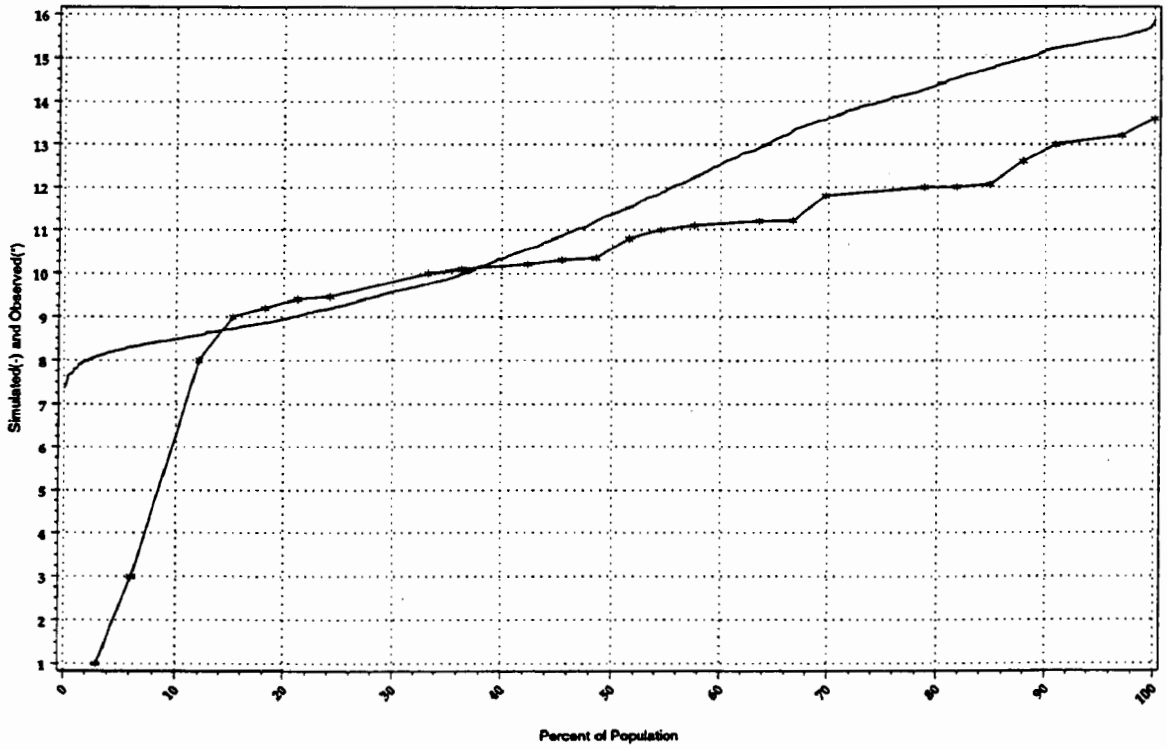
Dissolved Oxygen



East Branch Susquehanna at Segment 40
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

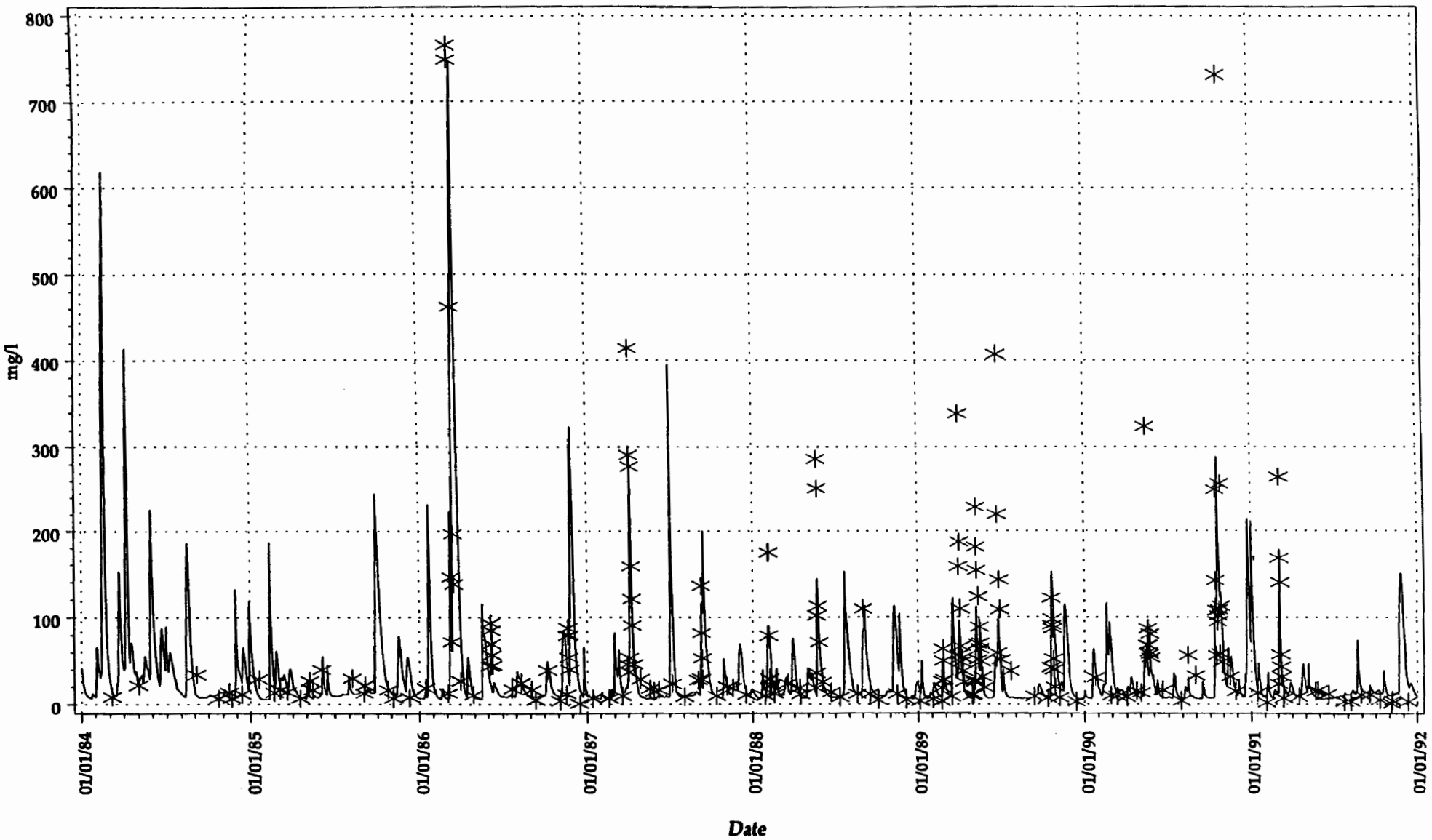


East Branch Susquehanna at Segment 40
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



East Branch Susquehanna River at Segment 40
Observed and Simulated versus Time
Total Suspended Sediment

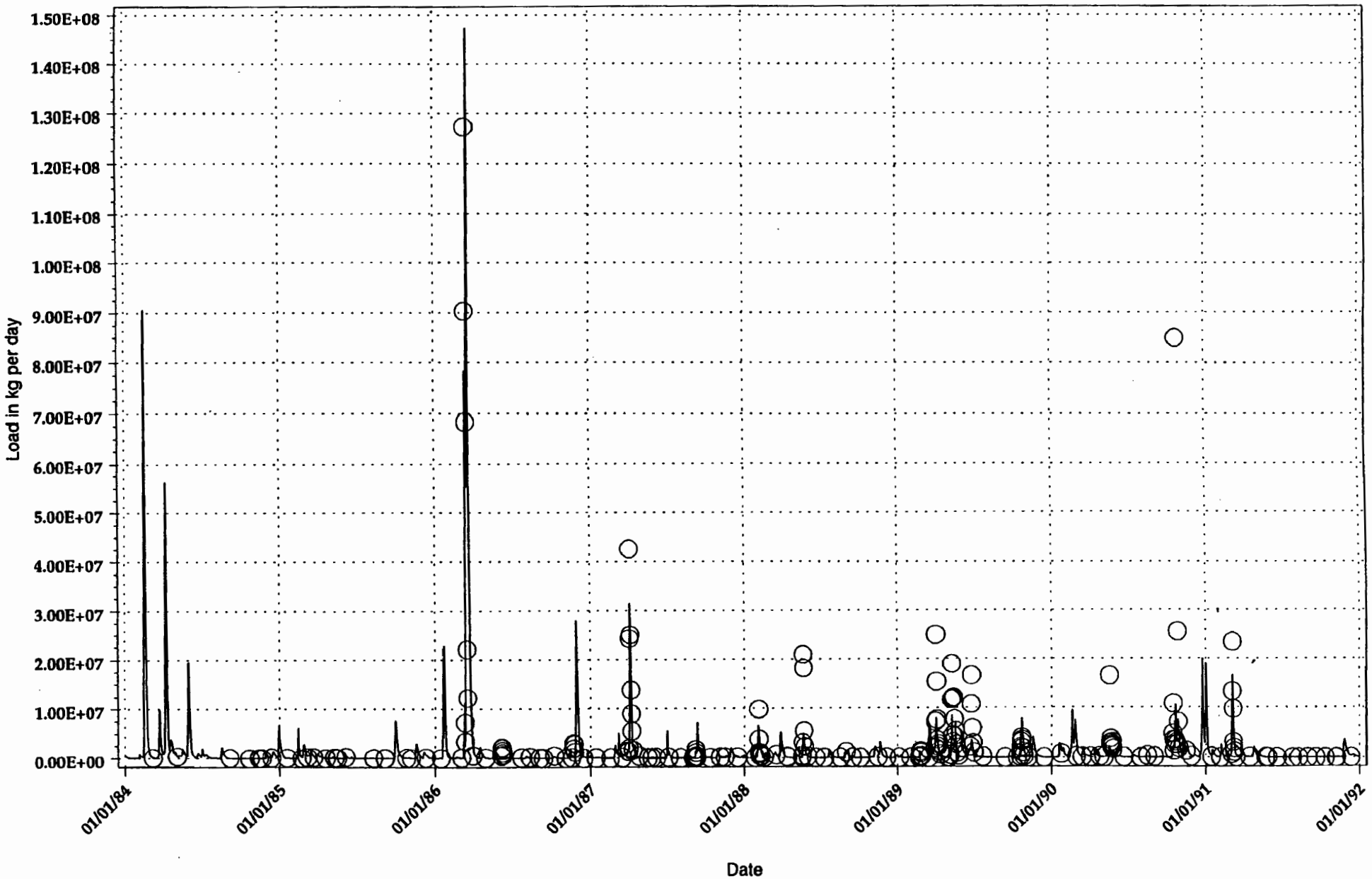
(*=Observed, -=Simulated)



East Branch Susquehanna River at Segment 40

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

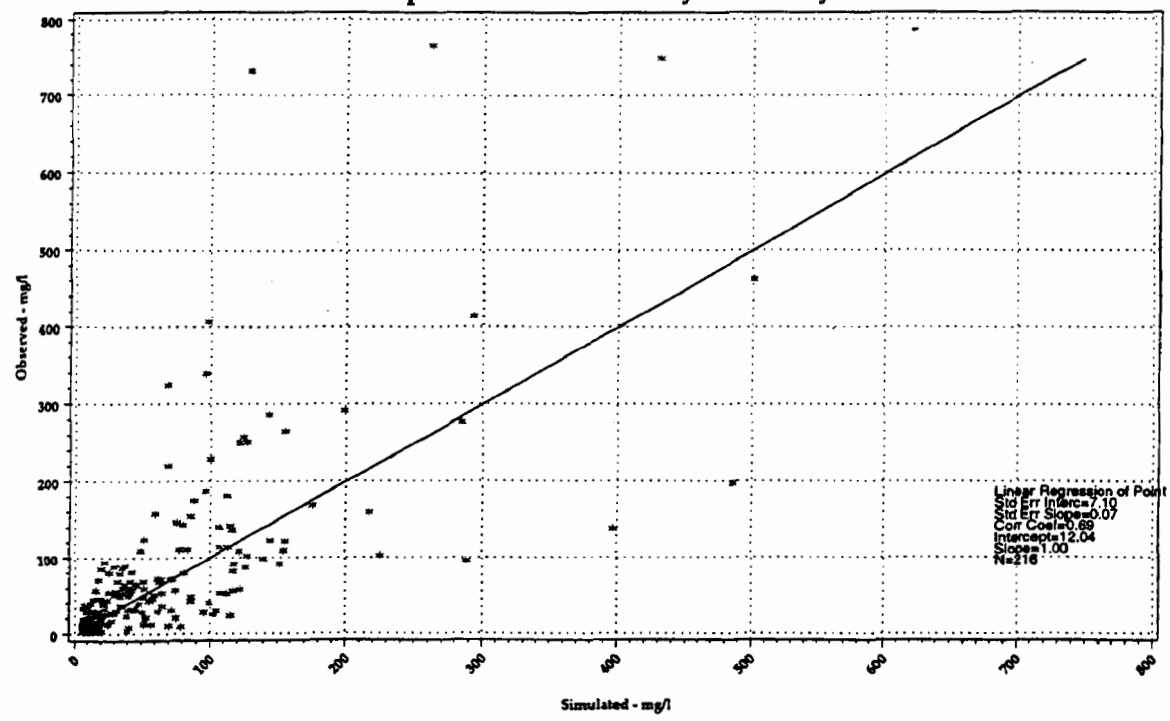


(y21_plot1.sas datastore2:(rqs.p3.james.sas) lkdlas)
(graph_a.drv 28JAN96 19:55,proc reg,model y=x)

East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

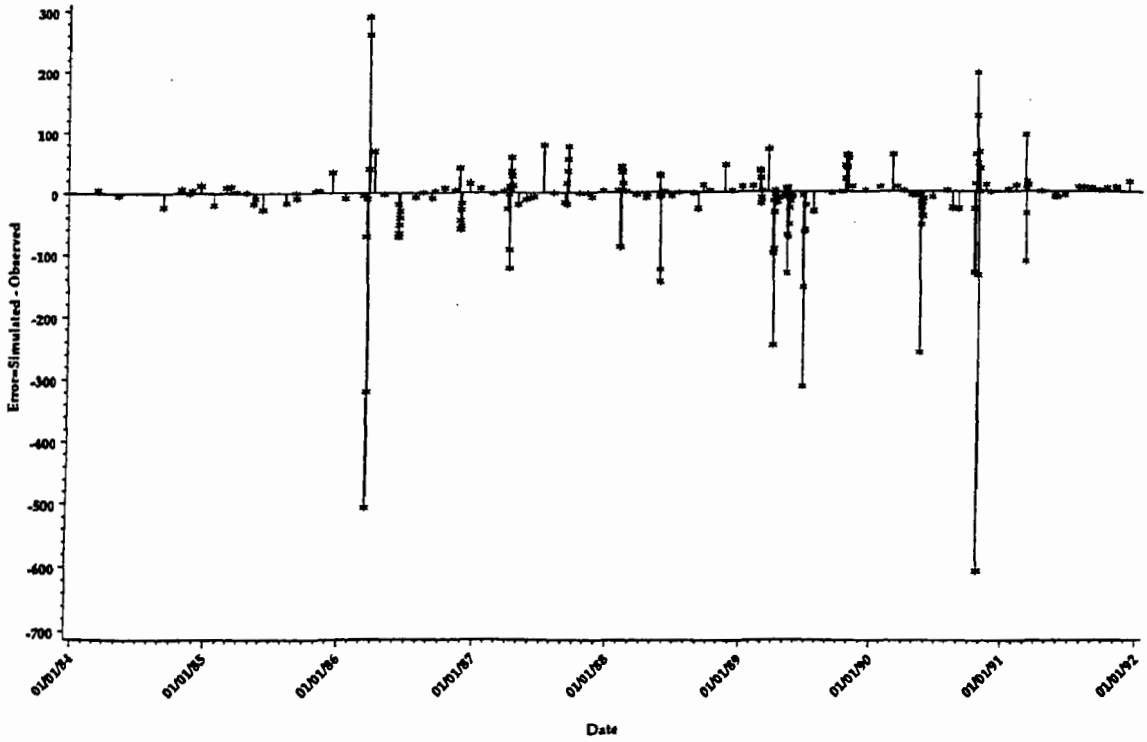
Total Suspended Sediment: 01JAN84 - 01JAN92



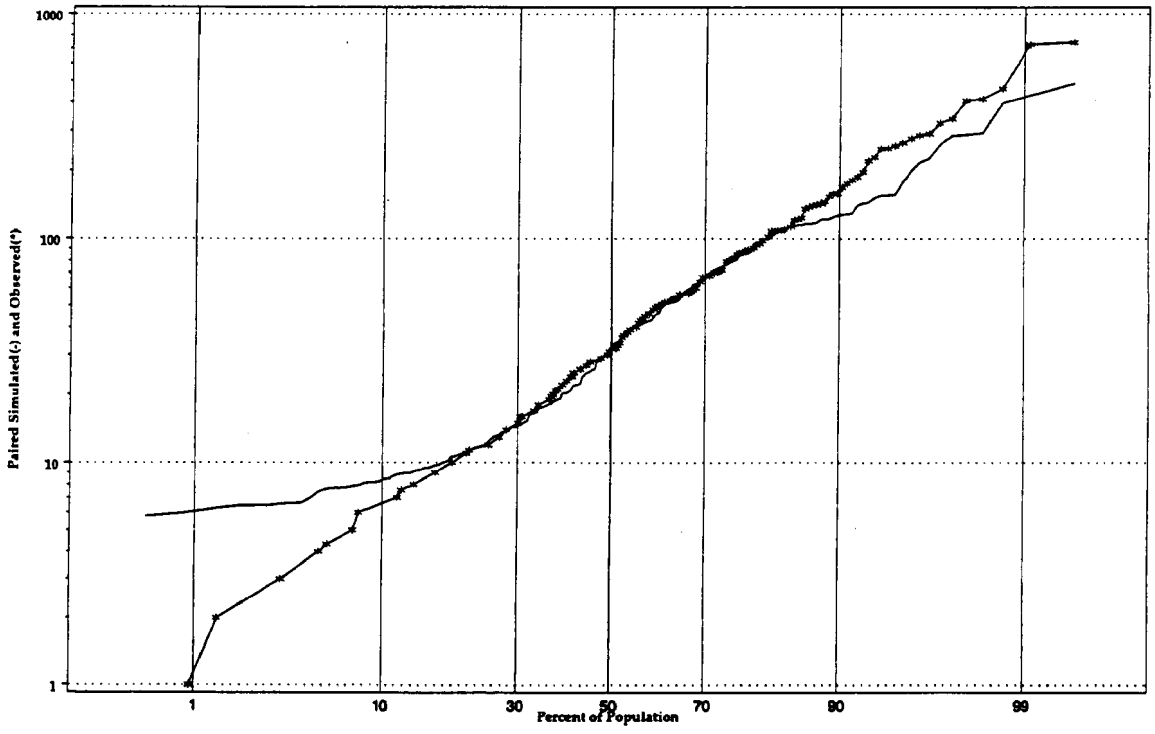
East Branch Susquehanna at Segment 40

Actual Error versus Time

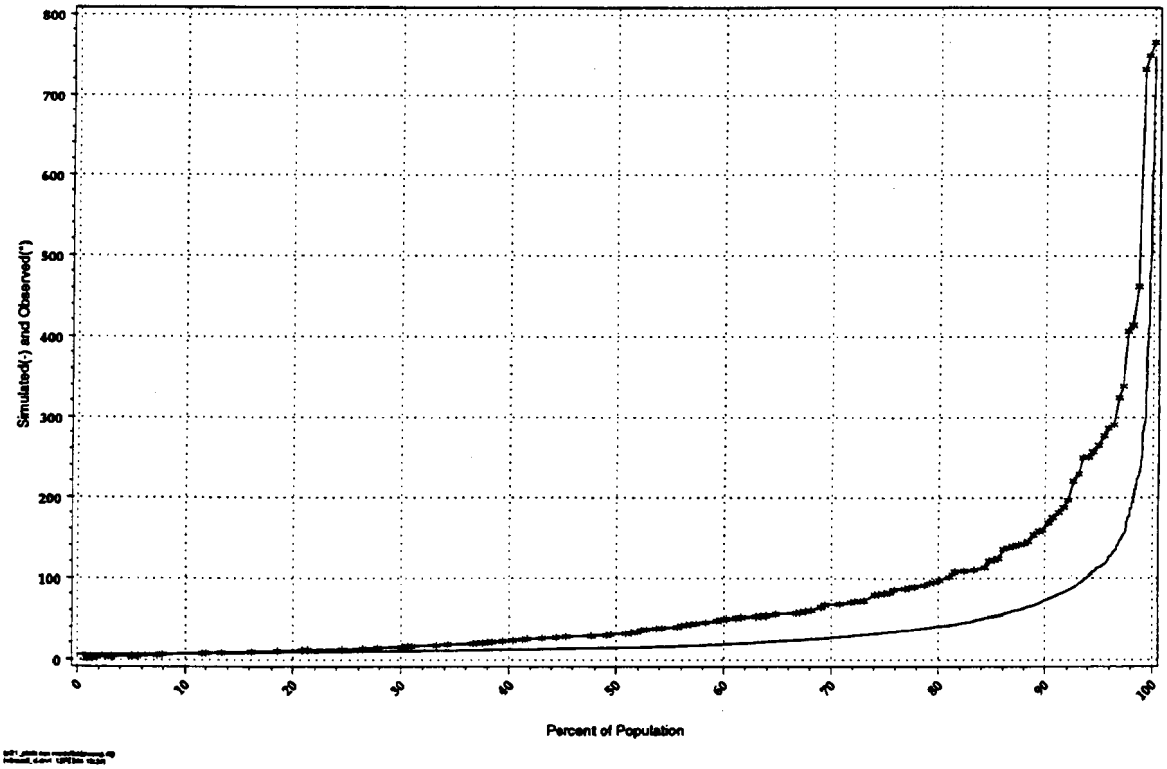
Total Suspended Sediment



East Branch Susquehanna at Segment 40
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

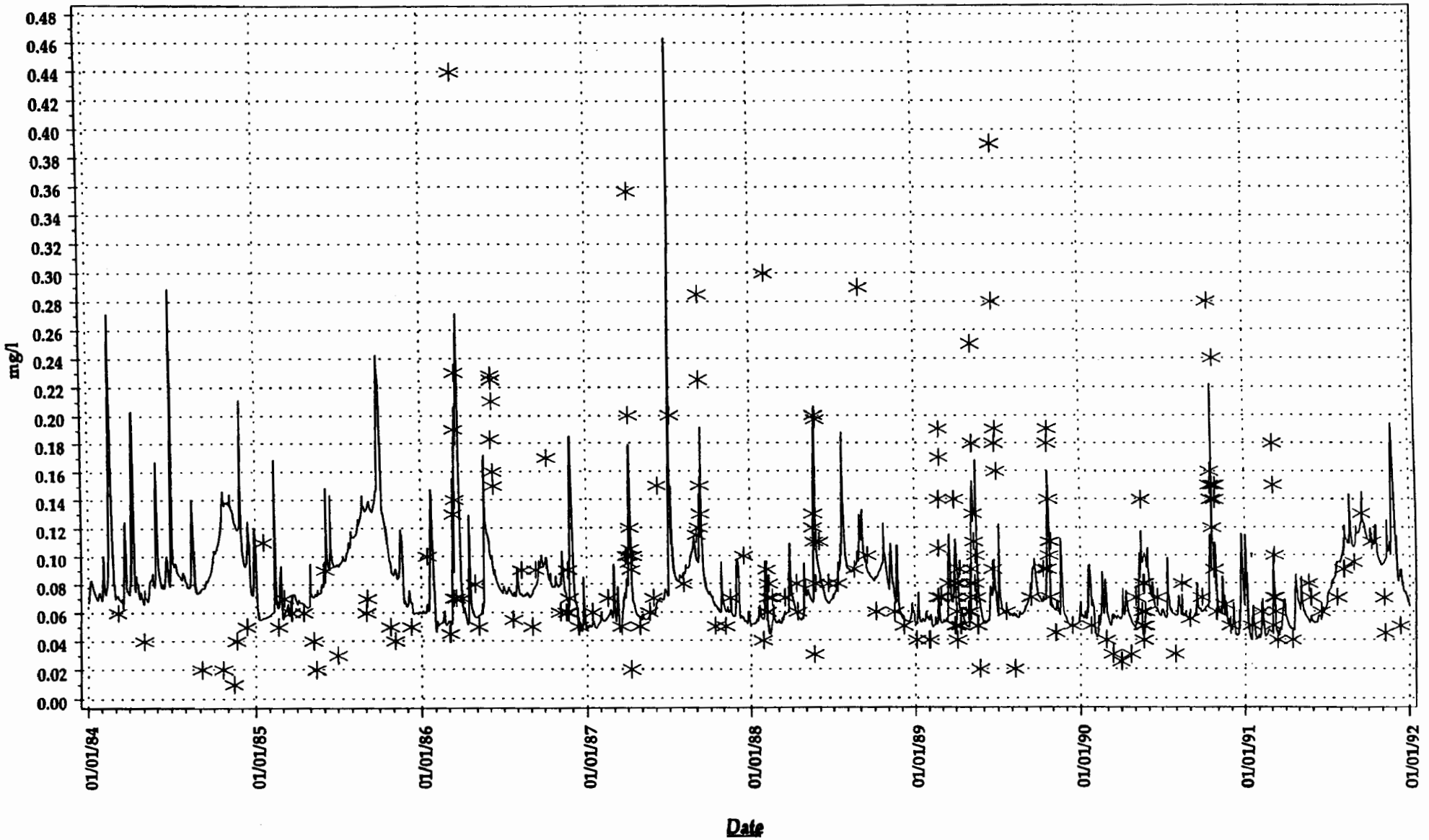


East Branch Susquehanna at Segment 40
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



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

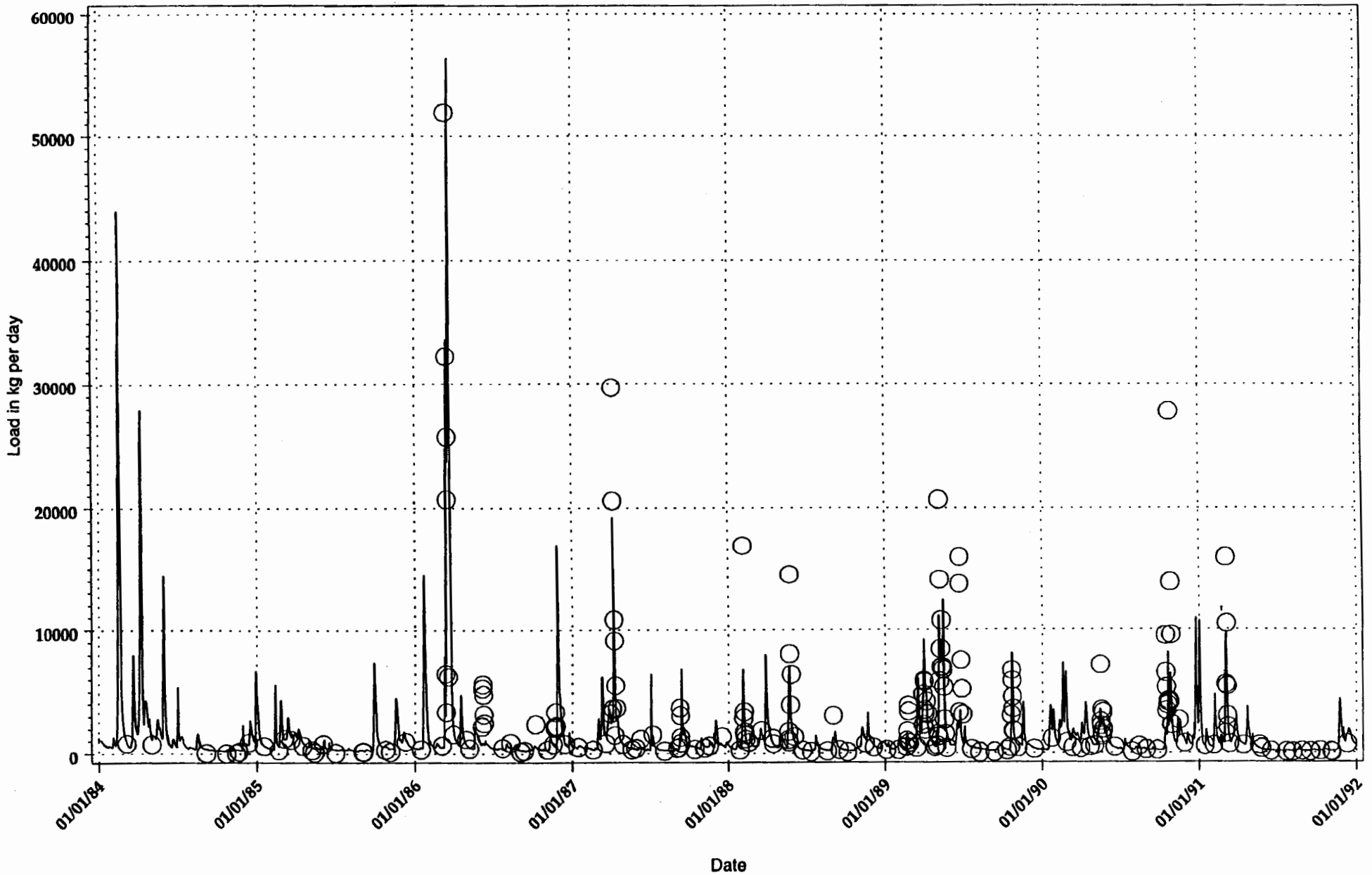
(*=Observed, -=Simulated)



East Branch Susquehanna River at Segment 40

Total Phosphorus Observed and Simulated Load vs Time

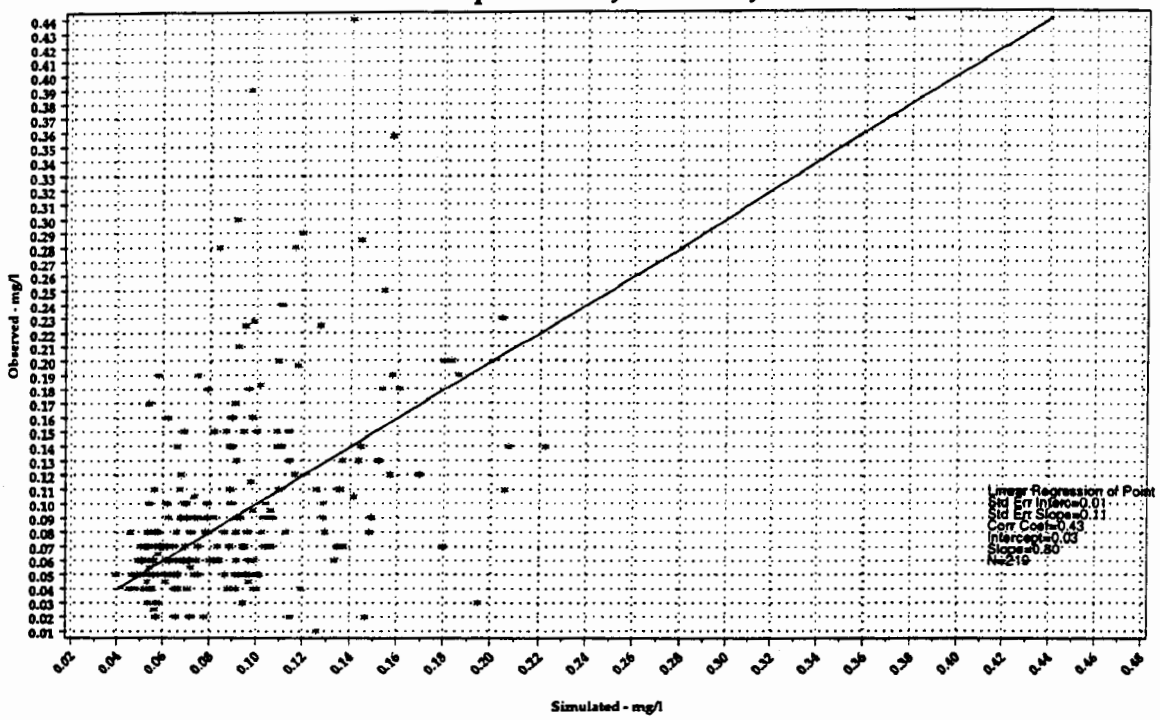
(line = simulated, O = observed)



(y21_plot1.sas datastore2(nps.p3 (ames.sas) lidlas)
(graph_e.drv 28JAN98 19:55,proc reg,model y=x)

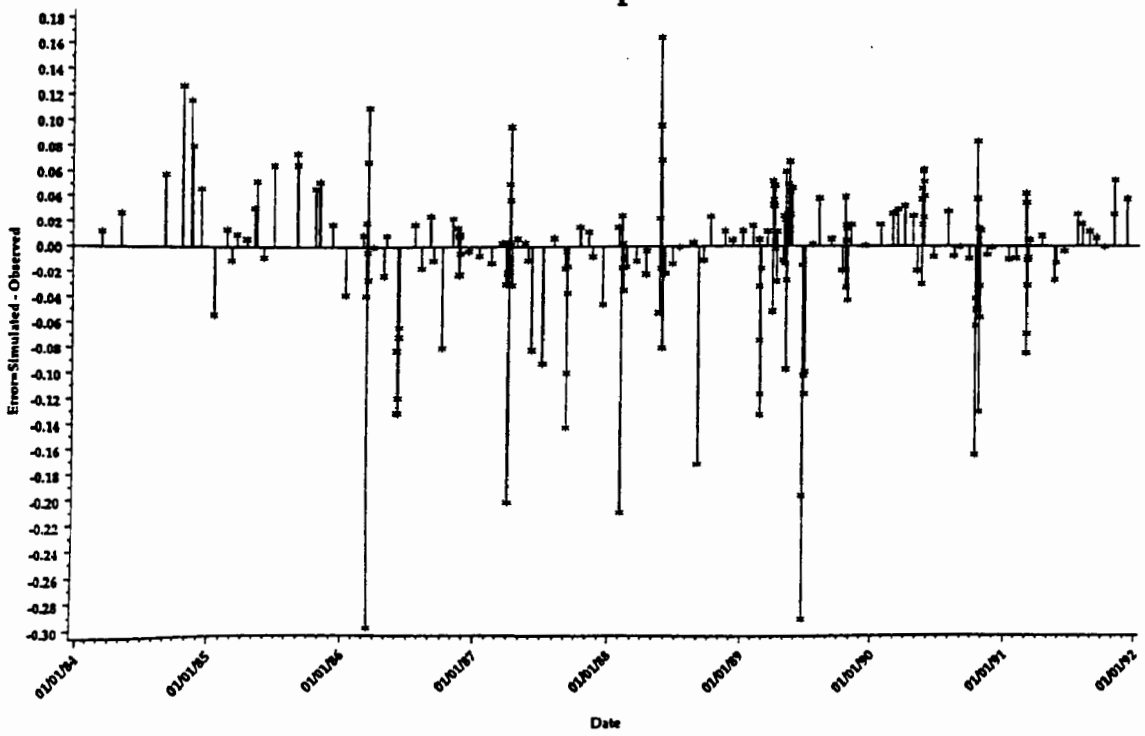
East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Phosphorus: 01JAN84 - 01JAN92

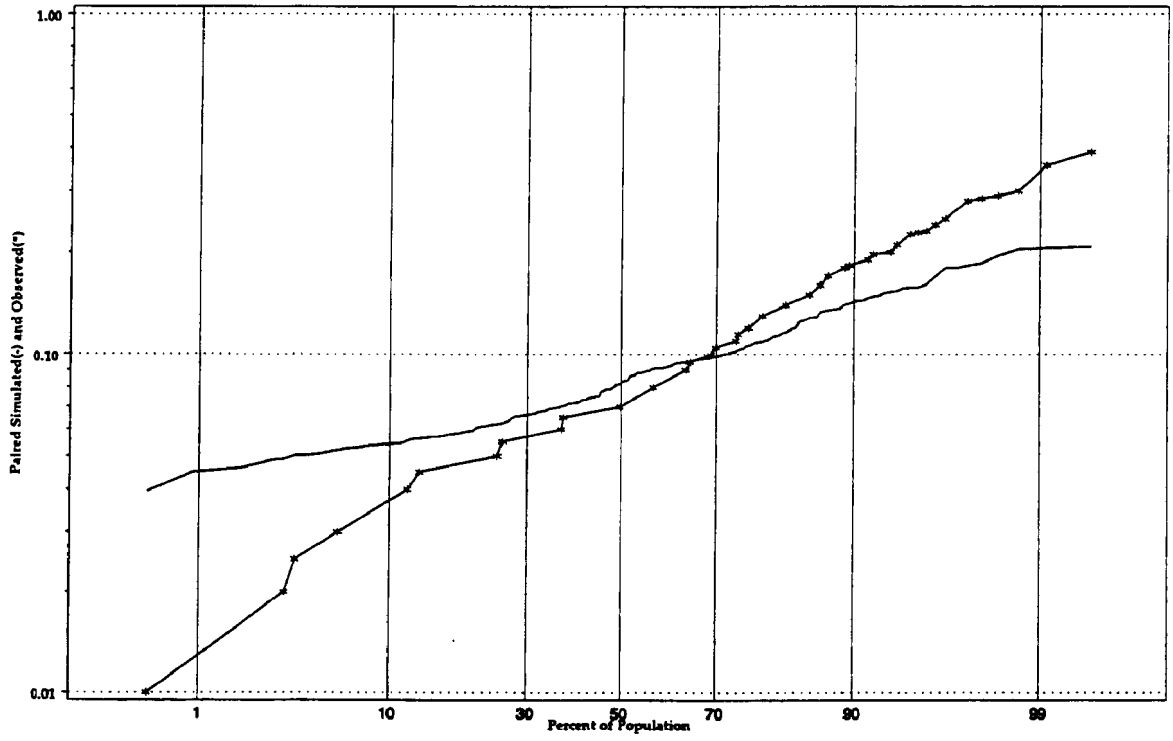


East Branch Susquehanna at Segment 40

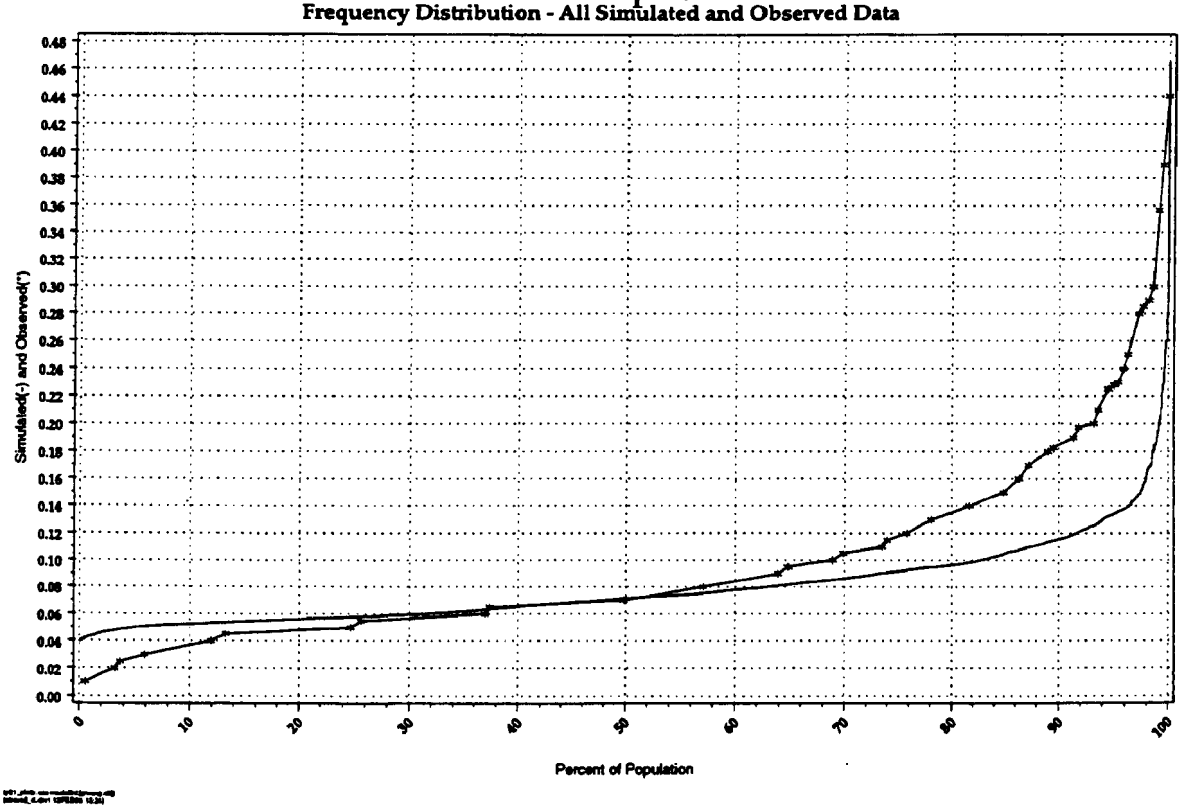
Actual Error versus Time
Total Phosphorus



East Branch Susquehanna at Segment 40
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

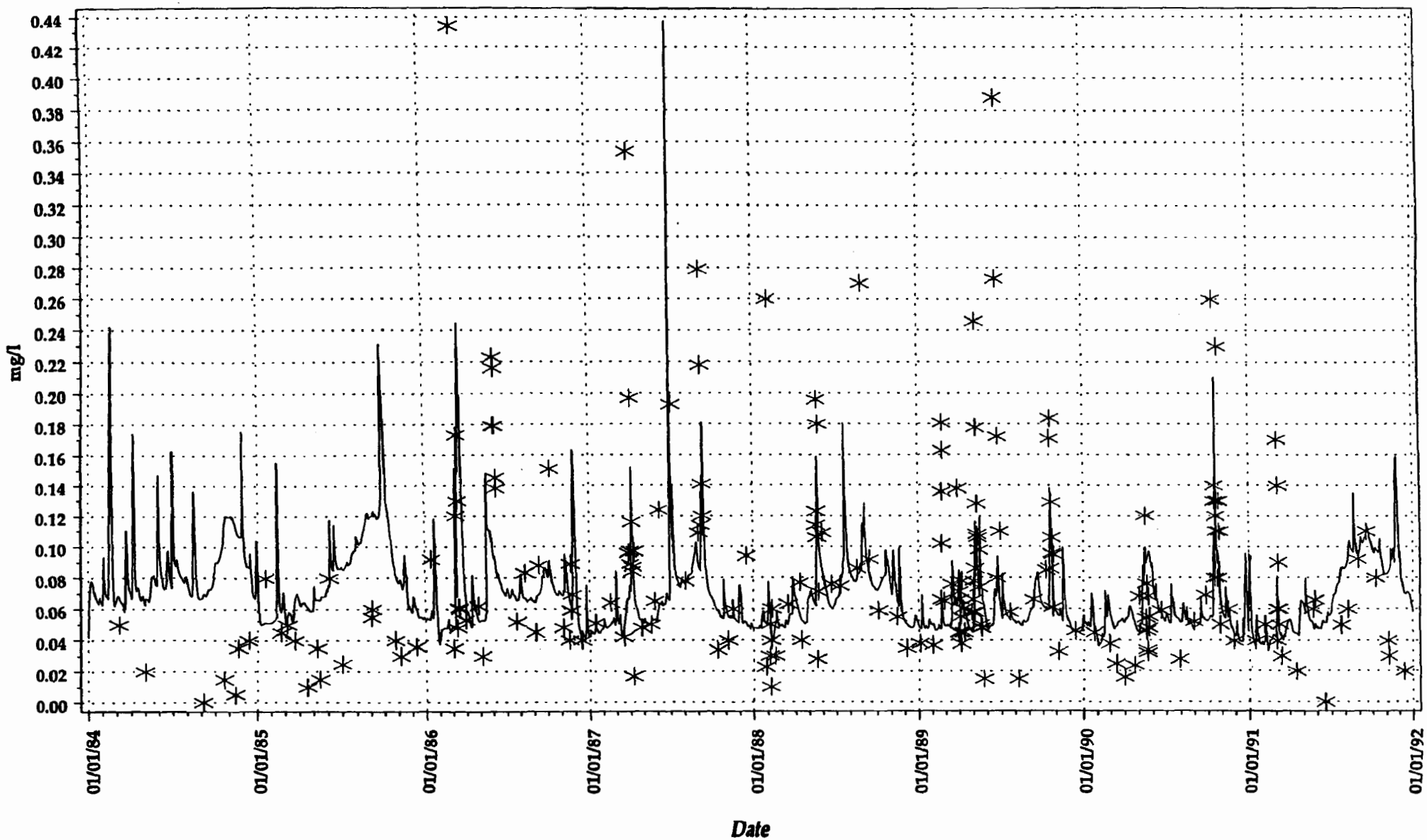


East Branch Susquehanna at Segment 40
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



East Branch Susquehanna River at Segment 40
Observed and Simulated versus Time
Organic and Particulate Phosphorus

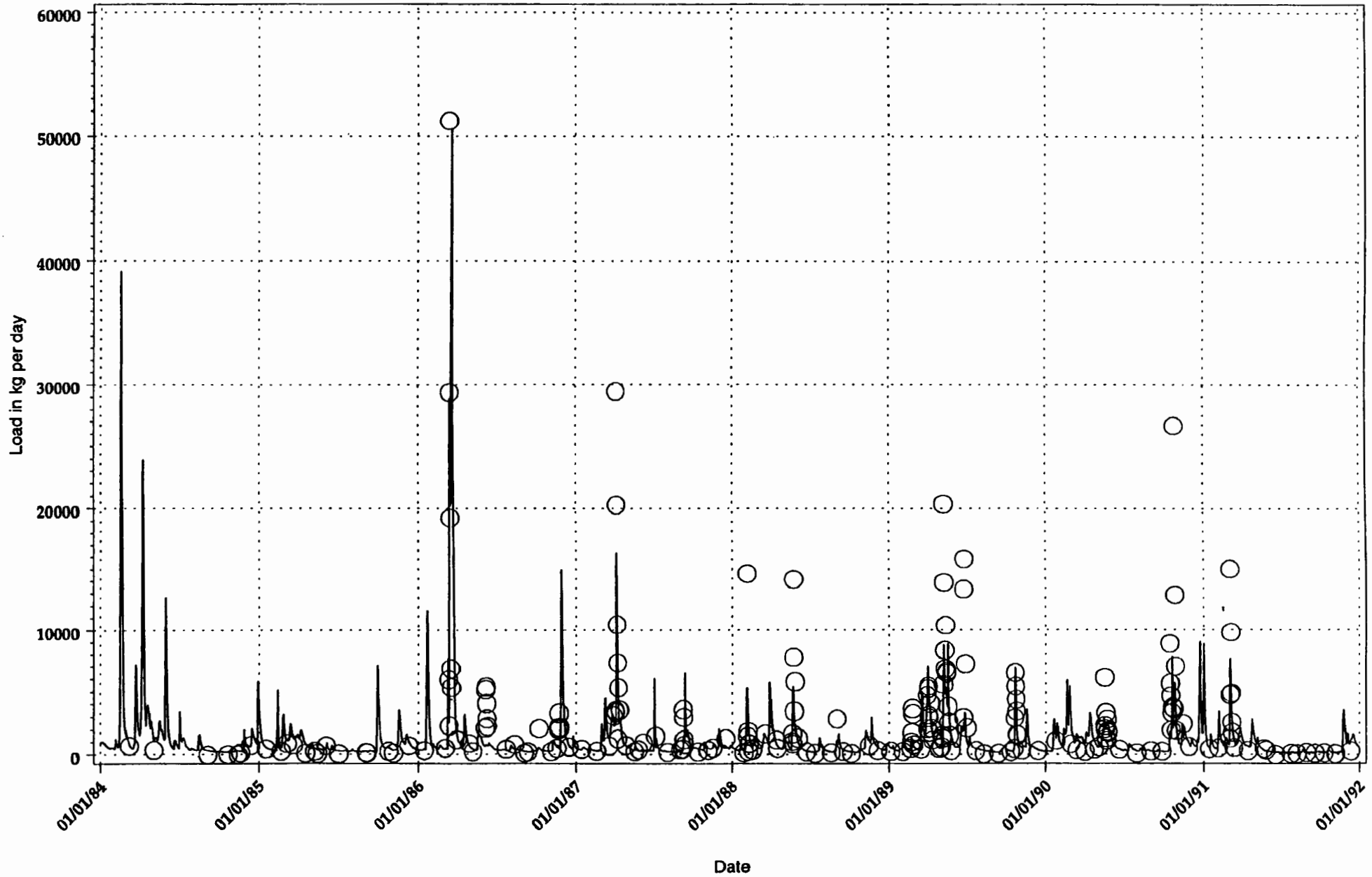
(*=Observed, -=Simulated)



East Branch Susquehanna River at Segment 40

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

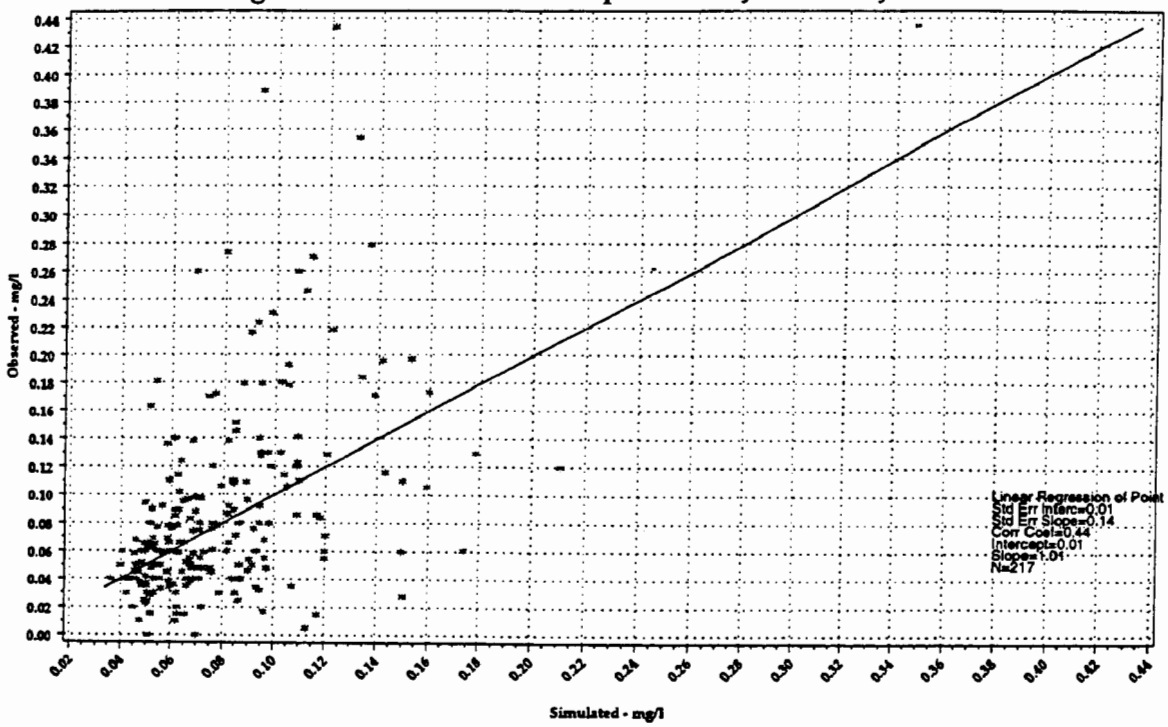


(y21_plot1.sas dataestore2:[rps.p3.james.sas] lidflse)
(graph_a.drv 28JAN98 19:55.proc reg.model y=x)

East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

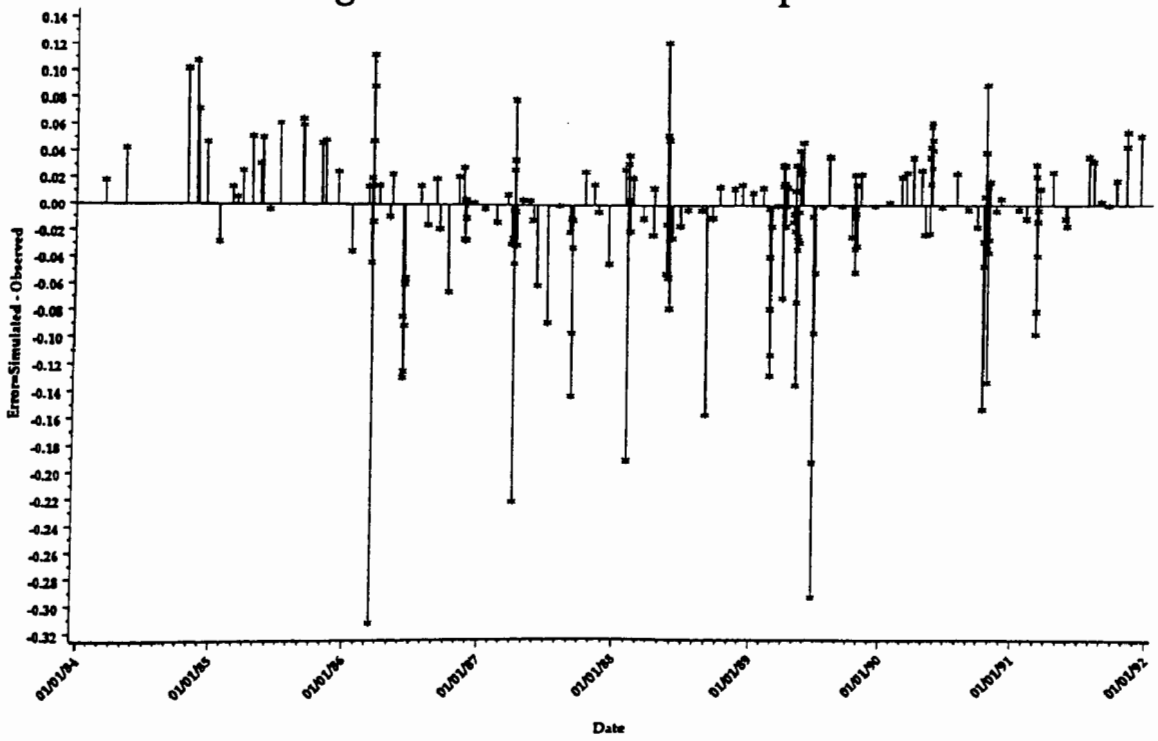
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



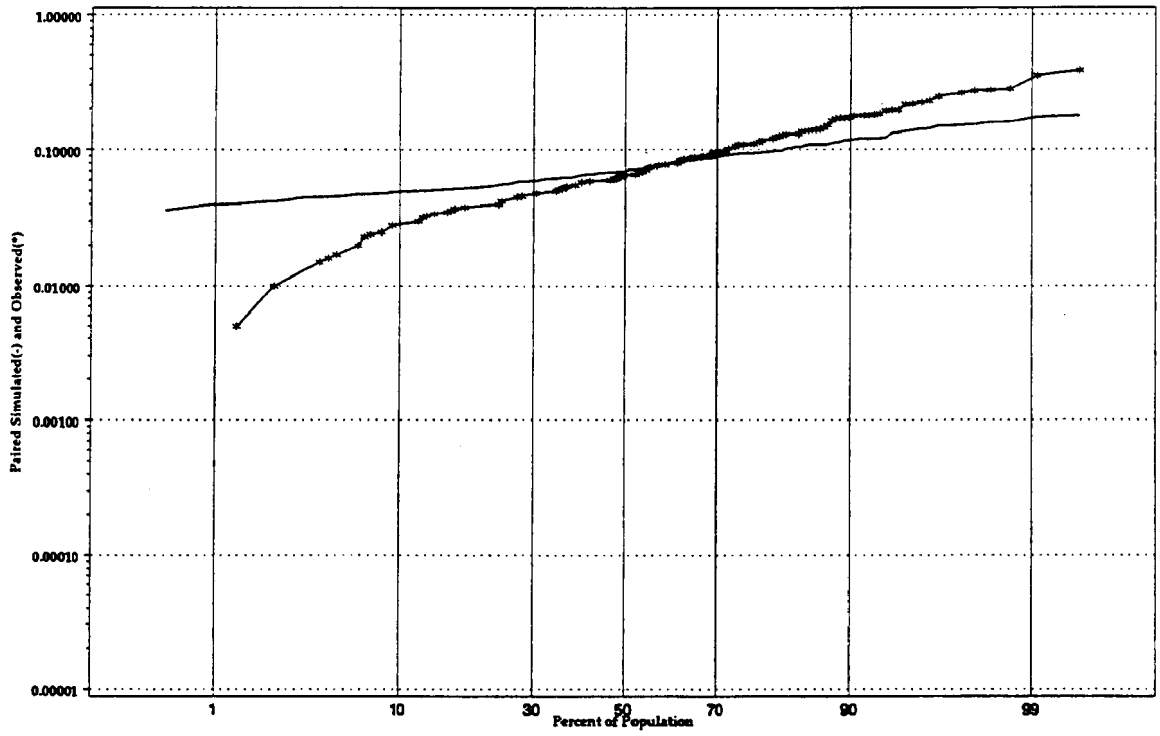
East Branch Susquehanna at Segment 40

Actual Error versus Time

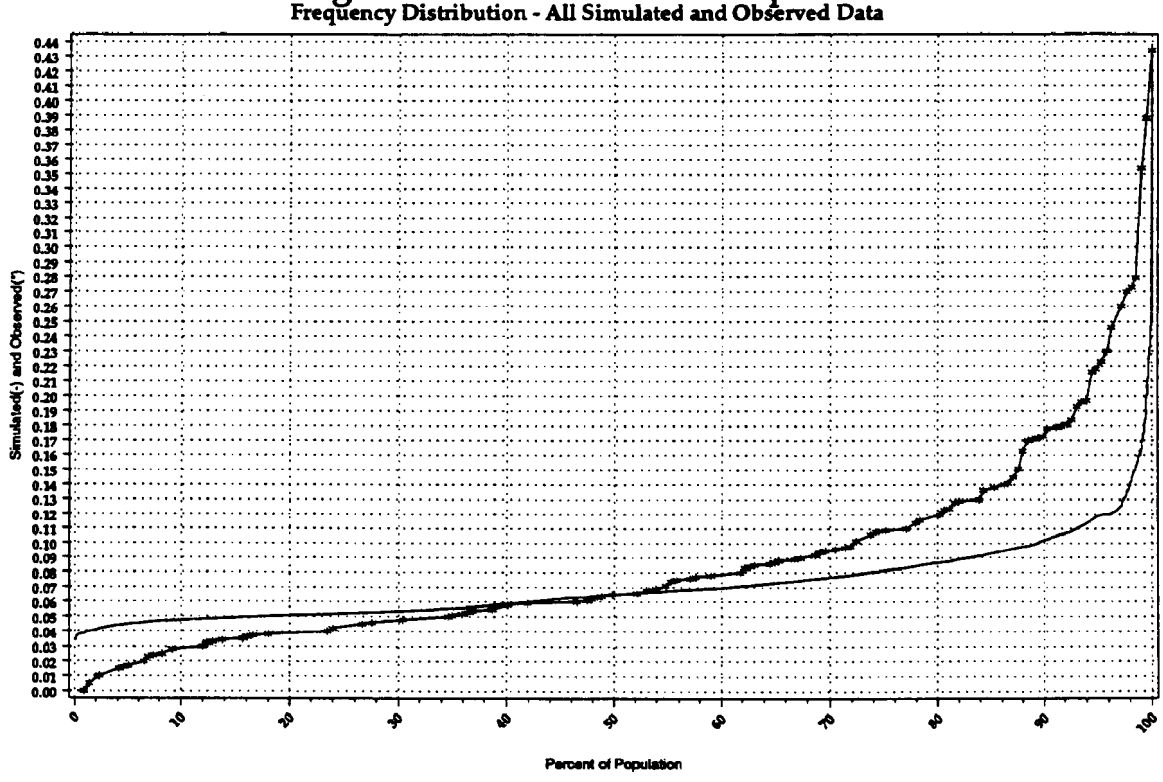
Organic and Particulate Phosphorus



East Branch Susquehanna at Segment 40
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

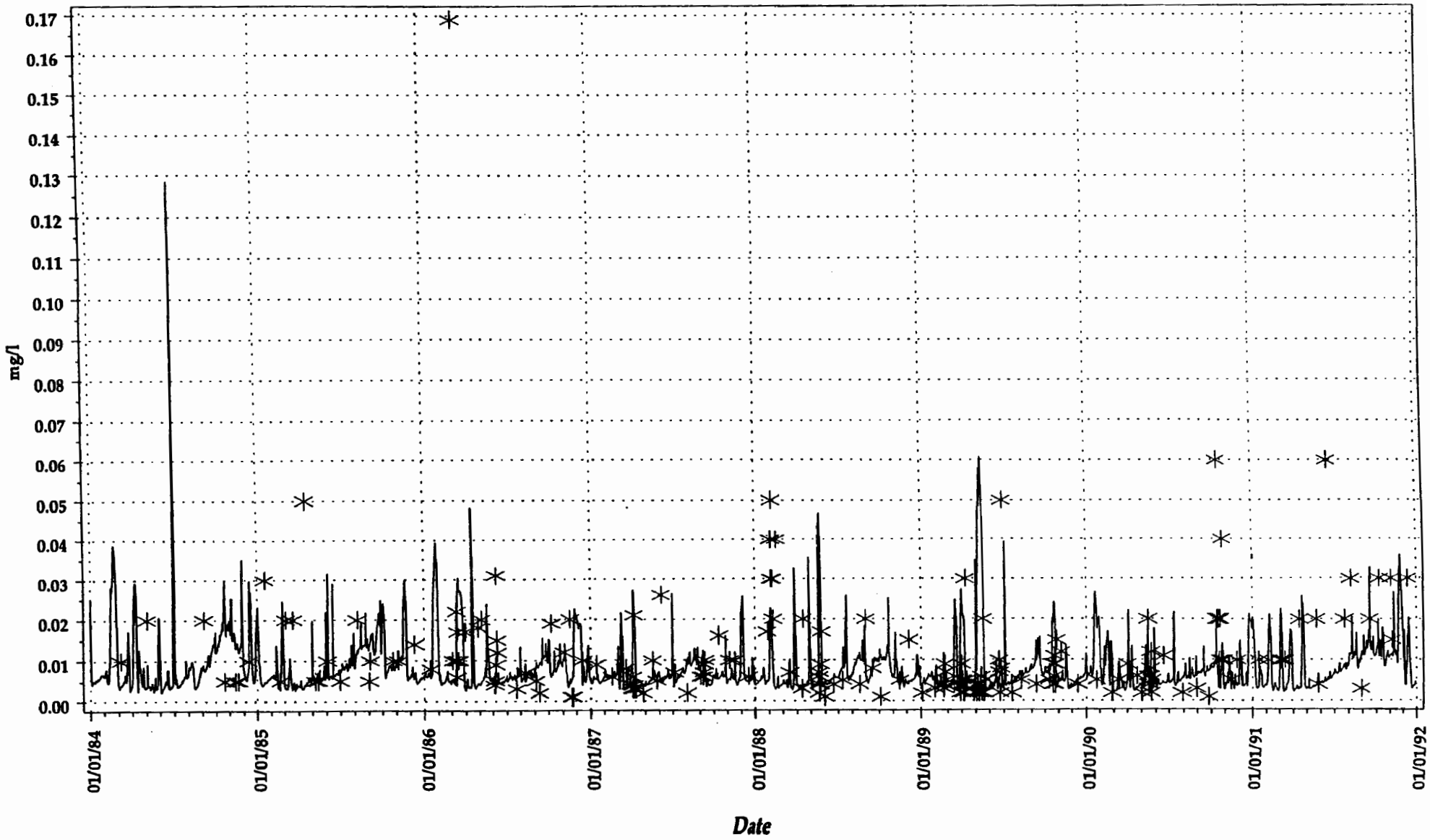


East Branch Susquehanna at Segment 40
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data

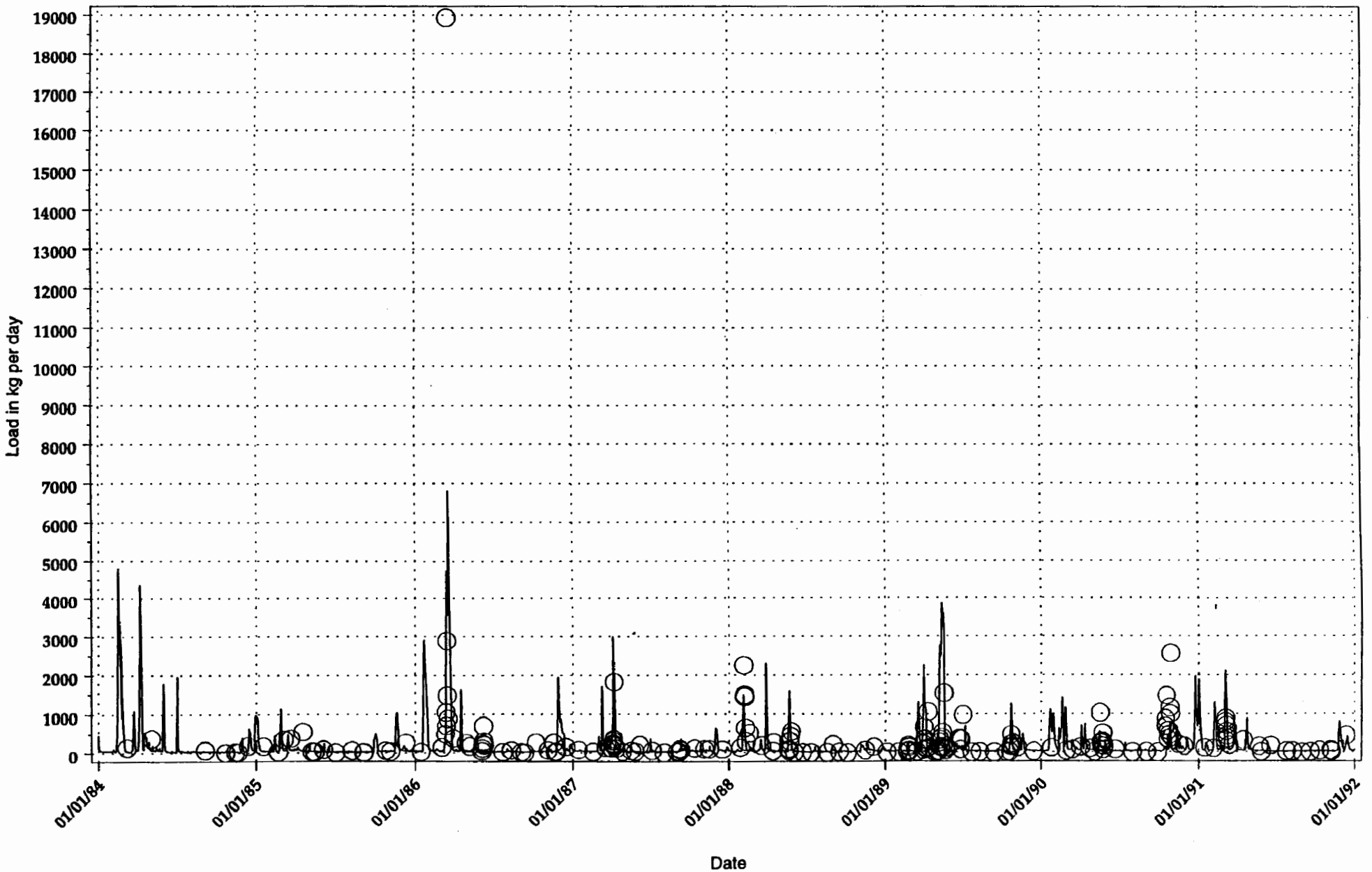


East Branch Susquehanna River at Segment 40
Observed and Simulated versus Time
Dissolved Phosphorus

(*=Observed, -=Simulated)



East Branch Susquehanna River at Segment 40
Dissolved Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

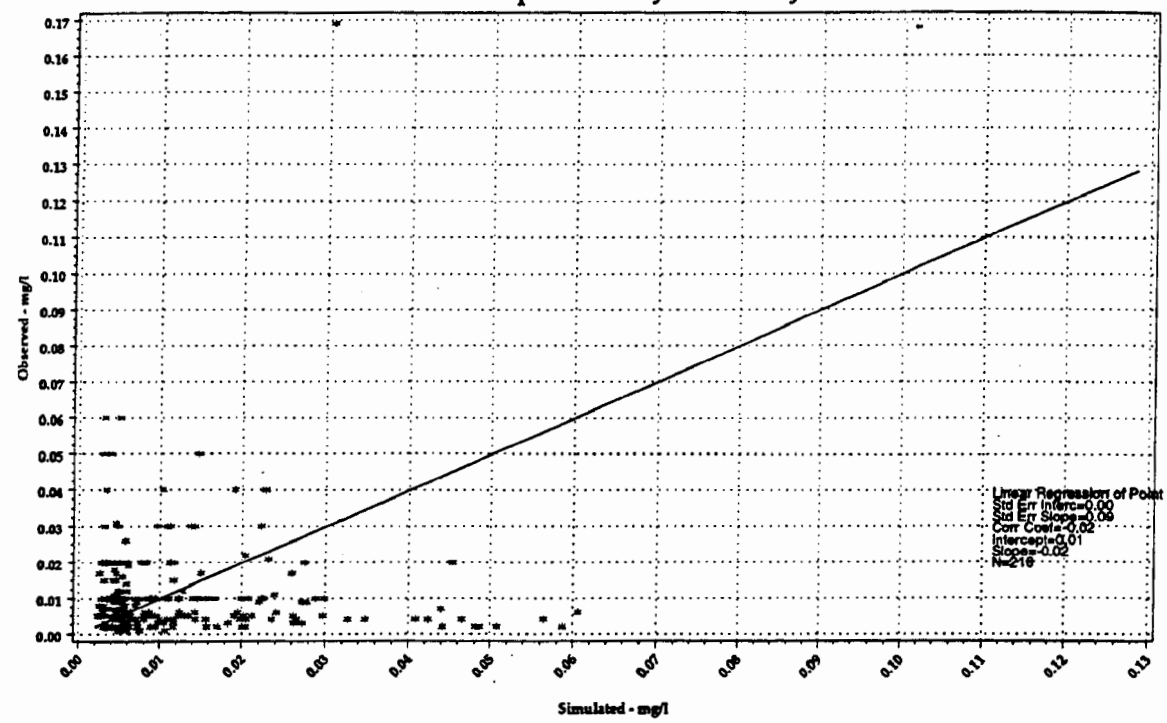


(y21_plot1.sas datastore2 [npe.p3 [smes.sas] lldflas)
(absus2_d.drv1 04FEB98 09:27,proc reg,model y=x)

East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

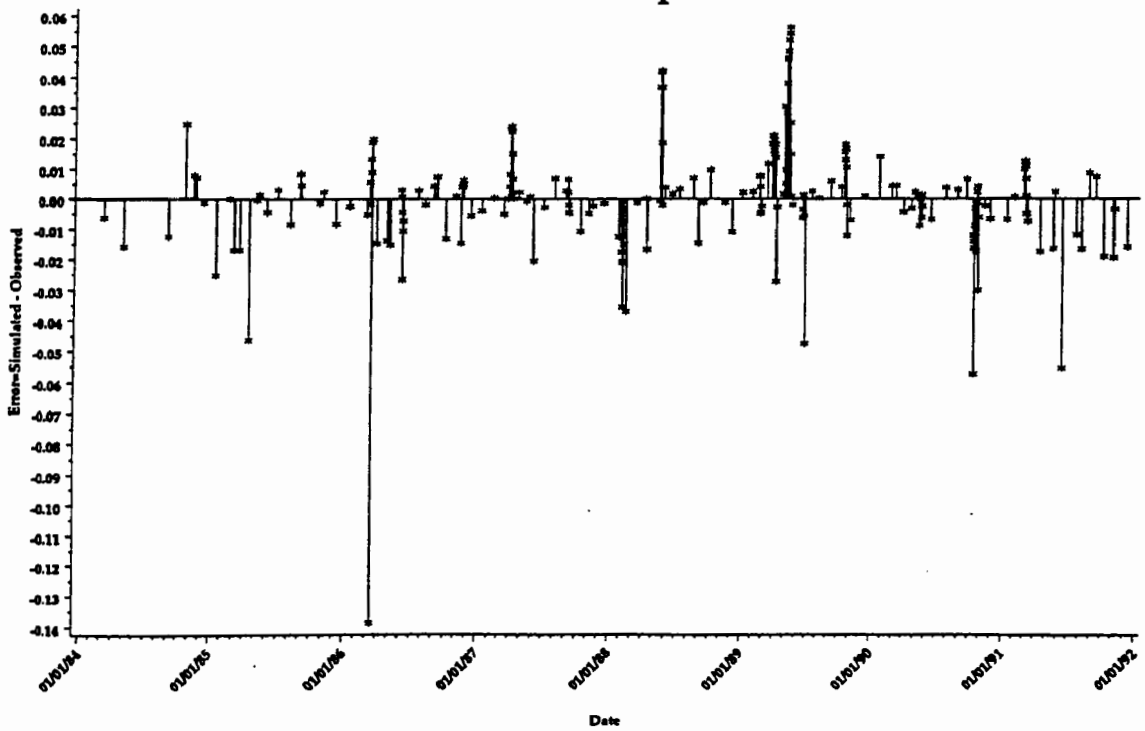
Dissolved Phosphorus: 01JAN84 - 01JAN92



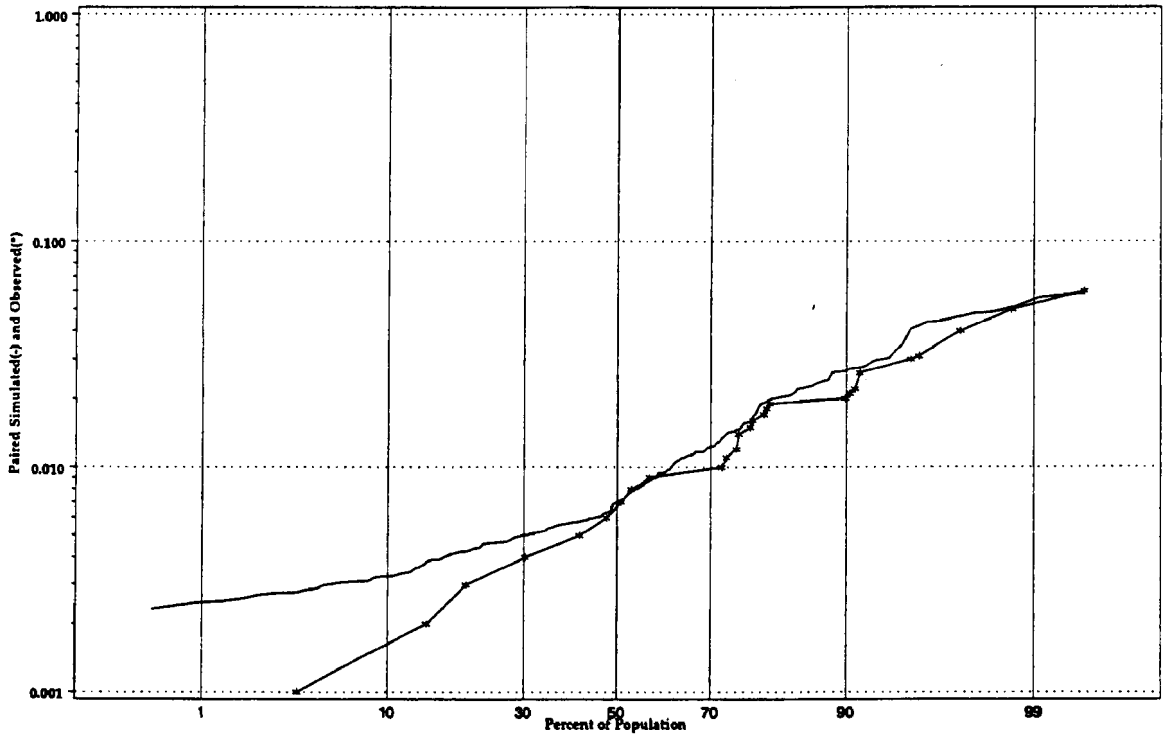
East Branch Susquehanna at Segment 40

Actual Error versus Time

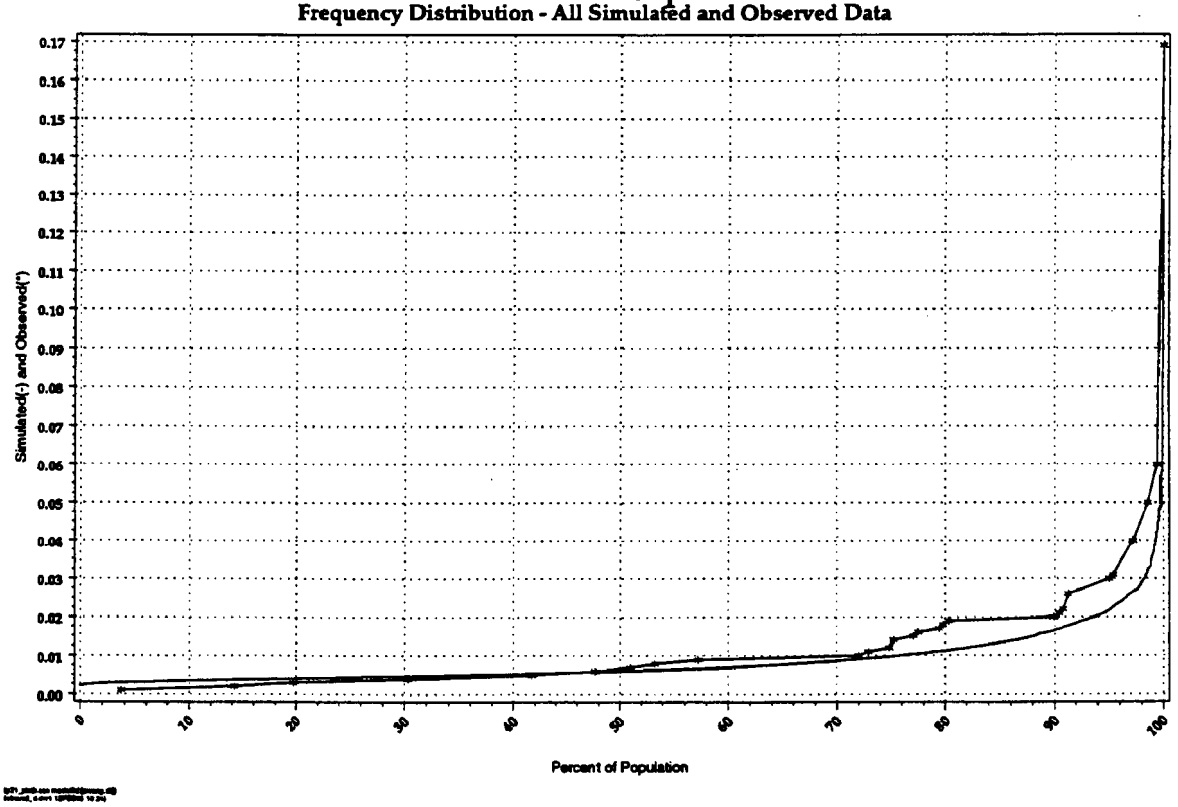
Dissolved Phosphorus



East Branch Susquehanna at Segment 40
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

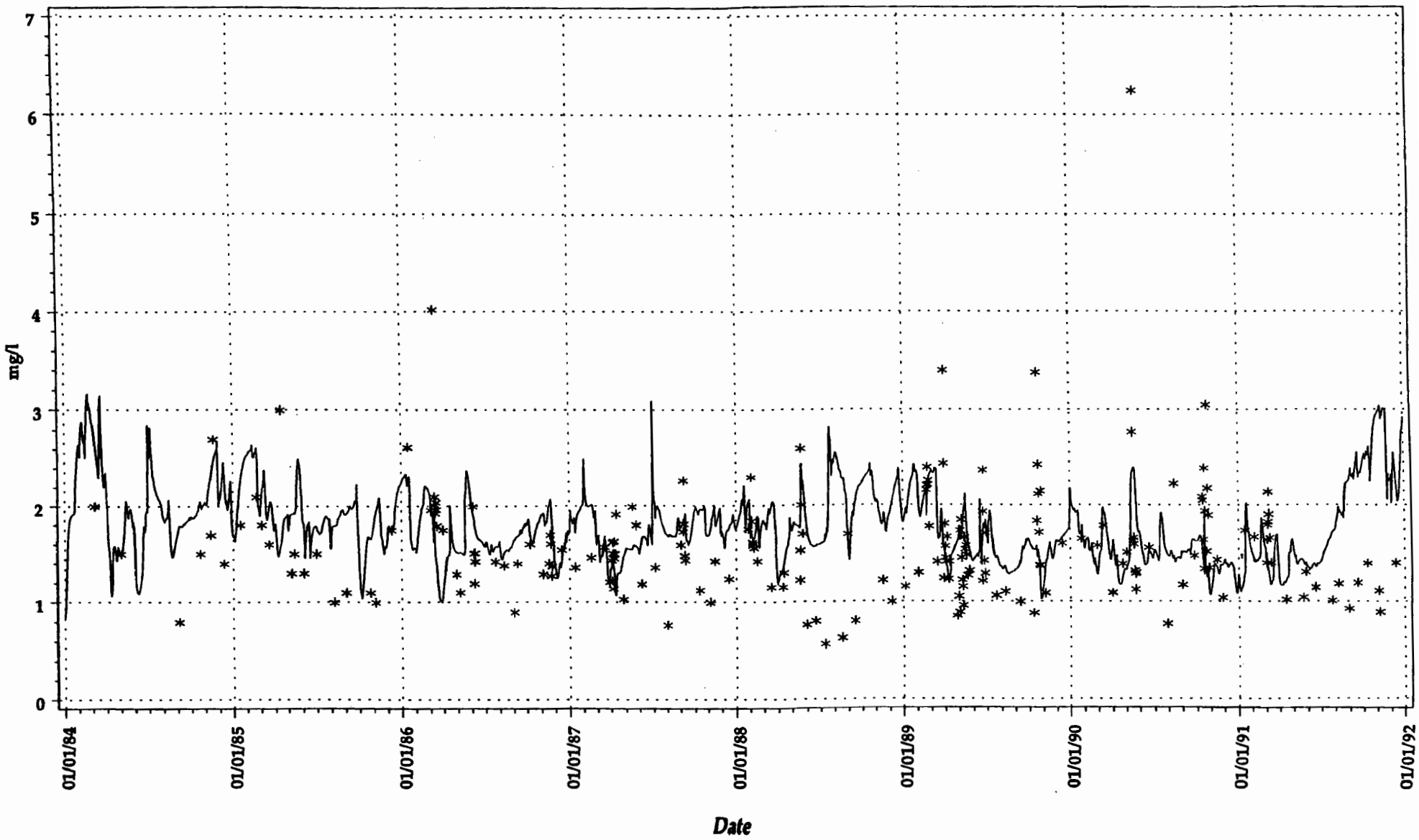


East Branch Susquehanna at Segment 40
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data

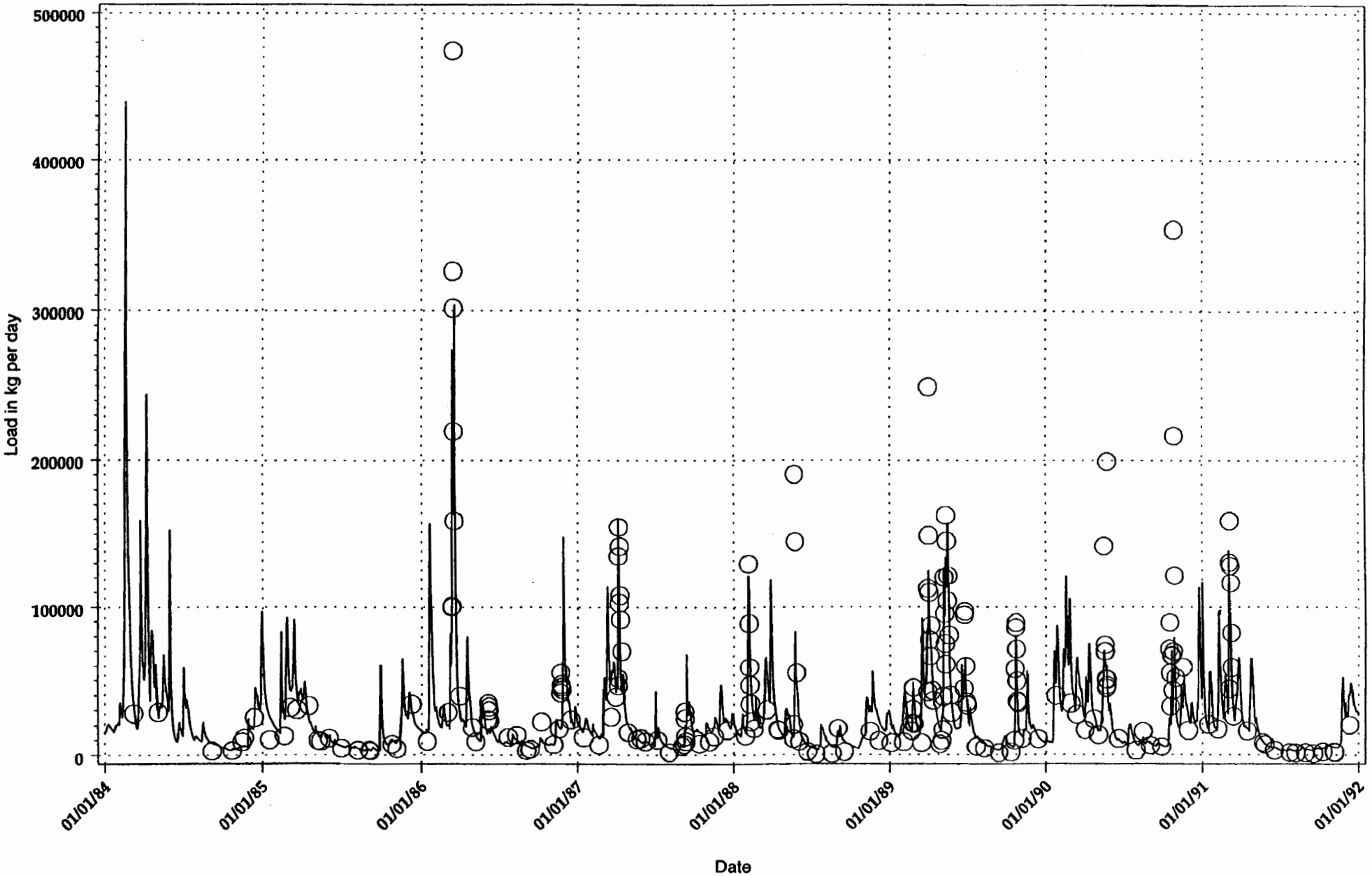


East Branch Susquehanna River at Segment 40
Observed and Simulated versus Time
Total Nitrogen

(*=Observed, -=Simulated)



East Branch Susquehanna River at Segment 40
Total Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)

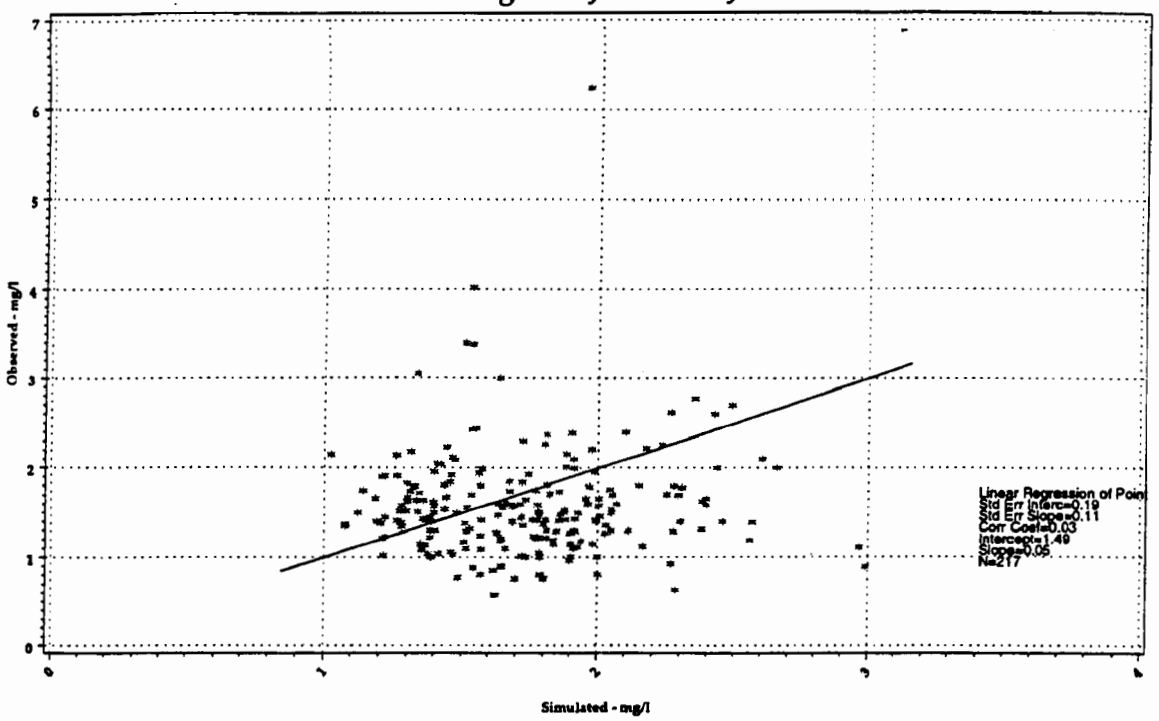


(y21_plot1.sas datastore2.jrpe.p3.james sas) 5dfiles)
(obsus2_d.drv1 04FEB98 09:27,proc reg,model y=x)

East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

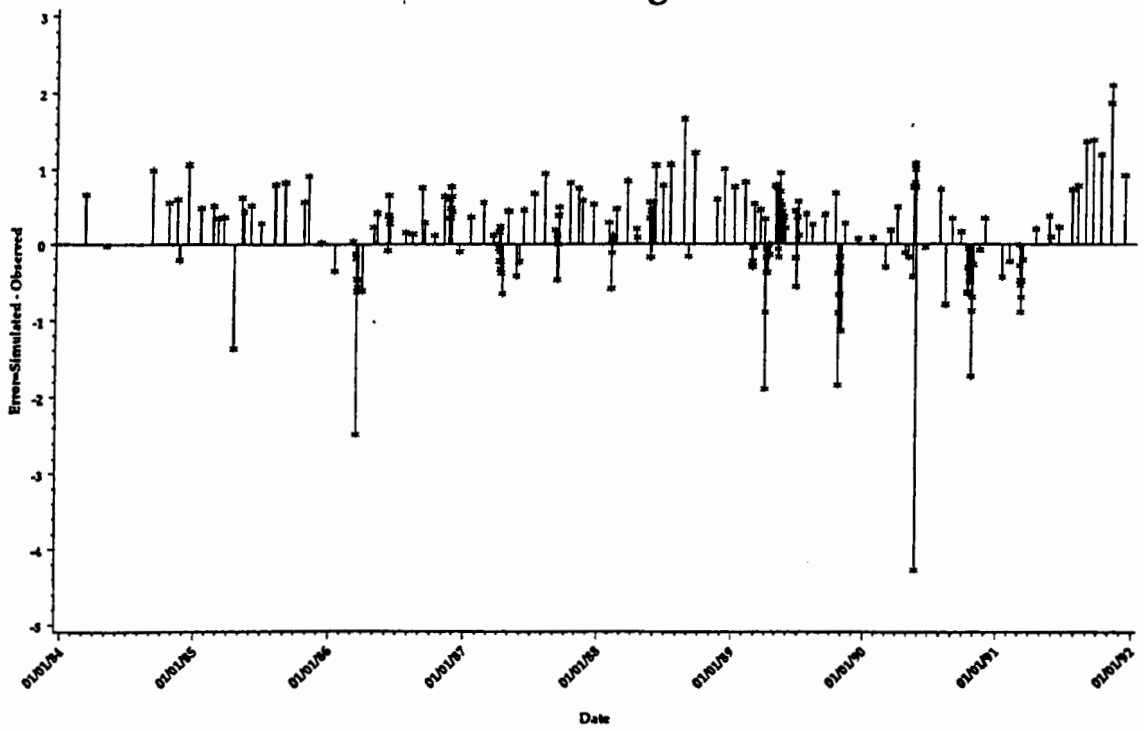
Total Nitrogen: 01JAN84 - 01JAN92



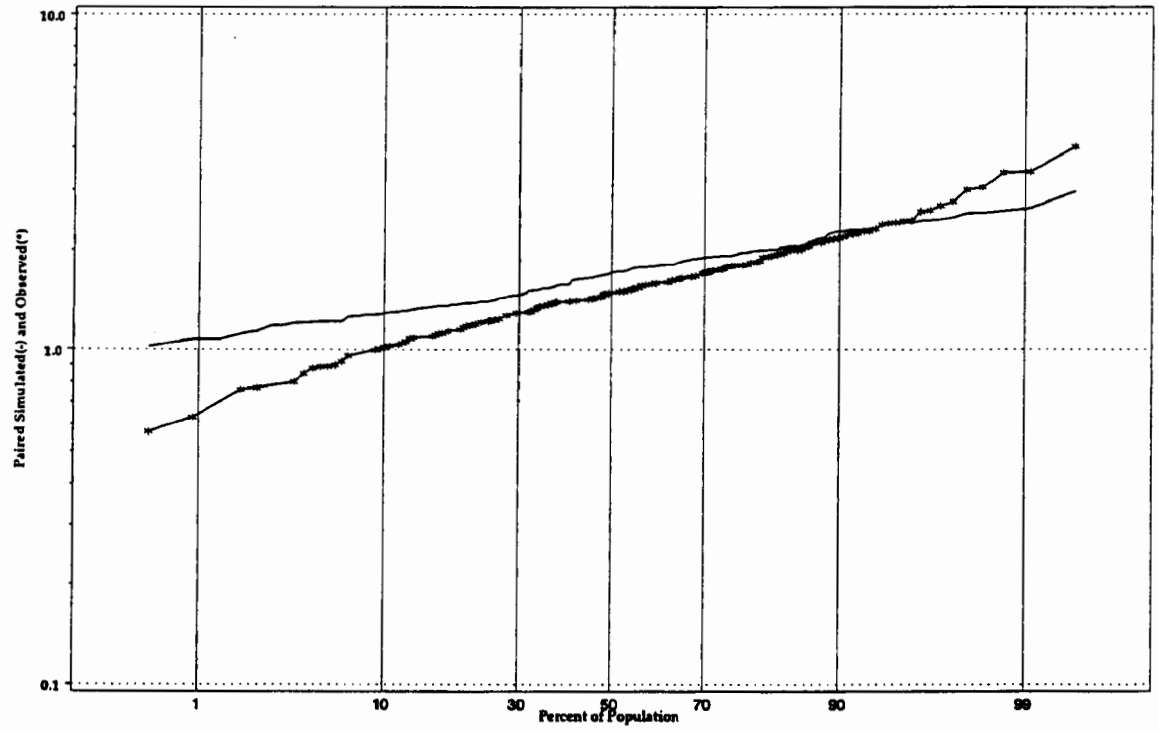
East Branch Susquehanna at Segment 40

Actual Error versus Time

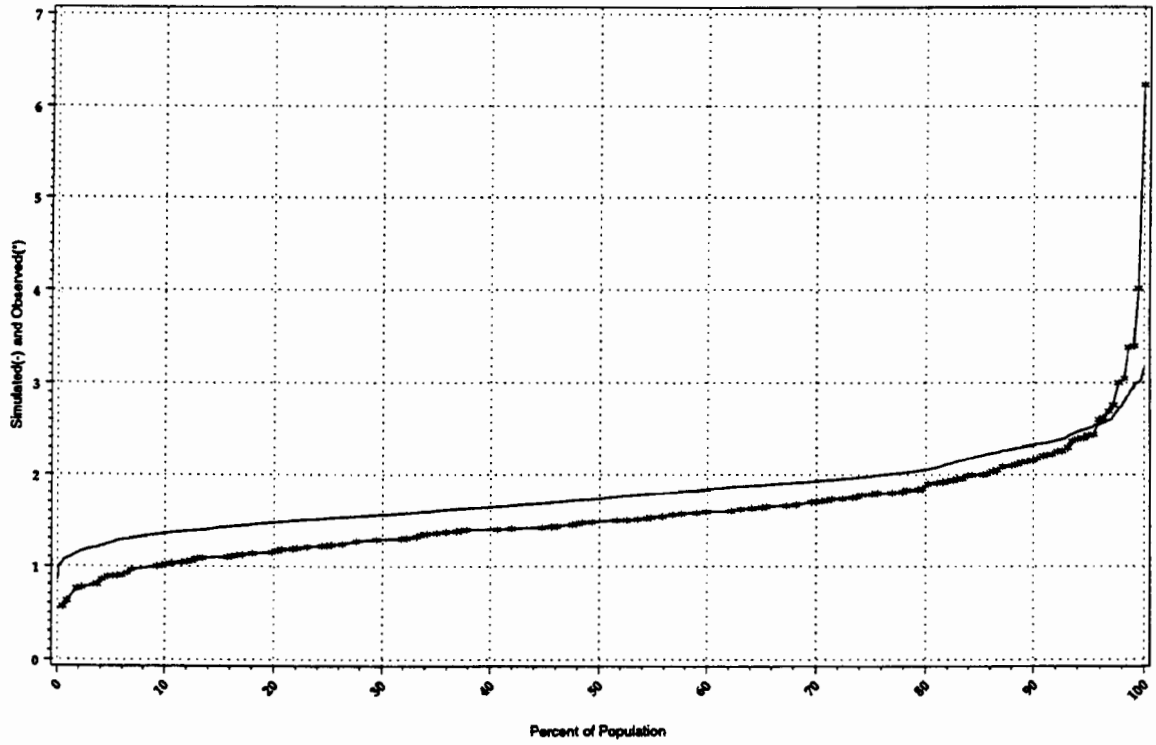
Total Nitrogen



East Branch Susquehanna at Segment 40
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

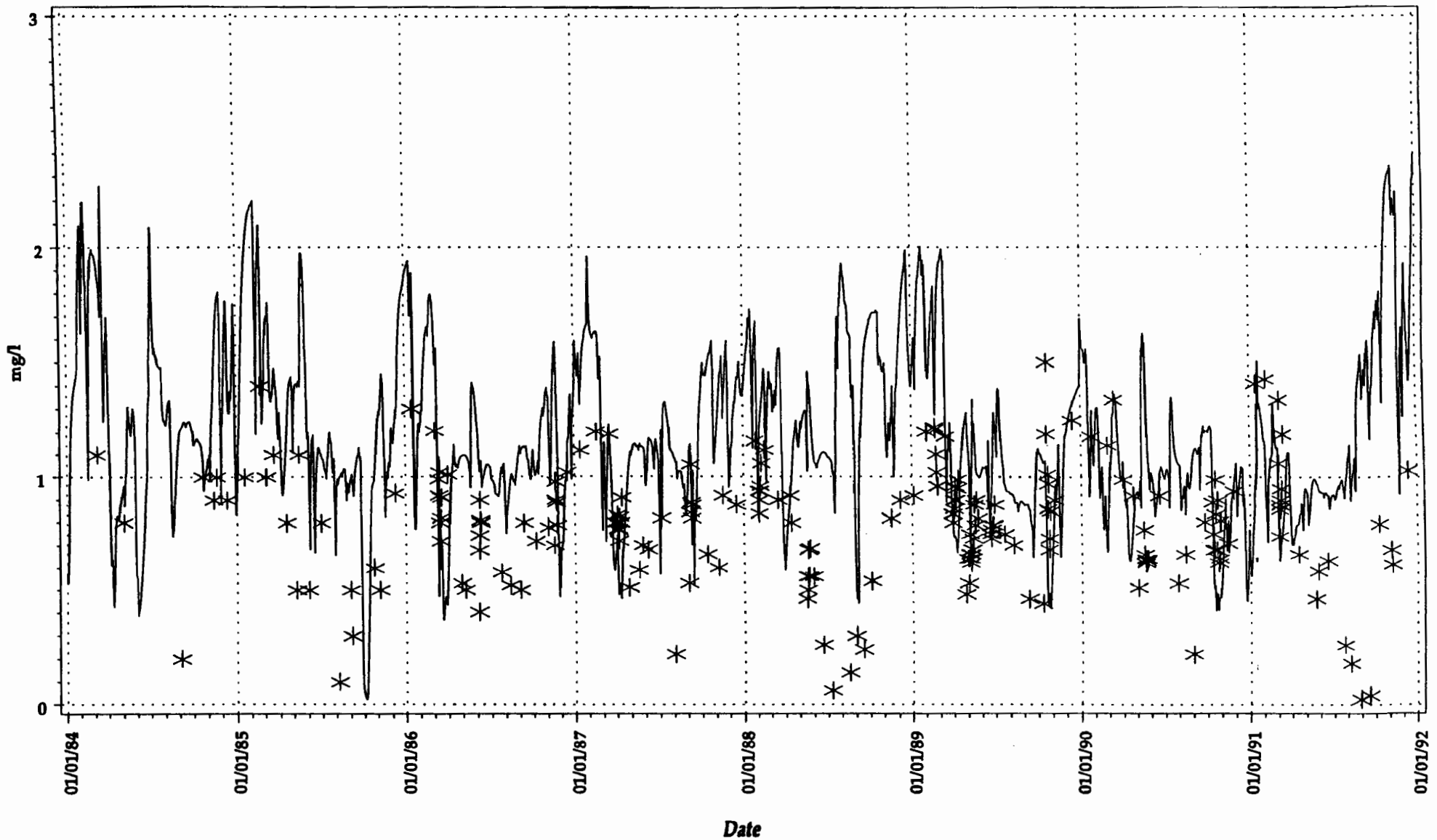


East Branch Susquehanna at Segment 40
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data



East Branch Susquehanna River at Segment 40
Observed and Simulated versus Time
NO3

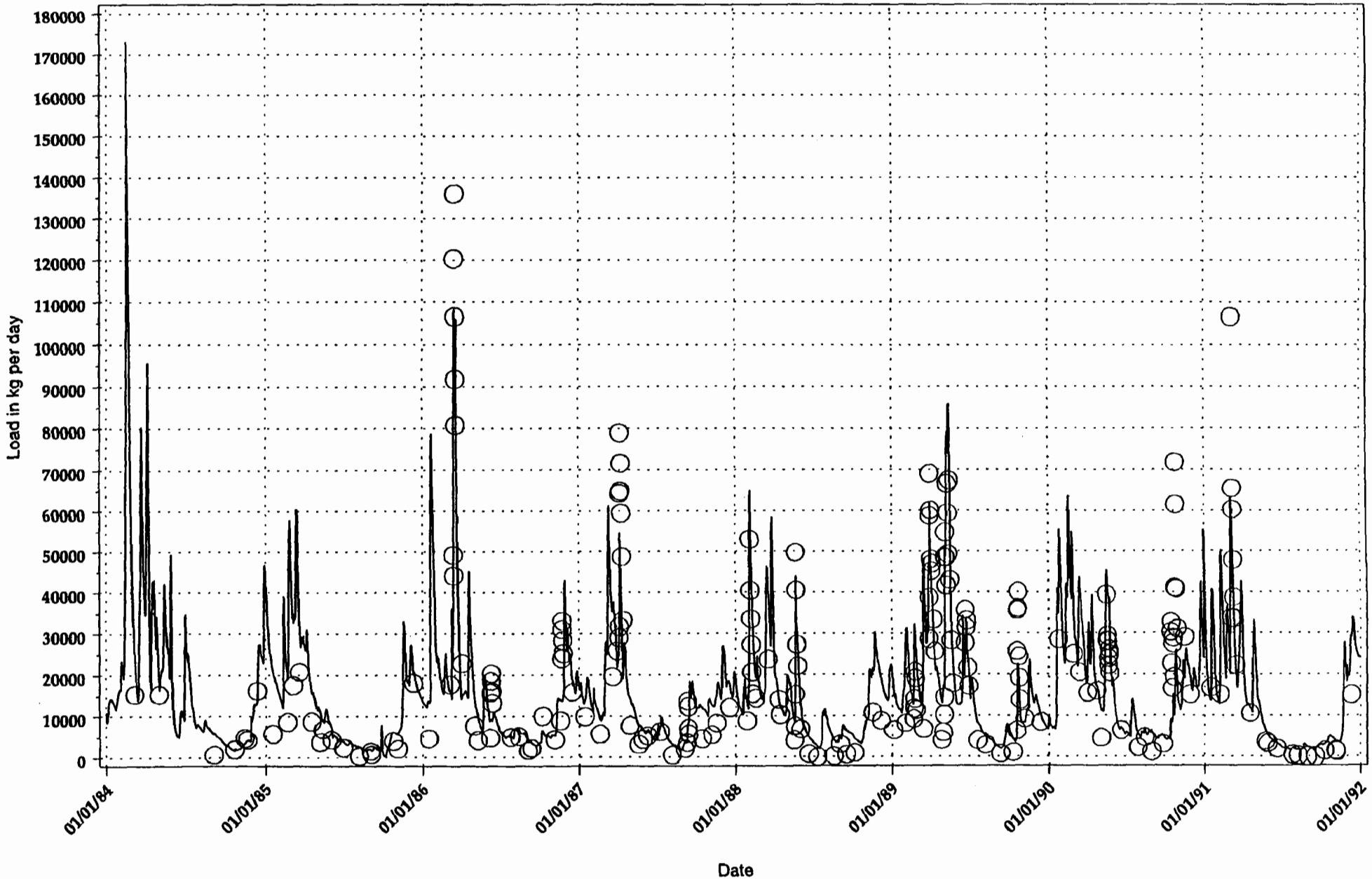
(*=Observed, -=Simulated)



East Branch Susquehanna River at Segment 40

NO3 Observed and Simulated Load vs Time

(line = simulated, O = observed)

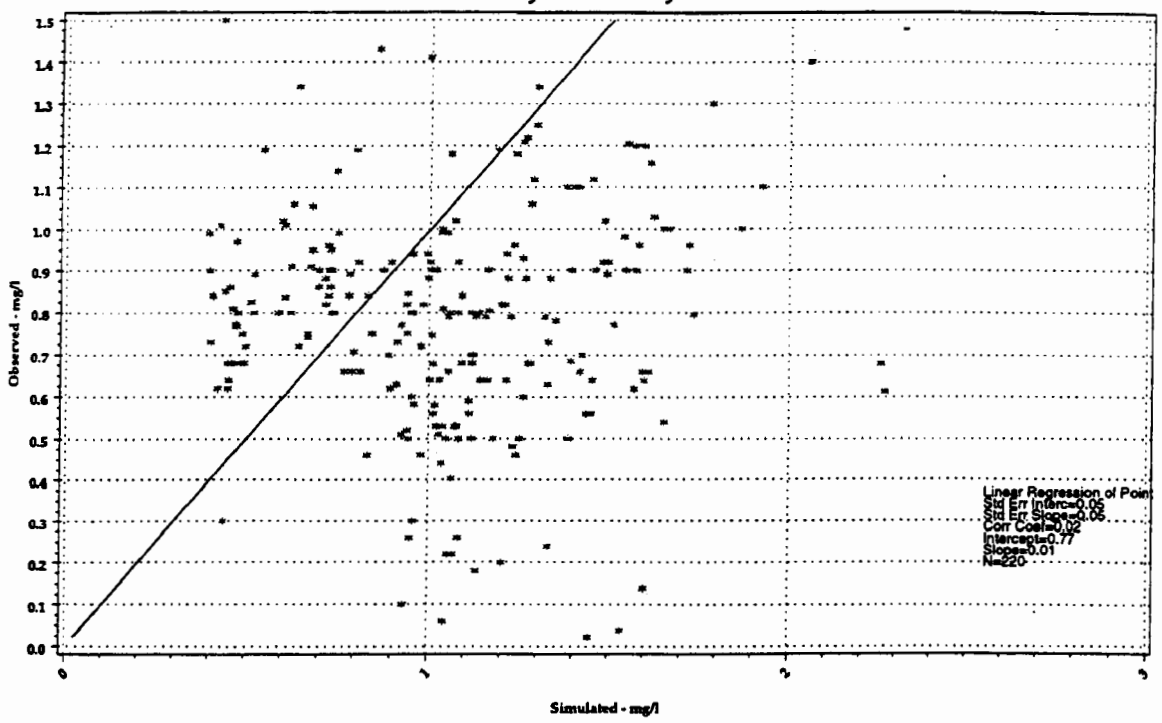


(y21_plot1.sas datastore2 (rps.p3.jamee.sas) 8dfile)
(graph_a.div 28JAN98 19:55.proc reg.model y=x)

East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

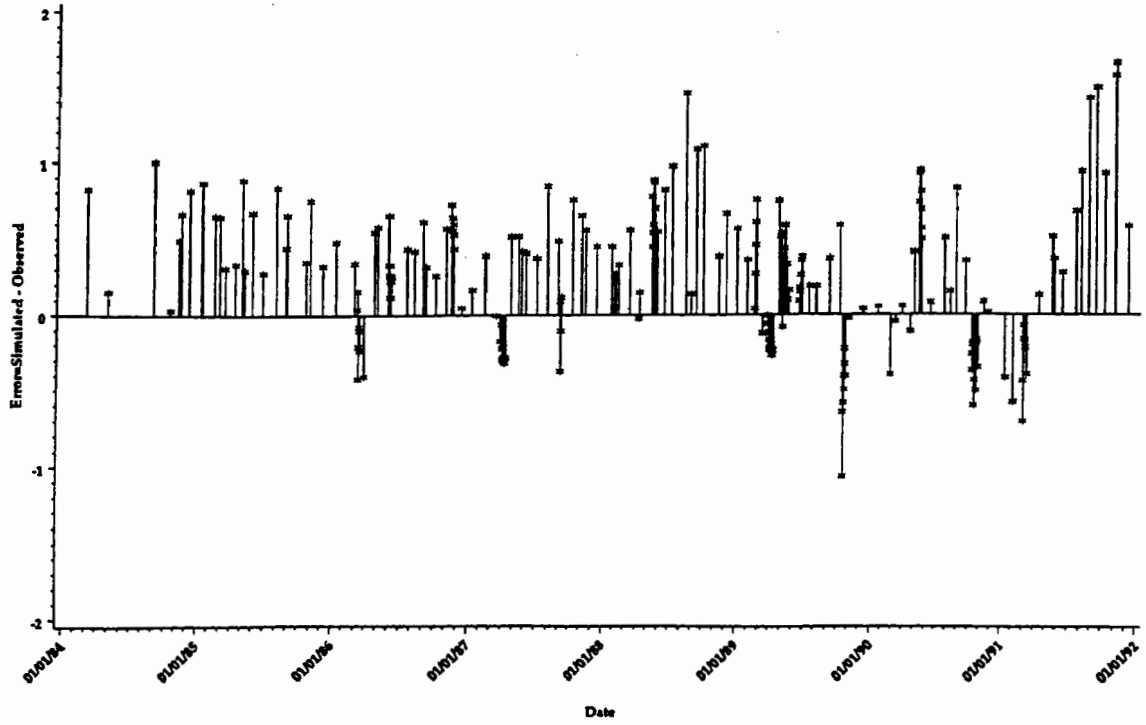
NO3: 01JAN84 - 01JAN92



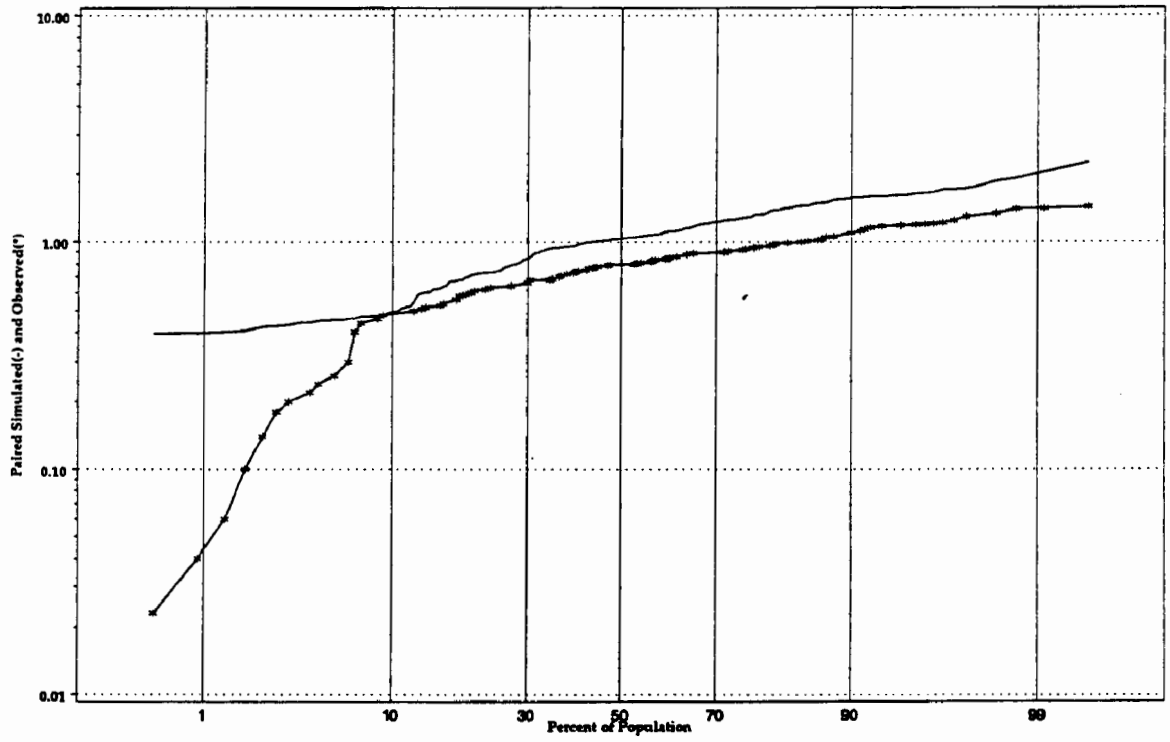
East Branch Susquehanna at Segment 40

Actual Error versus Time

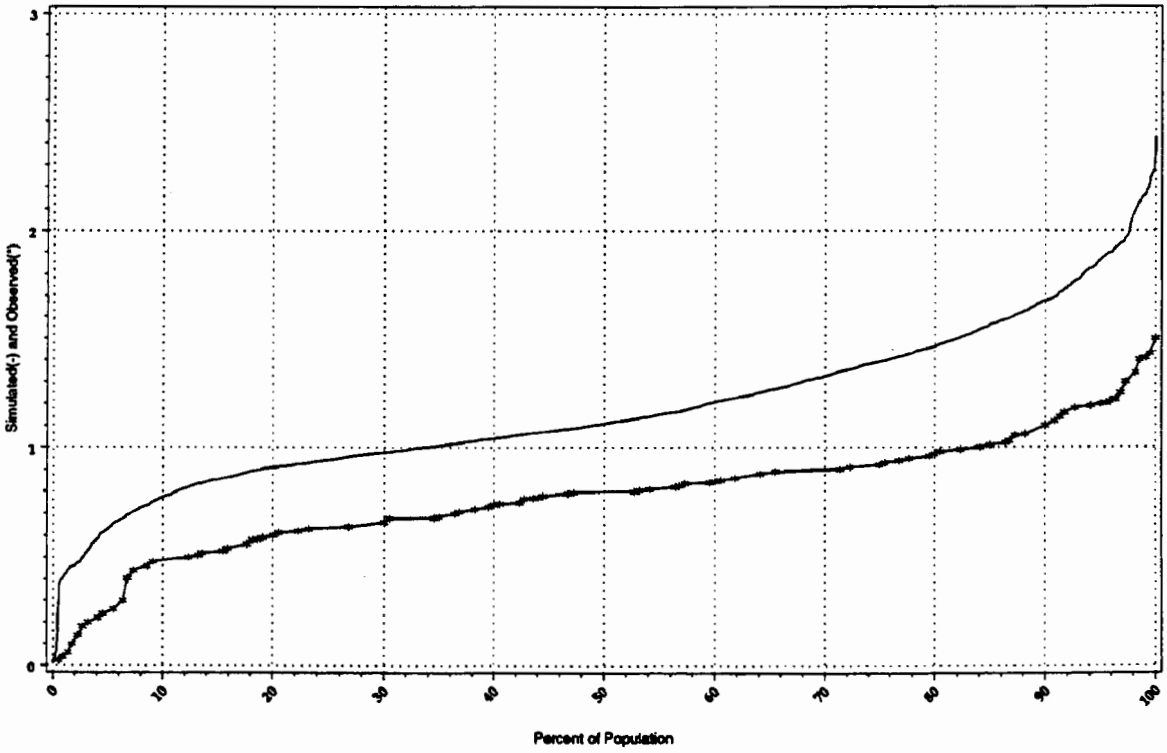
NO3



East Branch Susquehanna at Segment 40
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

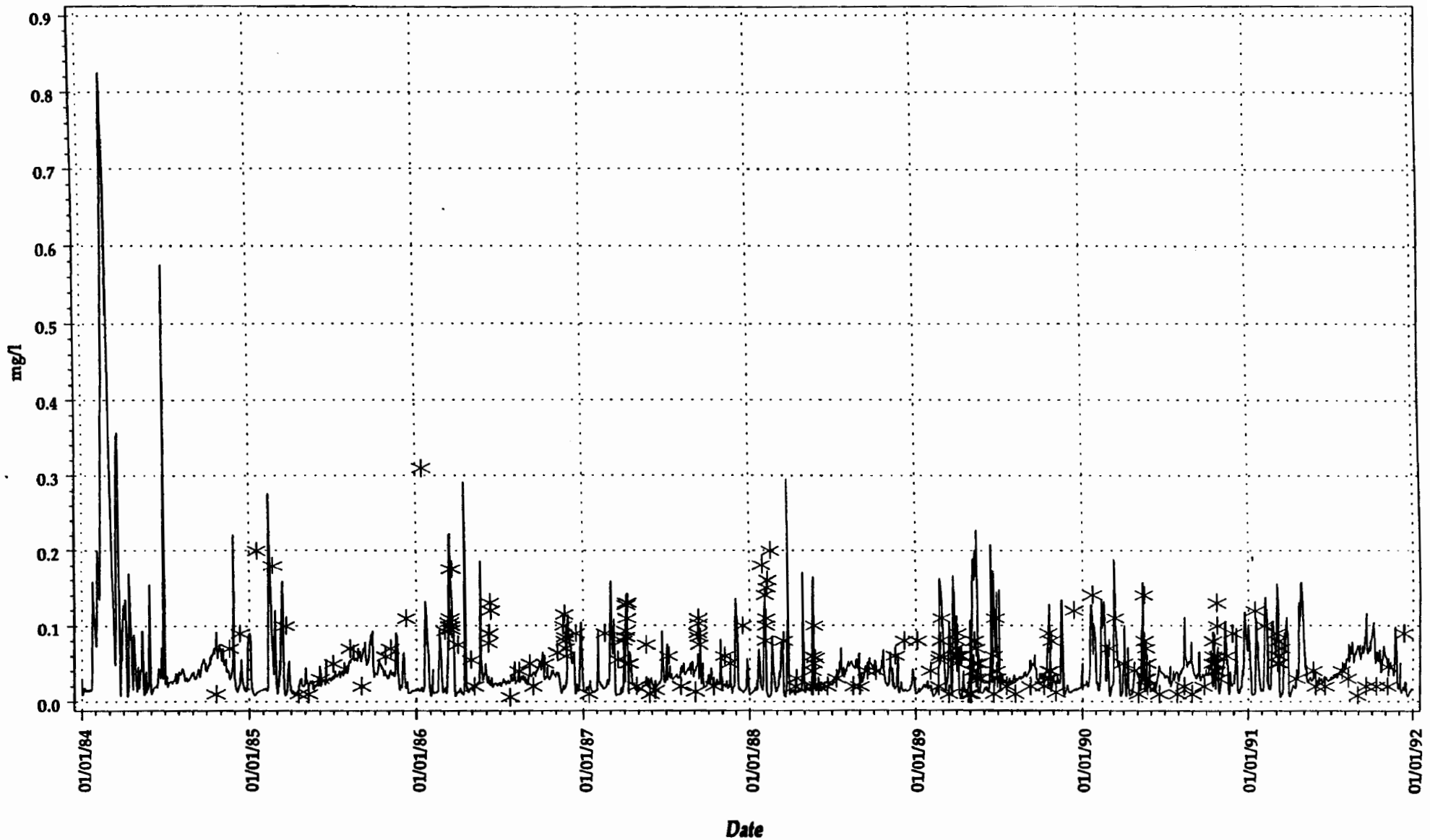


East Branch Susquehanna at Segment 40
NO3
Frequency Distribution - All Simulated and Observed Data

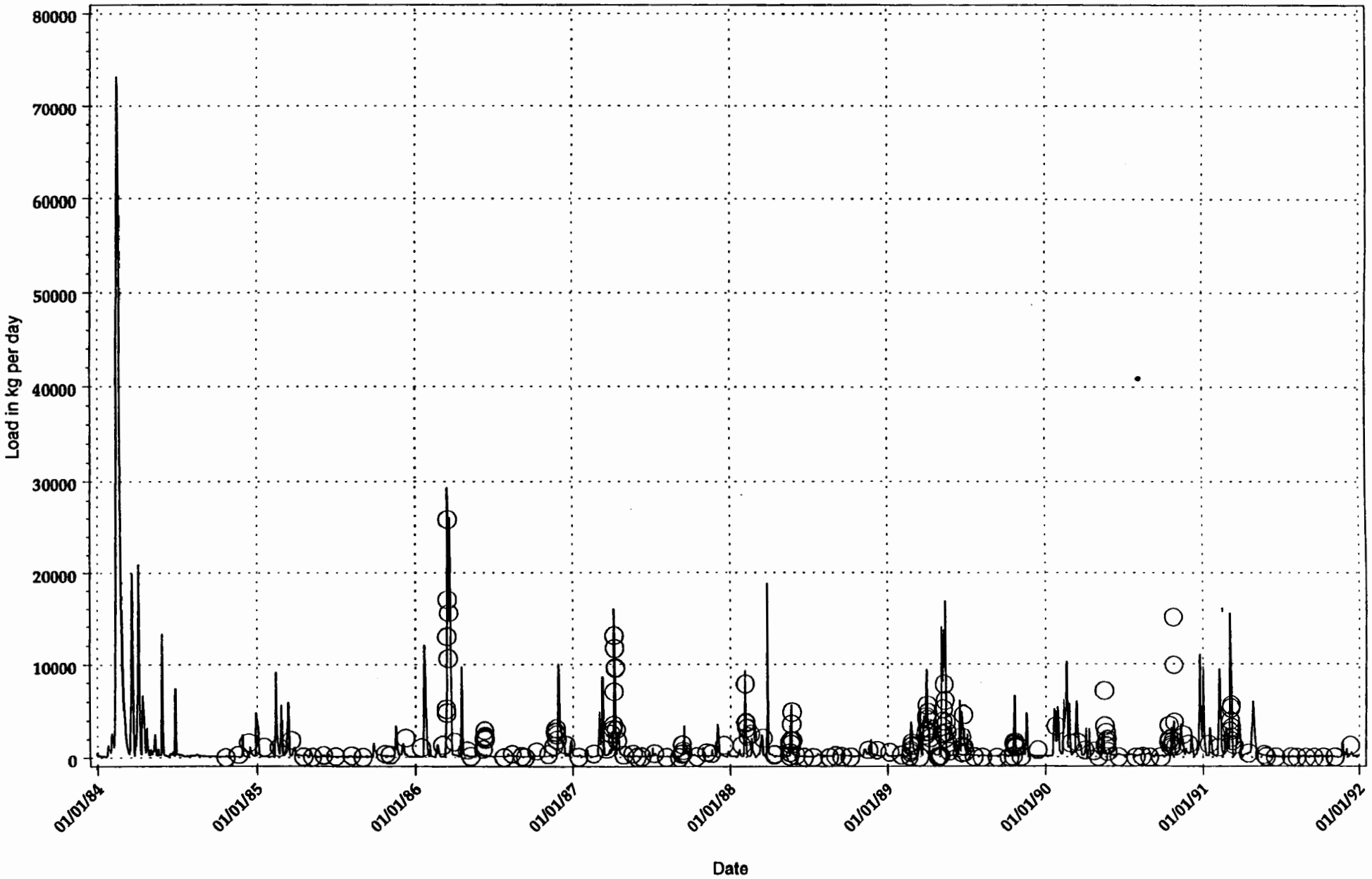


East Branch Susquehanna River at Segment 40
Observed and Simulated versus Time
Total Ammonia

(*=Observed, -=Simulated)



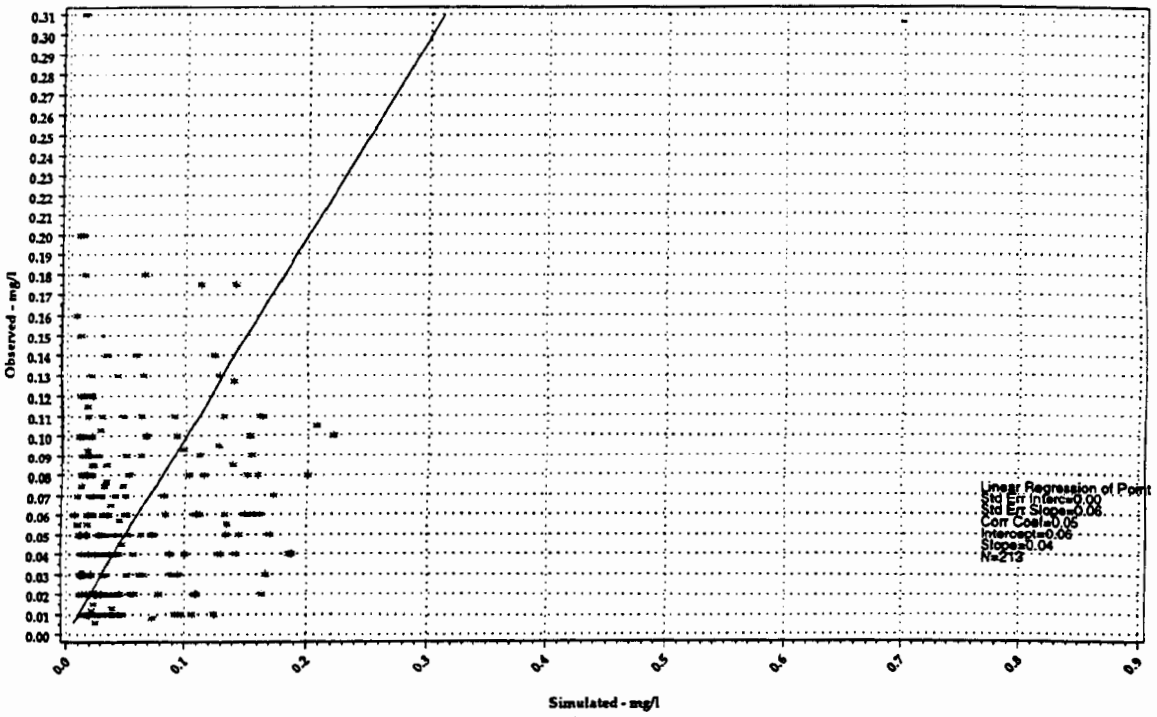
East Branch Susquehanna River at Segment 40
Total Ammonia Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plot1.sas datastore2:[npe.p3.]emes.sas] ldlfas)
(graph_a.drv 28JAN99 19:55,proc reg,model y=x)

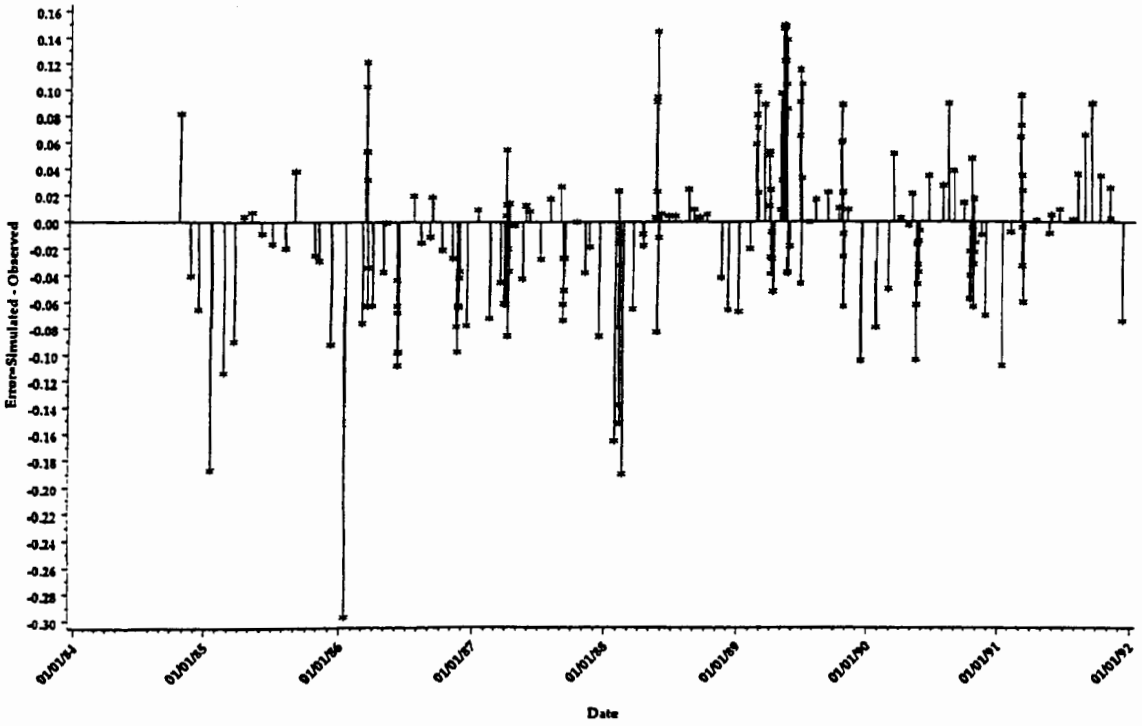
East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Ammonia: 01JAN84 - 01JAN92

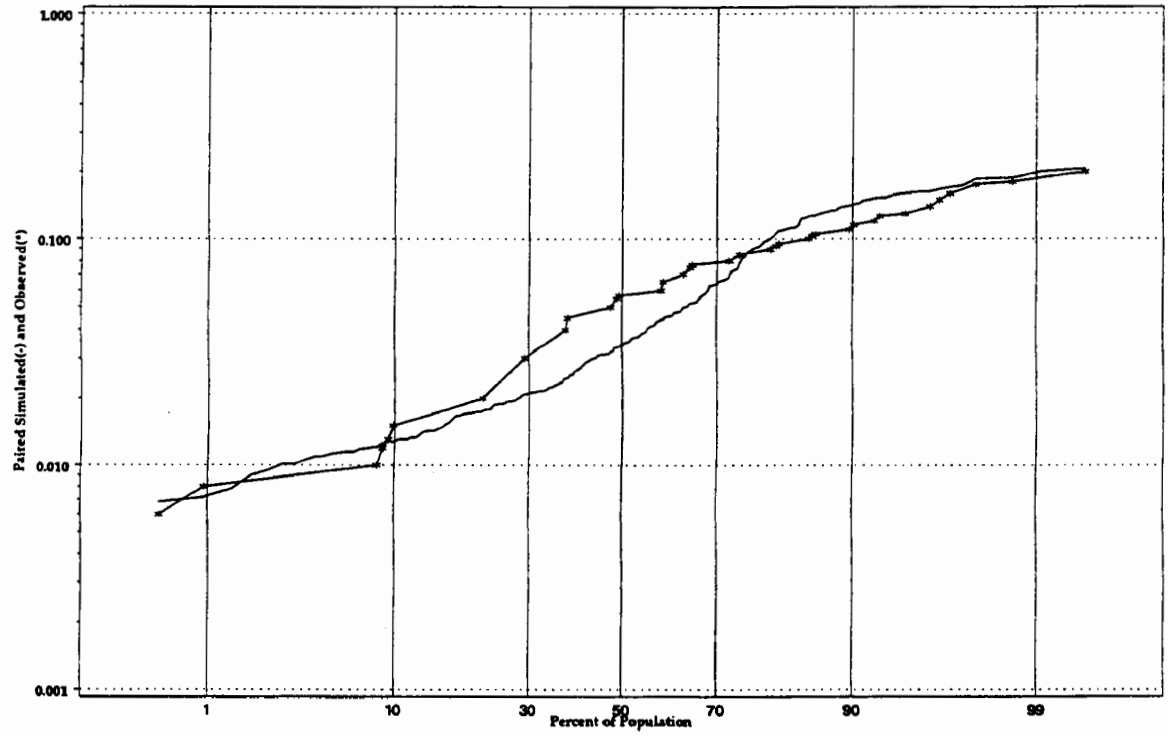


East Branch Susquehanna at Segment 40

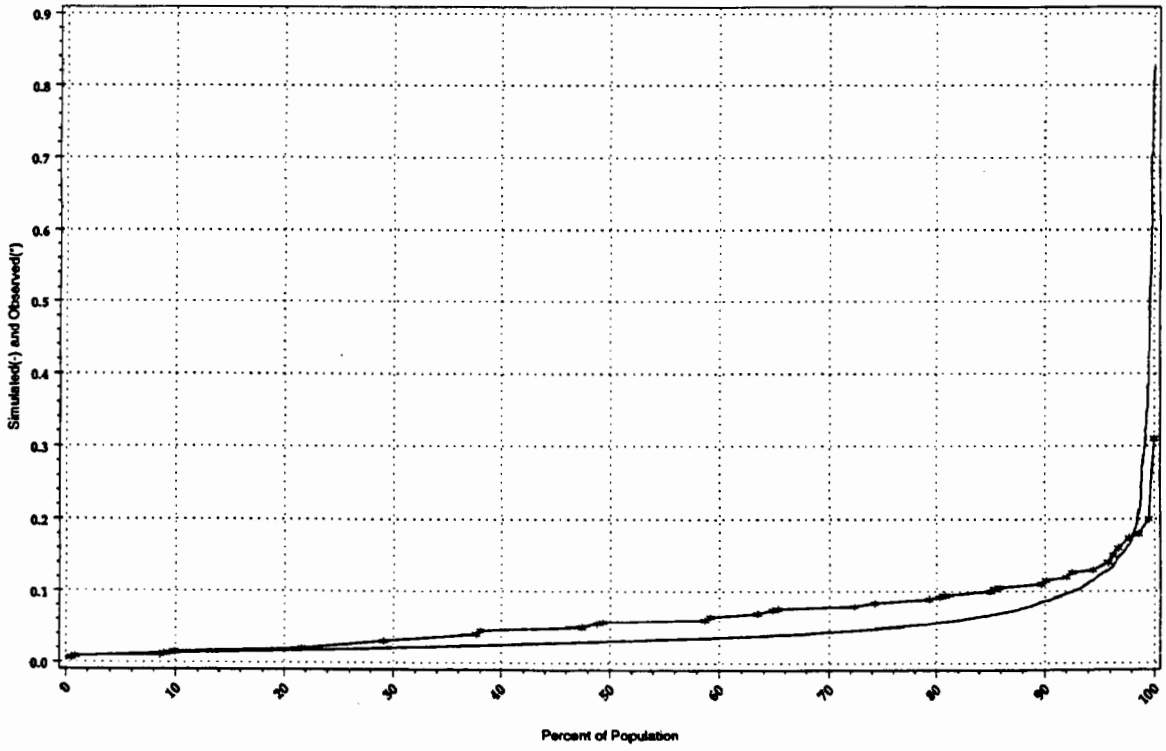
Actual Error versus Time
Total Ammonia



East Branch Susquehanna at Segment 40
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data

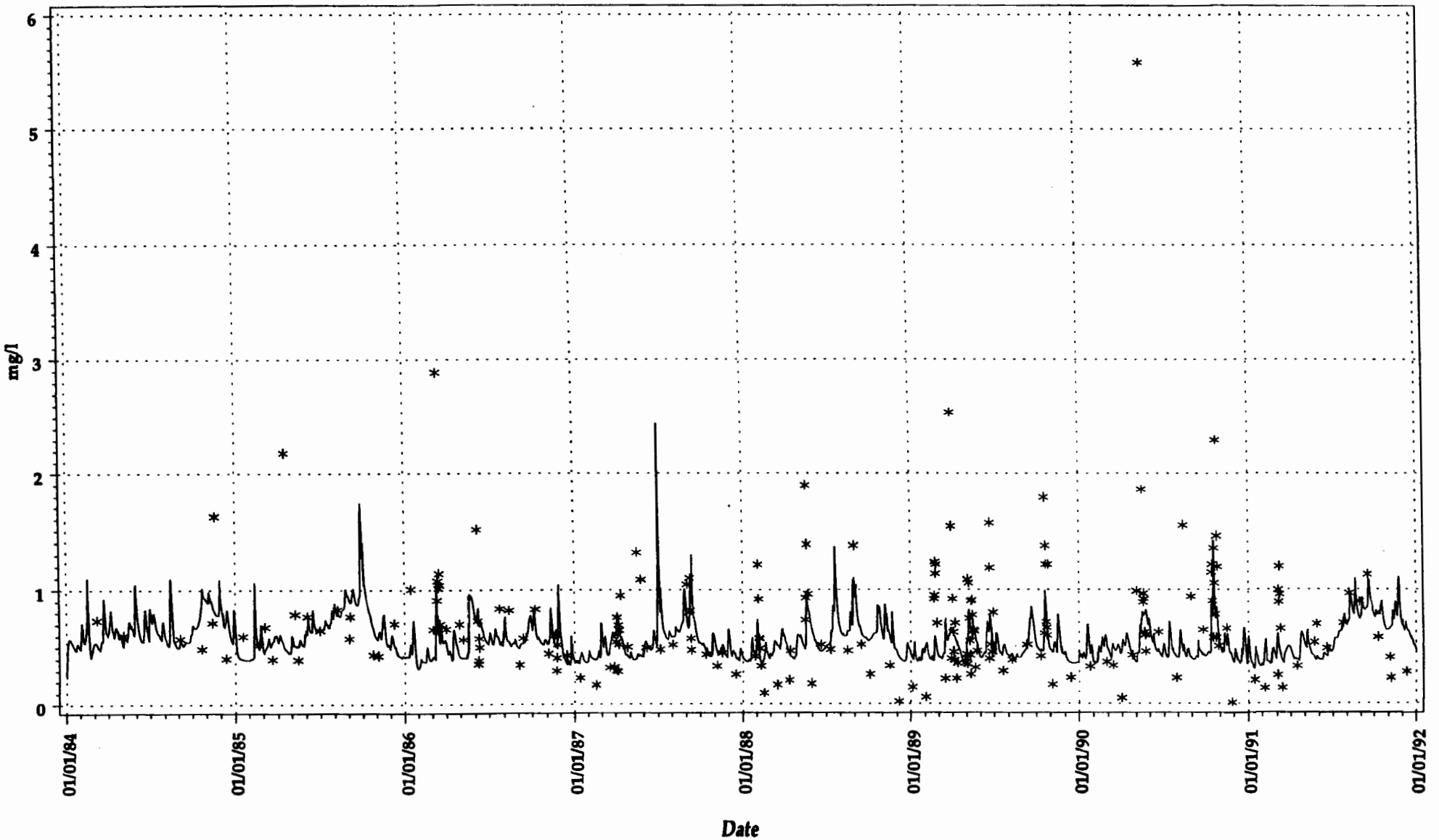


East Branch Susquehanna at Segment 40
Total Ammonia
Frequency Distribution - All Simulated and Observed Data

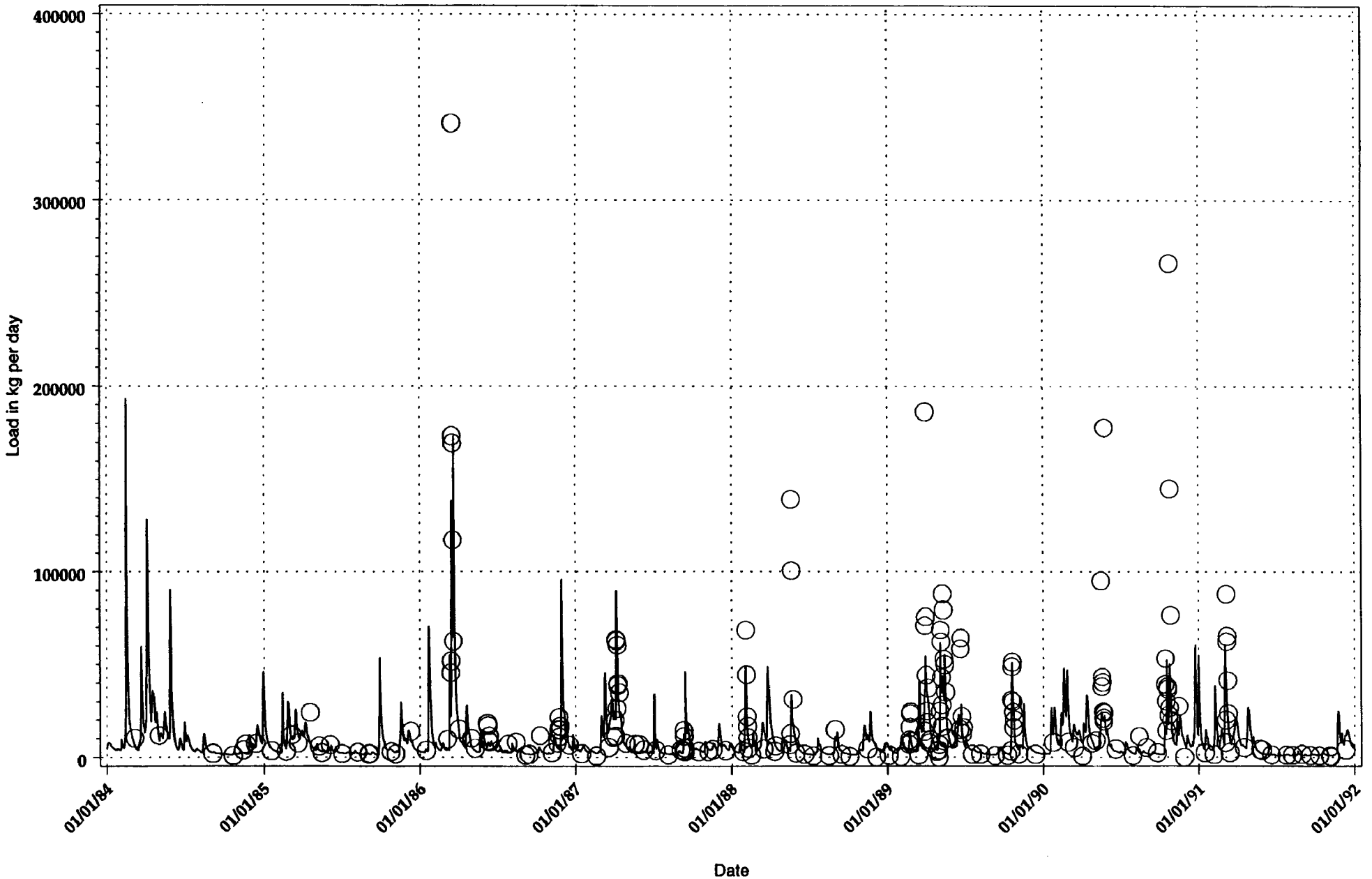


East Branch Susquehanna at Segment 40
Observed and Simulated versus Time
Organic Nitrogen

(*=Observed, -=Simulated)



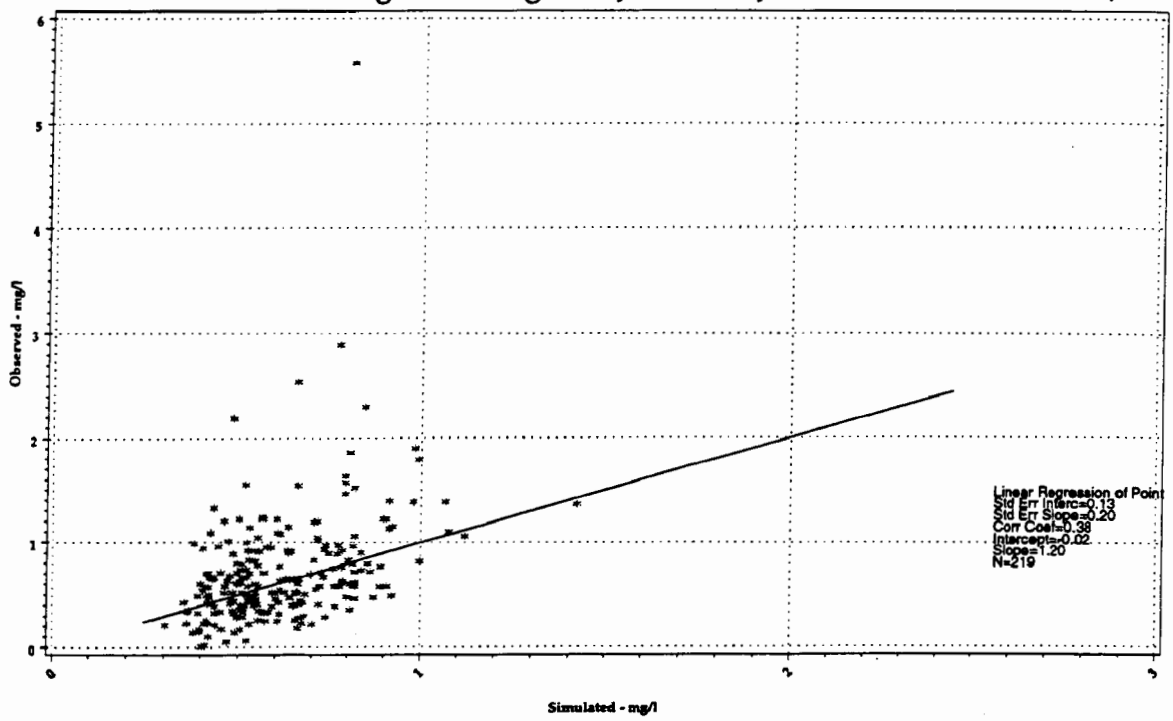
East Branch Susquehanna at Segment 40
Organic Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plotb.sas model3d:[pwang.dl] ldlles)
(ebsua2_d.drv1 23FEB98 09:08 proc reg model y=x)

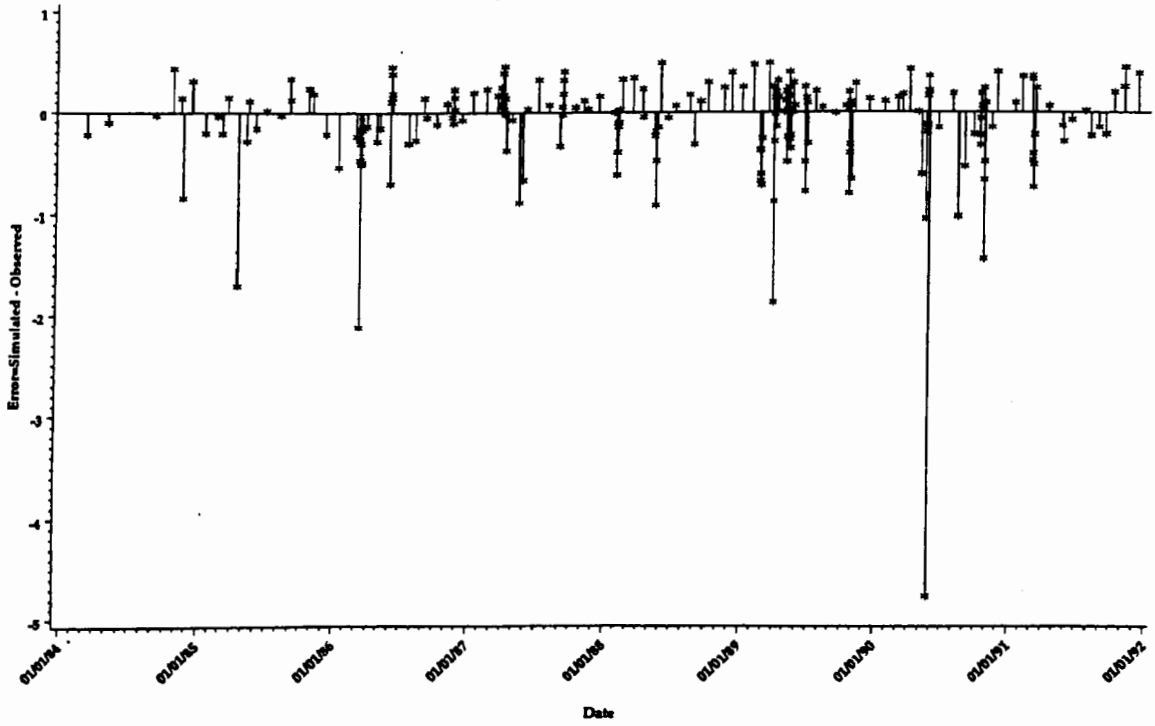
East Branch Susquehanna at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Organic Nitrogen: 01JAN84 - 01JAN92



East Branch Susquehanna at Segment 40

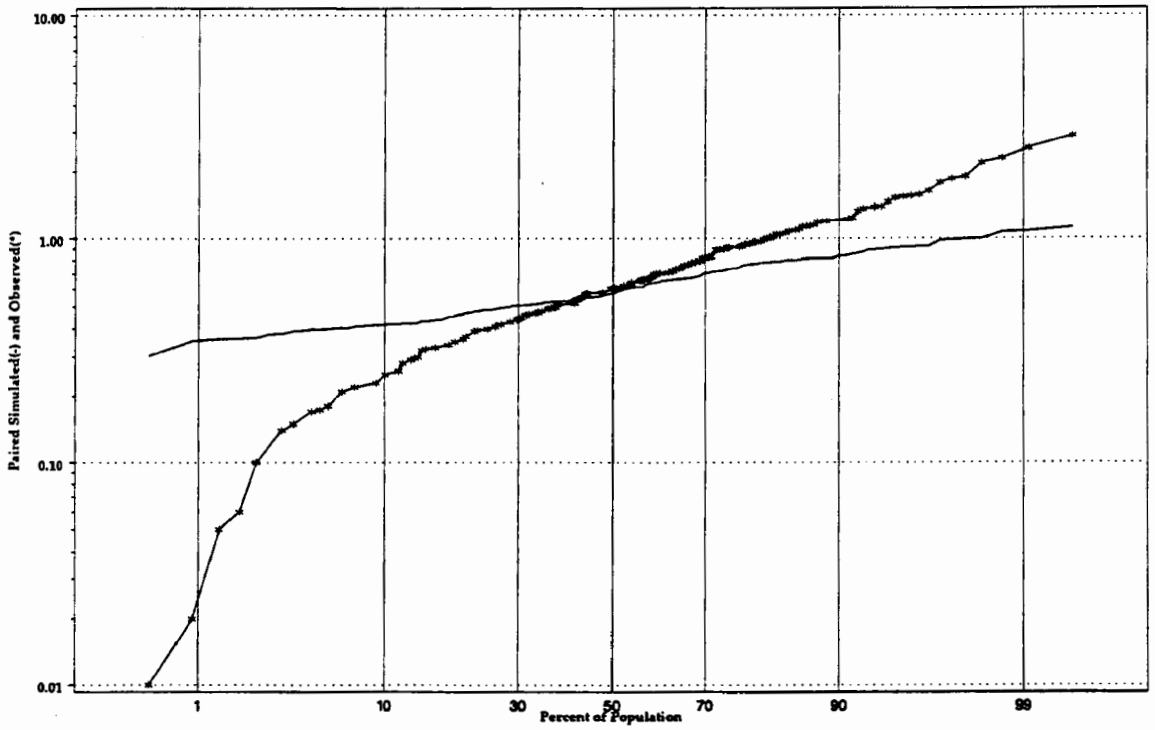
Actual Error versus Time
Organic Nitrogen



East Branch Susquehanna at Segment 40

Organic Nitrogen

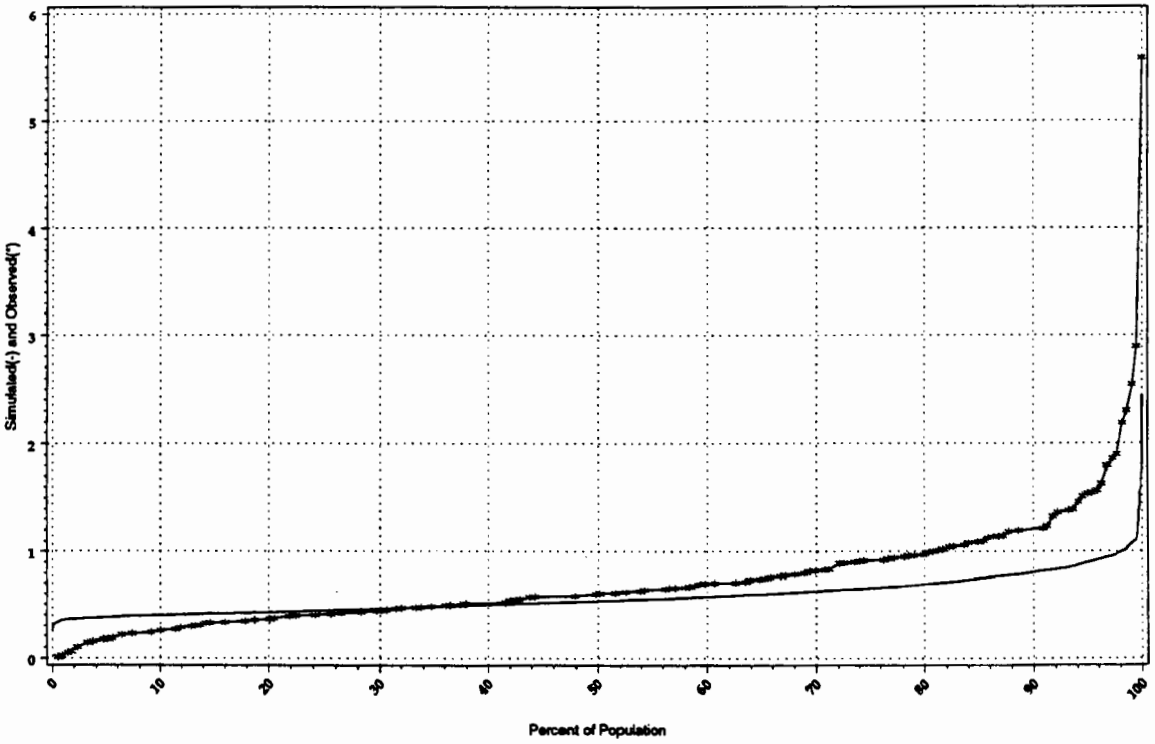
Frequency Distribution - PAIRED Simulated and Observed Data



East Branch Susquehanna at Segment 40

Organic Nitrogen

Frequency Distribution - All Simulated and Observed Data

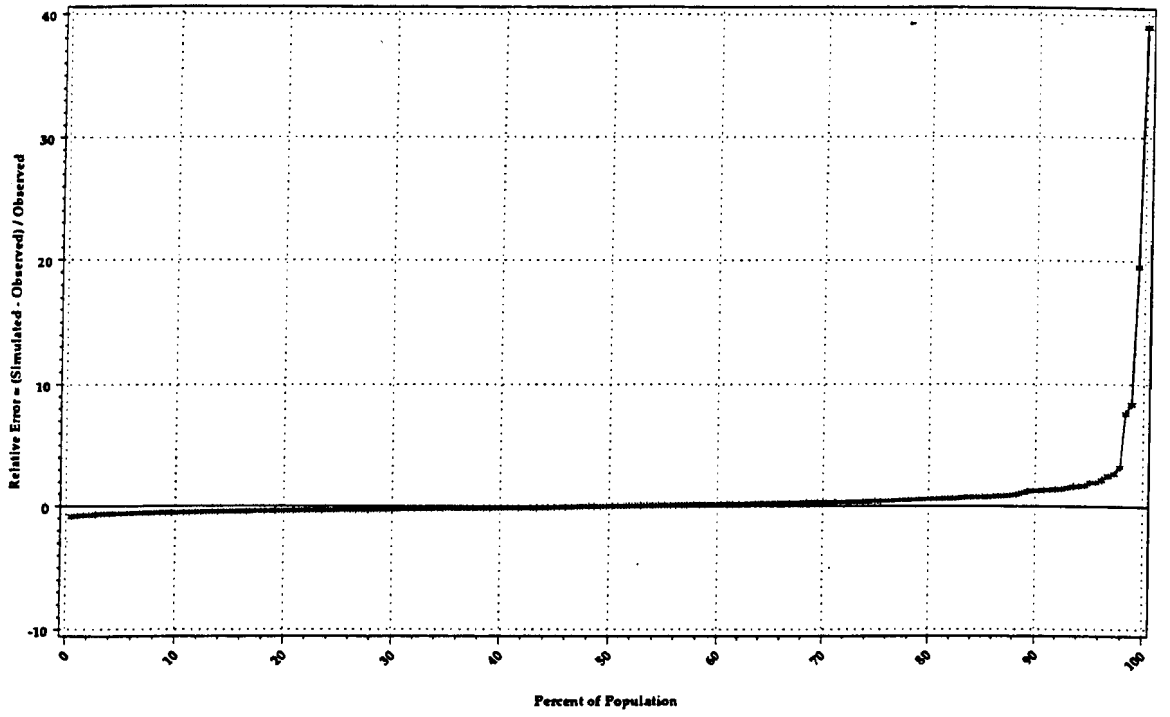


East Branch Susquehanna River at Segment 40

Relative Error versus Percentile Sample Population

Organic Nitrogen

Frequency Distribution - All Simulated and Observed Data

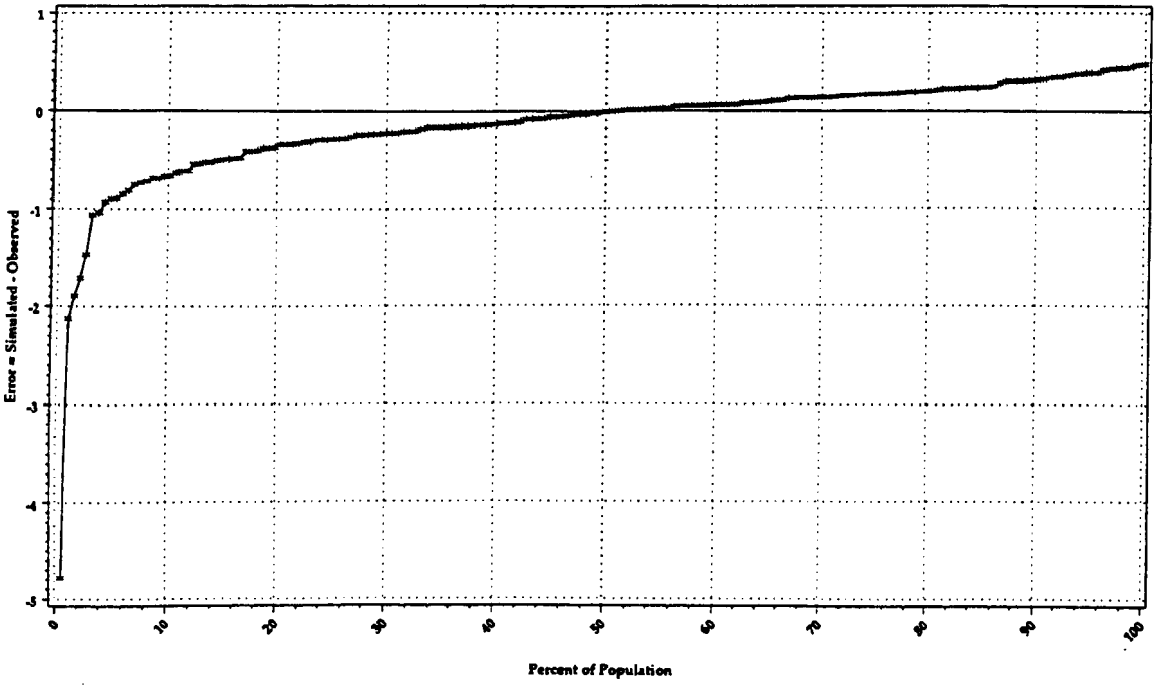


East Branch Susquehanna River at Segment 40

Actual error versus Percentile Sample Population

Organic Nitrogen

Frequency Distribution - All Simulated and Observed Data



B.1.2 West Branch Susquehanna River near Lewisburg, PA at Segment 70 (Monitoring Station: 1553500) (Above Fall Line Basin Segments: 50, 60, and 70)

Section Summary:

The West Branch Susquehanna basin is dominated by the large areas of forest. Total nitrogen and total phosphorus loads are generally low.

The West Branch Susquehanna basin above the gaged site covers an area of 7,014 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 80% forest land, 6% cropland, 11% other agricultural areas, 2% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 26.1 million pounds in 1985 to 22.2 million pounds in 1996. Total phosphorus loads over the same time period decreased from 0.8 million pounds to 0.5 million pounds. In general, point source loads above the gage site are low. In 1996, the total nitrogen point source load was 7% of the total load and the total phosphorus point source load was 23% of the total load. Estimated septic system total nitrogen loads increased 9%, from 0.50 million pounds in 1985 to 0.55 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 3%, and other agricultural loads (primarily pasture and manure loads) by 10%. Total phosphorus increased for cropland by 1% and decreased for other agricultural loads by 19%. Urban loads were estimated to have increased over the 1985 to 1996 period by 7% for total nitrogen and 9% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

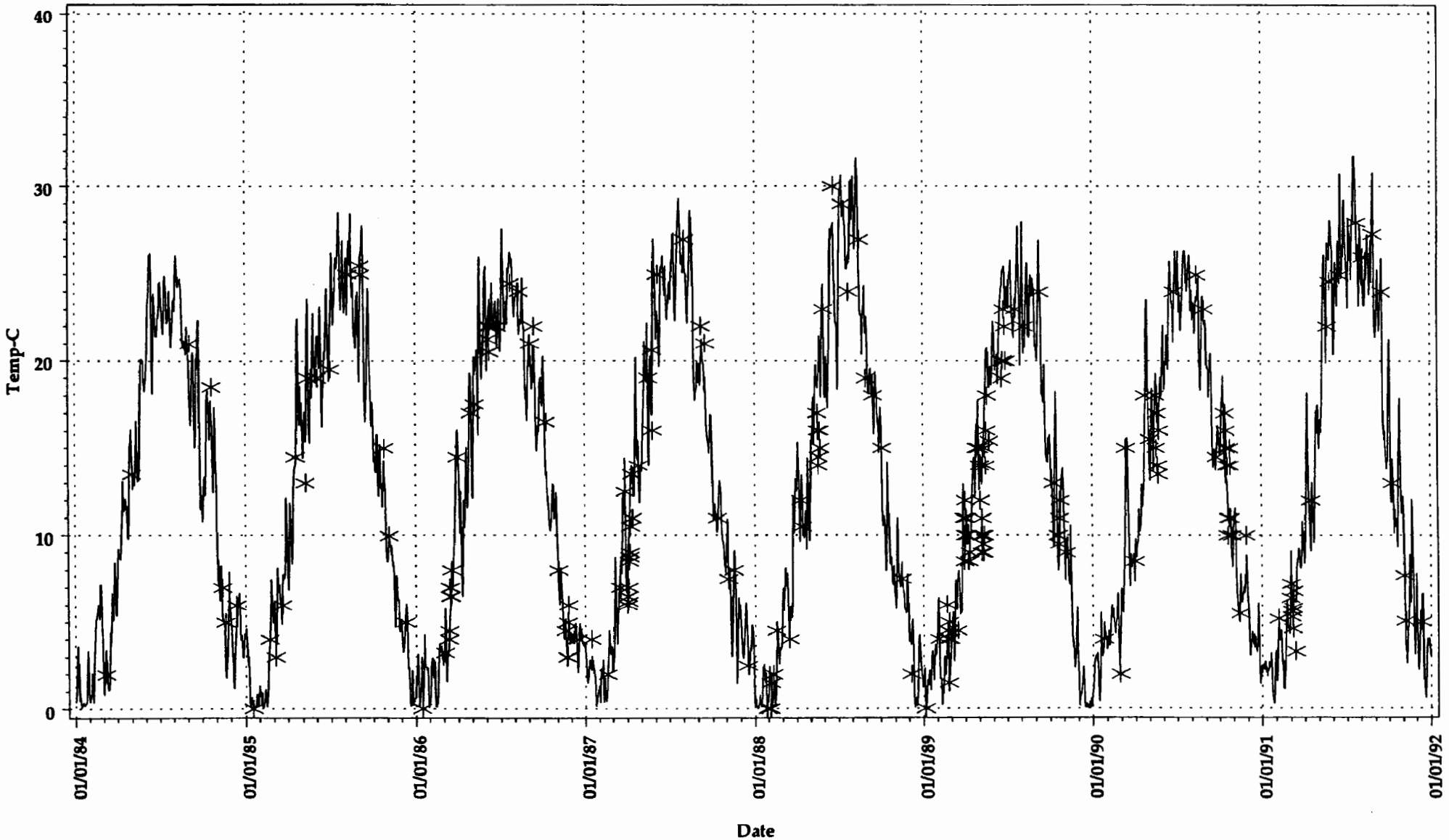
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Temperature-C

(*=Observed, -=Simulated)

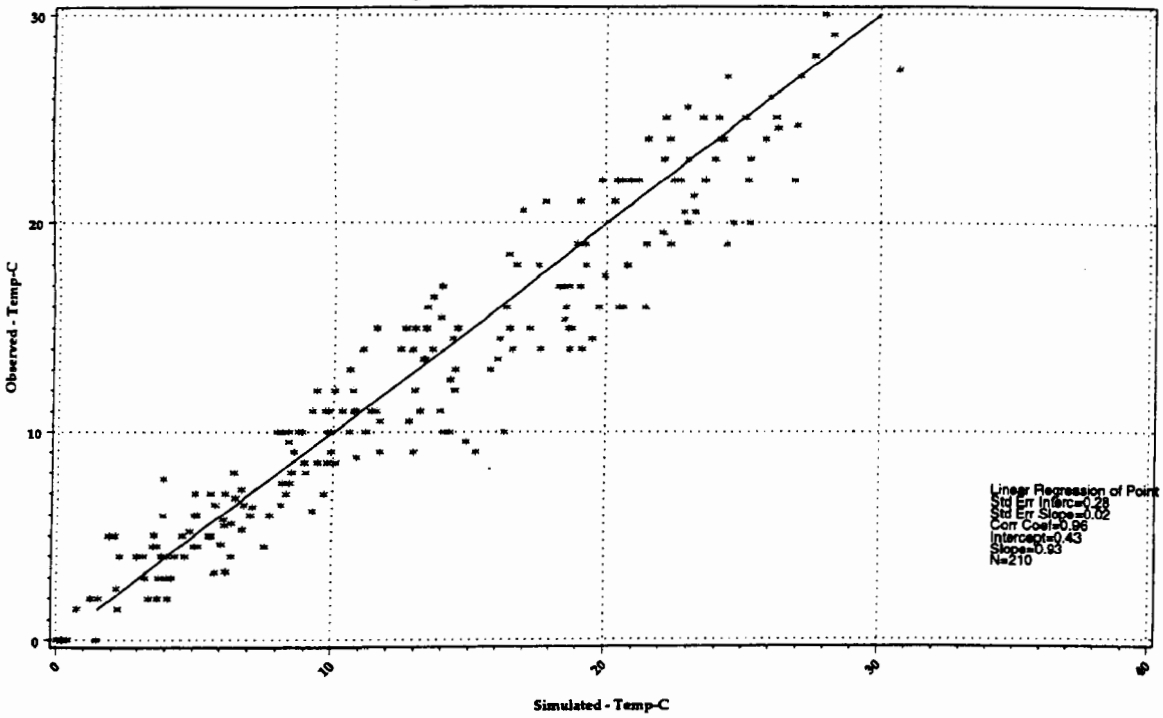


(y21_plotb.aaa model3d:[pwang.dt] plotomi - omtime)
(wbsus_d.drv1 20FEB98 08:46)

West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

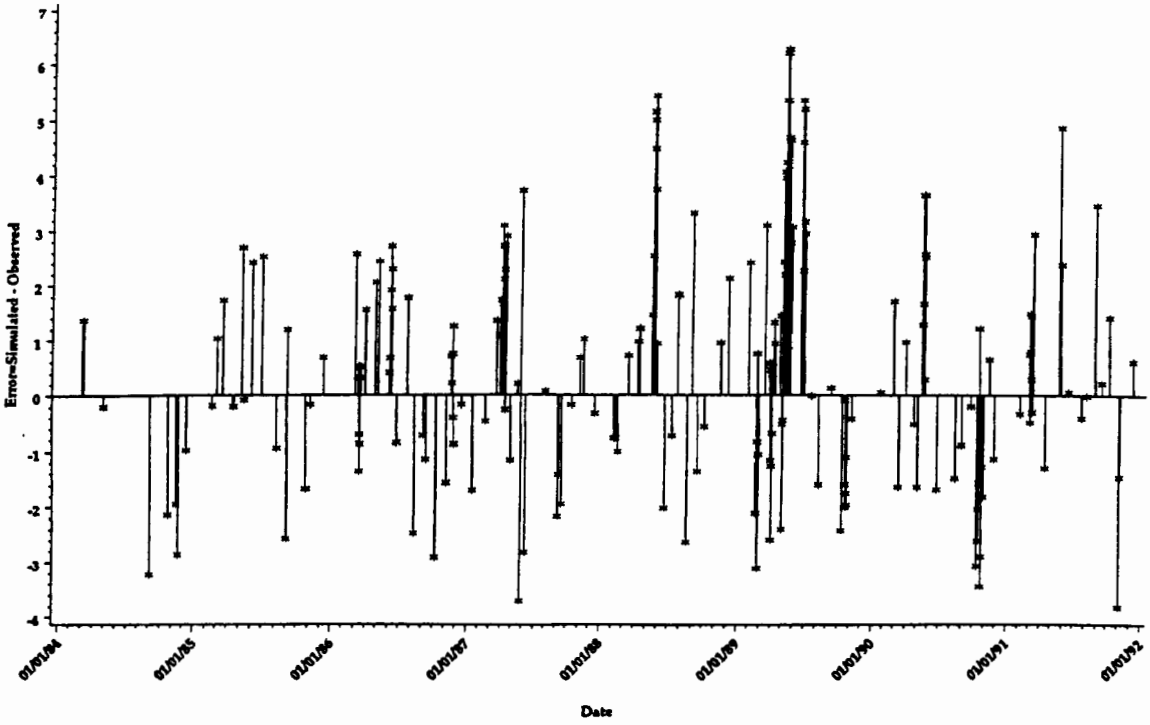
Temperature-C: 01JAN84 - 01JAN92



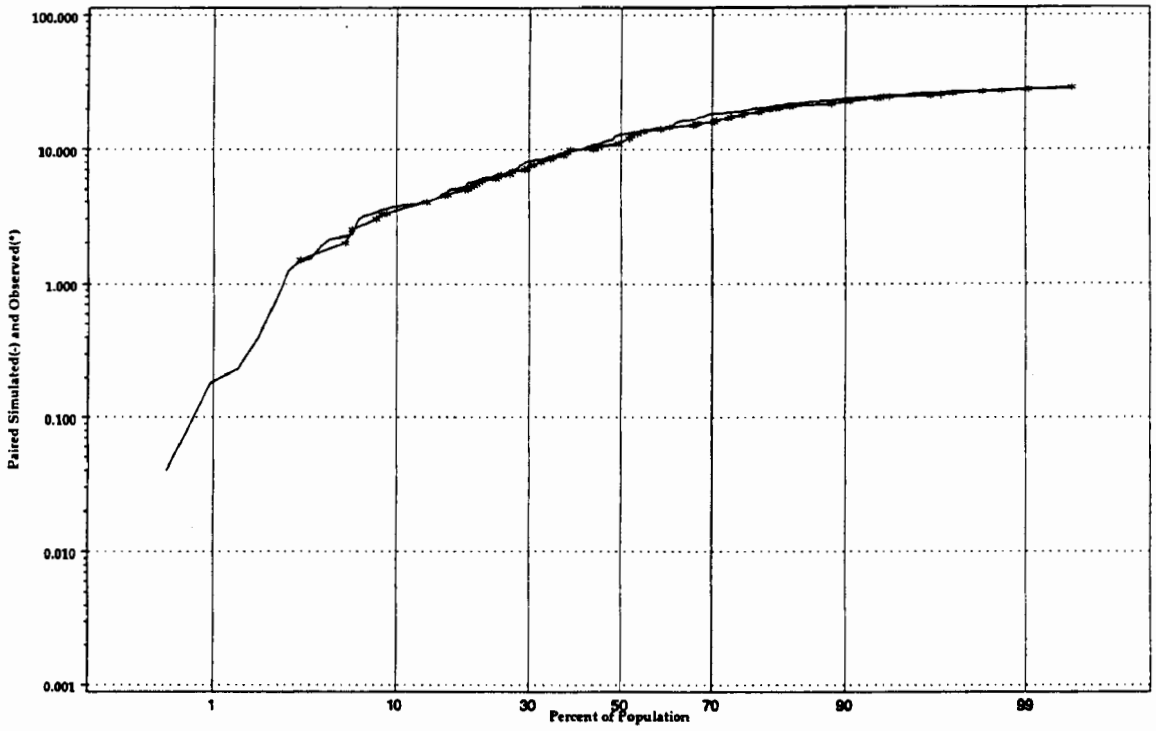
West Branch Susquehanna at Segment 70

Actual Error versus Time

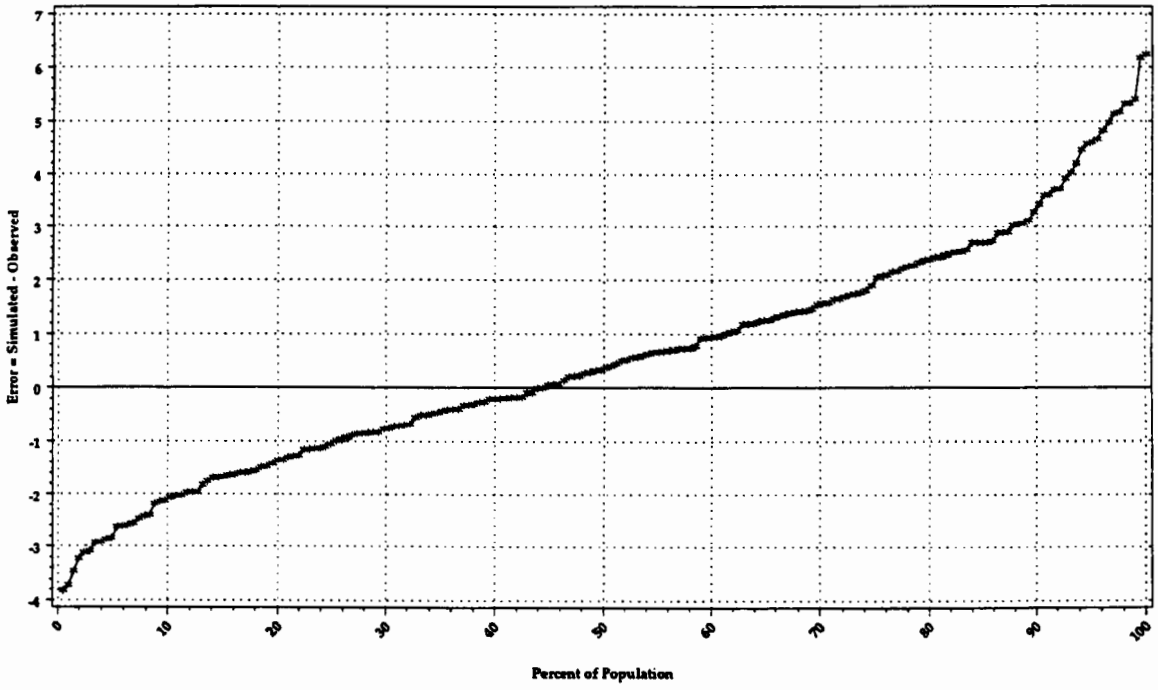
Temperature-C



West Branch Susquehanna at Segment 70
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

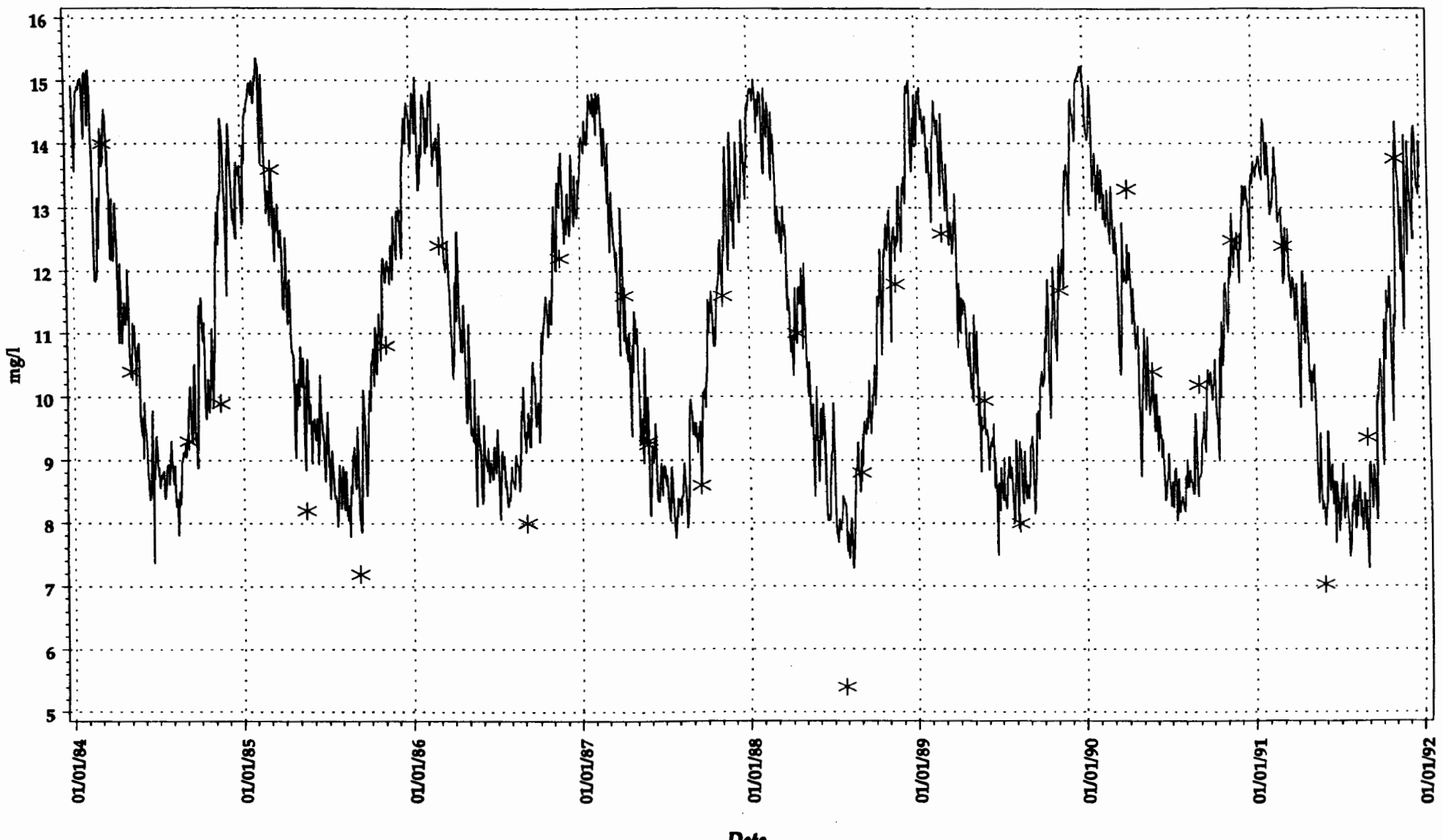


West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data

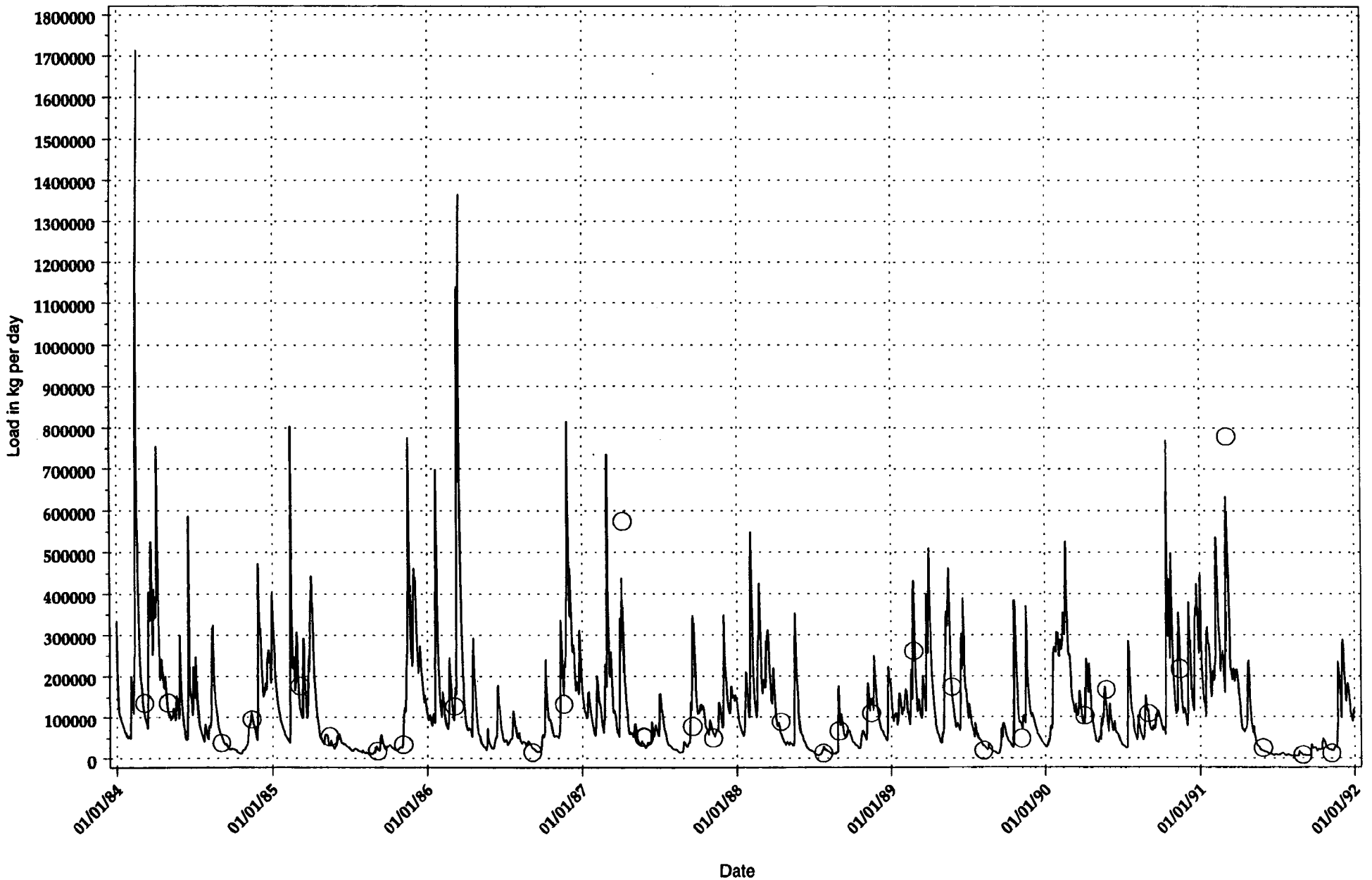


West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



West Branch Susquehanna at Segment 70
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)

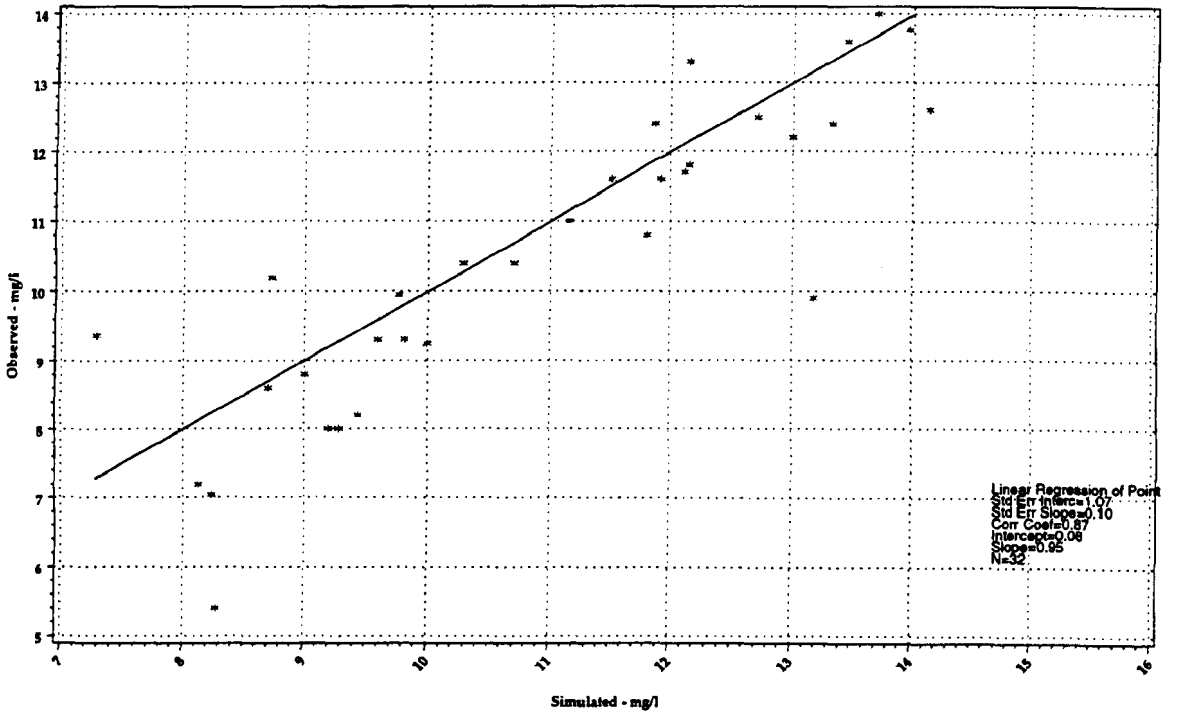


(y21_plotb.sas model3d:[pweng.dl] ldfles)
(wbsus_d.dv1 20FEB98 08:46,proc reg,model y=x)

West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

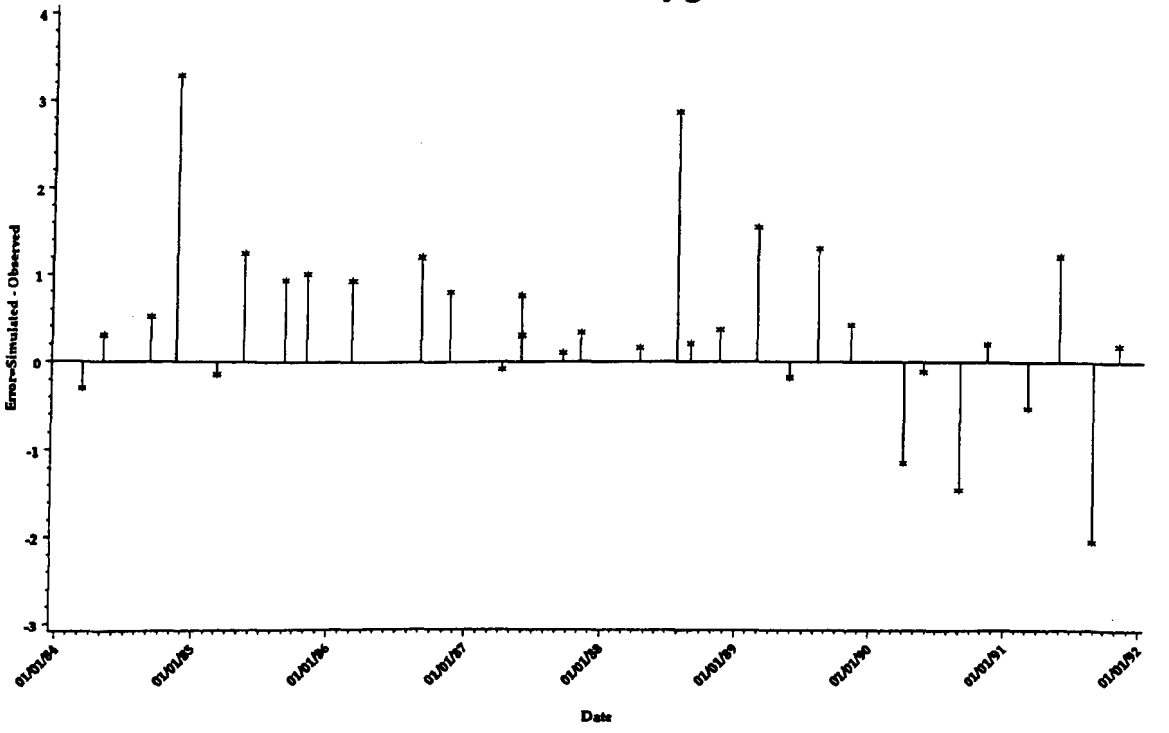
Dissolved Oxygen: 01JAN84 - 01JAN92



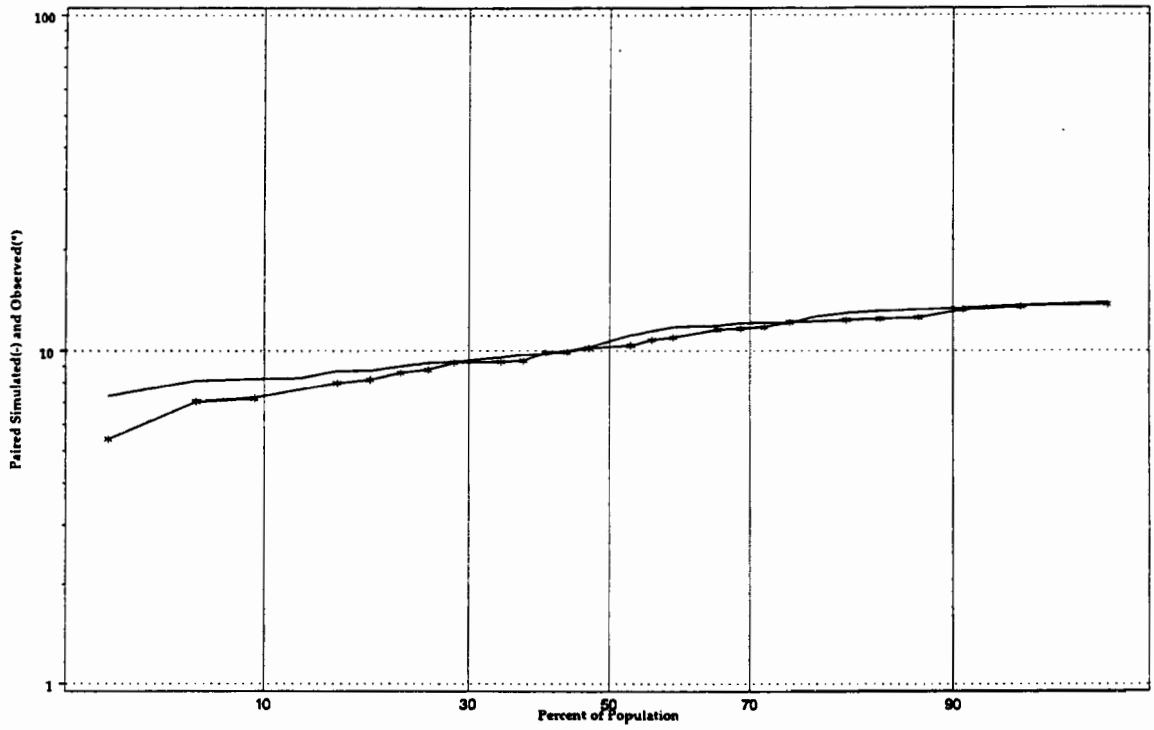
West Branch Susquehanna at Segment 70

Actual Error versus Time

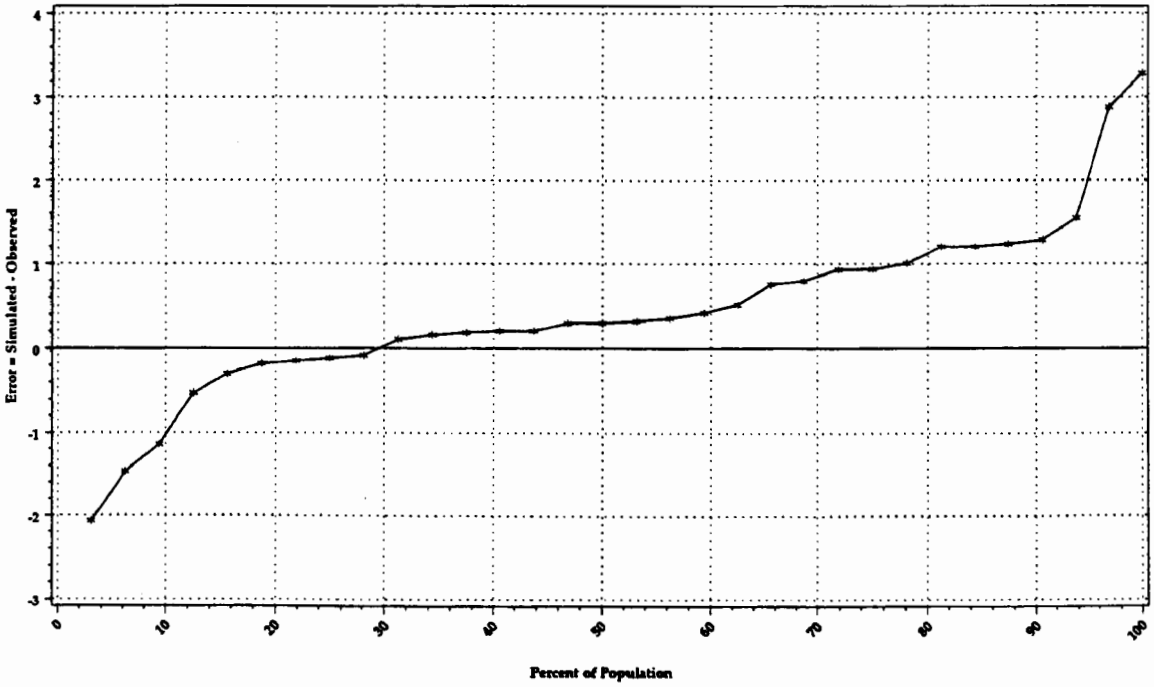
Dissolved Oxygen



West Branch Susquehanna at Segment 70
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

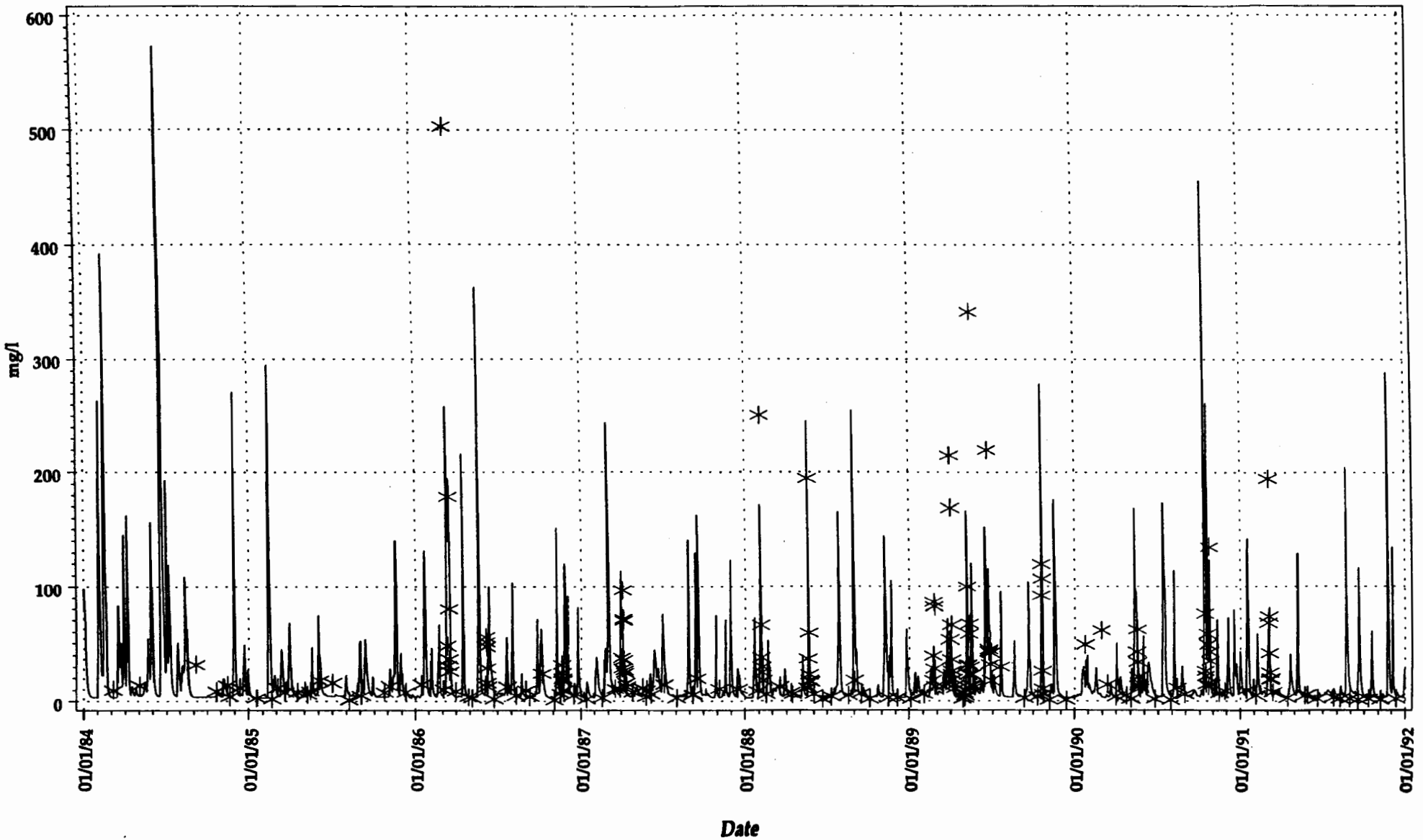


West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data

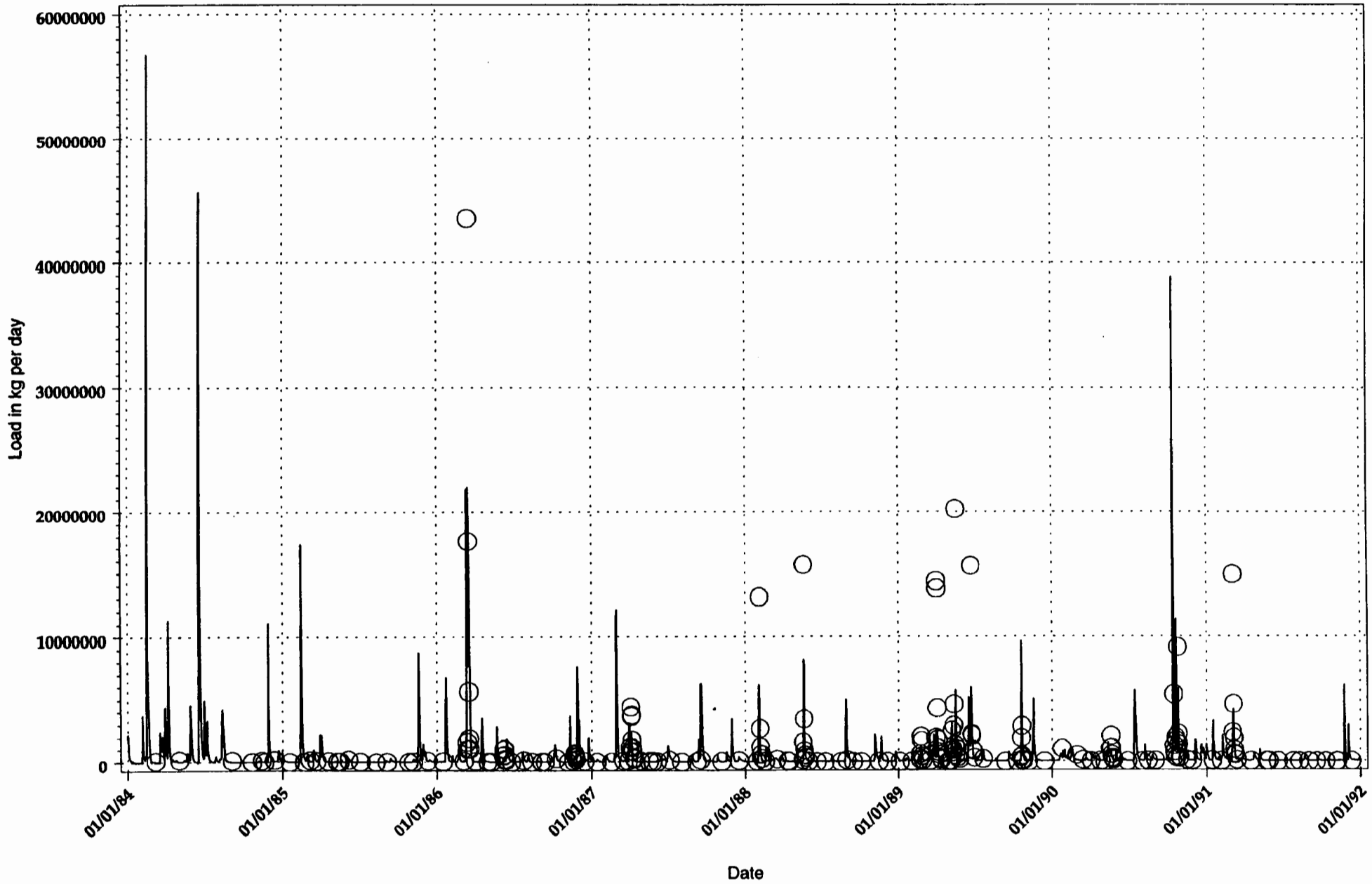


West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Total Suspended Sediment

(*=Observed, -=Simulated)



West Branch Susquehanna at Segment 70
Total Suspended Sediment Observed and Simulated Load vs Time
(line = simulated, O = observed)

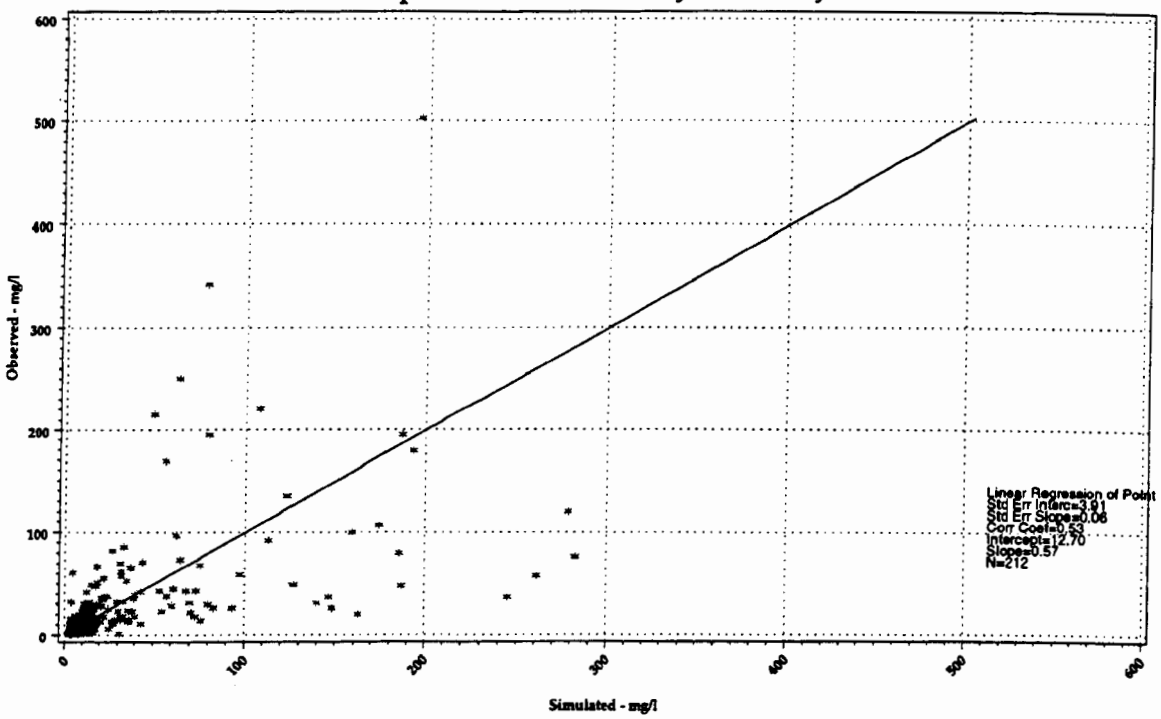


(y21_plotb.sas model3d:(pweng.dl| ldlles)
(wbsus_d.drv1 20FEB98 08:46,proc reg,model y=x)

West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

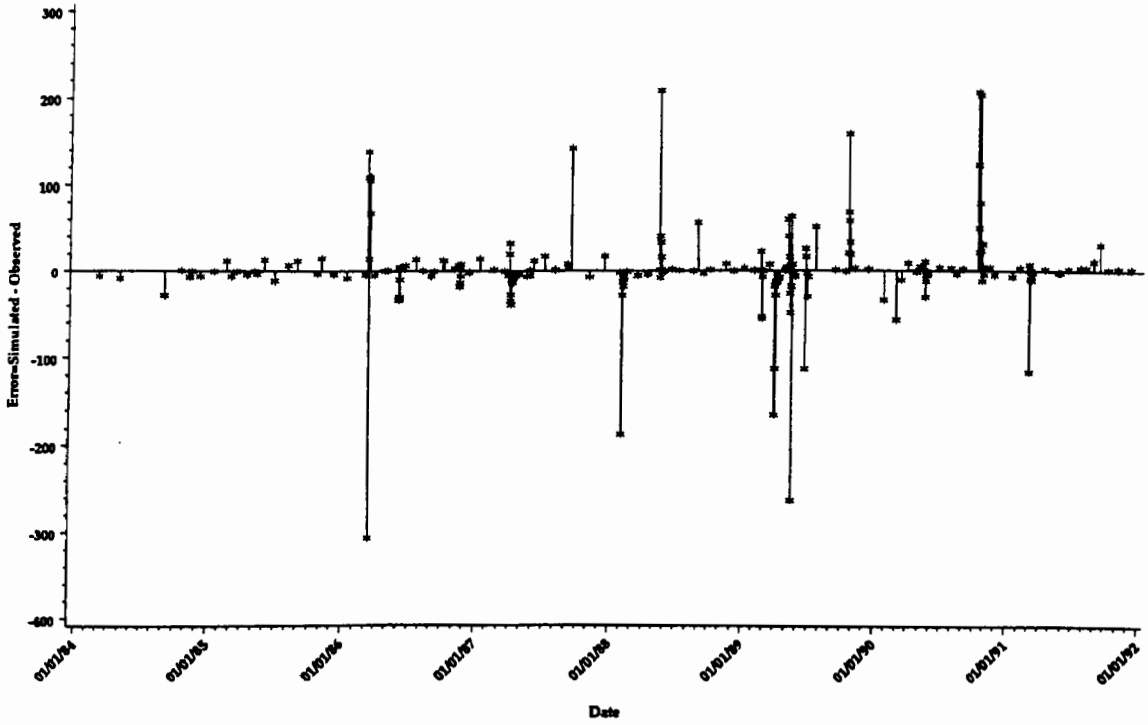
Total Suspended Sediment: 01JAN84 - 01JAN92



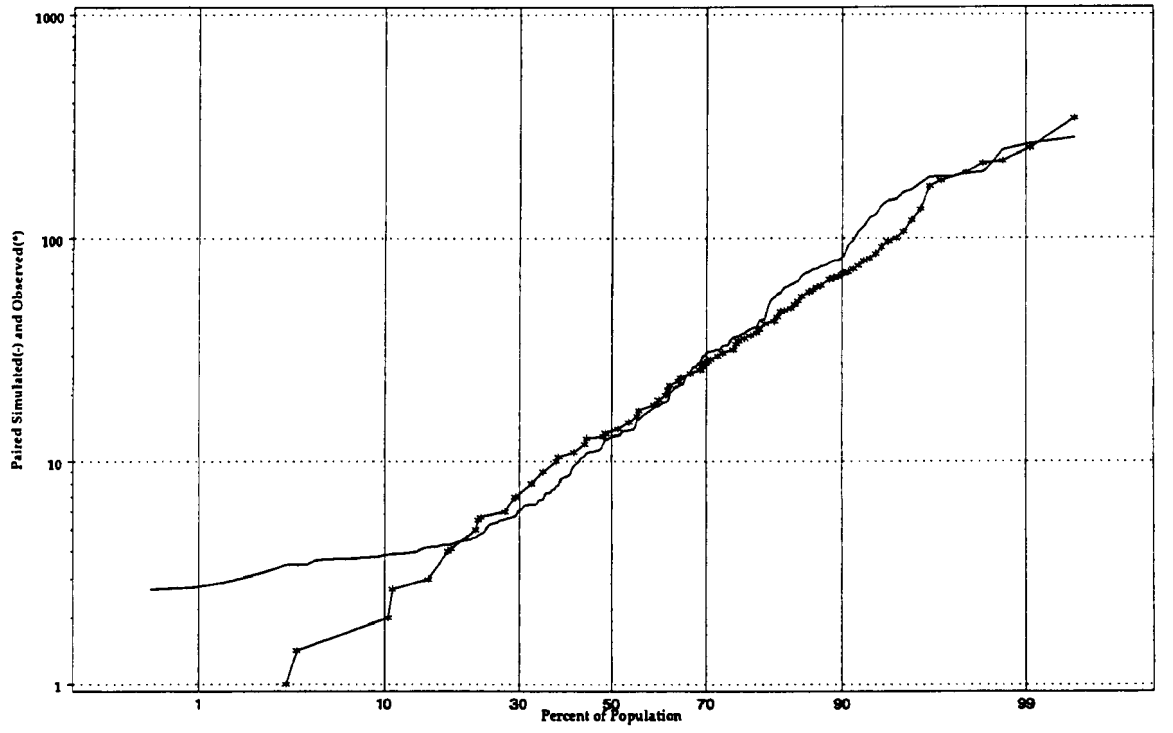
West Branch Susquehanna at Segment 70

Actual Error versus Time

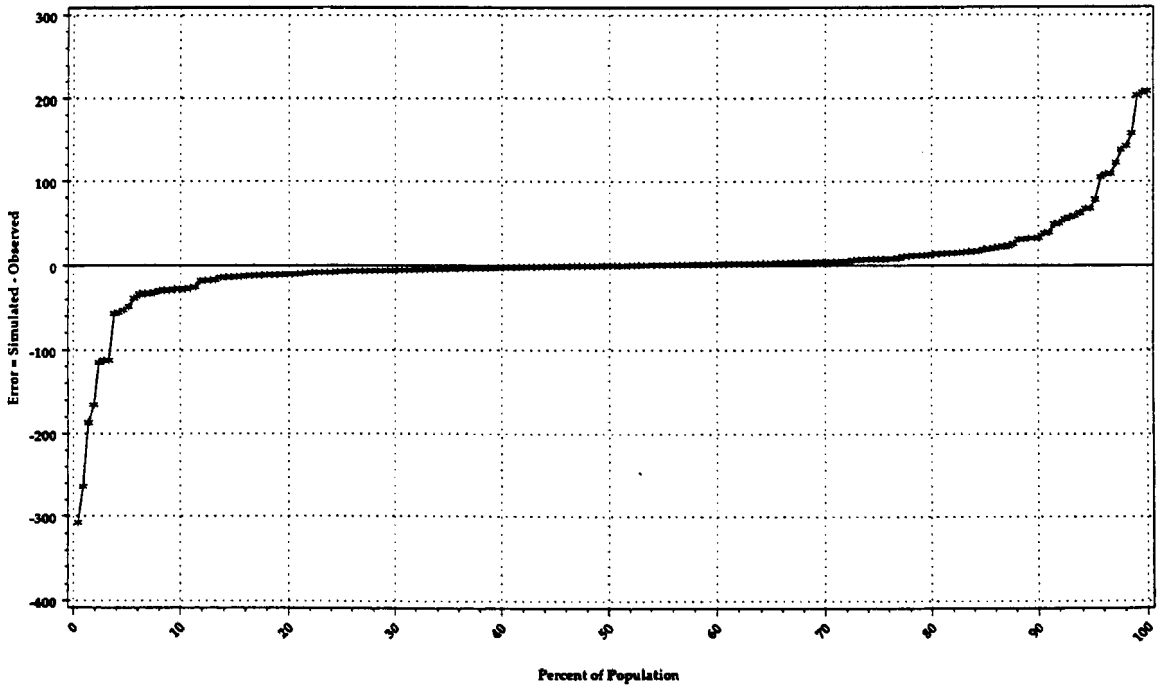
Total Suspended Sediment



West Branch Susquehanna at Segment 70
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

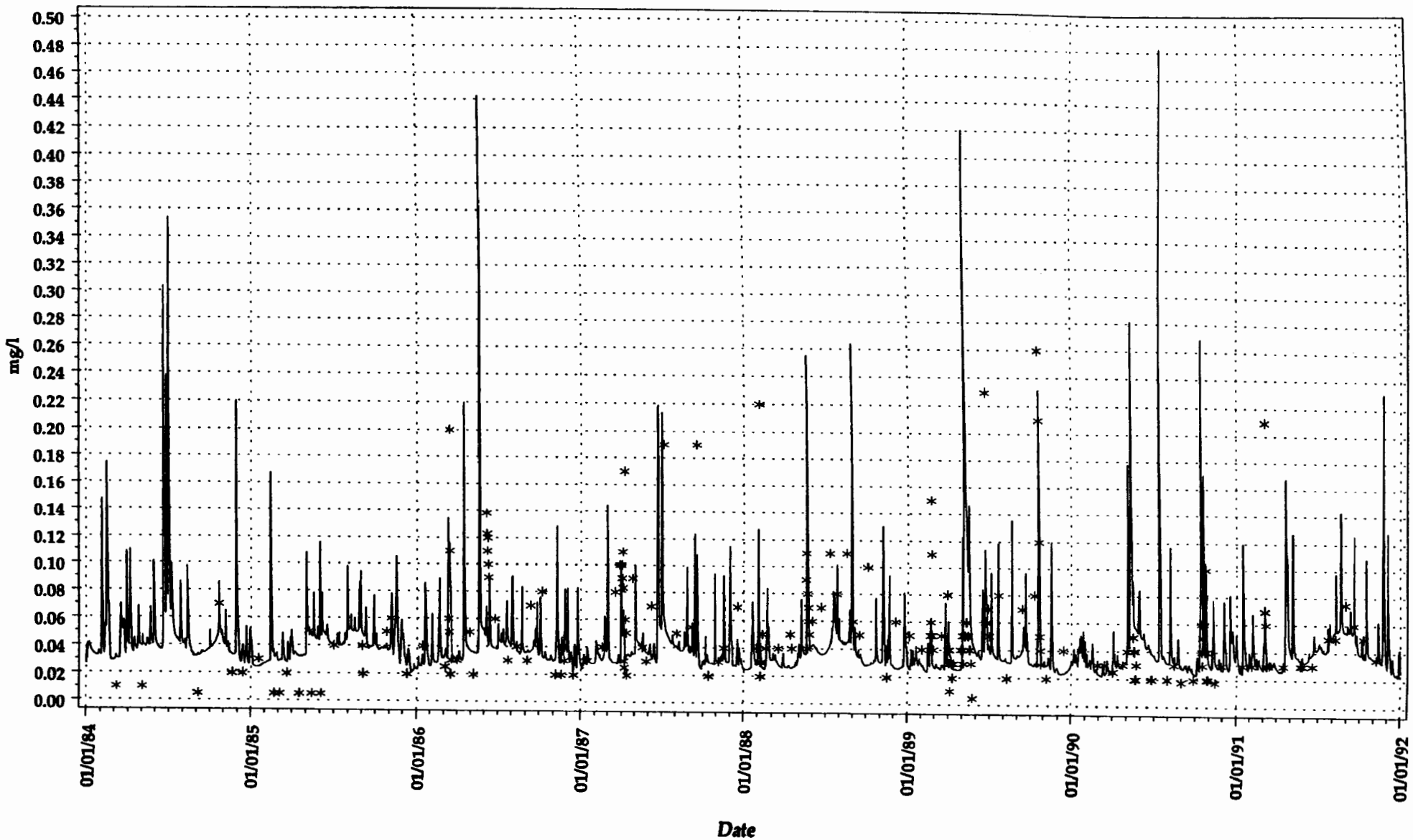


West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data

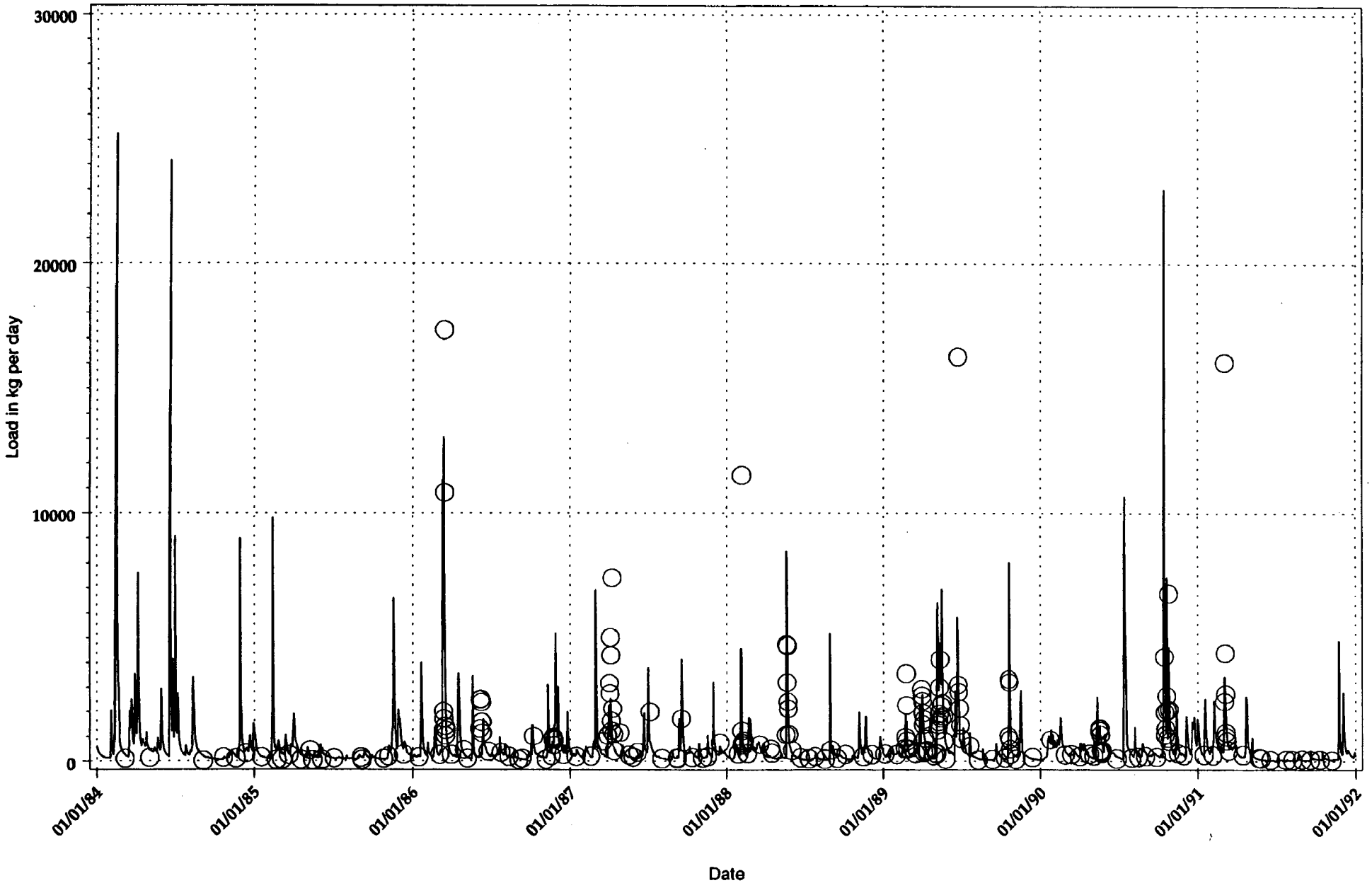


West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Total Phosphorus

(*=Observed, -=Simulated)



West Branch Susquehanna at Segment 70
Total Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

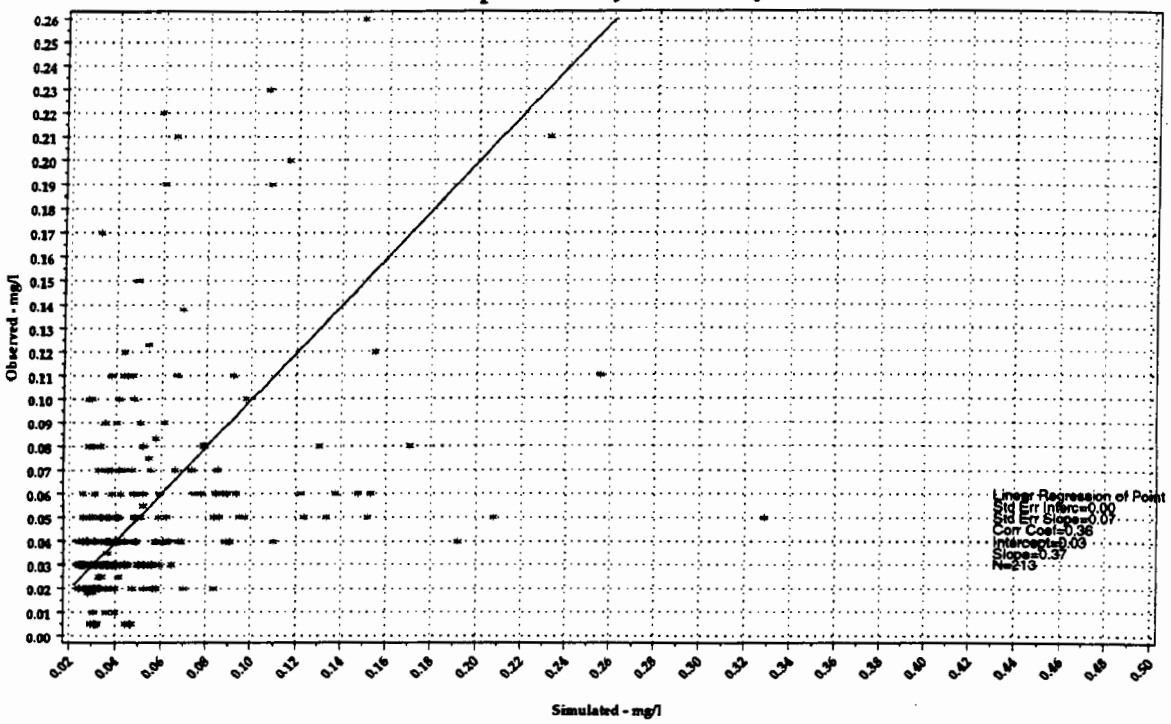


(y21_plotb.sas model3d:jpweng.dl] lldllas)
(wbsus_d.div1 20FEB96 08:46,proc reg,model y=x)

West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

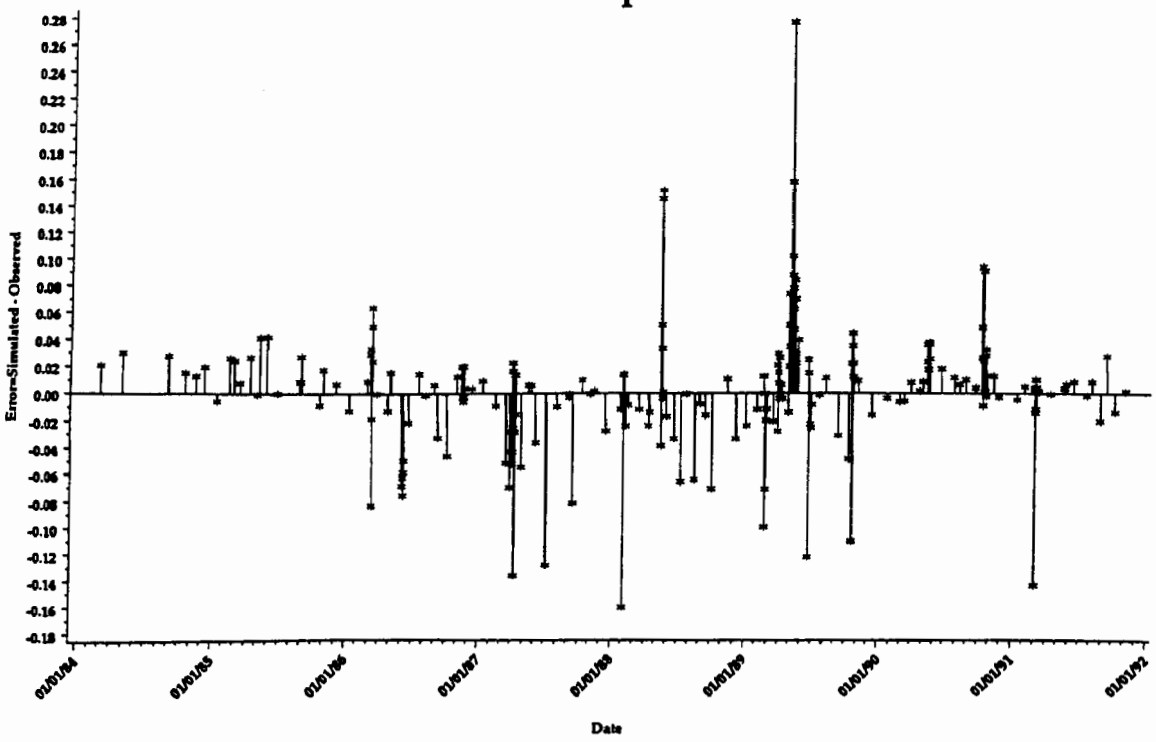
Total Phosphorus: 01JAN84 - 01JAN92



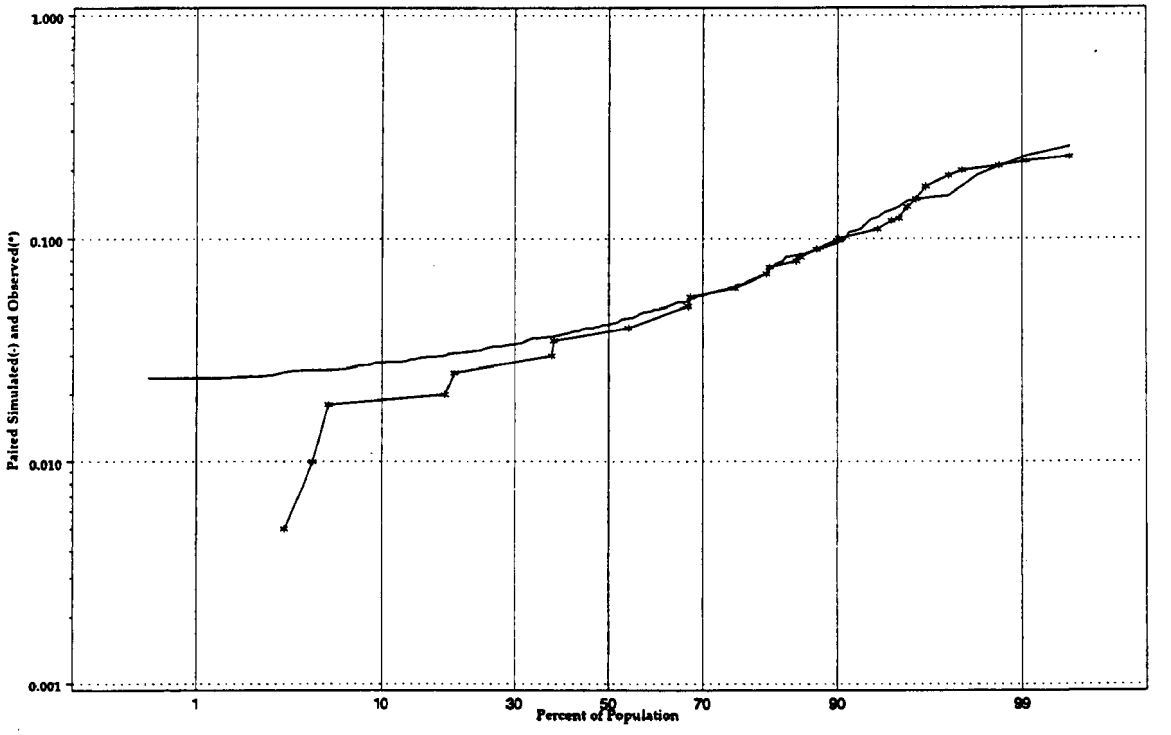
West Branch Susquehanna at Segment 70

Actual Error versus Time

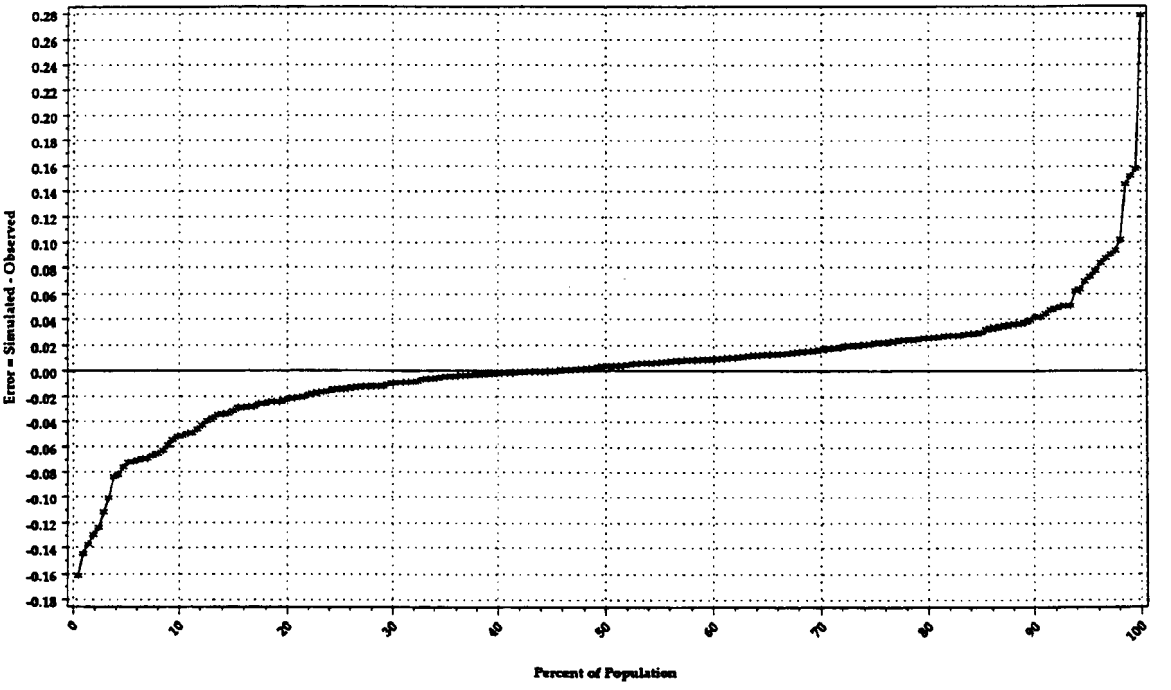
Total Phosphorus



West Branch Susquehanna at Segment 70
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

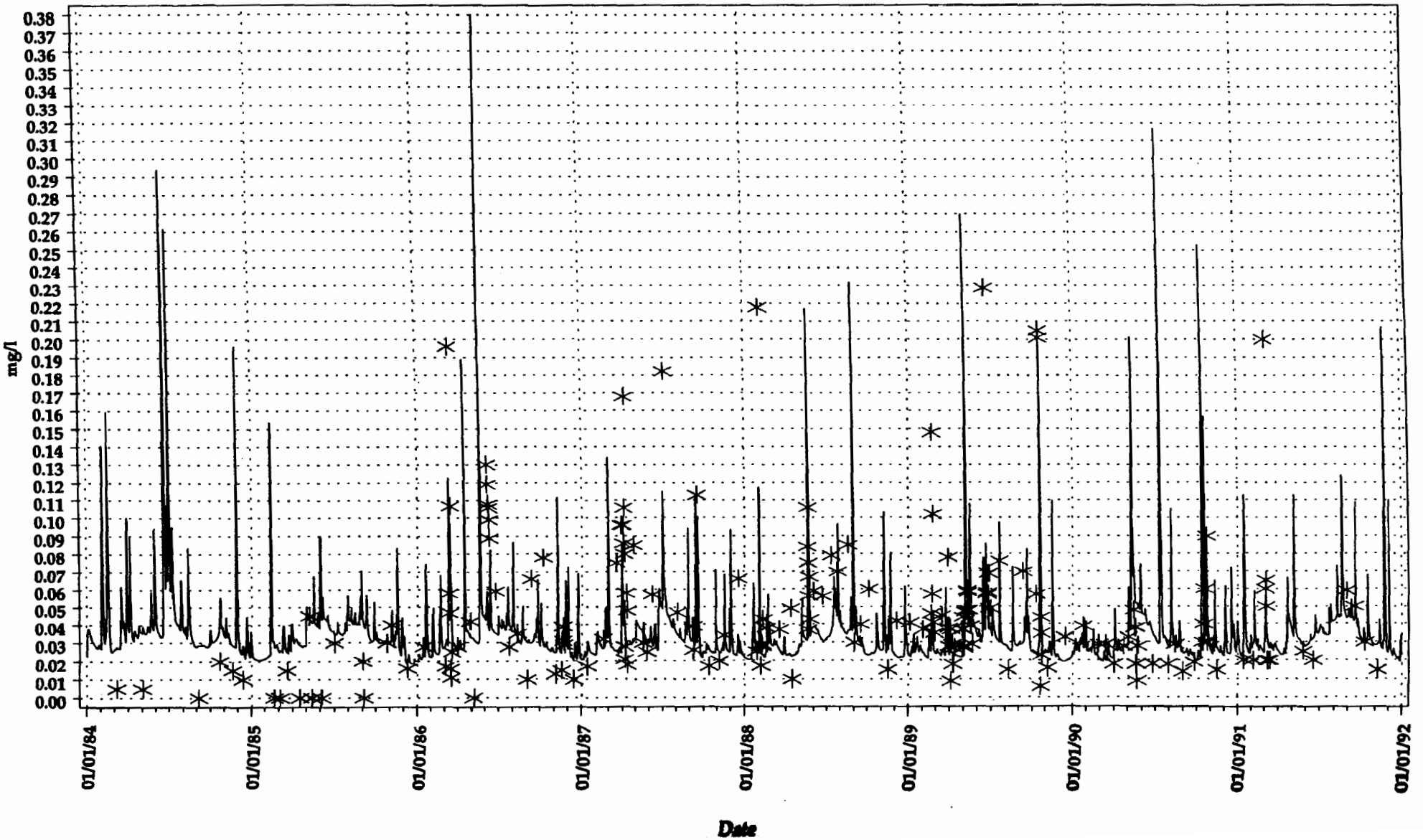


West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Organic and Particulate Phosphorus

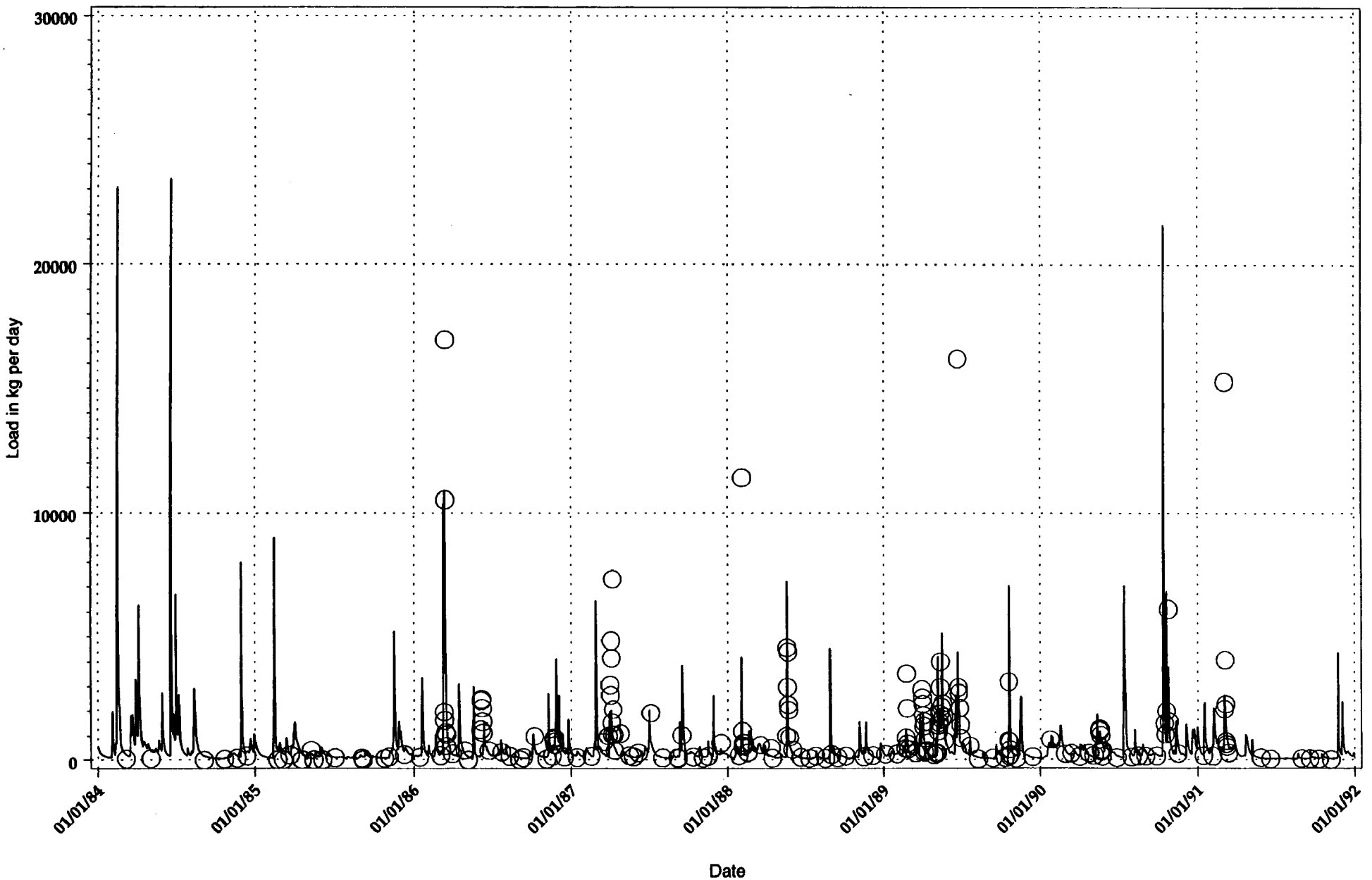
(*=Observed, -=Simulated)



West Branch Susquehanna at Segment 70

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

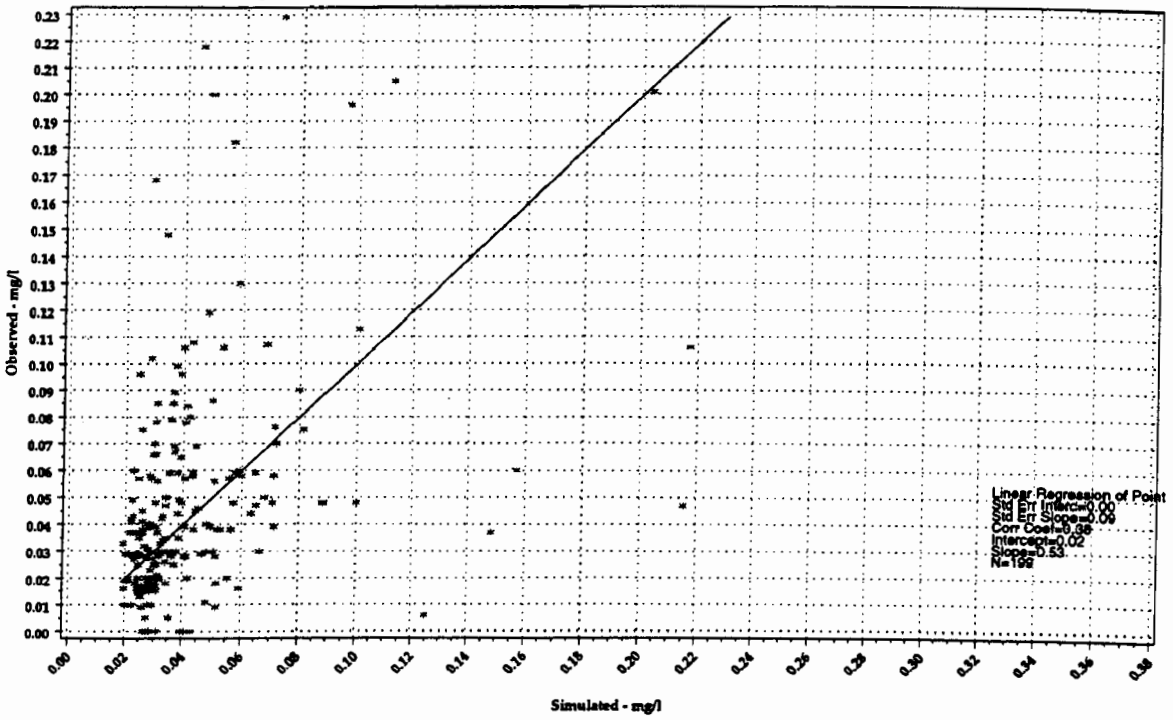


(y21_plotb.sas model3d.[pwang.dt] lidfles)
(wbsus_d.drv1 20FEB96 08:46,proc reg,model y=x)

West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

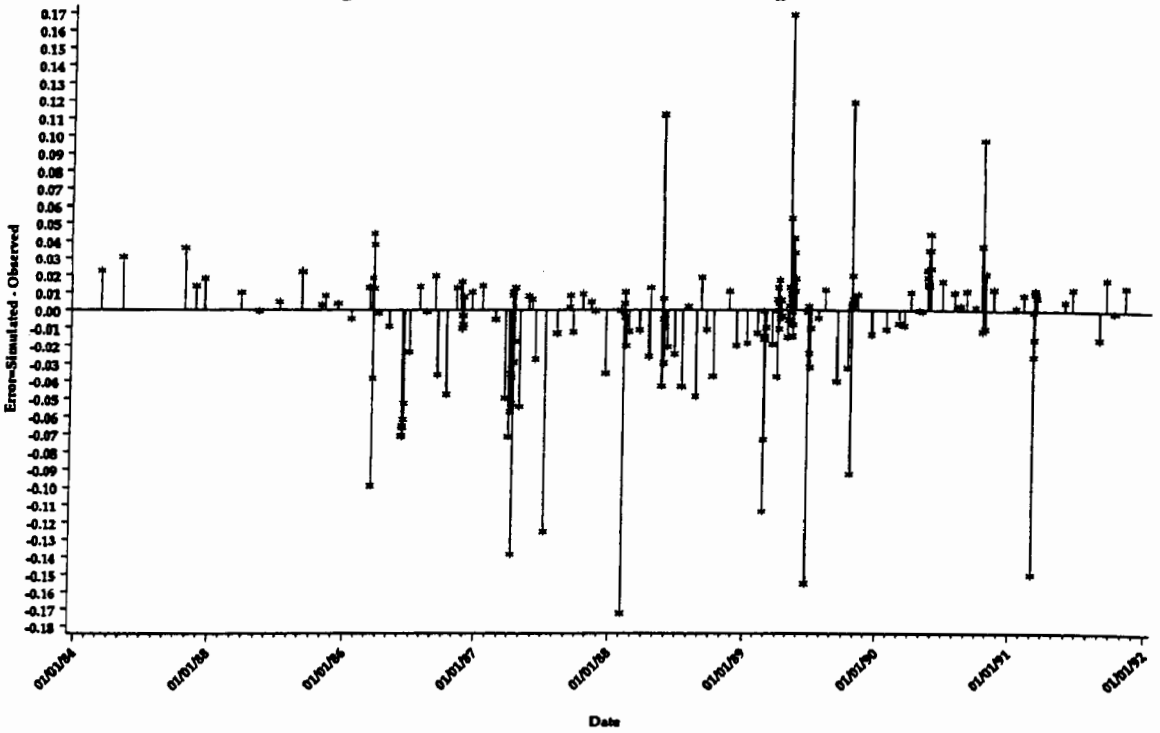
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



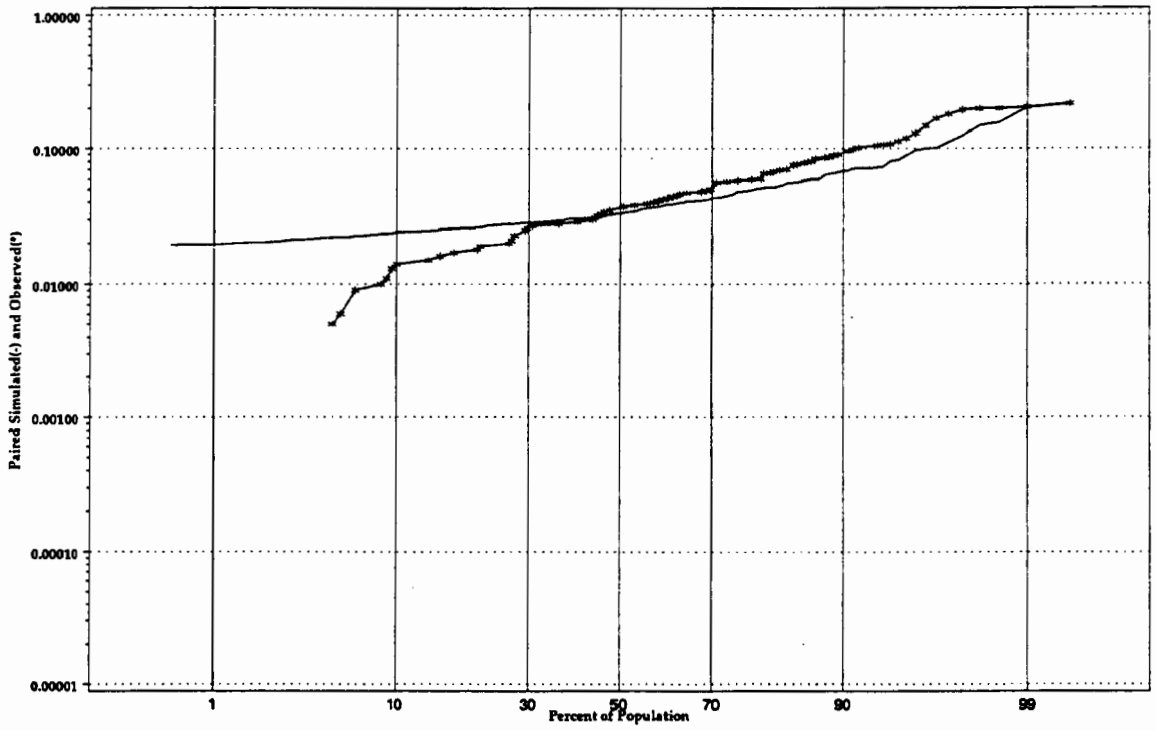
West Branch Susquehanna at Segment 70

Actual Error versus Time

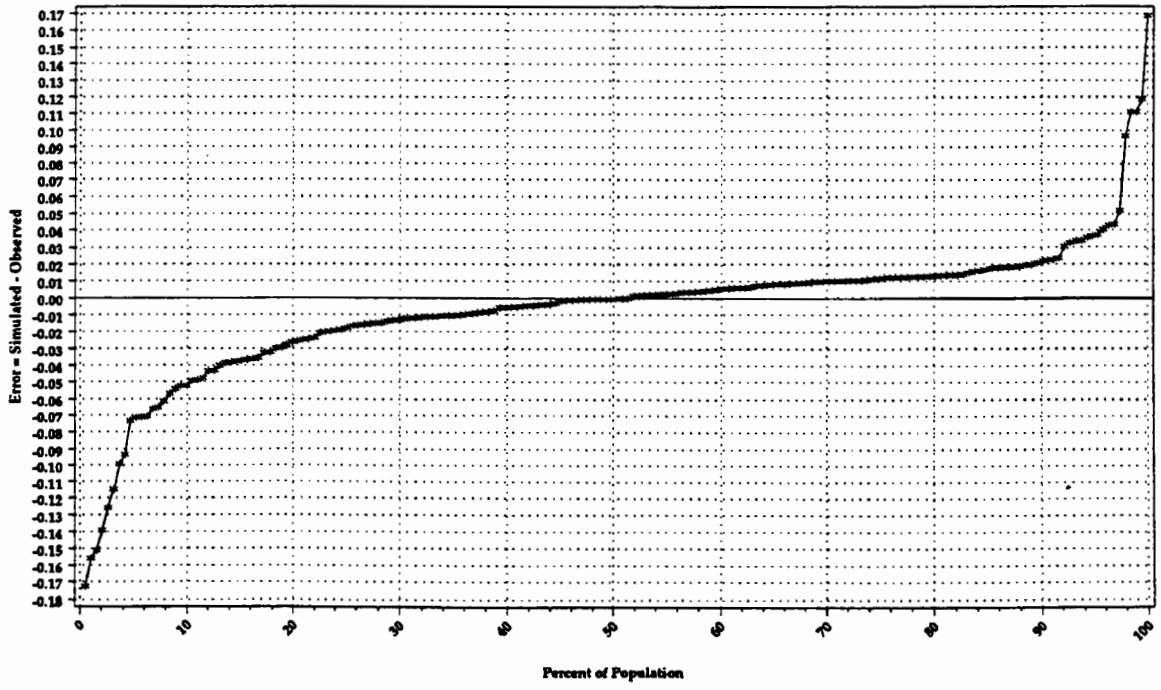
Organic and Particulate Phosphorus



West Branch Susquehanna at Segment 70
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

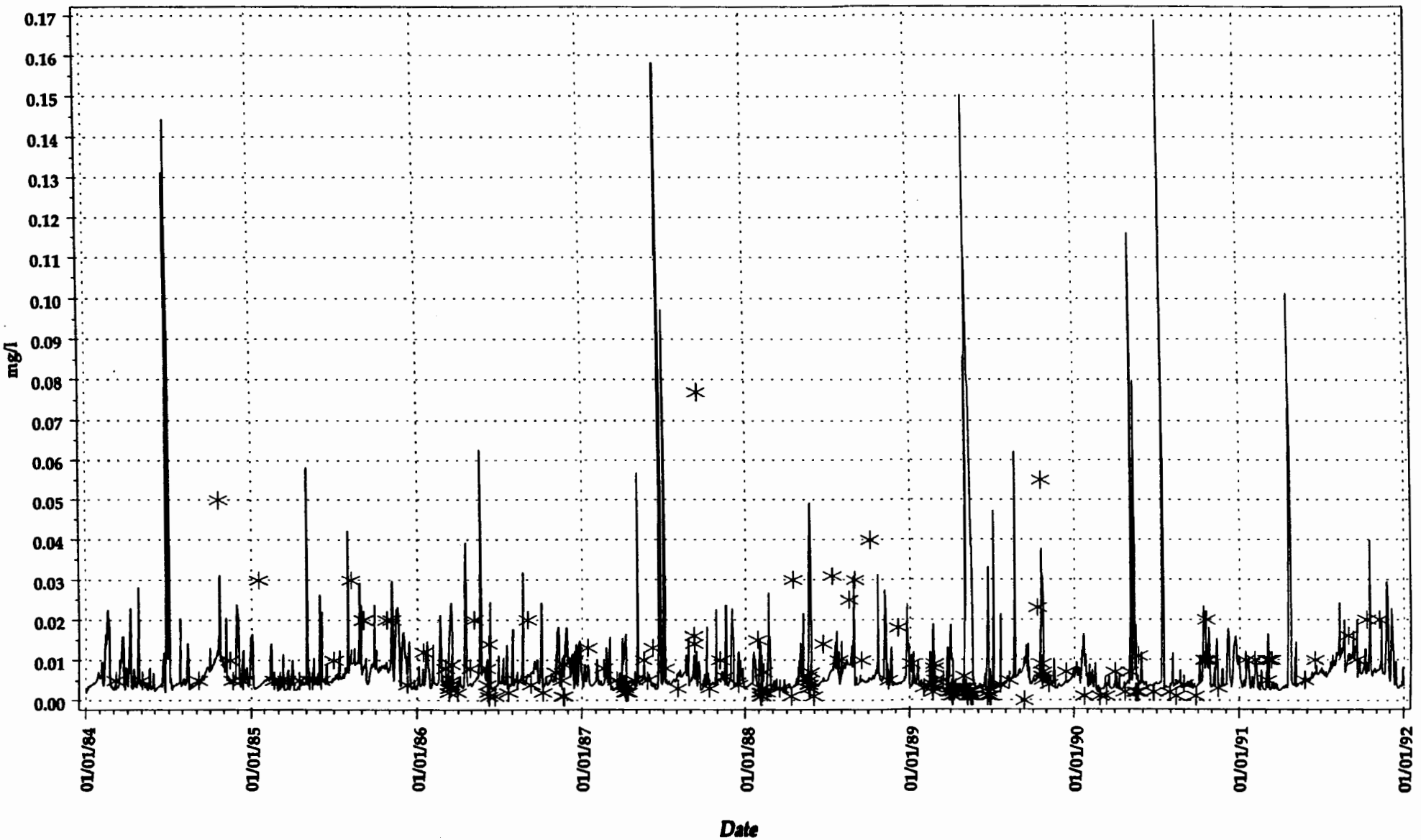


West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data

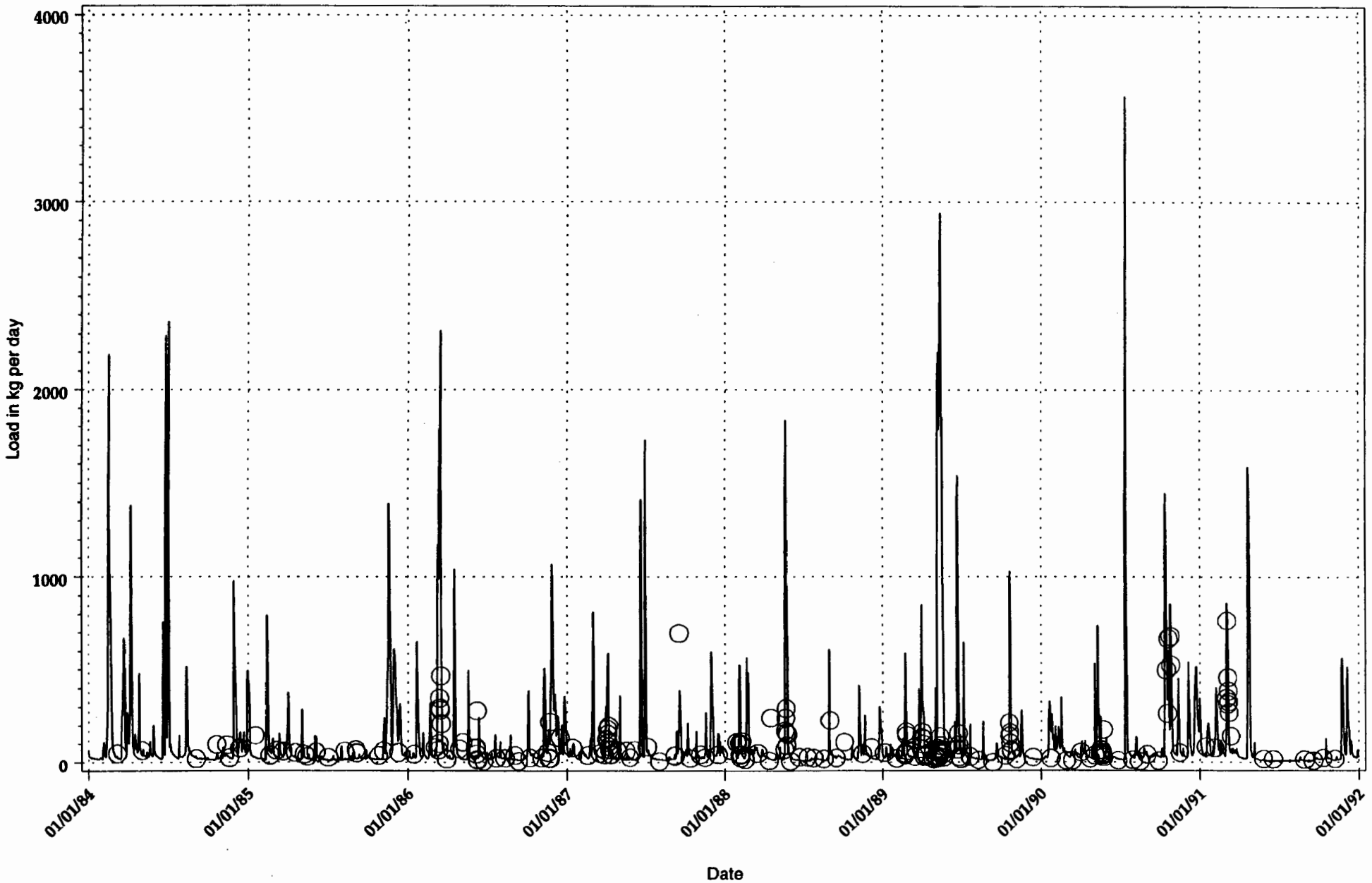


West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Dissolved Phosphorus

(*=Observed, -=Simulated)



West Branch Susquehanna at Segment 70
Dissolved Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

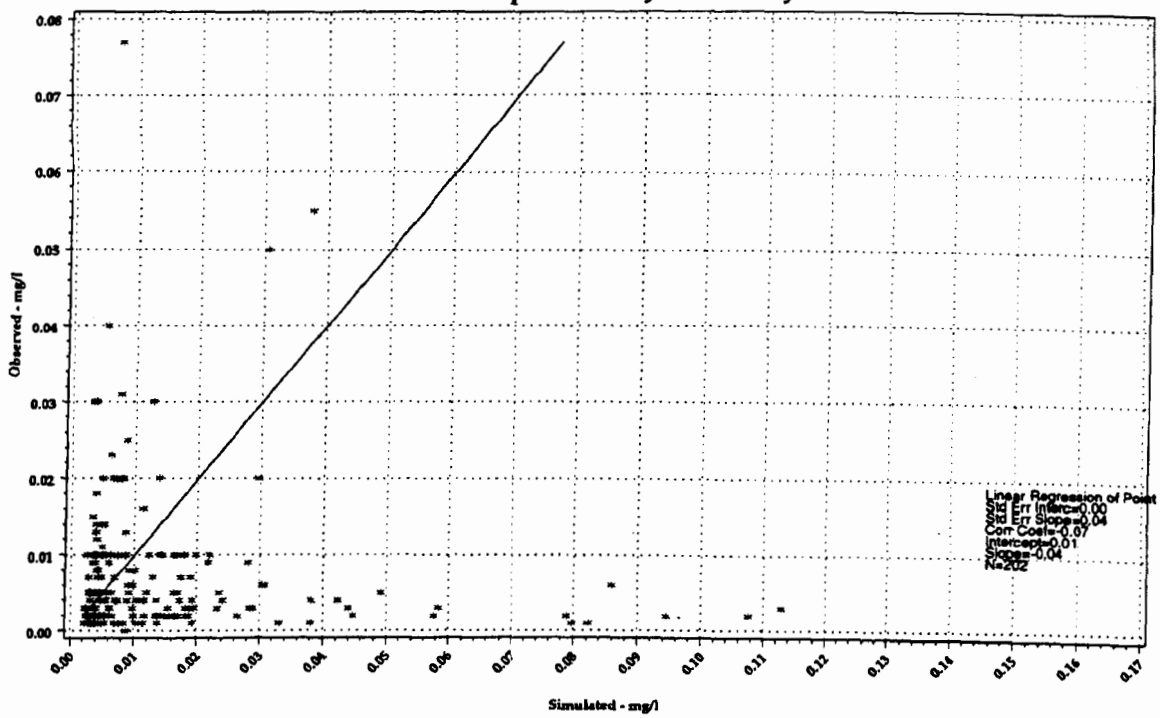


(y21_plotb.sas model3d:[pwang.dl] lidlies)
(sbsus_d.drv1 20FEB98 08:46,proc reg,model y=x)

West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

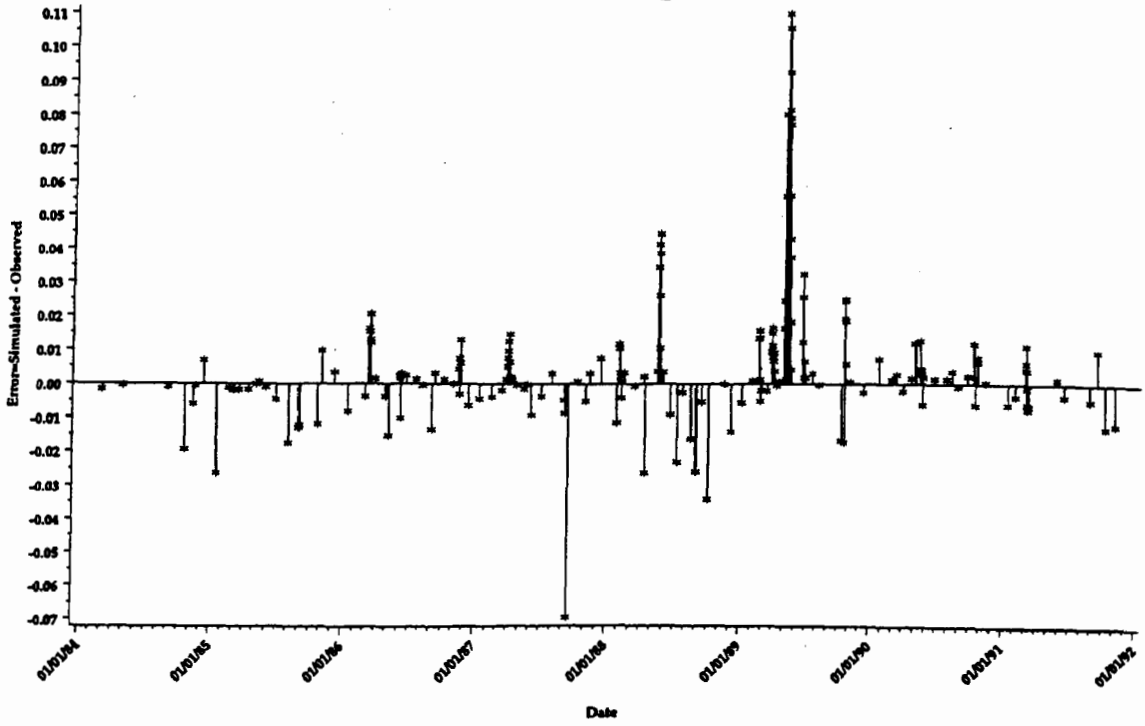
Dissolved Phosphorus: 01JAN84 - 01JAN92



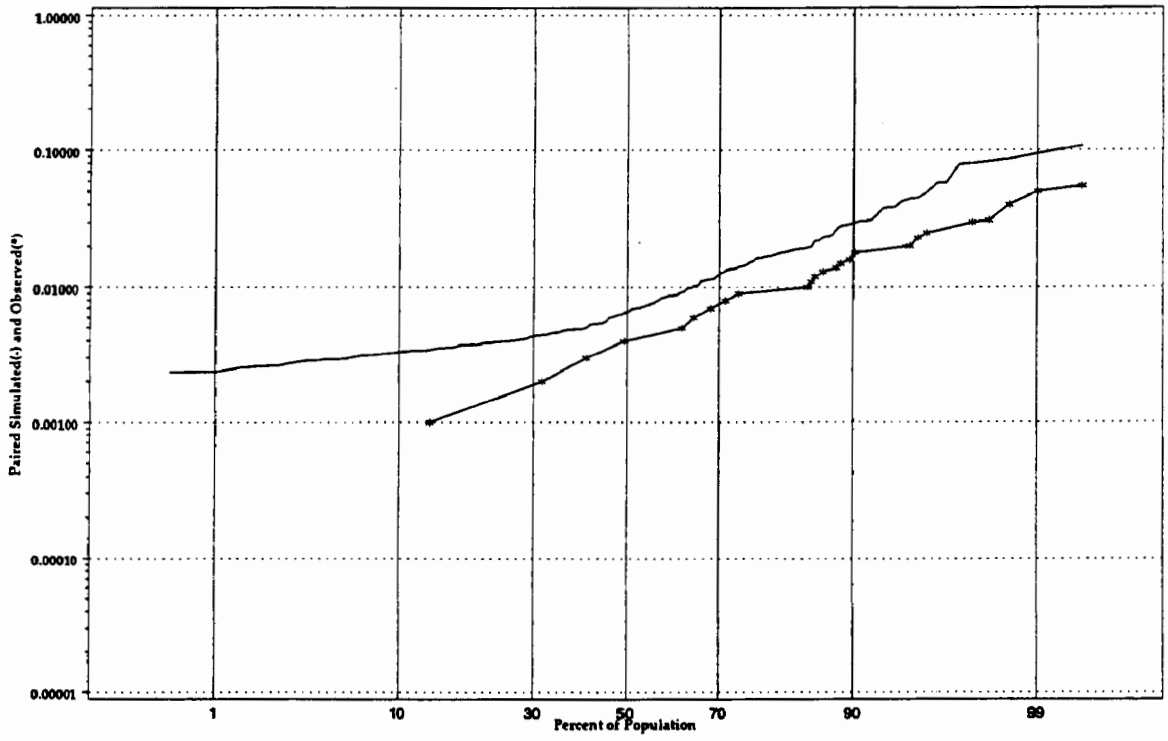
West Branch Susquehanna at Segment 70

Actual Error versus Time

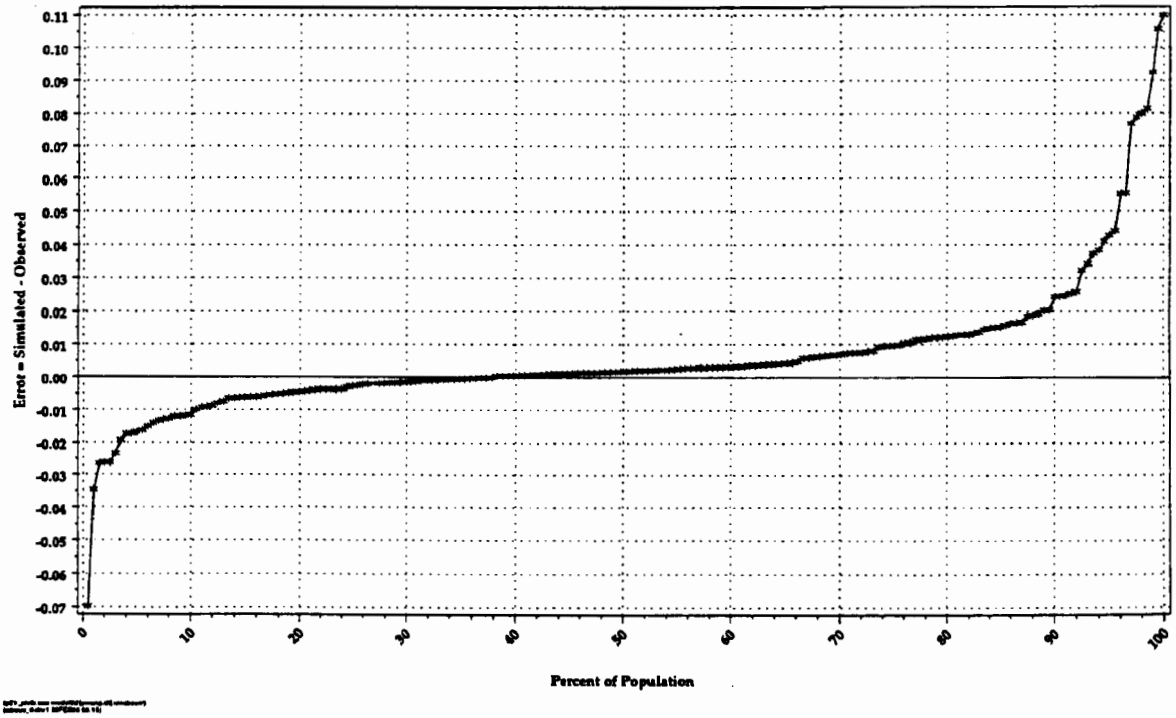
Dissolved Phosphorus



West Branch Susquehanna at Segment 70
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

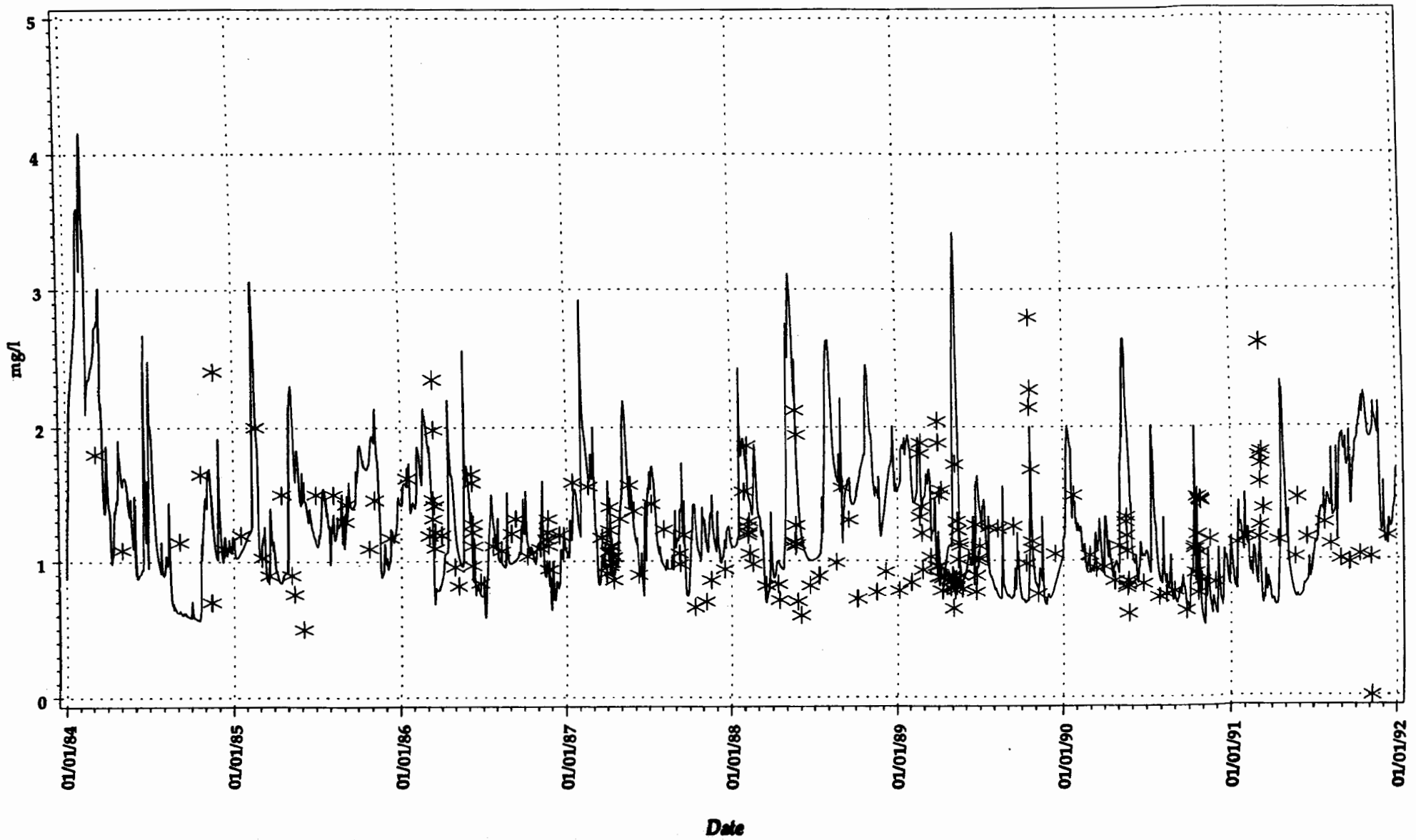


West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data

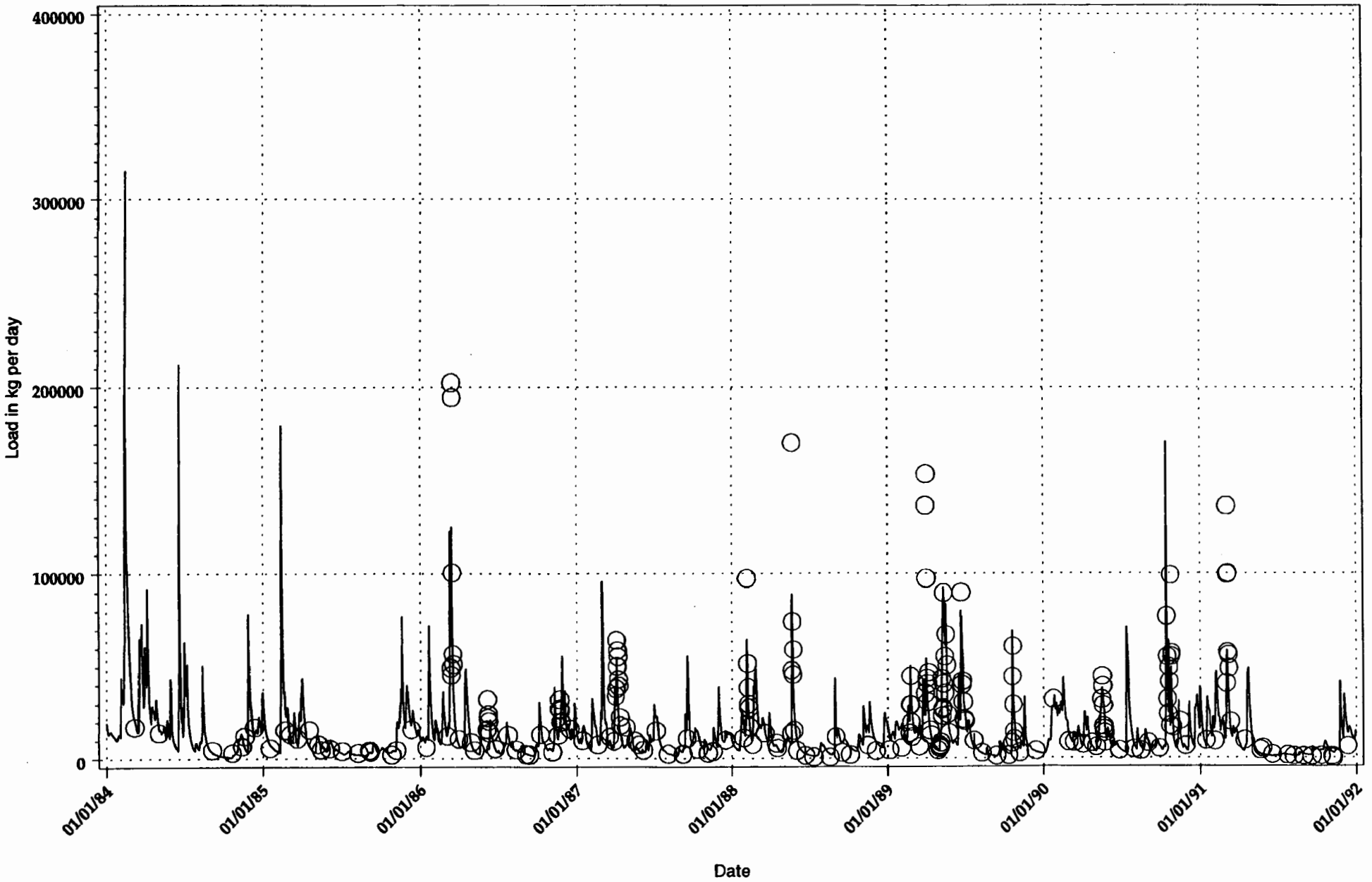


West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Total Nitrogen

(*=Observed, -=Simulated)



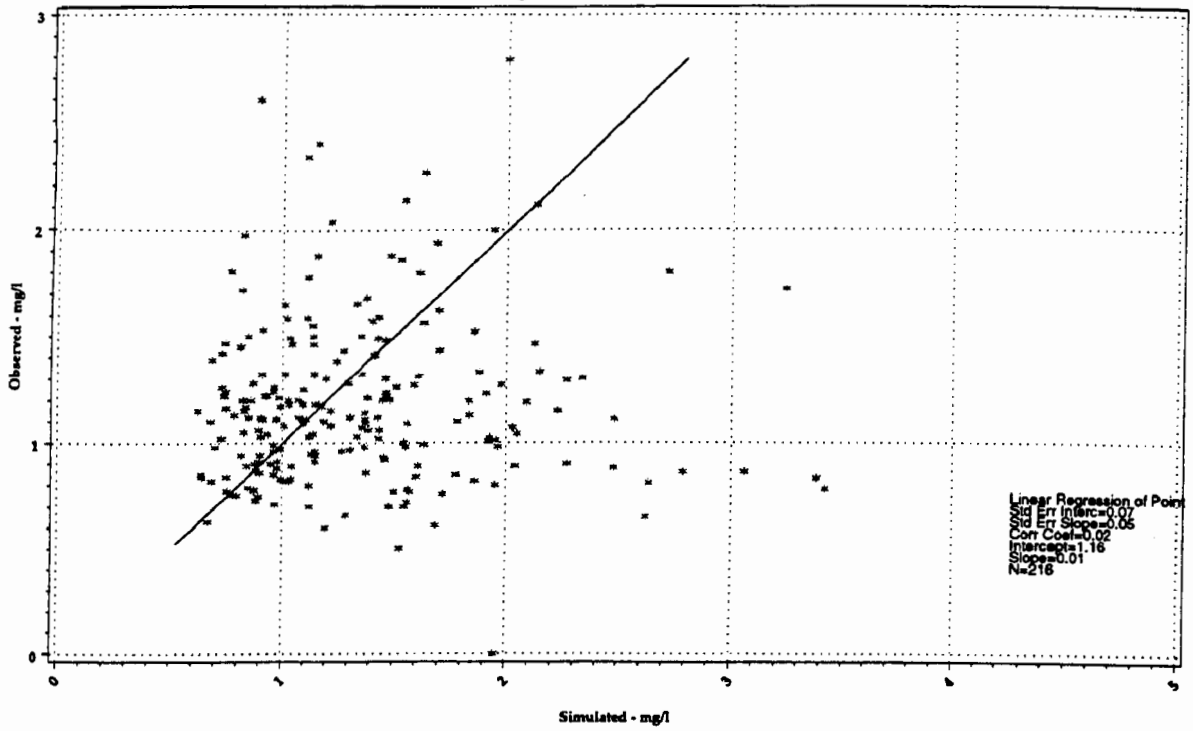
West Branch Susquehanna at Segment 70
Total Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plotb.sas model3d:jpwang.dt] 8dflas)
(wbsus_d.drv1 20FEB98 08:46,proc reg,model y=x)

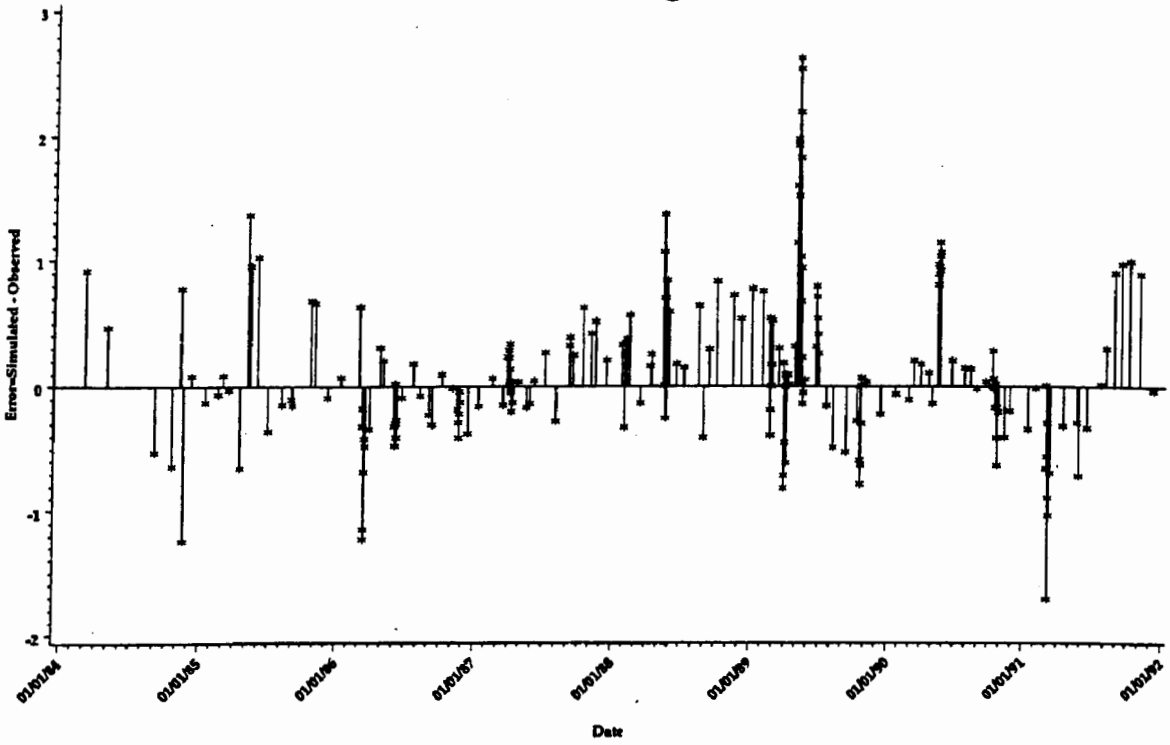
West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Nitrogen: 01JAN84 - 01JAN92

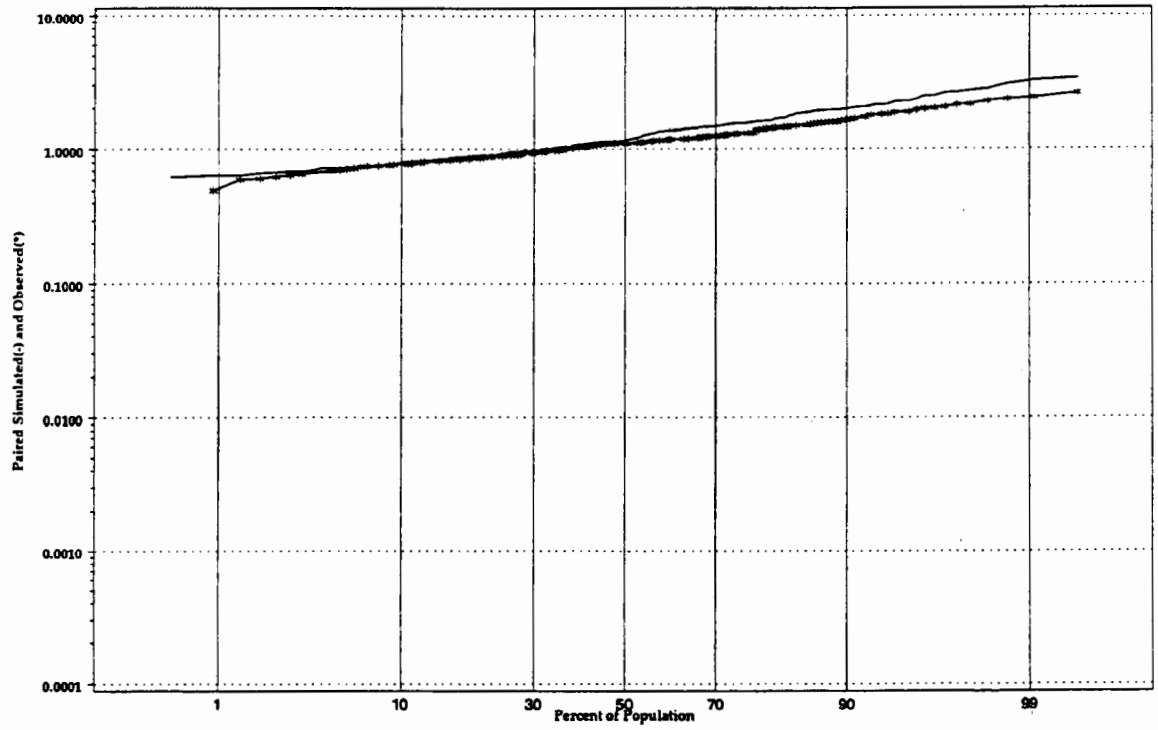


West Branch Susquehanna at Segment 70

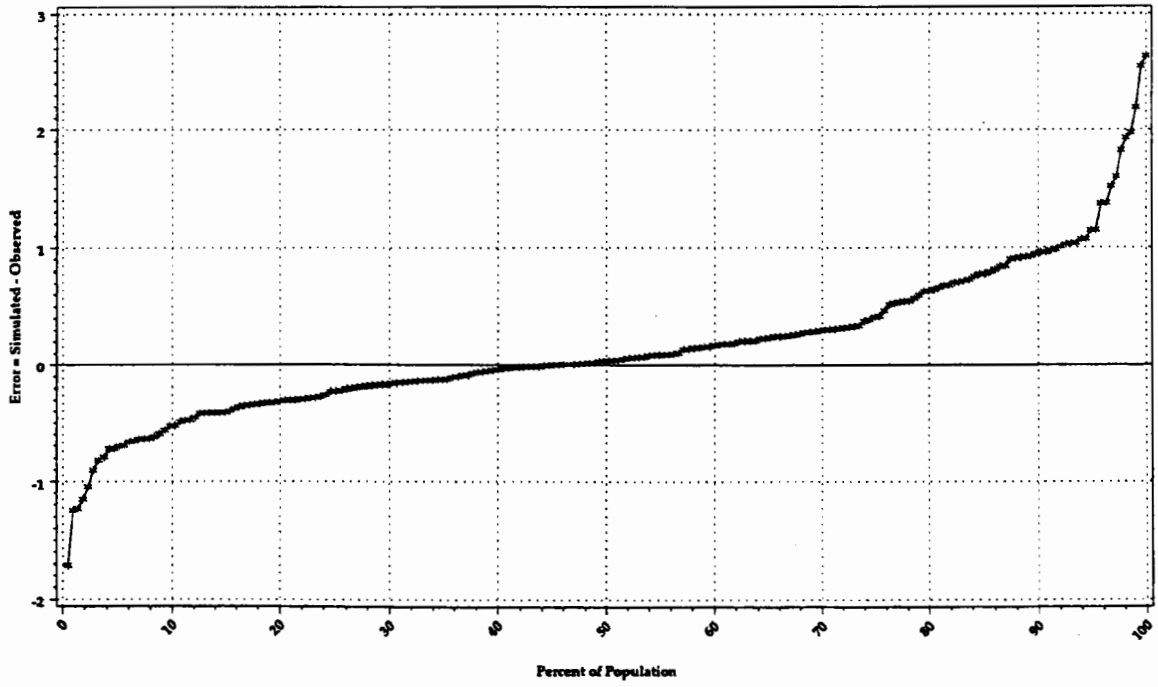
Actual Error versus Time
Total Nitrogen



West Branch Susquehanna at Segment 70
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

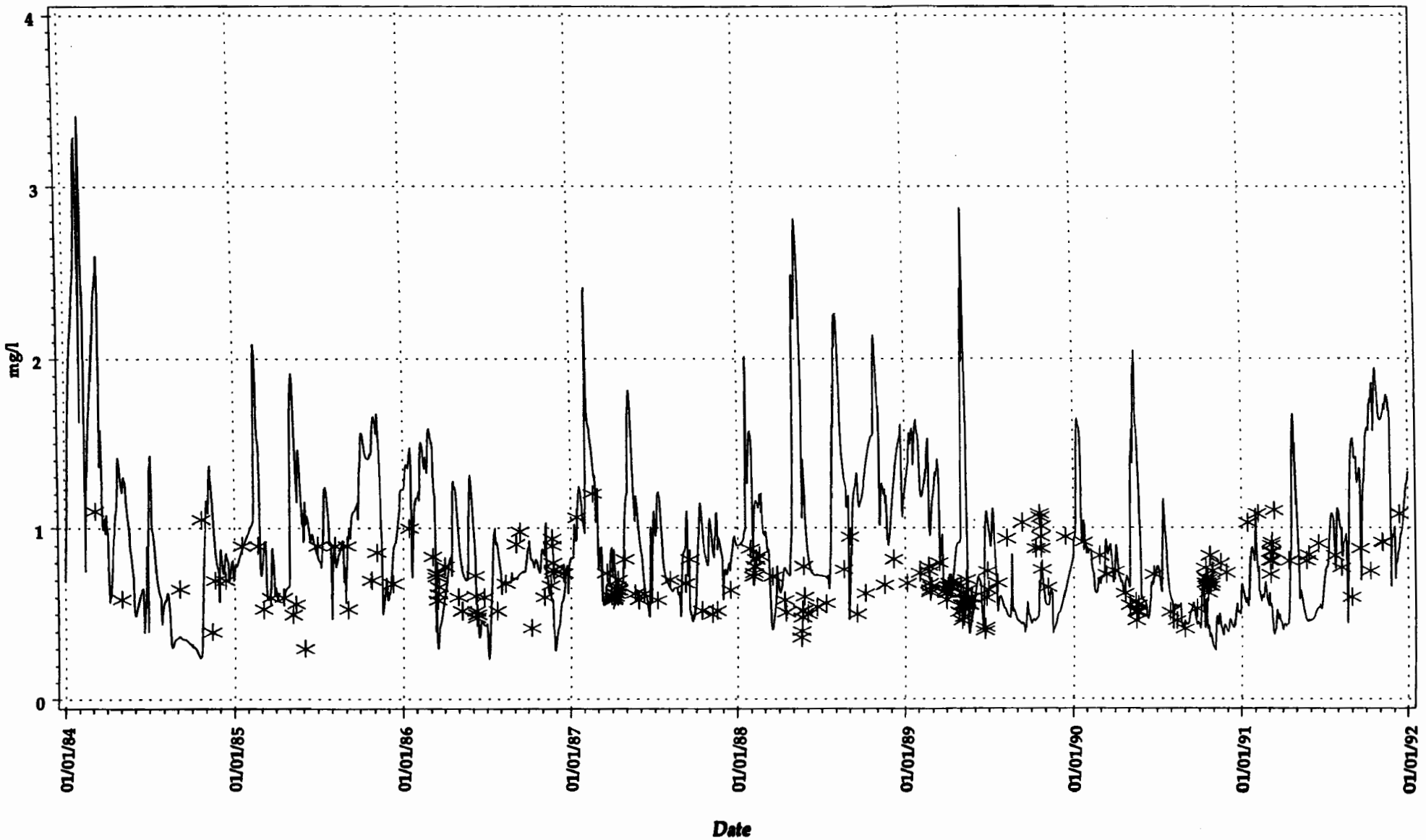


West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data

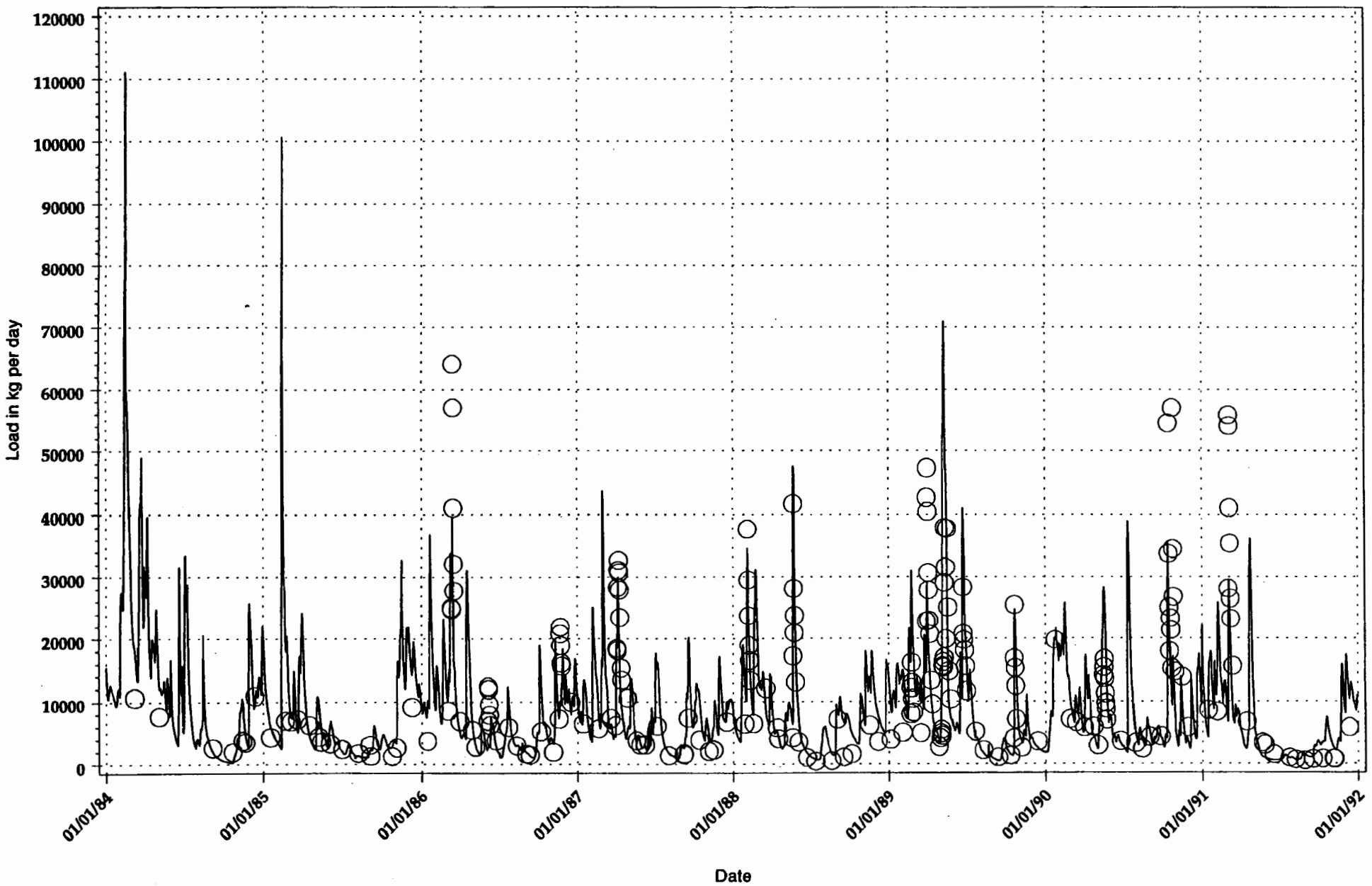


West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



West Branch Susquehanna at Segment 70
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

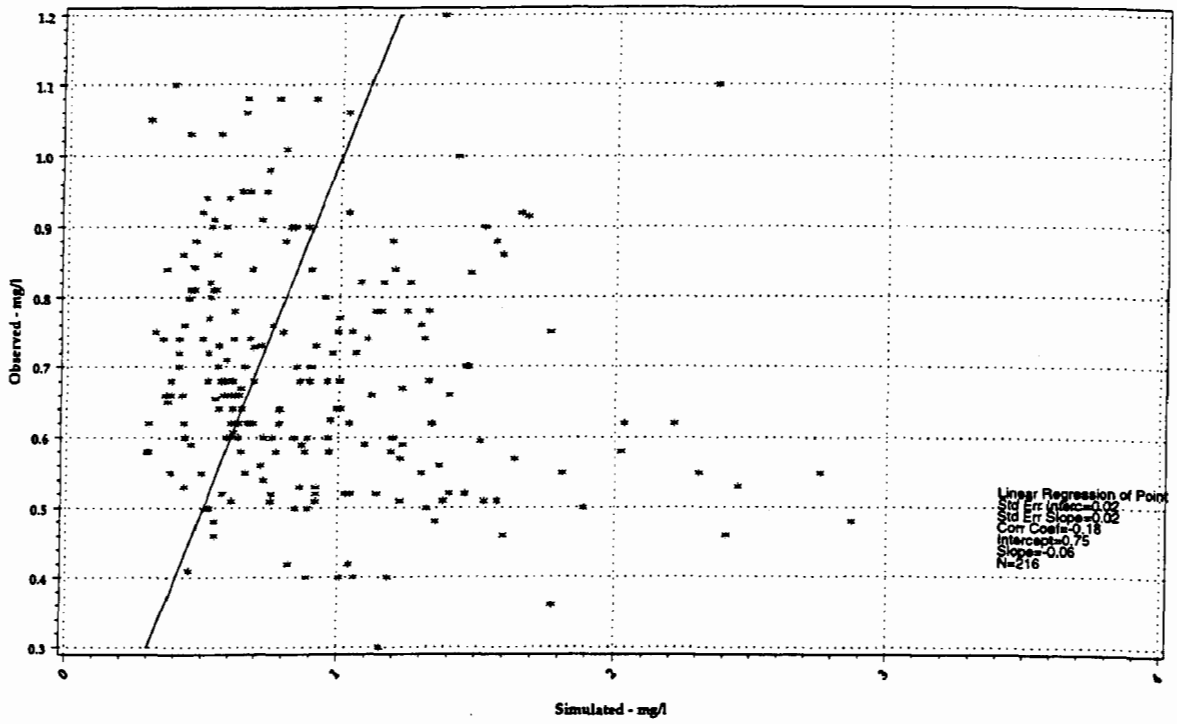


(y21_plotb.sas model3d:(pweng.dt) lldlles)
(wbsus_d.drv1 20FEB98 08:46,proc reg,model y=x)

West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

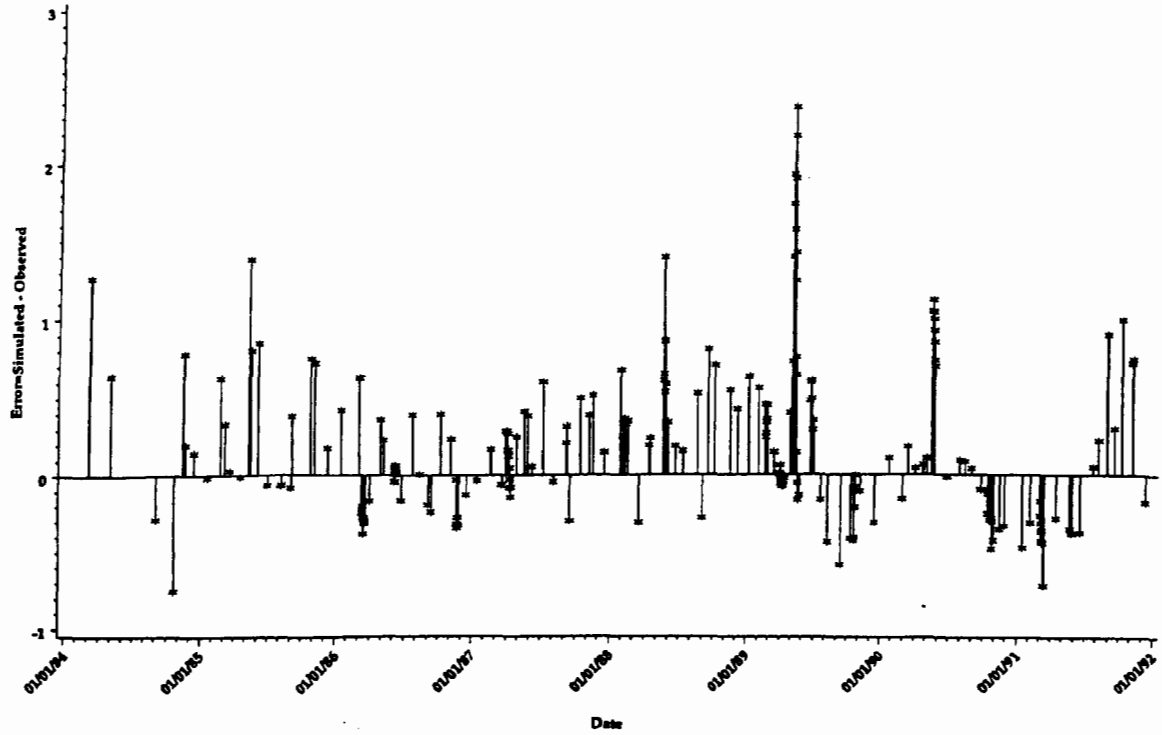
NO3: 01JAN84 - 01JAN92



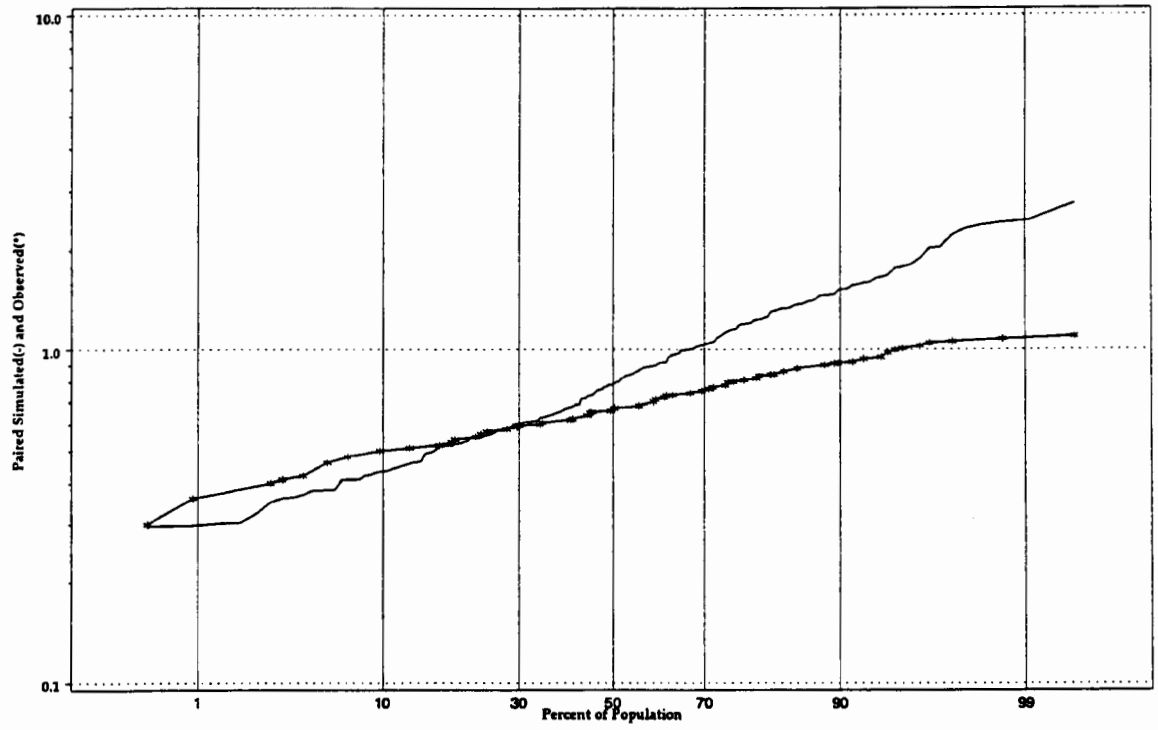
West Branch Susquehanna at Segment 70

Actual Error versus Time

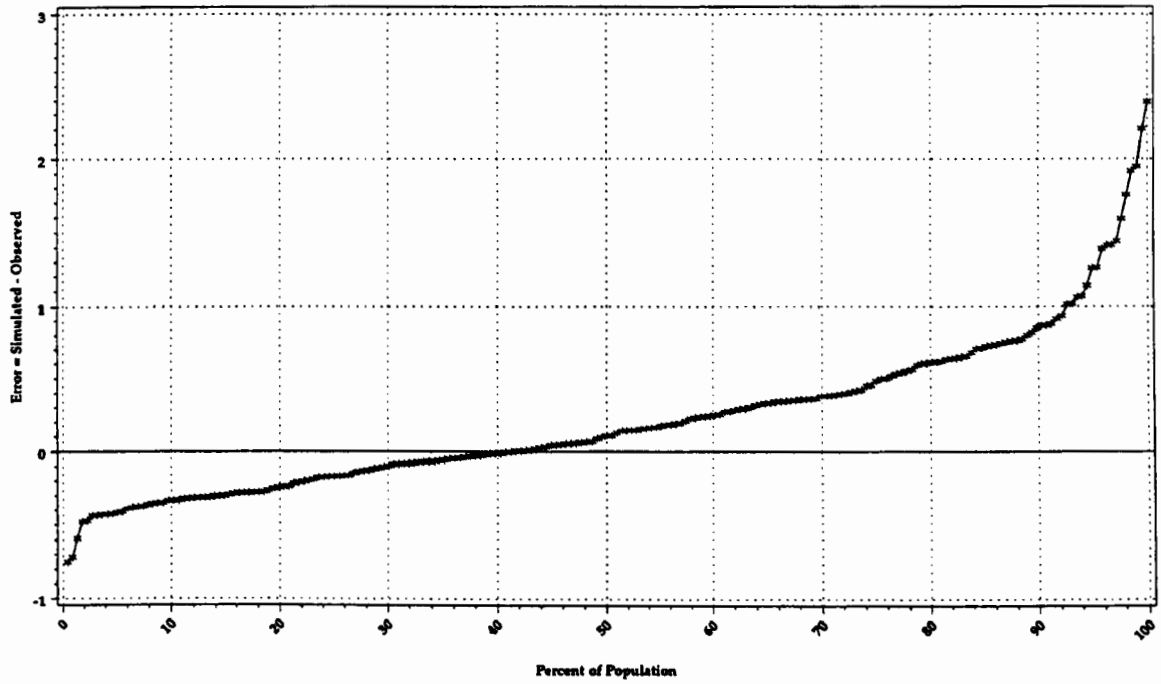
NO3



West Branch Susquehanna at Segment 70
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

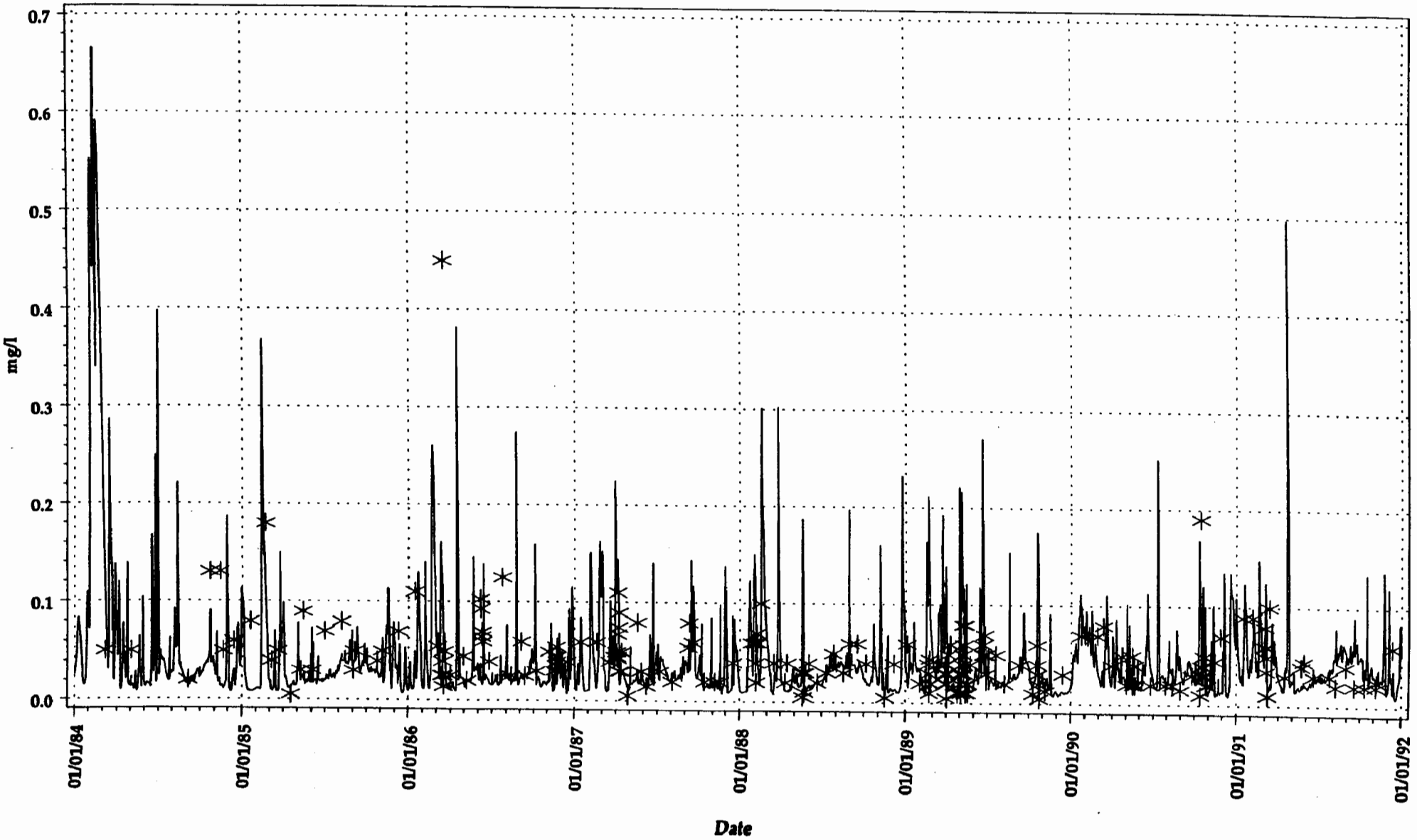


West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data

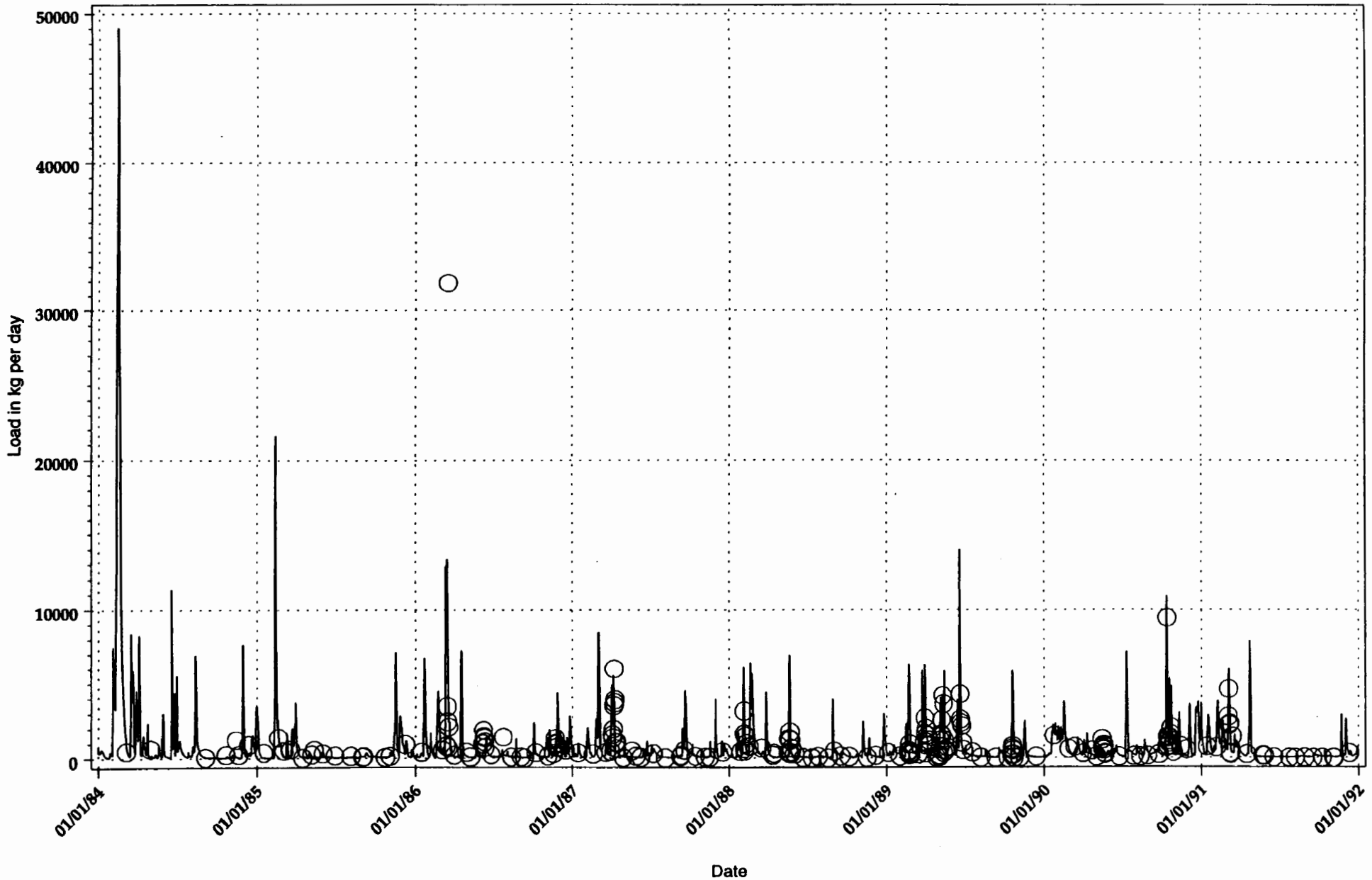


West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Total Ammonia

(*=Observed, -=Simulated)



West Branch Susquehanna at Segment 70
Total Ammonia Observed and Simulated Load vs Time
(line = simulated, O = observed)

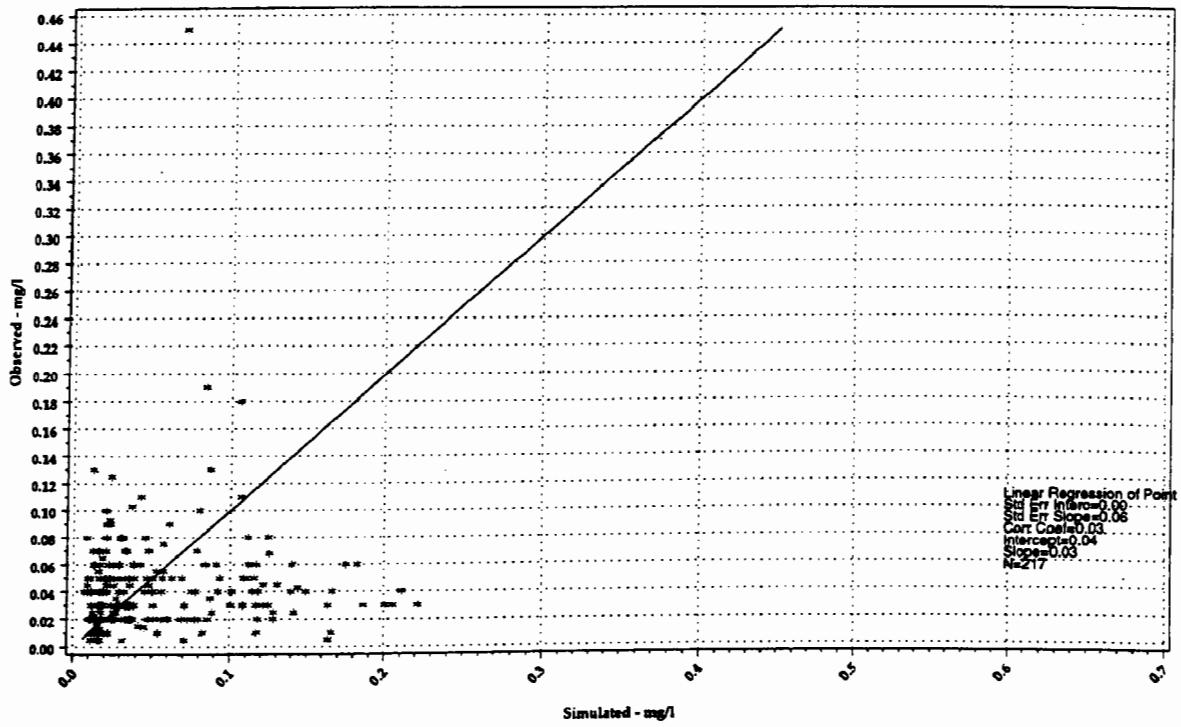


(y21_plotb.sas model3d:[pwang.dt] lldlles)
(wbsus_d.drv1 20FEB98 08:46,proc reg,model y=x)

West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

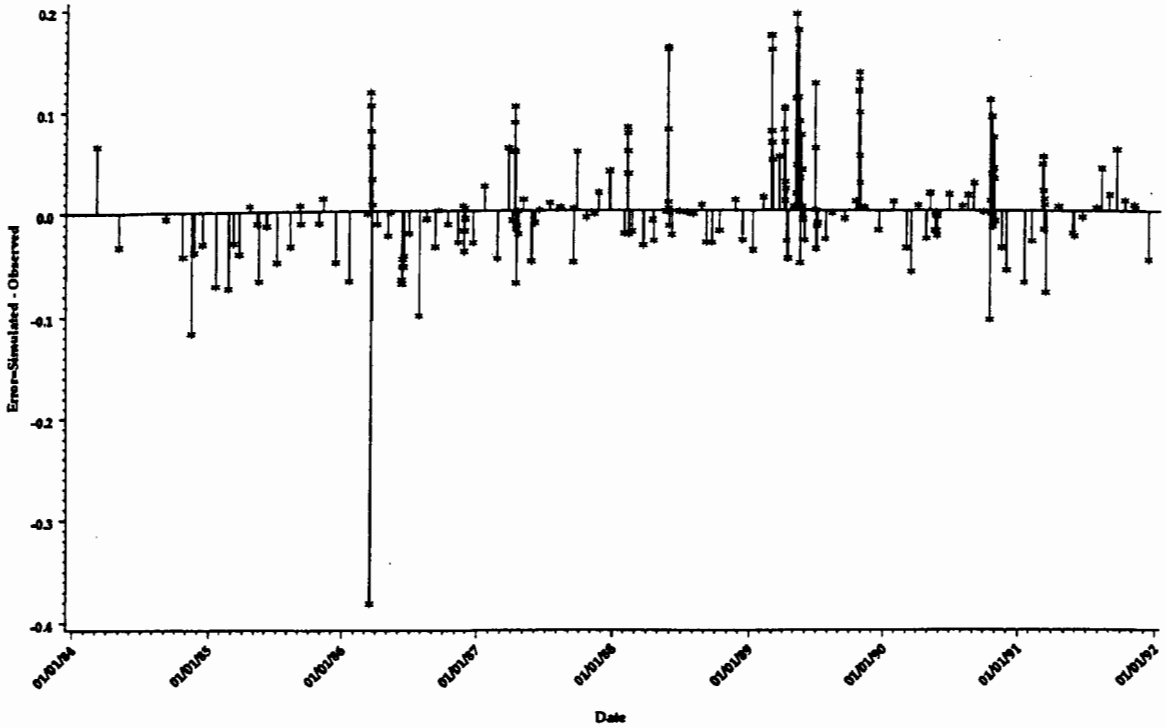
Total Ammonia: 01JAN84 - 01JAN92



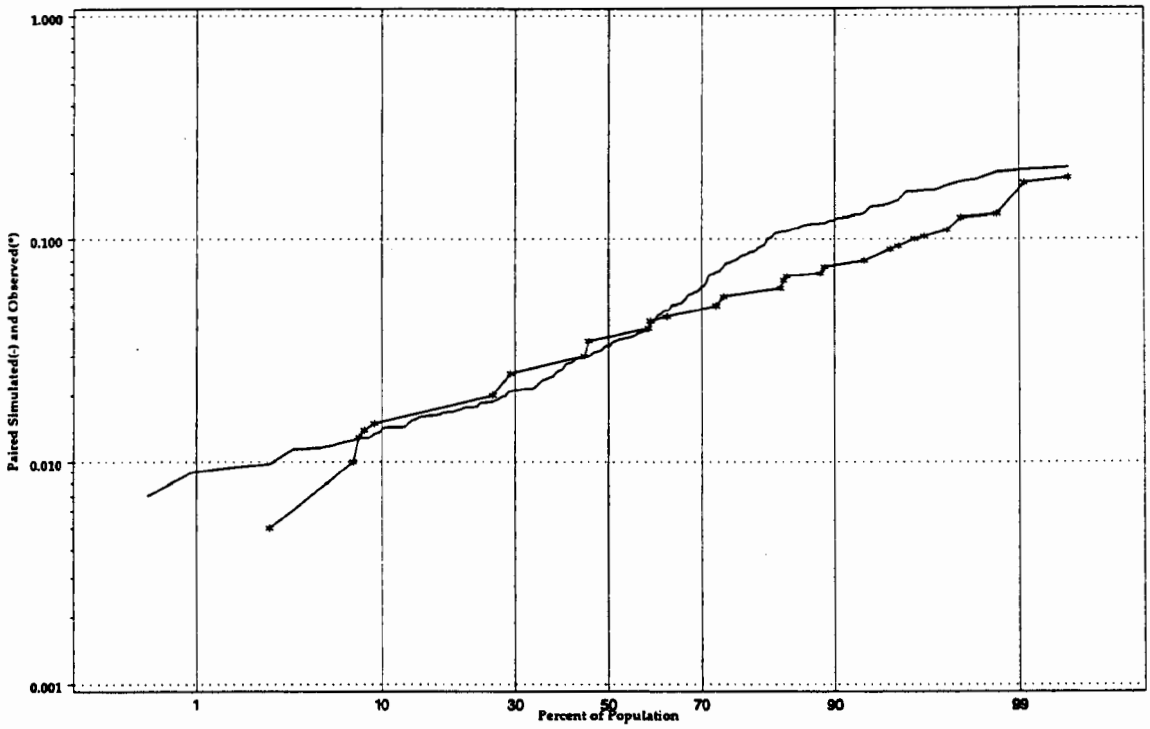
West Branch Susquehanna at Segment 70

Actual Error versus Time

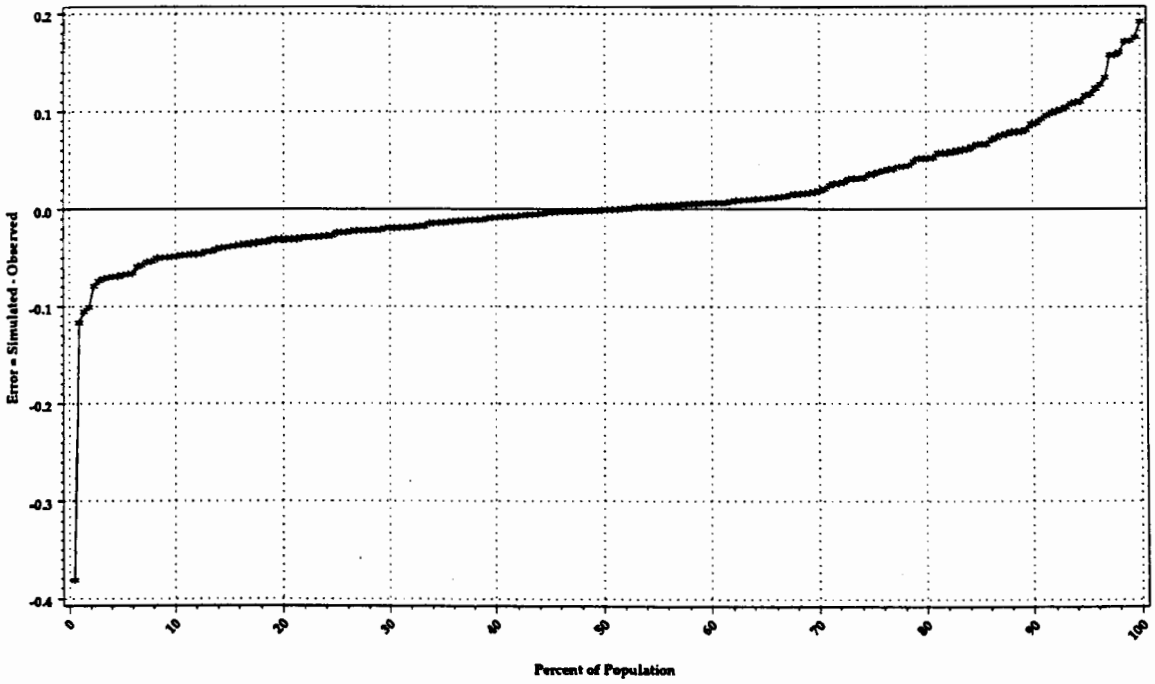
Total Ammonia



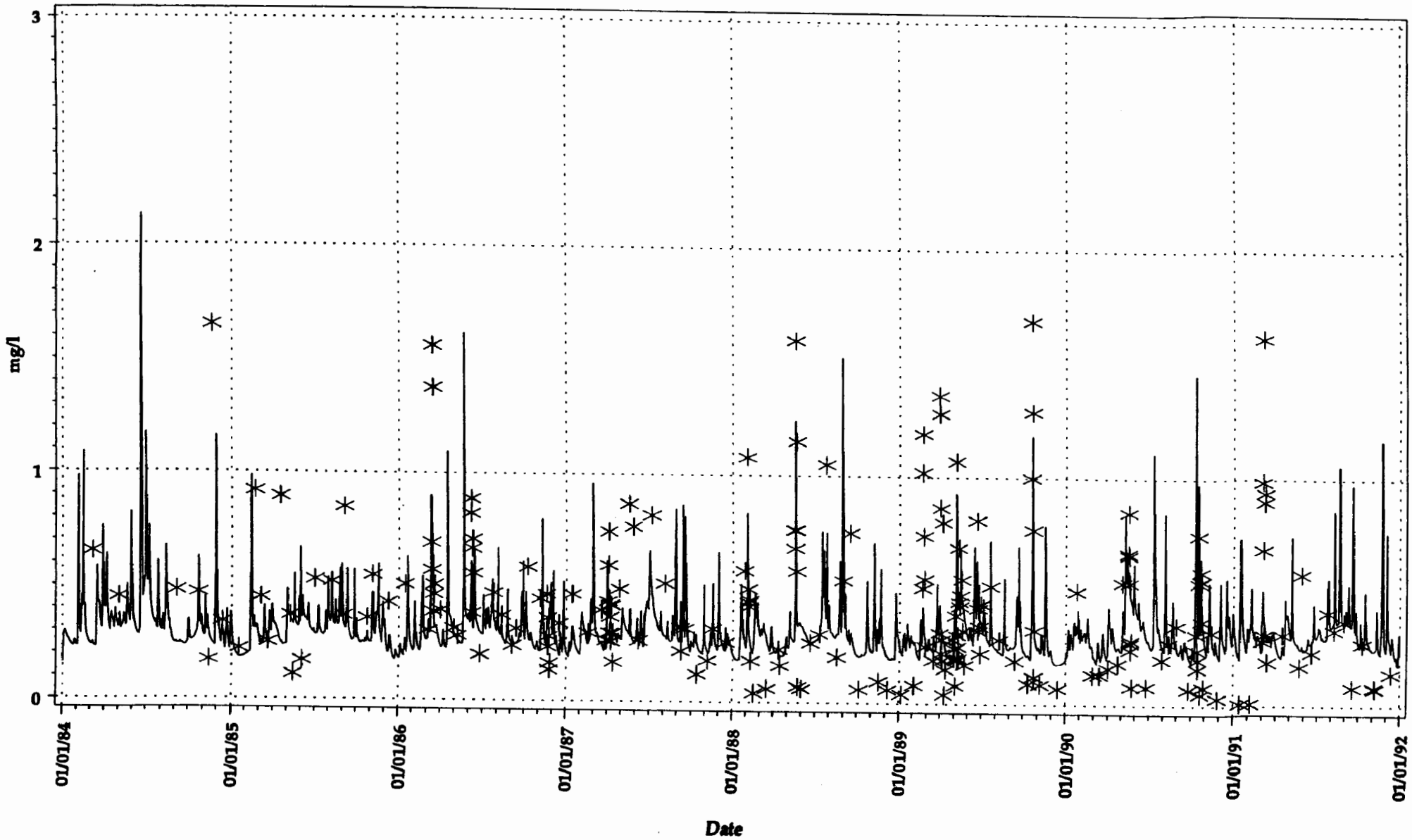
West Branch Susquehanna at Segment 70
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



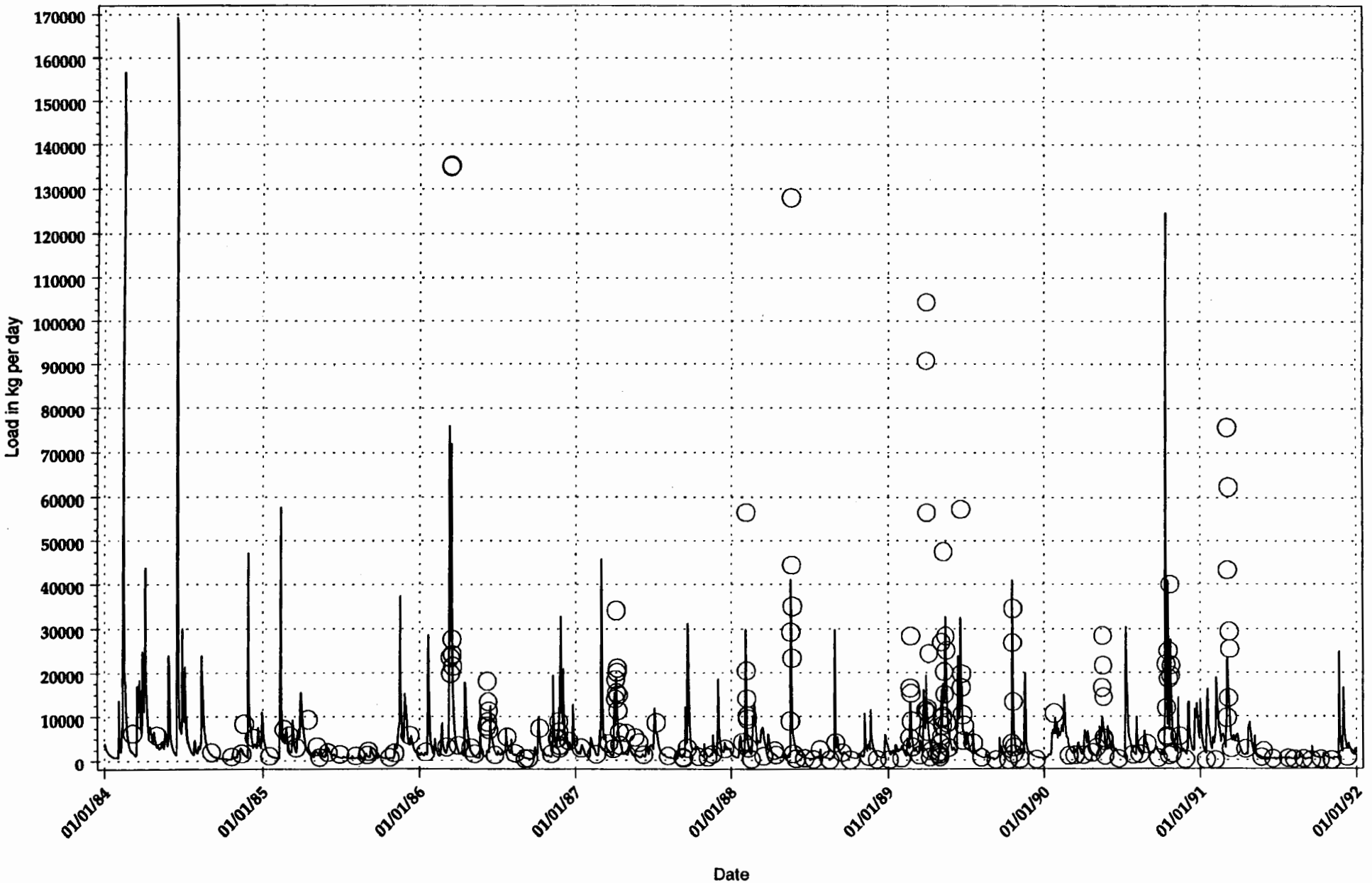
West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)



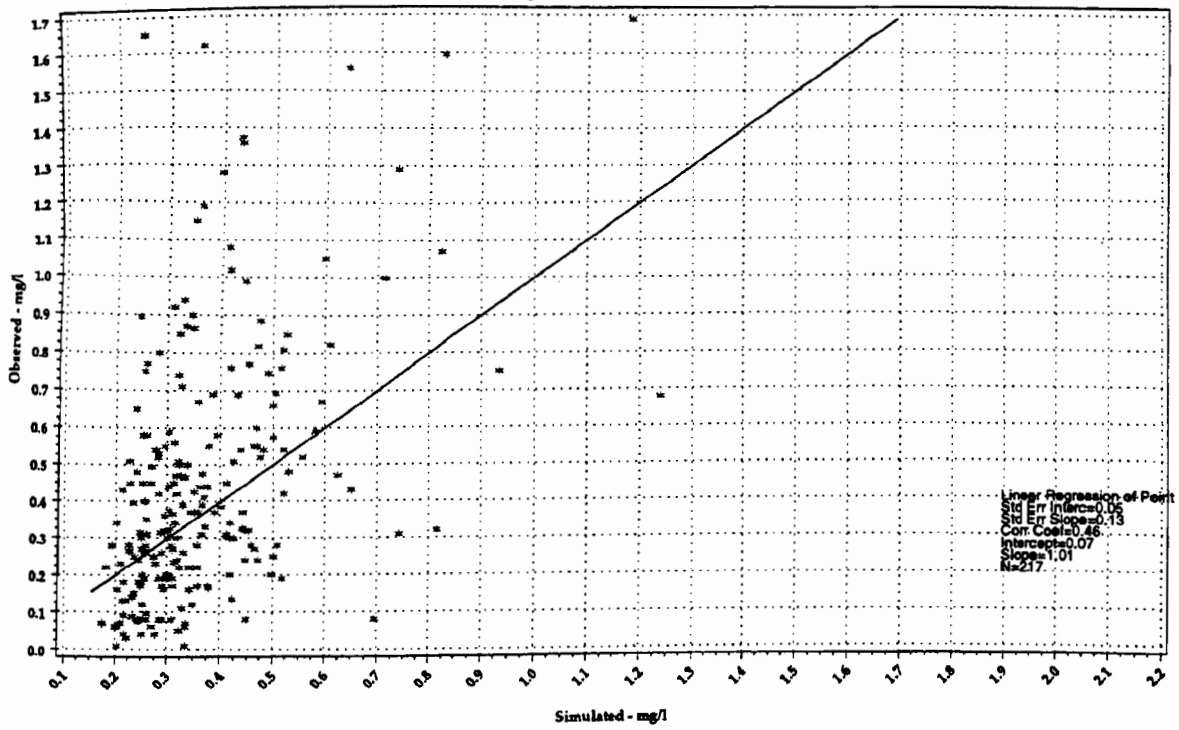
West Branch Susquehanna at Segment 70
Organic Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plotb.sas model3d:[pwang.dt] lldfles)
(wbsus_d.drv1 20FEB96 08:46,proc reg,model y=x)

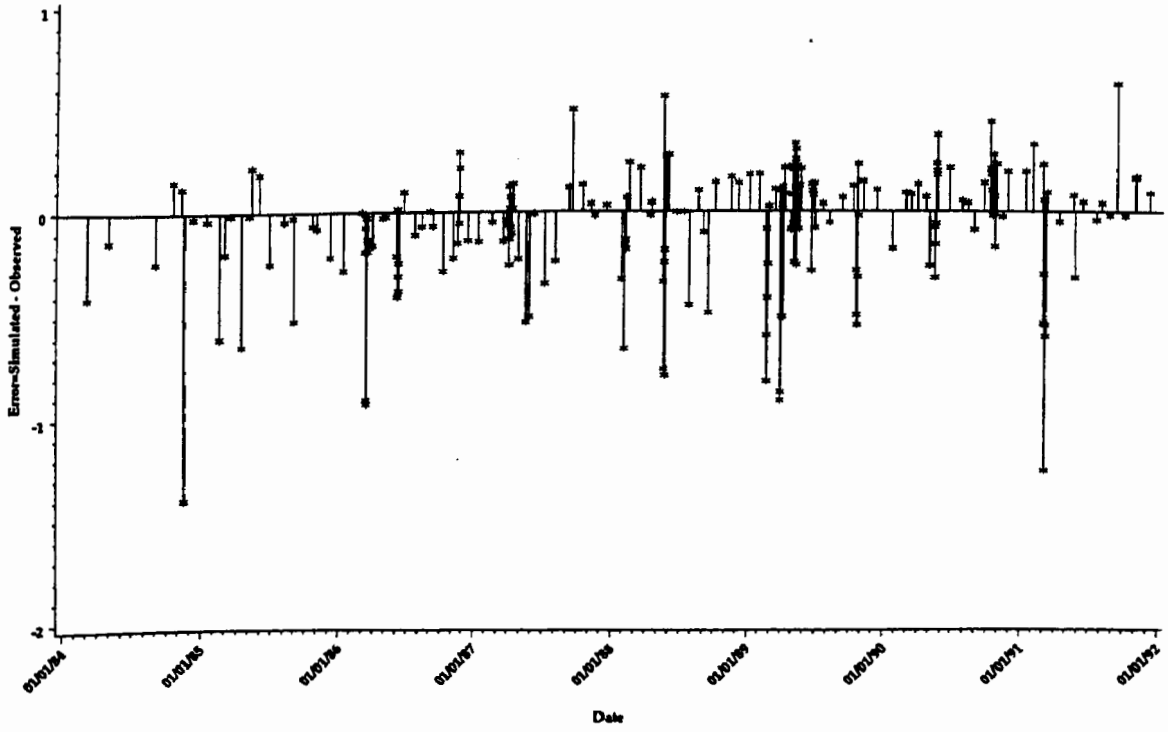
West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Organic Nitrogen: 01JAN84 - 01JAN92

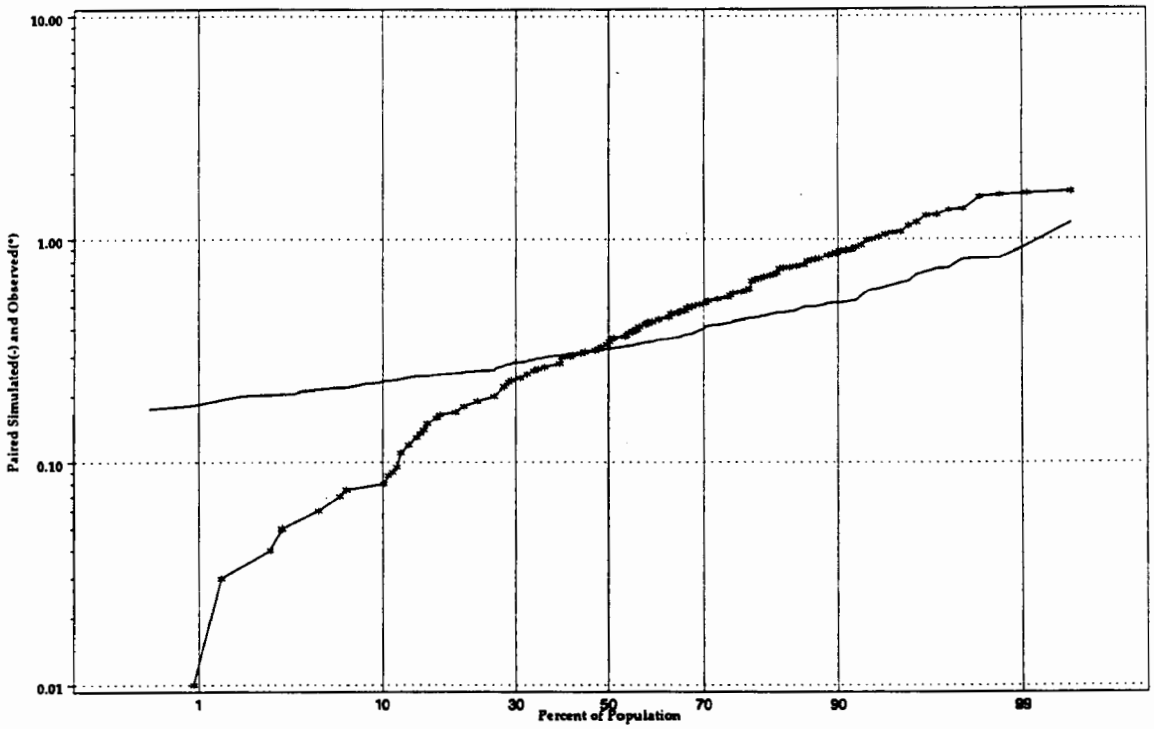


West Branch Susquehanna at Segment 70

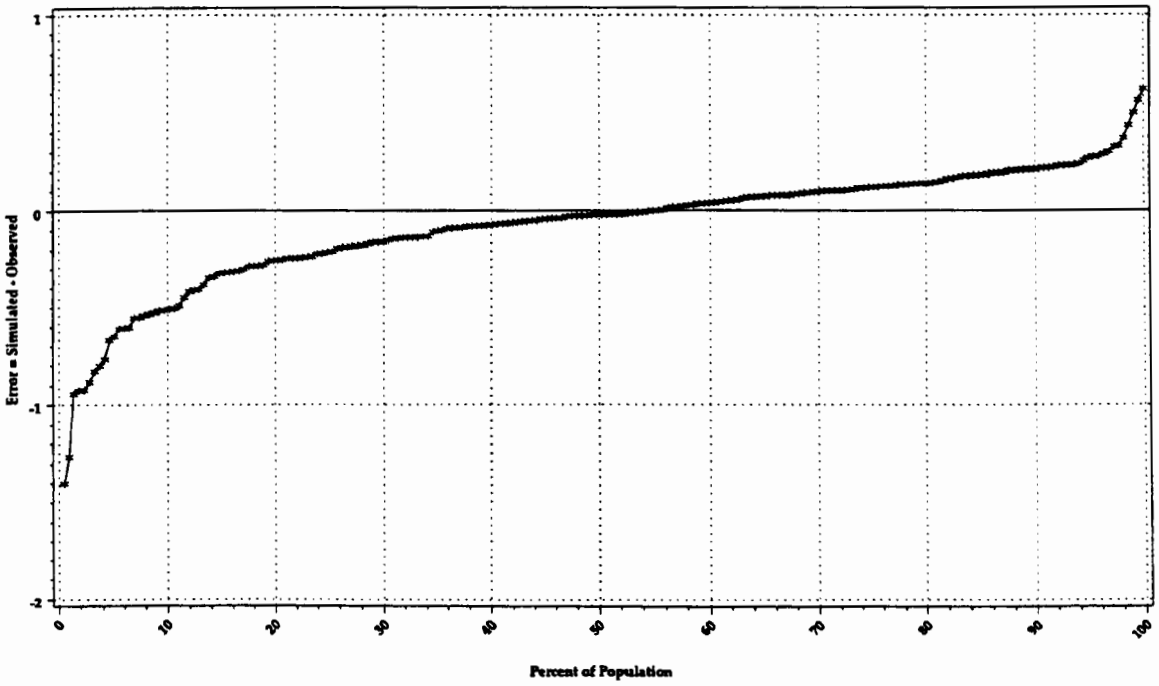
Actual Error versus Time
Organic Nitrogen



West Branch Susquehanna at Segment 70
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.1.3 Juniata River at Newport, PA near Segment 100 (Monitoring Station: 1567000) (Above Fall Line Basin Segments: 90 and 100)

Section Summary:

The Juniata basin is primarily rural and forested. The Raystown Reservoir, which intercepts drainage of 28% of the basin, has long hydrologic residence times which result in decreased total nitrogen and total phosphorus loads for this portion of the basin.

The Juniata basin above the gaged site covers an area of 3,355 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 69% forest land, 10% cropland, 18% other agricultural areas, 3% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage increased from 11.2 million pounds in 1985 to 11.3 million pounds in 1996. Total phosphorus loads over the same time period decreased from 0.5 million pounds to 0.4 million pounds. In general, point source loads above the gage site are low. In 1996, the total nitrogen point source load was 7% of the total load and the total phosphorus point source load was 12% of the total load. Estimated septic system total nitrogen loads increased 14%, from 0.32 million pounds in 1985 to 0.37 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 9%, and other agricultural loads (primarily pasture and manure loads) by 2%. Total phosphorus decreased for these land uses by 4% and 9% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 11% for total nitrogen and 8% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

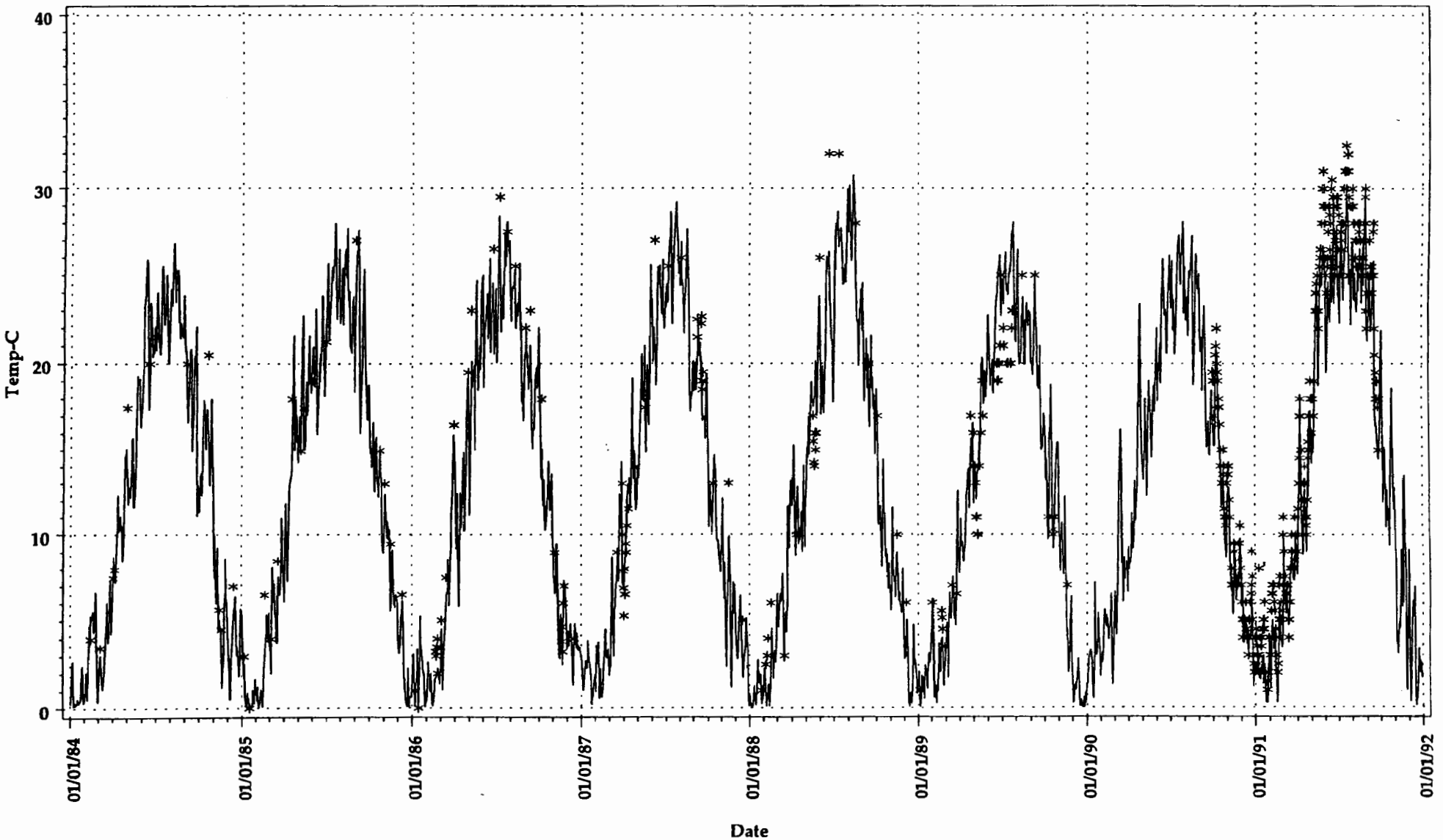
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

Juniata River at Segment 100
Observed and Simulated versus Time
Temperature-C

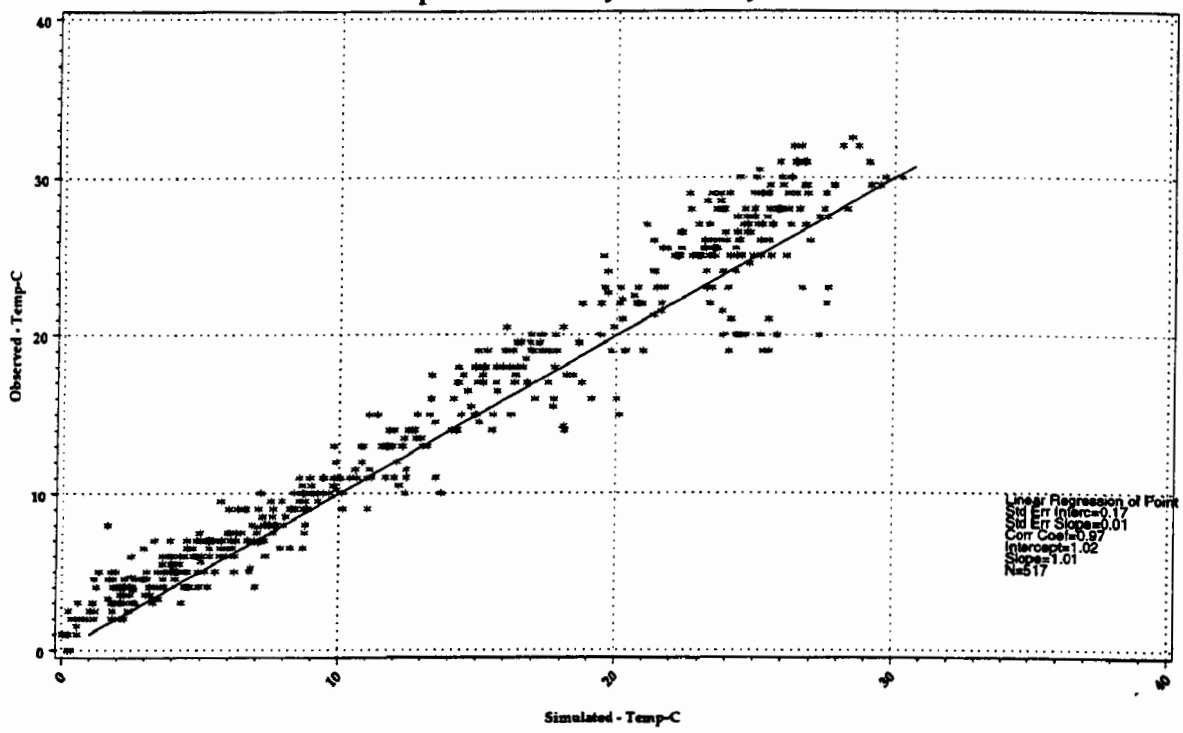
(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[rps.p3 james sas] plotomt - omtime)
(graph_a.drv 08SEP97 16:17)

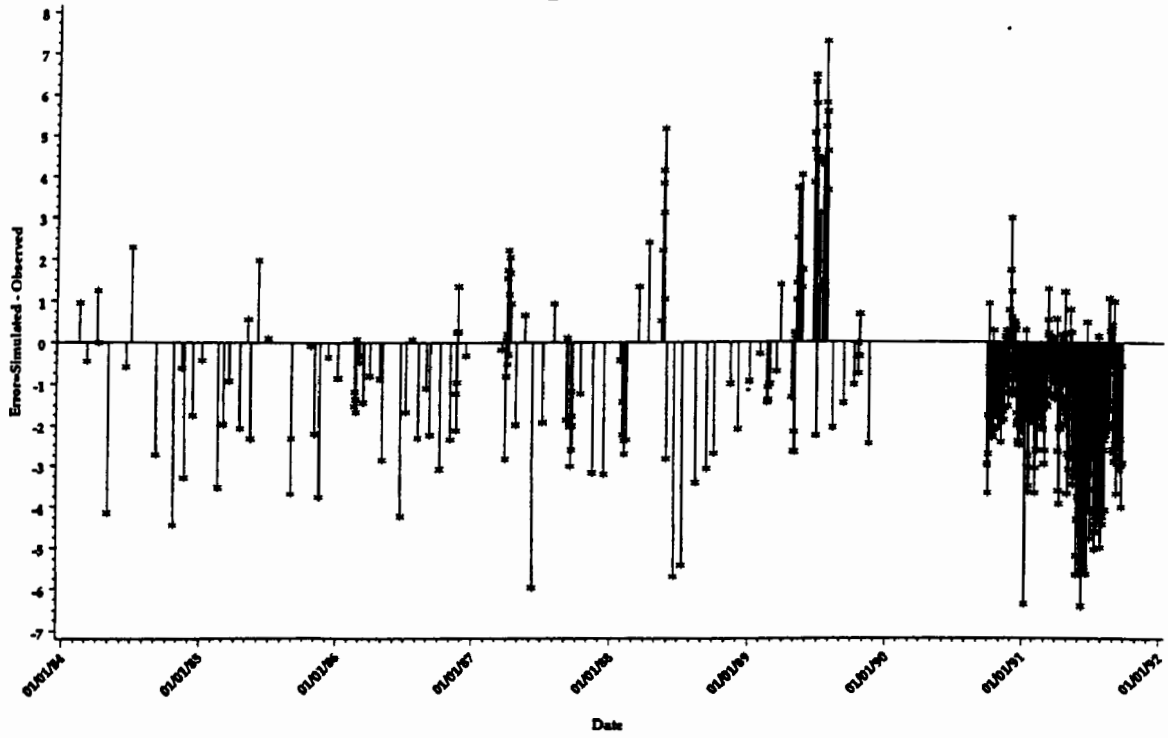
Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Temperature-C: 01JAN84 - 01JAN92

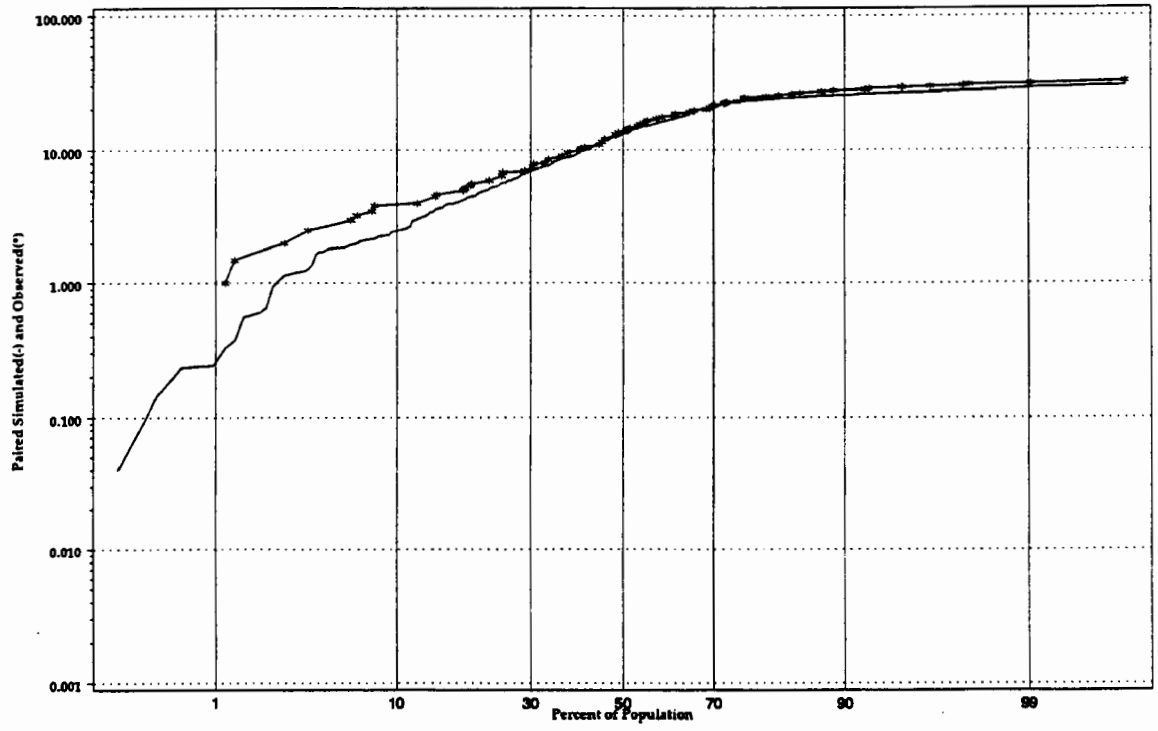


Juniata River at Segment 100

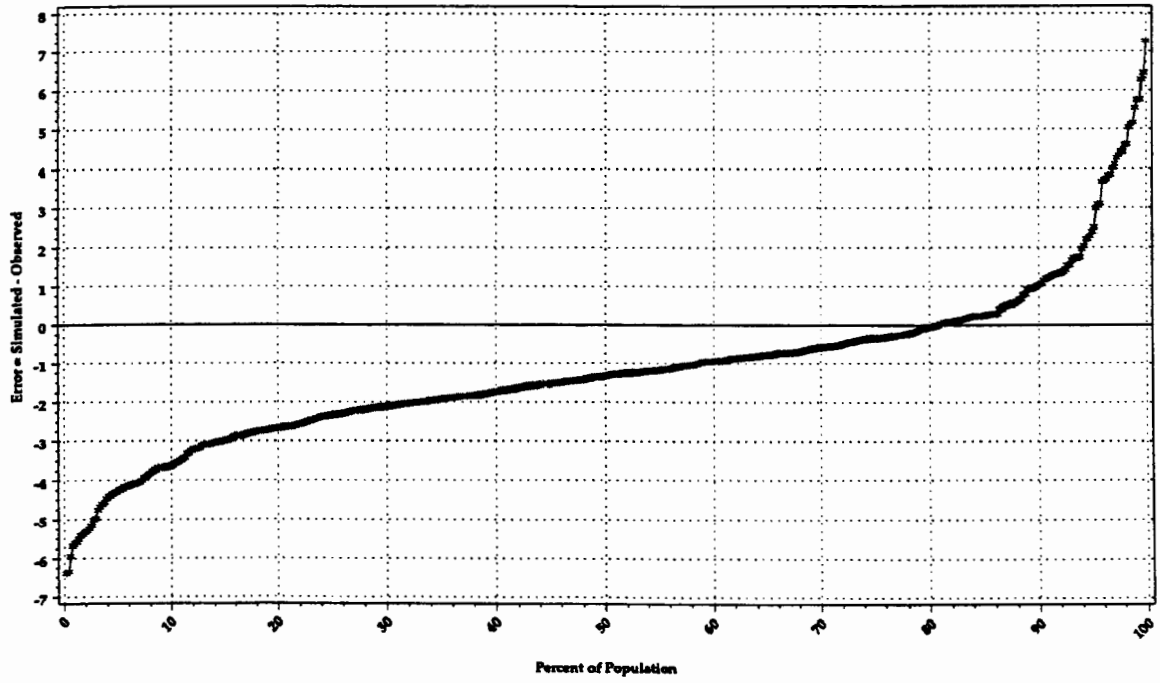
Actual Error versus Time
Temperature-C



Juniata River at Segment 100
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

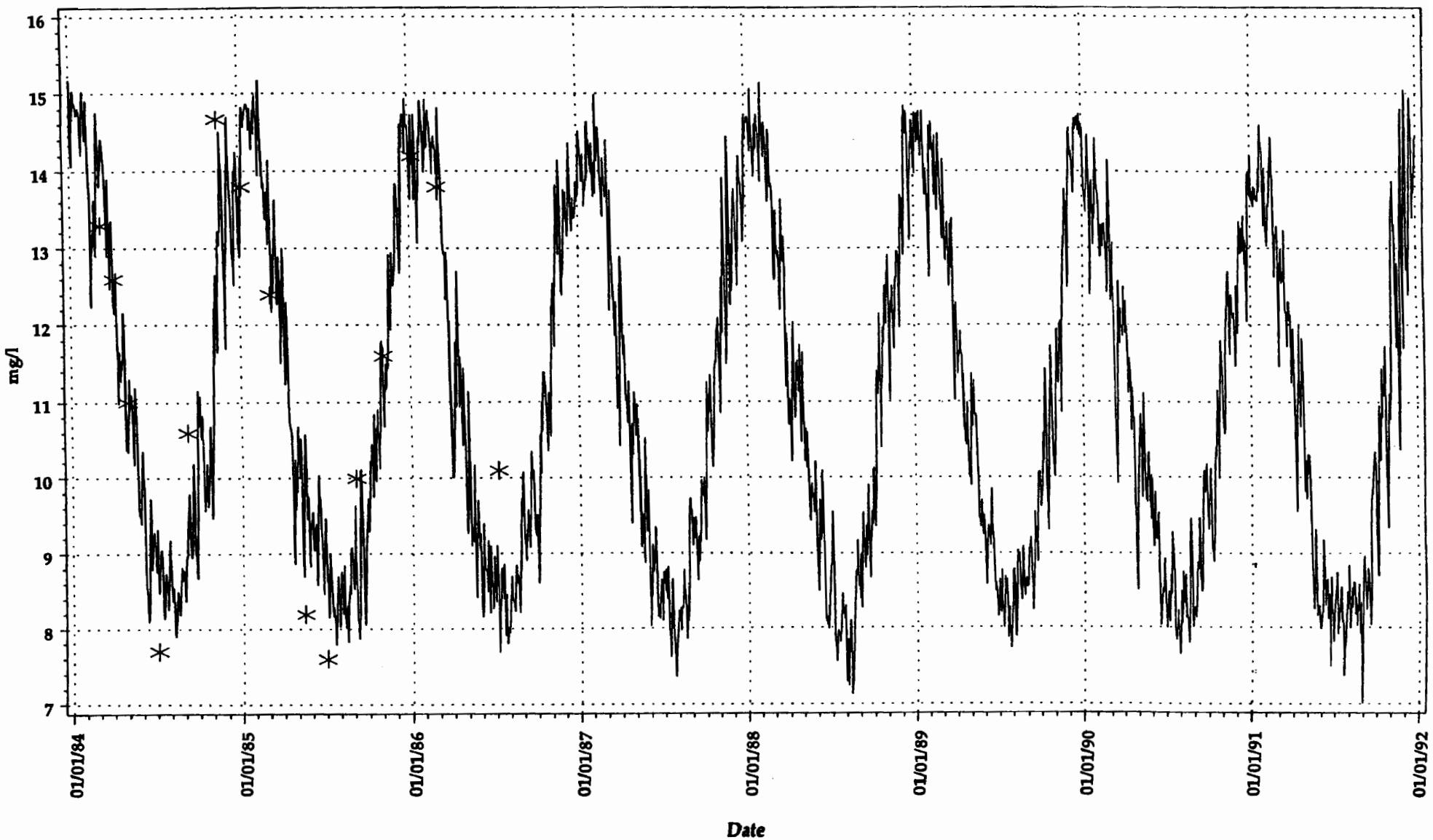


Juniata River at Segment 100
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data

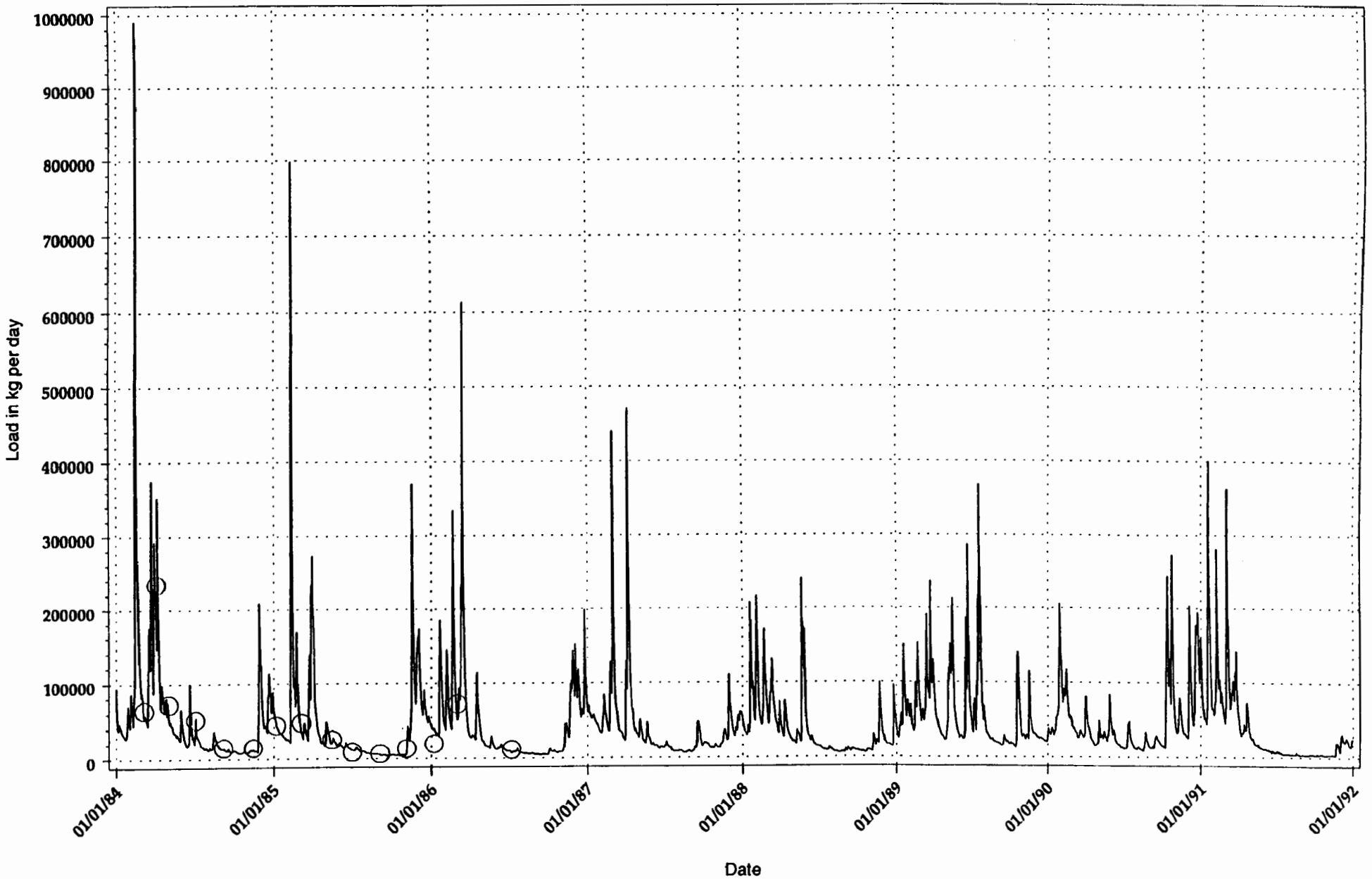


Juniata River at Segment 100
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



Juniata River at Segment 100
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)

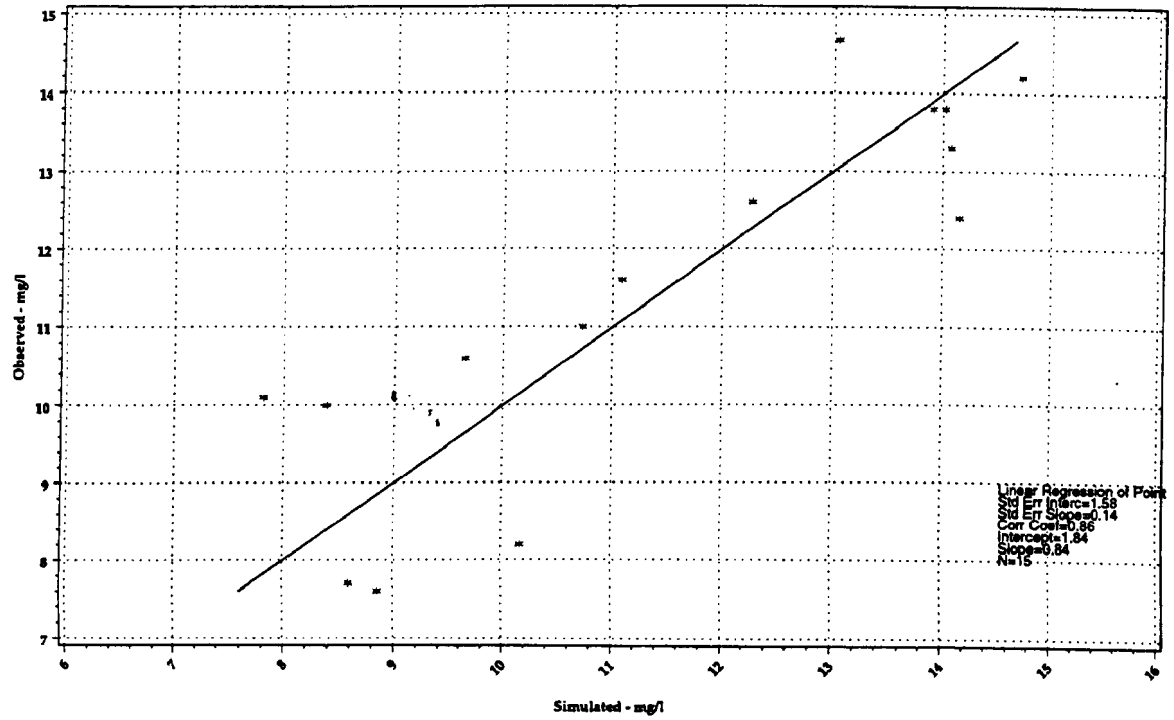


(y21_plot1.sas datastore2 [nps p3.james.sas] 8dflas)
(graph_a.dvr 08SEP97 16:17,proc reg,model y=x)

Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

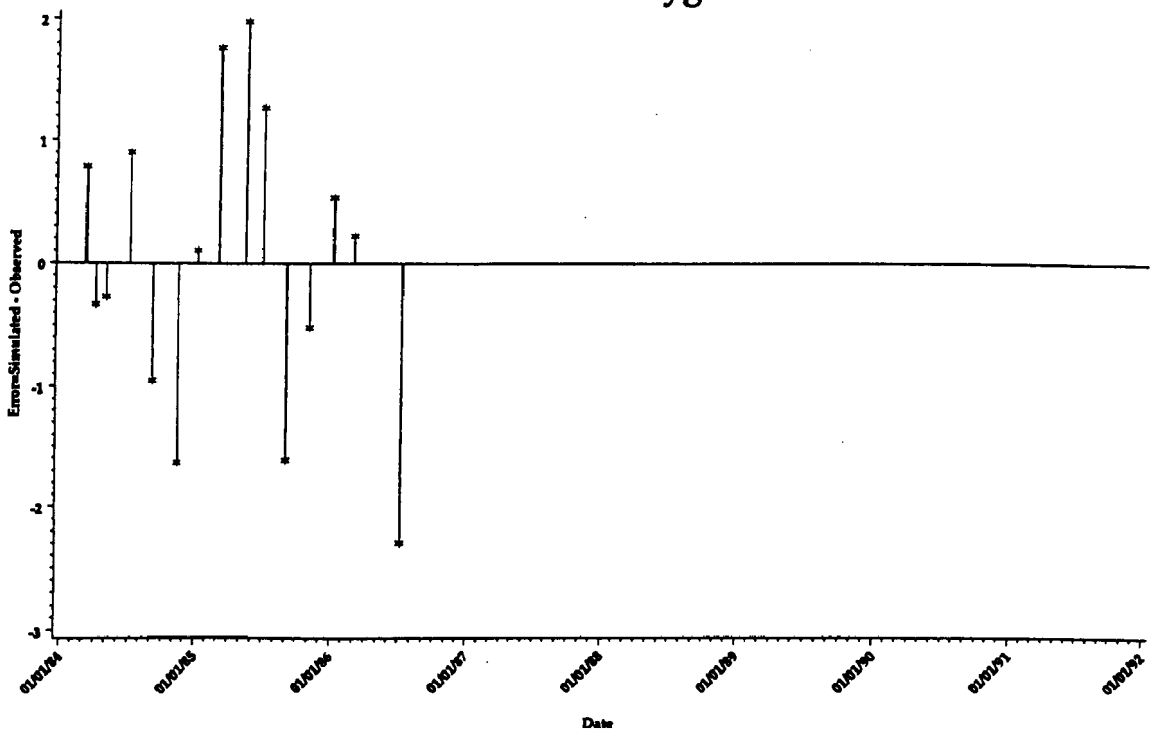
Dissolved Oxygen: 01JAN84 - 01JAN92



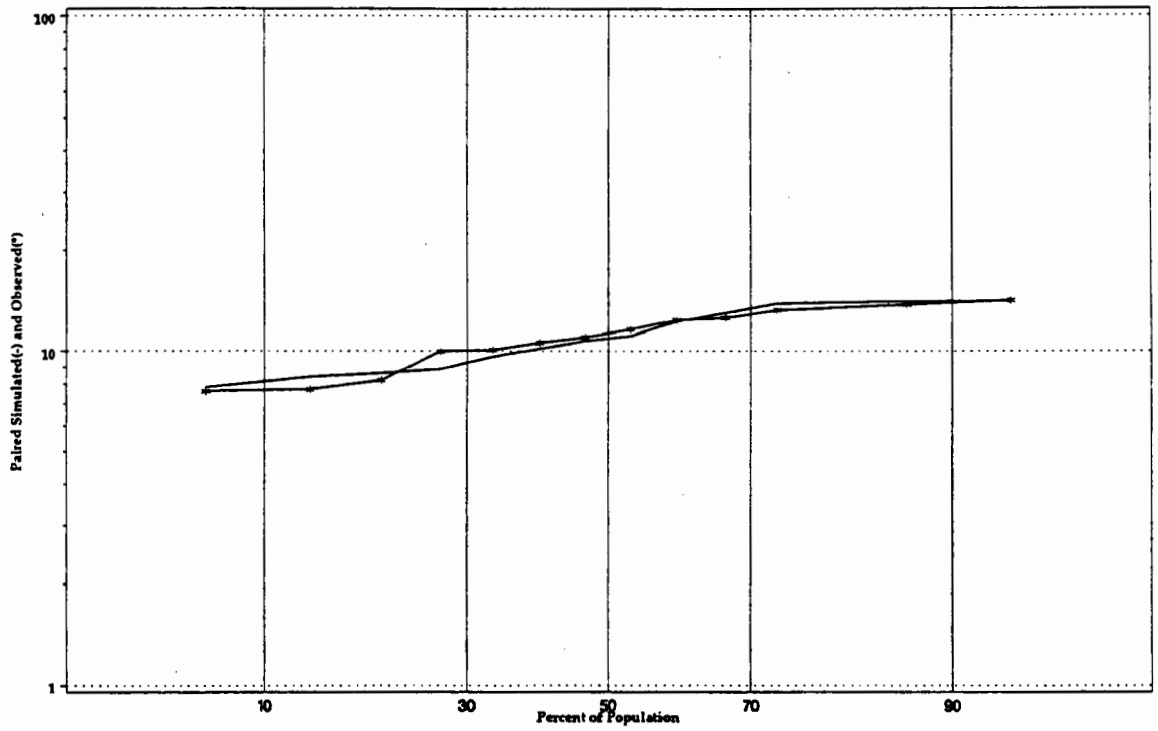
Juniata River at Segment 100

Actual Error versus Time

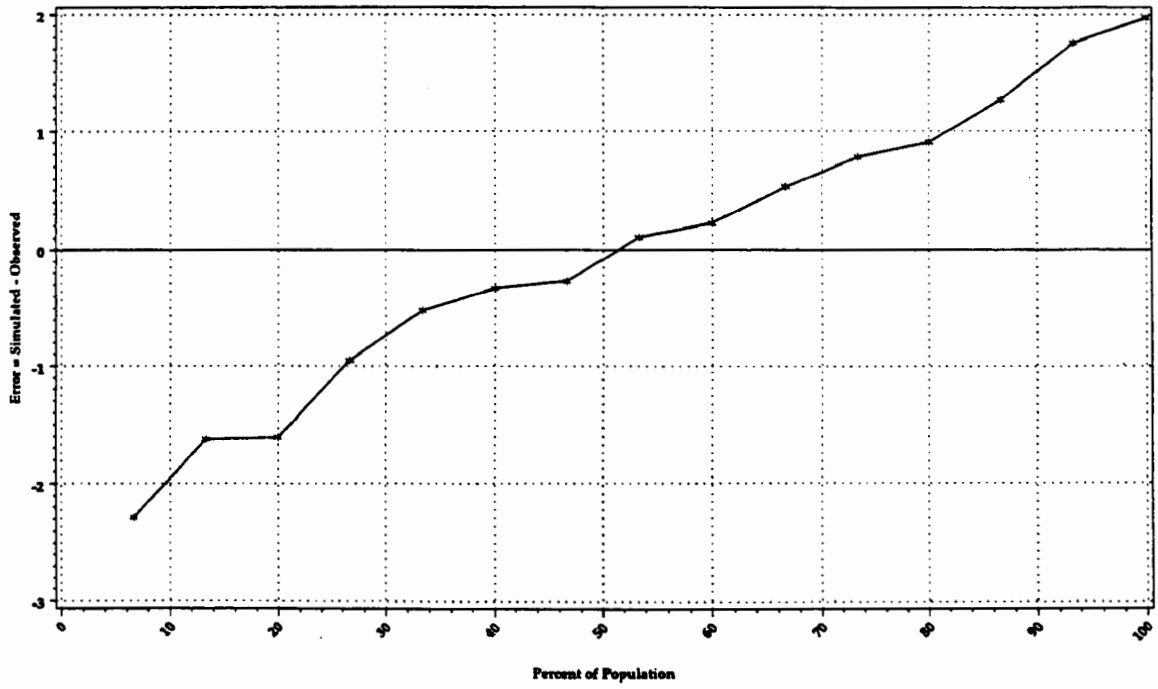
Dissolved Oxygen



Juniata River at Segment 100
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

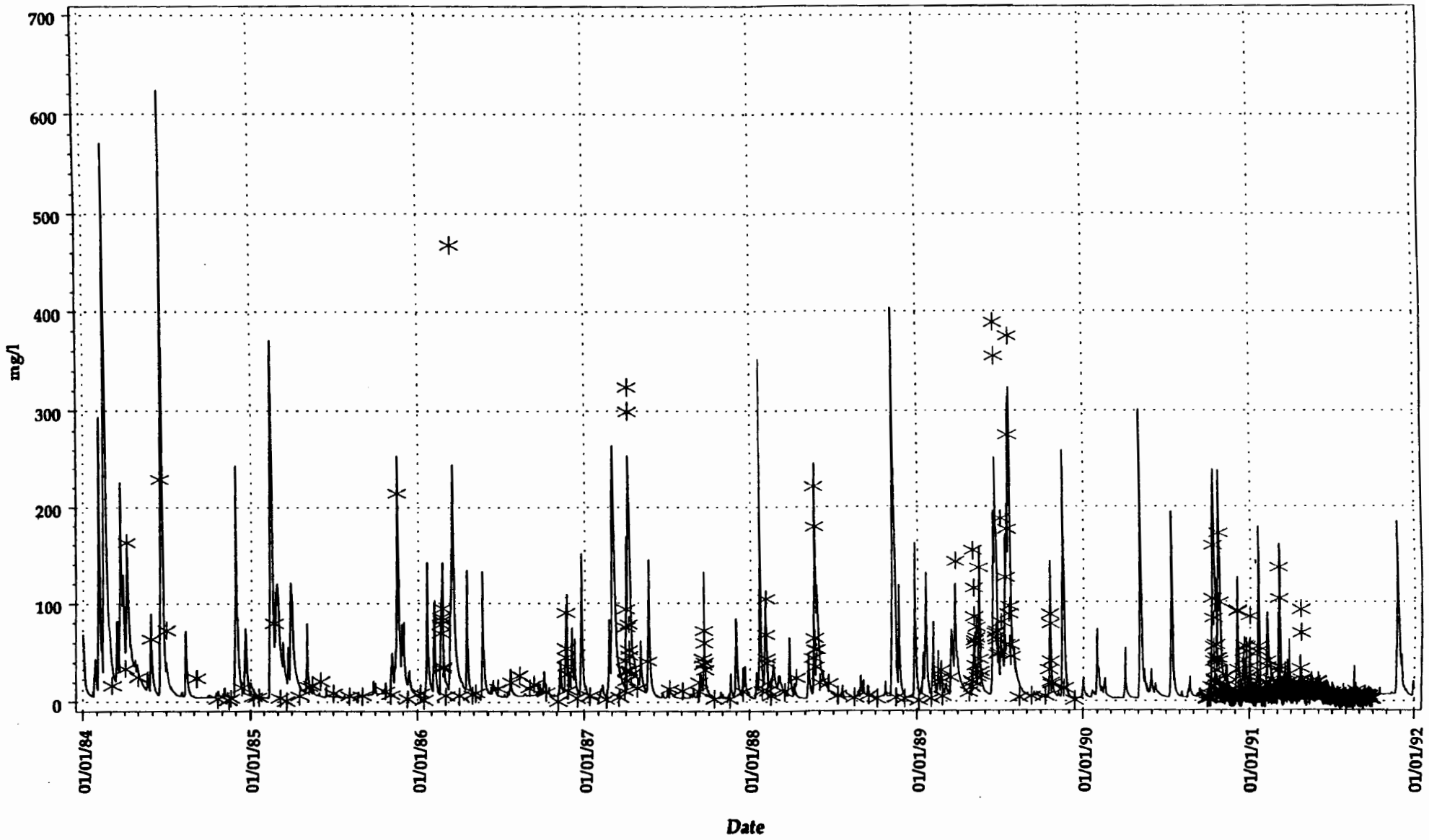


Juniata River at Segment 100
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Juniata River at Segment 100
Observed and Simulated versus Time
Total Suspended Sediment

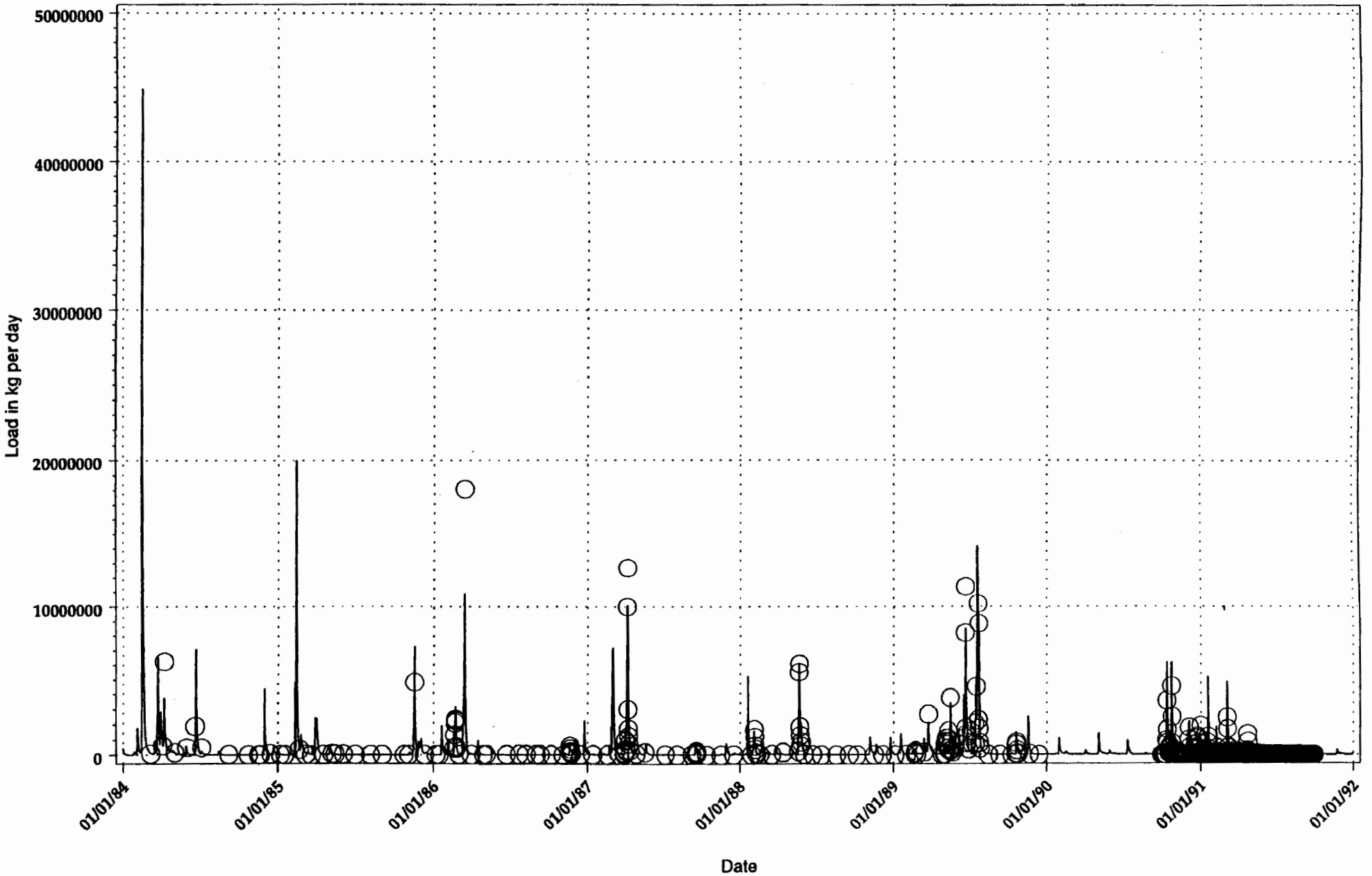
(*=Observed, -=Simulated)



Juniata River at Segment 100

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

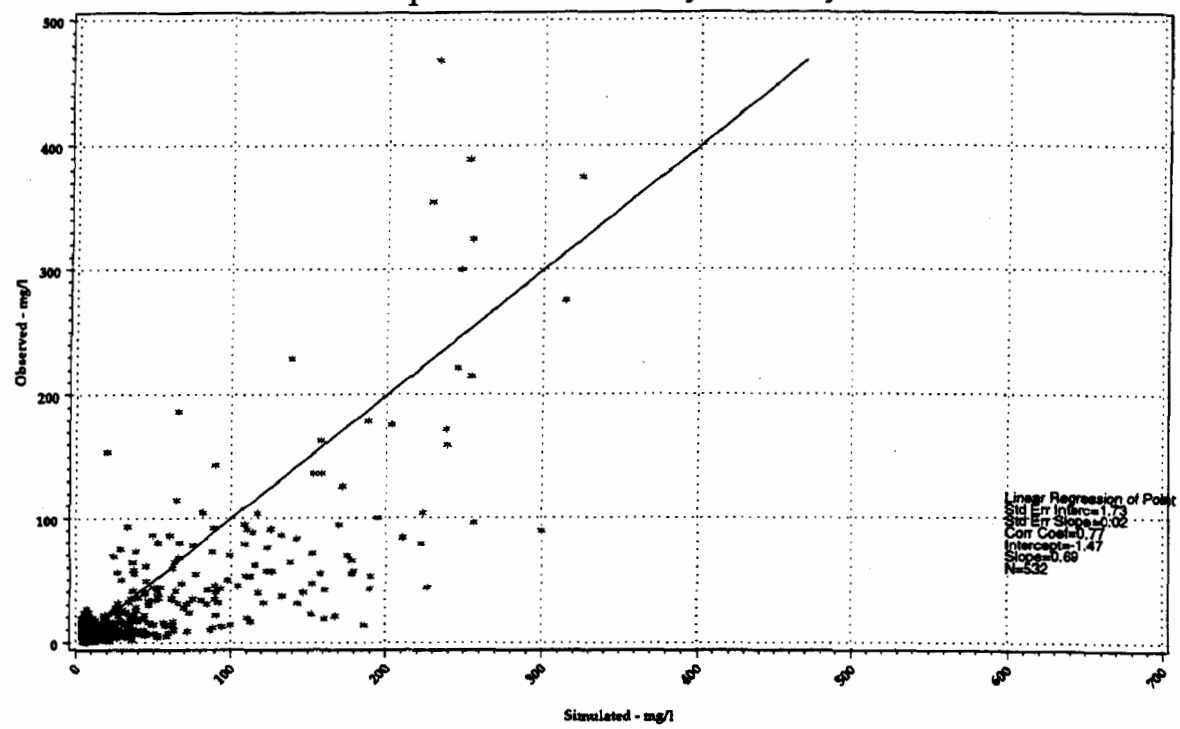


(y21_plot1.sas datastore2:[rps.p3 james.sas] tidflas)
(graph_a.drv 08SEP97 18:17_proc reg.model y=s)

Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

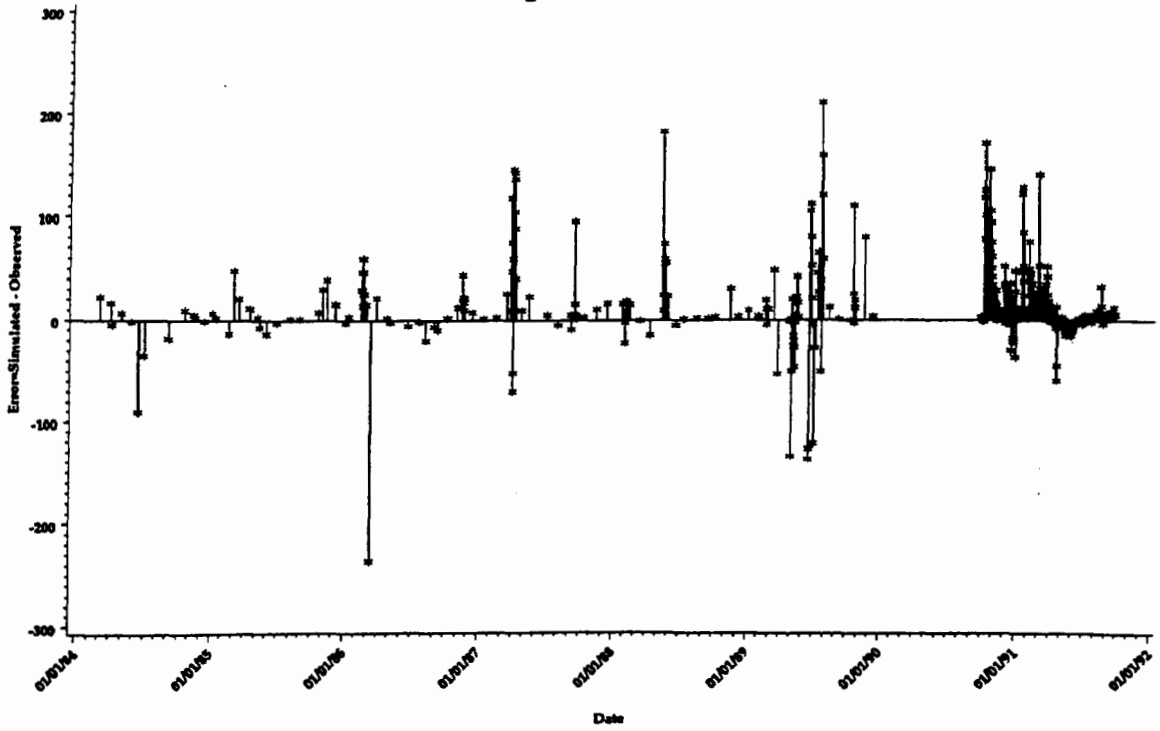
Total Suspended Sediment: 01JAN84 - 01JAN92



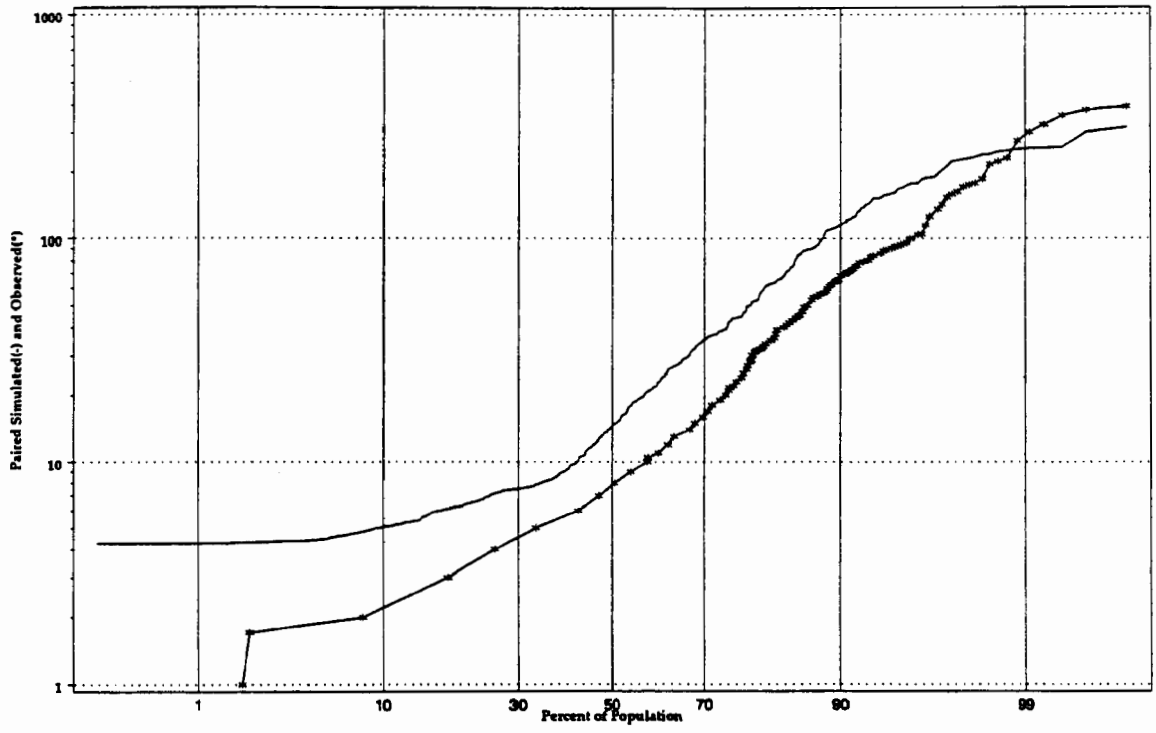
Juniata River at Segment 100

Actual Error versus Time

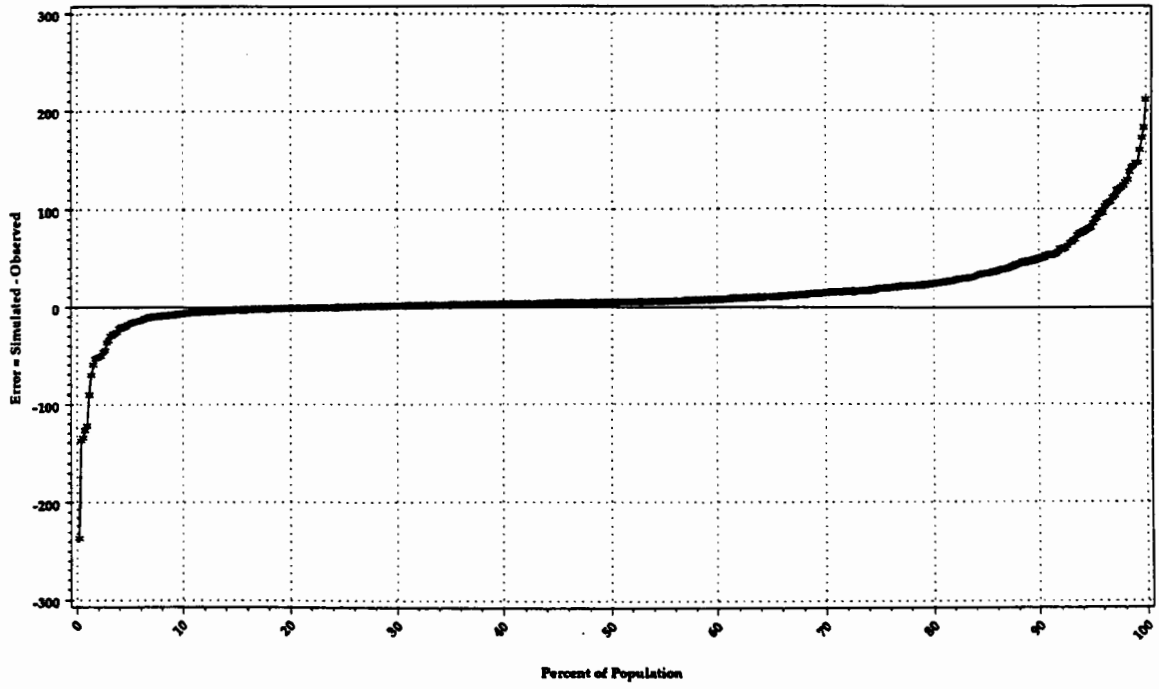
Total Suspended Sediment



Juniata River at Segment 100
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

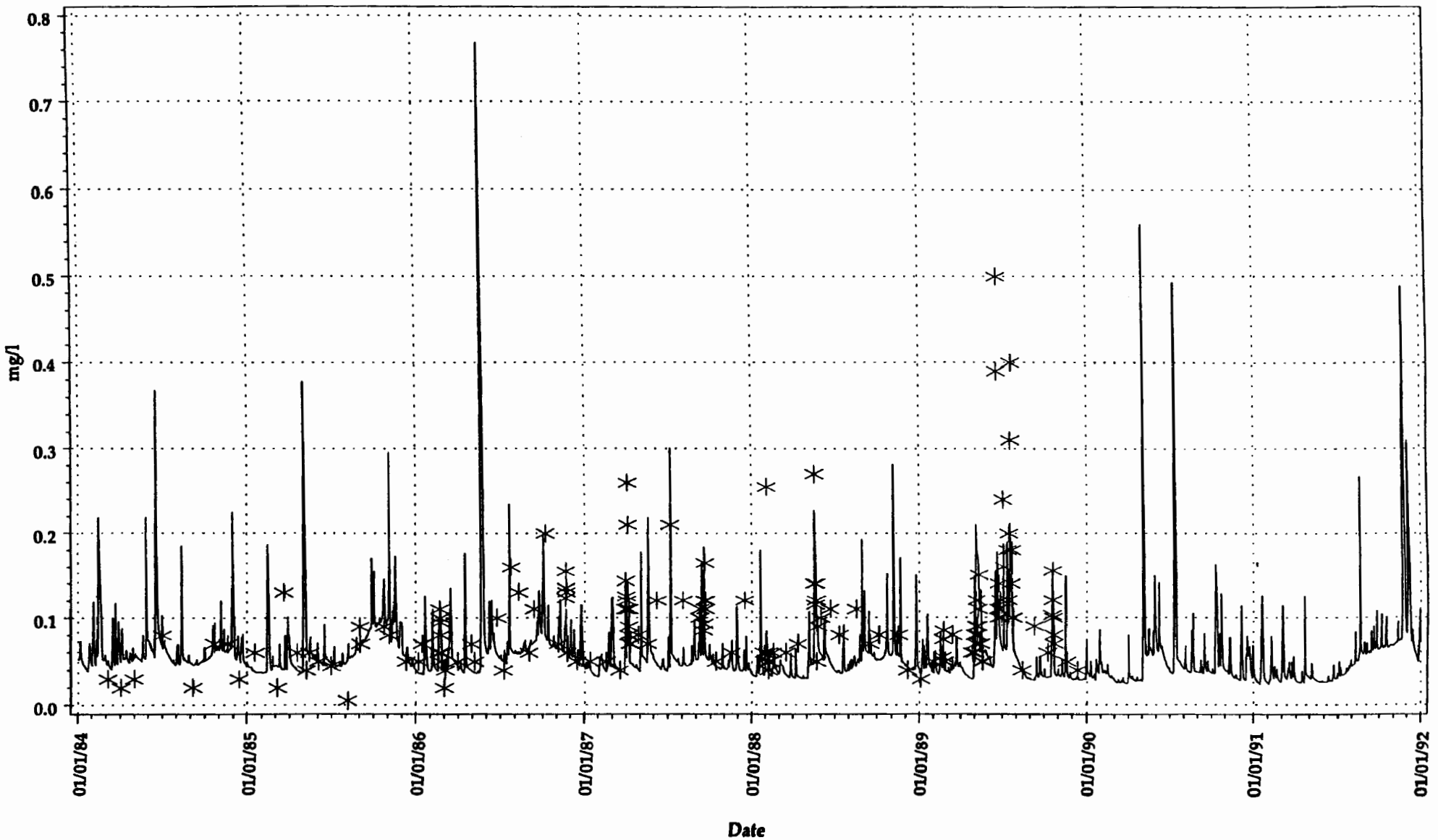


Juniata River at Segment 100
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



Juniata River at Segment 100
Observed and Simulated versus Time
Total Phosphorus

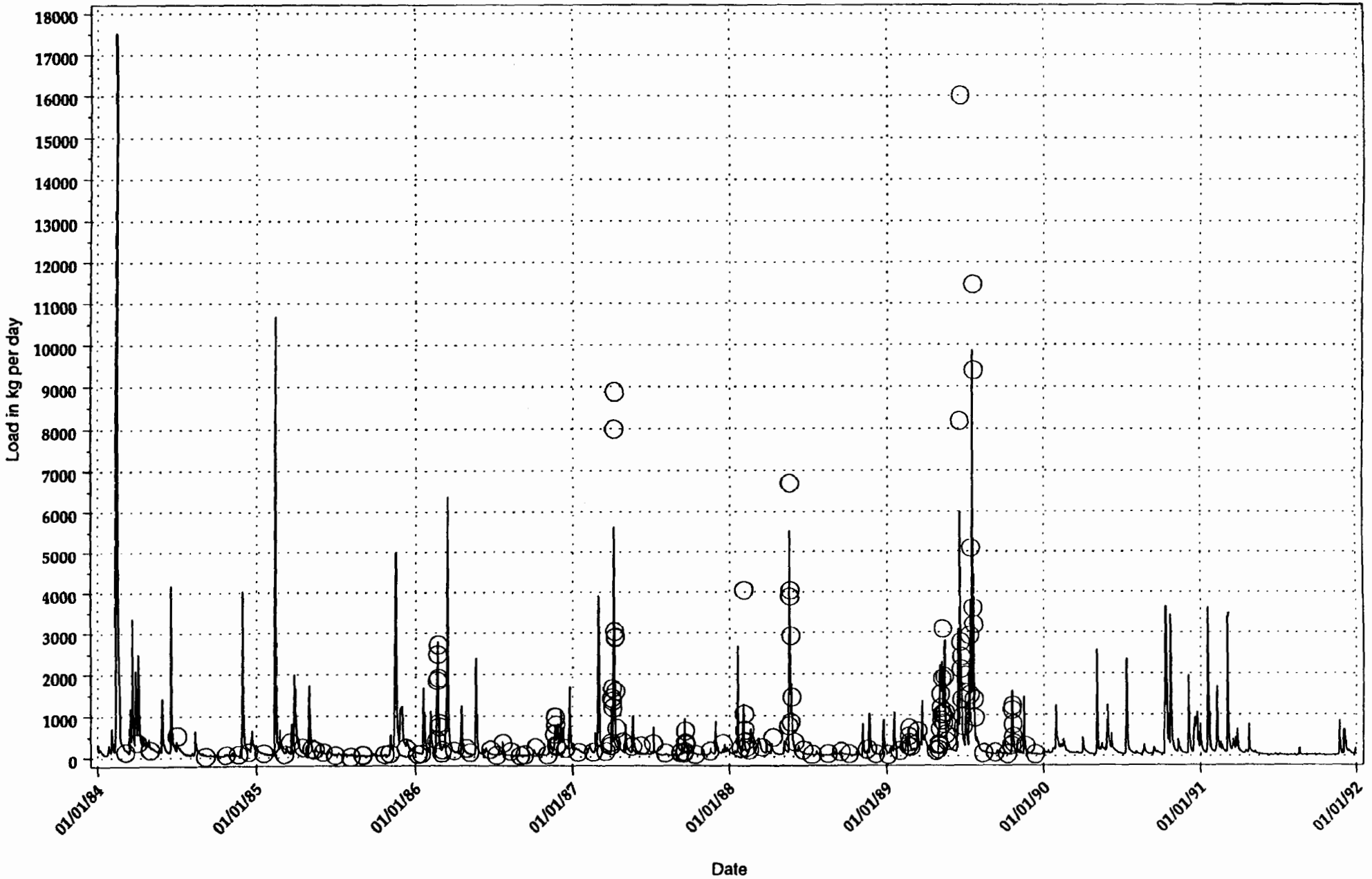
(*=Observed, -=Simulated)



Juniata River at Segment 100

Total Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

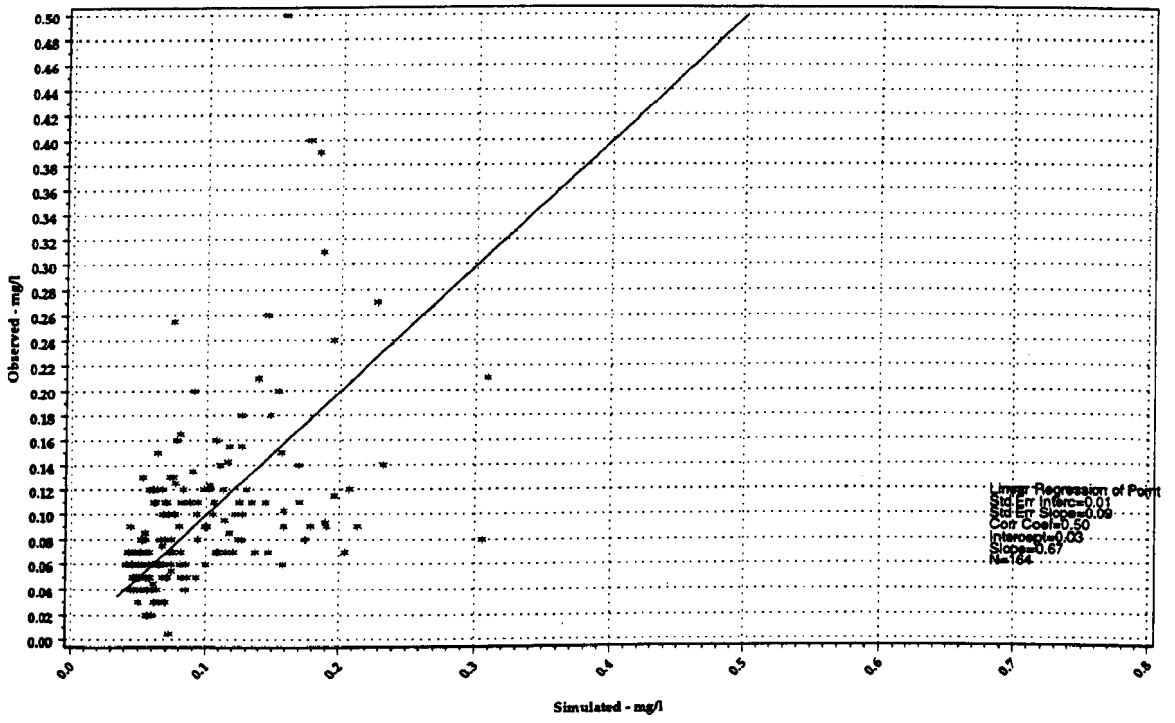


(y21_plot1.sas datastore2 jnps p3 jones sas) fldfles)
(graph_a.drv 08SEP97 16:17 proc reg model y=x)

Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

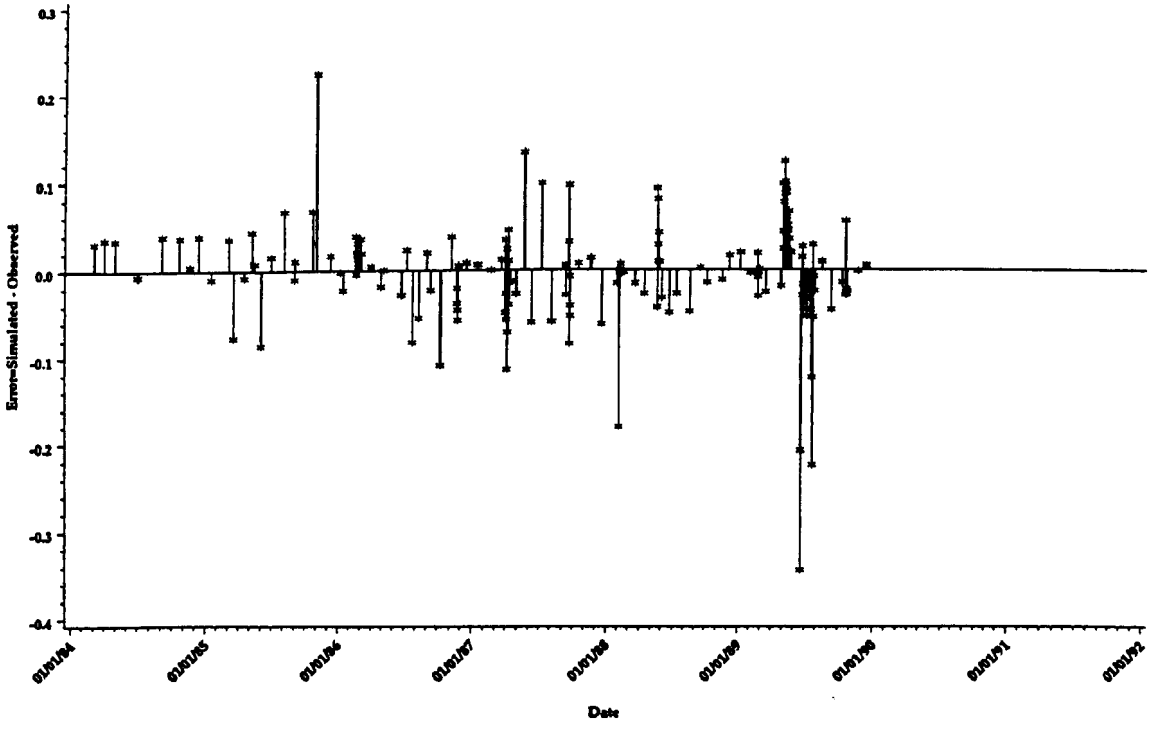
Total Phosphorus: 01JAN84 - 01JAN92



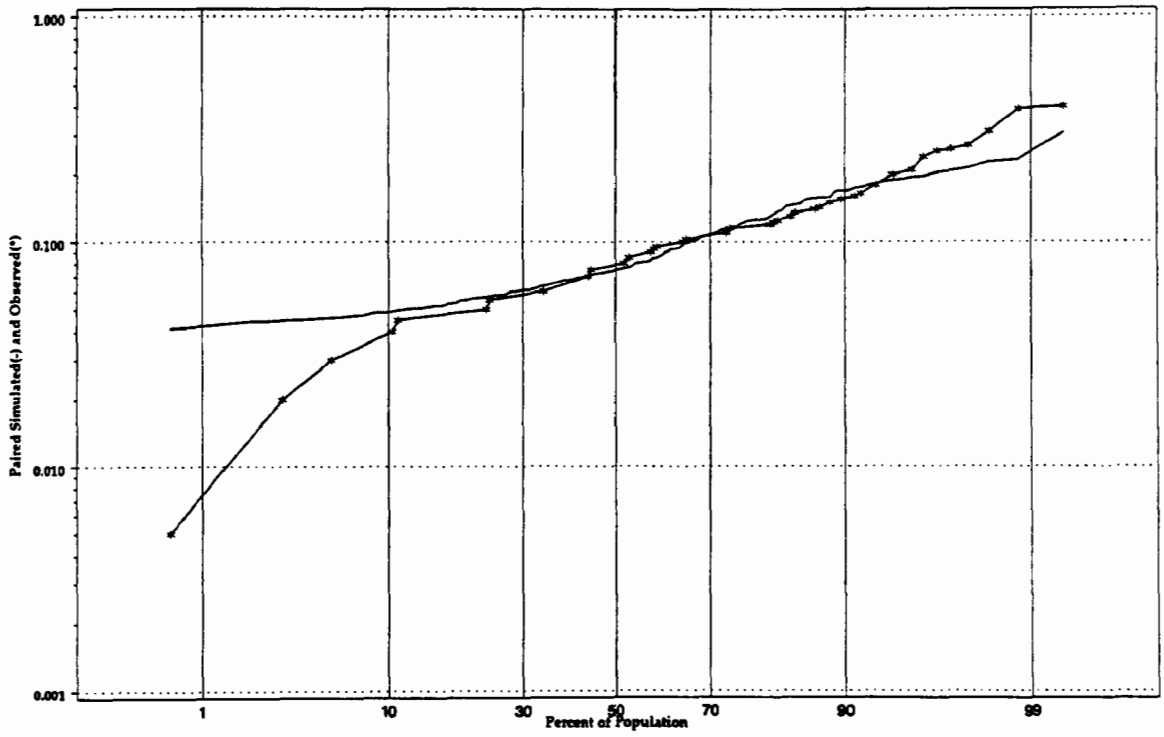
Juniata River at Segment 100

Actual Error versus Time

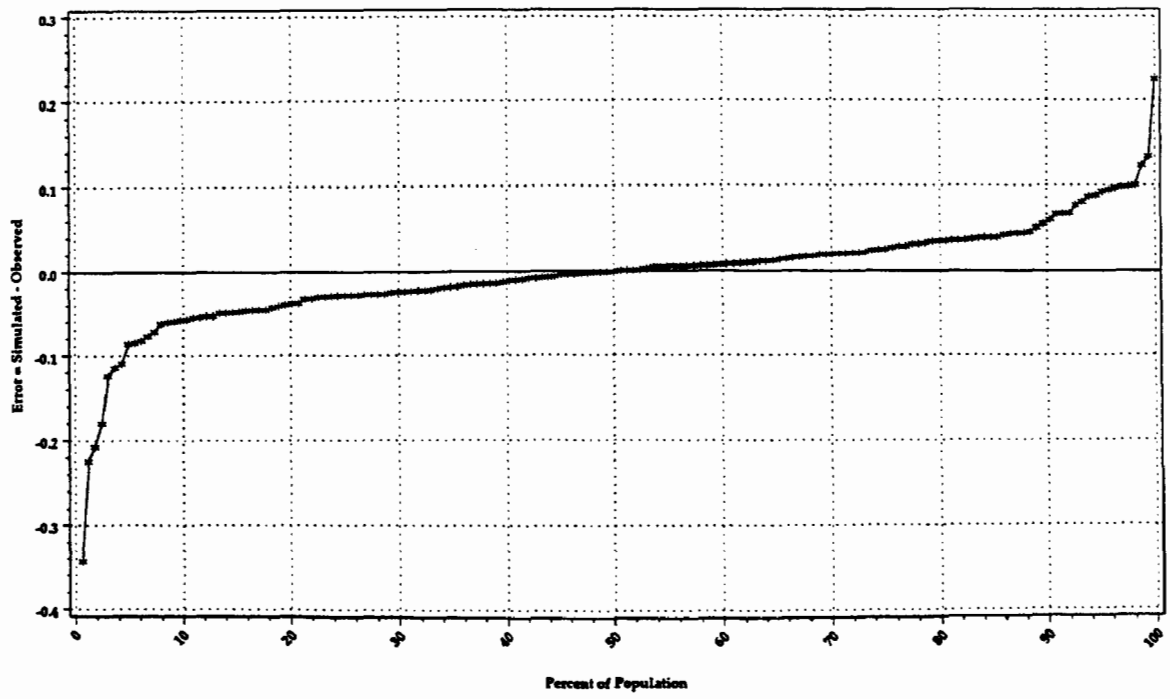
Total Phosphorus



Juniata River at Segment 100
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

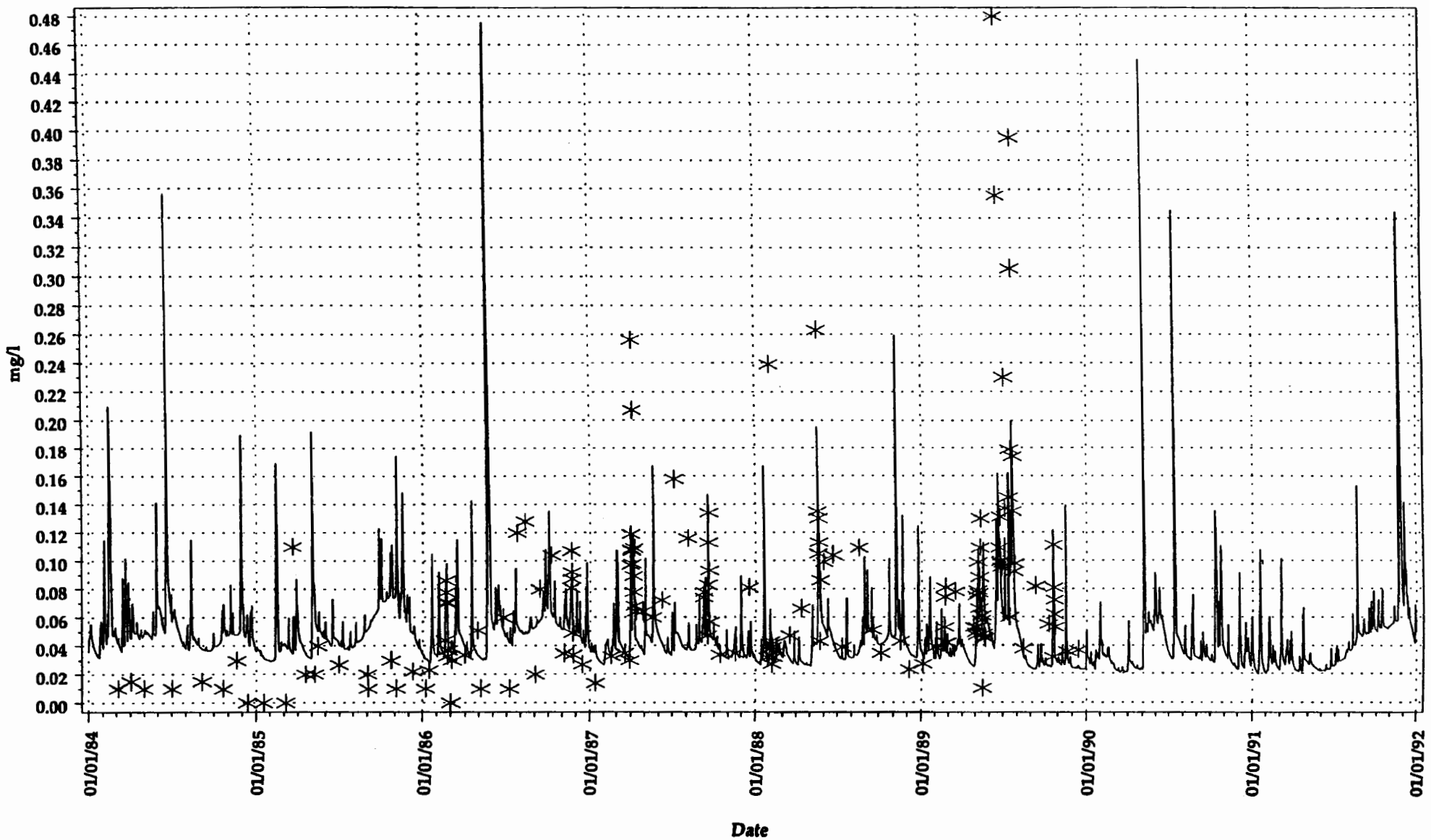


Juniata River at Segment 100
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Juniata River at Segment 100
Observed and Simulated versus Time
Organic and Particulate Phosphorus

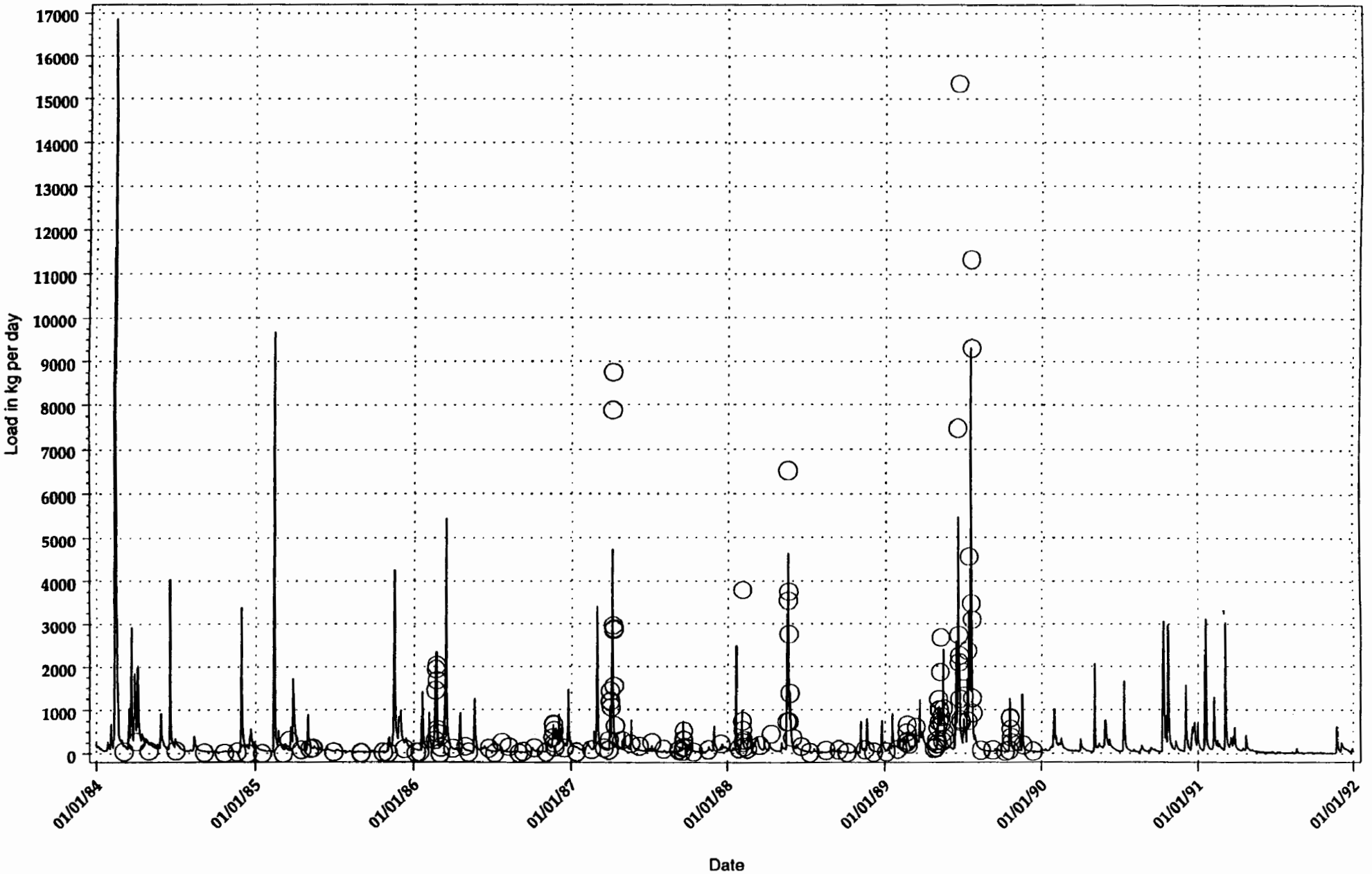
(*=Observed, -=Simulated)



Juniata River at Segment 100

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

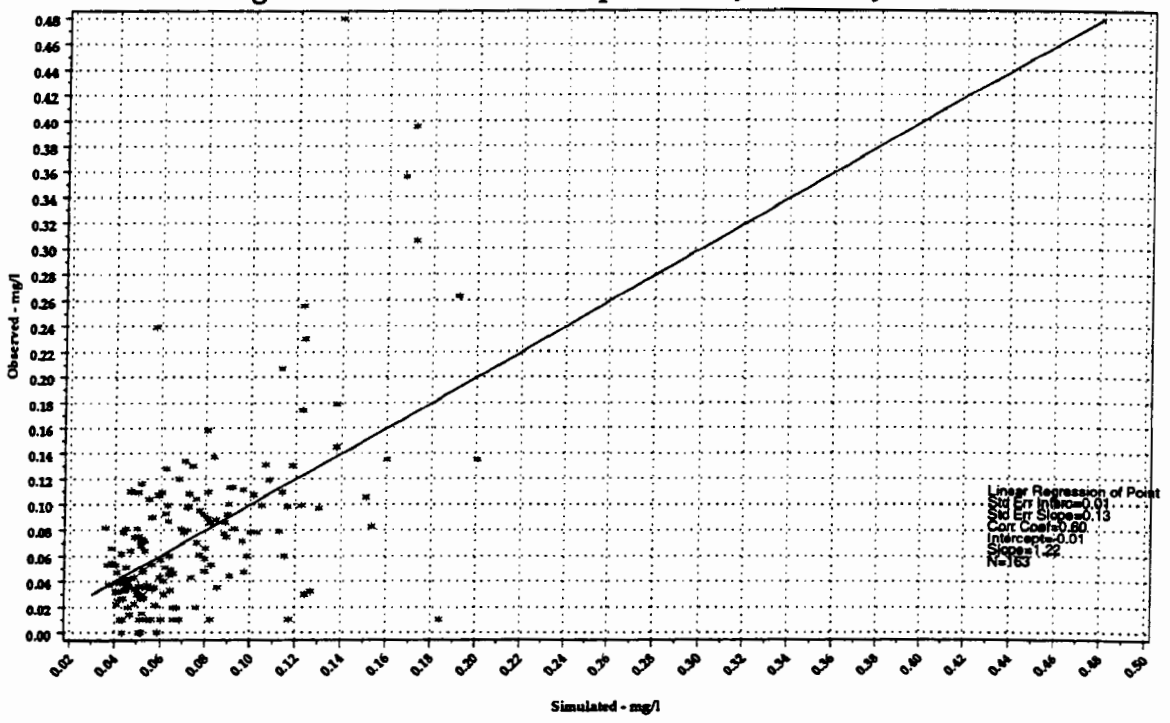


(y21_plot1.sas datastore2:[nps.p3.james.sas] lfdfles)
(graph_a.drv 08SEP97 16:17 proc reg model y=x)

Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

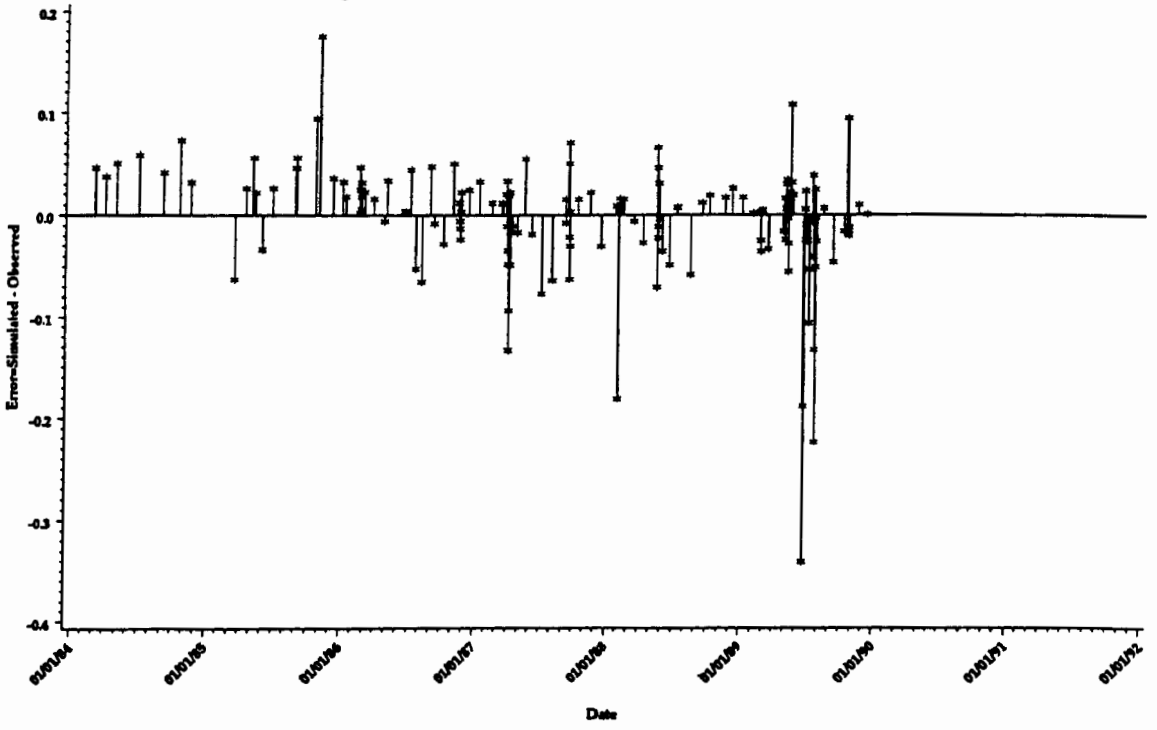
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



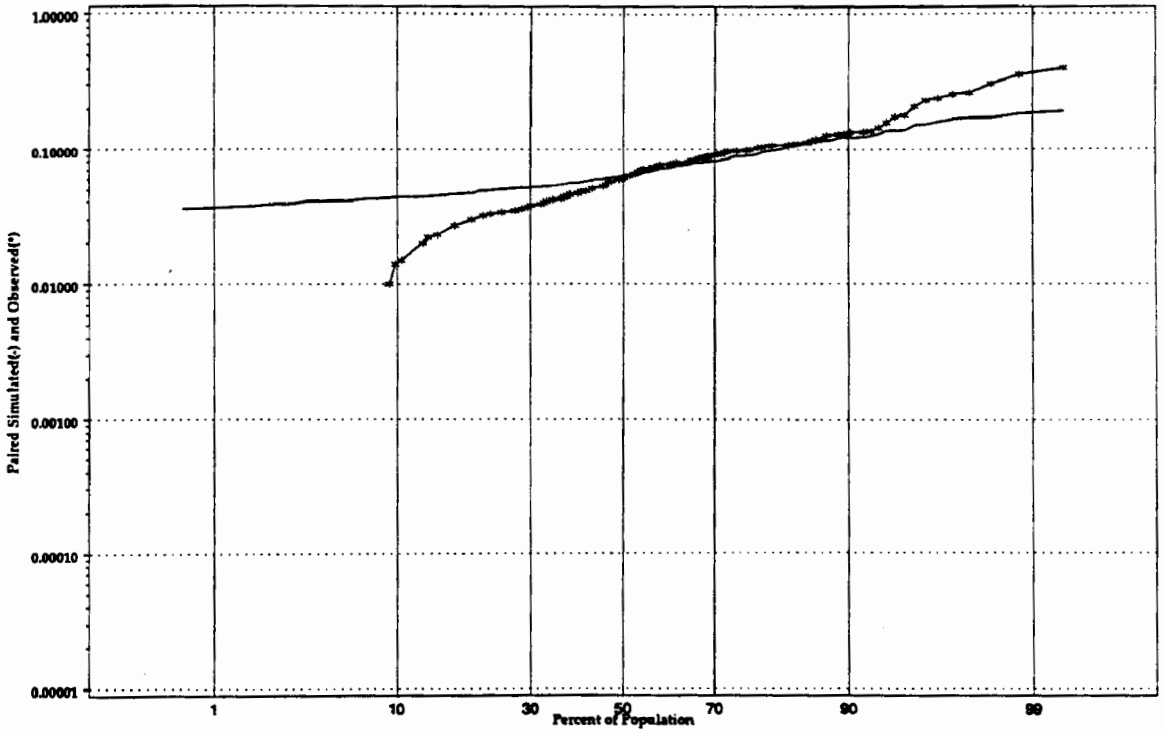
Juniata River at Segment 100

Actual Error versus Time

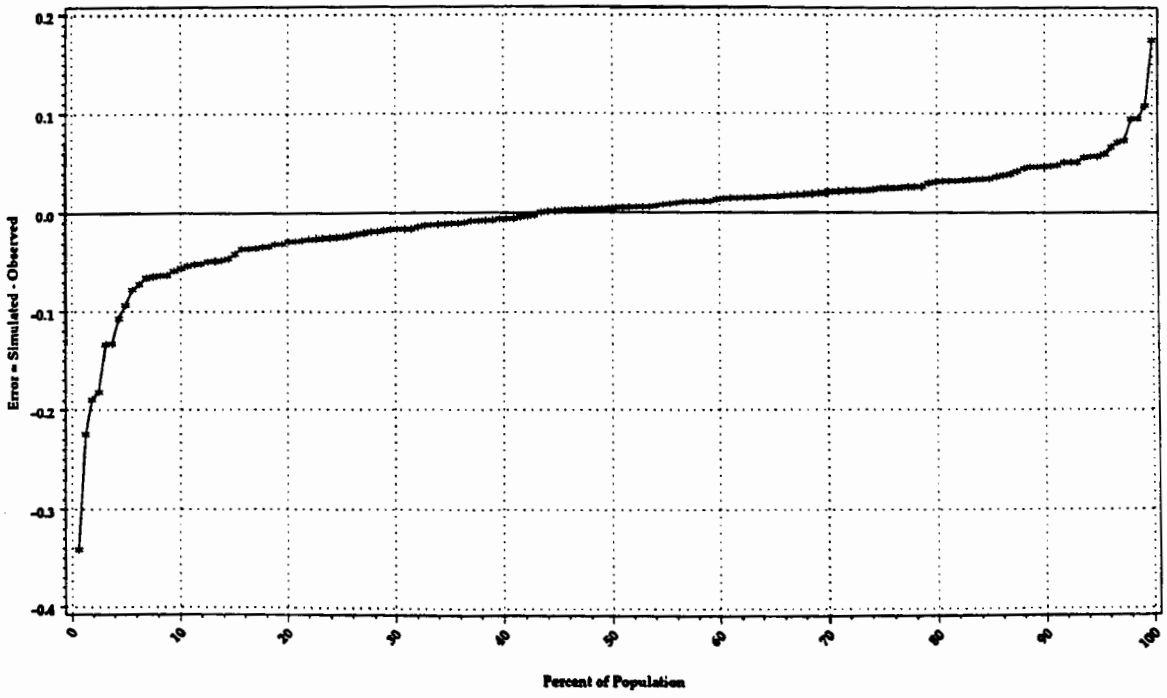
Organic and Particulate Phosphorus



Juniata River at Segment 100
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

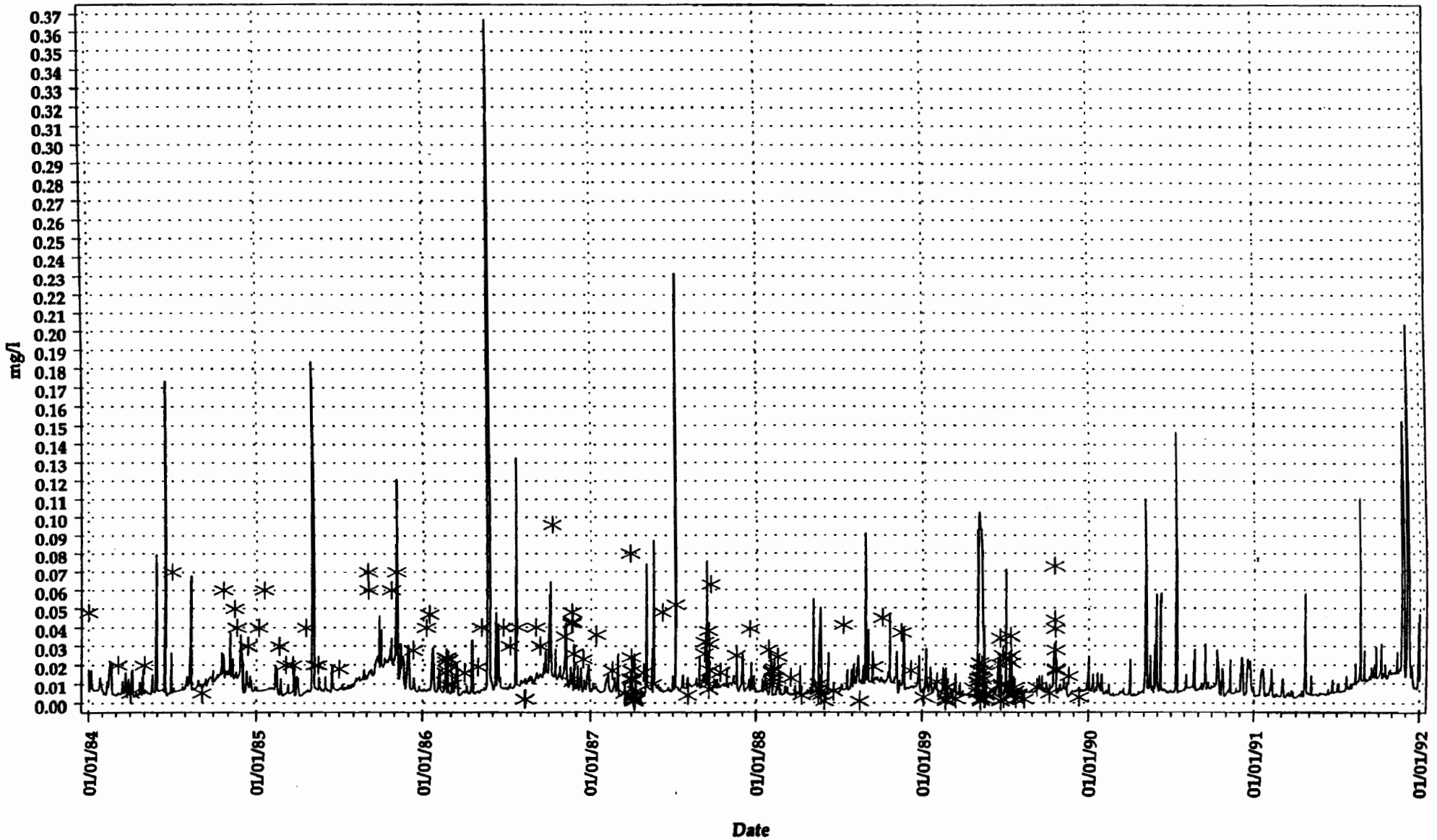


Juniata River at Segment 100
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data



Juniata River at Segment 100
Observed and Simulated versus Time
Dissolved Phosphorus

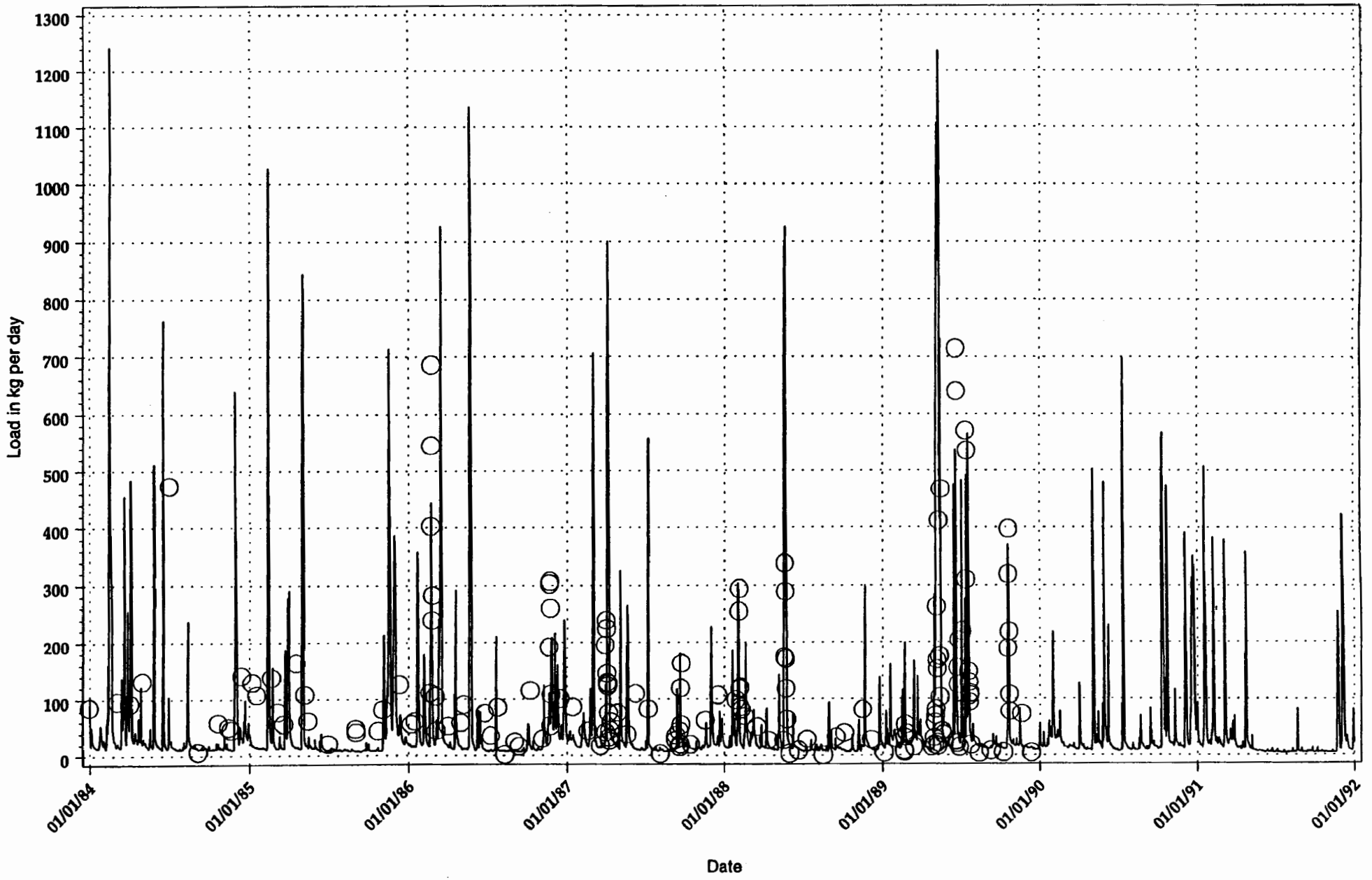
(*=Observed, -=Simulated)



Juniata River at Segment 100

Dissolved Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

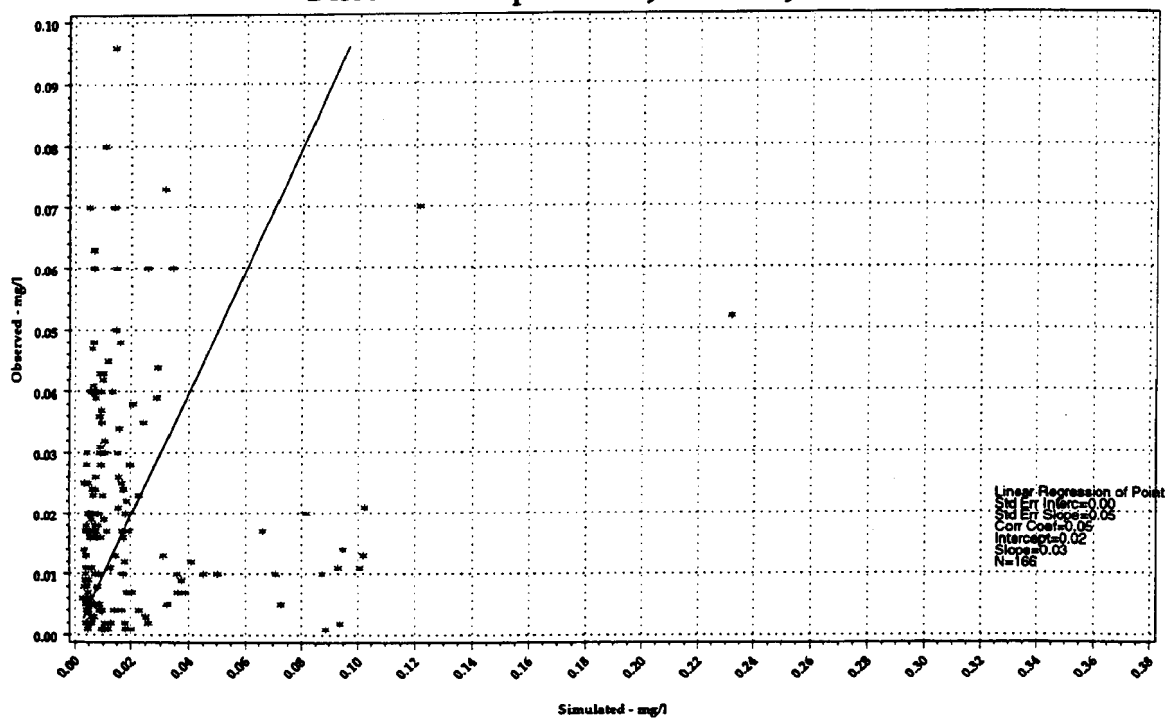


(y21_plot1.sas datastore2$rpe.p3 (james.sas) fdflas)
(junia_d.drv1 03FEB96 13:54,proc reg,model y=x)

Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

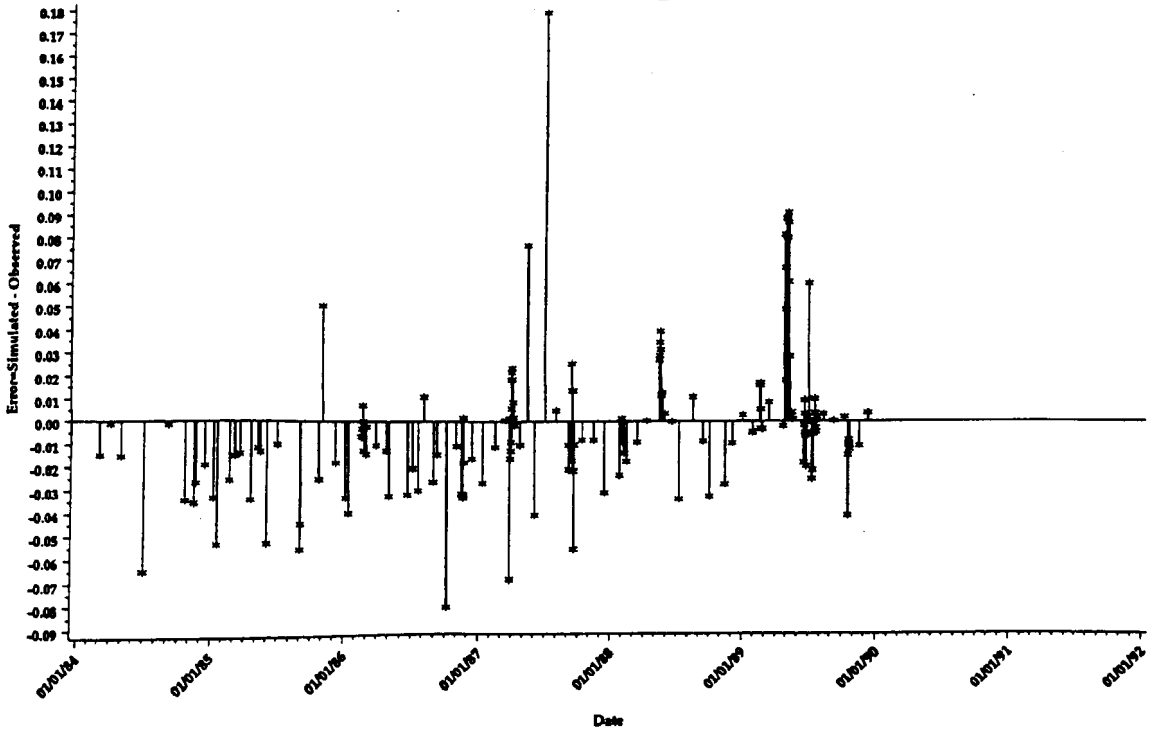
Dissolved Phosphorus: 01JAN84 - 01JAN92



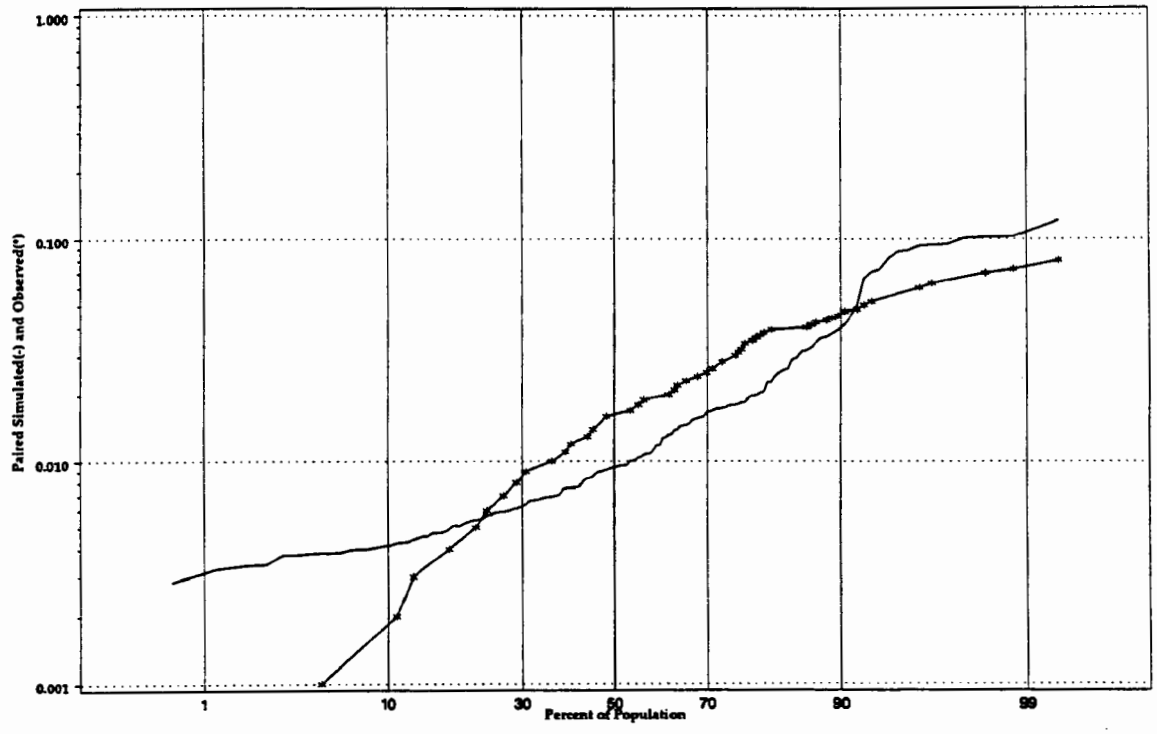
Juniata River at Segment 100

Actual Error versus Time

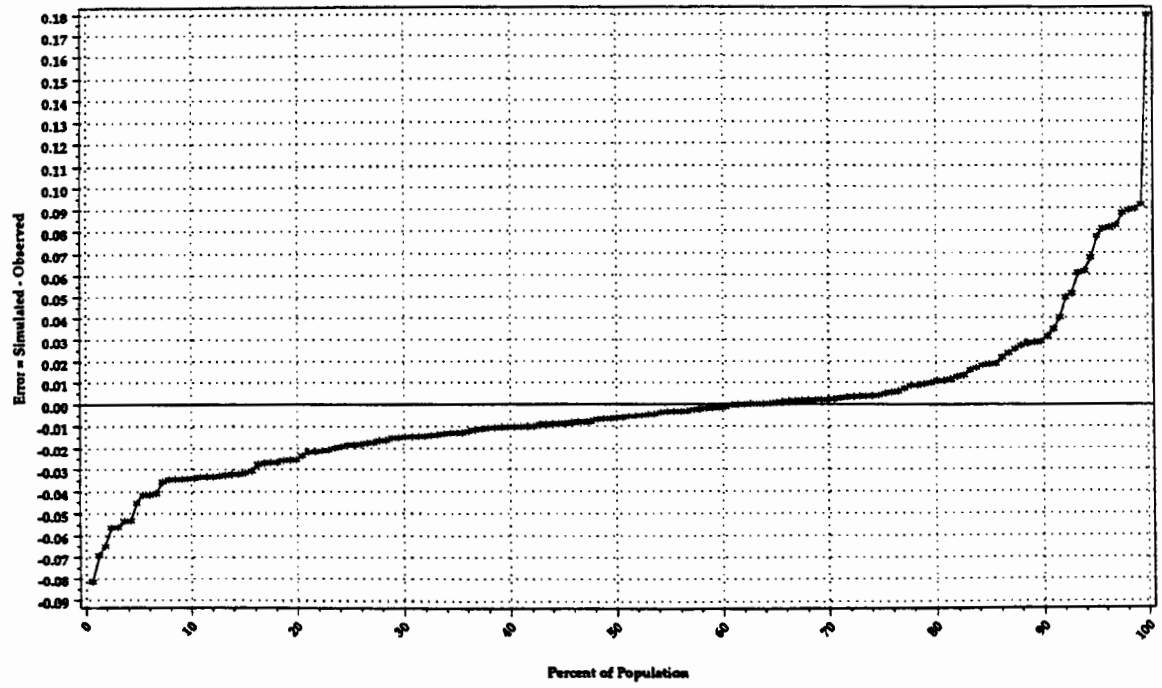
Dissolved Phosphorus



Juniata River at Segment 100
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

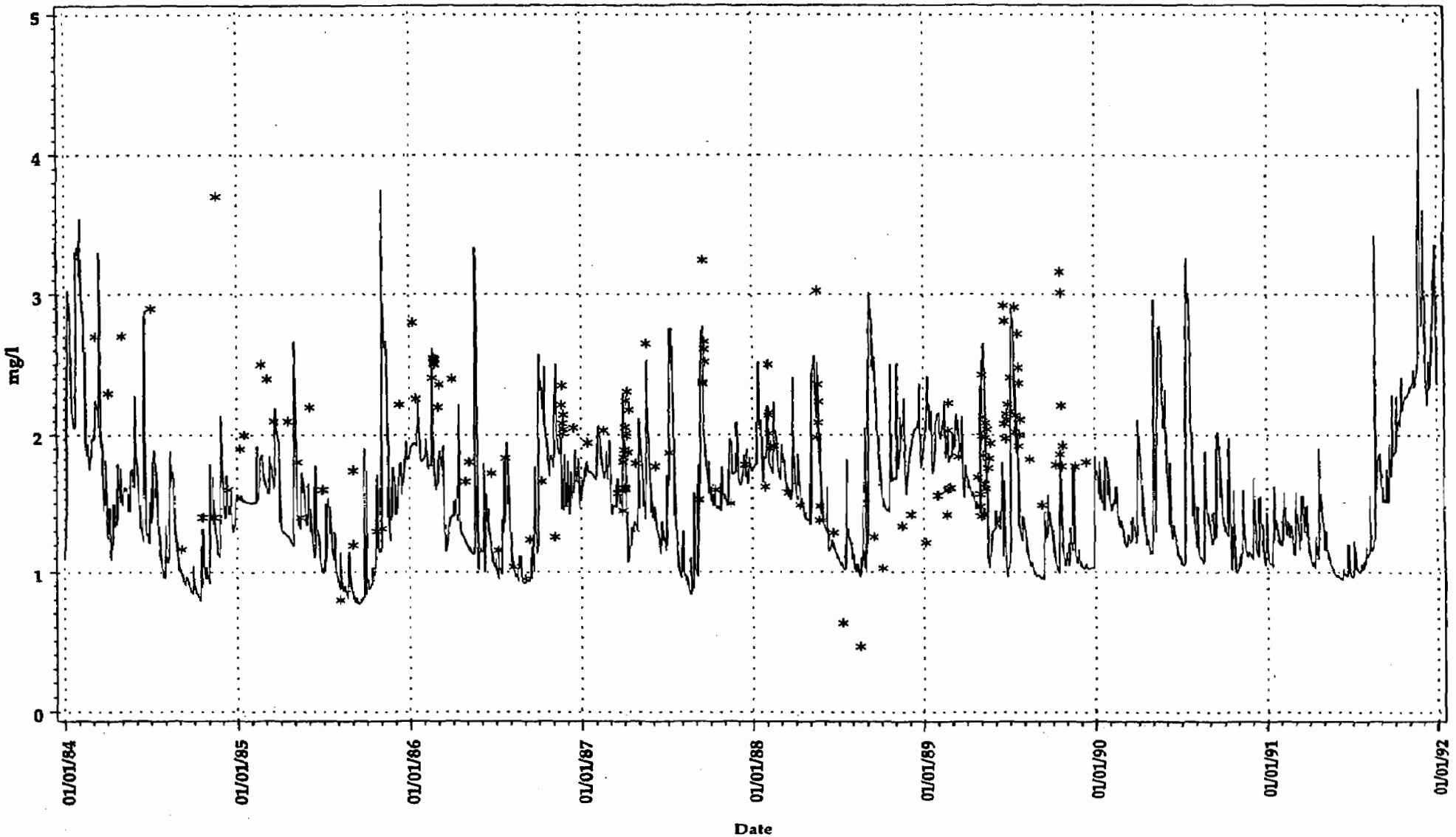


Juniata River at Segment 100
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



Juniata River at Segment 100
Observed and Simulated versus Time
Total Nitrogen

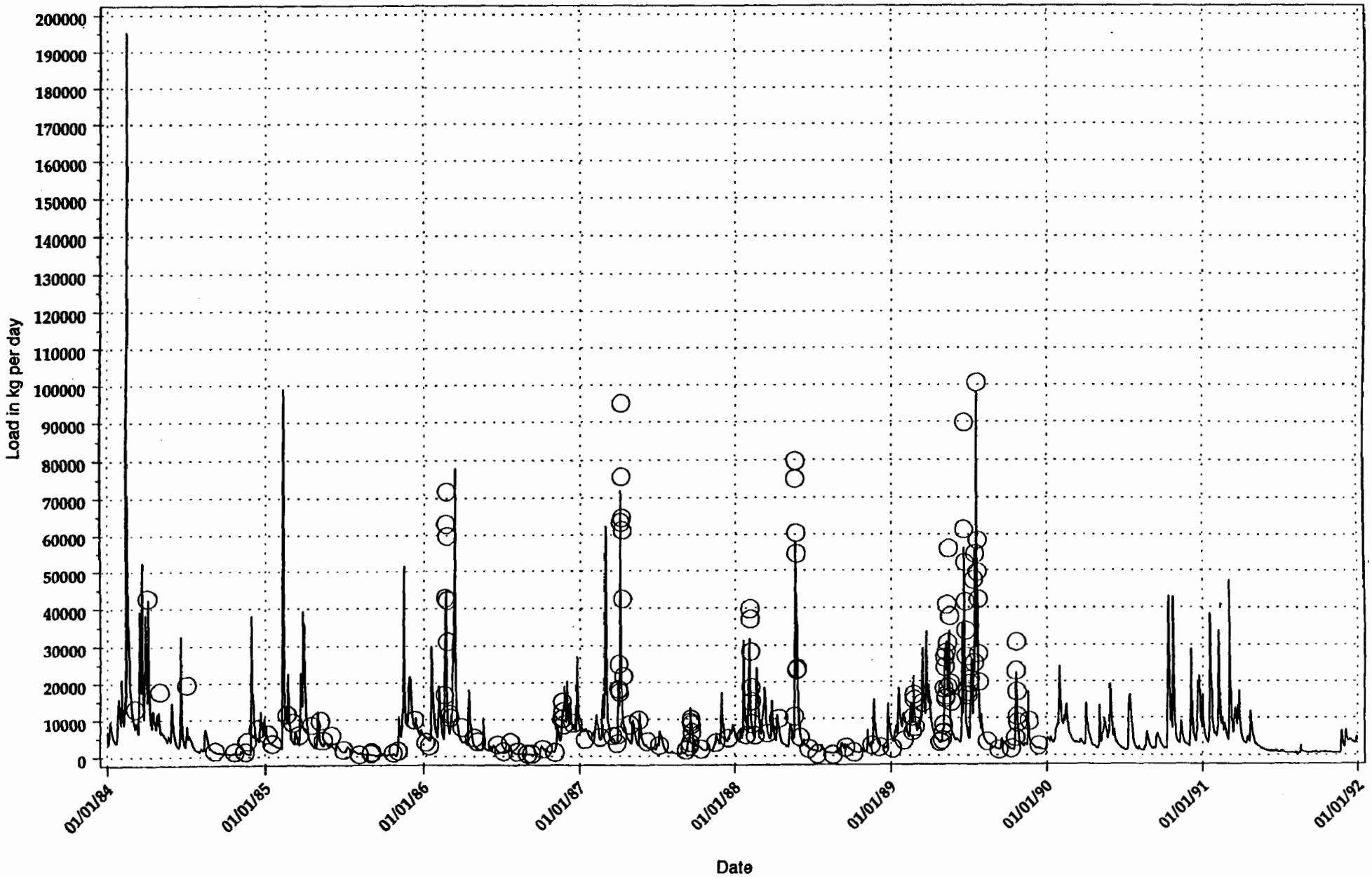
(*=Observed, -=Simulated)



Juniata River at Segment 100

Total Nitrogen Observed and Simulated Load vs Time

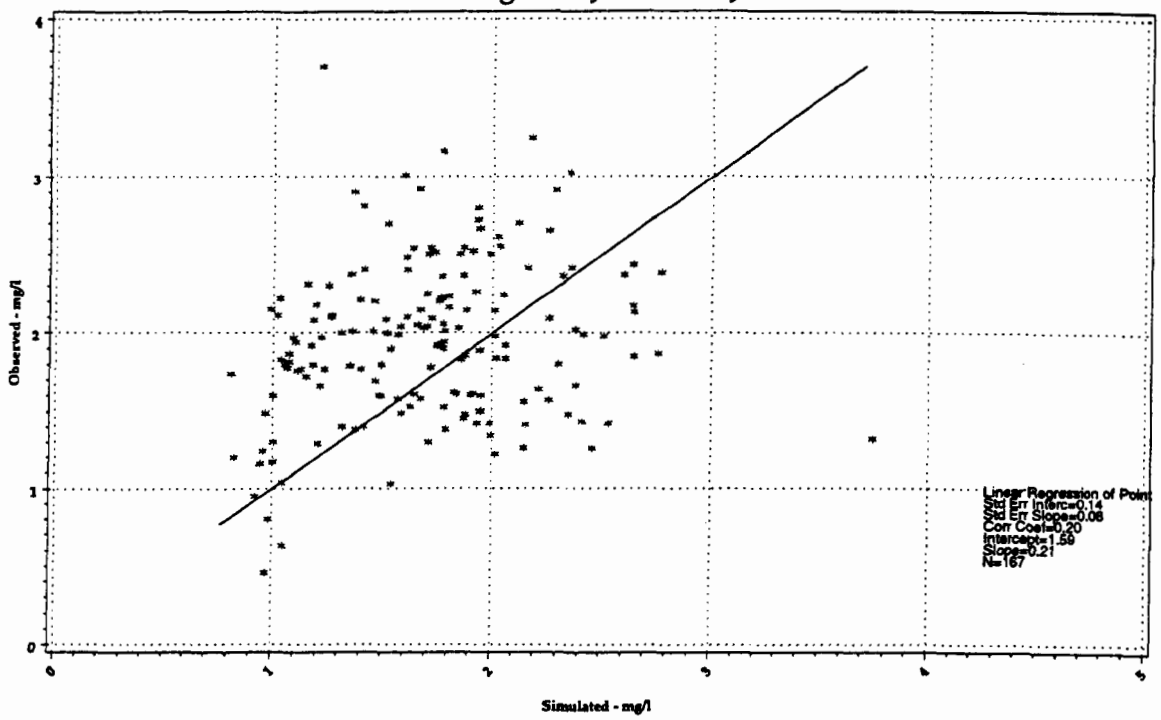
(line = simulated, O = observed)



(y21_plot1.sas datastore2 [rps.p3 James.sas] lkilas)
(juniata_d.drv1 03FEB96 13:54 proc reg model y=x)

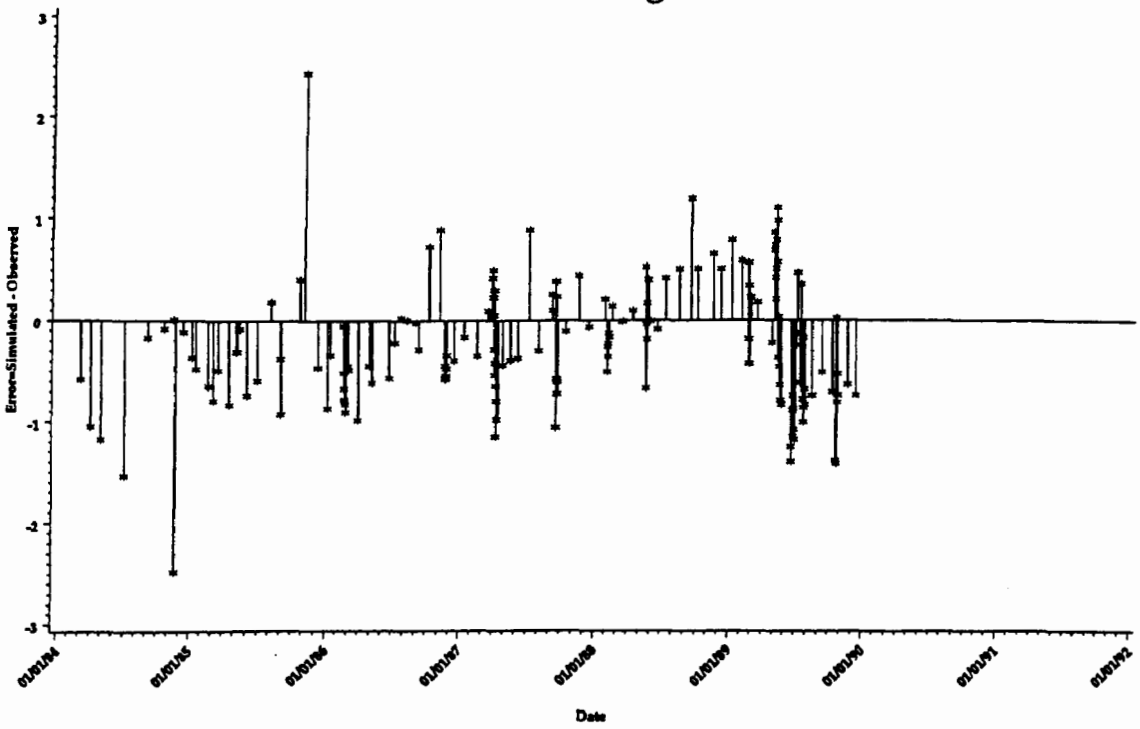
Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Nitrogen: 01JAN84 - 01JAN92

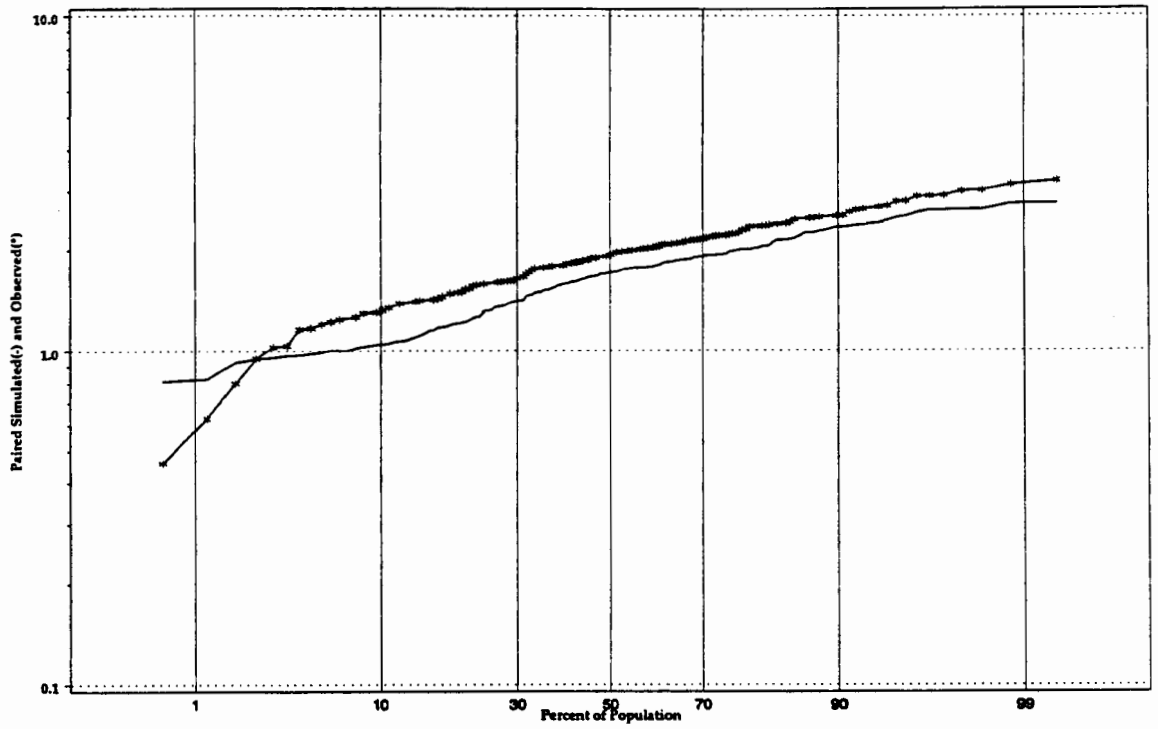


Juniata River at Segment 100

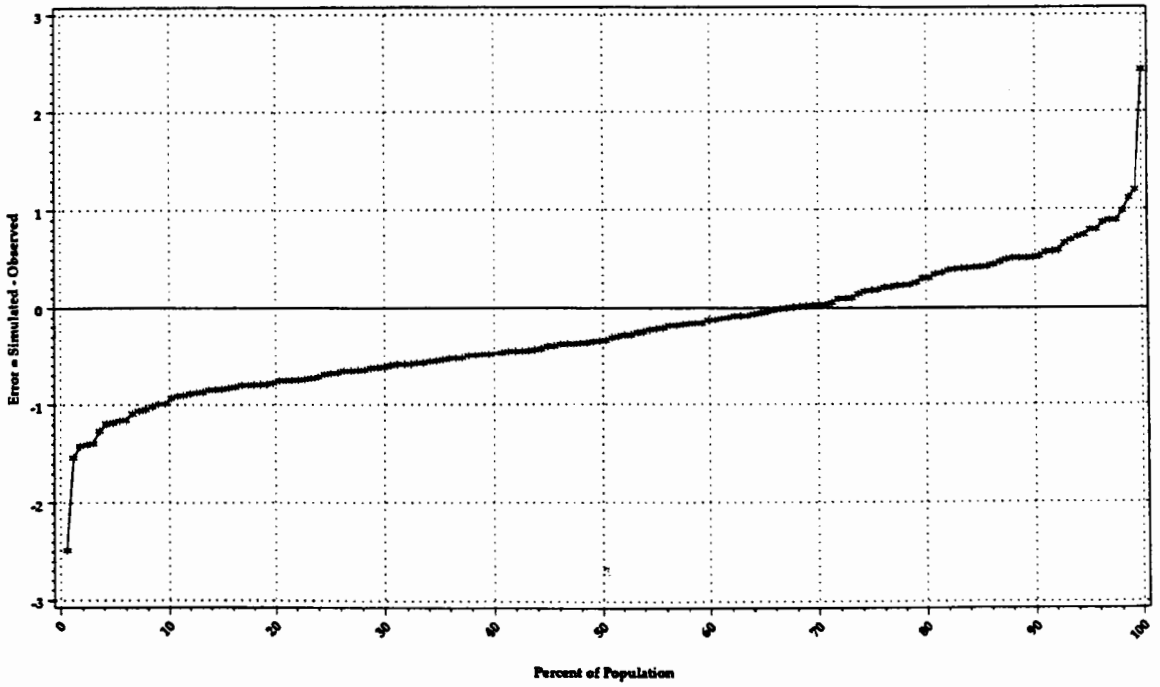
Actual Error versus Time
Total Nitrogen



Juniata River at Segment 100
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

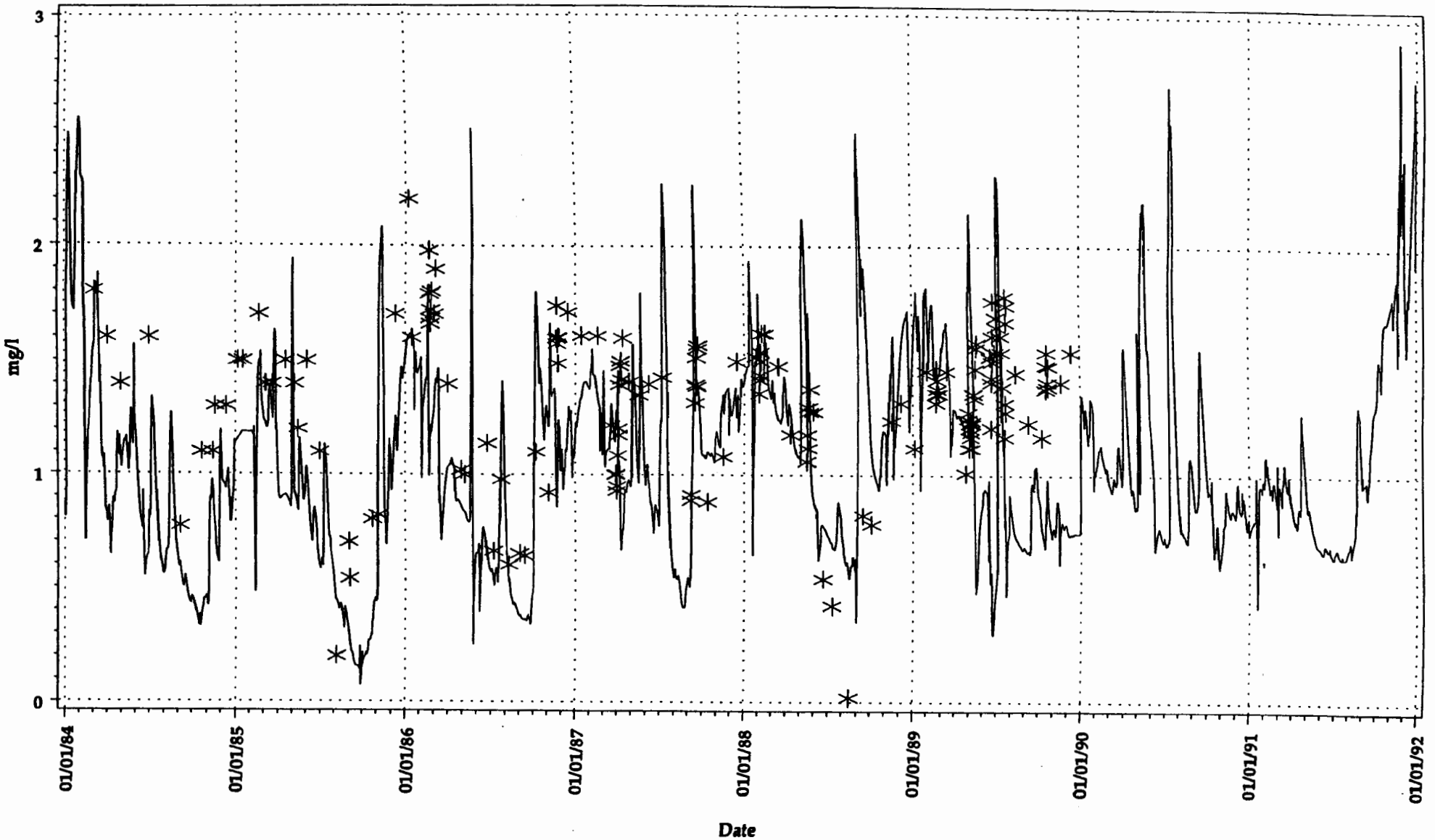


Juniata River at Segment 100
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data



Juniata River at Segment 100
Observed and Simulated versus Time
NO3

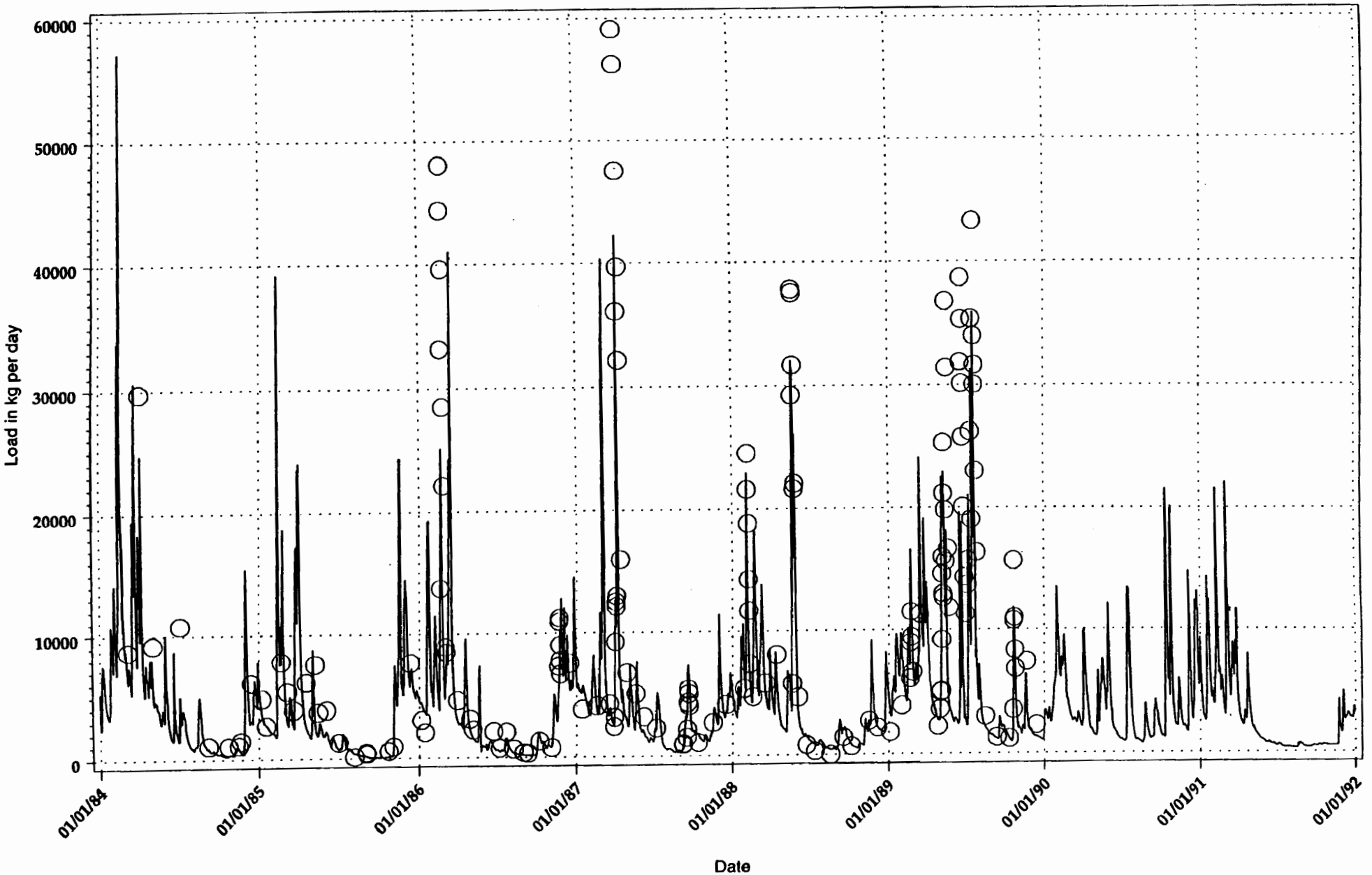
(*=Observed, -=Simulated)



Juniata River at Segment 100

NO3 Observed and Simulated Load vs Time

(line = simulated, O = observed)

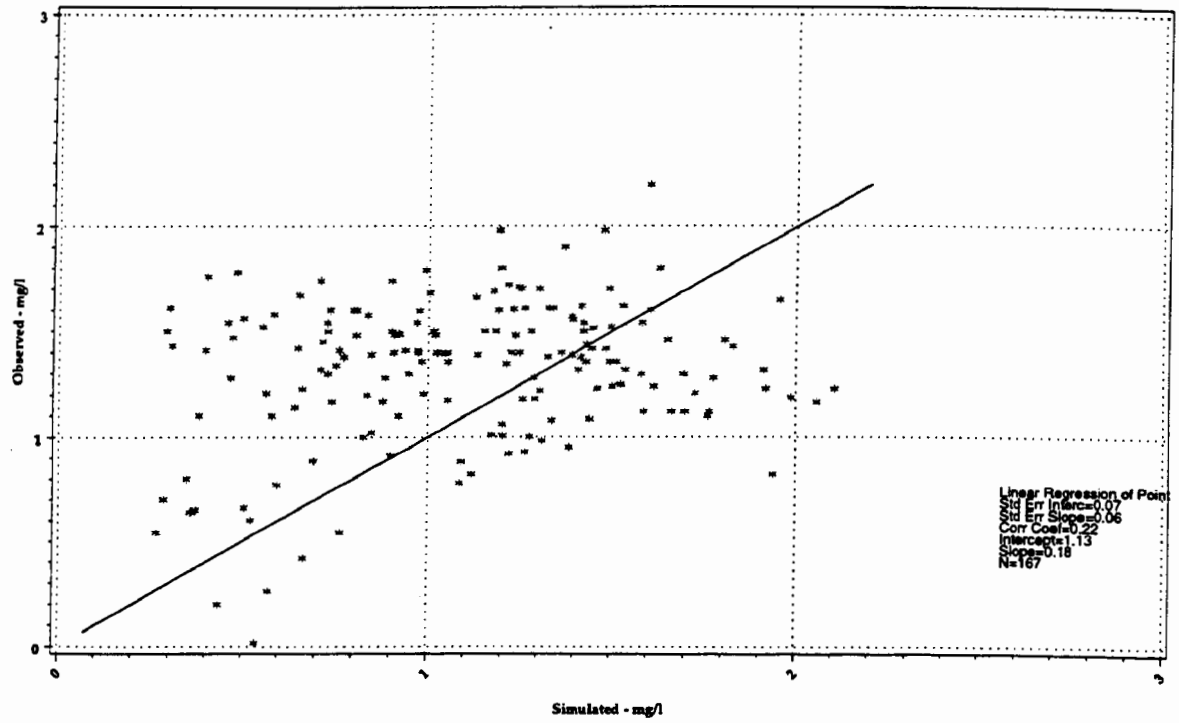


(y21_plot1.sas datastore2.$nps p3.james.sas) lldlles)
(graph_s drv 08SEP97 16:17 proc reg model y=x)

Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

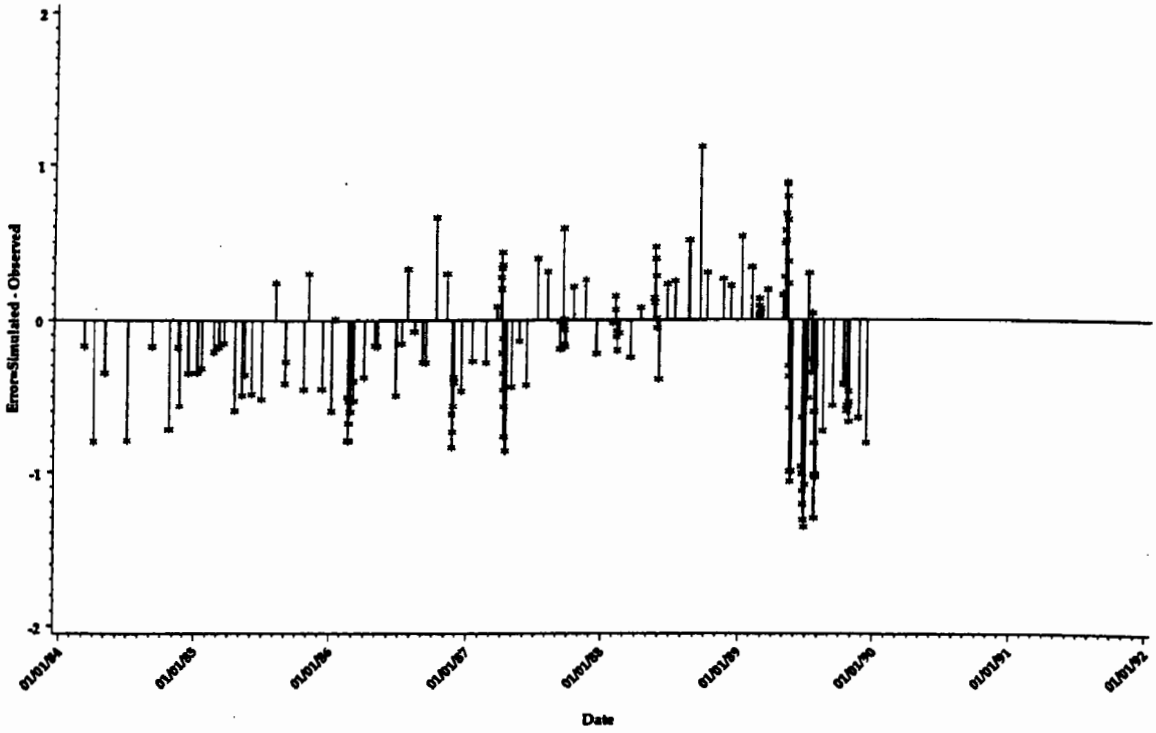
NO3: 01JAN84 - 01JAN92



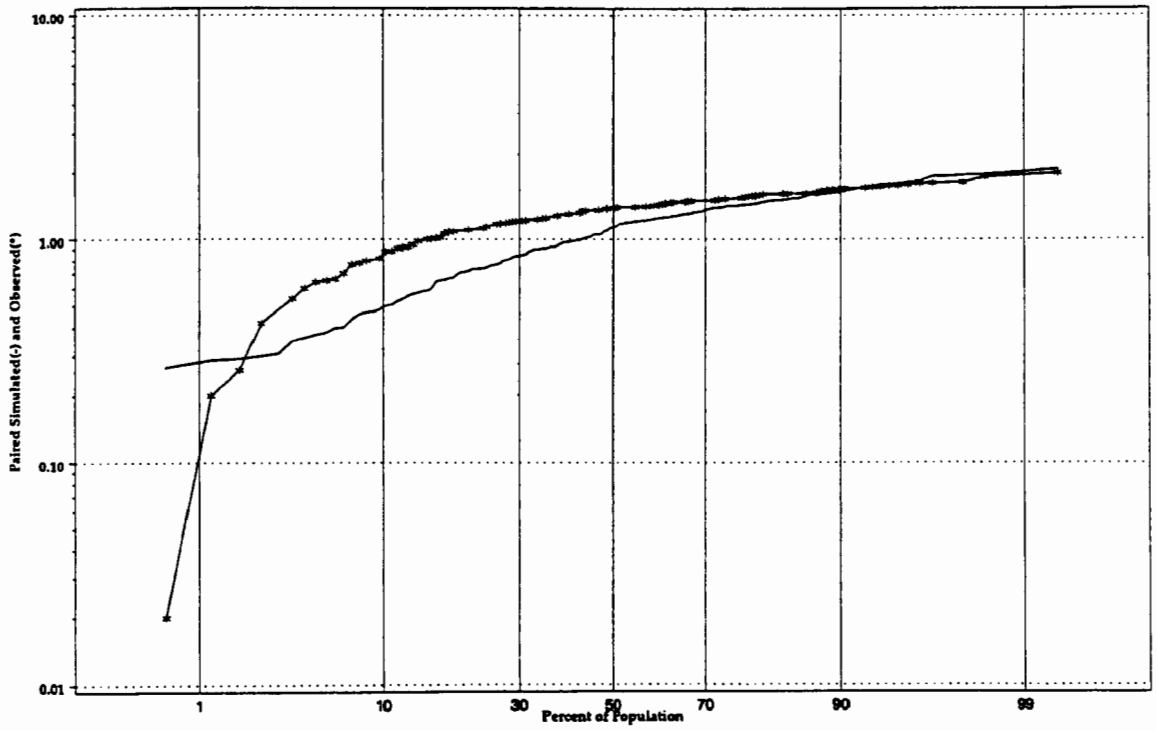
Juniata River at Segment 100

Actual Error versus Time

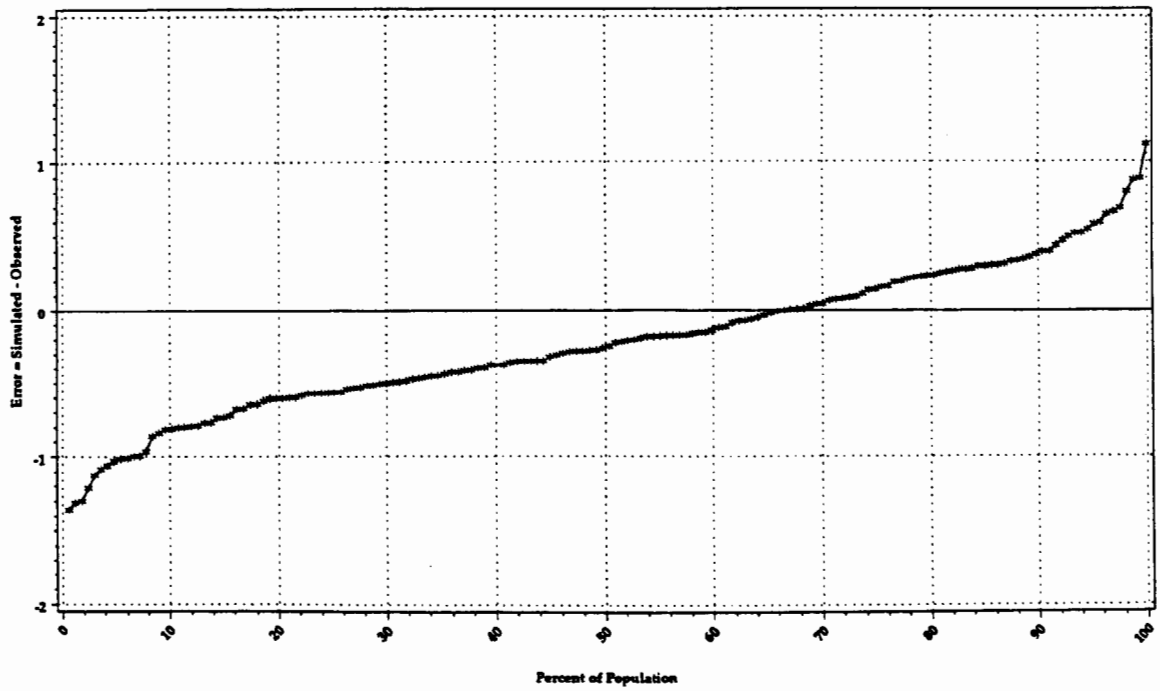
NO3



Juniata River at Segment 100
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

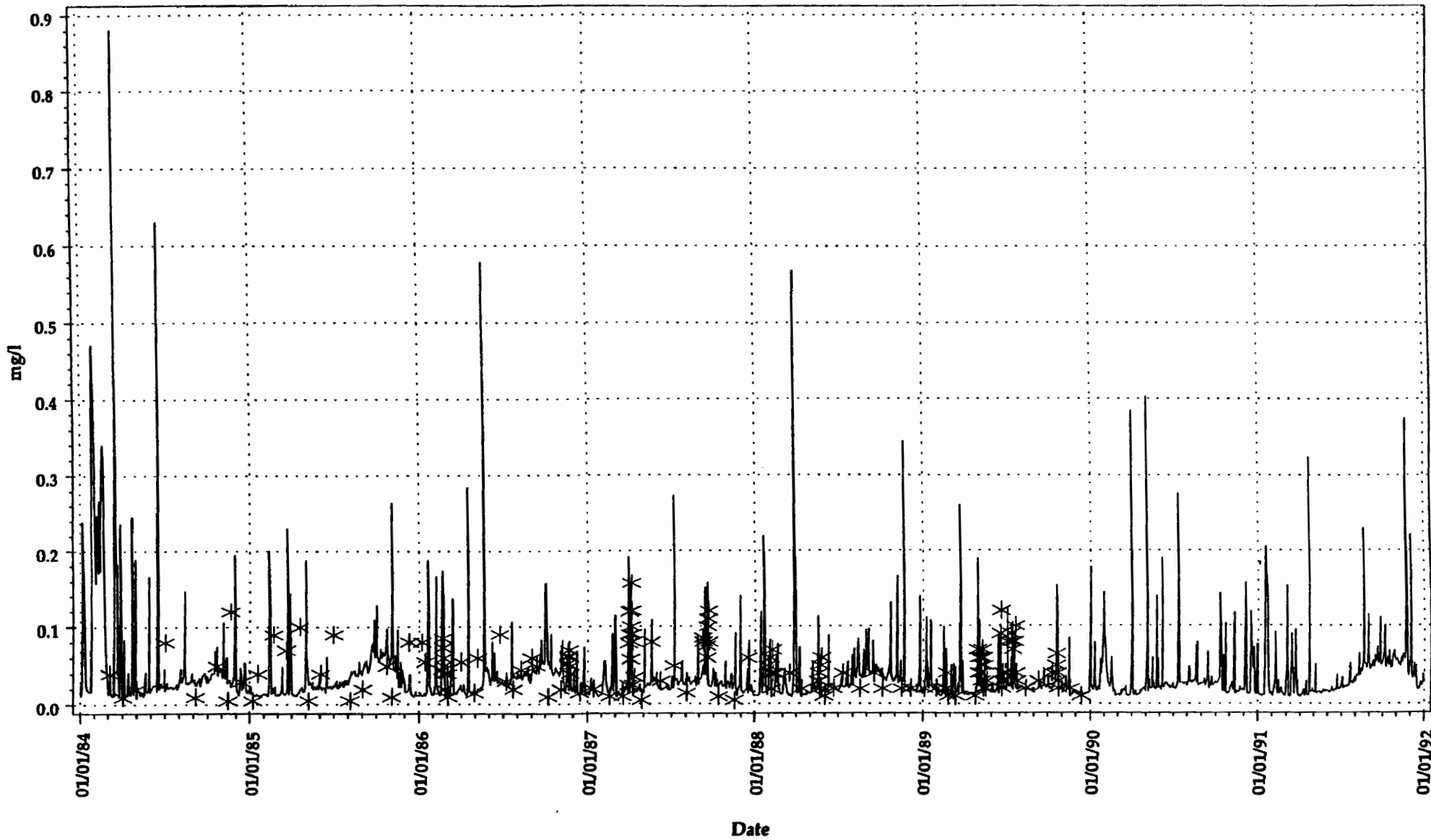


Juniata River at Segment 100
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data



Juniata River at Segment 100
Observed and Simulated versus Time
Total Ammonia

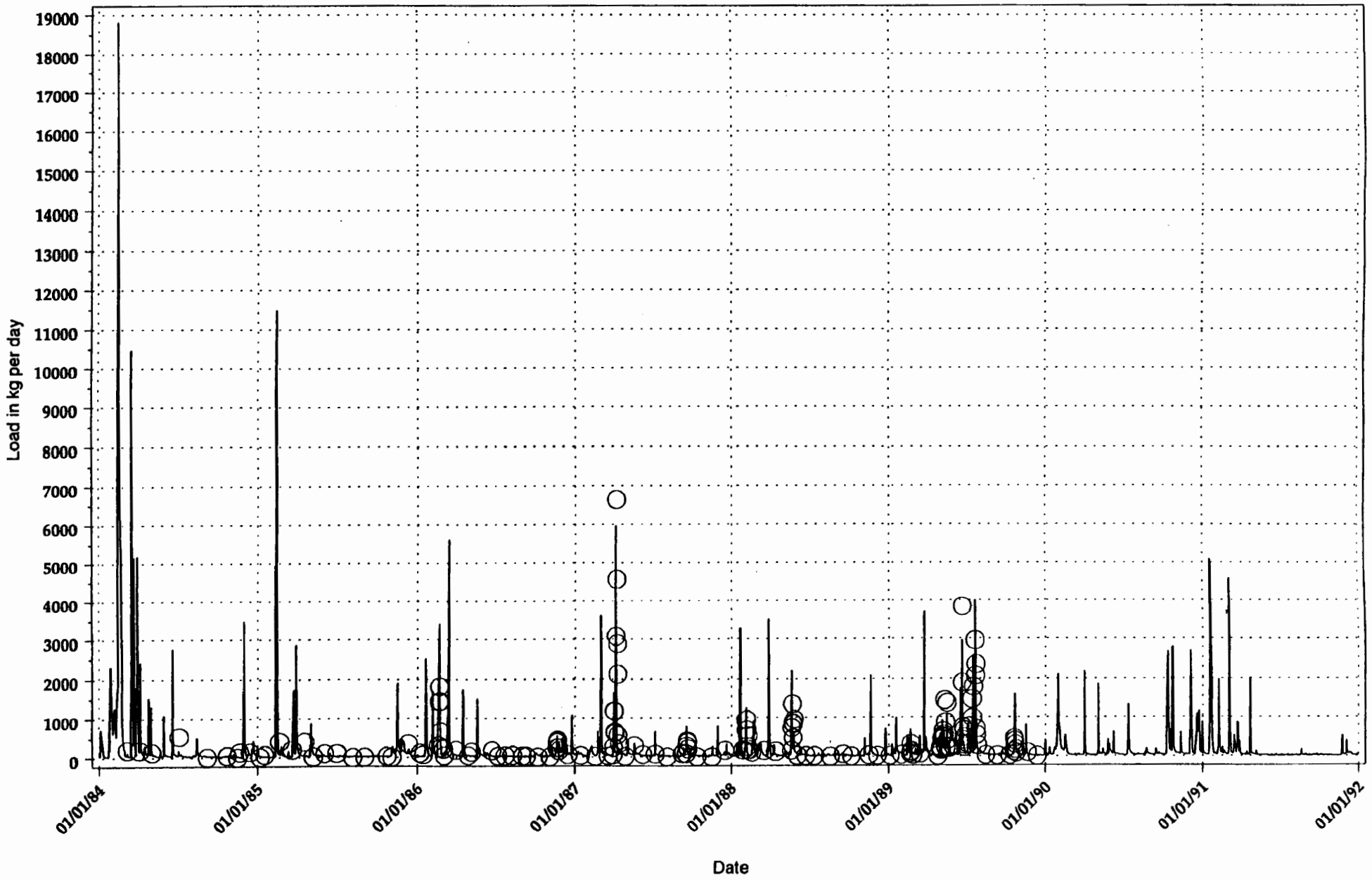
(*=Observed, -=Simulated)



Juniata River at Segment 100

Total Ammonia Observed and Simulated Load vs Time

(line = simulated, O = observed)

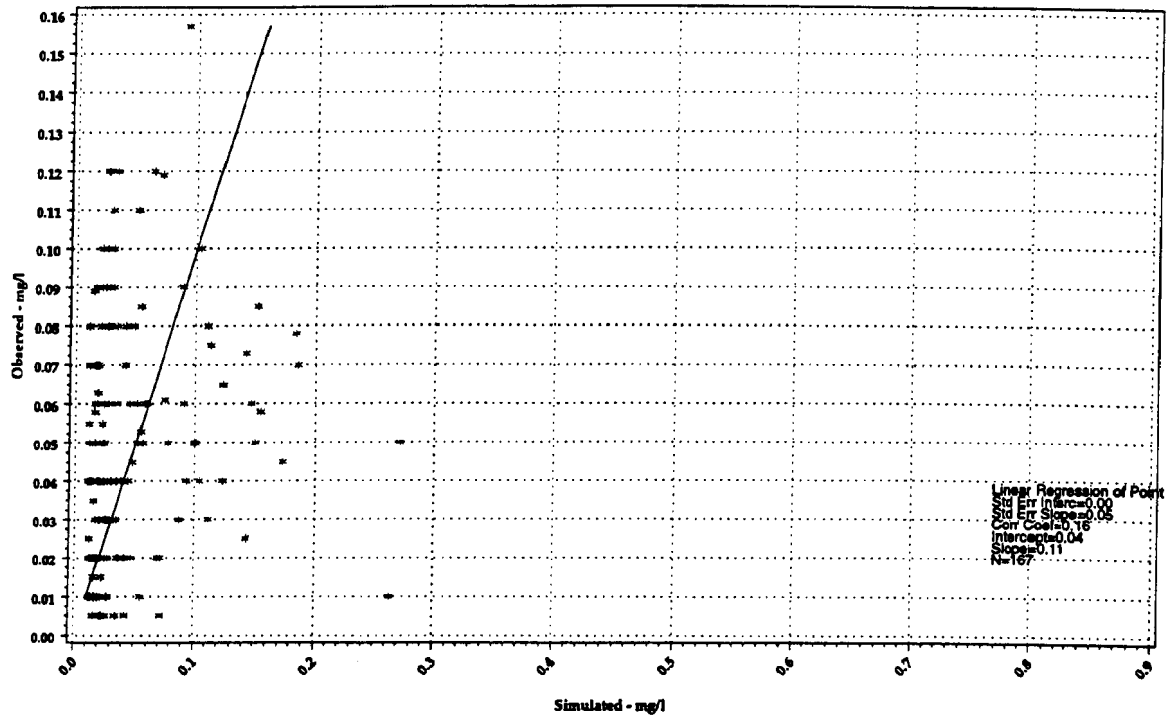


(y21_plot1.sas datastore2 [ypo.p3.james.sas] fdfiles)
(graph_e.dvr 06SEP97 16:17 proc reg model y=x)

Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

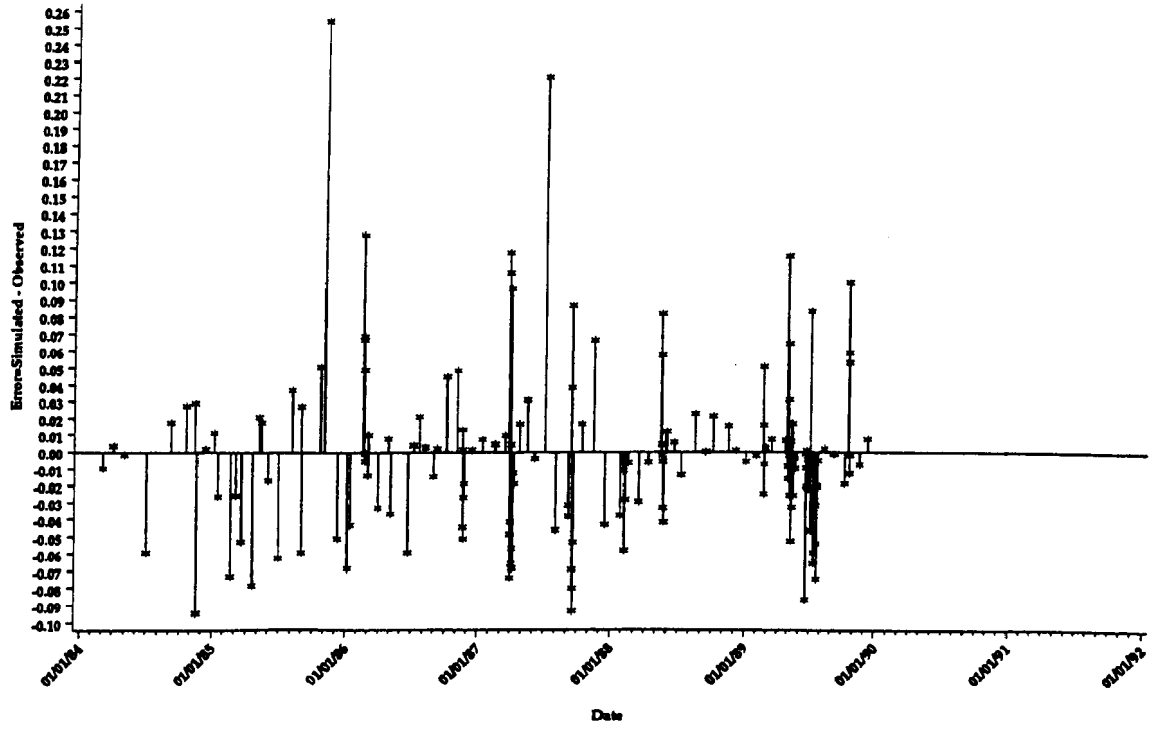
Total Ammonia: 01JAN84 - 01JAN92



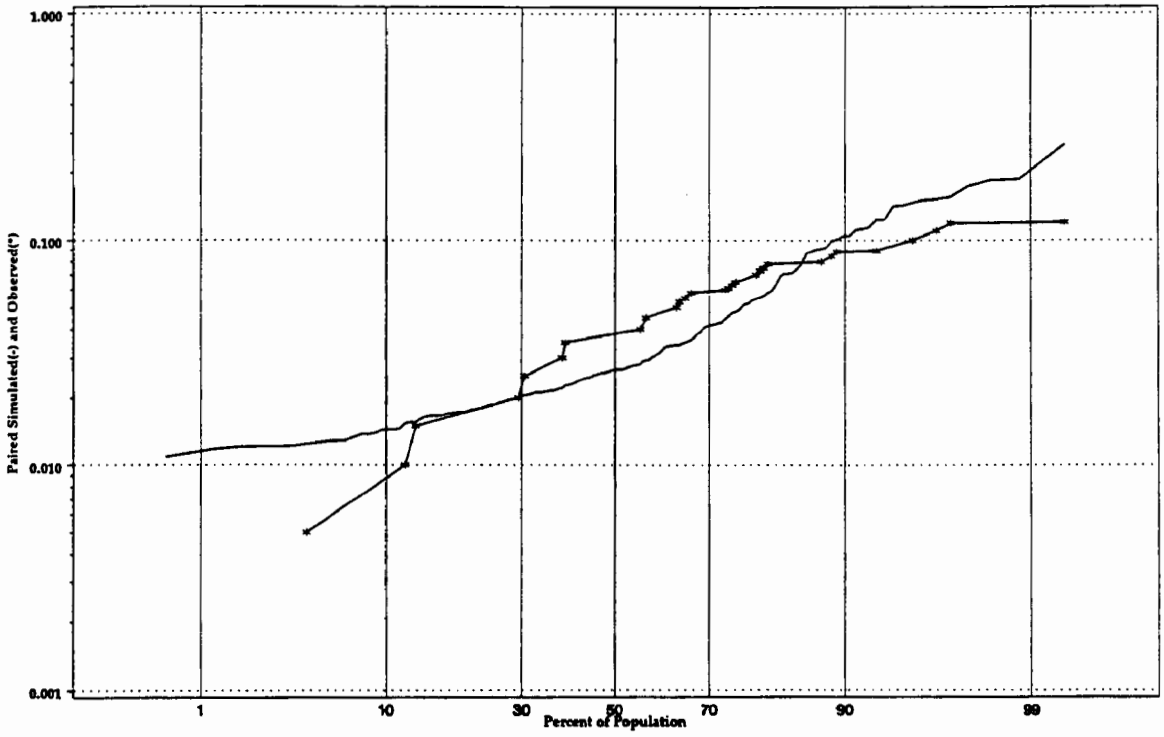
Juniata River at Segment 100

Actual Error versus Time

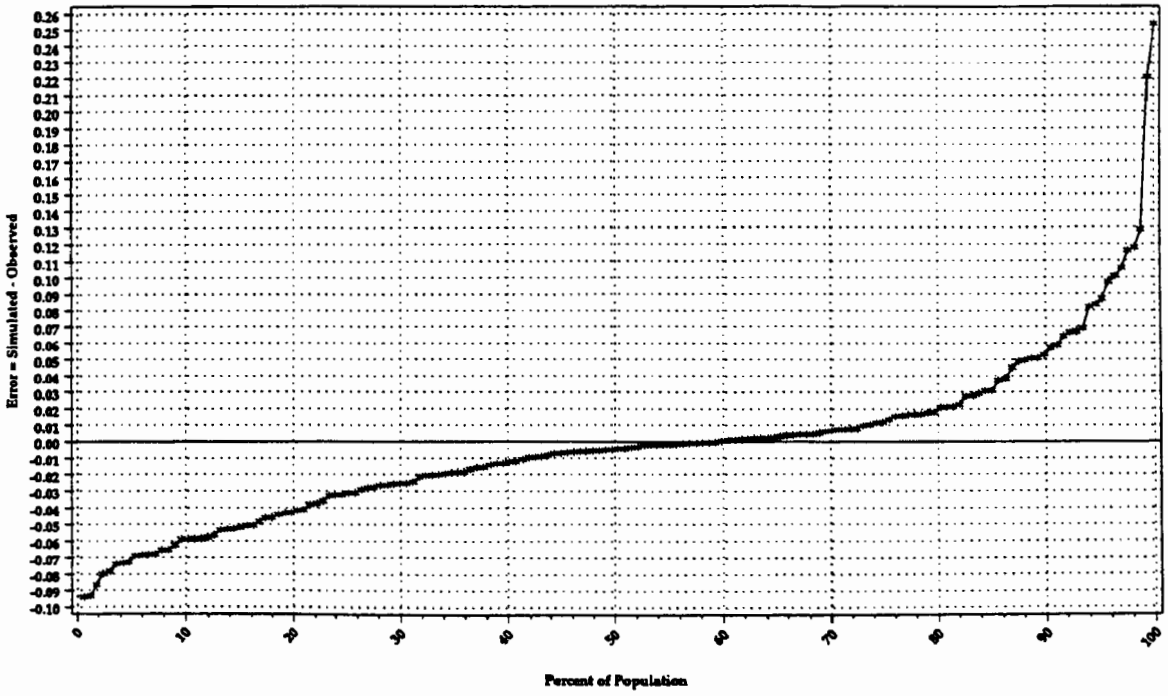
Total Ammonia



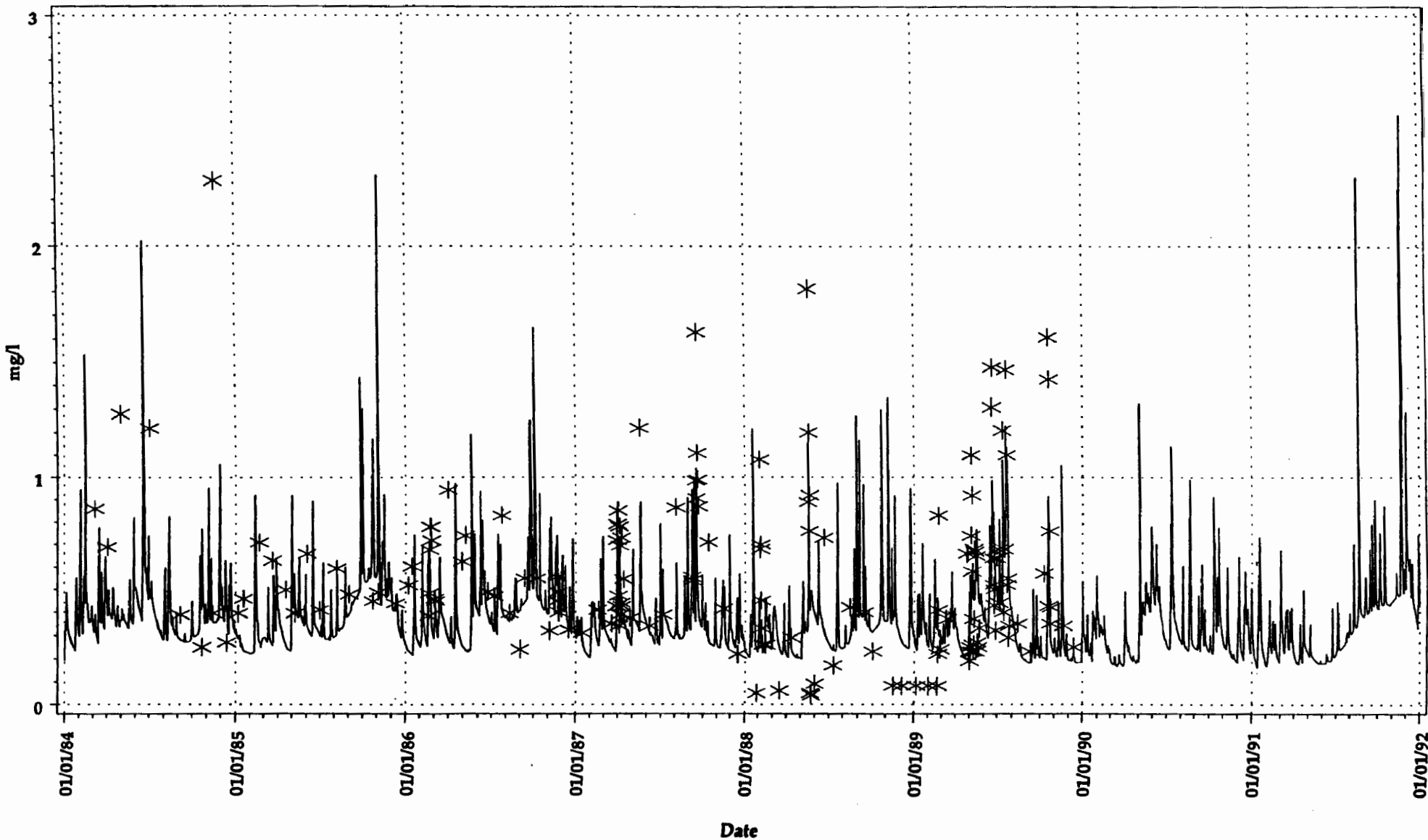
Juniata River at Segment 100
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



Juniata River at Segment 100
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



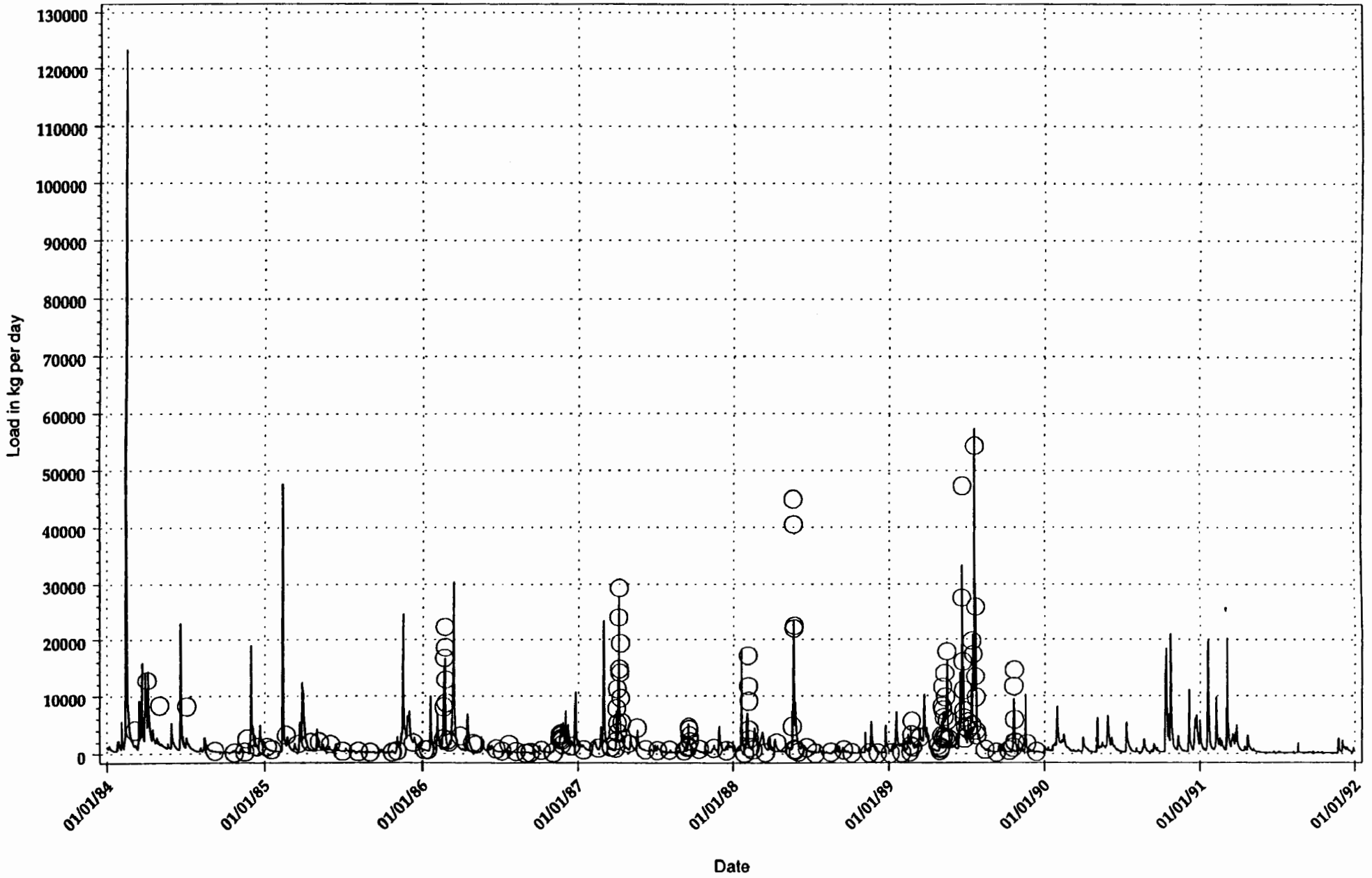
Juniata River at Segment 100
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)



Juniata River at Segment 100

Organic Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)

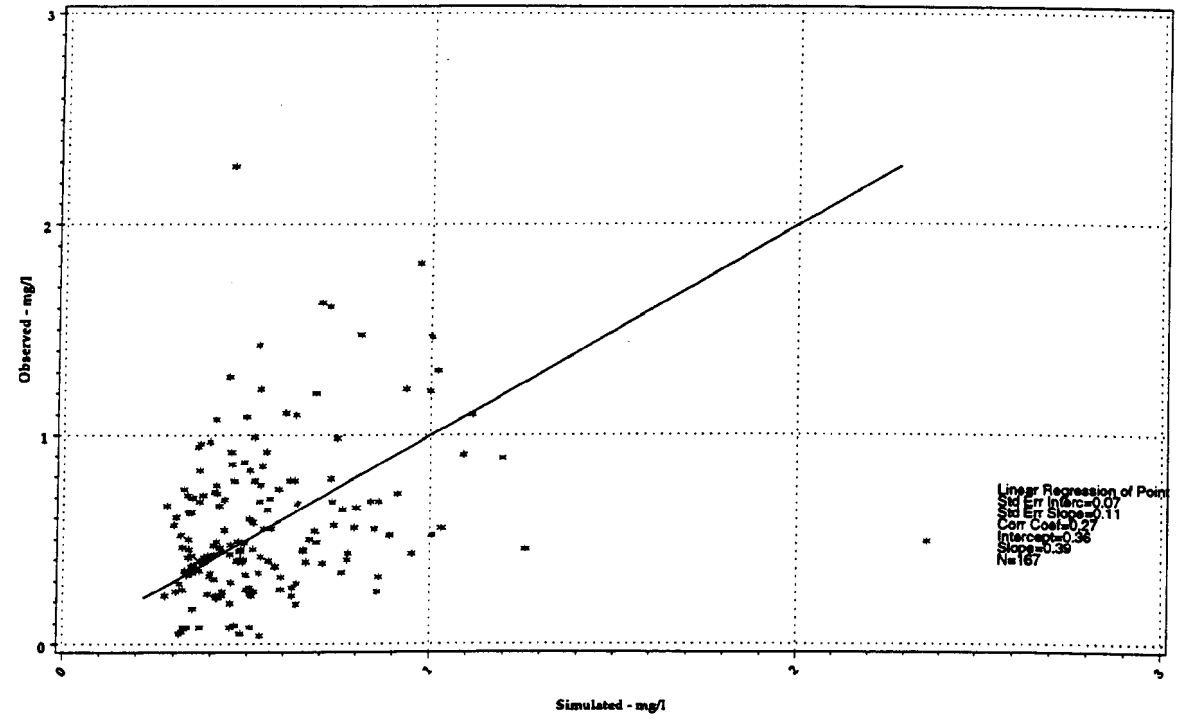


(y21_plot1.sas datastore2:[rps.p3.james.sas] 5dlbs)
(graph_a drv 08SEP97 16:17 proc reg,model y=x)

Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

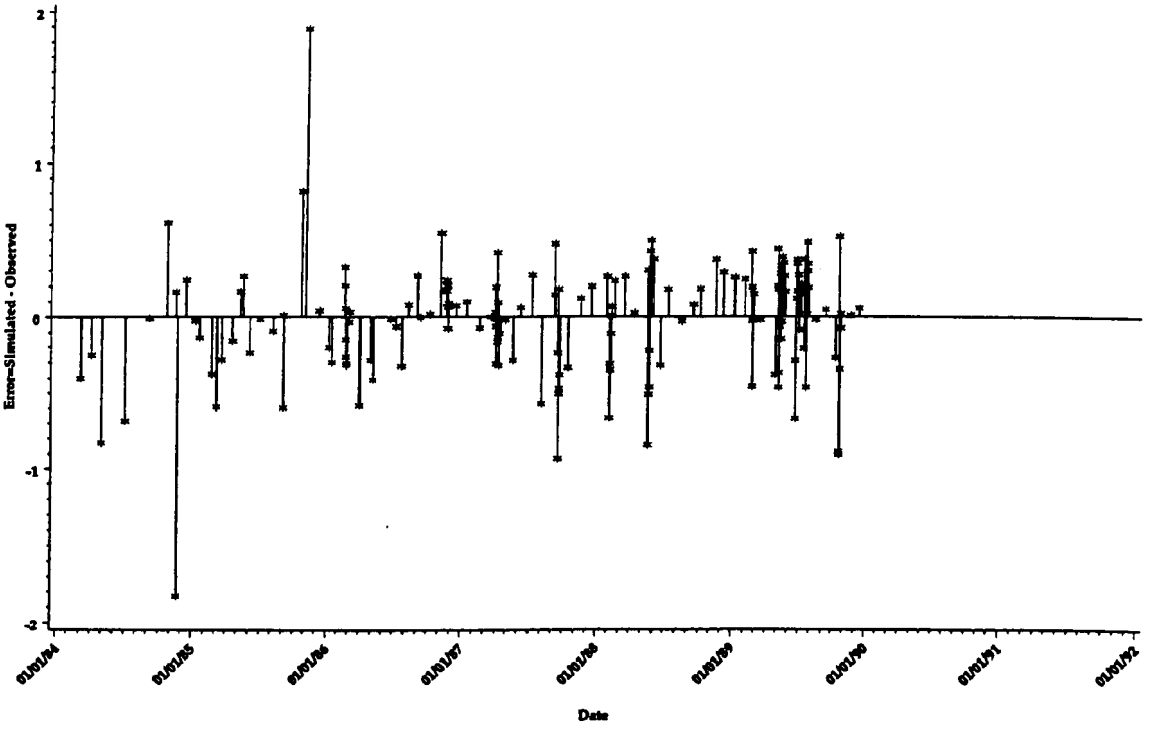
Organic Nitrogen: 01JAN84 - 01JAN92



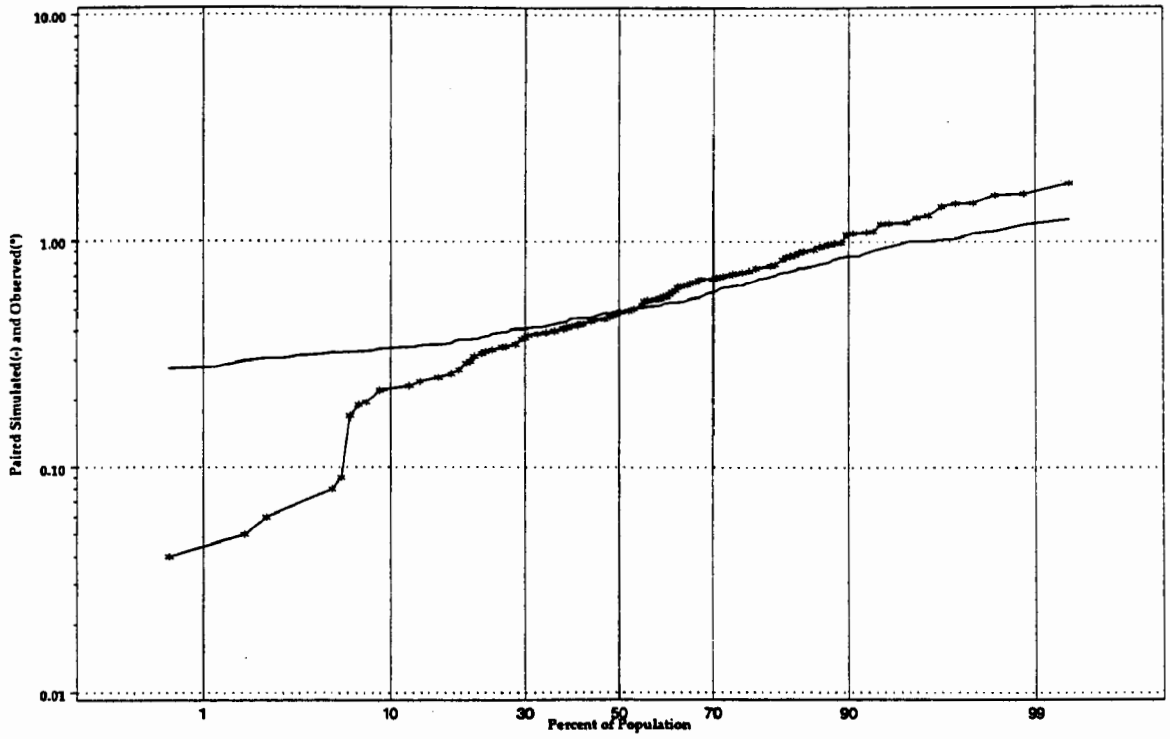
Juniata River at Segment 100

Actual Error versus Time

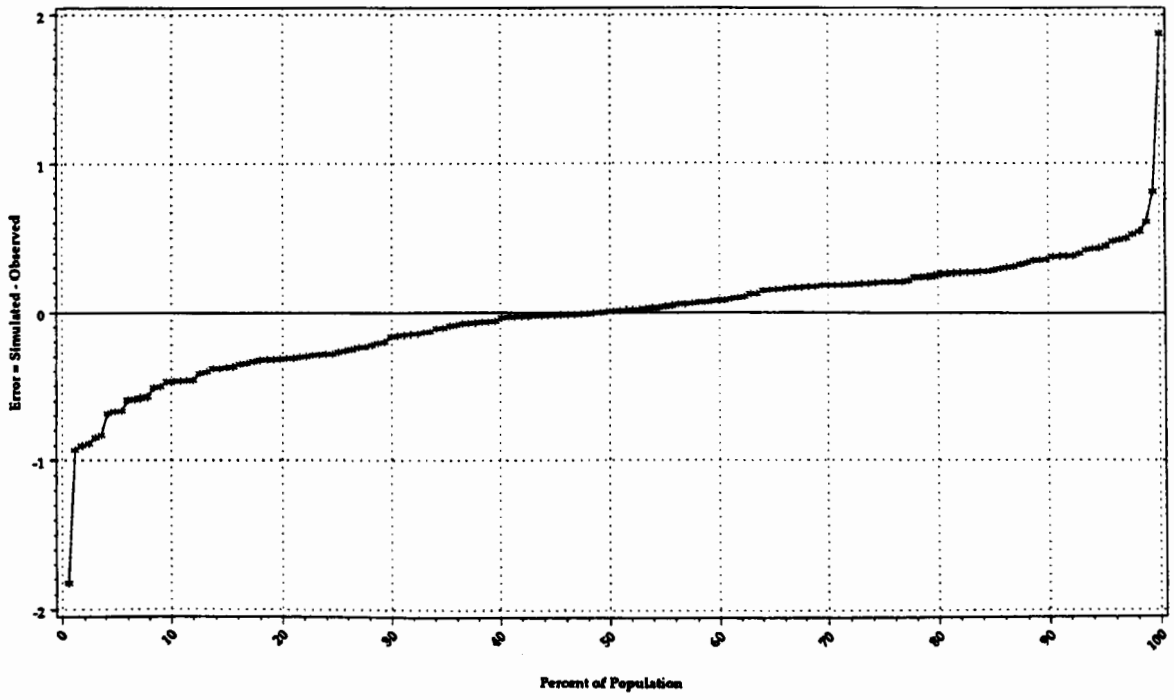
Organic Nitrogen



Juniata River at Segment 100
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Juniata River at Segment 100
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.1.4 Lower Susquehanna River at Marietta, PA Segment 110 (Monitoring Station: 1576000) (Above Fall Line Basin Segments: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 700, and 710)

Section Summary:

Water quality at the Lower Susquehanna water quality gaging station reflects the water quality of the upstream basins of the East Branch Susquehanna, West Branch Susquehanna, and the Juniata as well as changes in land use, point source loads, and nonpoint source management practices of the Lower Susquehanna basin. The Lower Susquehanna basin is largely rural, and influenced by the upstream agricultural loads and forest loads, as well as lower basin agricultural loads and point sources from the cities of Harrisburg, York, and Hershey.

The Lower Susquehanna basin above the gaged site covers an area of 26,184 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 64% forest land, 10% cropland, 20% other agricultural areas, 5% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 122 million pounds in 1985 to 115 million pounds in 1996. Total phosphorus loads over the same time period decreased from 4.8 million pounds to 3.9 million pounds. In general, point source loads above the gage site are low. In 1996, the total nitrogen point source load was 11% of the total load and the total phosphorus point source load was 22% of the total load. Estimated septic system total nitrogen loads increased 9%, from 3.5 million pounds in 1985 to 3.8 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 9%, and other agricultural loads (primarily pasture and manure loads) by 10%. Total phosphorus decreased for these land uses by 5% and 22% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 7% for total nitrogen and 9% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

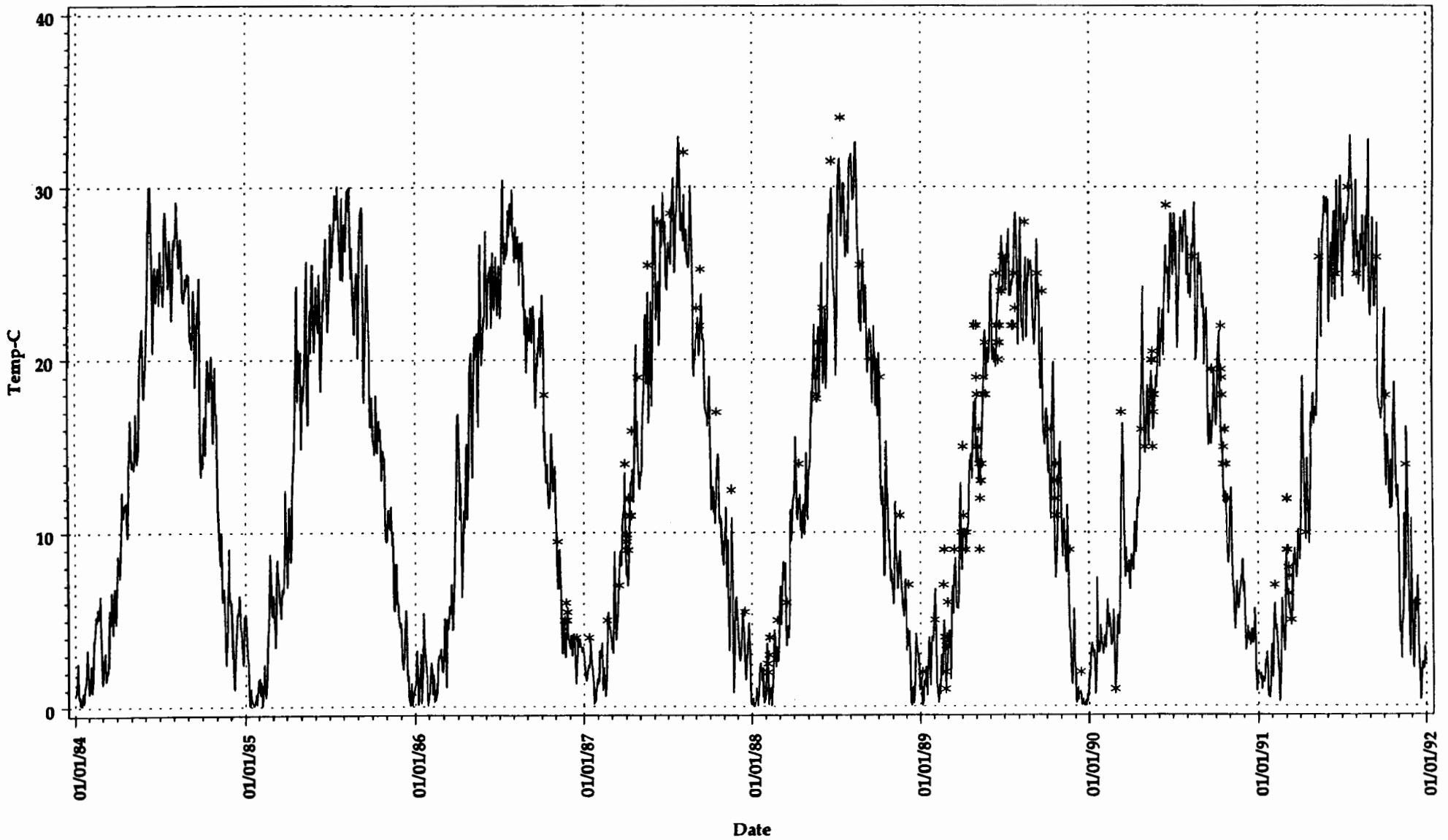
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date – Temperature
Observed and Simulated Loads versus Date – Dissolved Oxygen

Susquehanna River at Segment 110
Observed and Simulated versus Time
Temperature-C

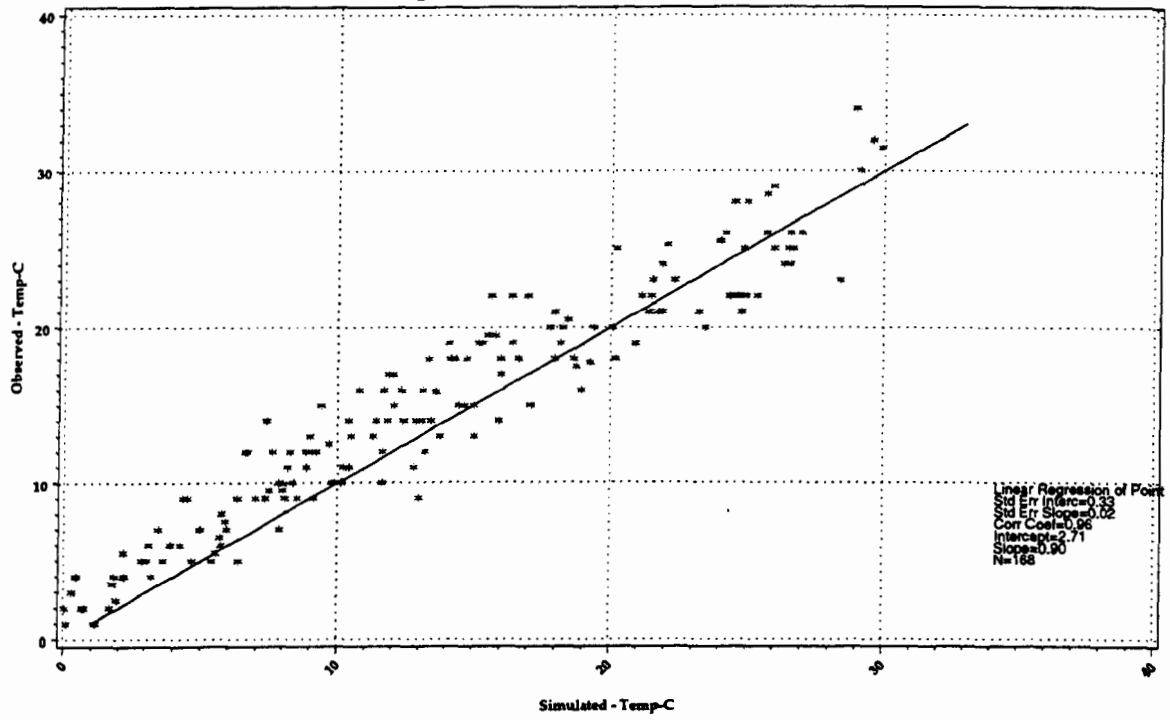
(*=Observed, -=Simulated)



(y21_plotb.aes model3d [pwang.dt] plotomt - omtime)
(cosus_d.drv1 23FEB96 16:13)

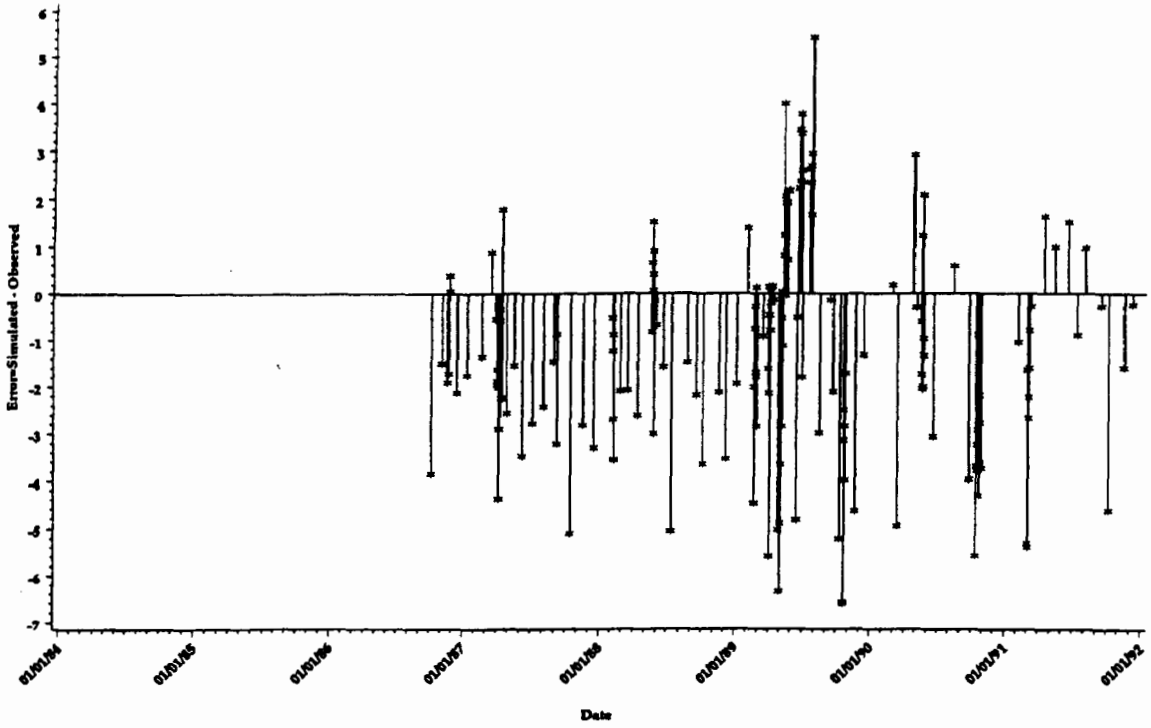
Susquehanna River at Segment 110

Scatter Plot and Regression of Simulated versus Observed with Ideal Line Temperature-C: 01JAN84 - 01JAN92

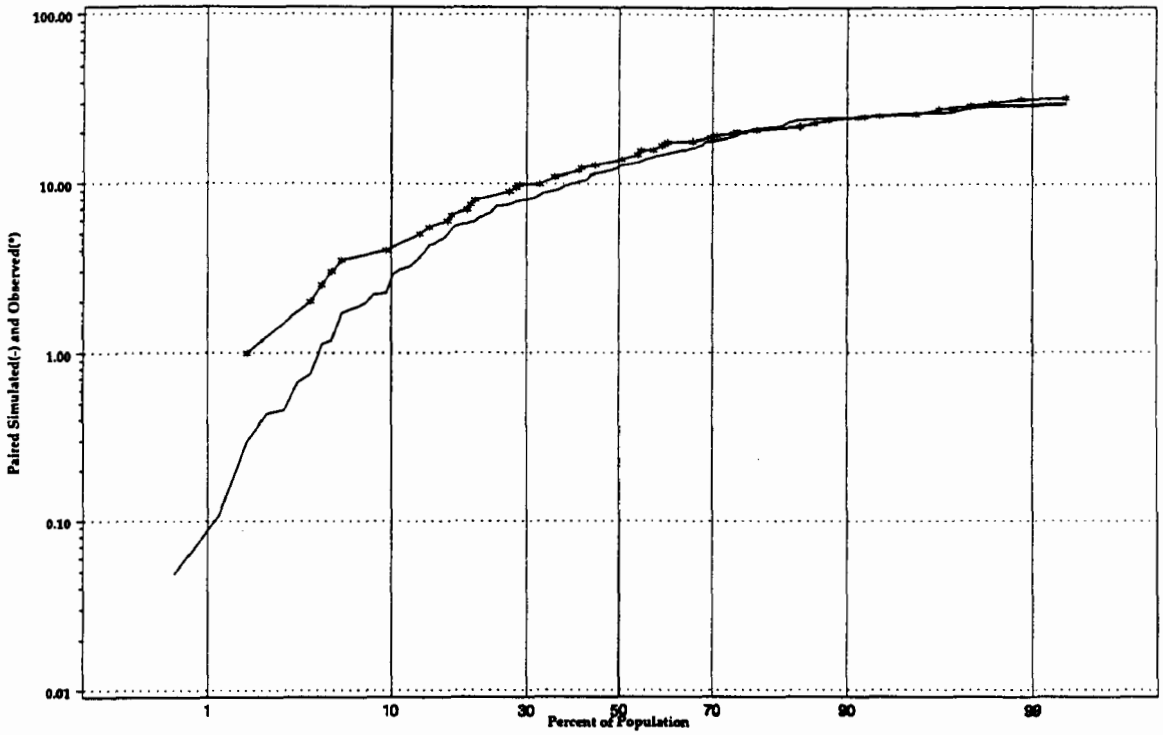


Susquehanna River at Segment 110

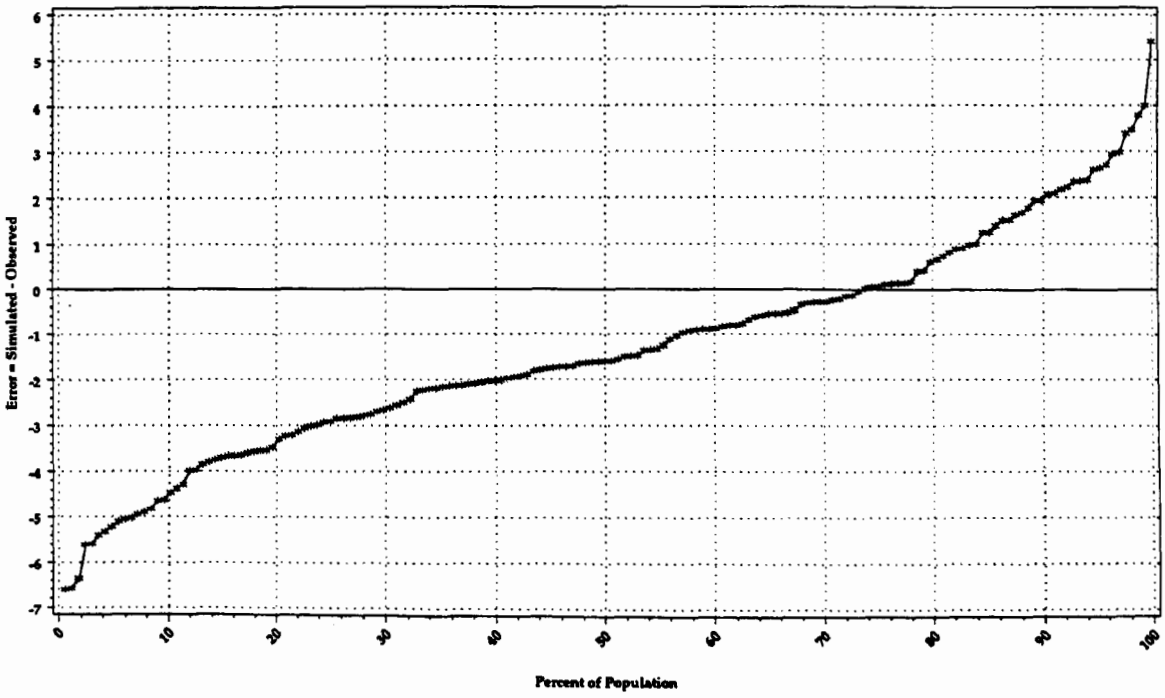
Actual Error versus Time Temperature-C



Susquehanna River at Segment 110
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

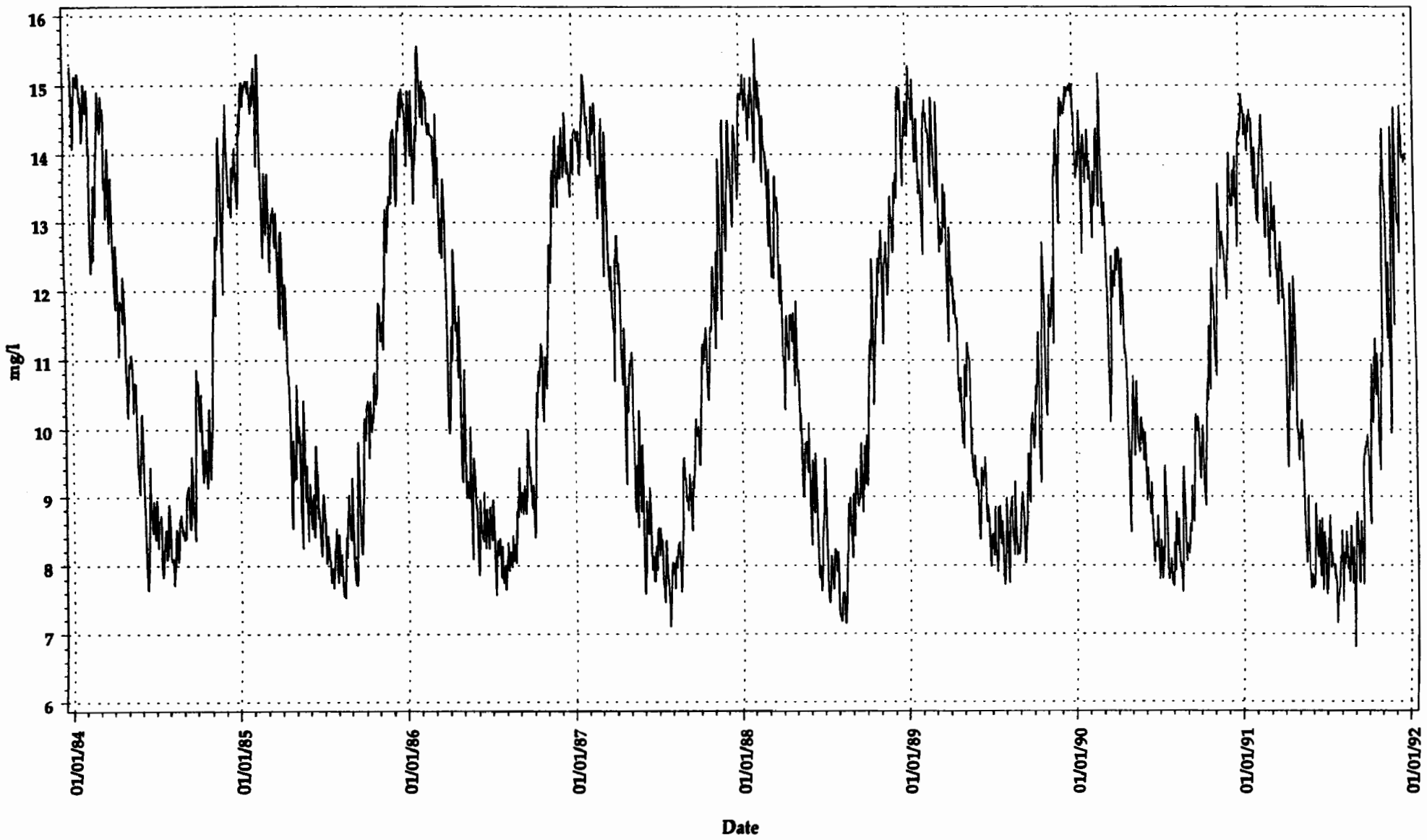


Susquehanna River at Segment 110
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data



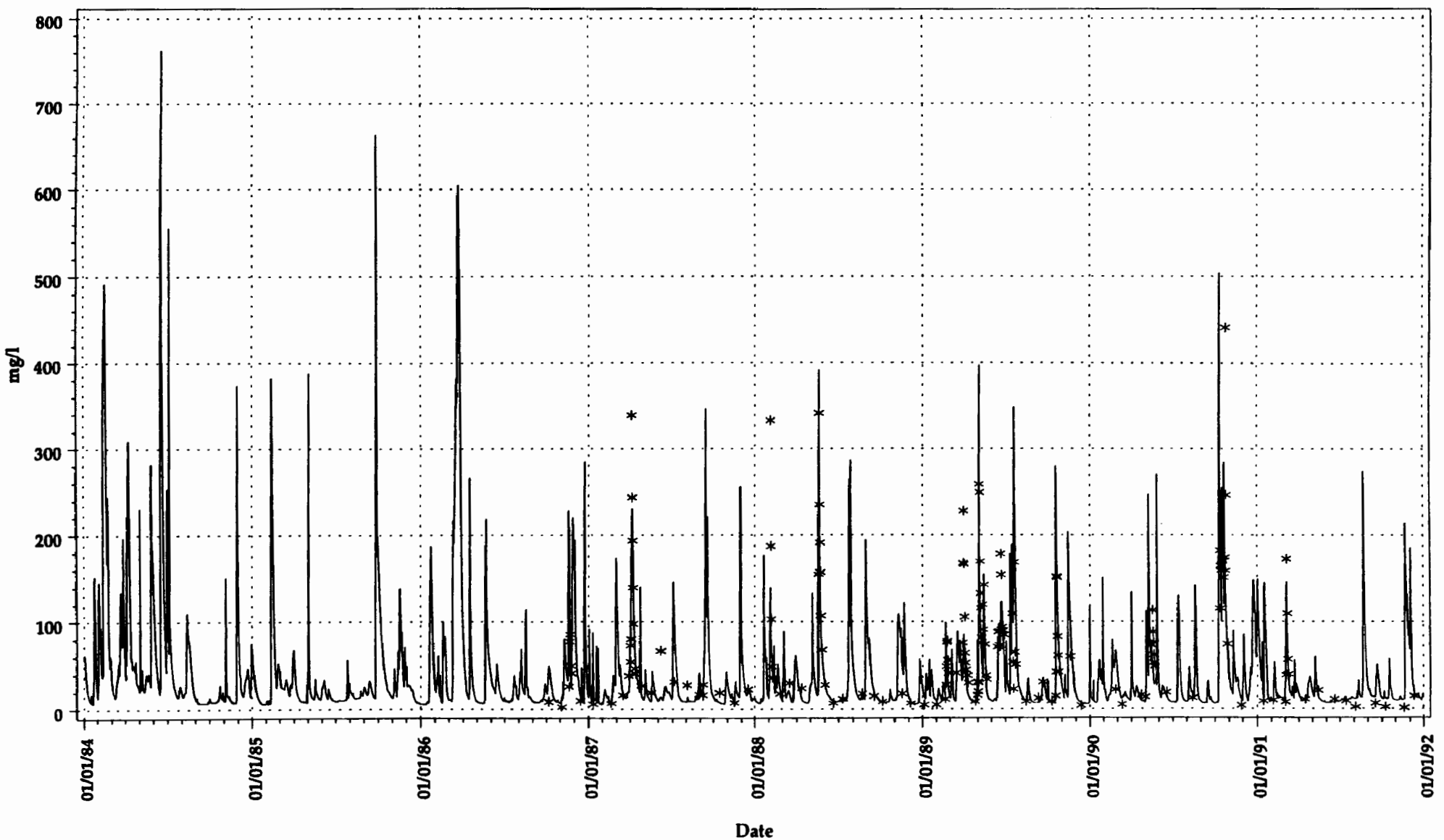
Susquehanna River at Segment 110
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



Susquehanna River at Segment 110
Observed and Simulated versus Time
Total Suspended Sediment

(*=Observed, -=Simulated)

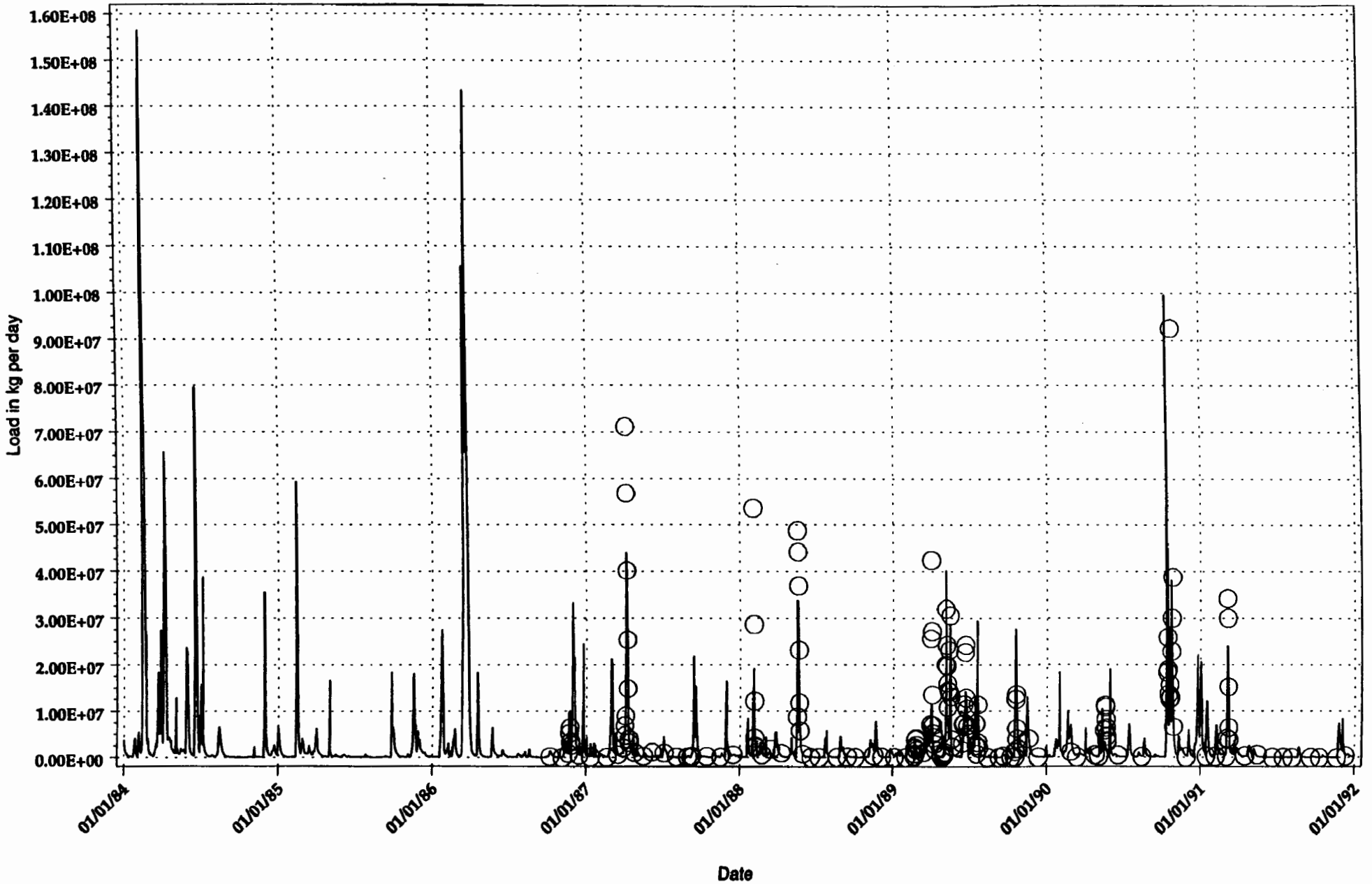


(y21_plotb.sas model3d:jpwang.dt] plotsmt - omdlme)
(focus_d.drv1 13FEB98 13:31)

Susquehanna River at Segment 110

Total Suspended Sediment Observed and Simulated Load vs Time

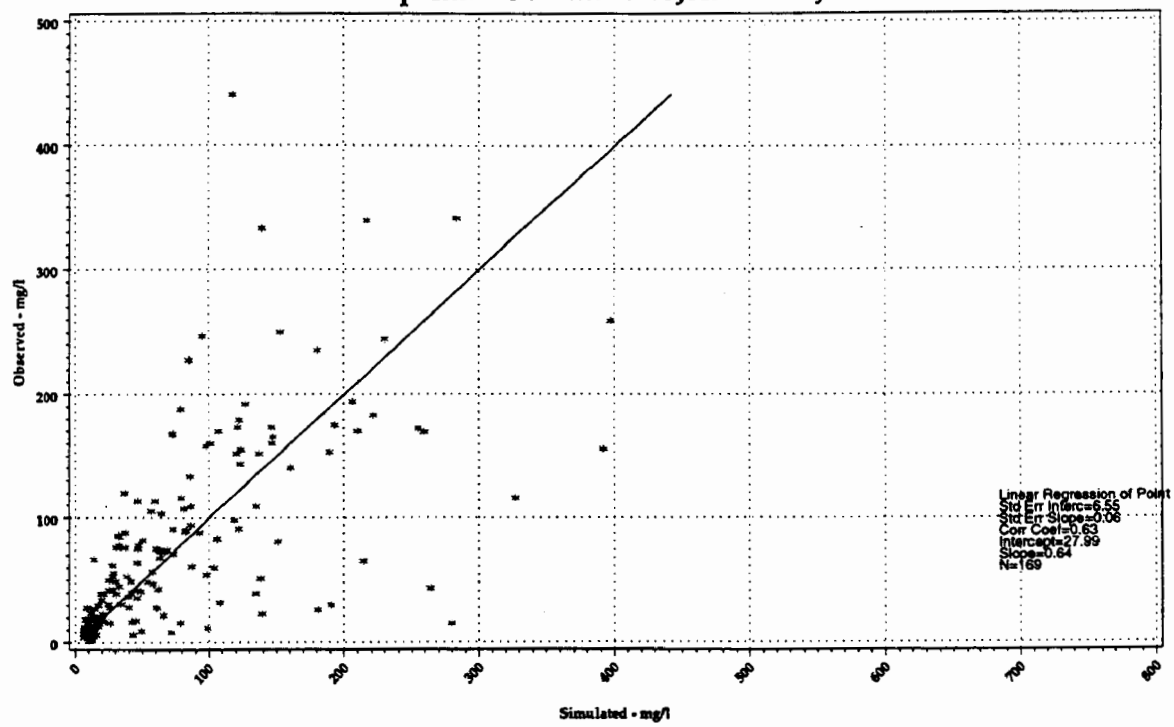
(line = simulated, O = observed)



Susquehanna River at Segment 110

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

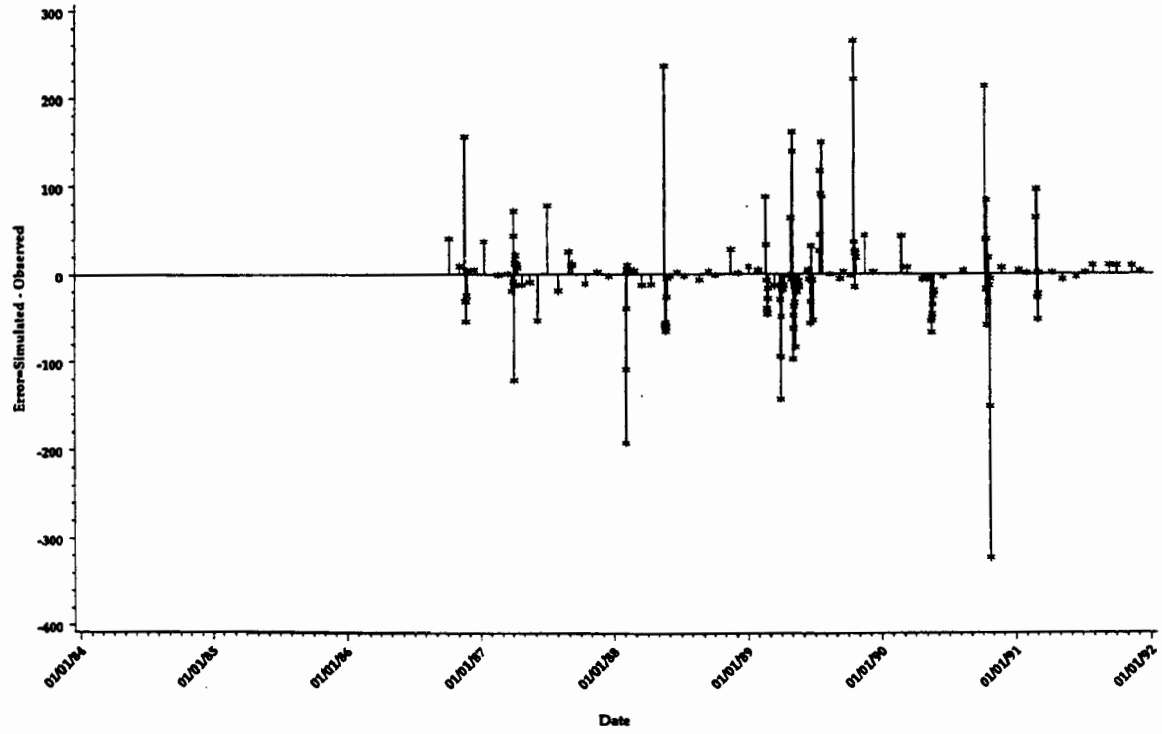
Total Suspended Sediment: 01JAN84 - 01JAN92



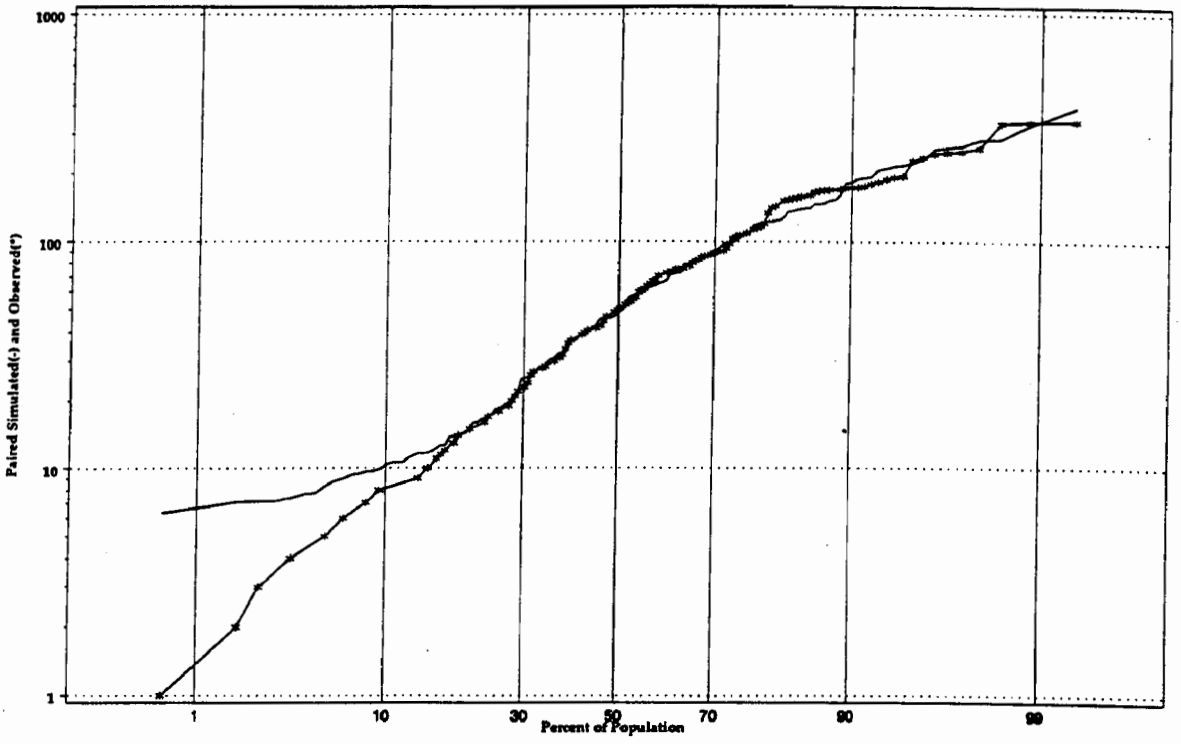
Susquehanna River at Segment 110

Actual Error versus Time

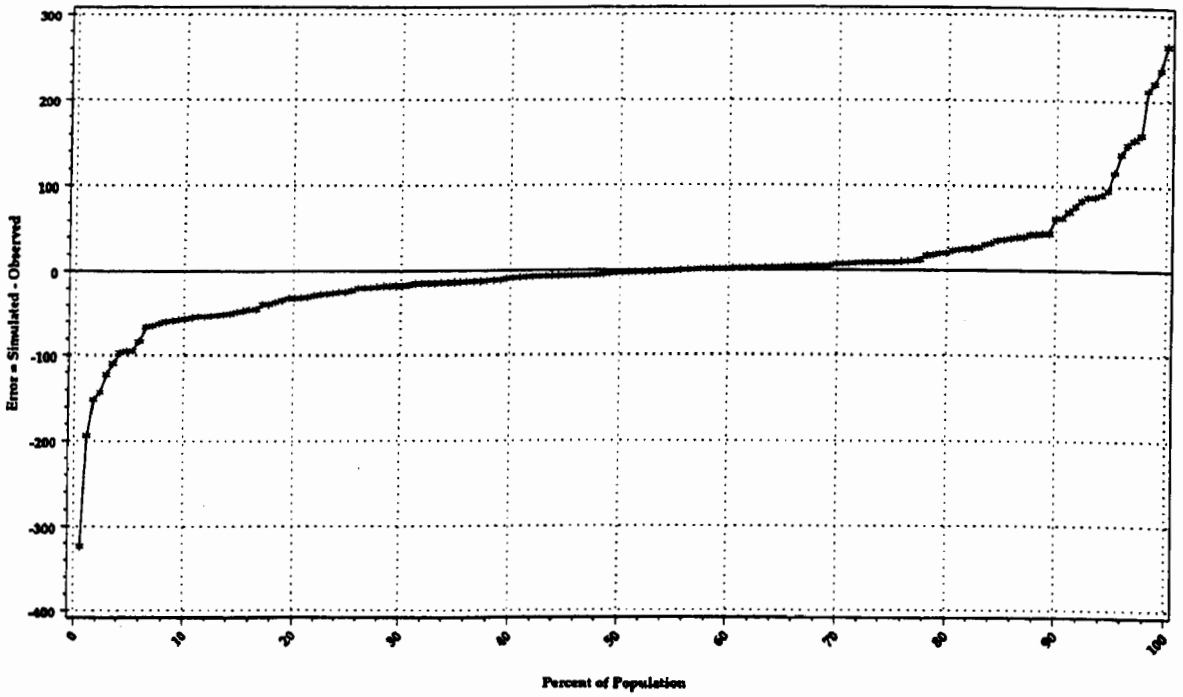
Total Suspended Sediment



Susquehanna River at Segment 110
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

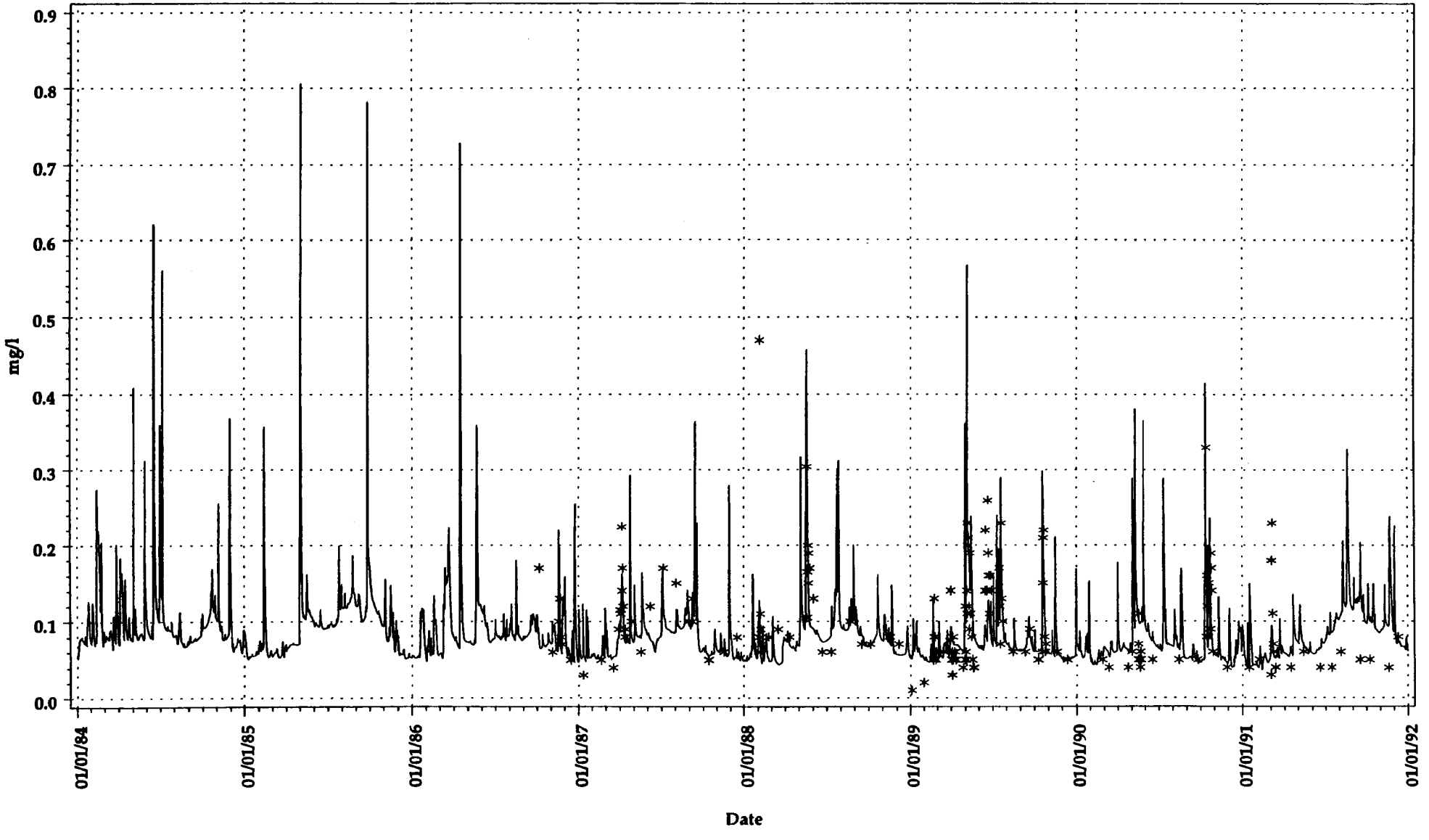


Susquehanna River at Segment 110
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



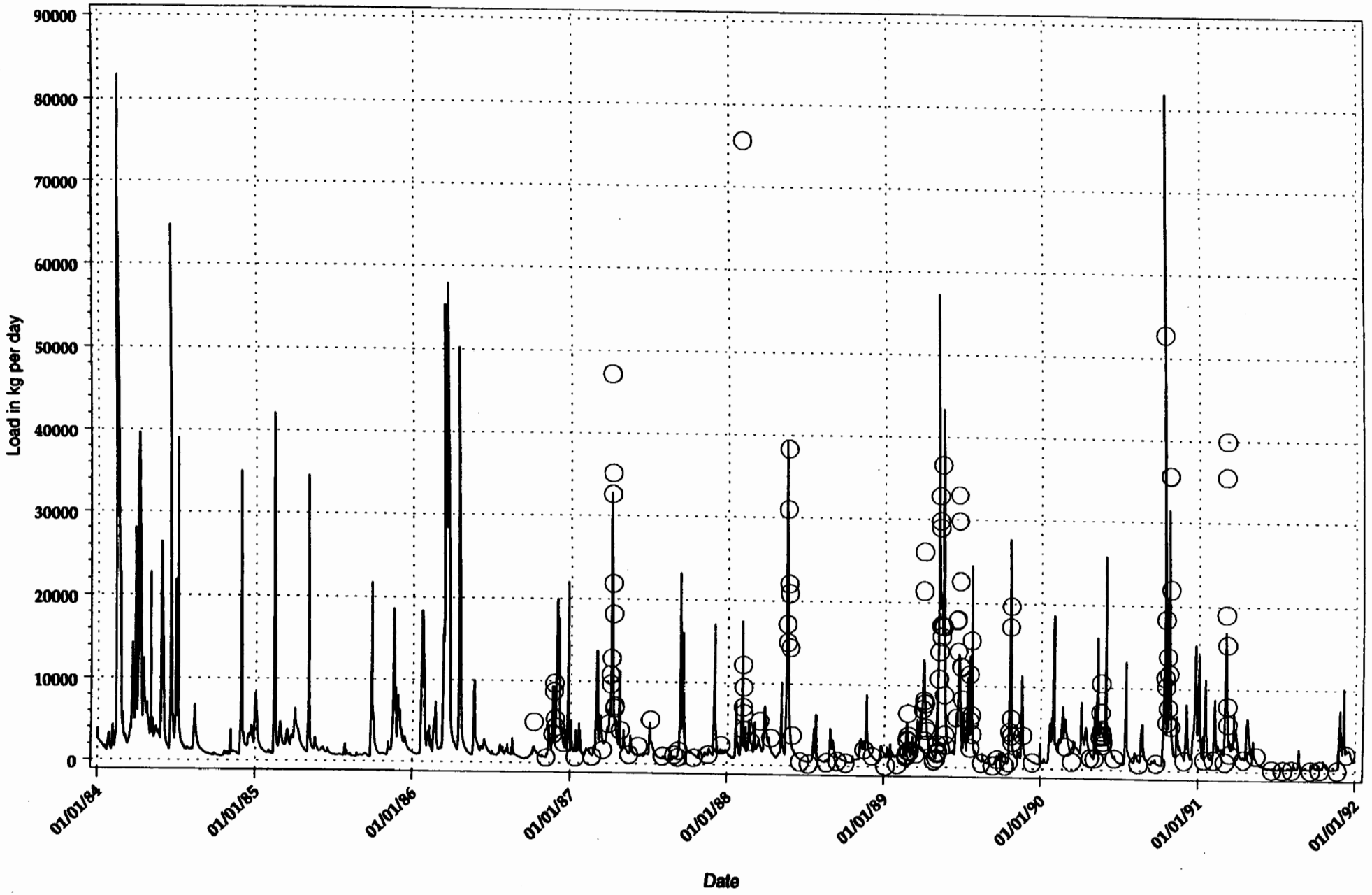
Susquehanna River at Segment 110
Observed and Simulated versus Time
Total Phosphorus

(*=Observed, -=Simulated)



(y21_plotb.sas model3d\pwang.dl; plotomi - omlime)
(susu_d.dv1 13FEB98 13:53)

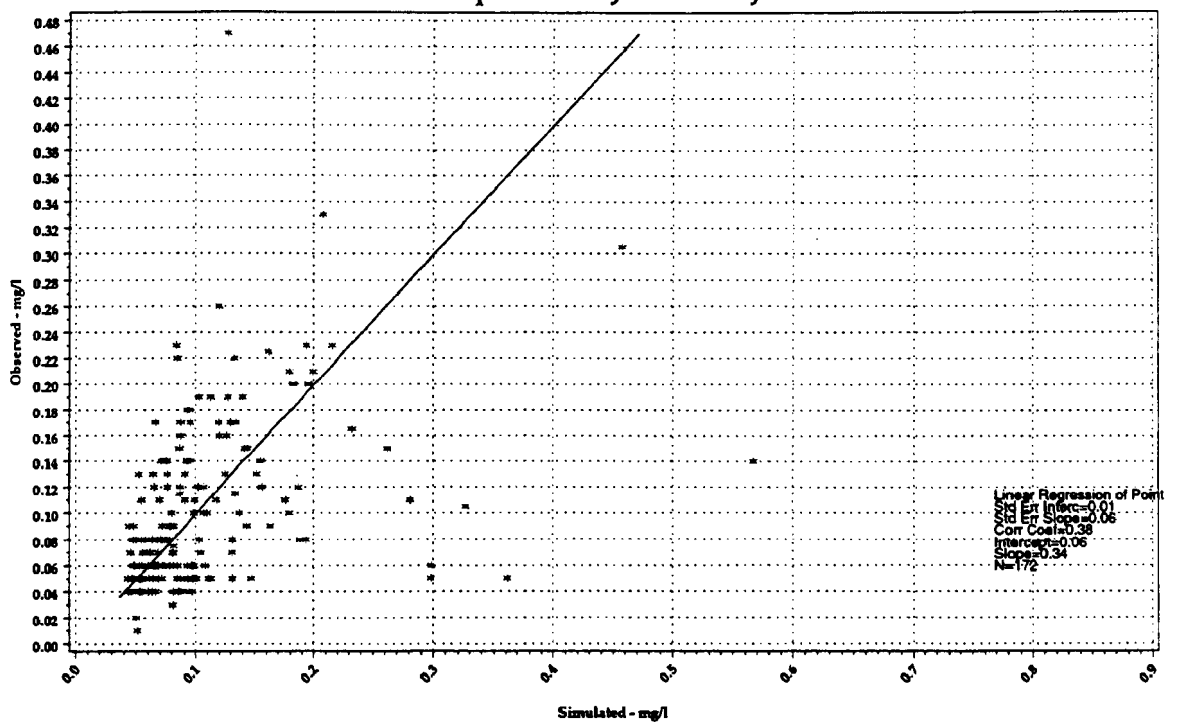
Susquehanna River at Segment 110
Total Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)



Susquehanna River at Segment 110

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

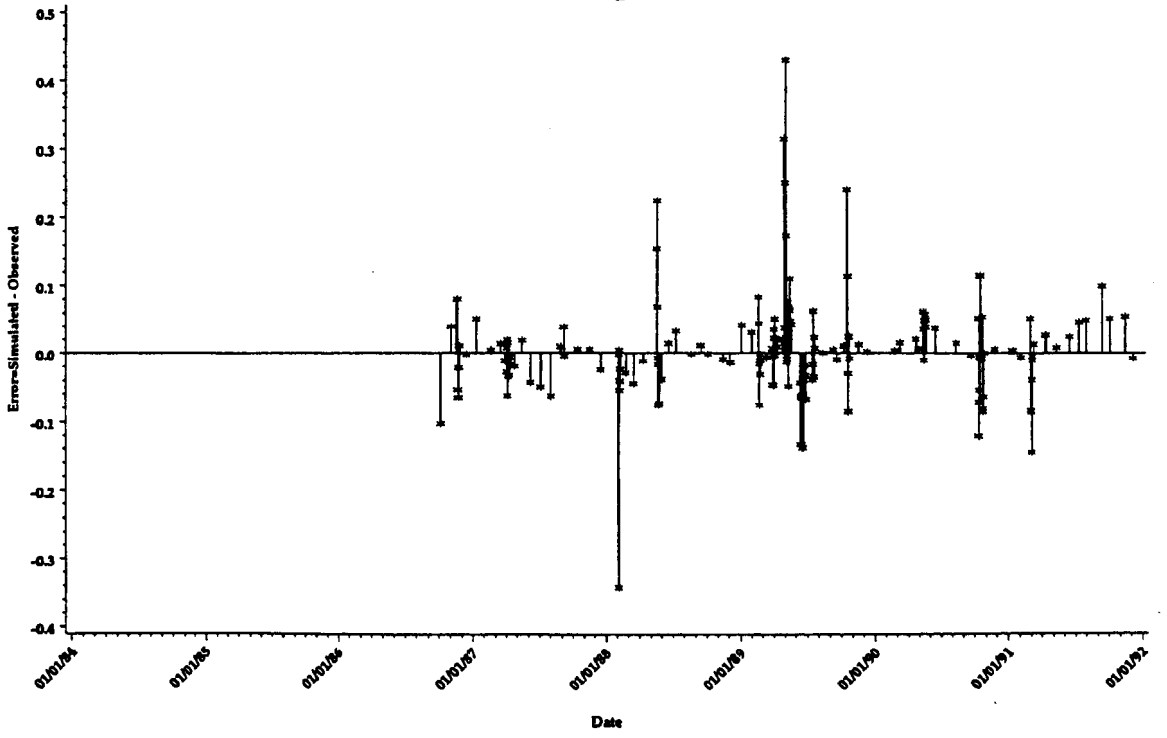
Total Phosphorus: 01JAN84 - 01JAN92



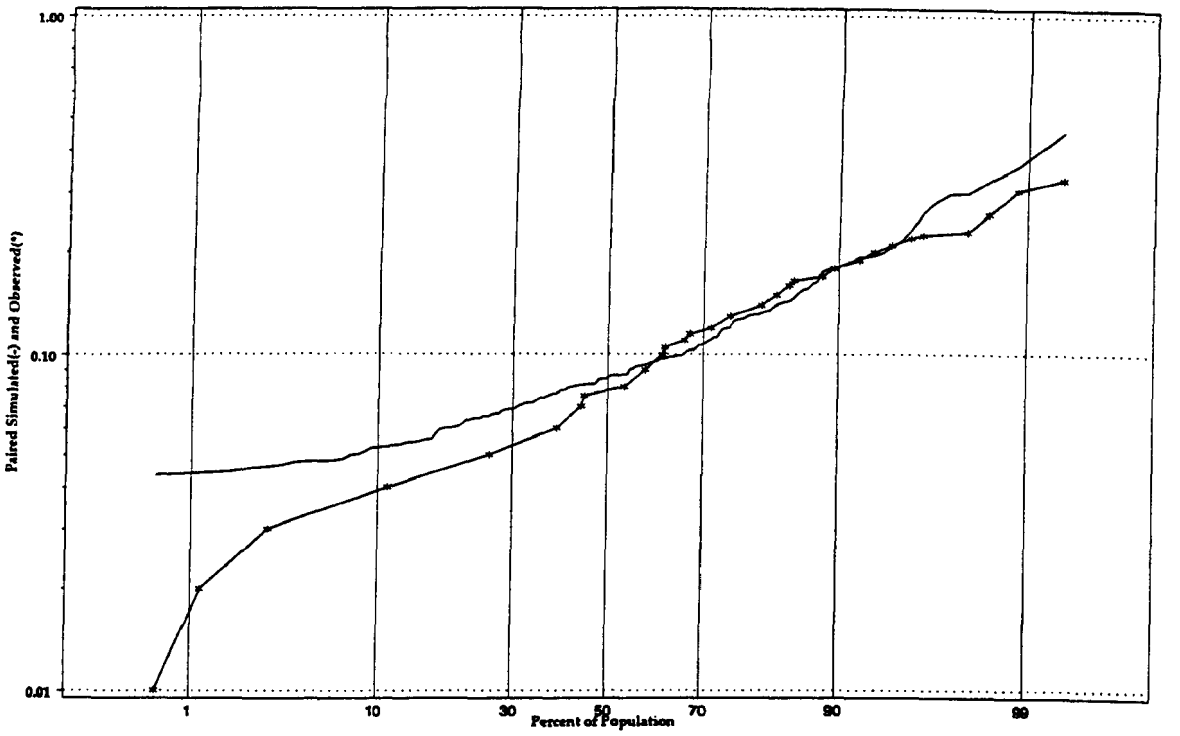
Susquehanna River at Segment 110

Actual Error versus Time

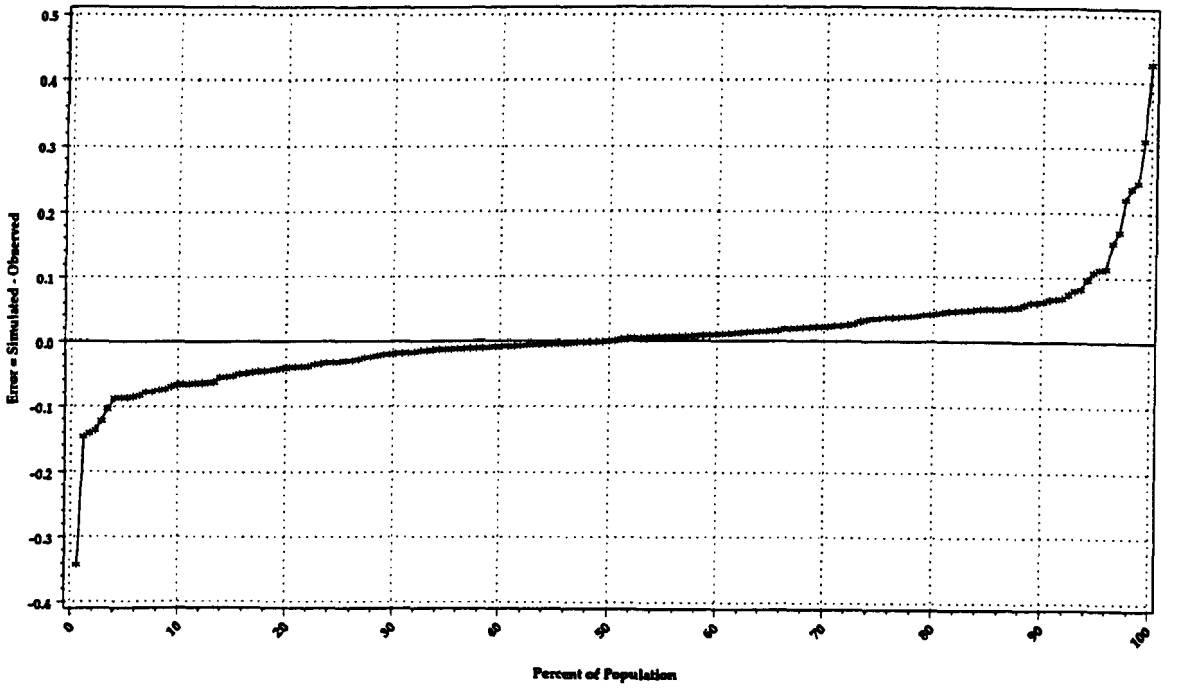
Total Phosphorus



Susquehanna River at Segment 110
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

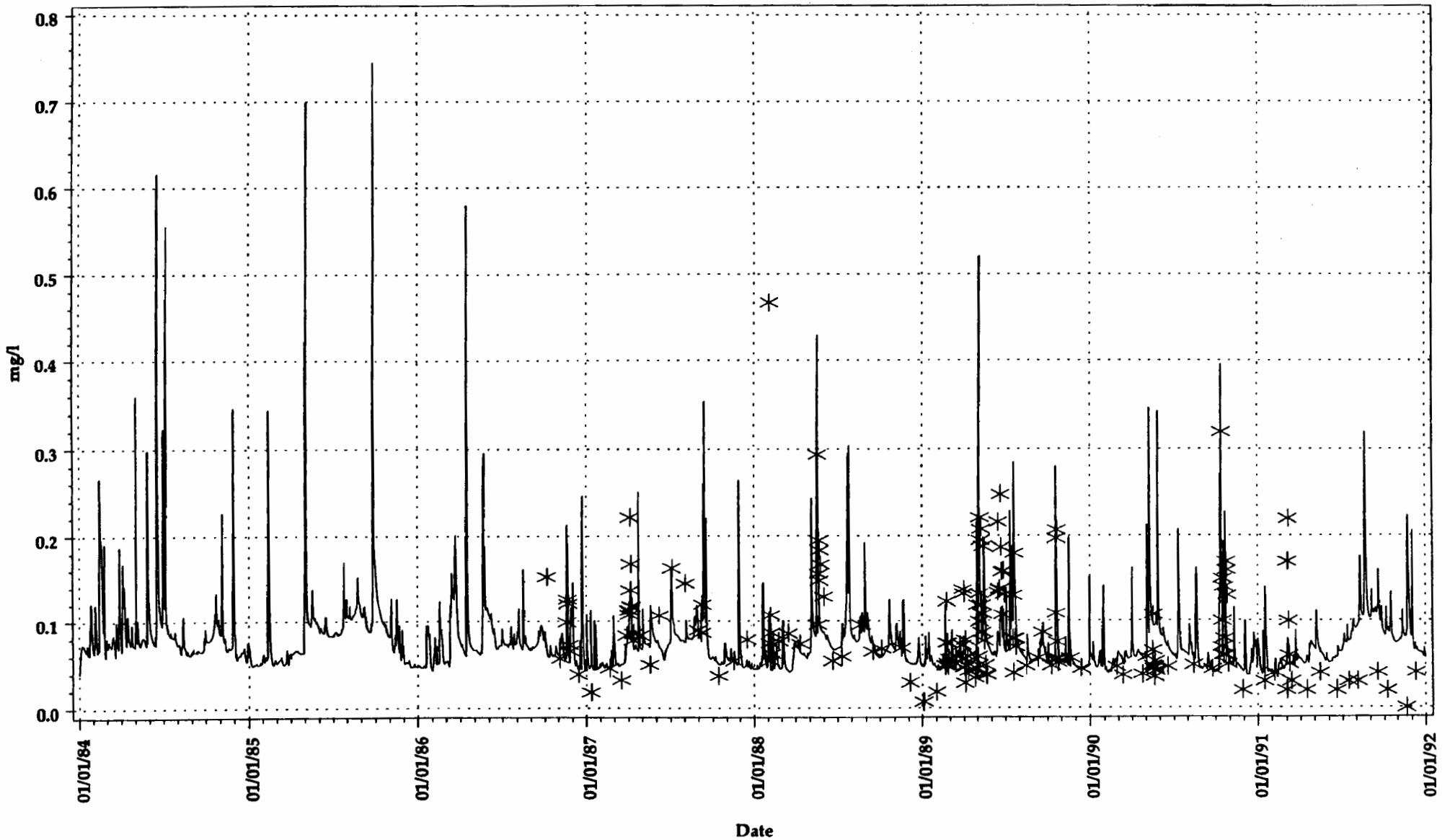


Susquehanna River at Segment 110
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Susquehanna River at Segment 110
Observed and Simulated versus Time
Organic and Particulate Phosphorus

(*=Observed, -=Simulated)

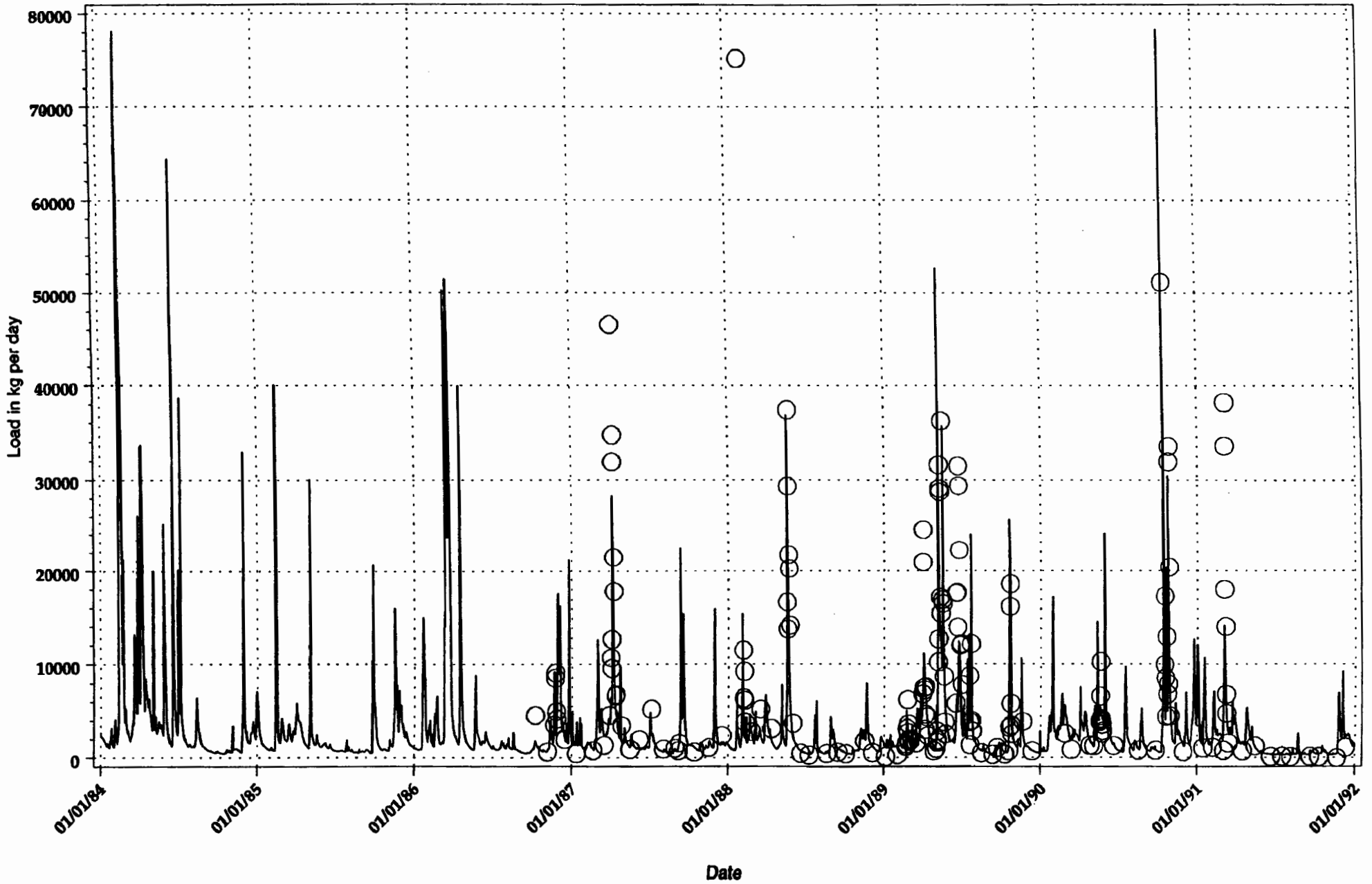


(y21_plotb.sas model3d:[pwang.dt] plotomt - omtime)
(bsus_d.drv1 13FEB98 13:53)

Susquehanna River at Segment 110

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

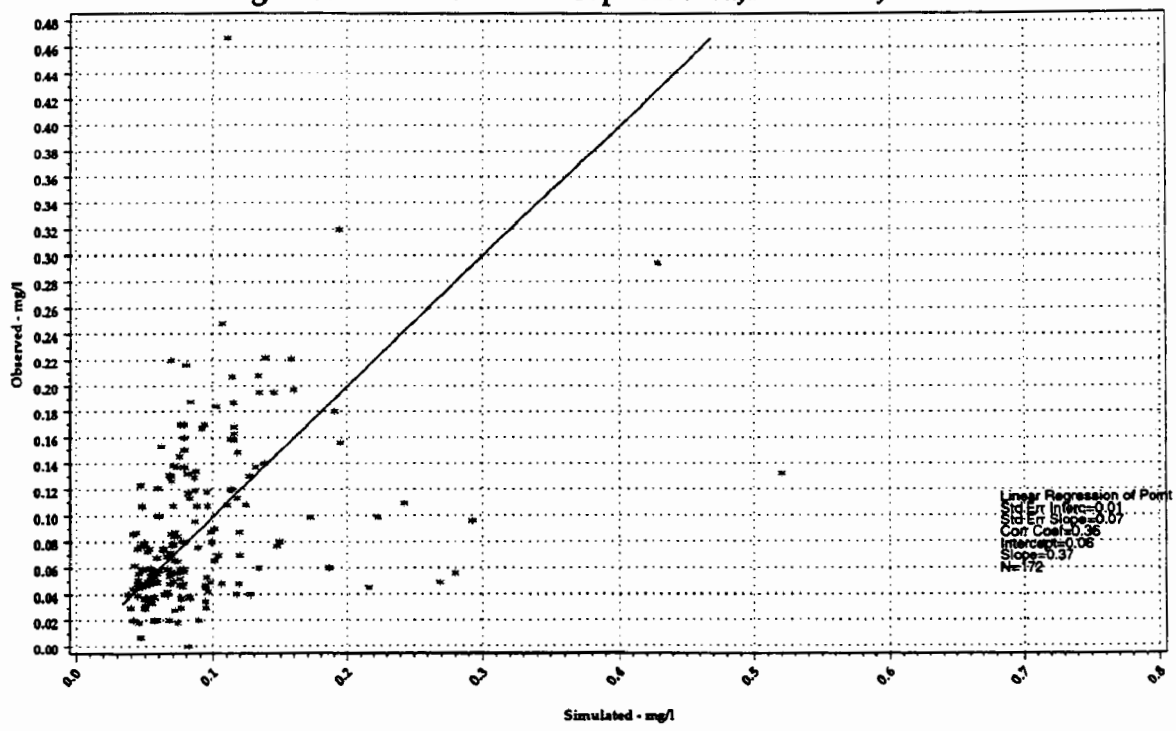
(line = simulated, O = observed)



Susquehanna River at Segment 110

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

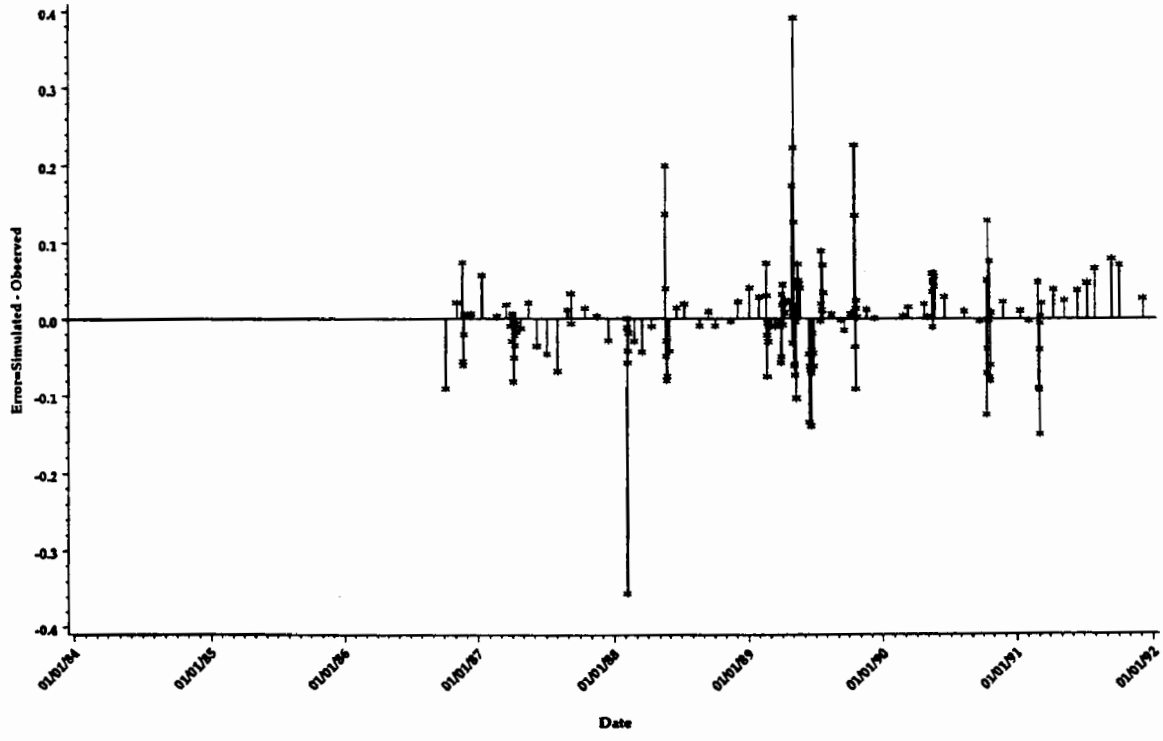
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



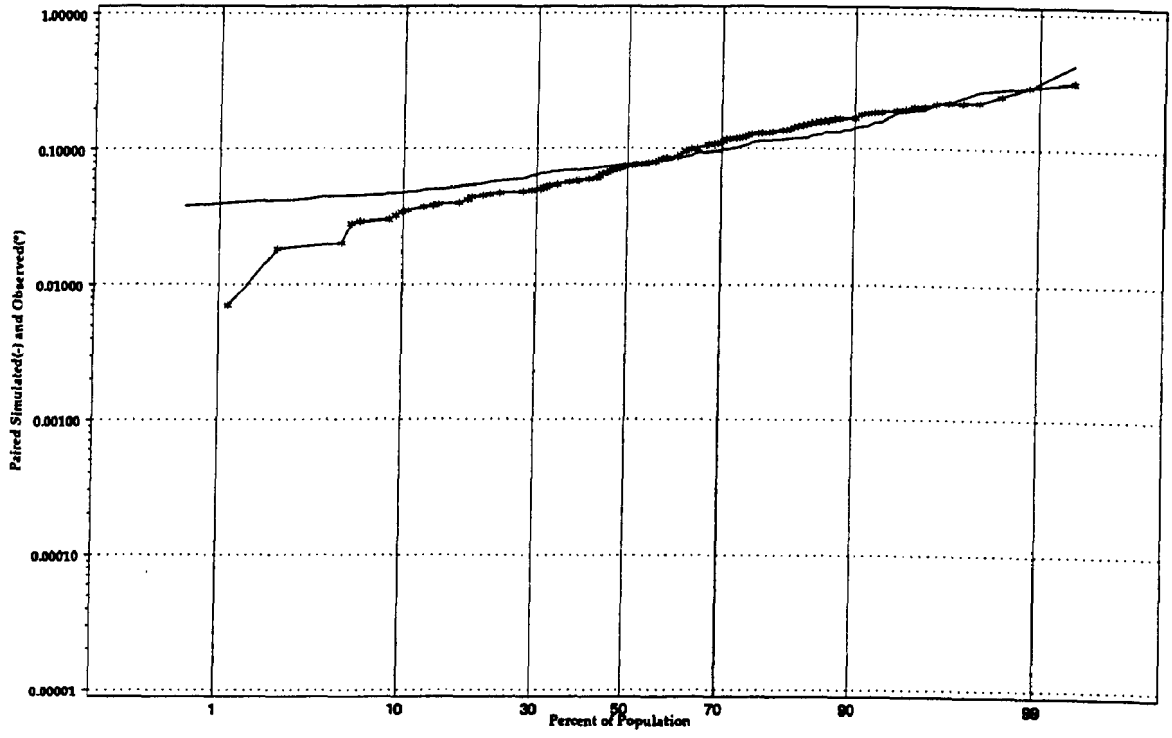
Susquehanna River at Segment 110

Actual Error versus Time

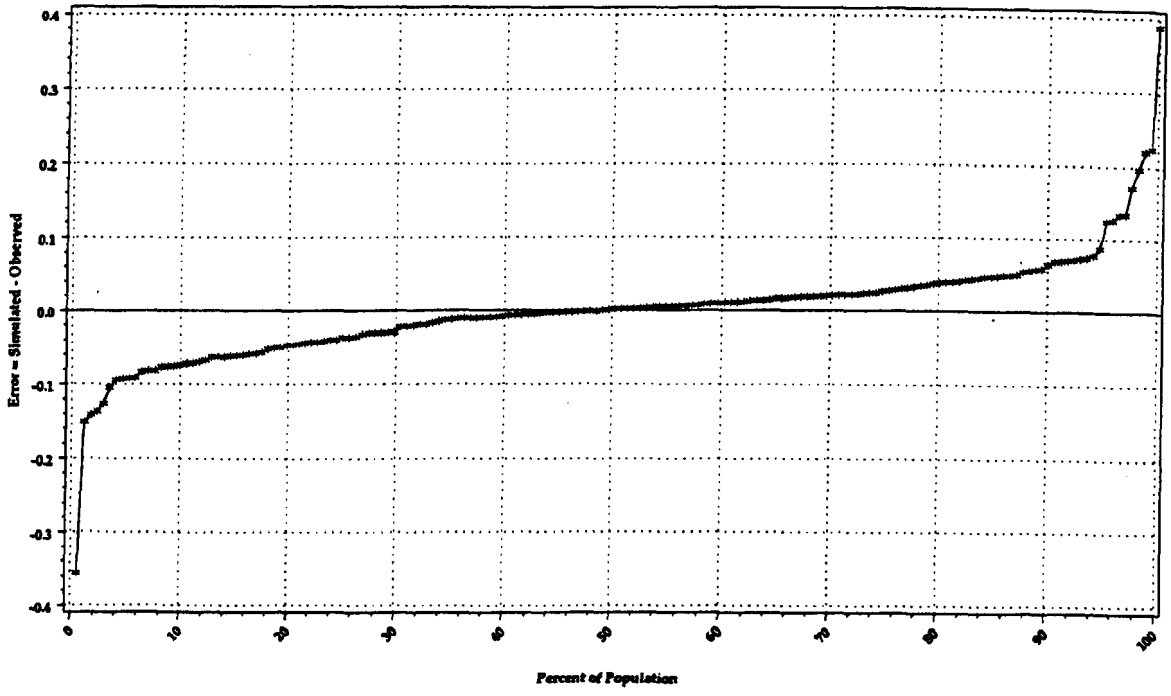
Organic and Particulate Phosphorus



Susquehanna River at Segment 110
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

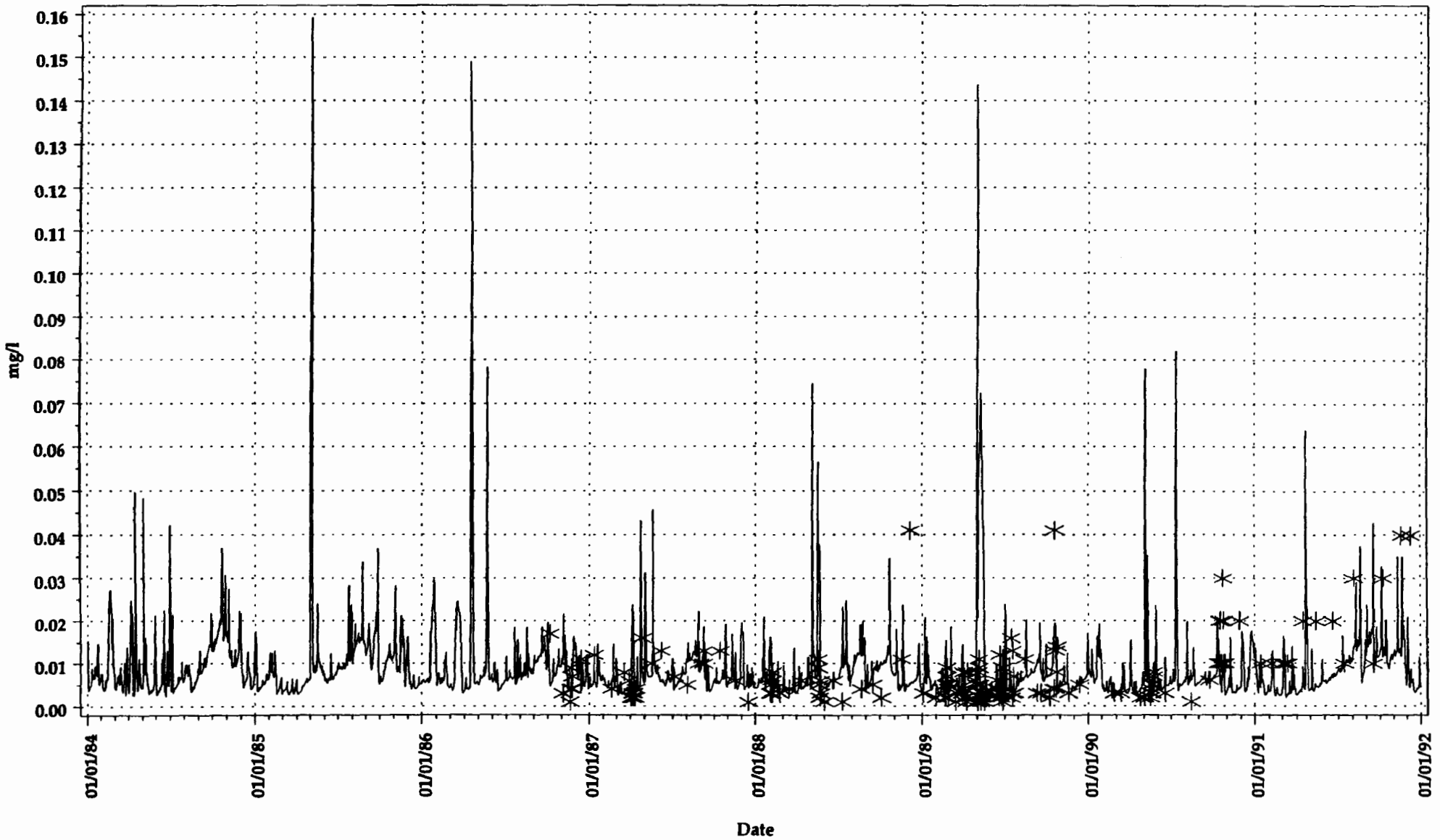


Susquehanna River at Segment 110
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data



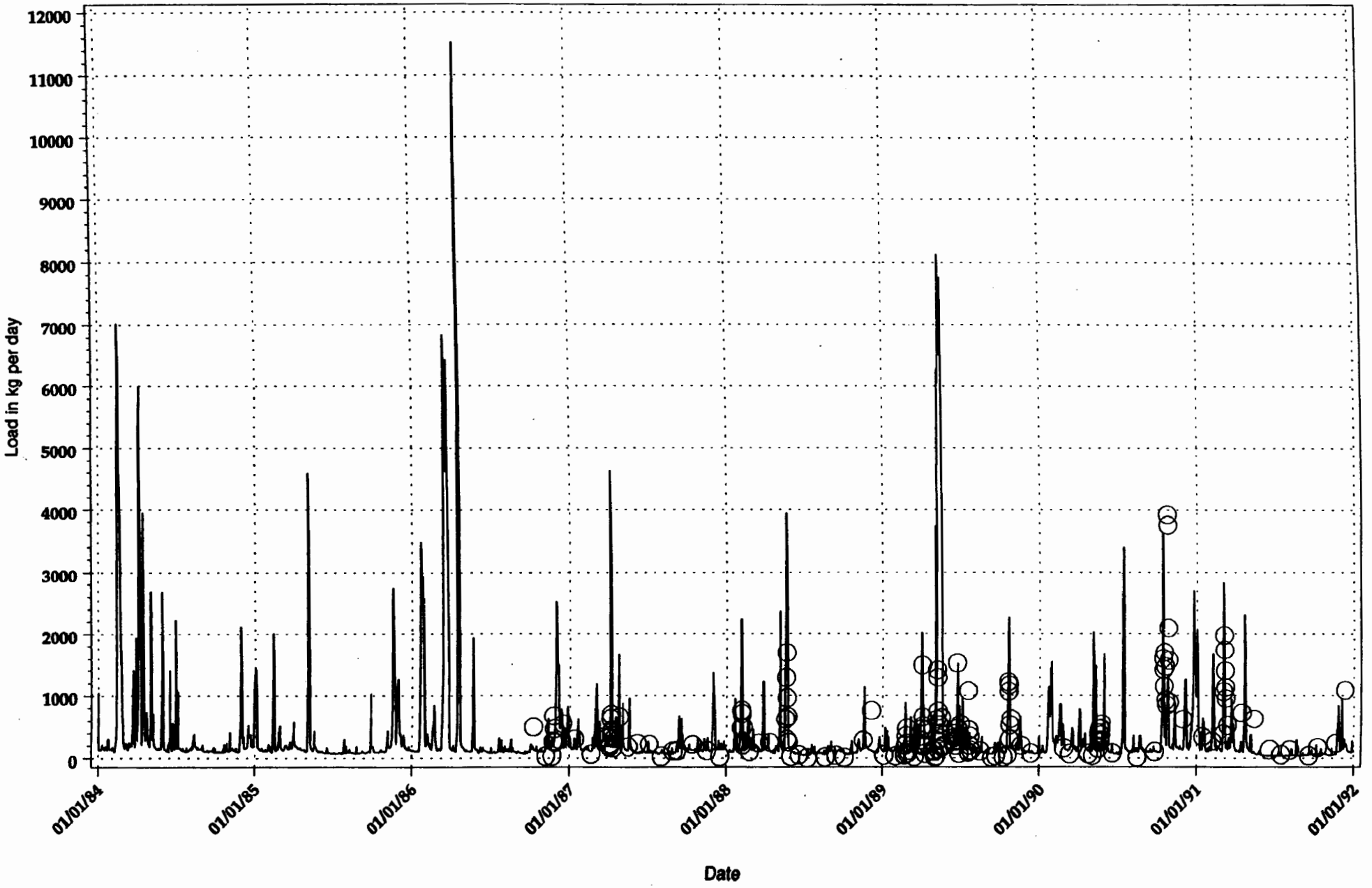
Susquehanna River at Segment 110
Observed and Simulated versus Time
Dissolved Phosphorus

(*=Observed, -=Simulated)



(y21_plotb.sas model3d:[pweng.dl] plotomt - omfirne)
(ossus_d.dv1 13FEB96 13:53)

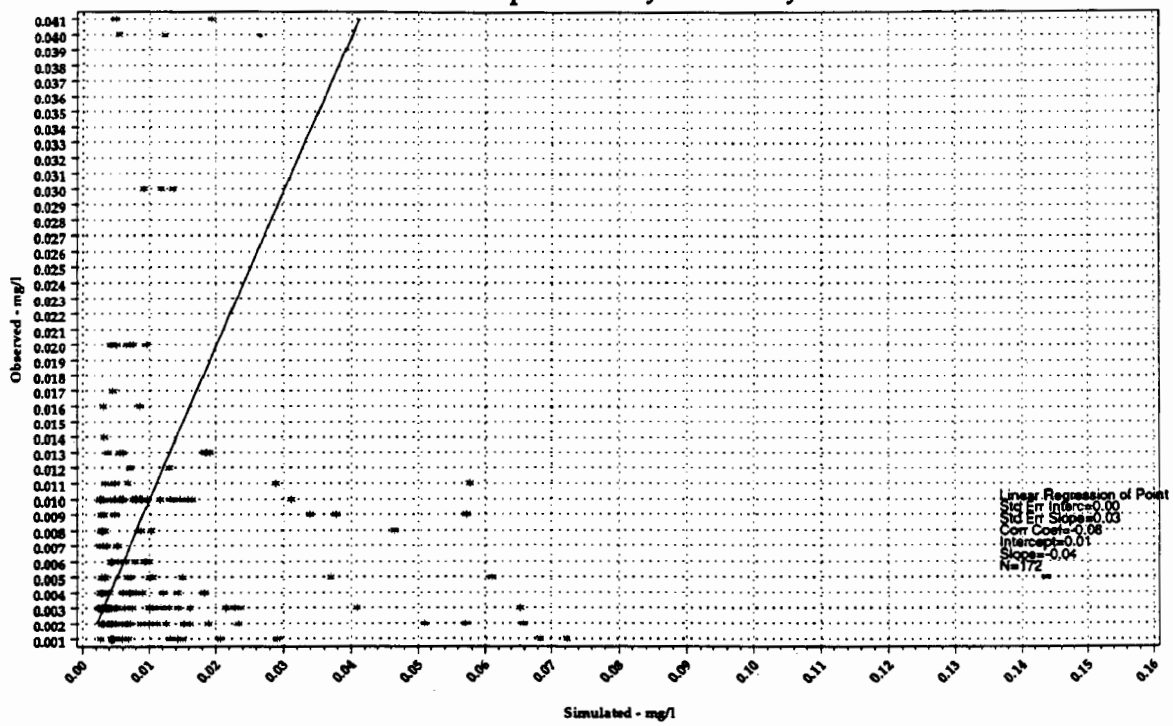
Susquehanna River at Segment 110
Dissolved Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)



Susquehanna River at Segment 110

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

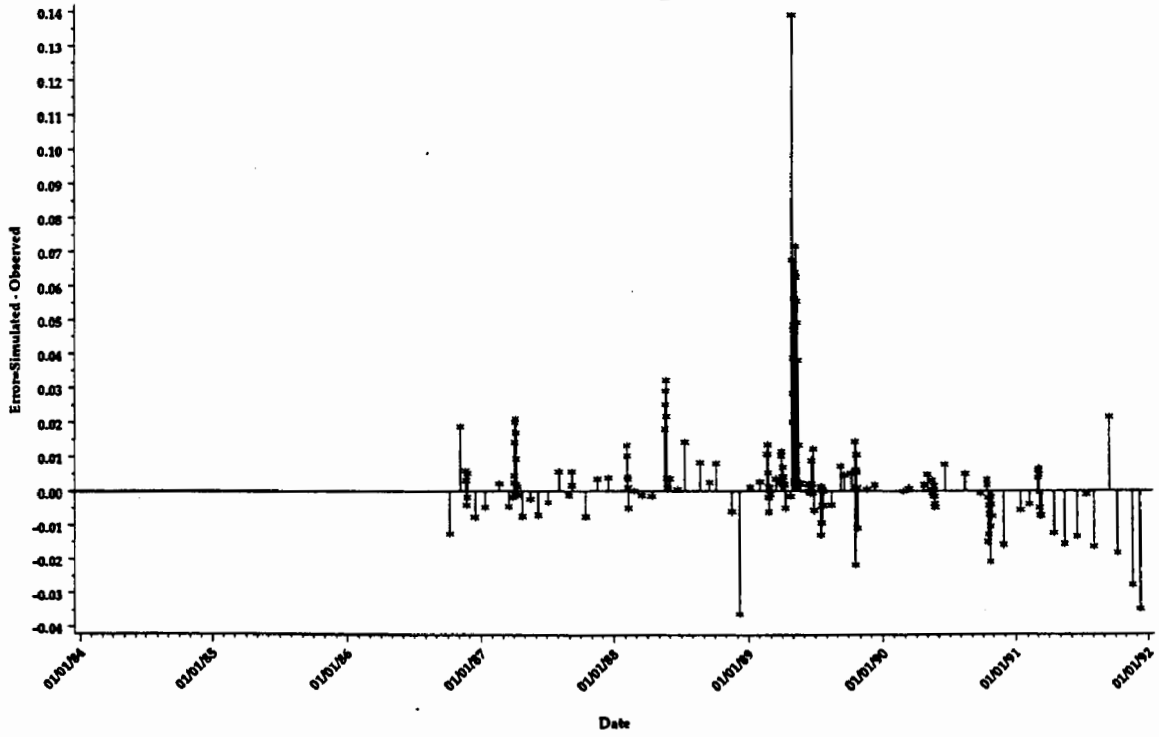
Dissolved Phosphorus: 01JAN84 - 01JAN92



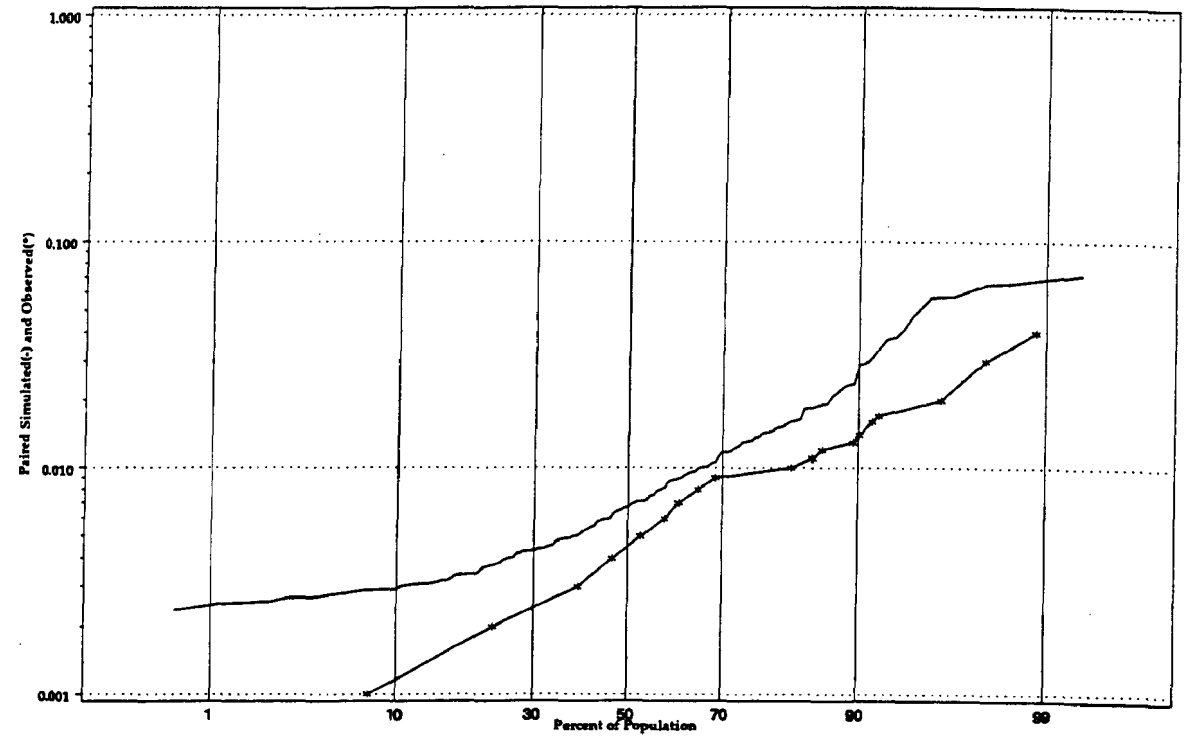
Susquehanna River at Segment 110

Actual Error versus Time

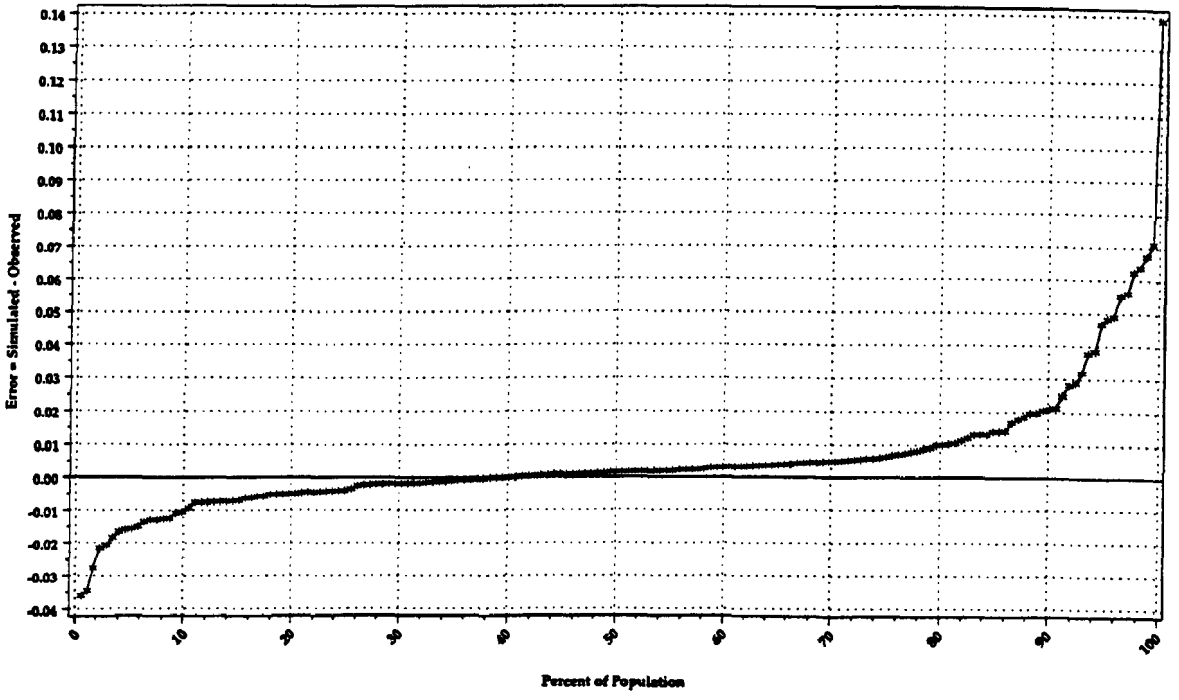
Dissolved Phosphorus



Susquehanna River at Segment 110
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

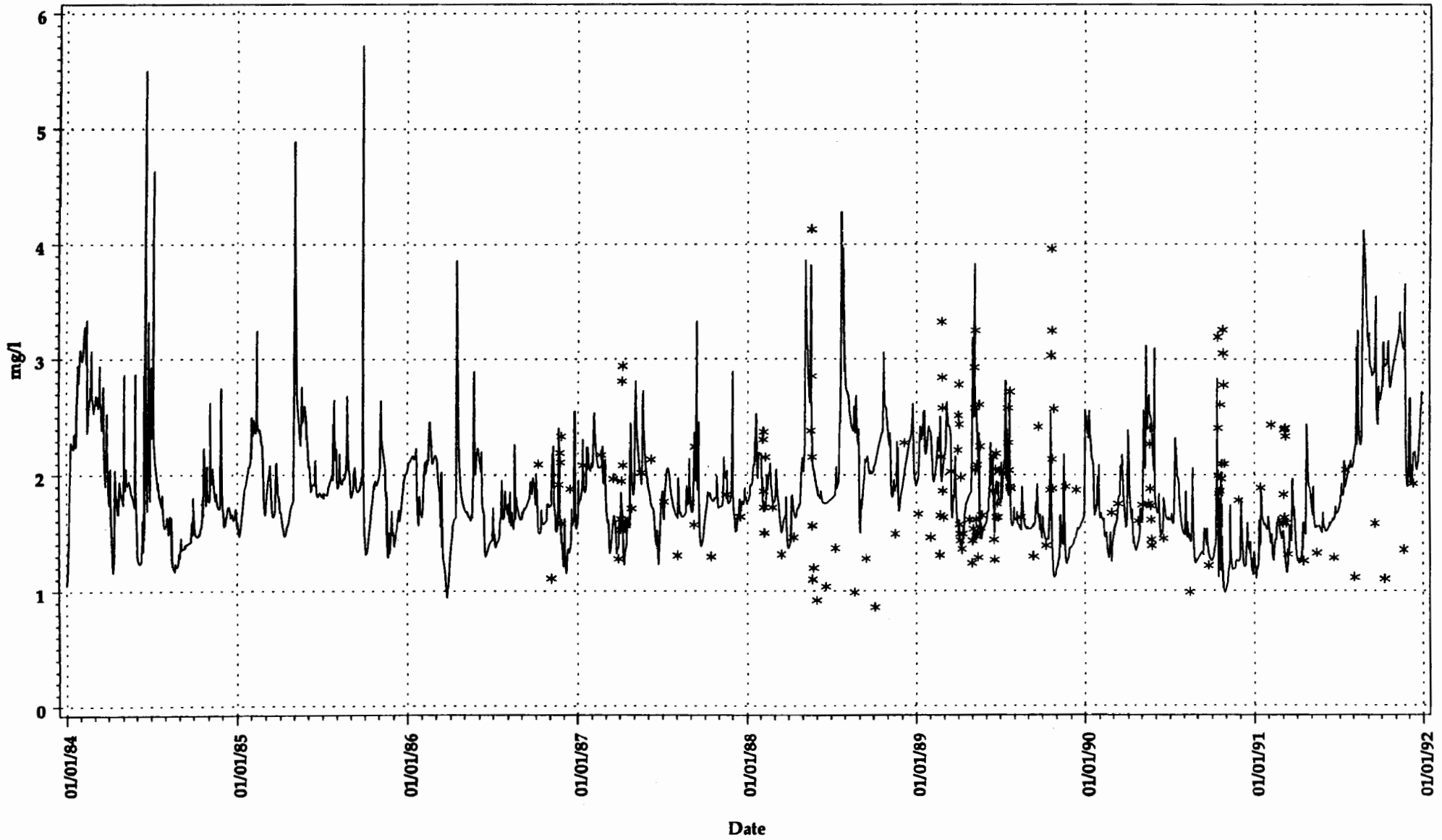


Susquehanna River at Segment 110
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



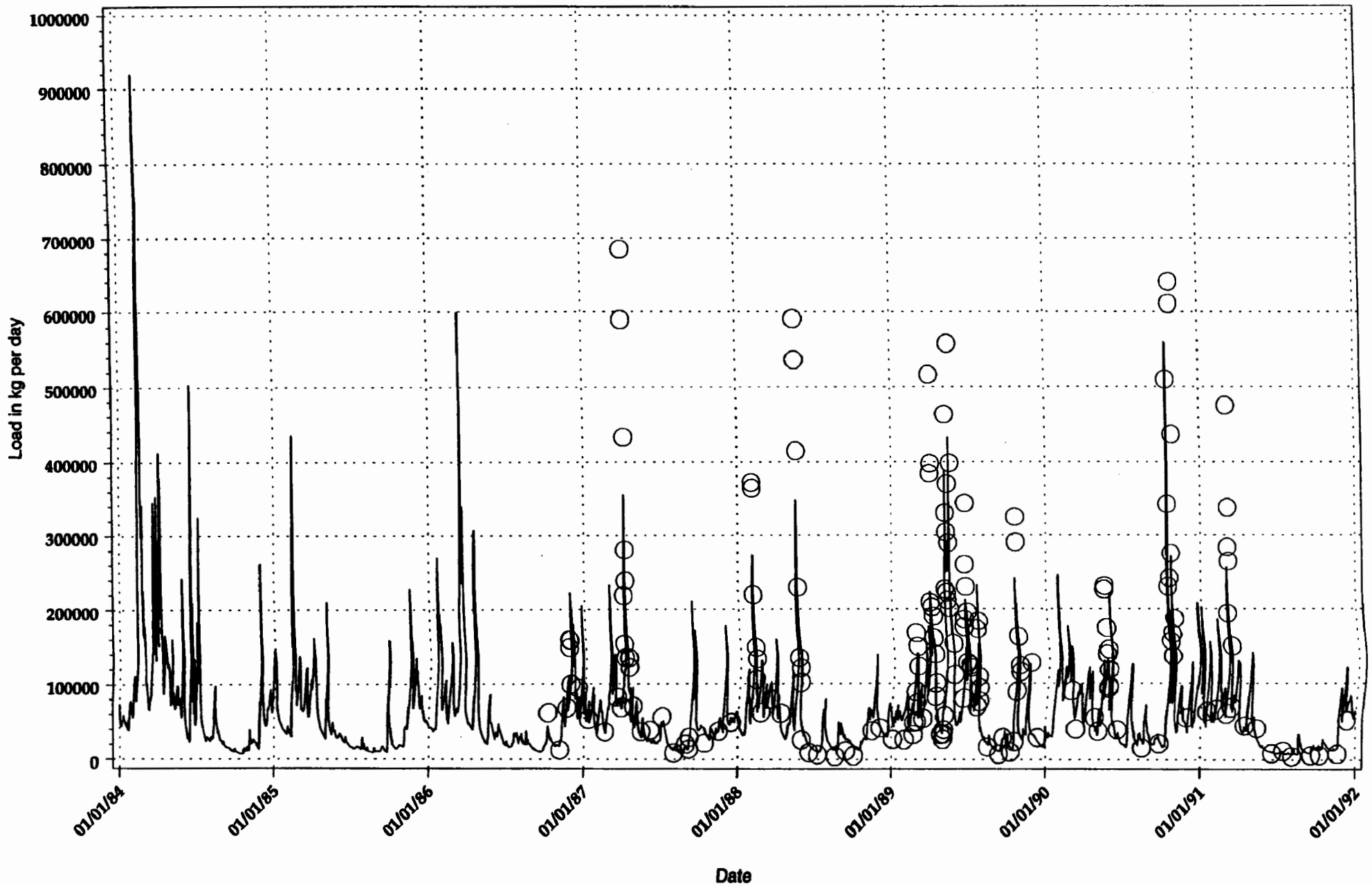
Susquehanna River at Segment 110
Observed and Simulated versus Time
Total Nitrogen

(*=Observed, -=Simulated)



(y21_plotb.sas model3d (pwang.dt) plotomt - omtime)
(susu_d.drv1 13FEB98 11:51)

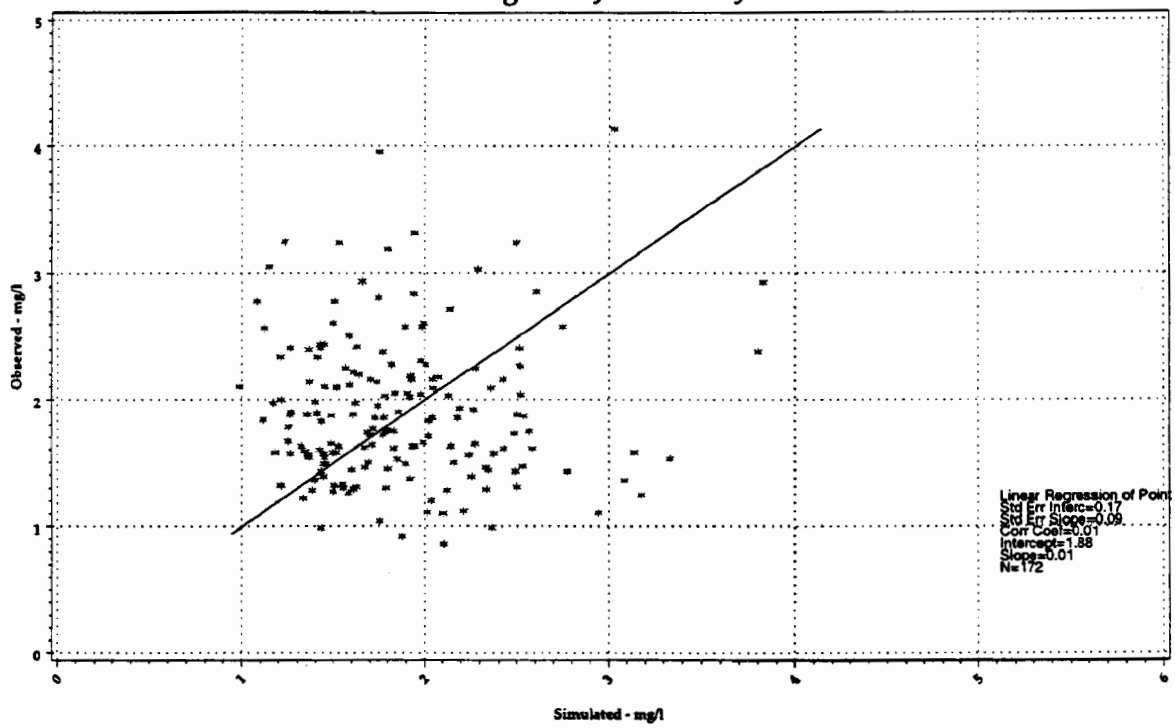
Susquehanna River at Segment 110
Total Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)



Susquehanna River at Segment 110

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

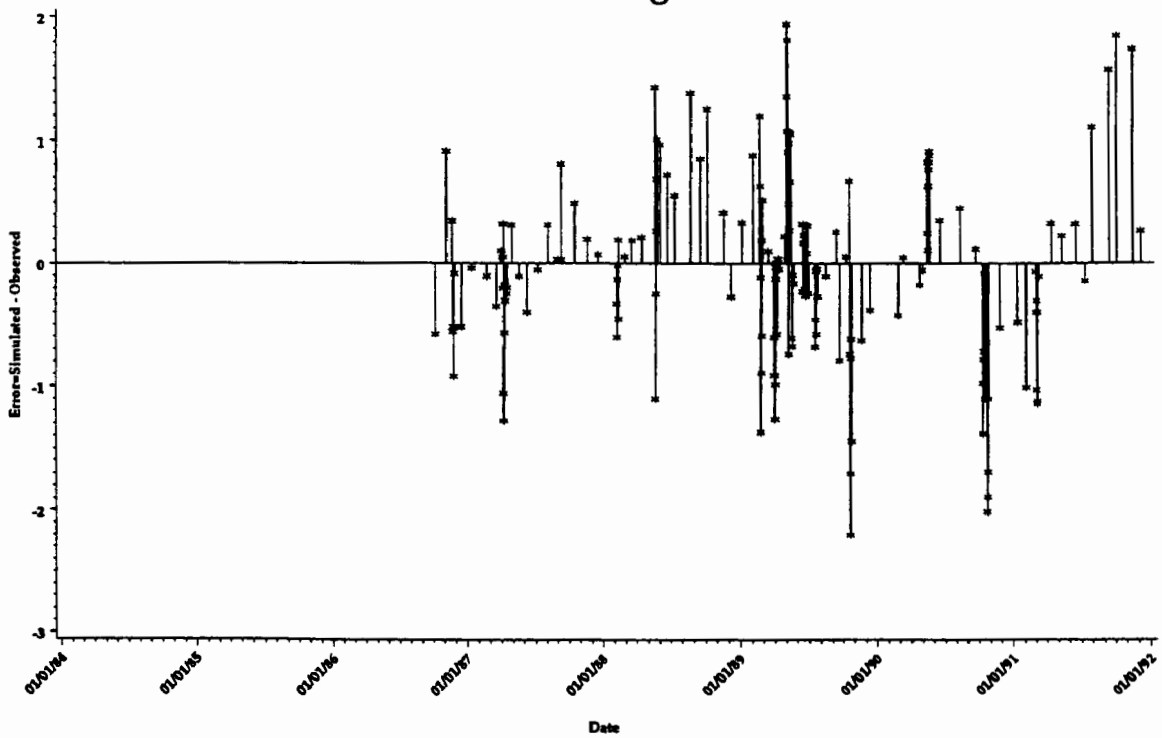
Total Nitrogen: 01JAN84 - 01JAN92



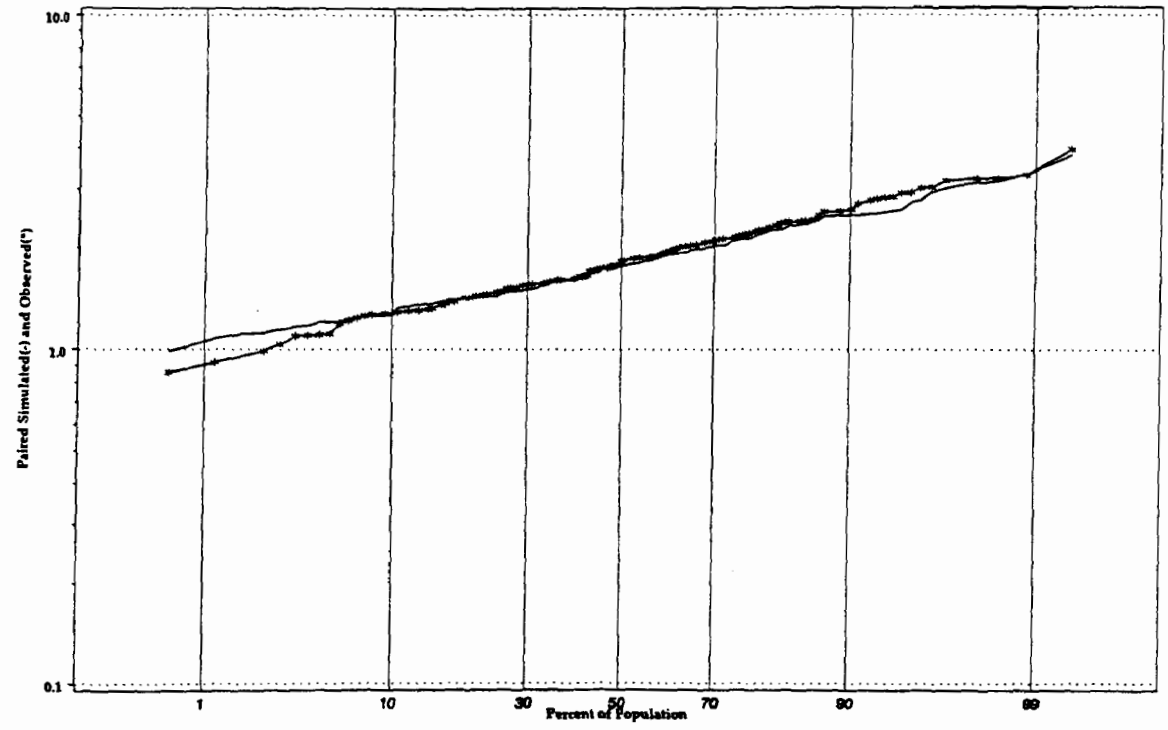
Susquehanna River at Segment 110

Actual Error versus Time

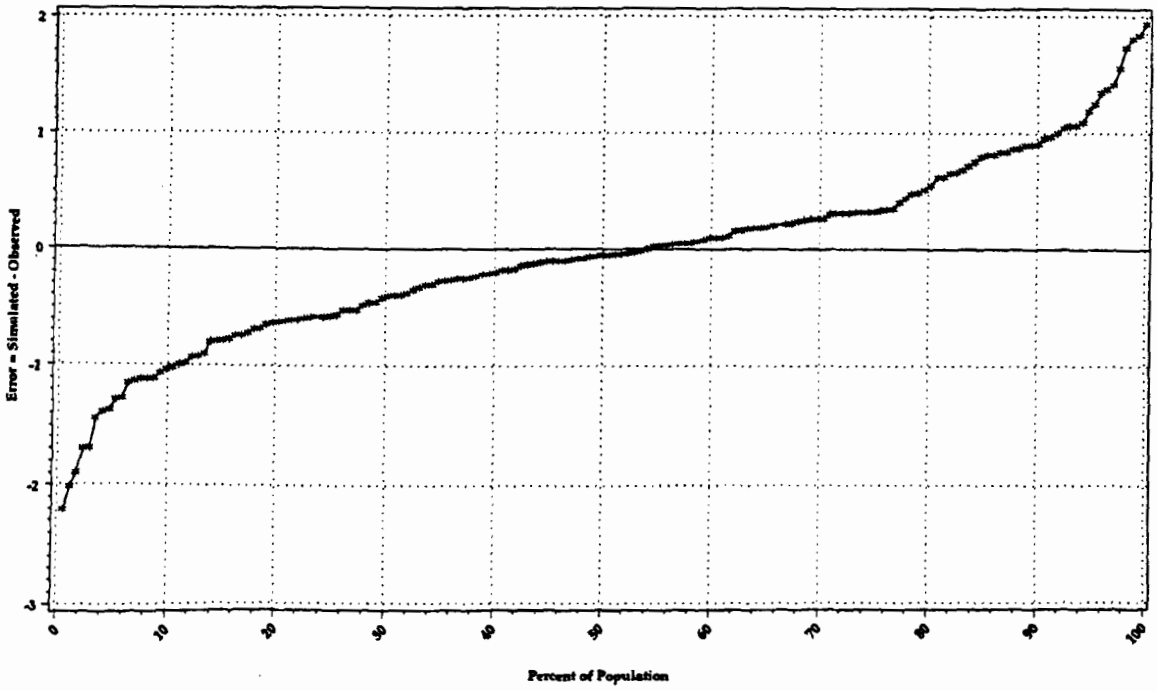
Total Nitrogen



Susquehanna River at Segment 110
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

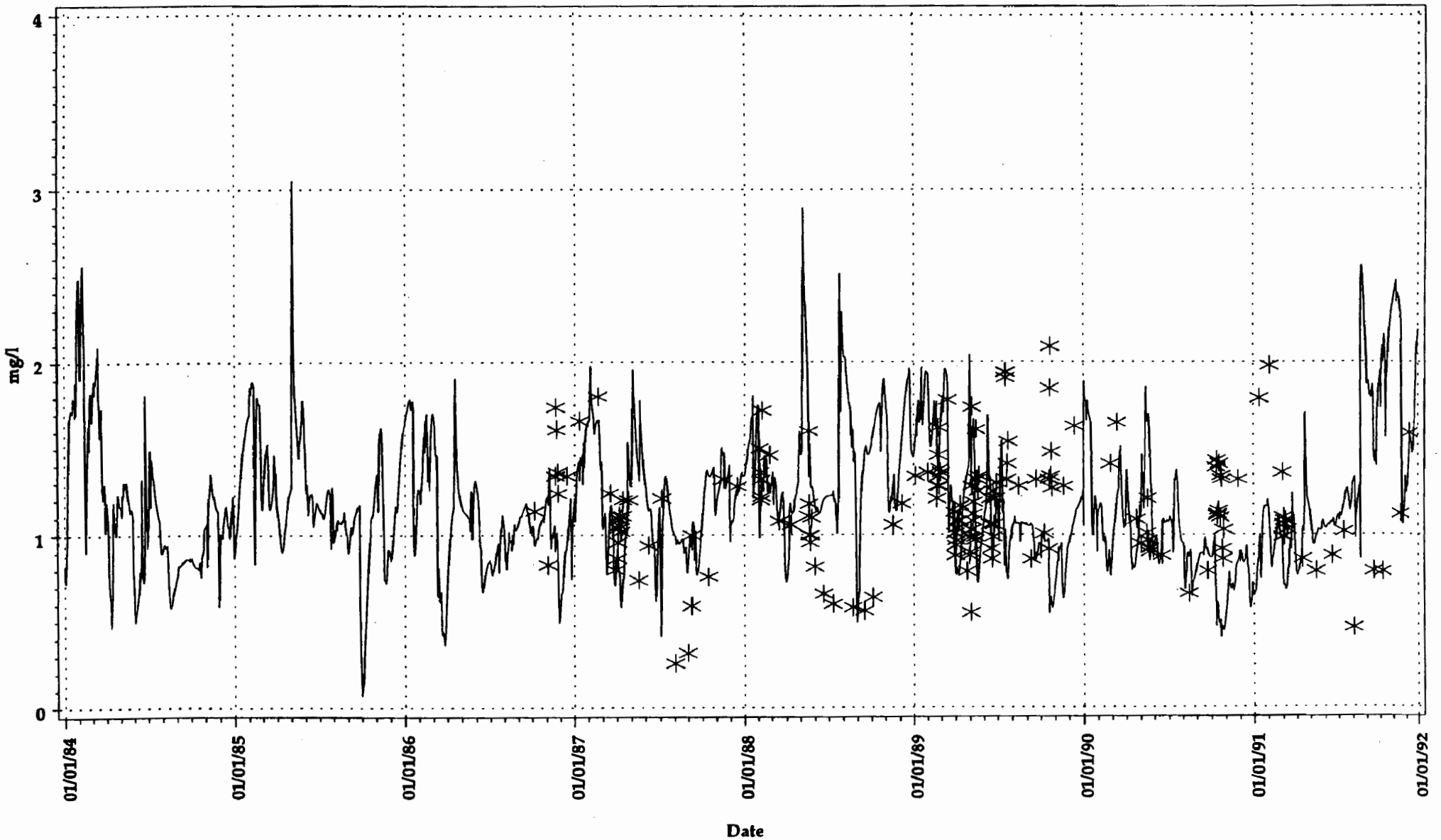


Susquehanna River at Segment 110
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data



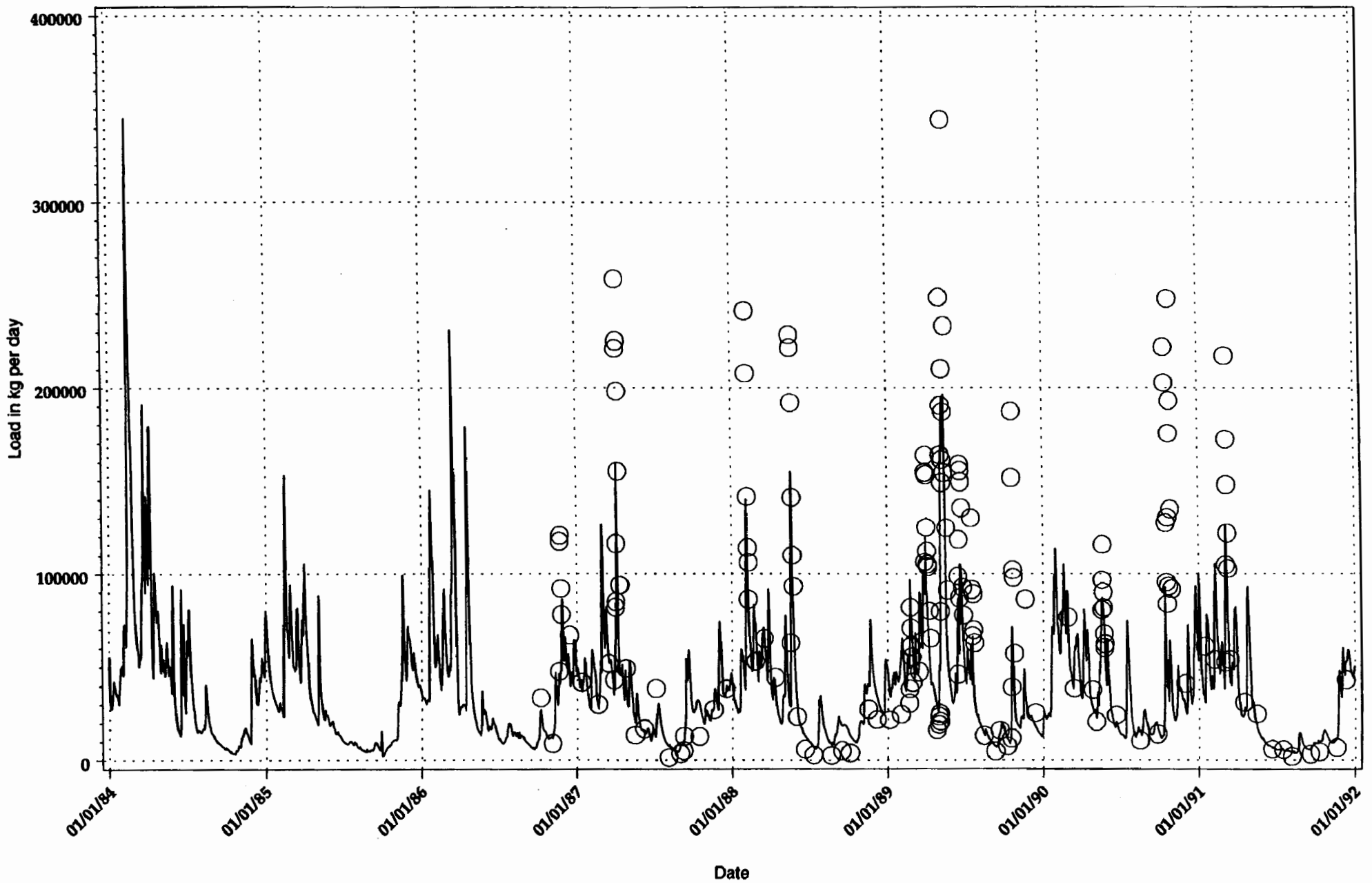
Susquehanna River at Segment 110
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



(y21_plotb.sas model3d [pwang.dl] plotomt - omtime)
(loeus_d.drv1 13FEB96 13:53)

Susquehanna River at Segment 110
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

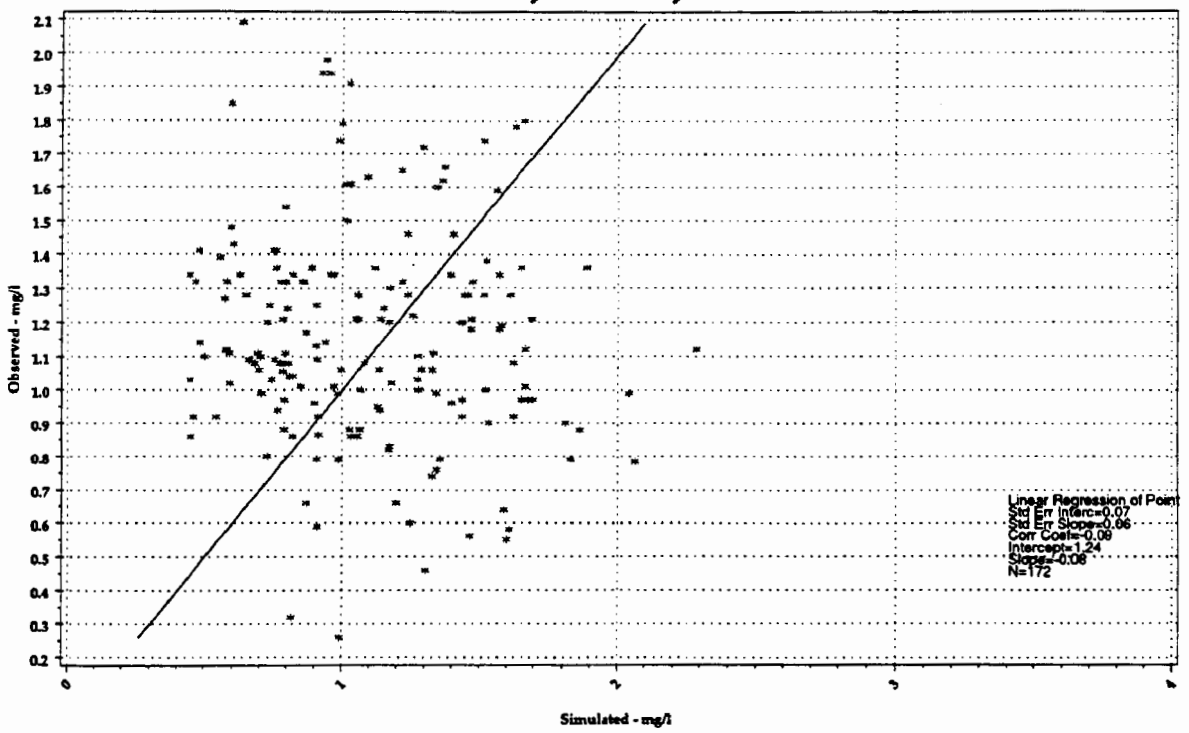


(y21_plotb.sas model3d:[pwang.dl] ldfile)
(loau_d.dnr1 13FEB96 13:53,proc reg,model y=x)

Susquehanna River at Segment 110

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

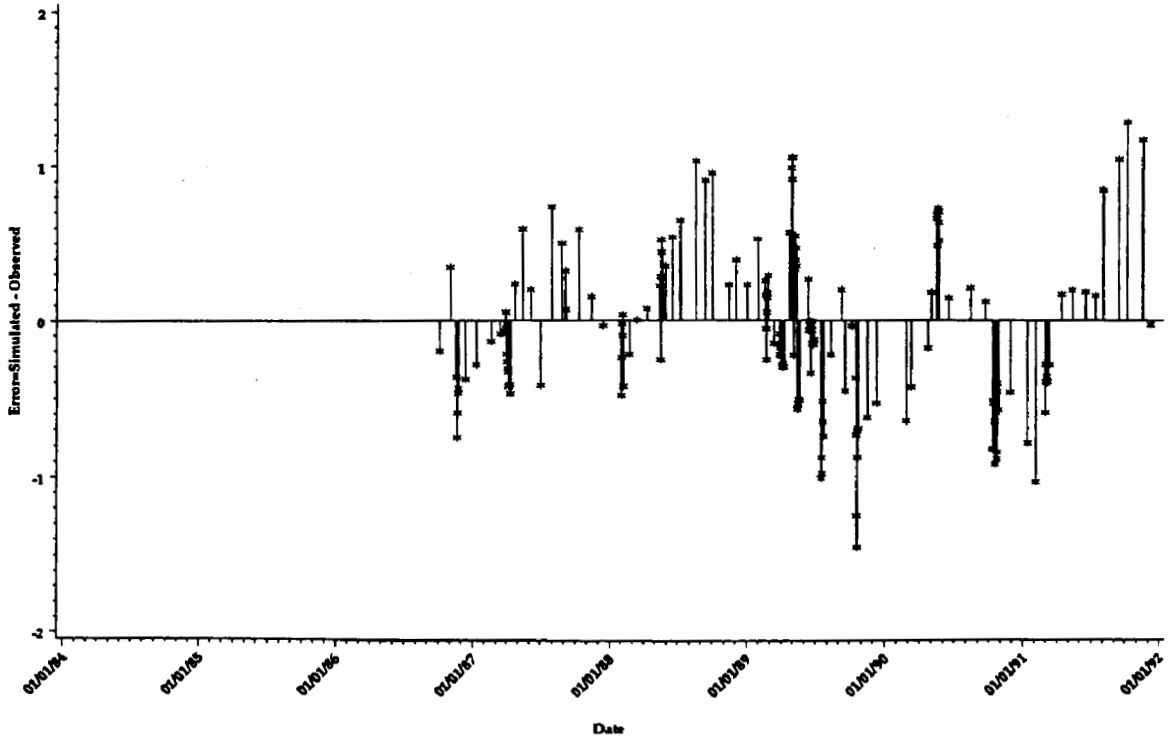
NO3: 01JAN84 - 01JAN92



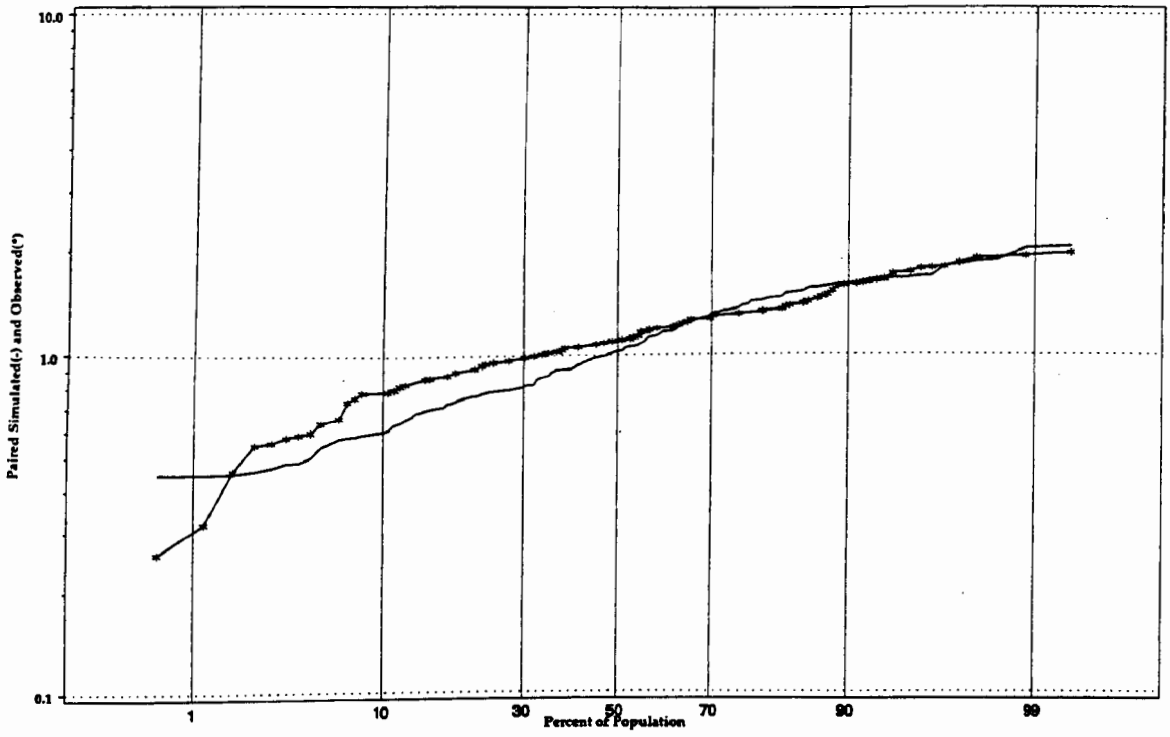
Susquehanna River at Segment 110

Actual Error versus Time

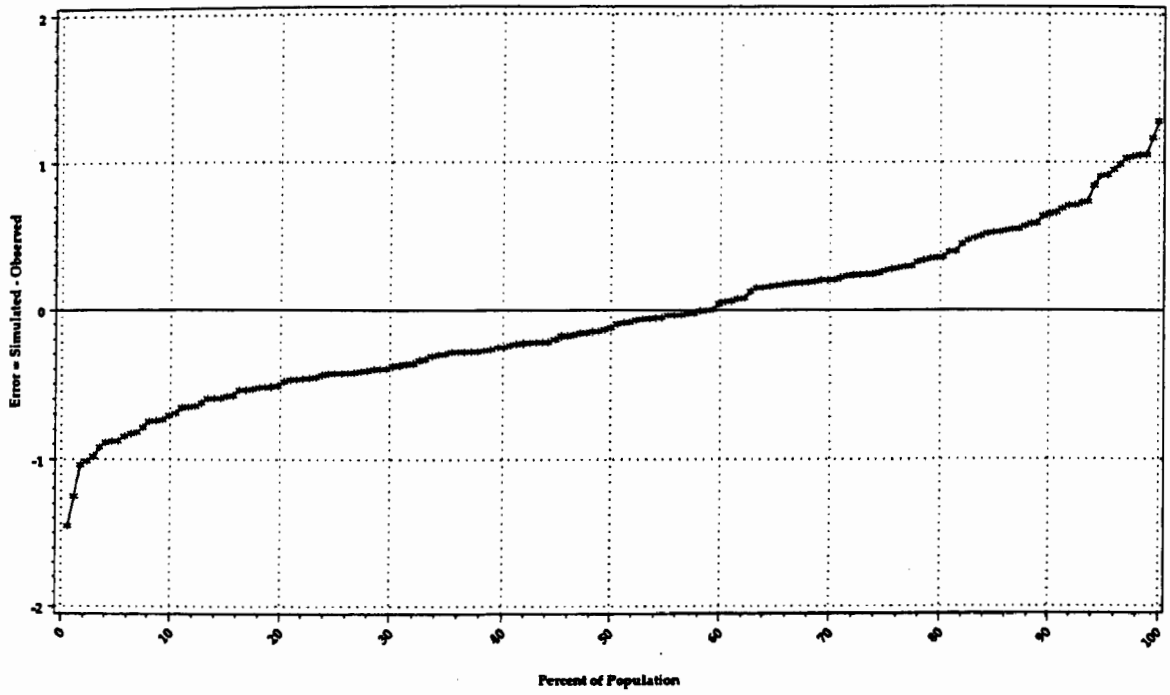
NO3



Susquehanna River at Segment 110
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

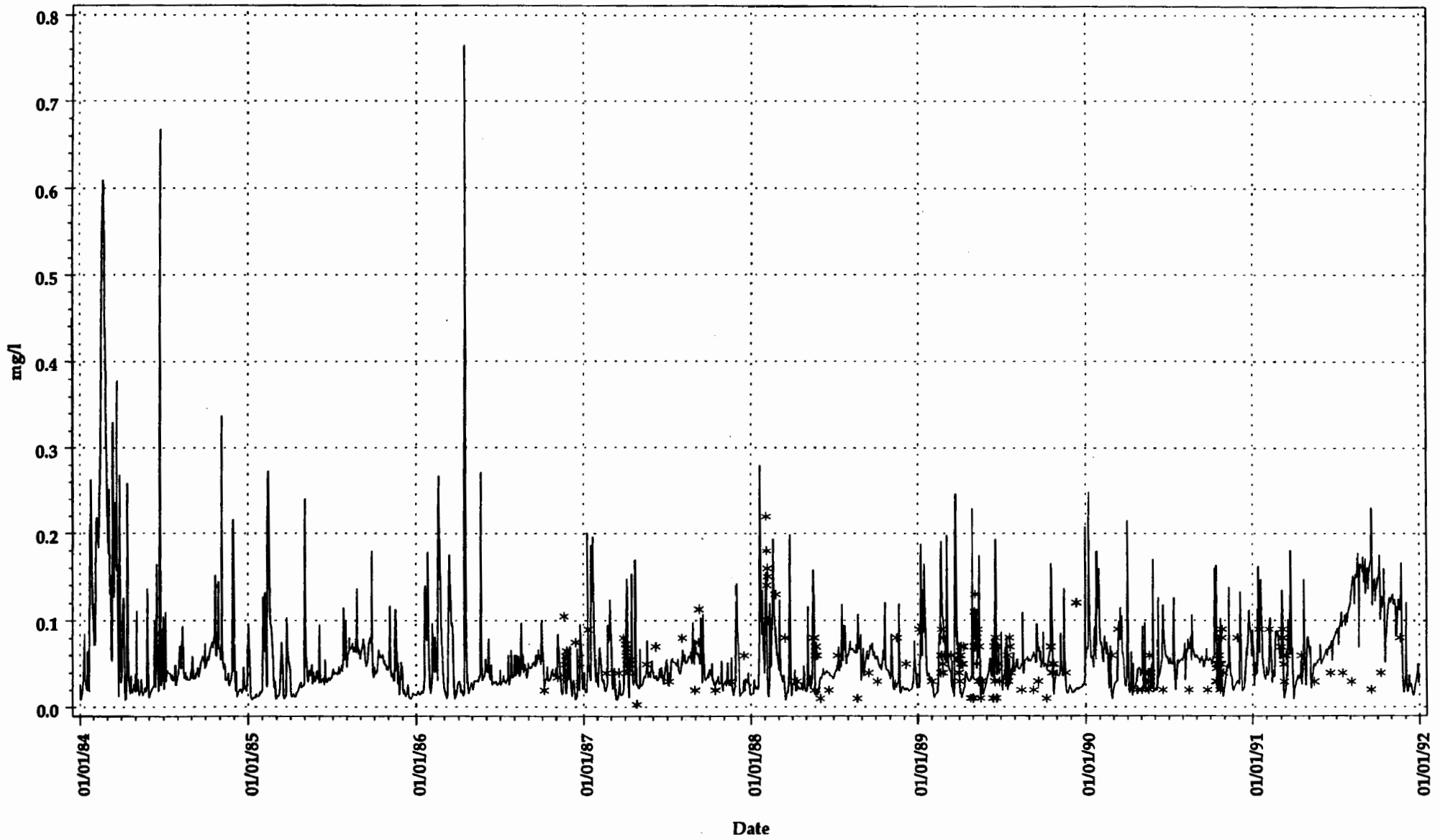


Susquehanna River at Segment 110
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data



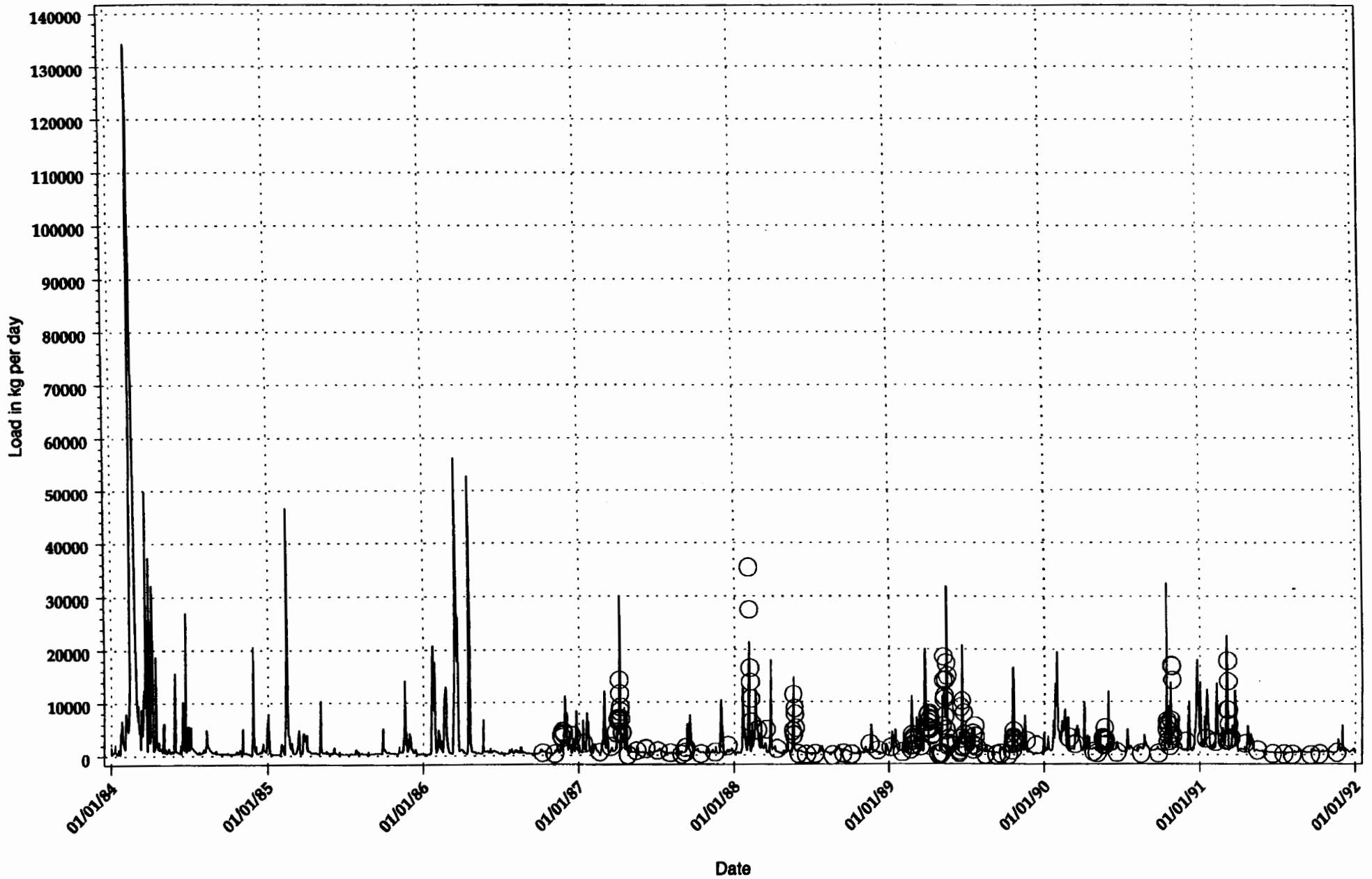
Susquehanna River at Segment 110
Observed and Simulated versus Time
Total Ammonia

(*=Observed, -=Simulated)



(y21_plotp.sas model3d:[pwang.dl] plotomt - omtime)
(loeus_d.drv1 23FEB96 11:49)

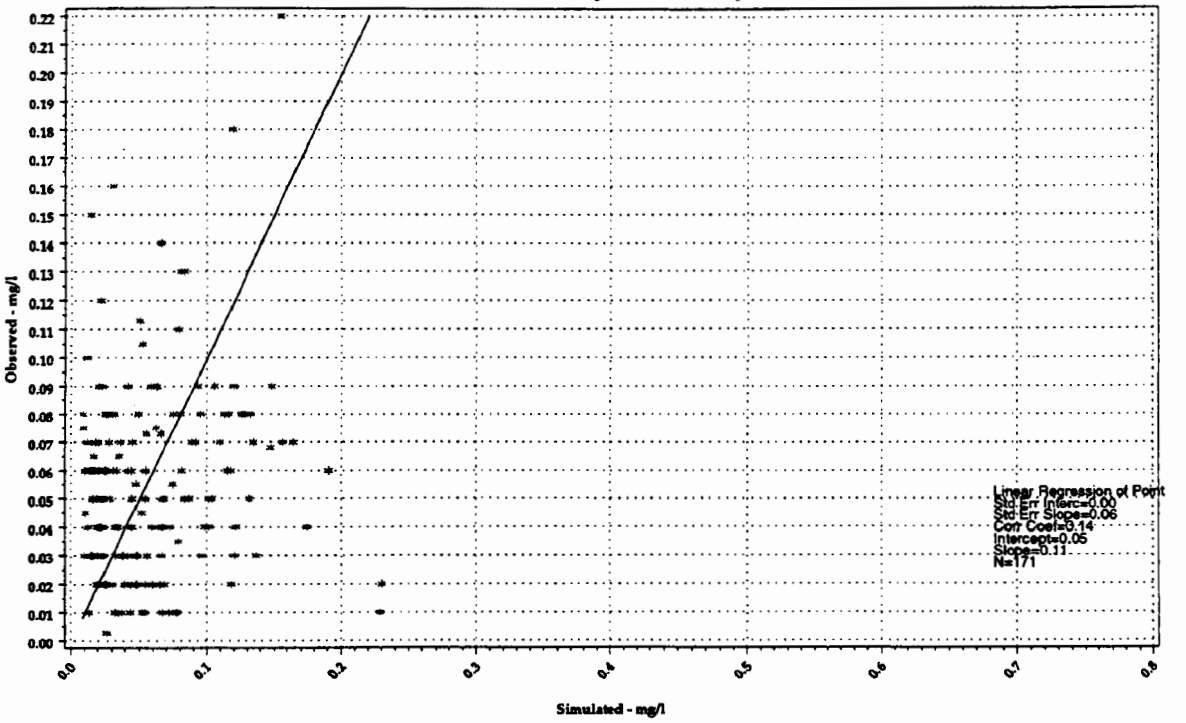
Susquehanna River at Segment 110
Total Ammonia Observed and Simulated Load vs Time
(line = simulated, O = observed)



Susquehanna River at Segment 110

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

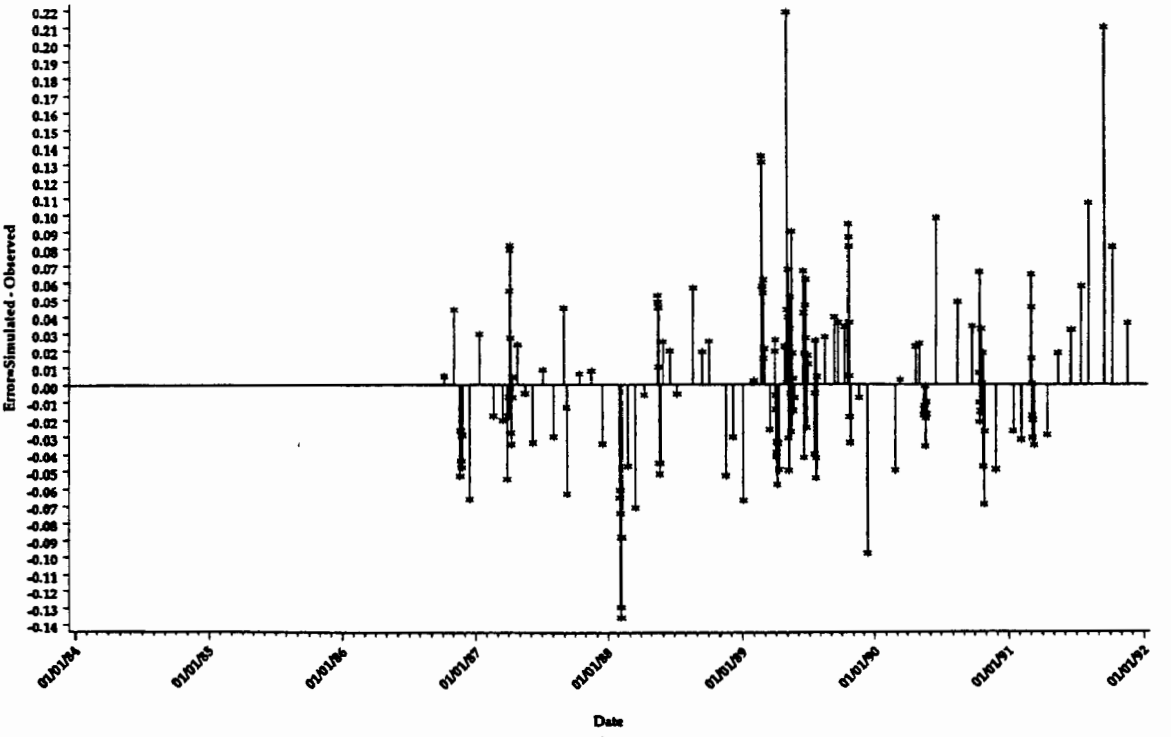
Total Ammonia: 01JAN84 - 01JAN92



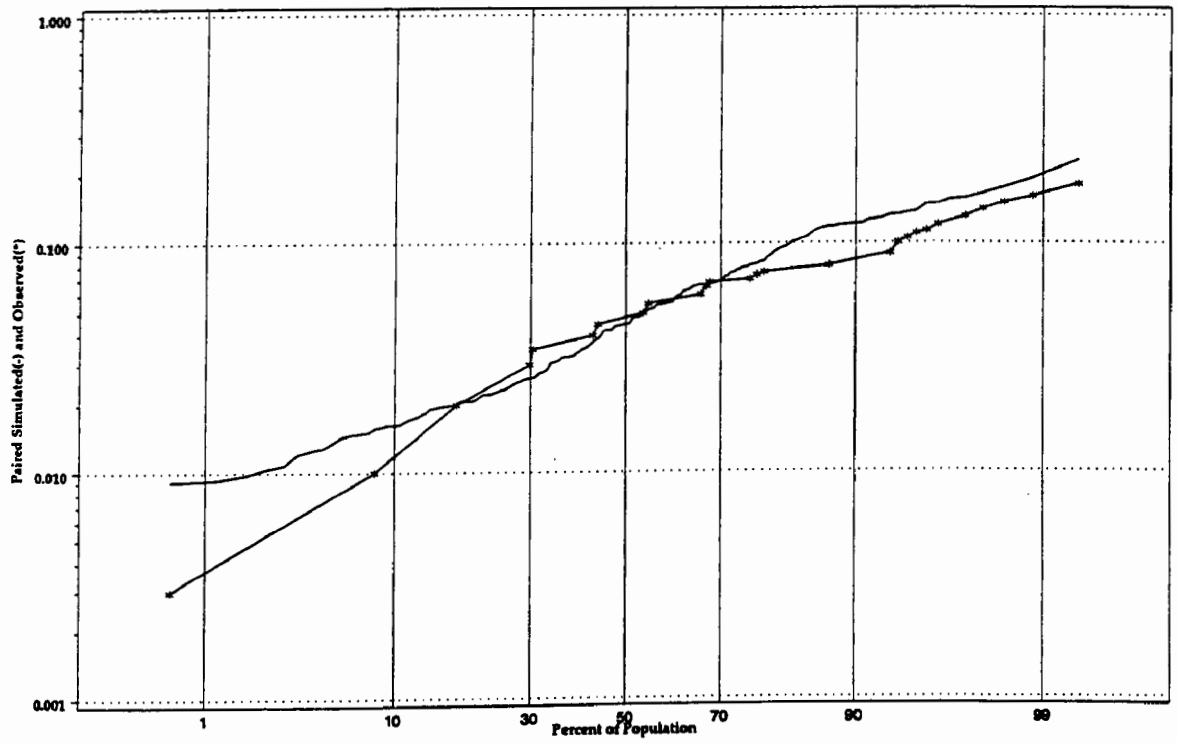
Susquehanna River at Segment 110

Actual Error versus Time

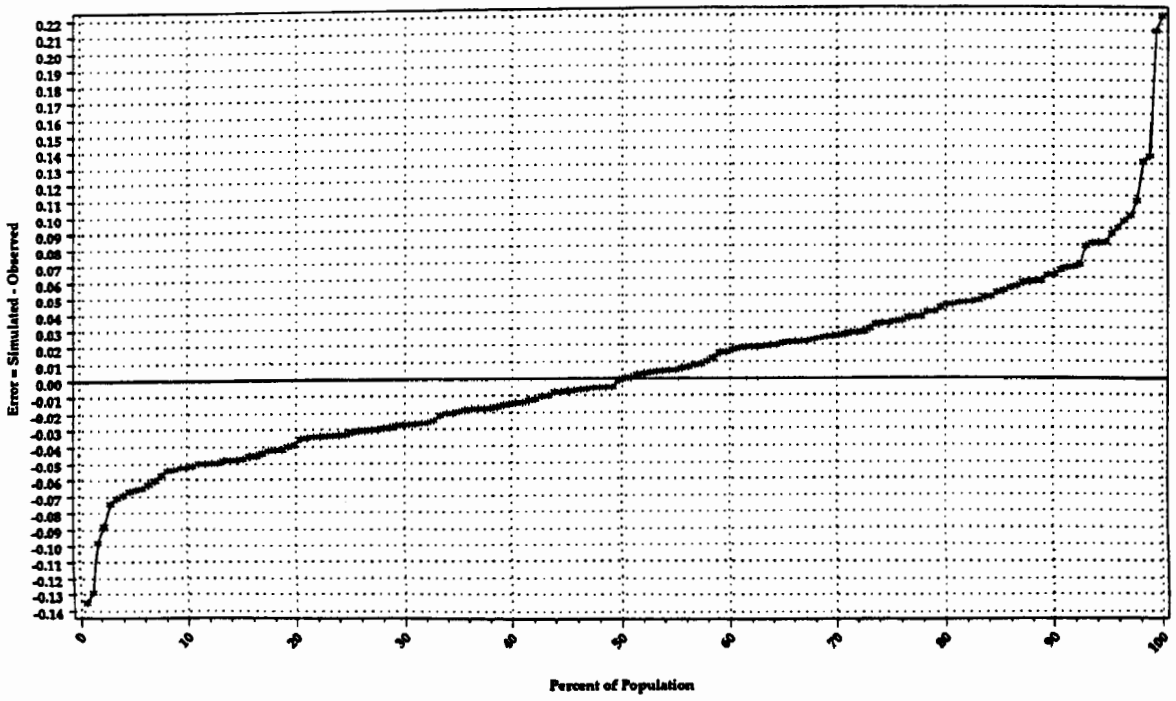
Total Ammonia



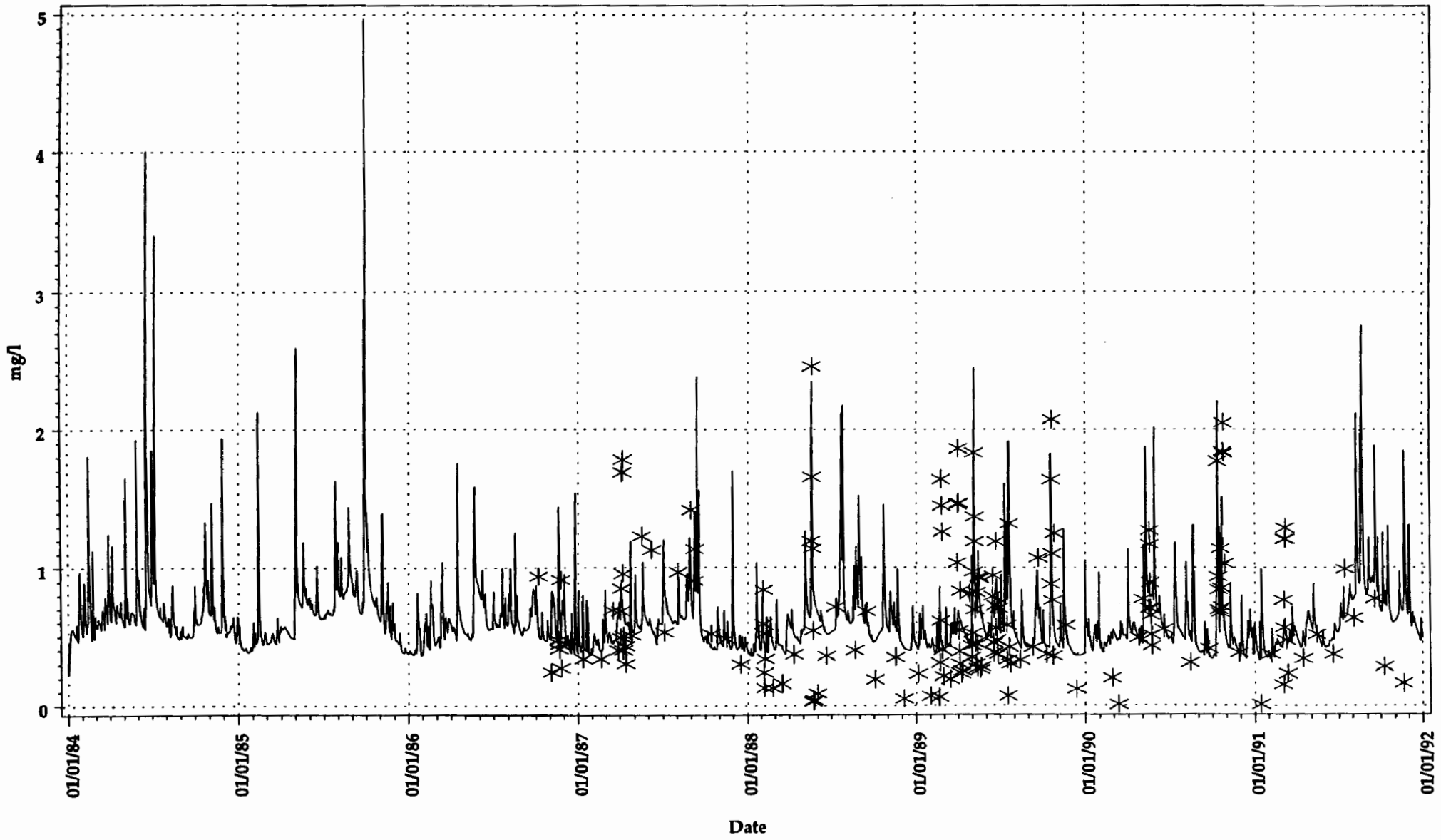
Susquehanna River at Segment 110
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



Susquehanna River at Segment 110
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data

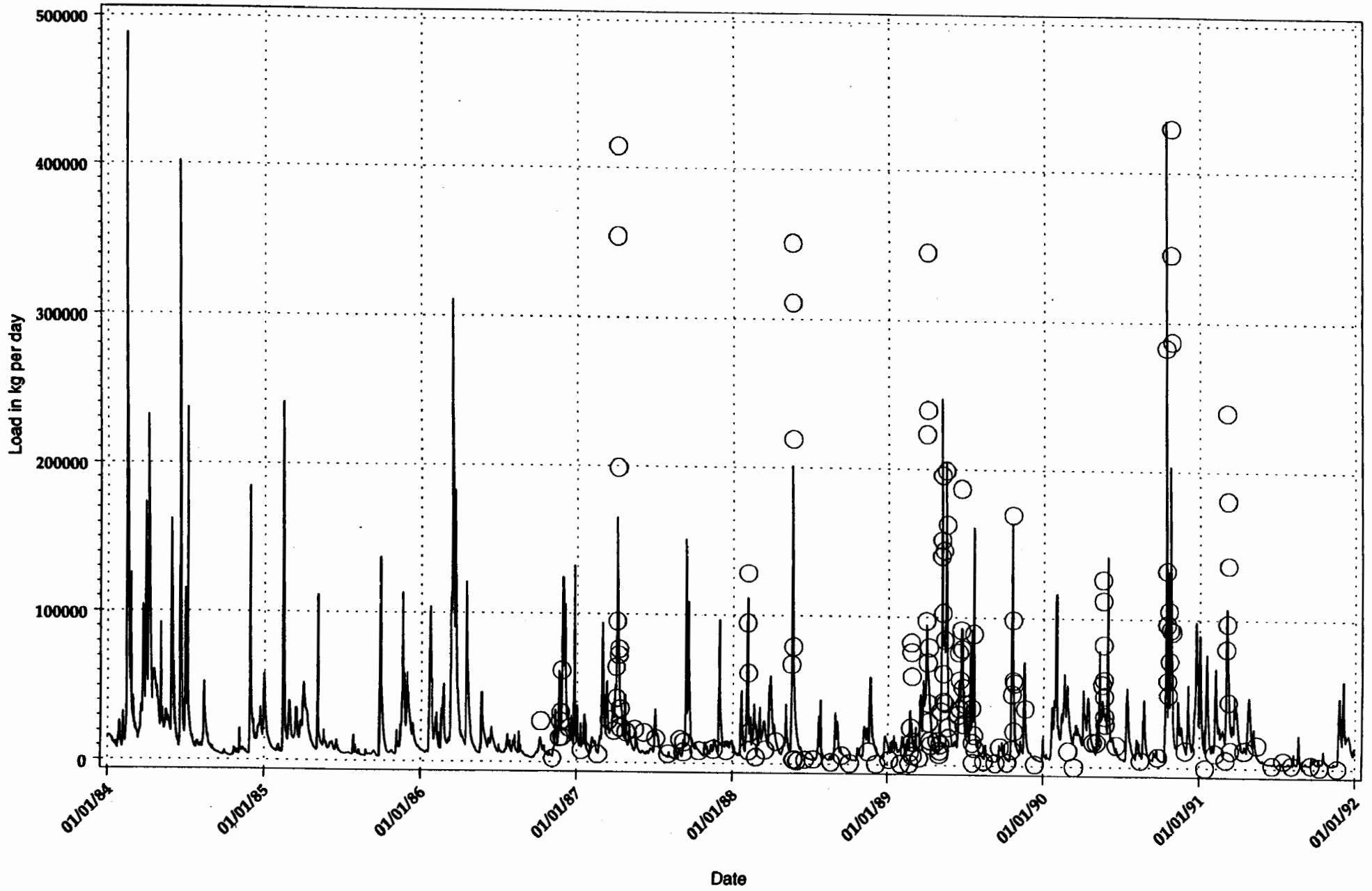


Susquehanna River at Segment 110
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)



(y21_plotp.sas model3d:[pwang.dt] plotomt - omlime)
(losus_d.drv1 23FEB96 11:49)

Susquehanna River at Segment 110
Organic Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)

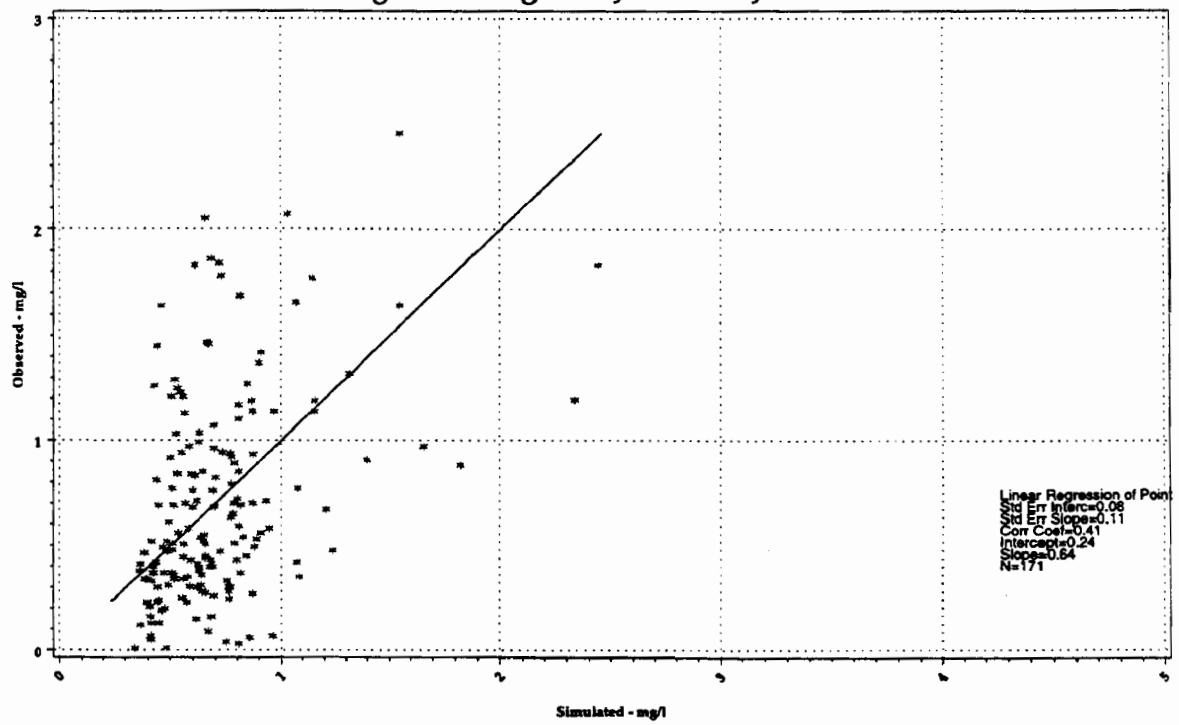


(y21_plotp.sas model3d:[pwang.dl] fdflus)
(bosus_d.drv1 22FEB00 11:49,proc reg,model y=x)

Susquehanna River at Segment 110

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

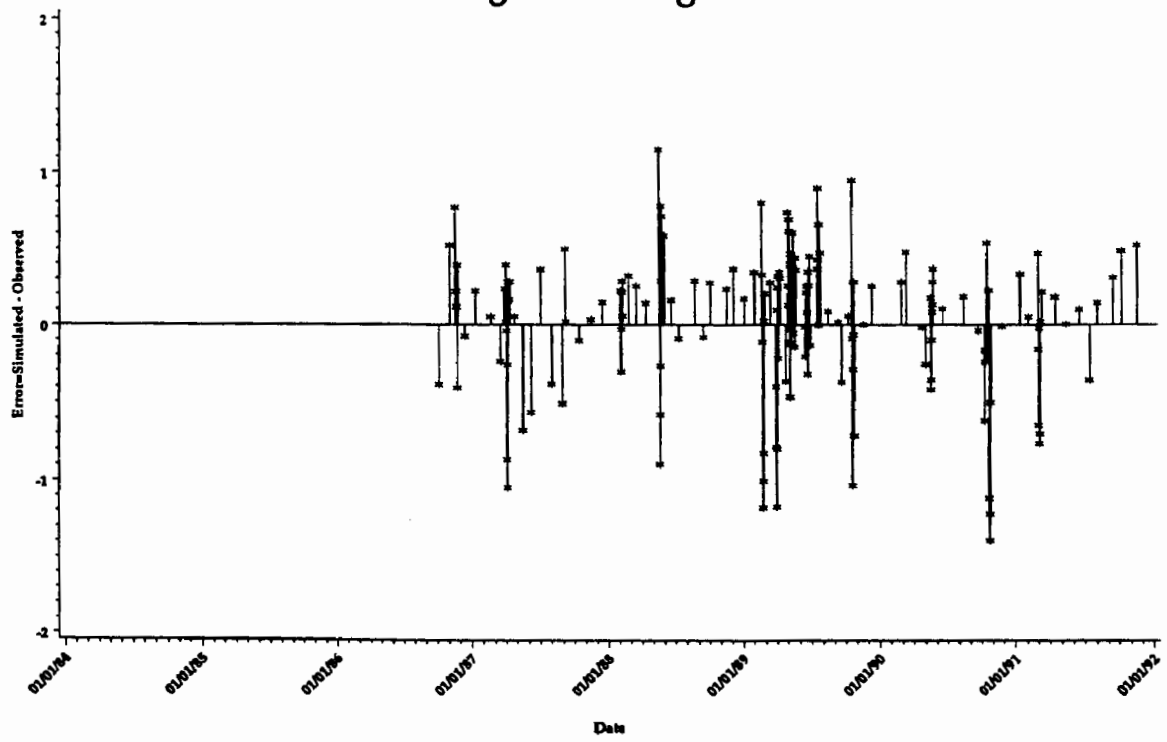
Organic Nitrogen: 01JAN84 - 01JAN92



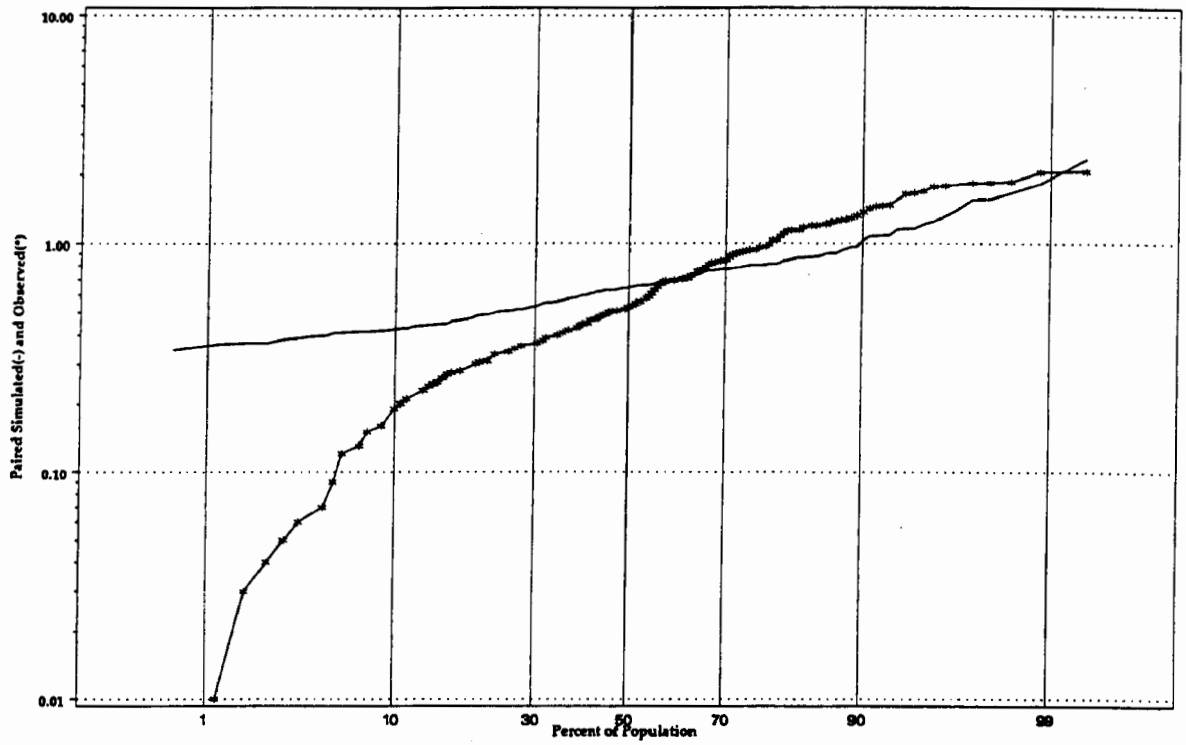
Susquehanna River at Segment 110

Actual Error versus Time

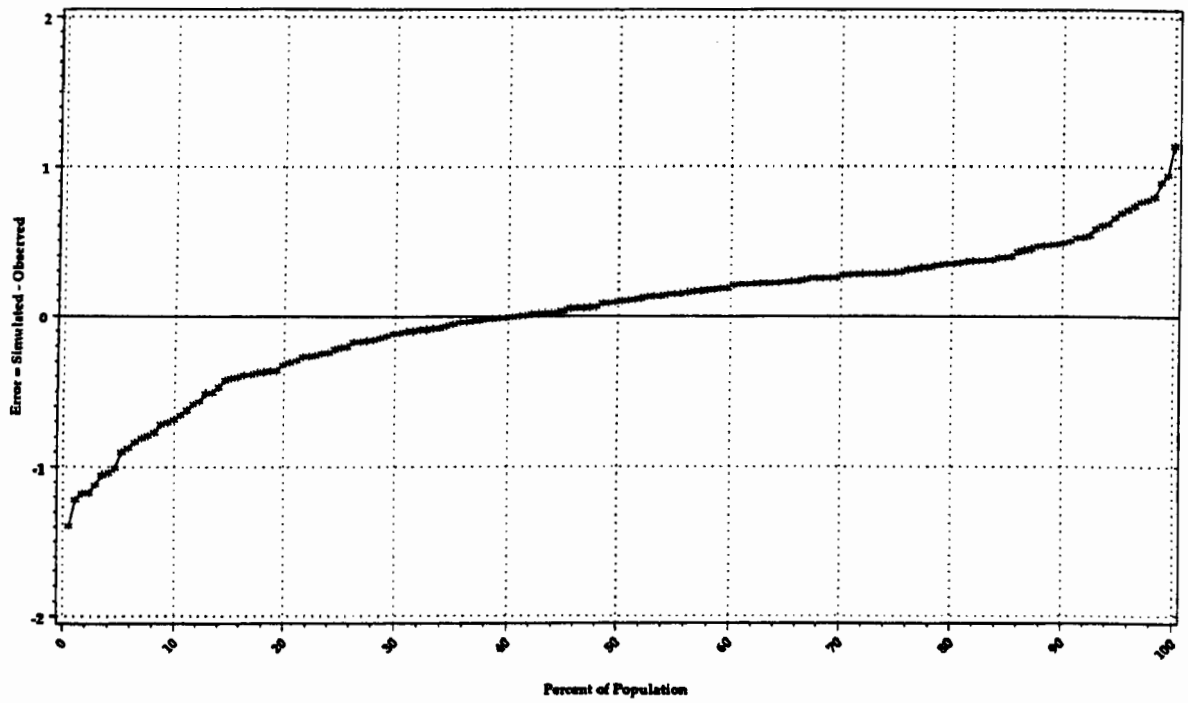
Organic Nitrogen



Susquehanna River at Segment 110
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Susquehanna River at Segment 110
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.1.5 Susquehanna River near Conowingo, MD At Segment 140 (Monitoring Station: 1578310) (Above Fall Line Basin Segments: 120, 140, and 720)

Section Summary:

Water quality at the Conowingo water quality gaging station reflects water quality of the upstream basins of the East Branch Susquehanna, West Branch Susquehanna, Juniata, and the Lower Susquehanna basins as well as local changes in land use, point source loads, and nonpoint source management practices. The Conowingo gage station is the largest basin in the Chesapeake watershed. The Conowingo basin is largely rural, with particularly high agricultural loads from areas in the basin like the Conestoga watershed. Water quality at the Conowingo gage station is influenced by three reservoirs on the Conowingo mainstem, the Holtwood, Safe Harbor, and Conowingo reservoirs.

The Conowingo basin above the gaged site covers an area of 27,155 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 47% forest land, 23% cropland, 22% other agricultural areas, 8% urban areas, and 2% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 134 million pounds in 1985 to 130 million pounds in 1996. Total phosphorus loads over the same time period decreased from 5.5 million pounds to 4.5 million pounds. In general, point source loads above the gage site are low. In 1996, the total nitrogen point source load was 11% of the total load and the total phosphorus point source load was 20% of the total load. Estimated septic system total nitrogen loads increased 13%, from 3.8 million pounds in 1985 to 4.3 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 9%, and other agricultural loads (primarily pasture and manure loads) by 11%. Total phosphorus decreased for these land uses by 5% and 23% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 9% for total nitrogen and 10% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

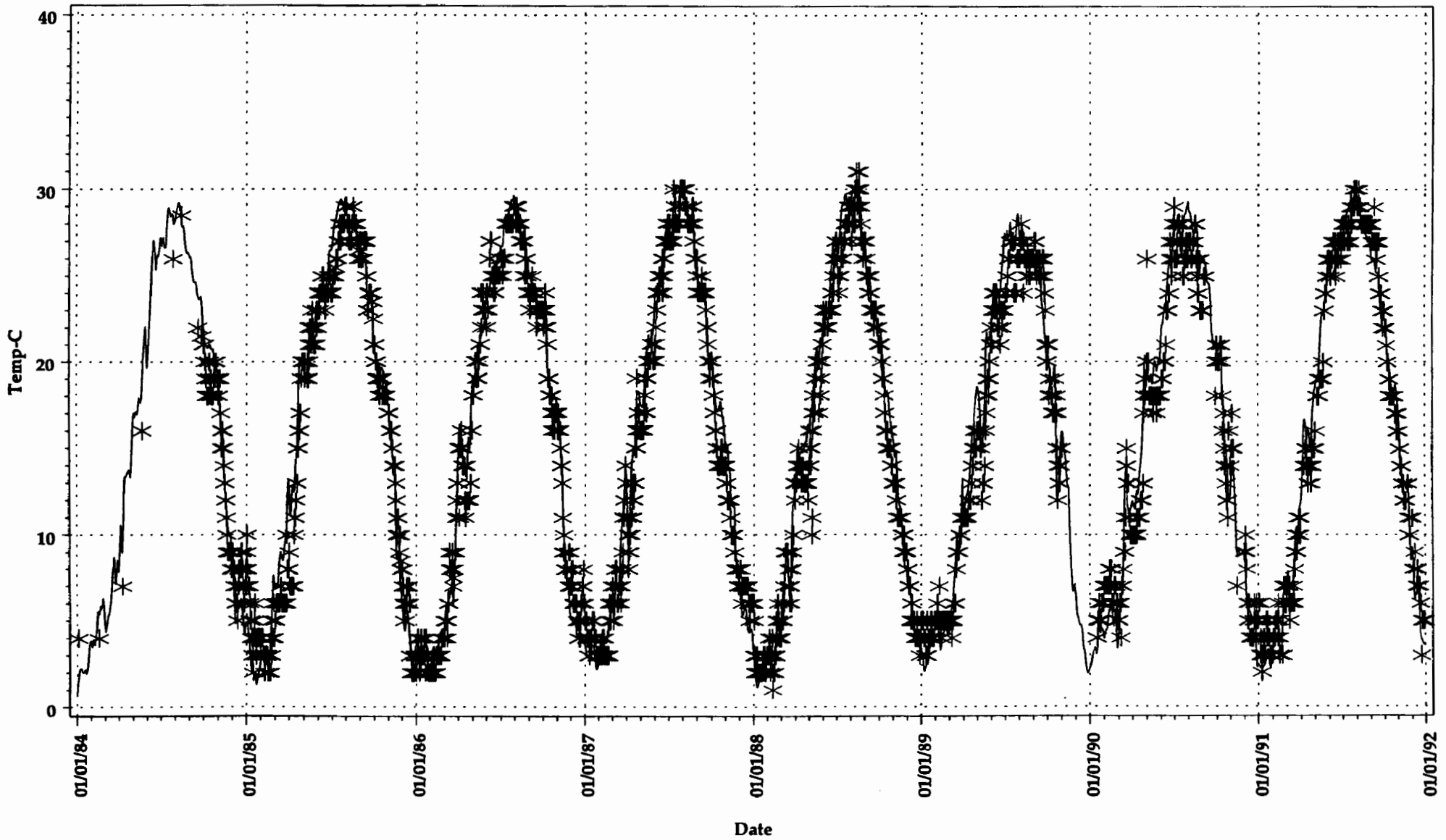
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

Susquehanna River at Segment 140
Observed and Simulated versus Time
Temperature-C

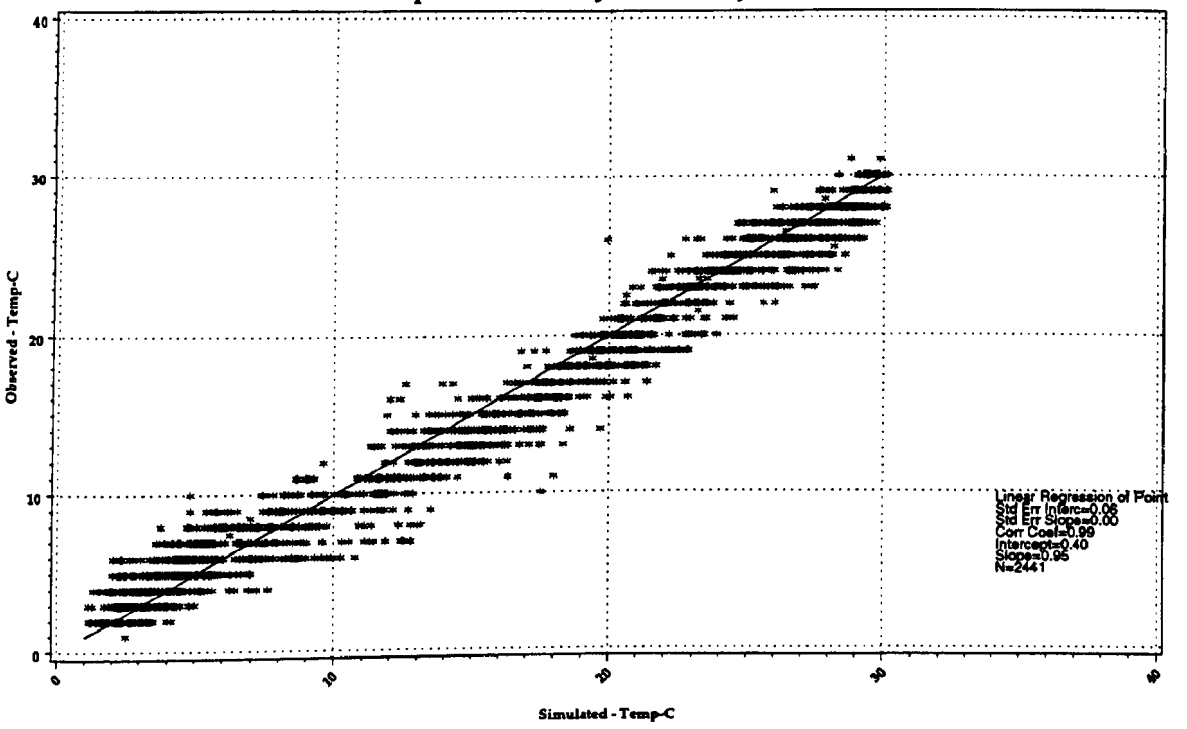
(*=Observed, -=Simulated)



(y21_plotb.sas model3d:[pwang.dt] plotomt - omsime)
(sonow.drv 24FEB96 13:47)

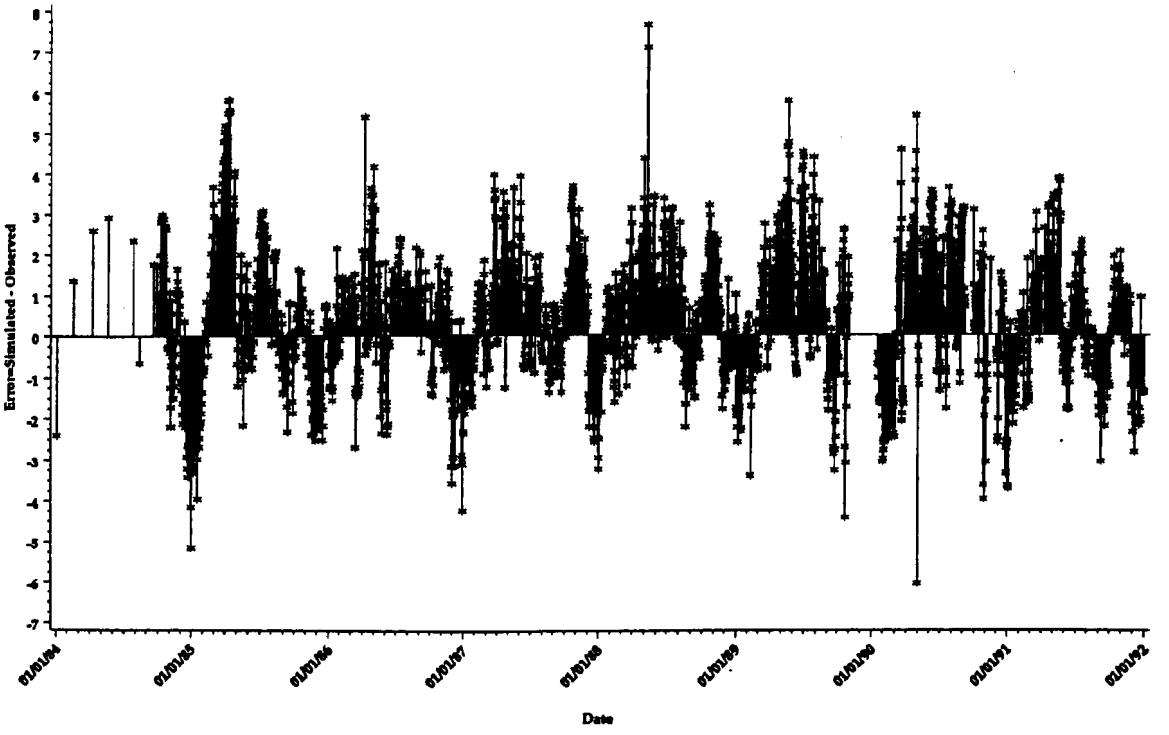
Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Temperature-C: 01JAN84 - 01JAN92

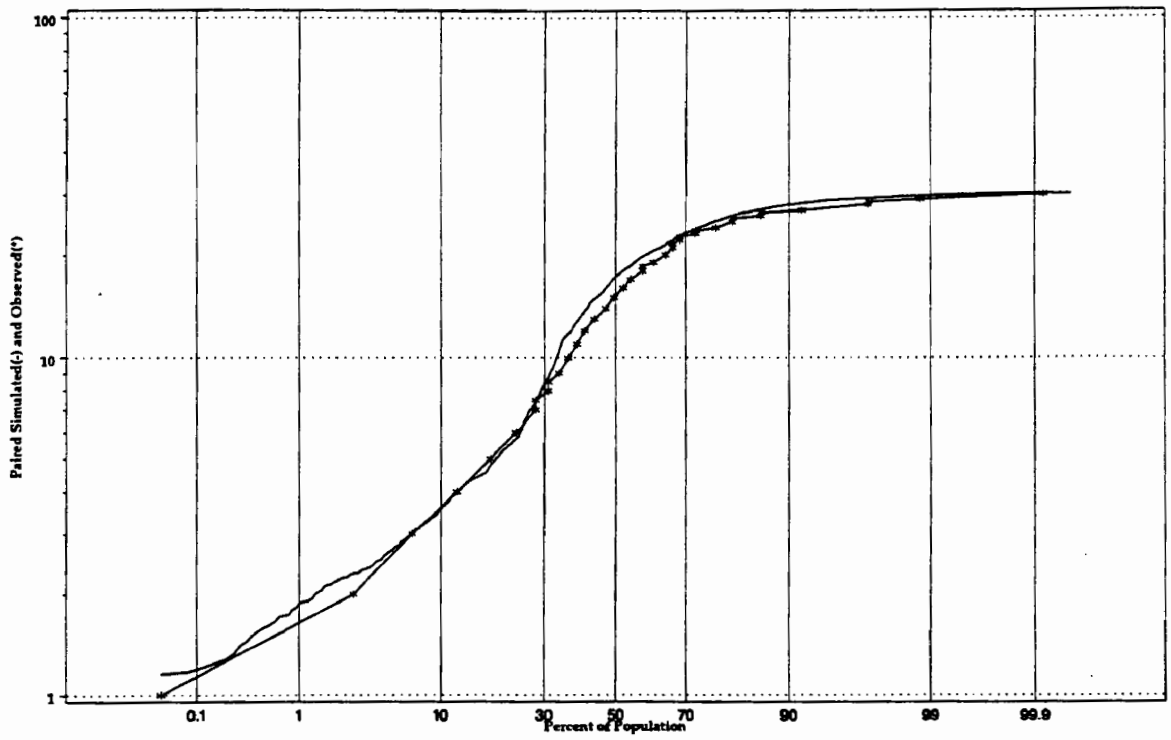


Susquehanna River at Segment 140

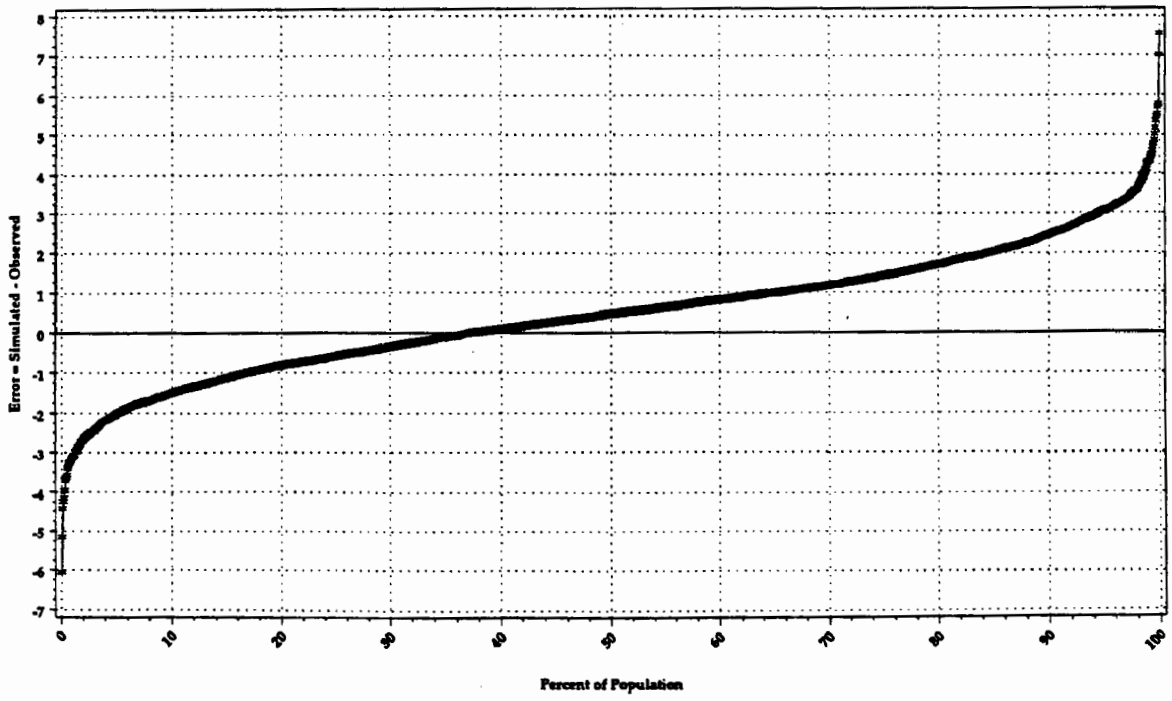
Actual Error versus Time
Temperature-C



Susquehanna River at Segment 140
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

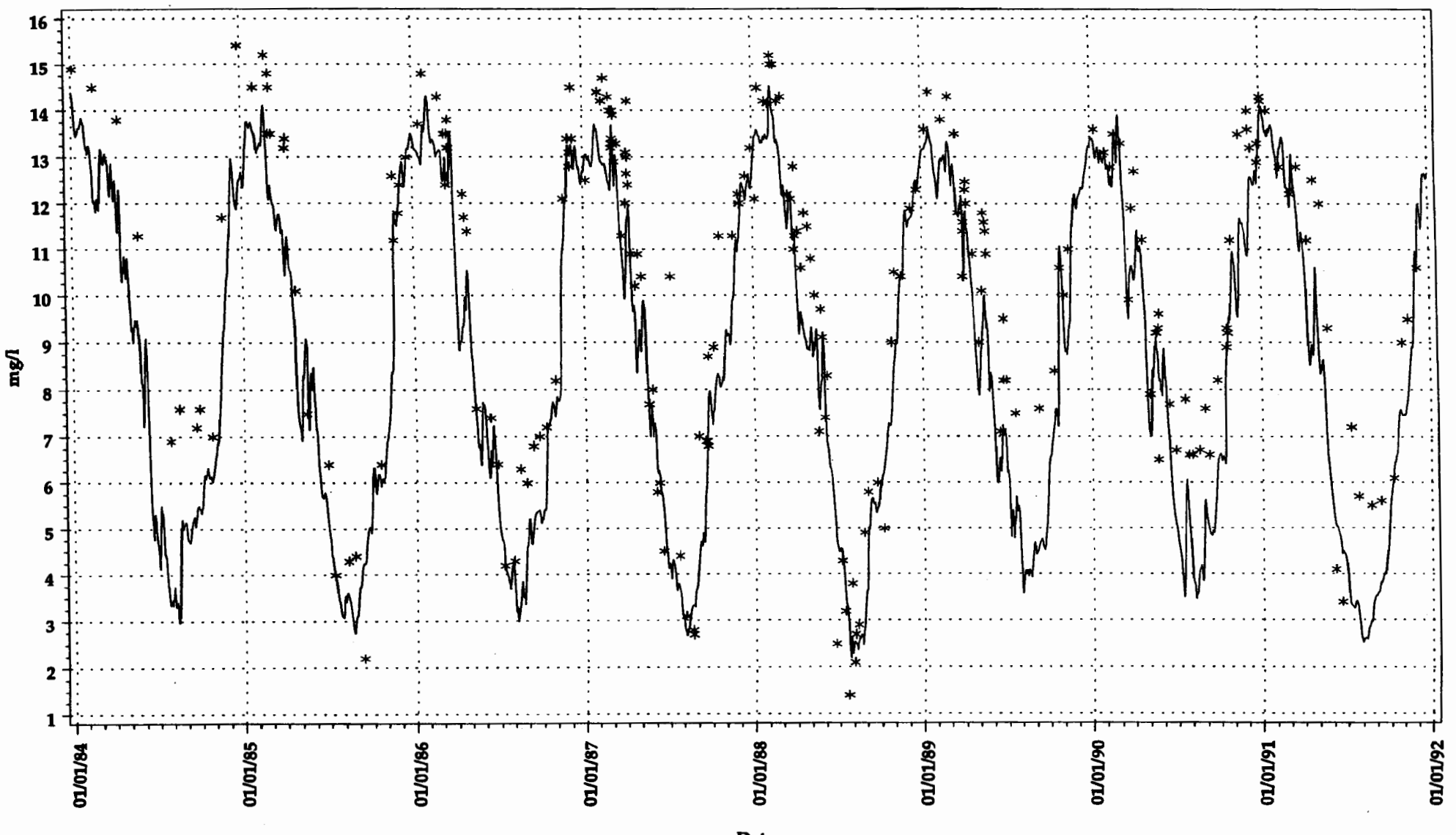


Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data



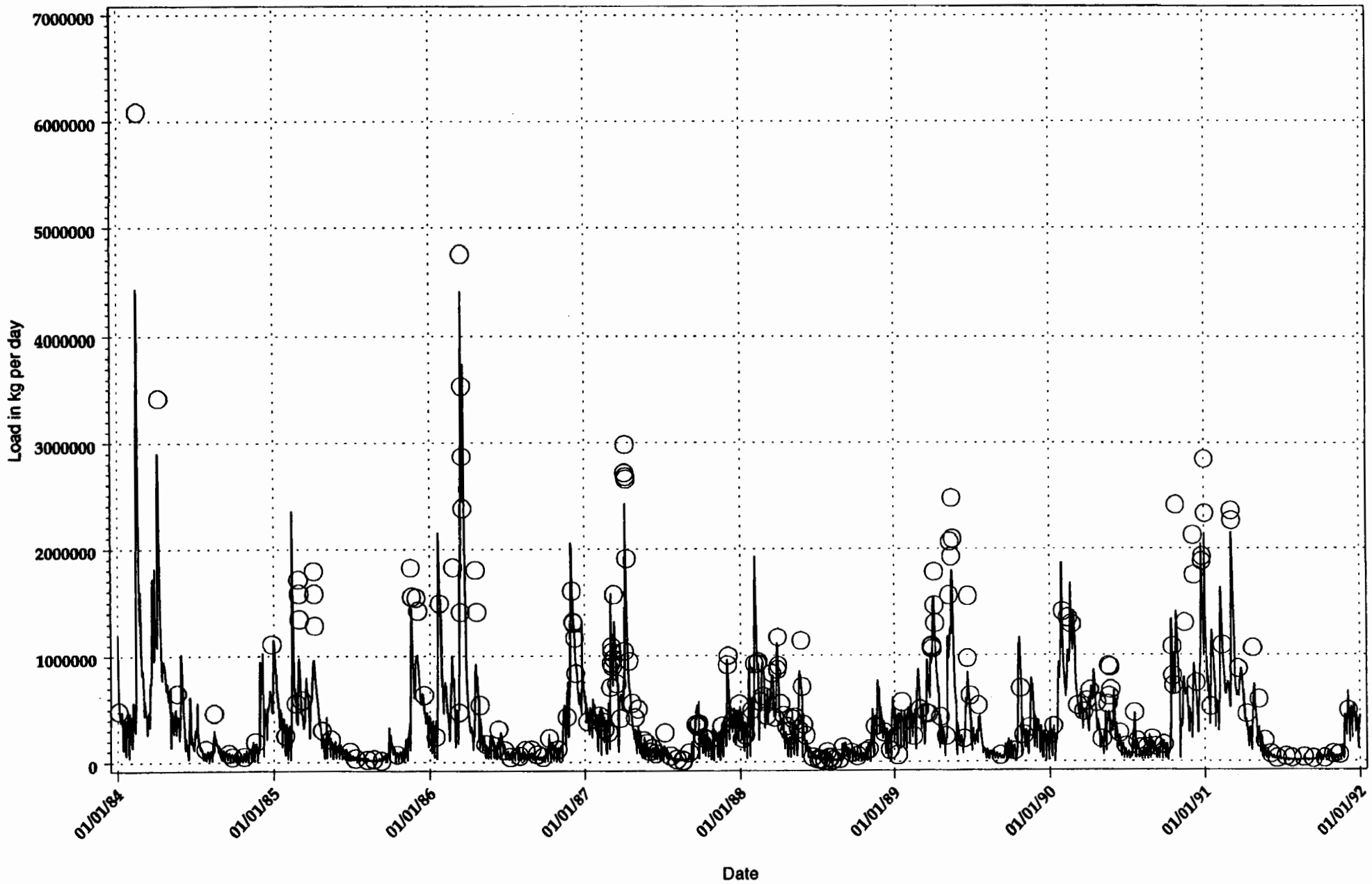
Susquehanna River at Segment 140
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



(y21_plot.exe model3d\pnung.dl plotcmt - cmtime)
(sonow.dv 24FEB98 13:47)

Susquehanna River at Segment 140
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)

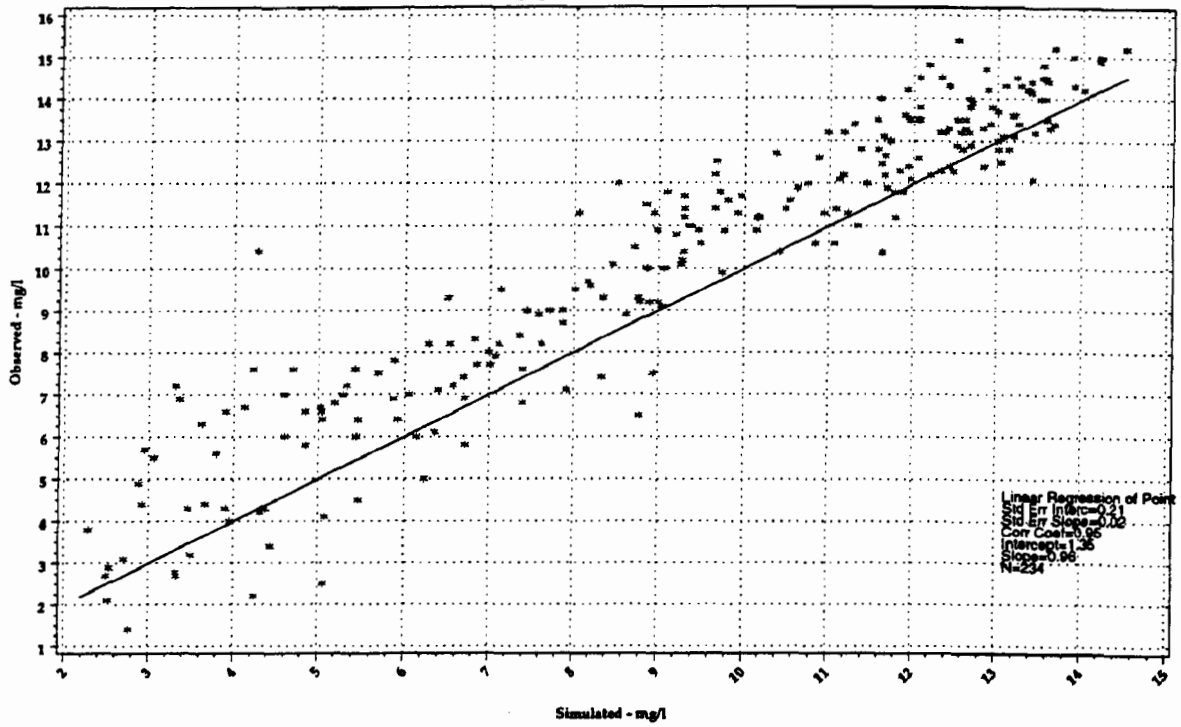


(y21_plotb.sas model3d:[pwang.dt] lldfles)
(oonow.drv 24FEB98 13:47,proc reg,model y=x)

Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

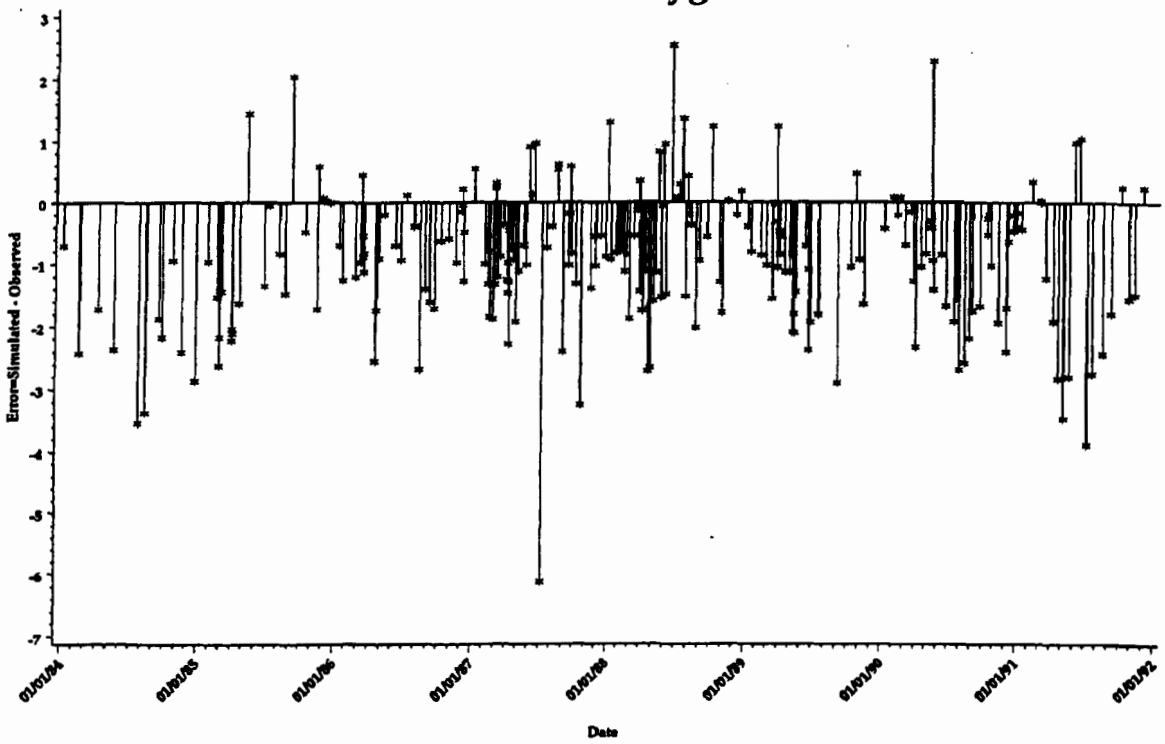
Dissolved Oxygen: 01JAN84 - 01JAN92



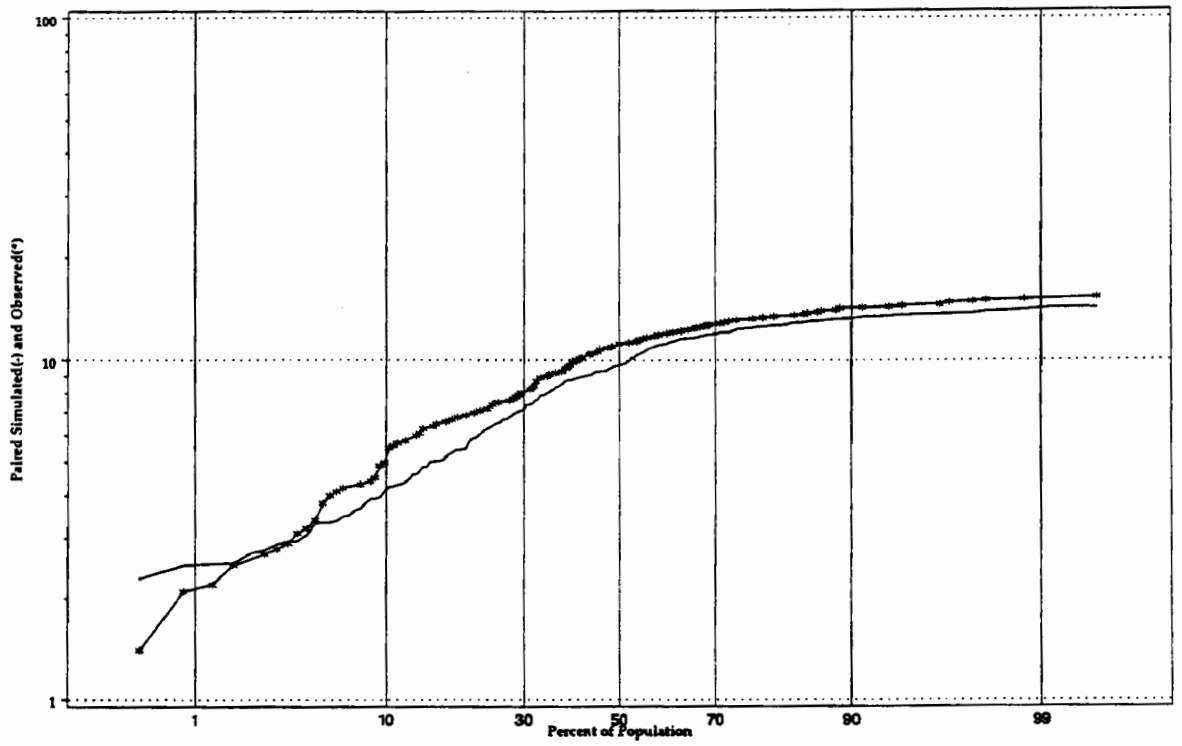
Susquehanna River at Segment 140

Actual Error versus Time

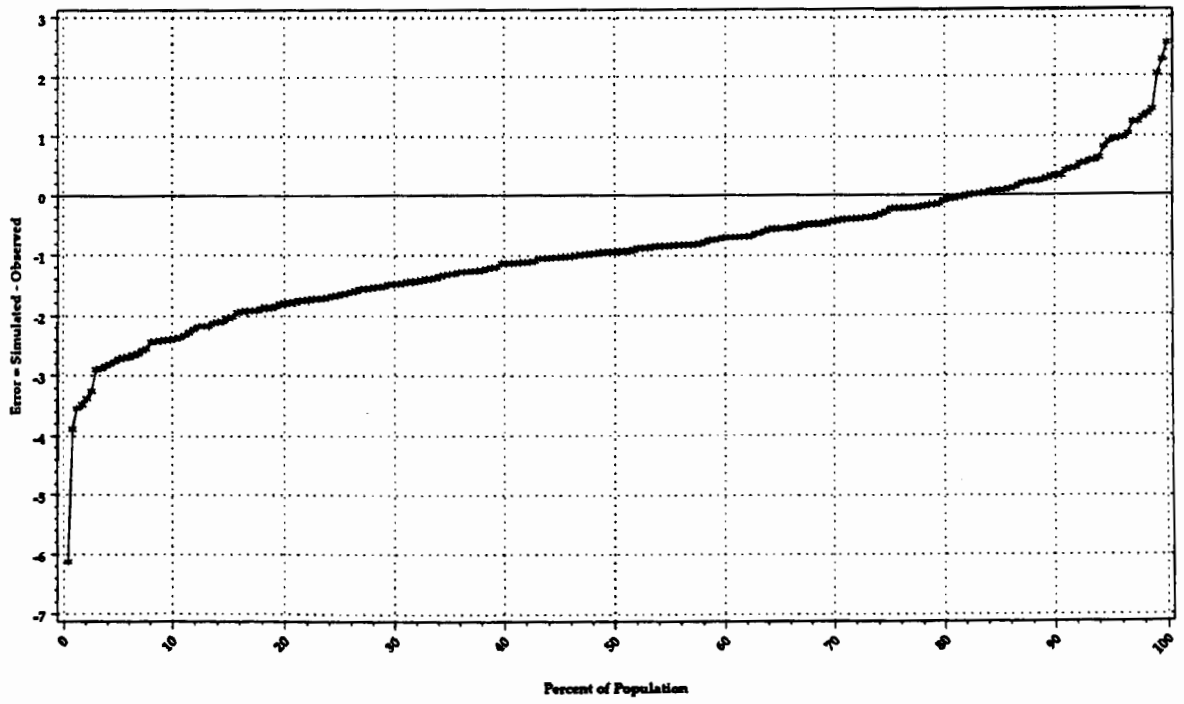
Dissolved Oxygen



Susquehanna River at Segment 140
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

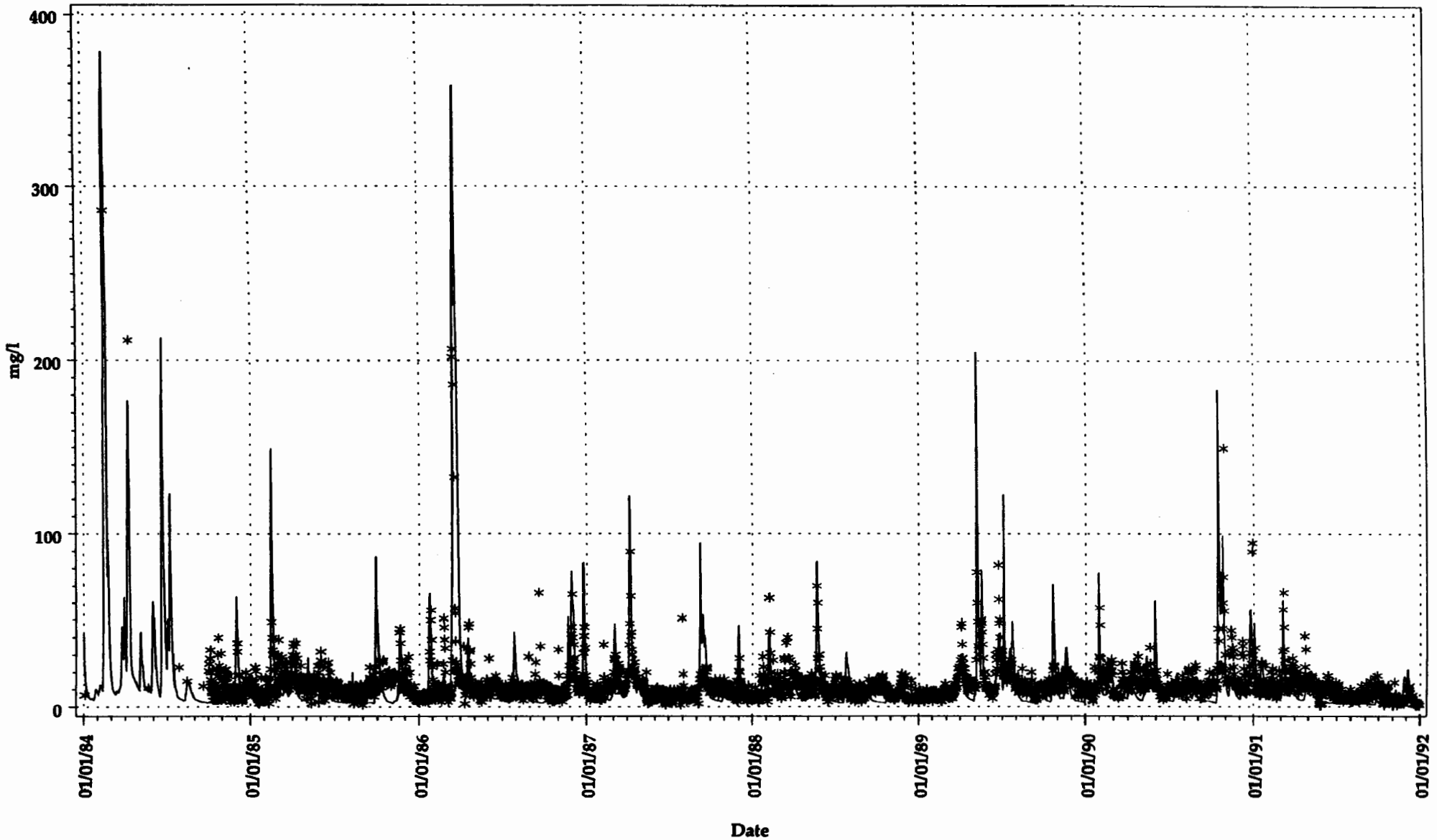


Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Susquehanna River at Segment 140
Observed and Simulated versus Time
Total Suspended Sediment

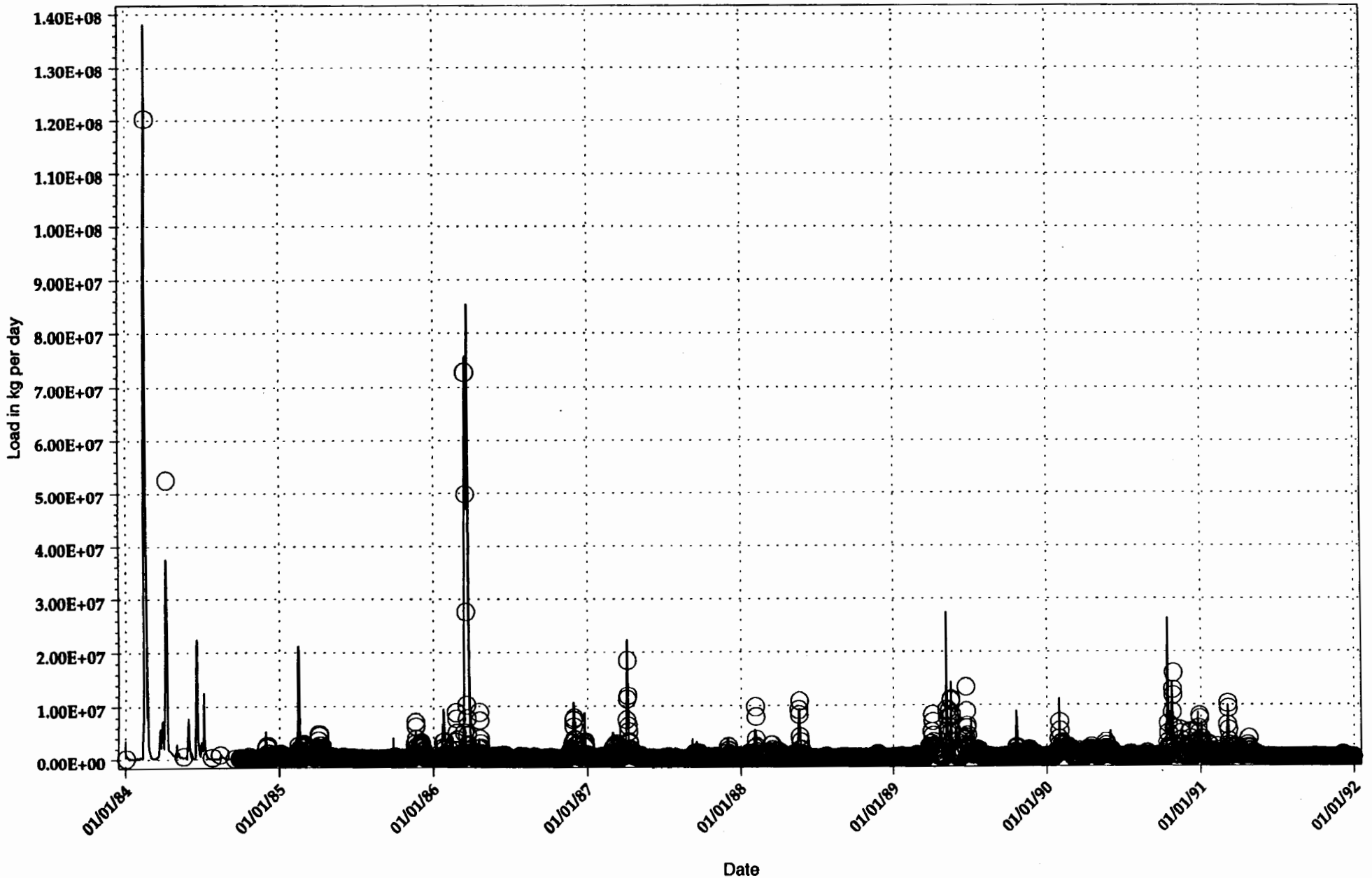
(*=Observed, -=Simulated)



Susquehanna River at Segment 140

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

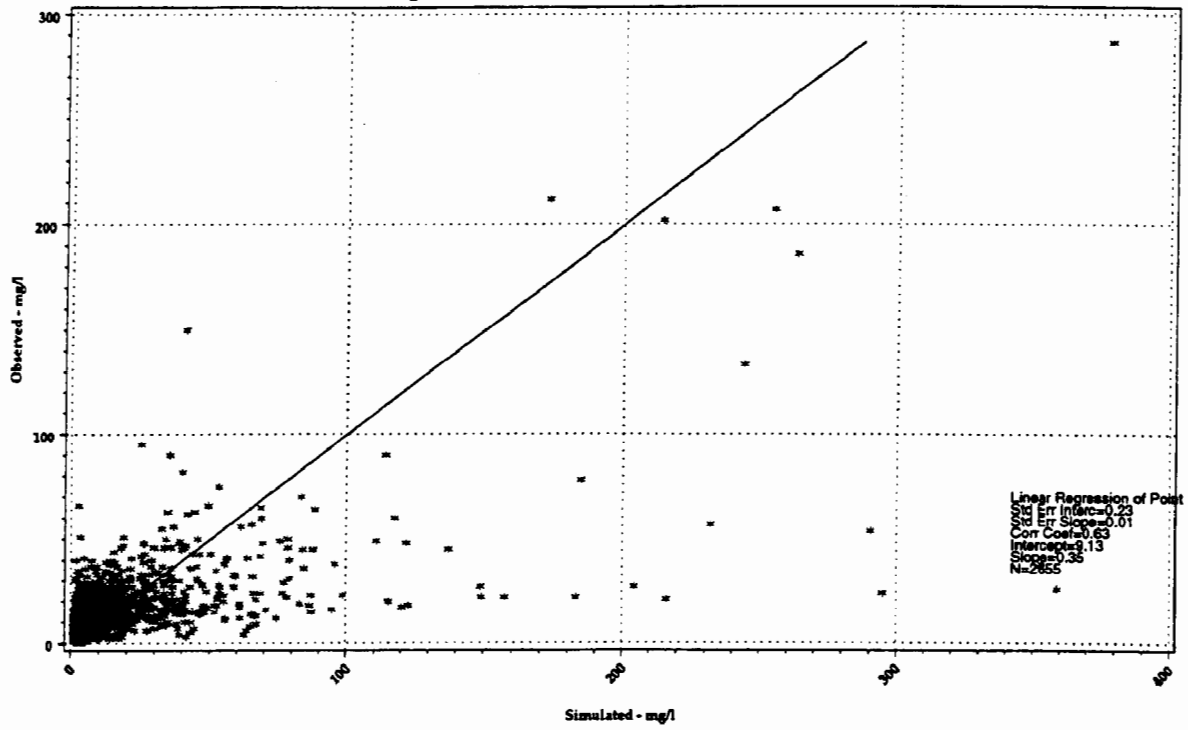


(y21_plotb.sas model3d:gweng.dl| ldlles)
(concw.drv 24FEB98 13:36,proc reg,model y=x)

Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

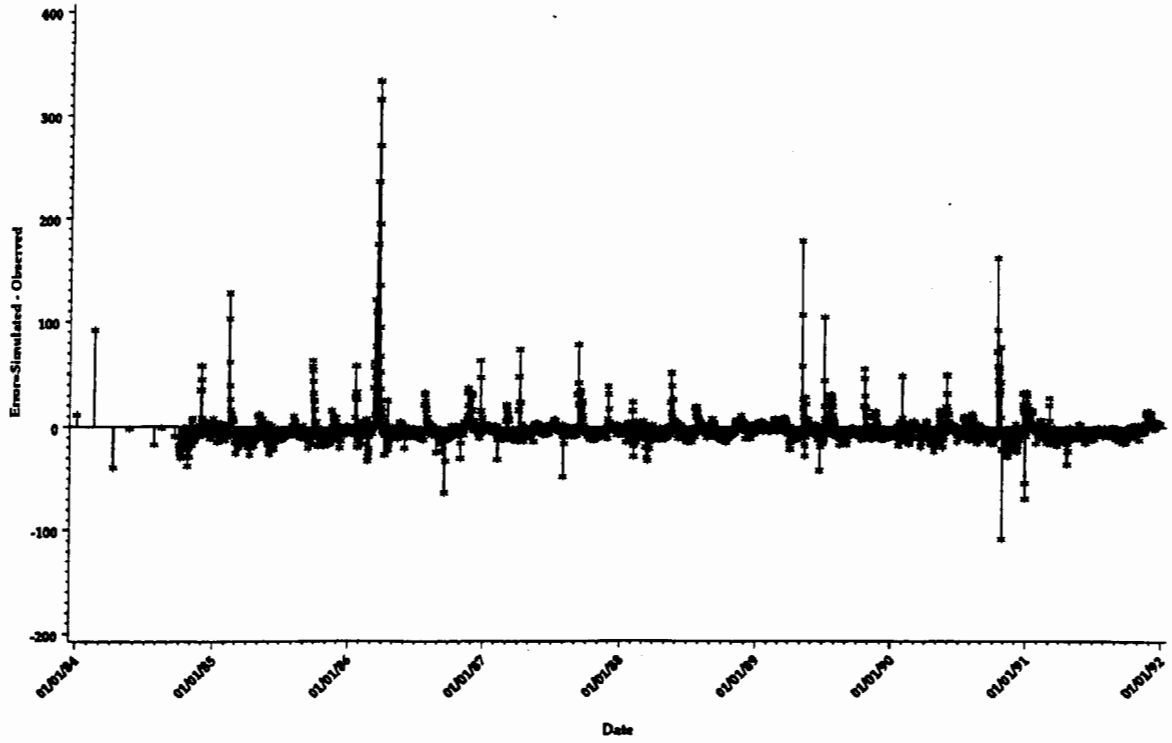
Total Suspended Sediment: 01JAN84 - 01JAN92



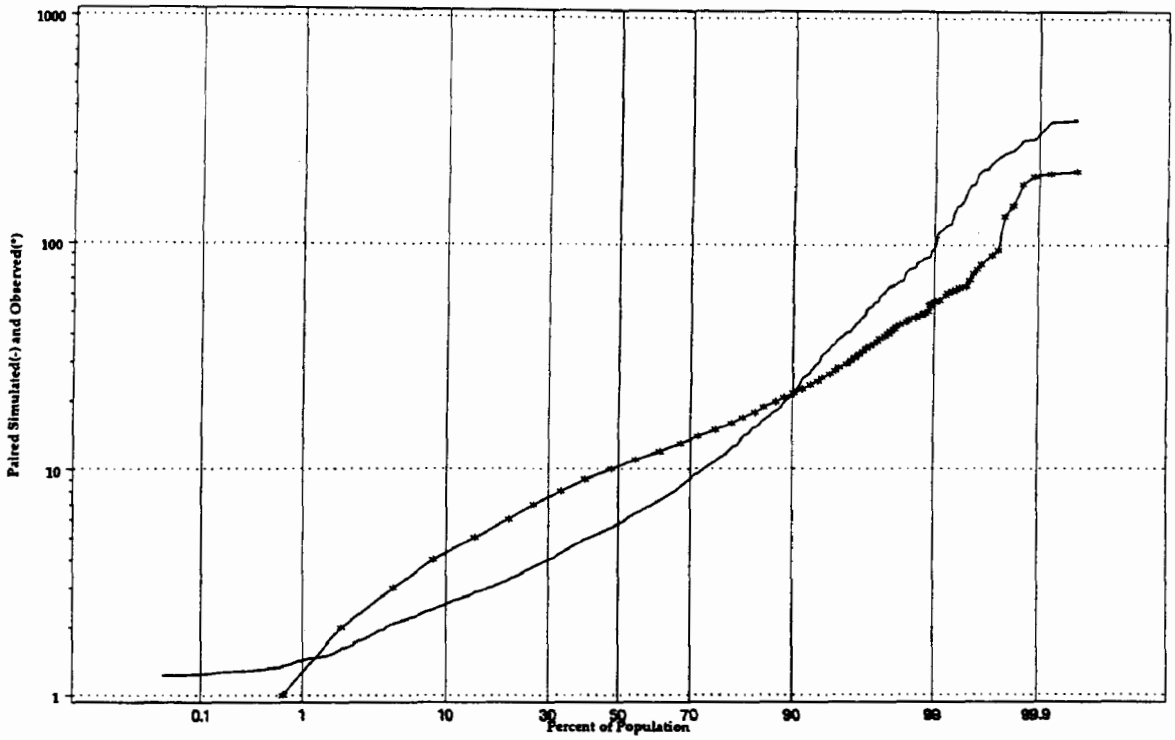
Susquehanna River at Segment 140

Actual Error versus Time

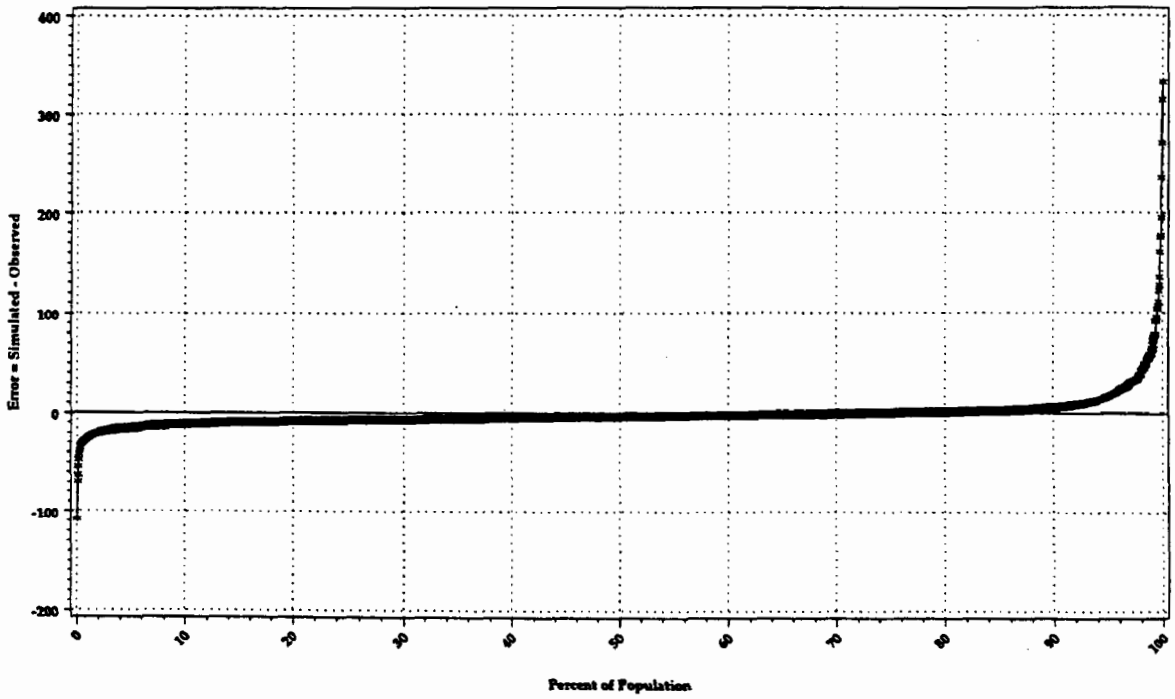
Total Suspended Sediment



Susquehanna River at Segment 140
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

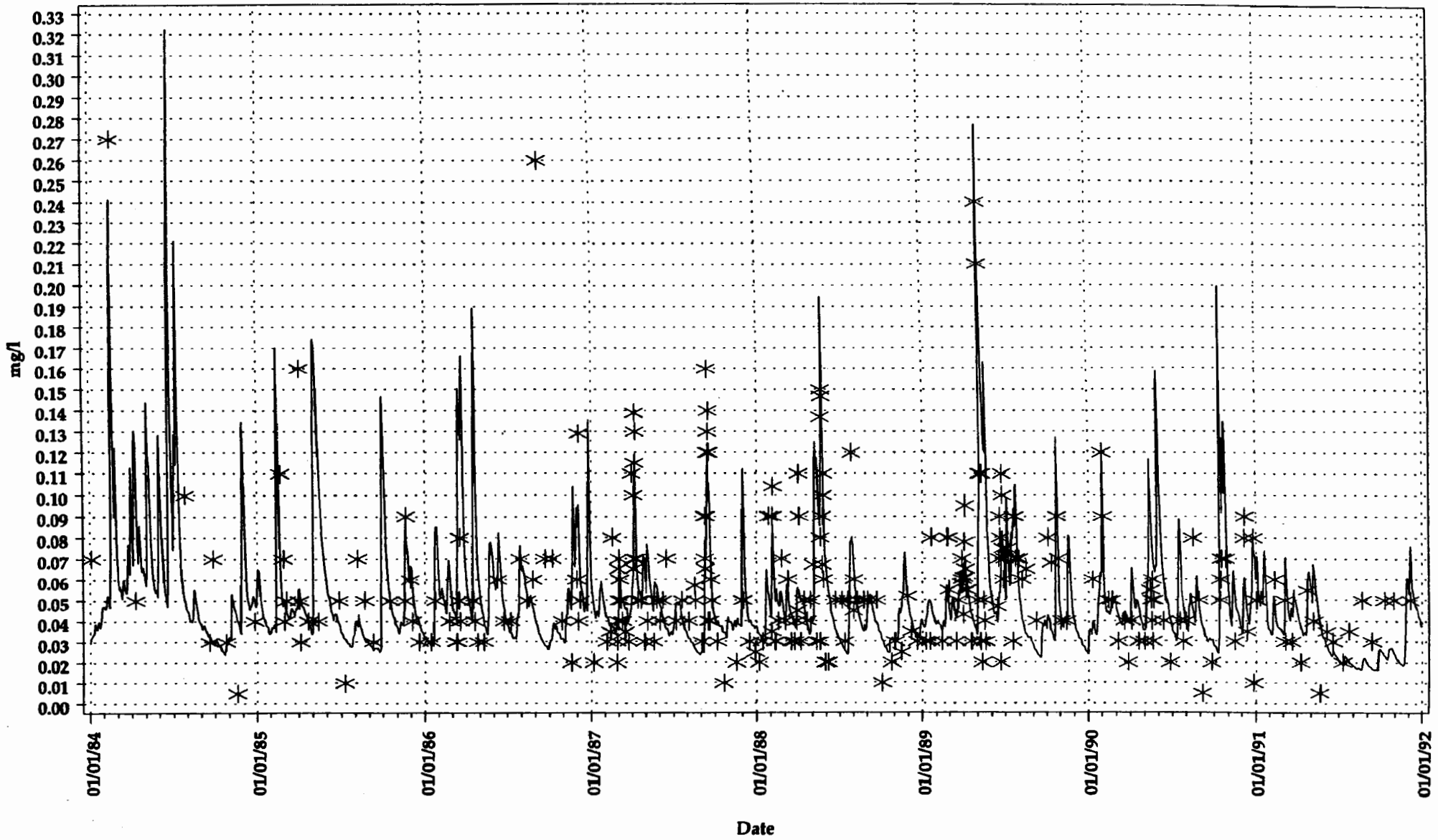


Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



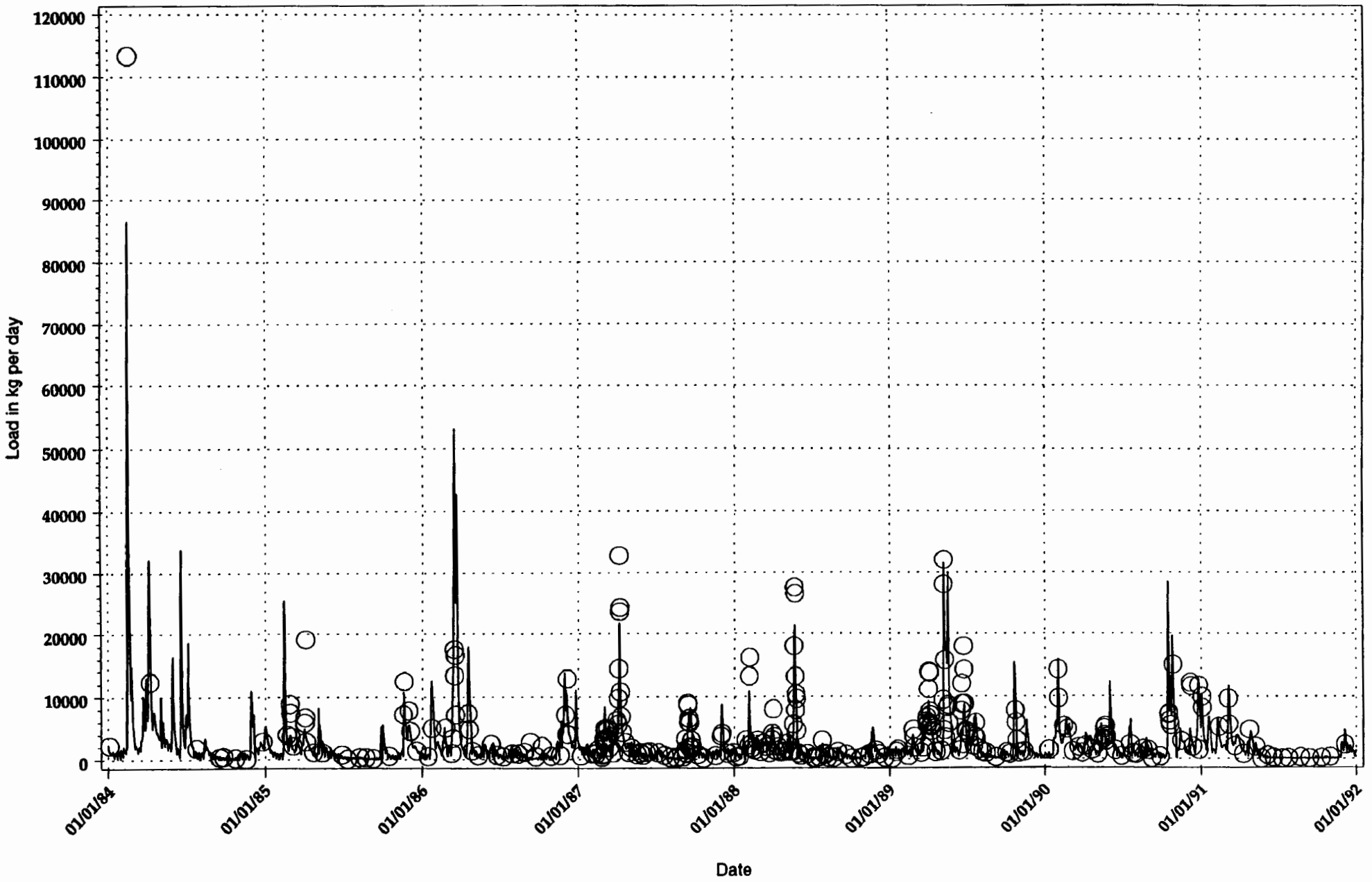
Susquehanna River at Segment 140
Observed and Simulated versus Time
Total Phosphorus

(*=Observed, -=Simulated)



(y21_plotb.sas model3d[gwang.dt] plotomi - online)
(canow.dev 24FEB98 13:47)

Susquehanna River at Segment 140
Total Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

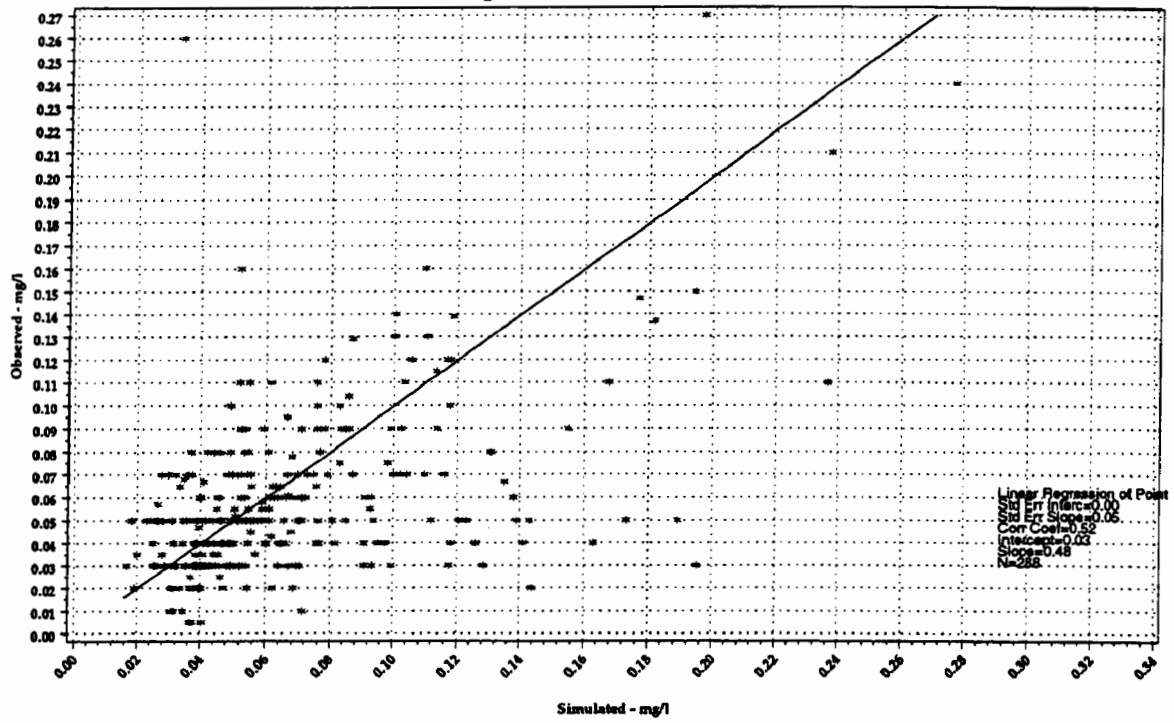


(y21_plot8.sas model3d[pwang.dt] lkflas)
(conow.dv 24FEB99 13:47.proc reg.model y=x)

Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

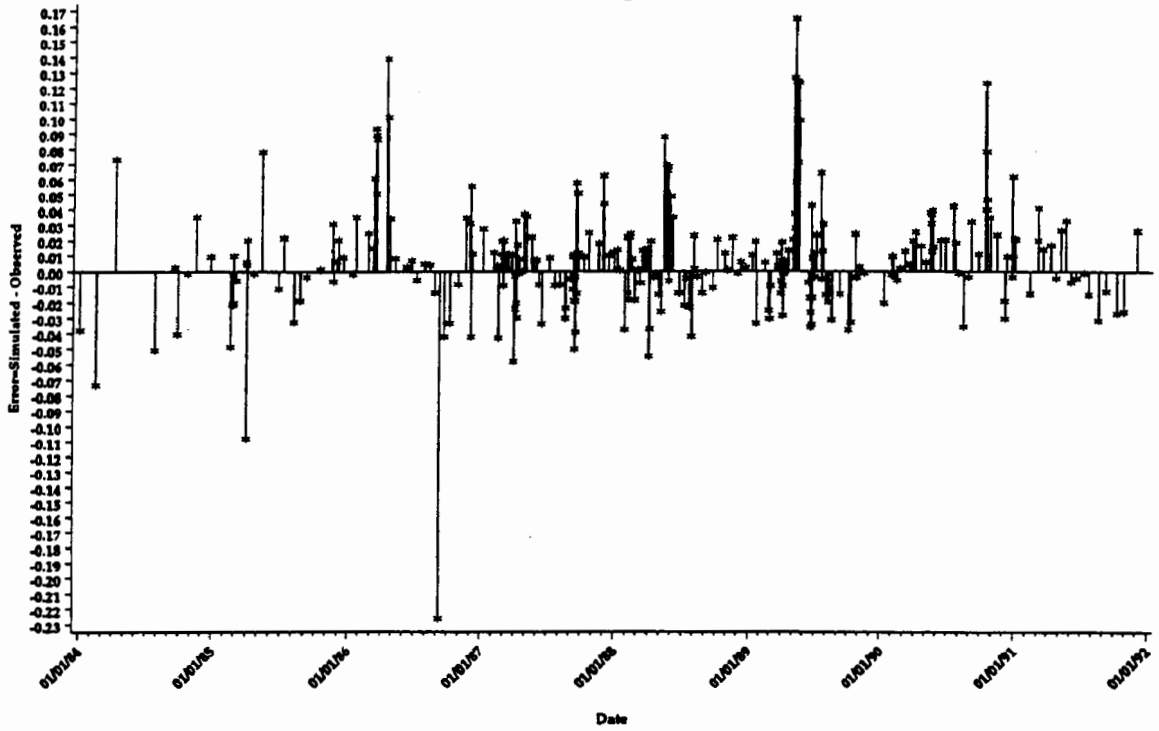
Total Phosphorus: 01JAN84 - 01JAN92



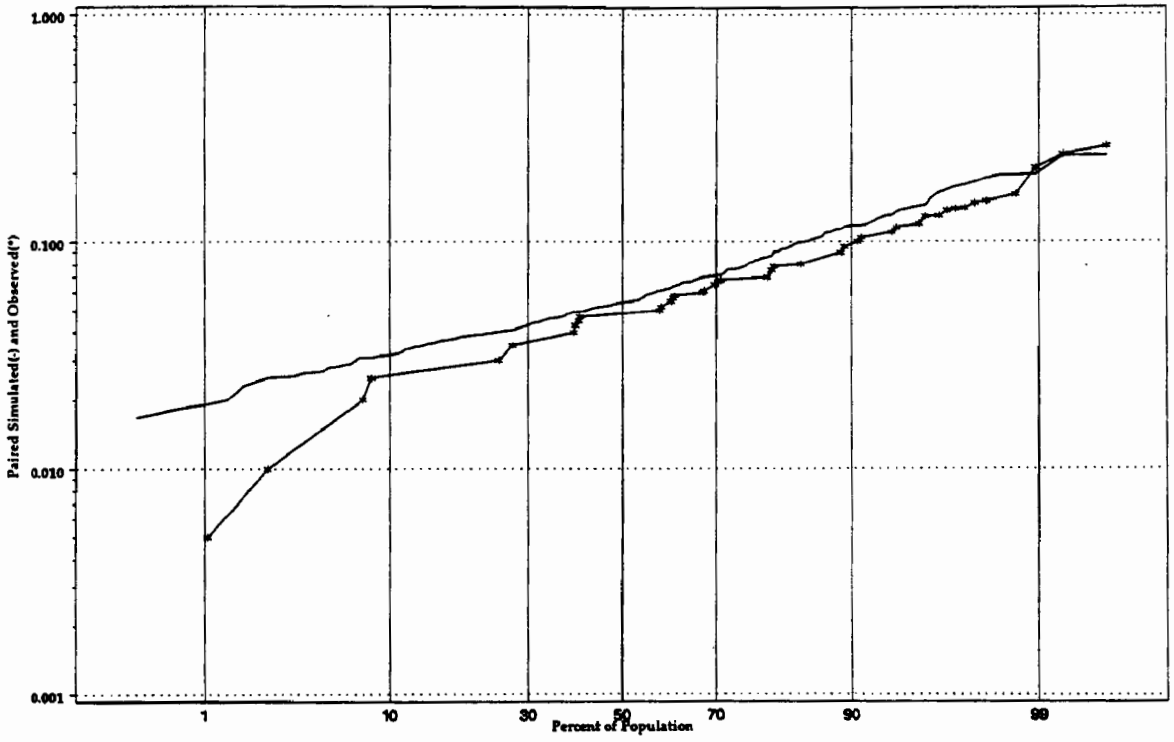
Susquehanna River at Segment 140

Actual Error versus Time

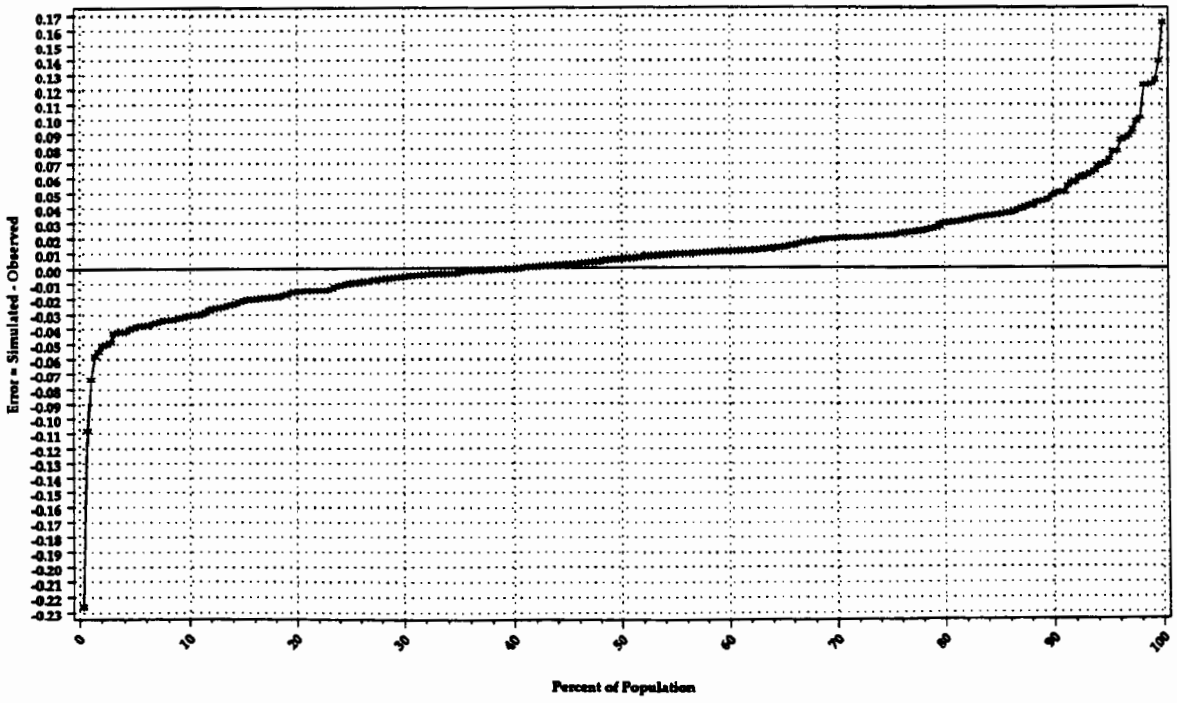
Total Phosphorus



Susquehanna River at Segment 140
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

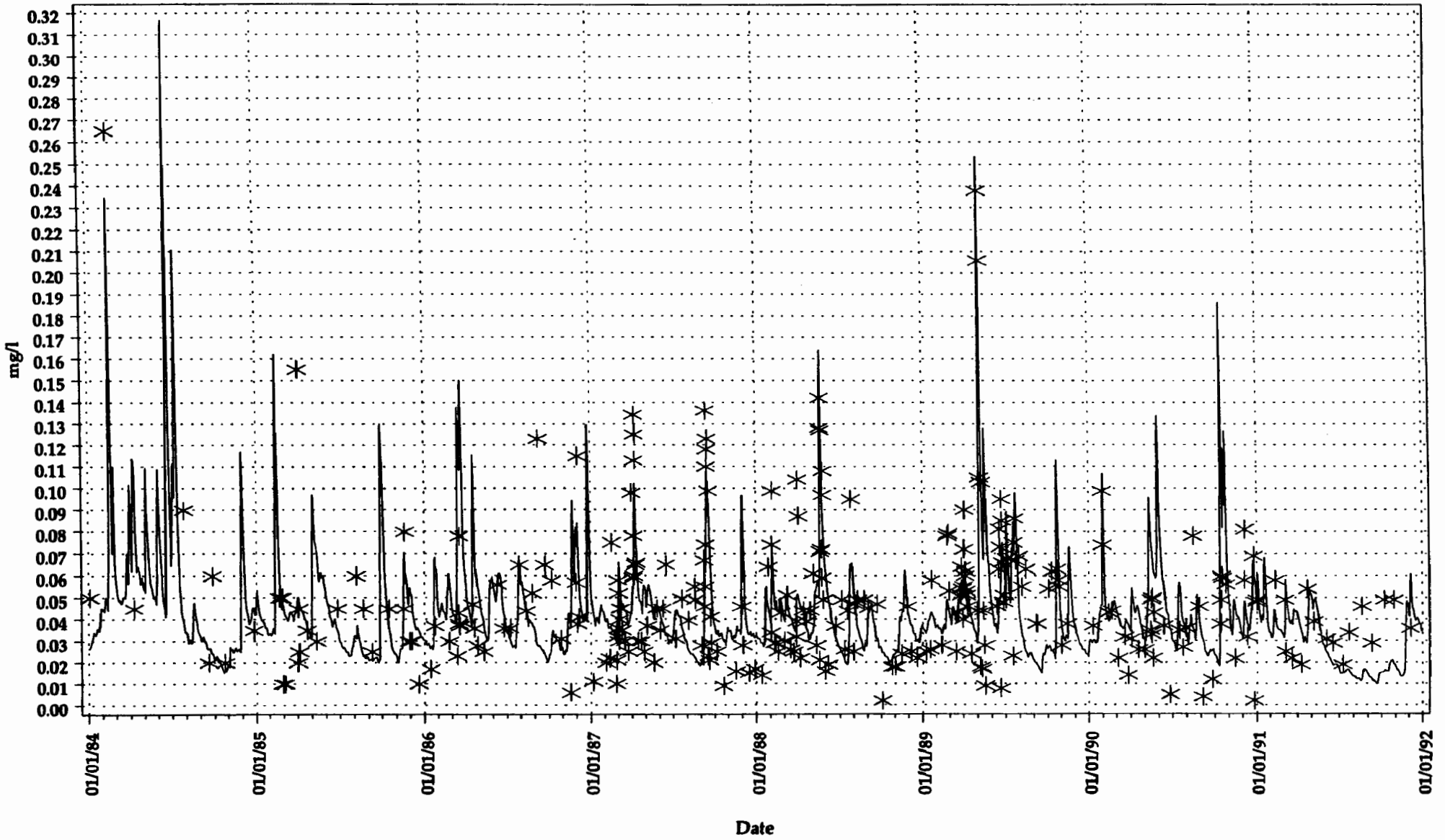


Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Susquehanna River at Segment 140
Observed and Simulated versus Time
Organic and Particulate Phosphorus

(*=Observed, -=Simulated)

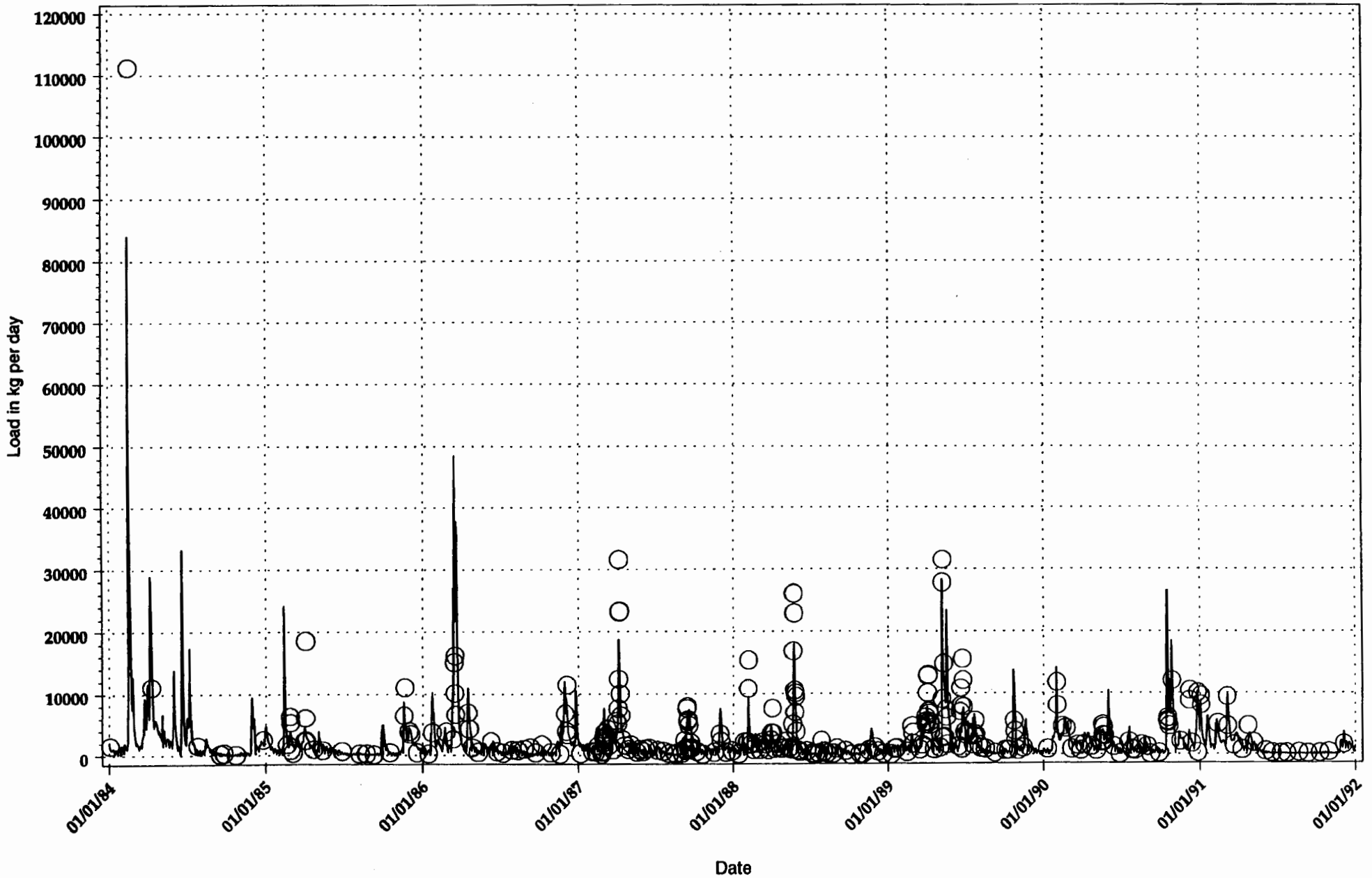


(y21_plotb.ass model3d/pwang.dl[plotsmt - ontime)
(panow.dir 24FEB00 15:47)

Susquehanna River at Segment 140

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

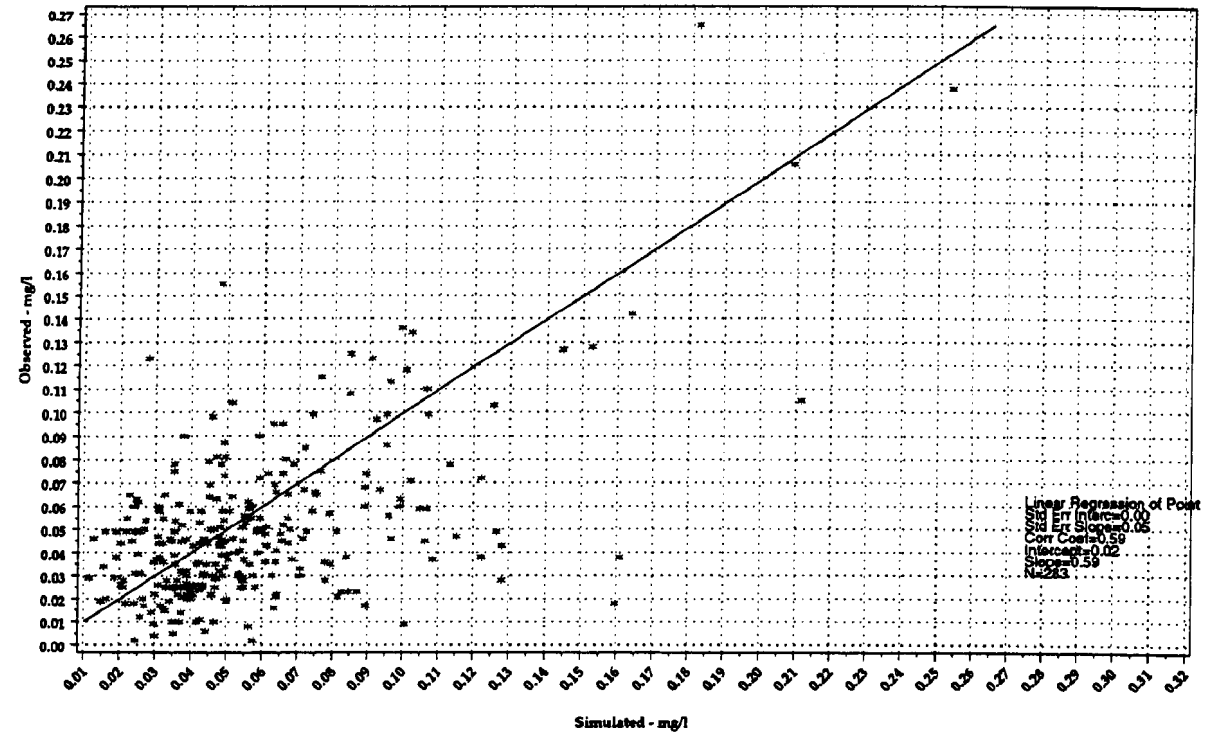


(y21_plotb.sas model3d.$pwang.dl| lldfles)
(conovr.drv 24FEB98 13:47,proc reg,model y=x)

Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

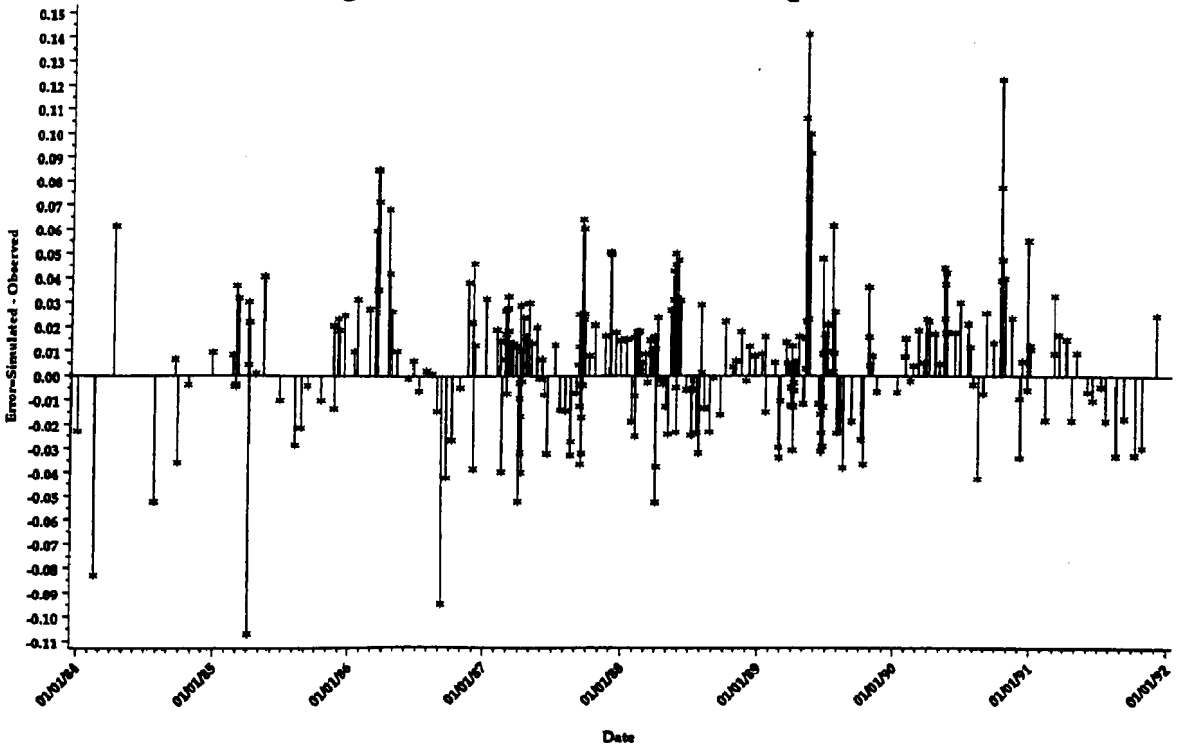
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



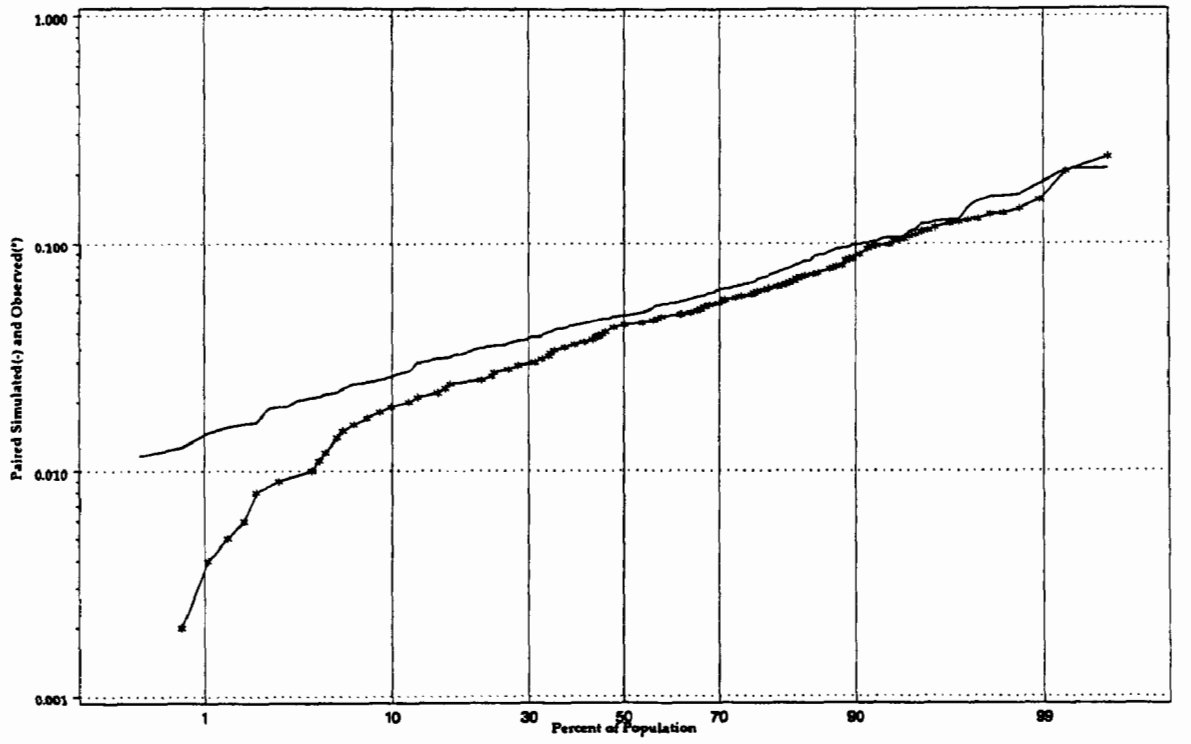
Susquehanna River at Segment 140

Actual Error versus Time

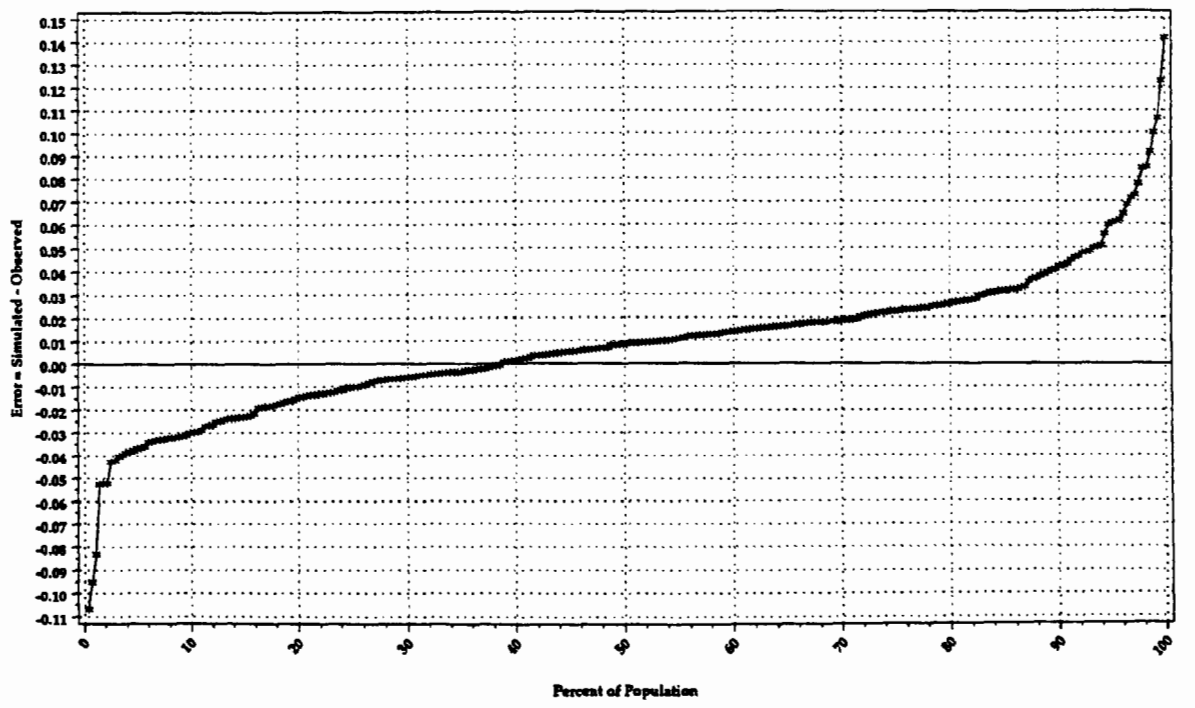
Organic and Particulate Phosphorus



Susquehanna River at Segment 140
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

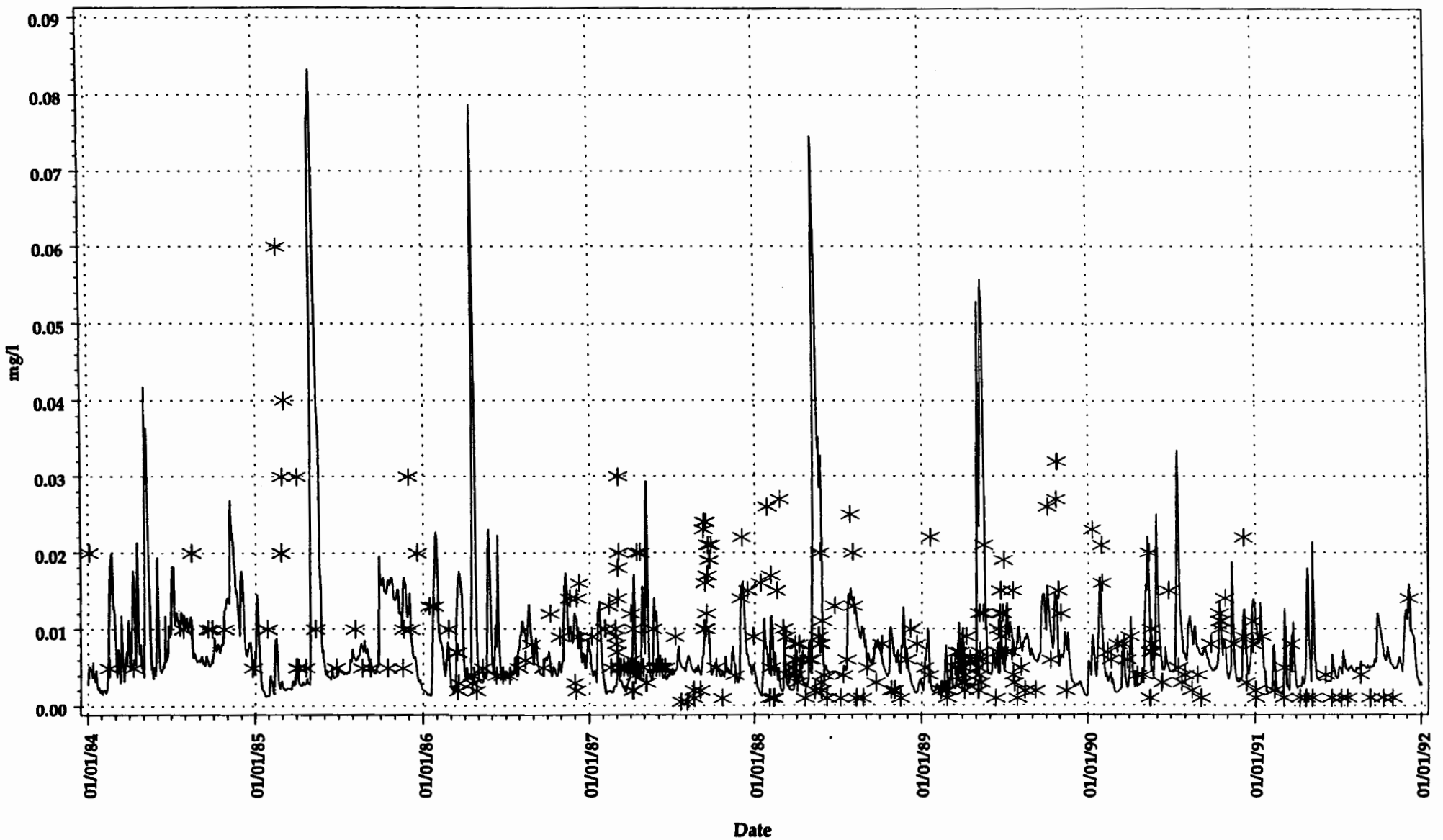


Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data



Susquehanna River at Segment 140
Observed and Simulated versus Time
Dissolved Phosphorus

(*=Observed, -=Simulated)

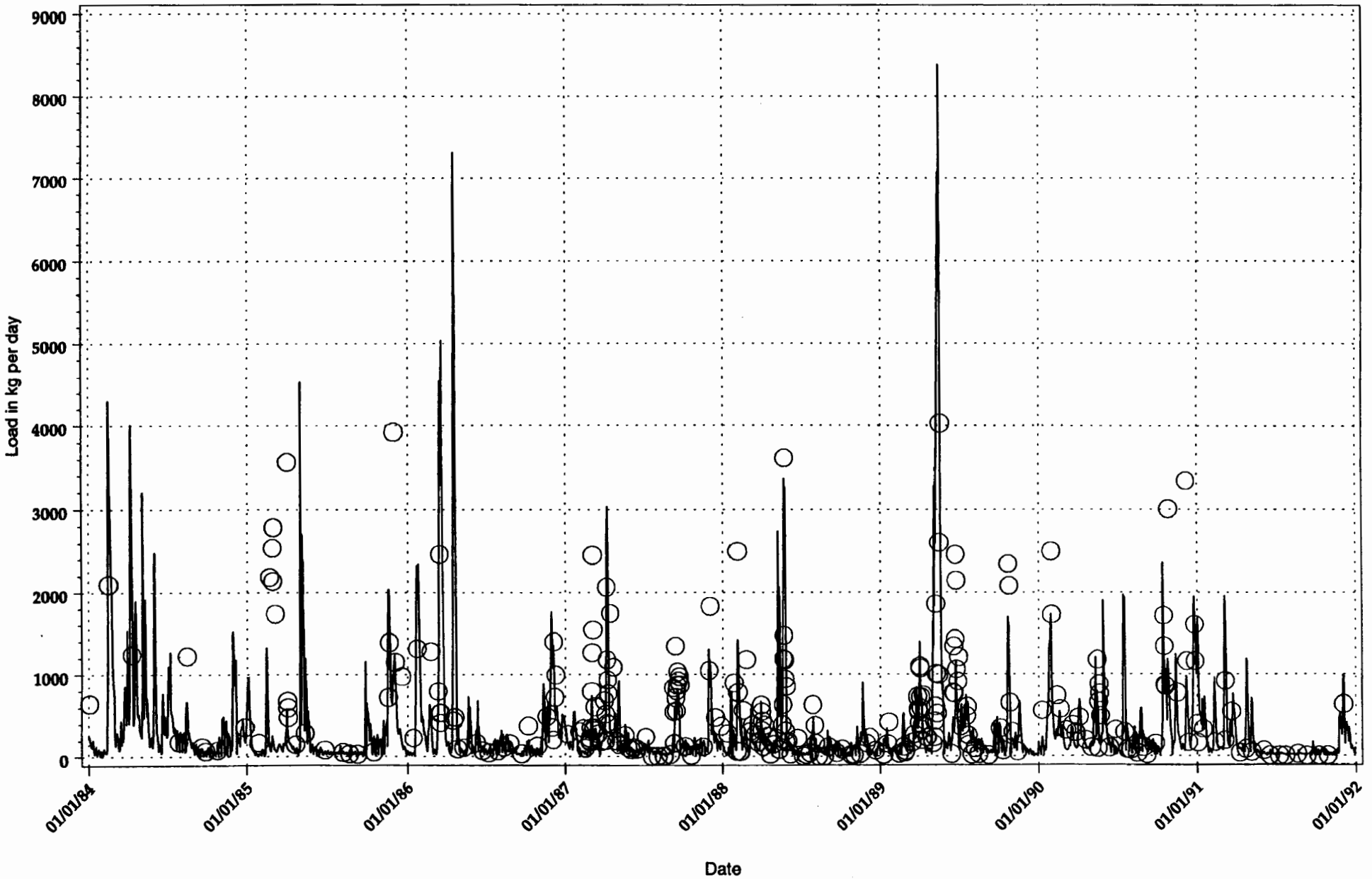


(y21_plotb.sas model3d[gwang.dt] plotcmt - ontime)
(conov.drv 24FEB98 13:47)

Susquehanna River at Segment 140

Dissolved Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

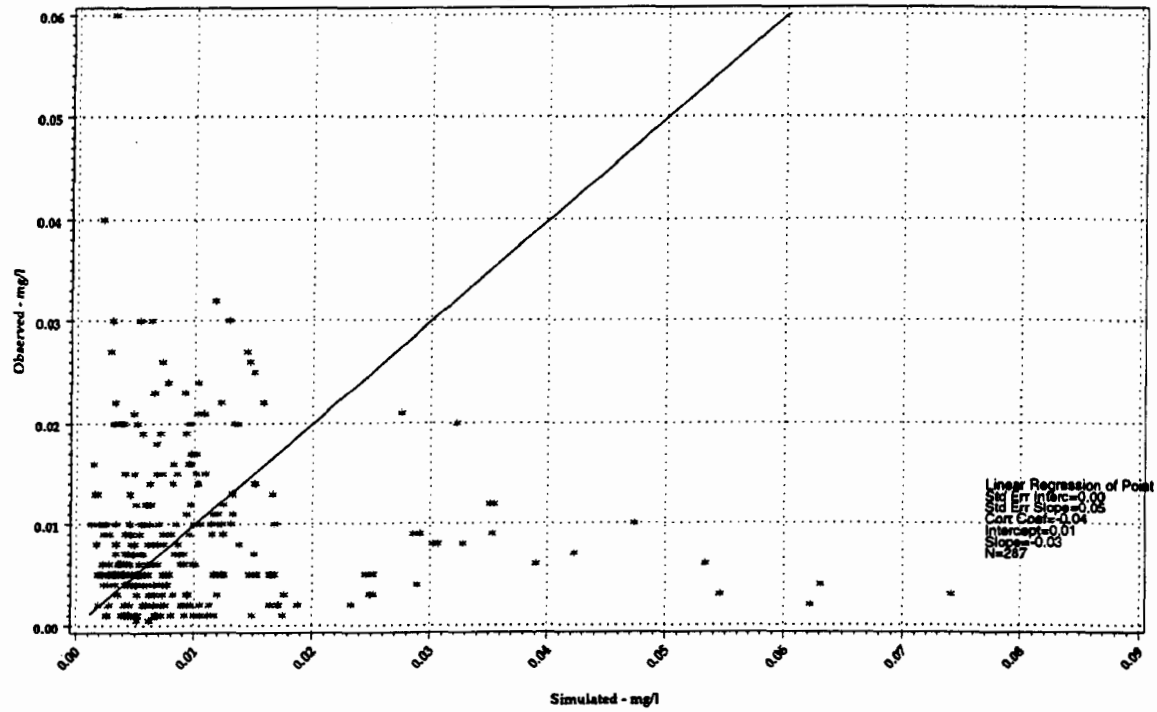


(y21_plotb.sas model3d:[pwang.dt] fdfiles)
(conow.drv 24FEB96 13:47,proc reg,model y=x)

Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

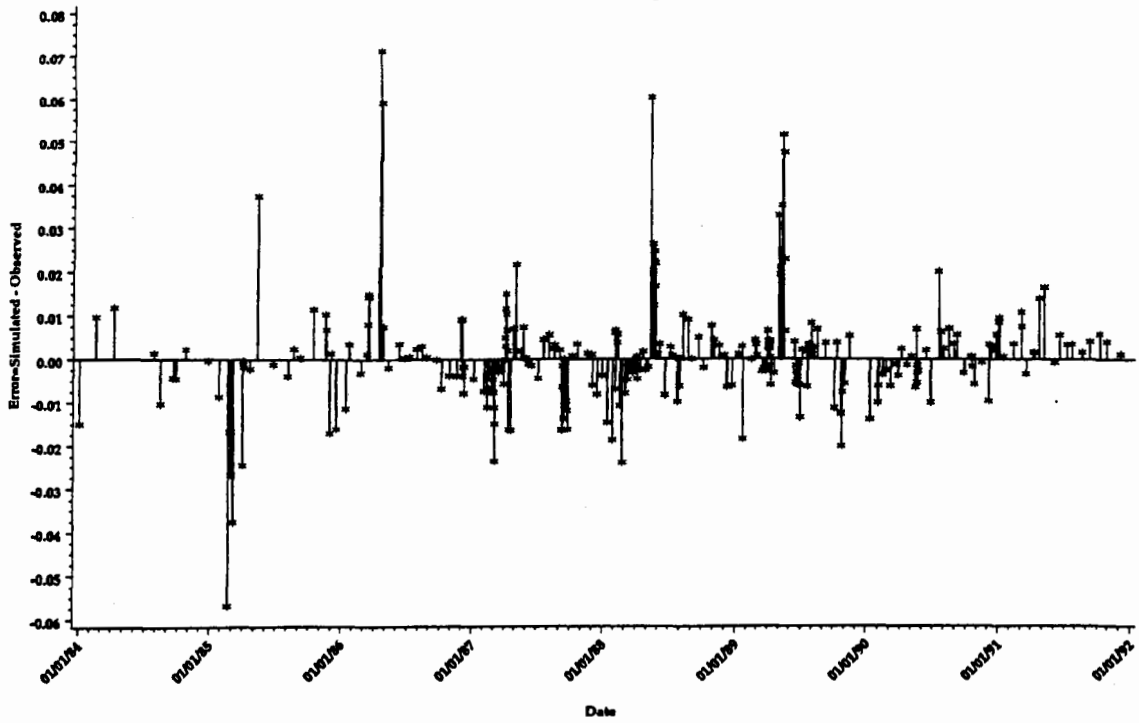
Dissolved Phosphorus: 01JAN84 - 01JAN92



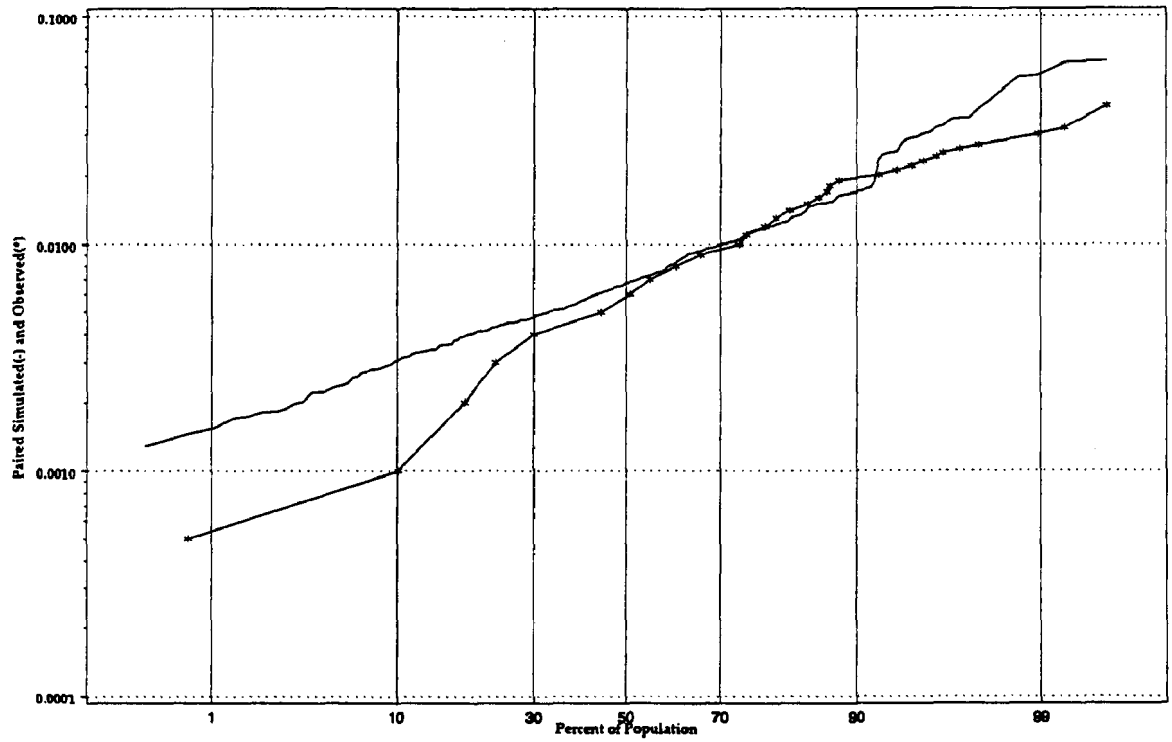
Susquehanna River at Segment 140

Actual Error versus Time

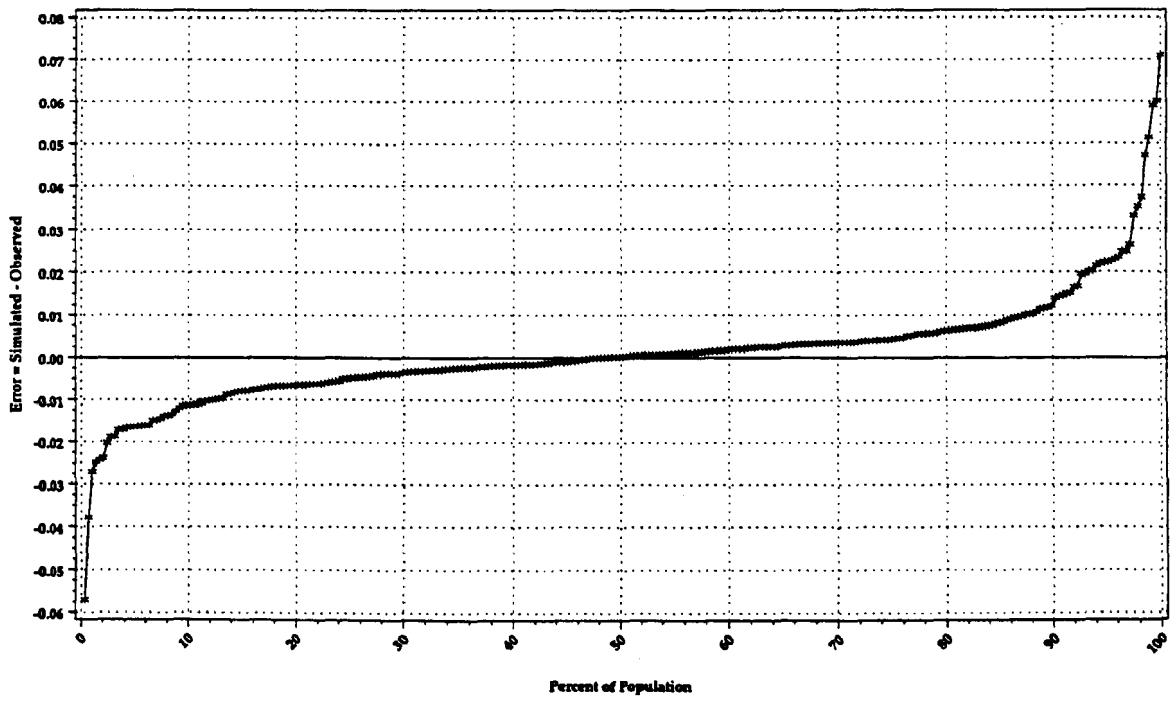
Dissolved Phosphorus



Susquehanna River at Segment 140
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

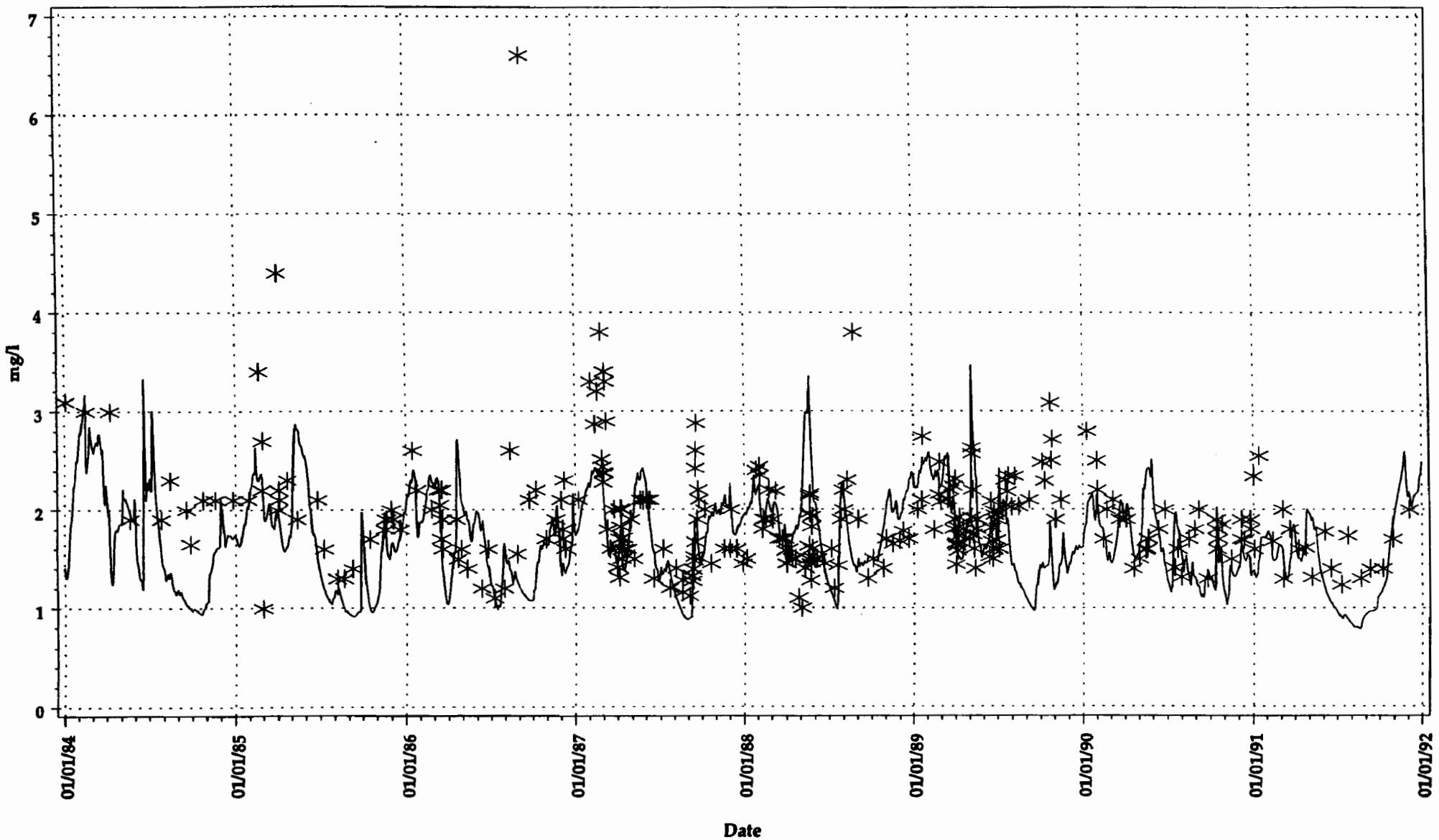


Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



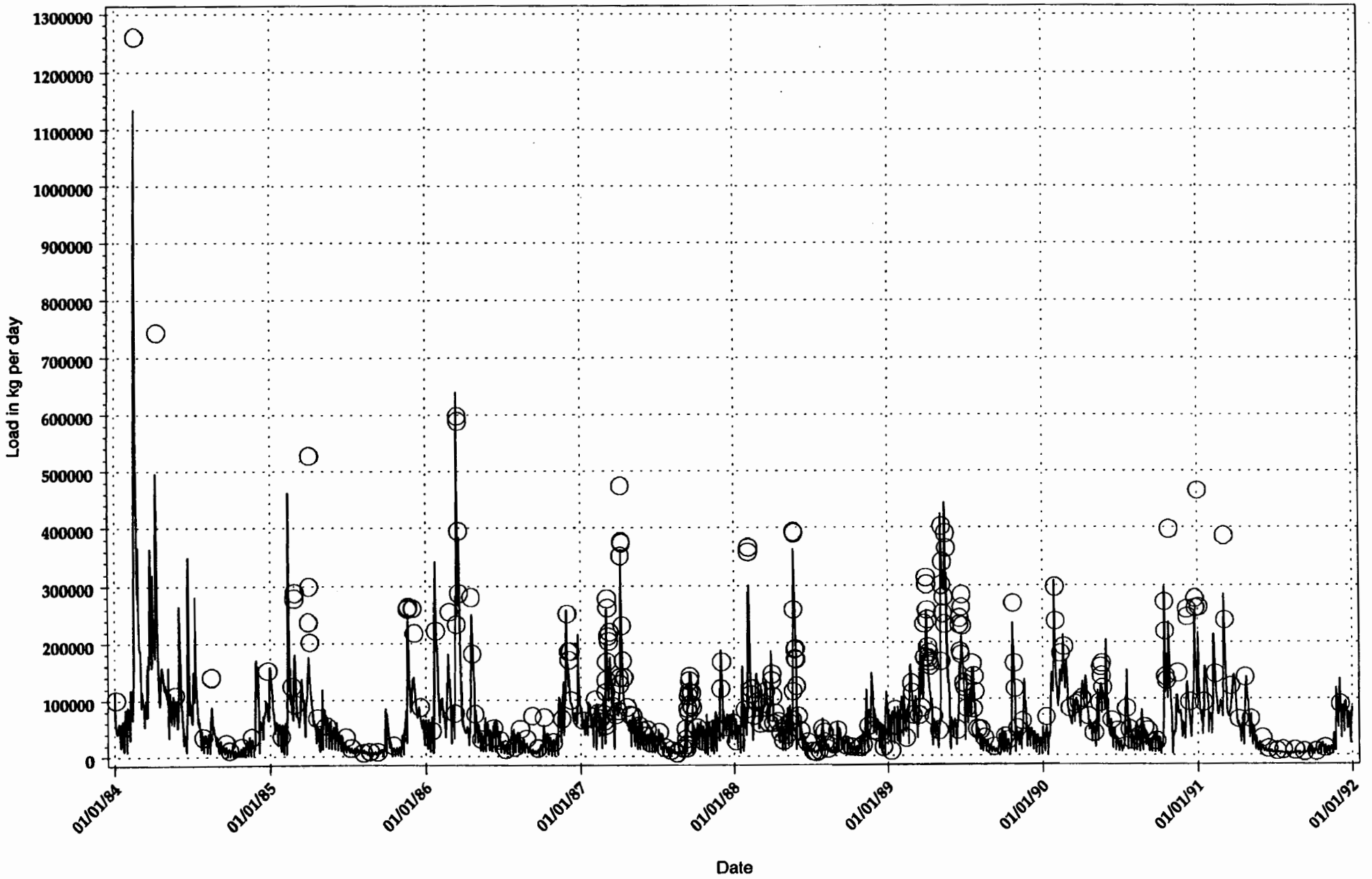
Susquehanna River at Segment 140
Observed and Simulated versus Time
Total Nitrogen

(*=Observed, -=Simulated)



(y21_plot6.sas model24/gwang.dl(plotcmt - cmfmo)
(conuz.drv 24FEB99 13:47)

Susquehanna River at Segment 140
Total Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)

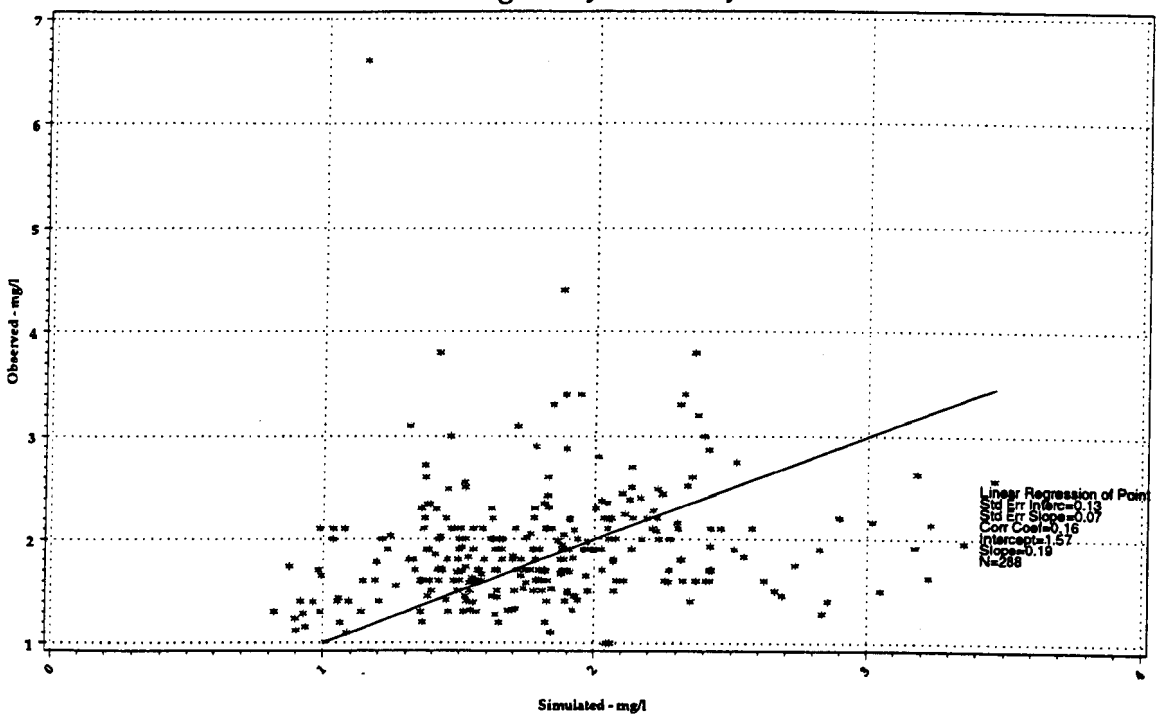


(y21_plob.sas model3d[pwang.dt] lidfles)
(conow.drv 24FEB96 13:47,proc reg,model y=x)

Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

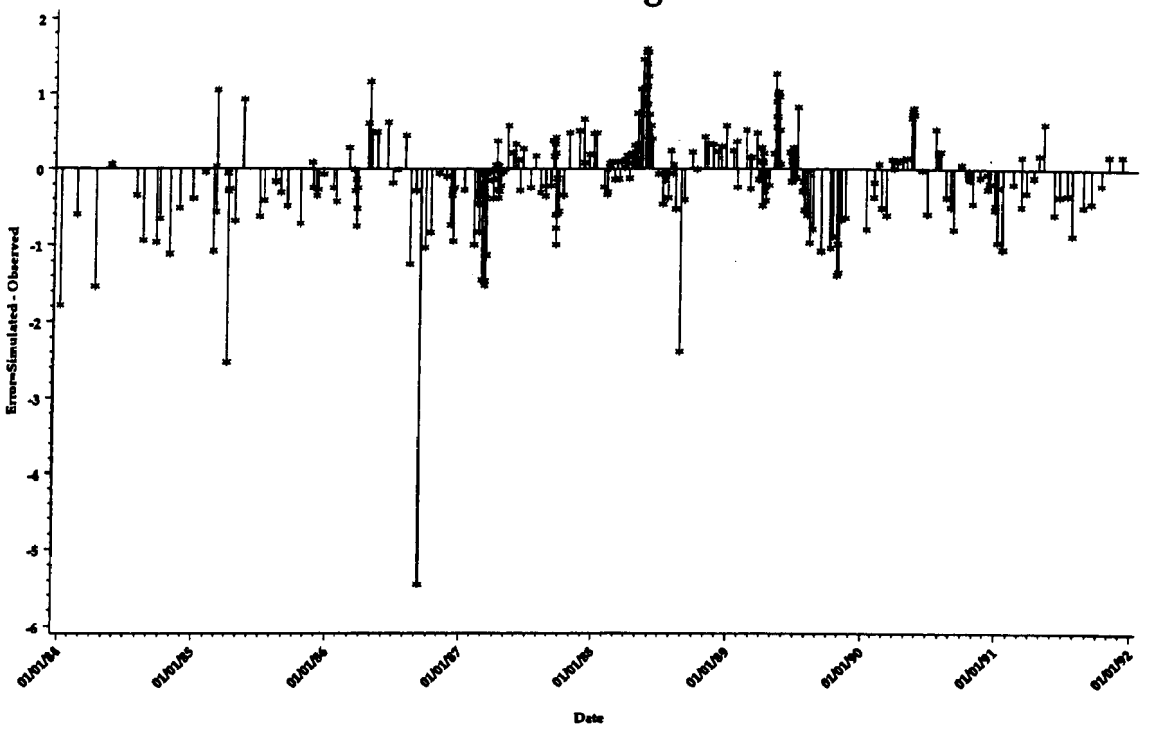
Total Nitrogen: 01JAN84 - 01JAN92



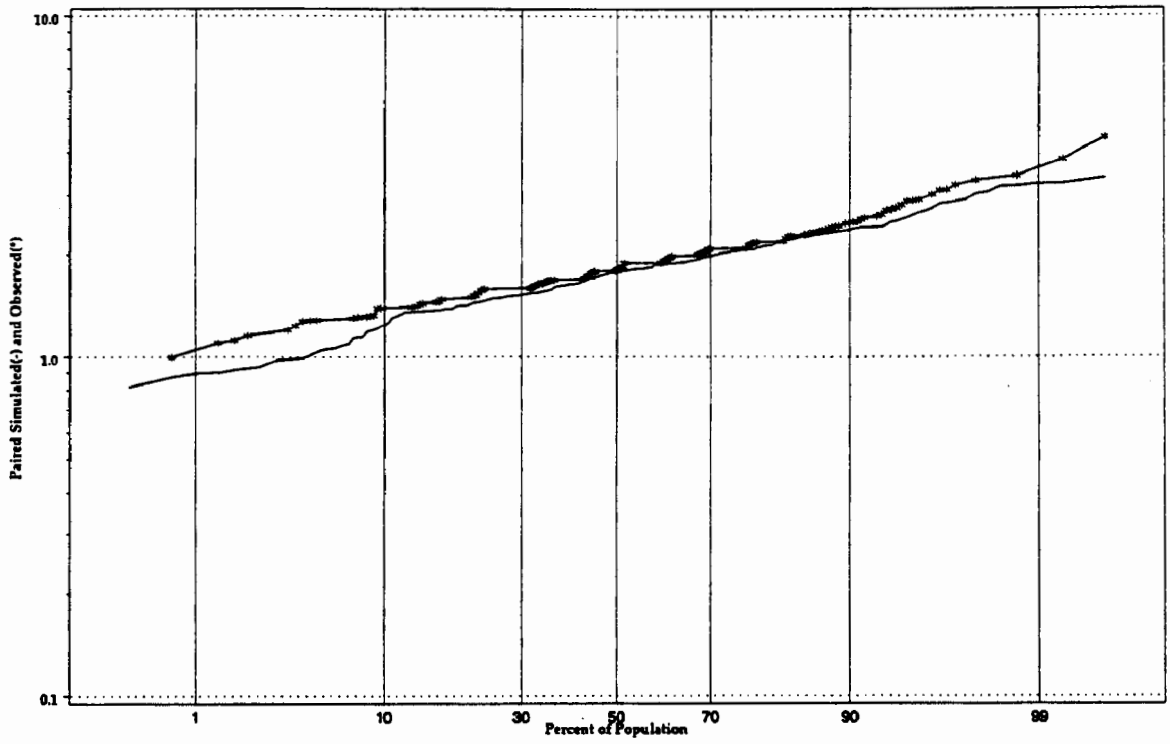
Susquehanna River at Segment 140

Actual Error versus Time

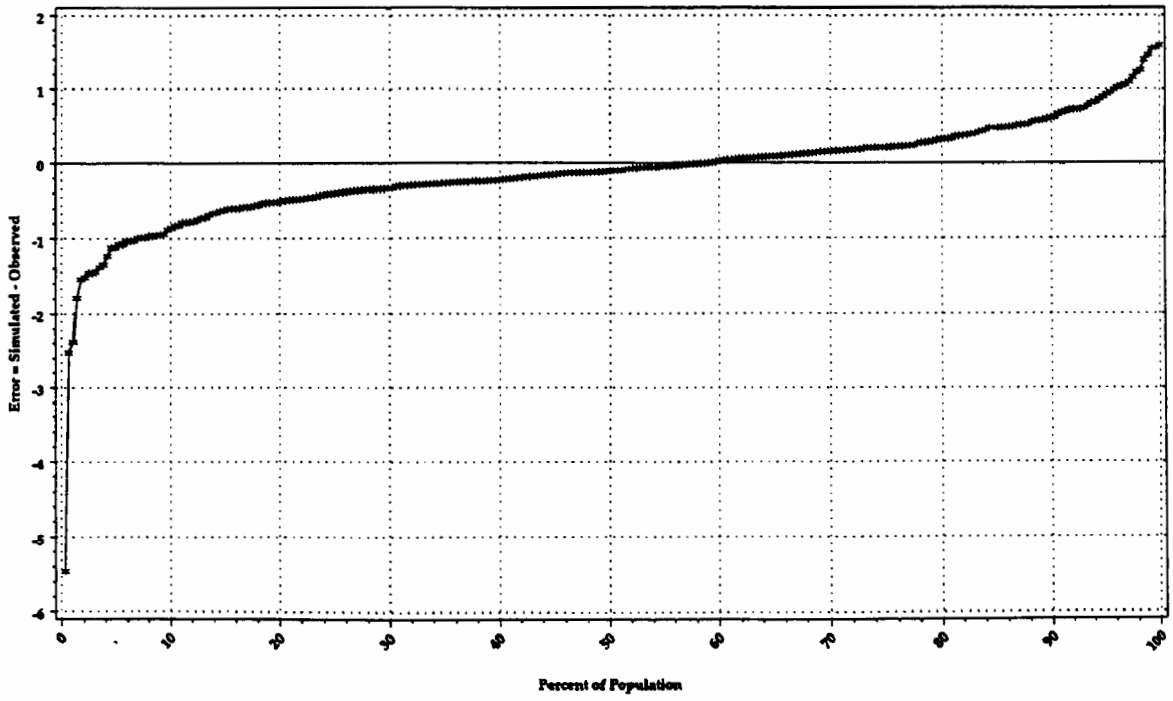
Total Nitrogen



Susquehanna River at Segment 140
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

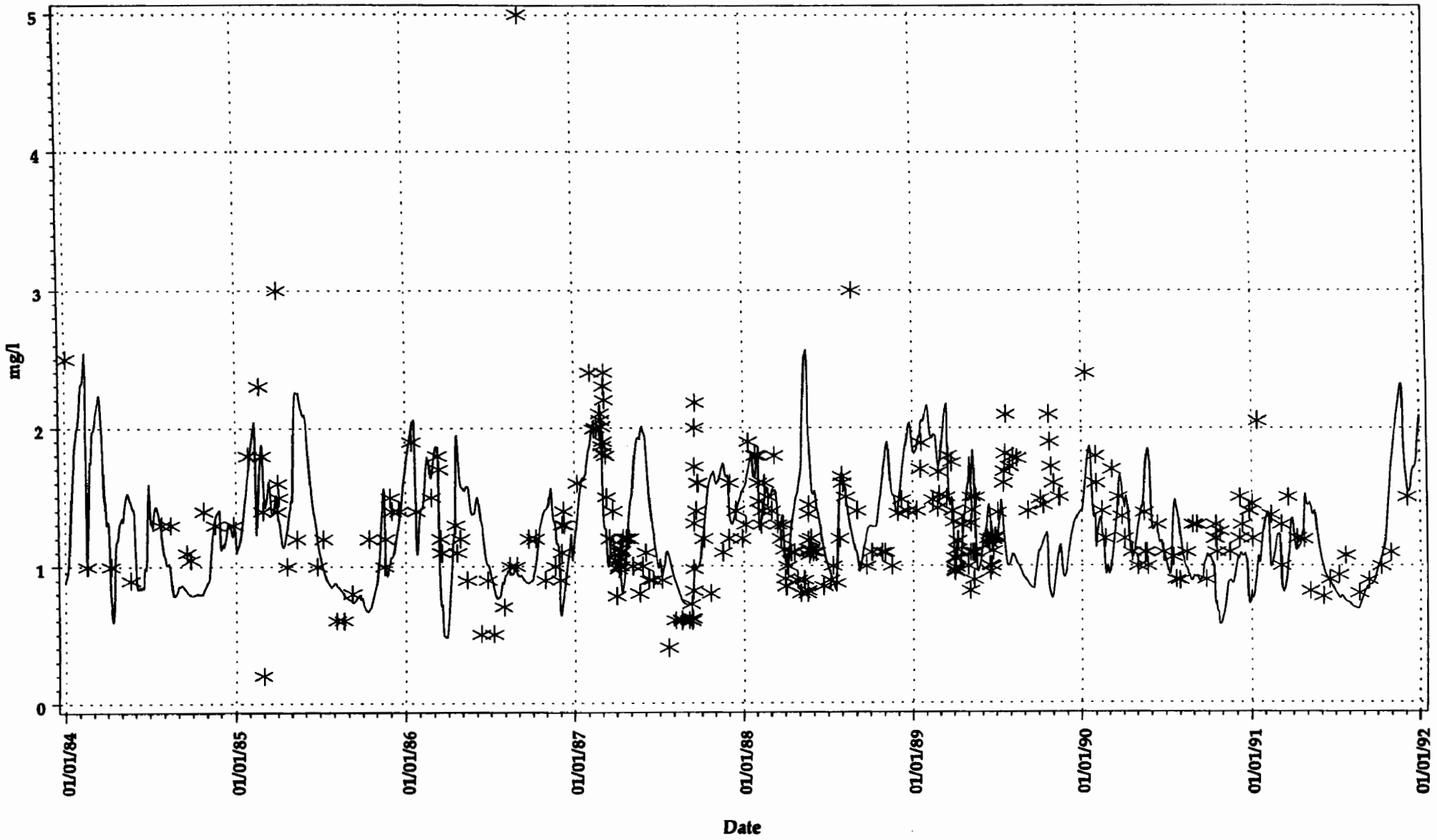


Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data



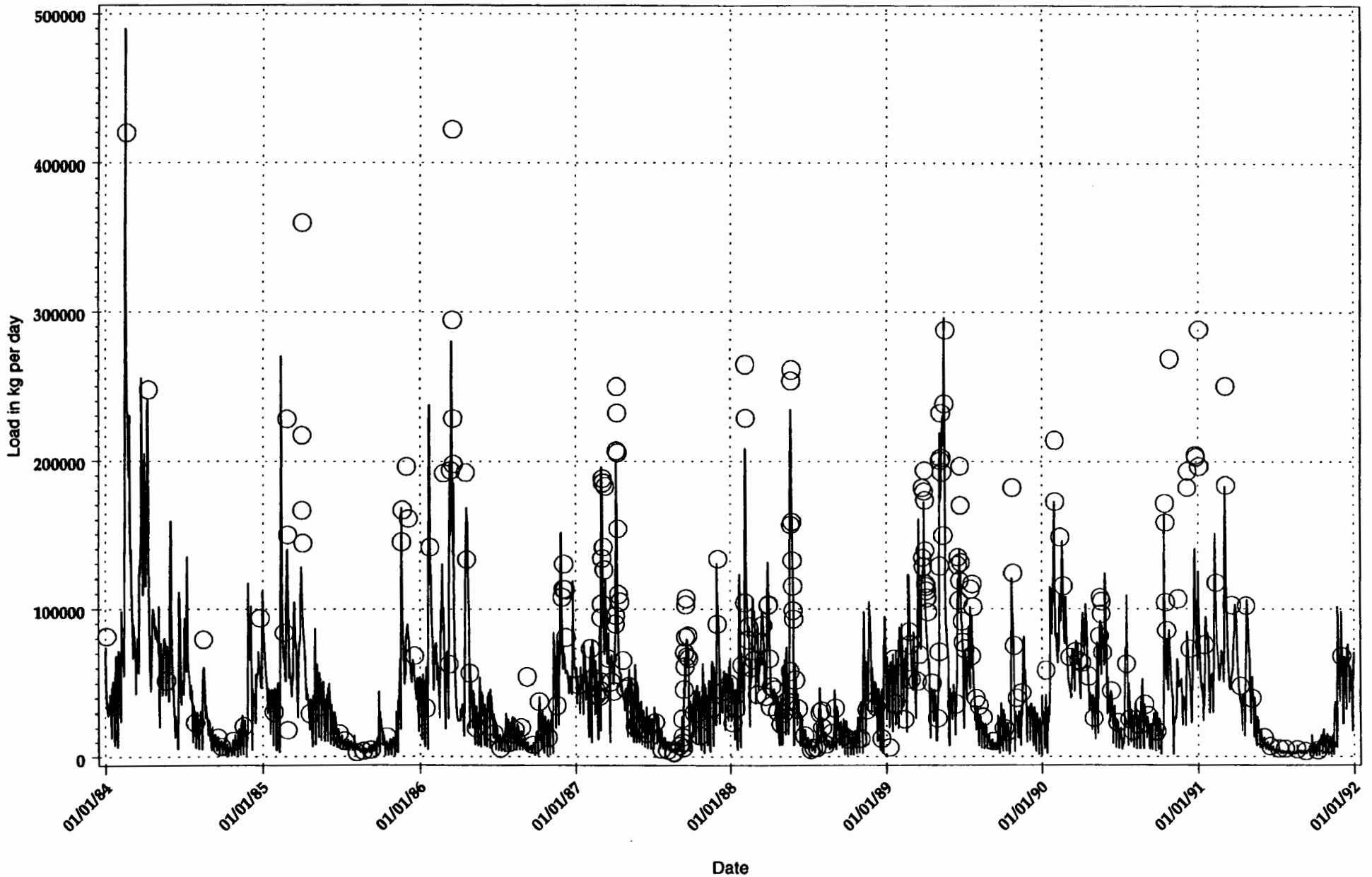
Susquehanna River at Segment 140
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



(p21_plots.sas model3d/gwang.dl(plotsmt - cmlime)
(bensv.dir 24FEB95 12:47)

Susquehanna River at Segment 140
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

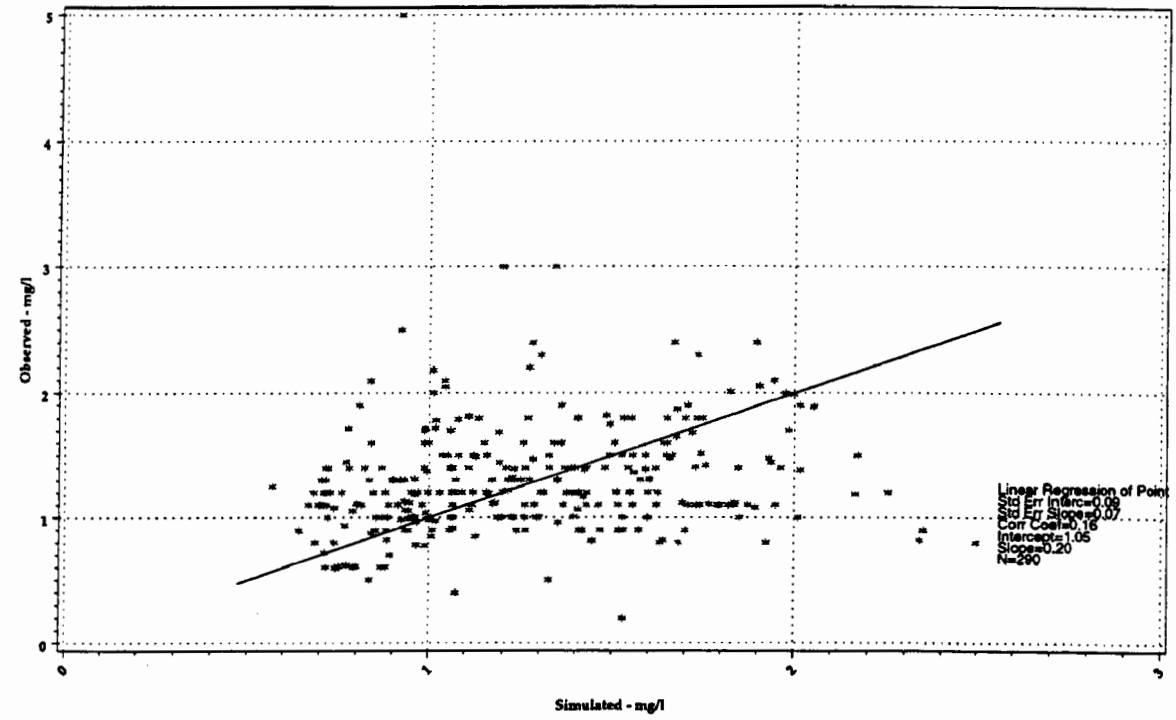


(y21_plotb.sas model3d:[pwang.dt] lidflas)
(conow.dnr 24FEB96 13:47,proc reg,model y=x)

Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

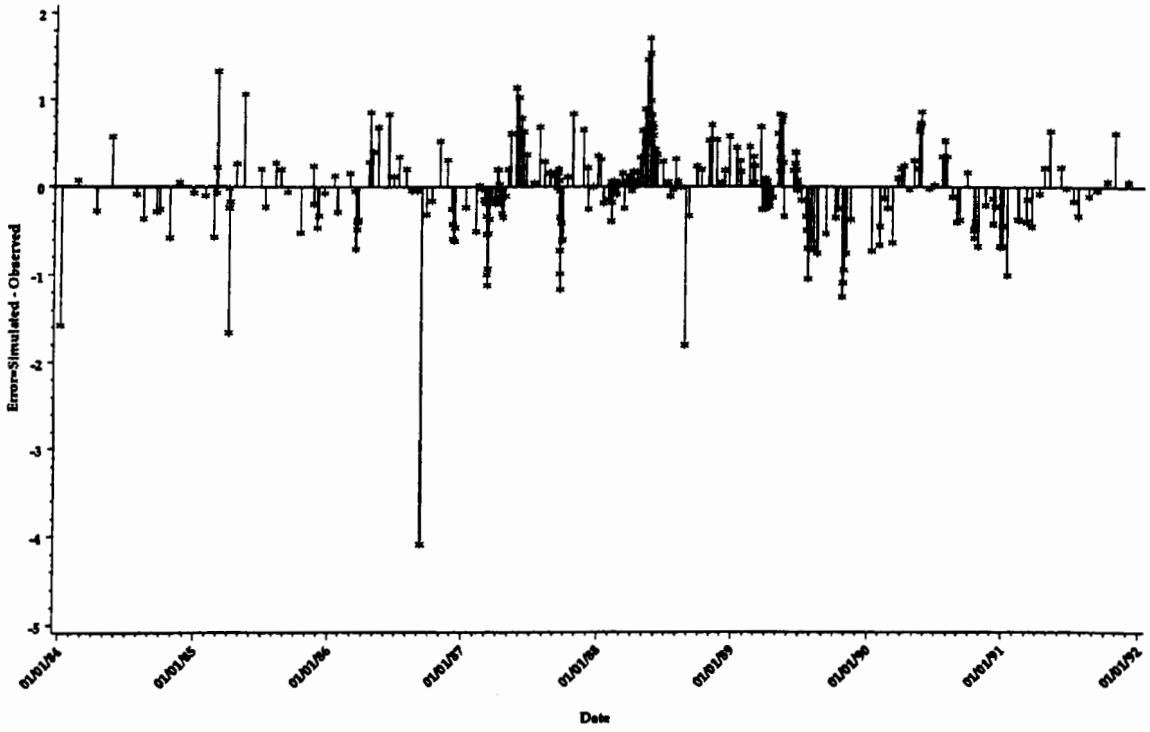
NO3: 01JAN84 - 01JAN92



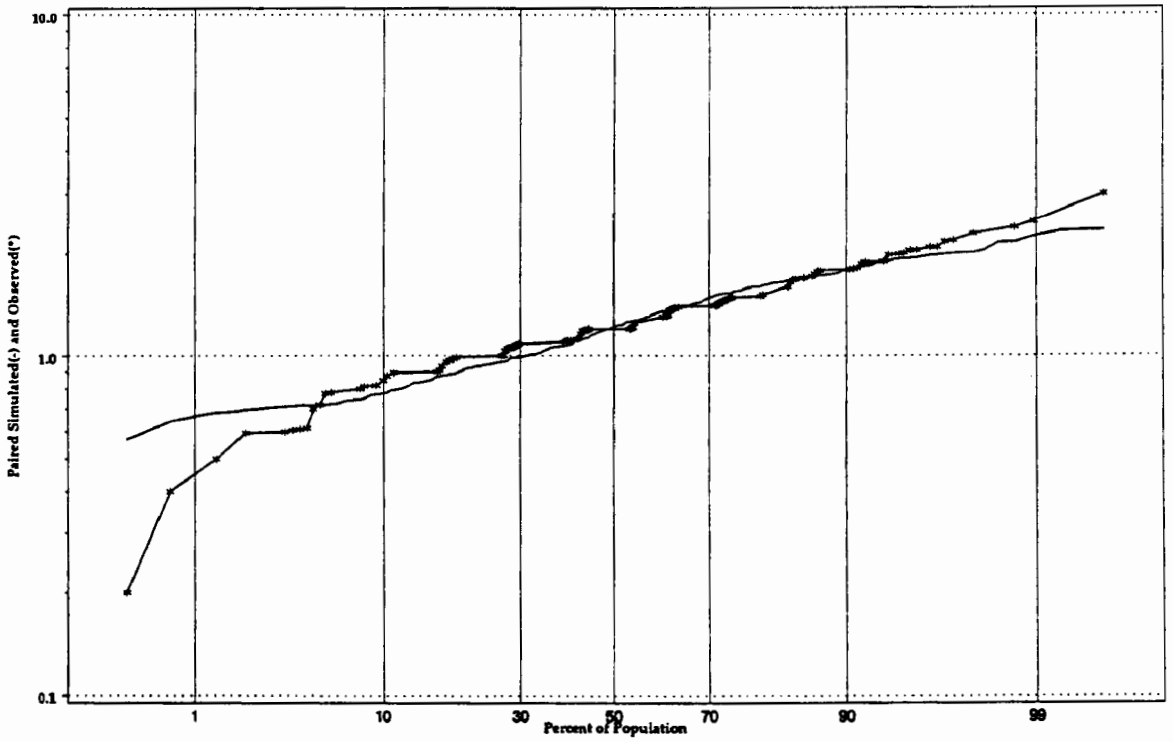
Susquehanna River at Segment 140

Actual Error versus Time

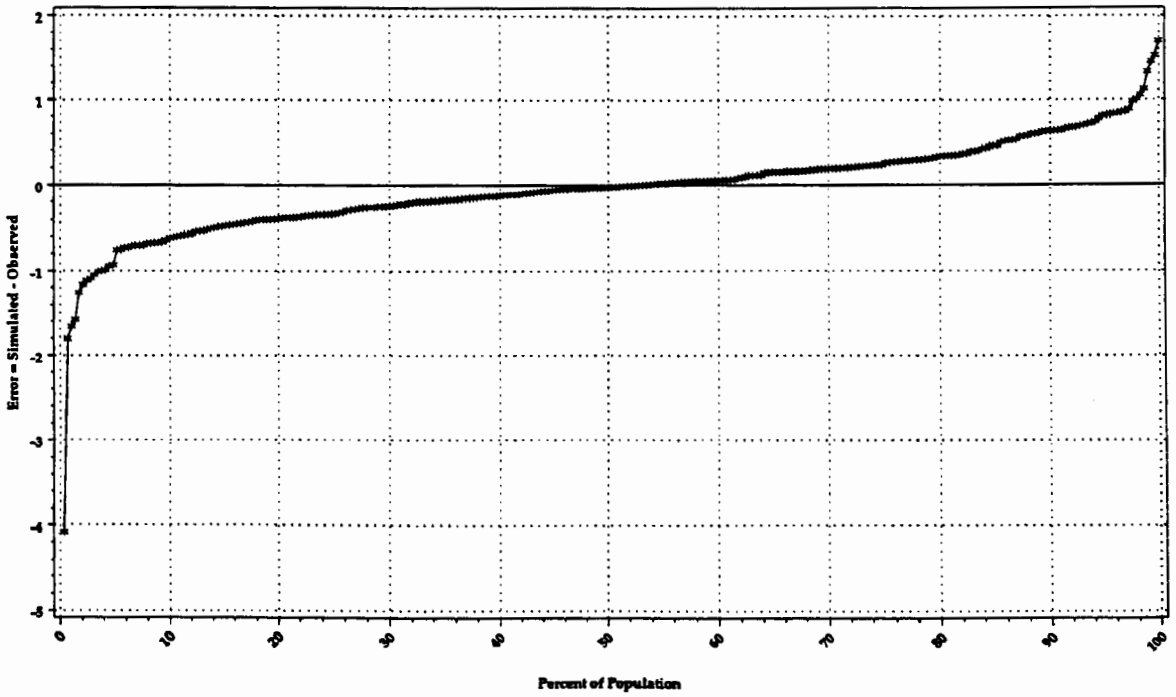
NO3



Susquehanna River at Segment 140
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

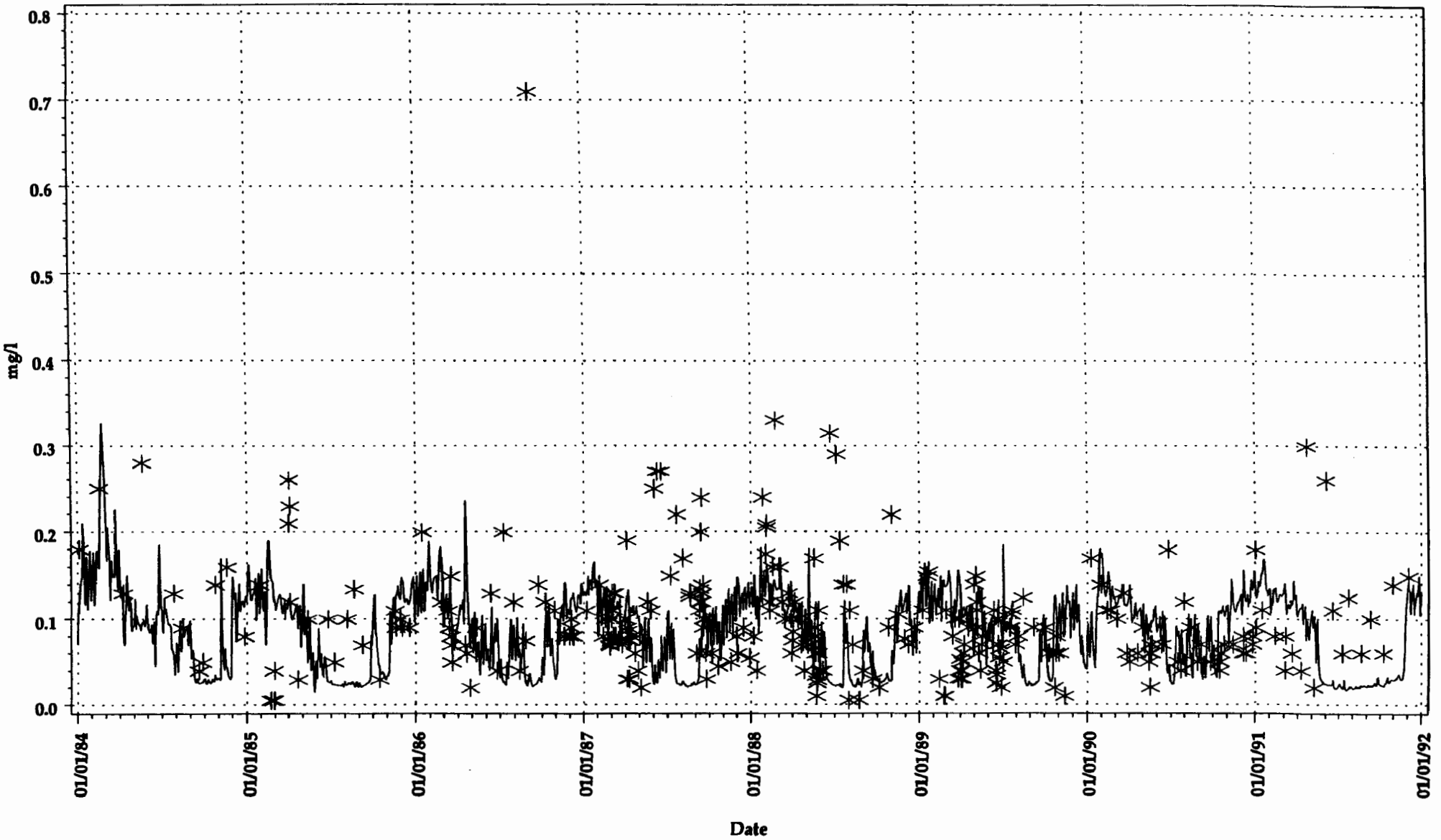


Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data



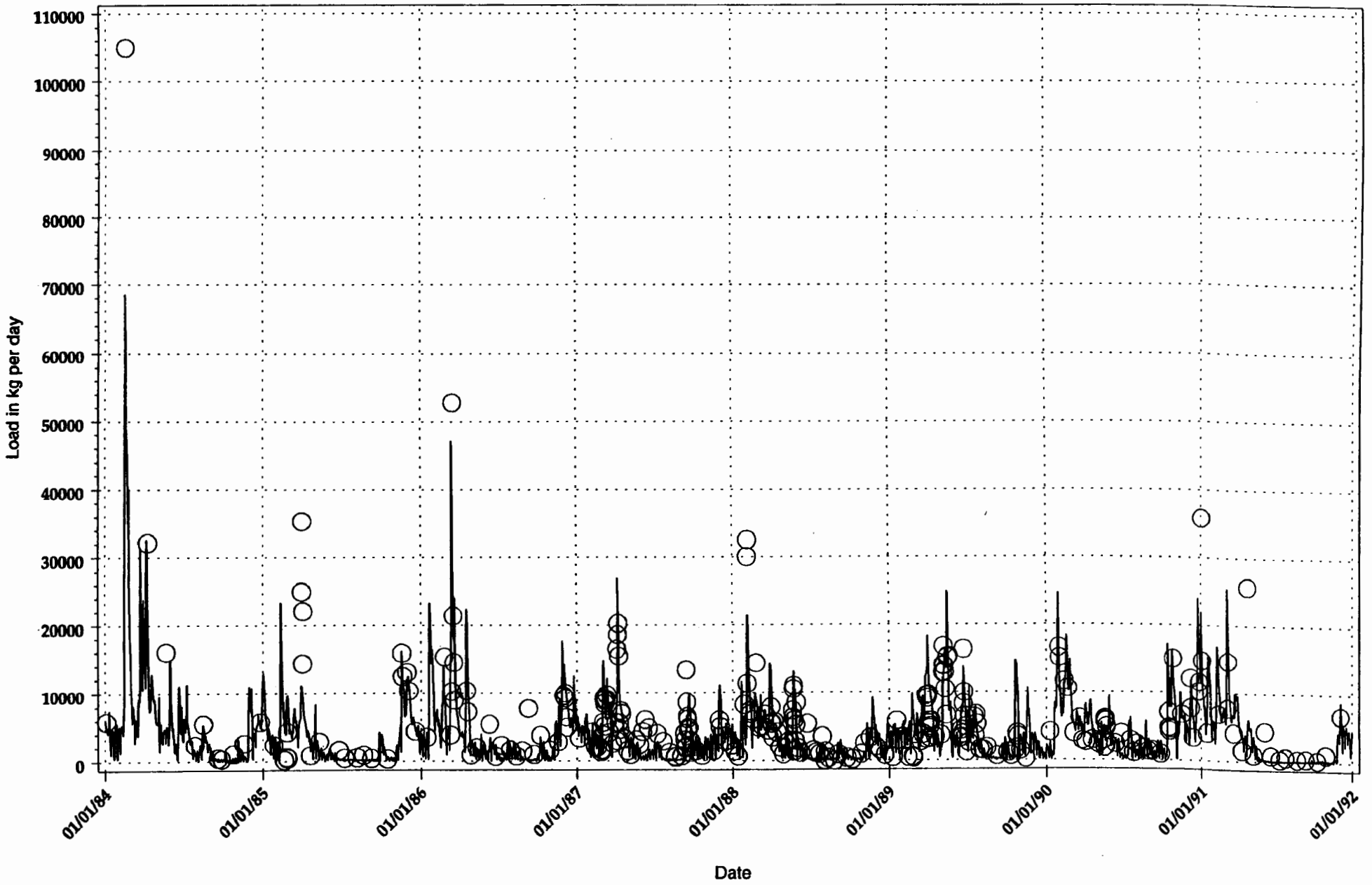
Susquehanna River at Segment 140
Observed and Simulated versus Time
Total Ammonia

(*=Observed, -=Simulated)



(y21_plotb.sas model3d.[illegible] plotsmt - cmflow)
(consor.dv 24FEB96 13:47)

Susquehanna River at Segment 140
Total Ammonia Observed and Simulated Load vs Time
(line = simulated, O = observed)

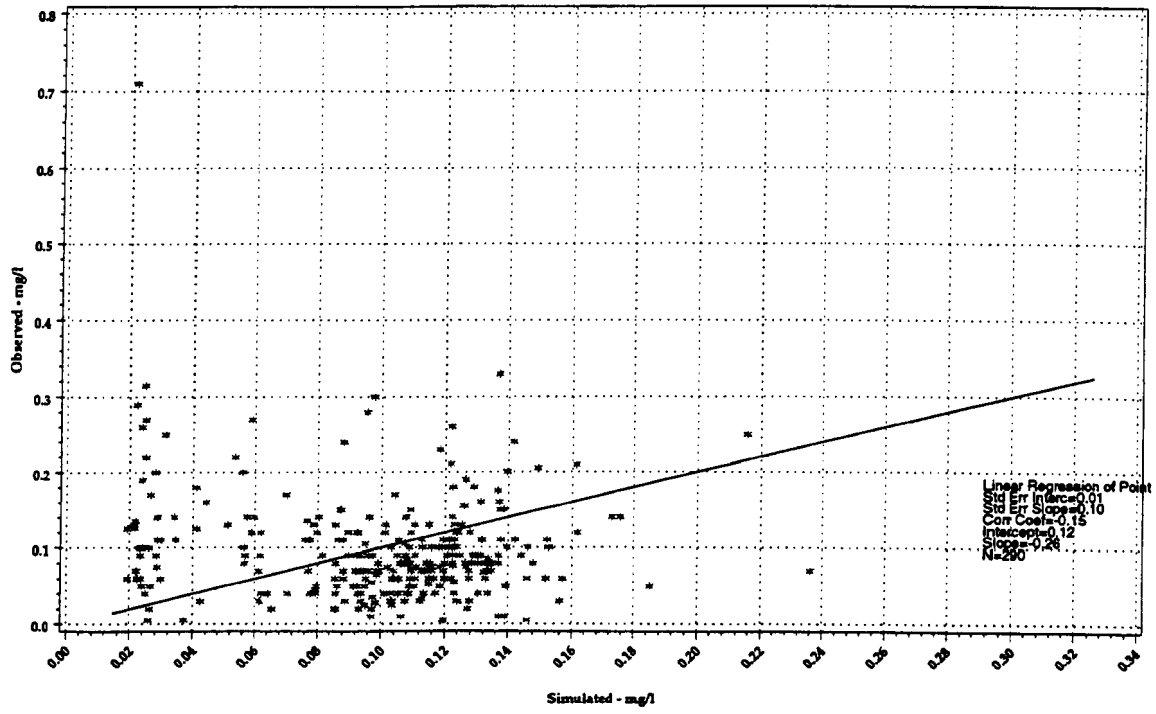


[y21_plotb.sas model3d(pwang.dl) lidlas)
(conow.drv 23FEB96 12:14,proc reg,model y=x)

Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

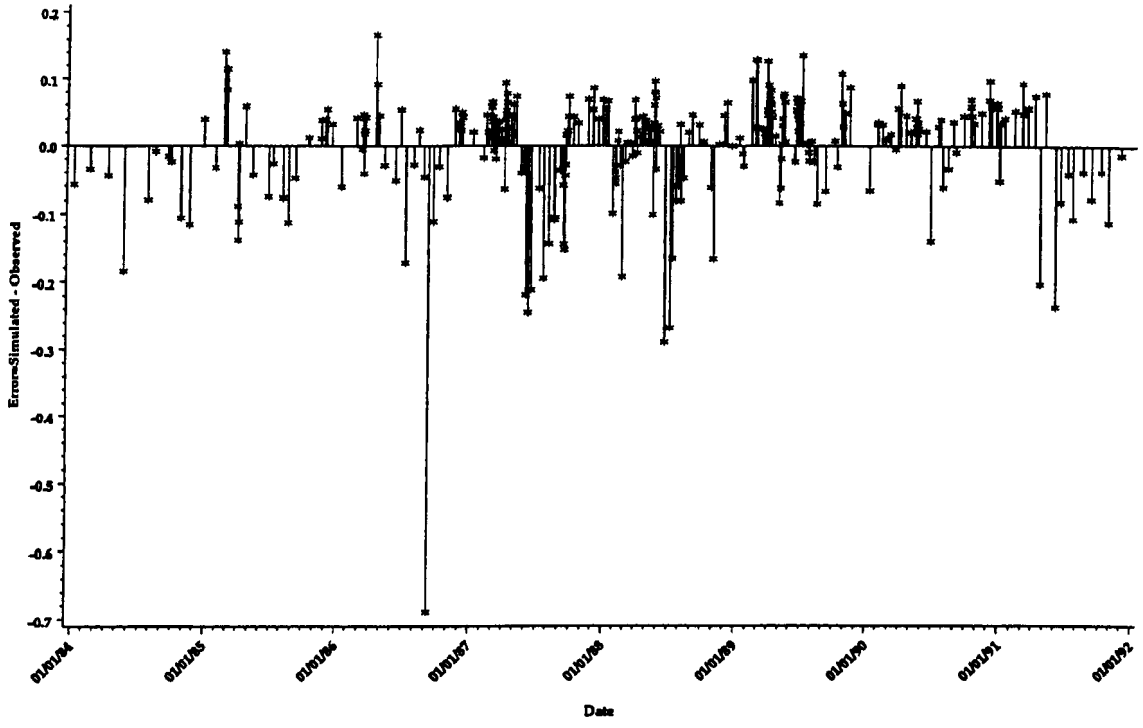
Total Ammonia: 01JAN84 - 01JAN92



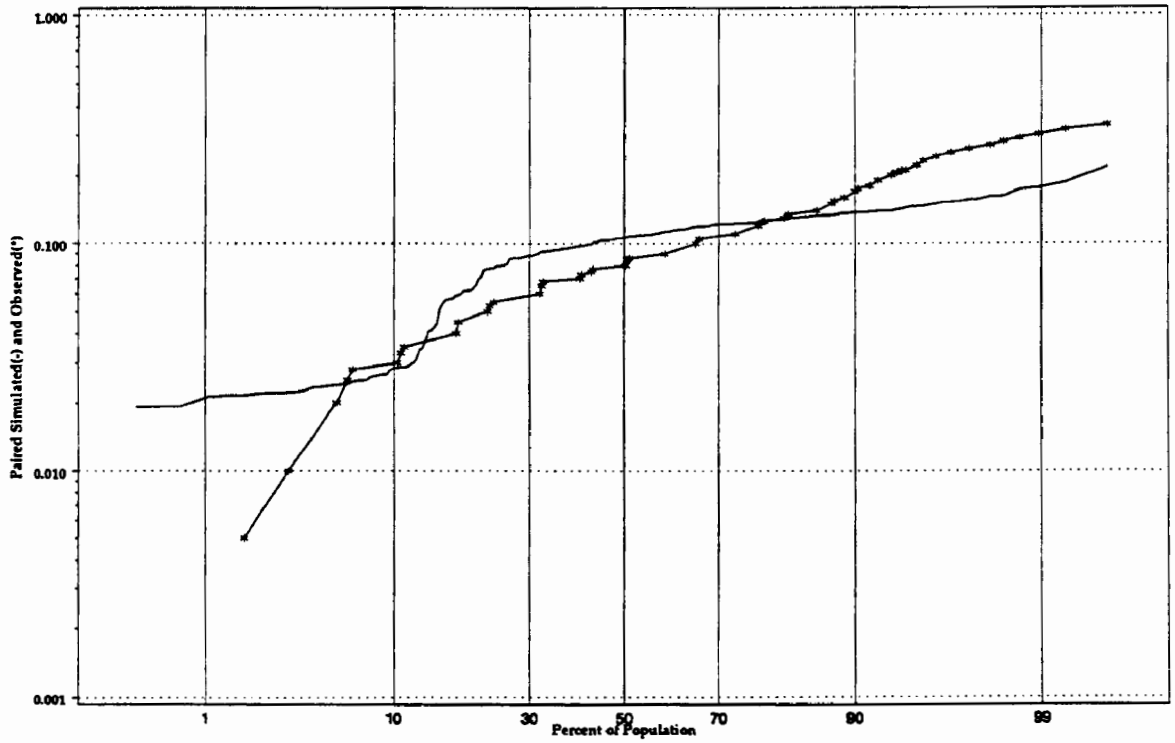
Susquehanna River at Segment 140

Actual Error versus Time

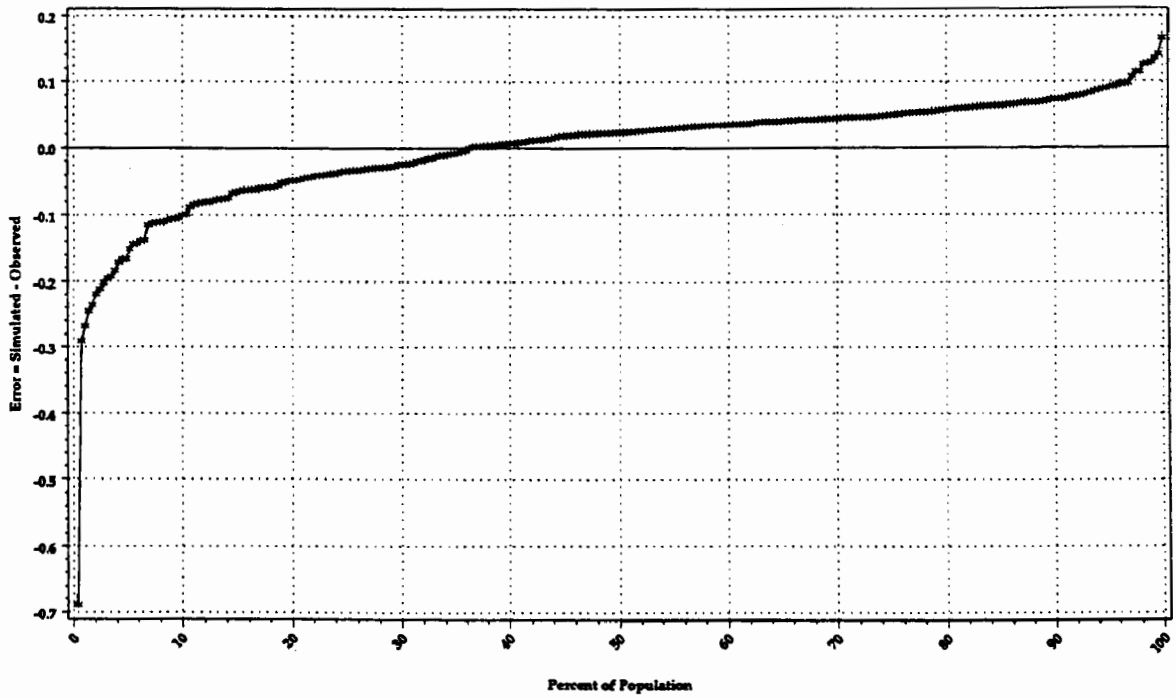
Total Ammonia



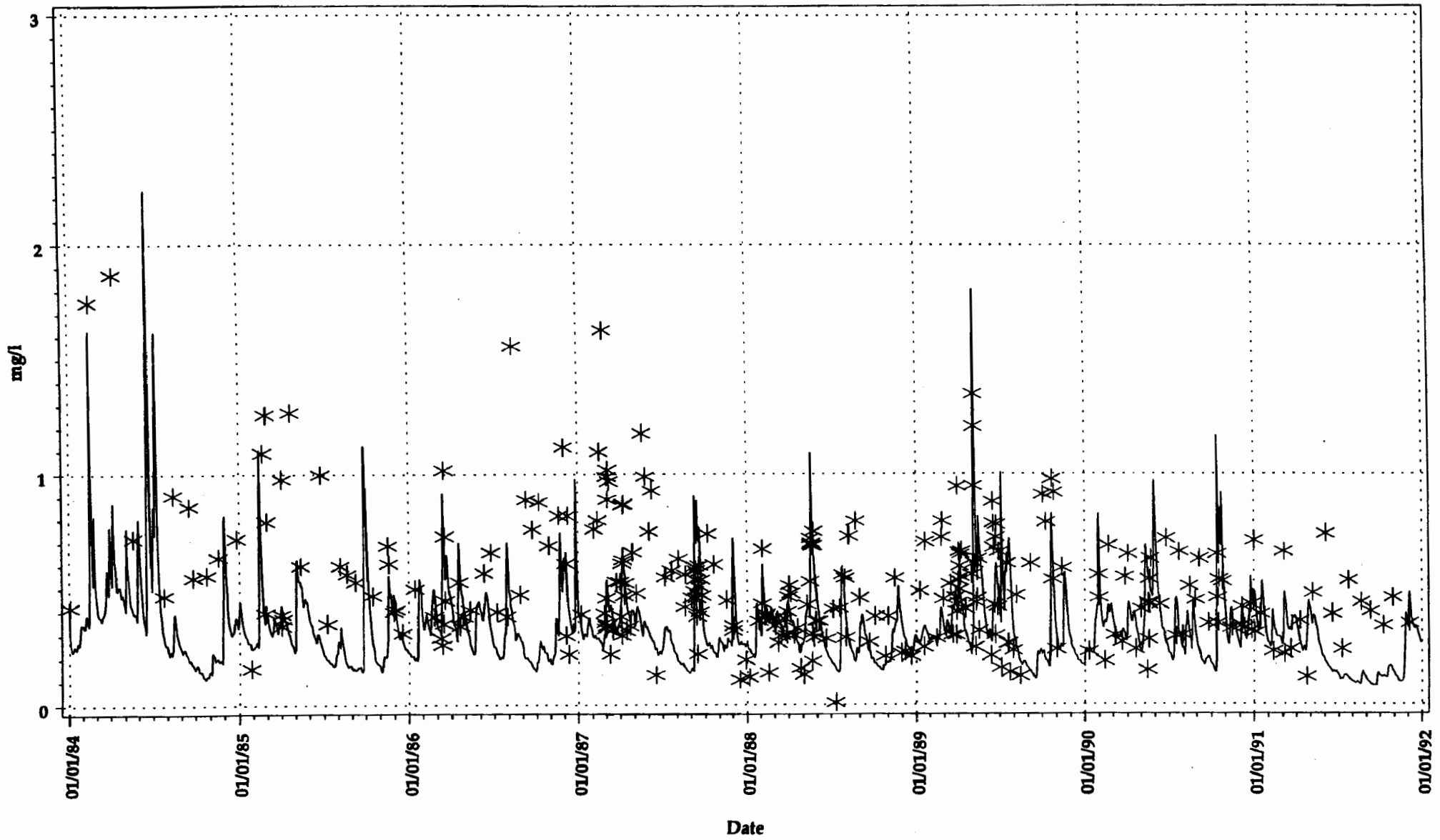
Susquehanna River at Segment 140
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



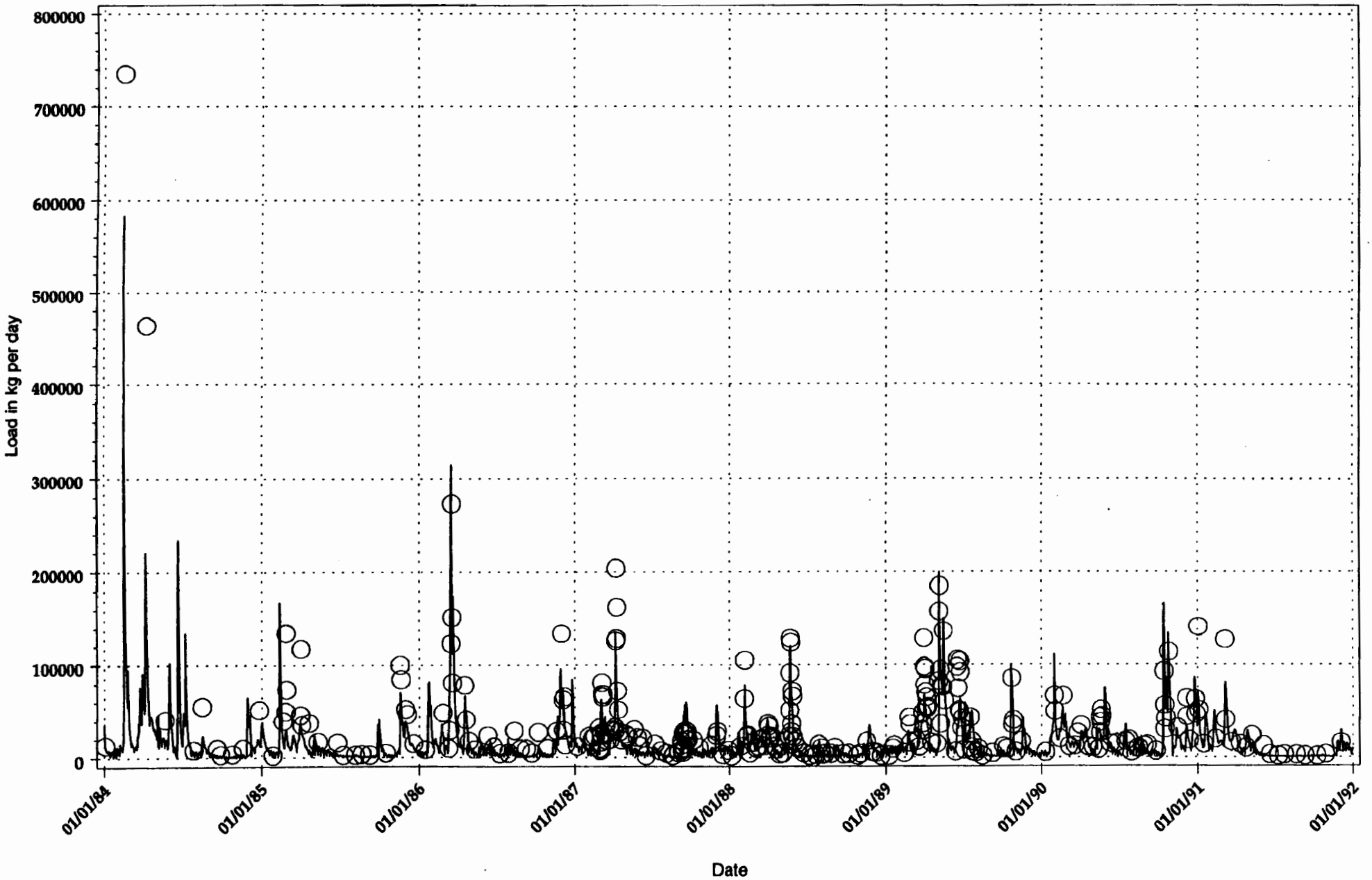
Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



Susquehanna River at Segment 140
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)



Susquehanna River at Segment 140
Organic Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)

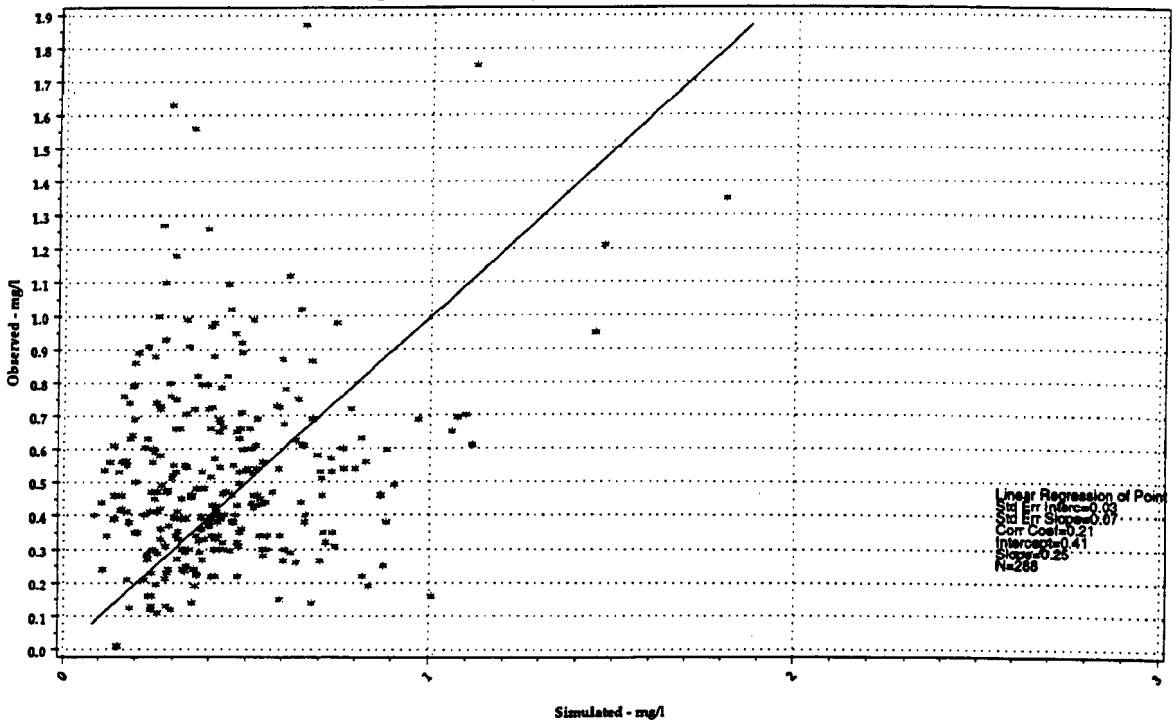


(y21_plotb.sas model3d:(pwang.dt) ldfiles)
(concw.drv 23FEB96 12:14,proc reg,model y=x)

Susquehanna River at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

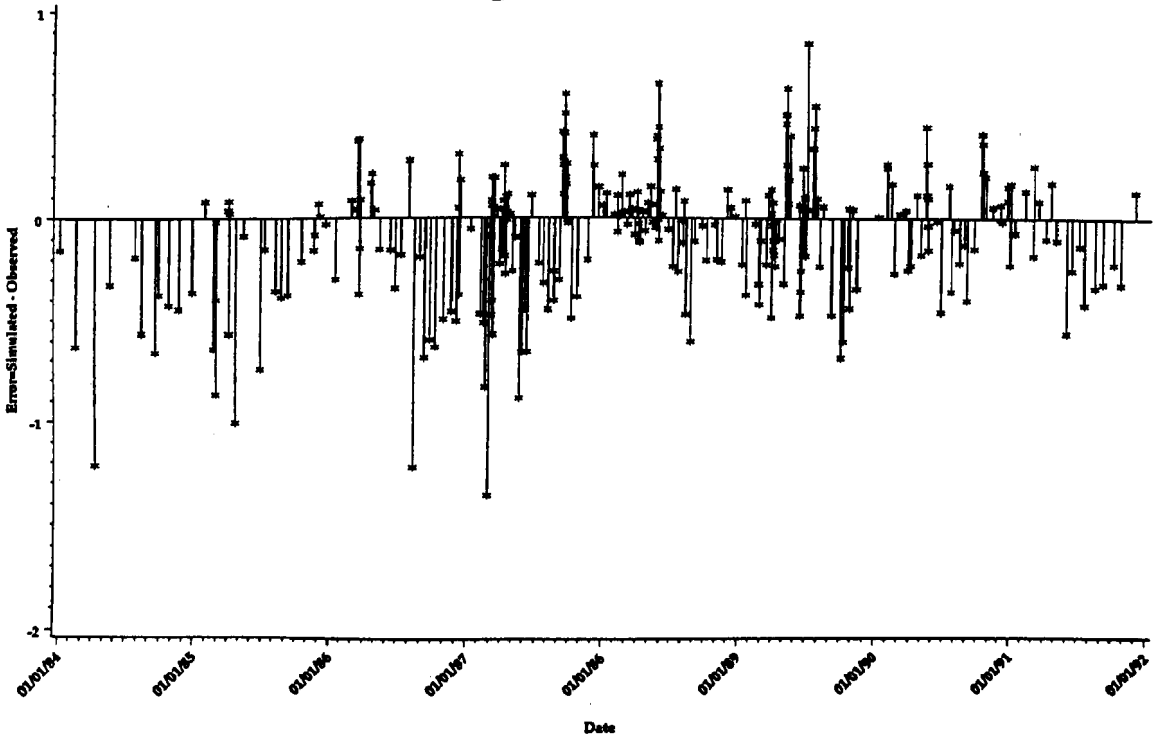
Organic Nitrogen: 01JAN84 - 01JAN92



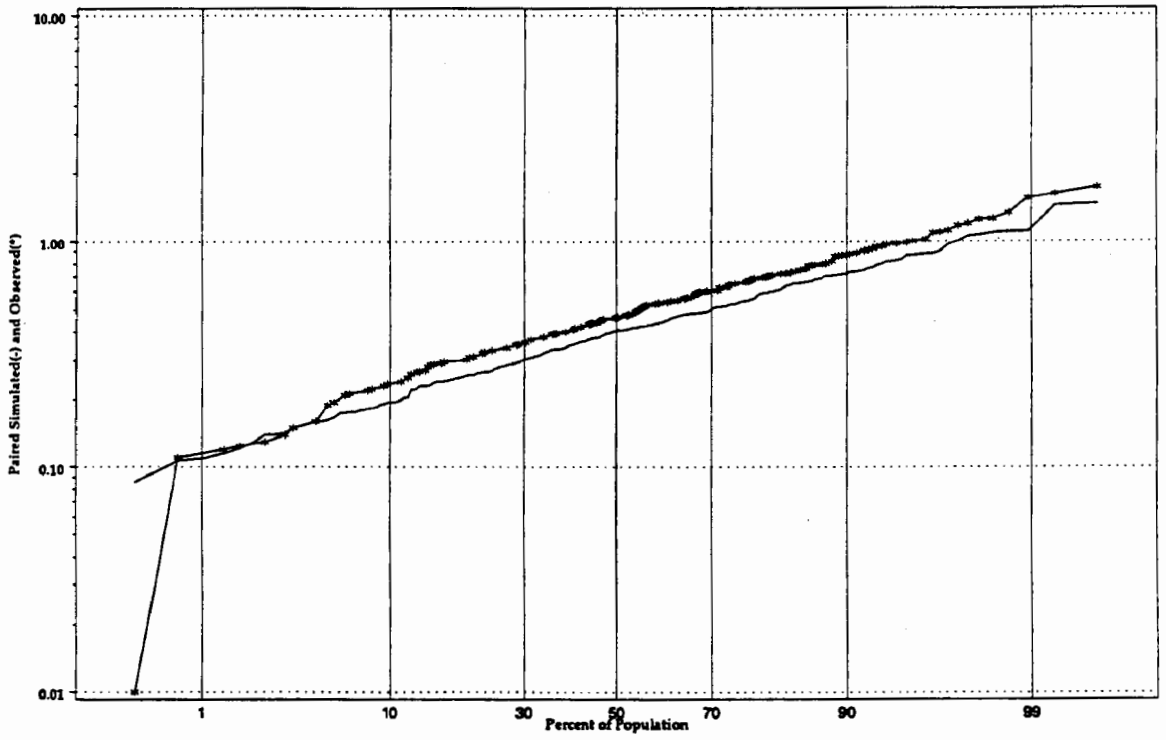
Susquehanna River at Segment 140

Actual Error versus Time

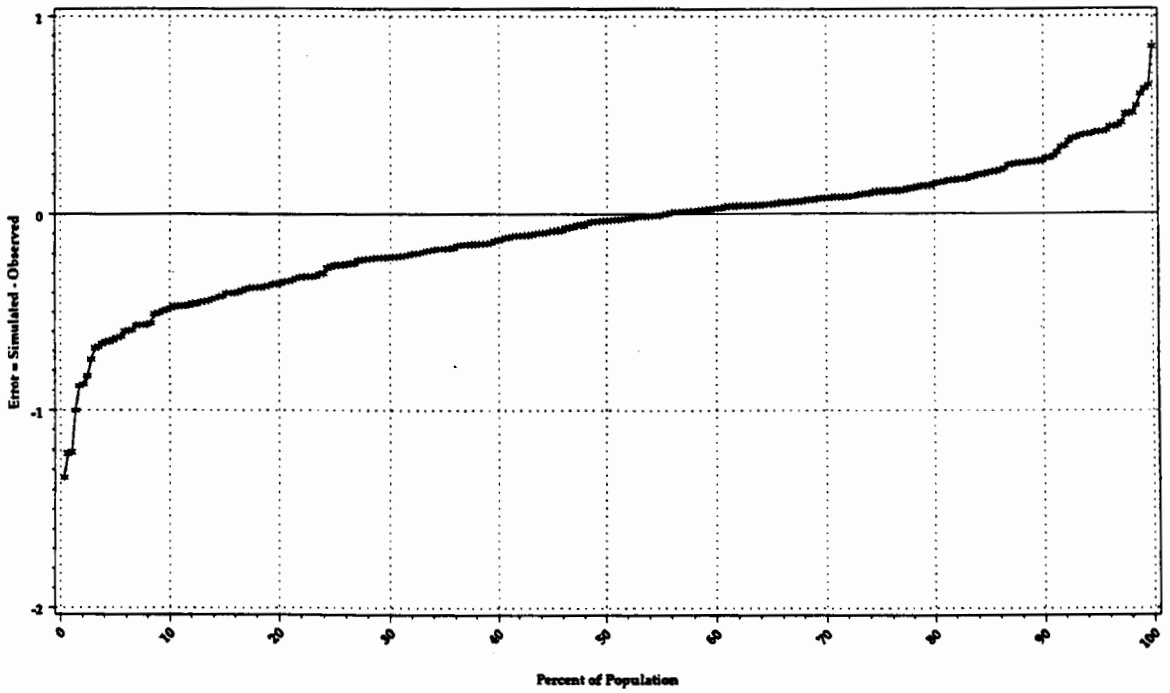
Organic Nitrogen



Susquehanna River at Segment 140
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Susquehanna River at Segment 140
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.2.0 Patuxent River

Basin Segments:

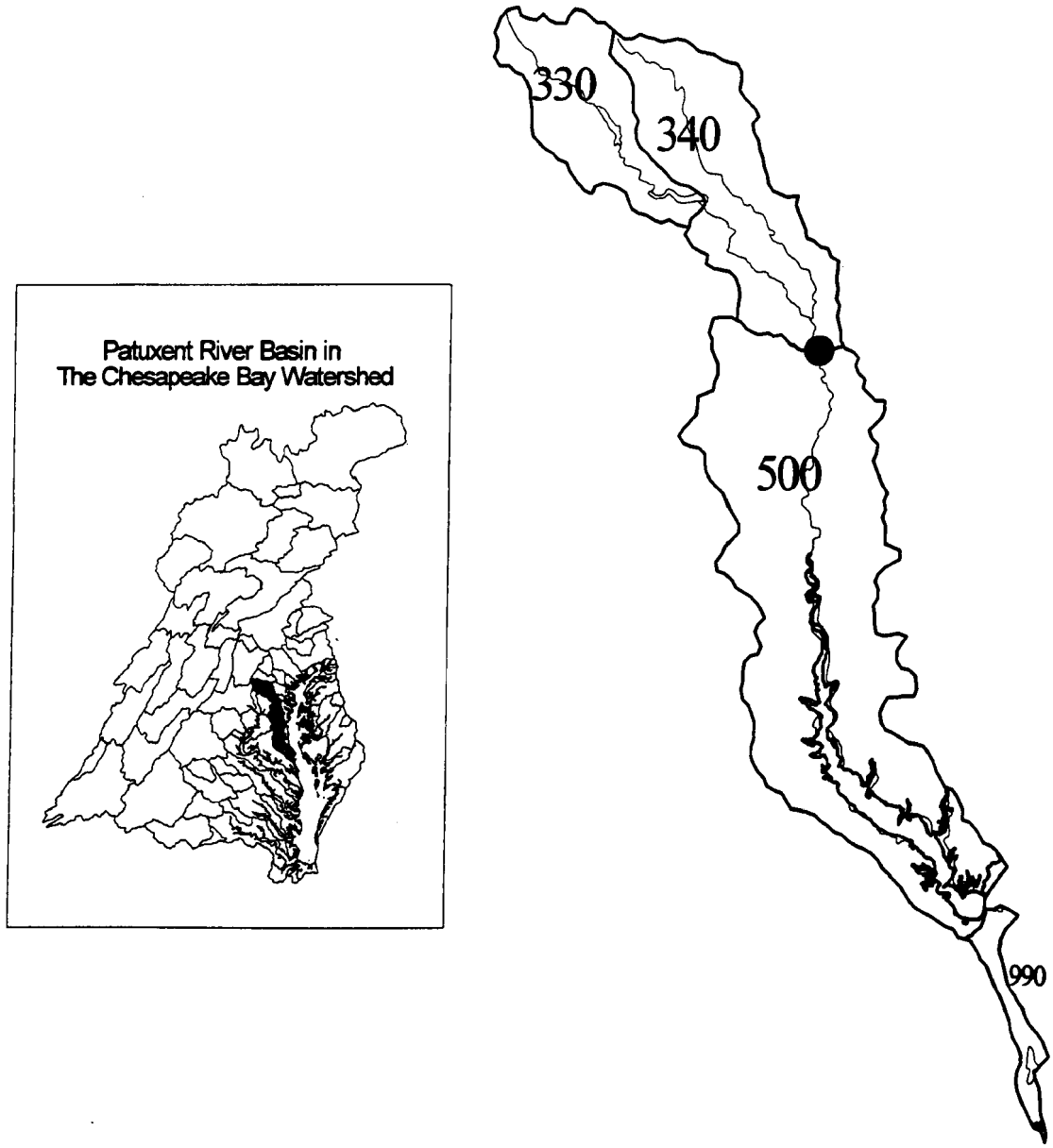
Above Fall Line Basin Segments: 330, and 340
Below Fall Line Basin Segments: 500, and 990

Section Contents:

B.2.0 Monitoring Stations in the Patuxent River Basin (Figure B.2.0)
B.2.1 Patuxent River, near Bowie, MD (Monitoring Station: 1594440)

Figure B.2

Monitoring Stations in the Patuxent River Basin



Calibration Stations
● 1594440
Streams
Model Segments

Chesapeake Bay Program

Map Date: April 1998

Source: USGS and USEPA Chesapeake Bay Program

N

KJH

B.2.1 Patuxent River near Bowie, MD at Segment 340 (Monitoring Station: 1594440) (Above Fall Line Basin Segments: 330, 340, 500, and 990)

Section Summary:

The Patuxent basin is the most urbanized of the major Chesapeake Bay Program basins. The water quality time series reflects the urban, hydrologically "flashy" character of the basin. Basin water quality is dominated by point source discharges. Changes in point source discharges over the simulation period including the phosphorus detergent ban in January, 1984, and Biological Nutrient Removal (BNR) treatment in the 1990s have resulted in large step-wise changes in water quality in both the observed and simulated water quality data.

The Patuxent basin above the gaged site covers an area of 902 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 45% forest land, 19% cropland, 11% other agricultural areas, 24% urban areas, and 2% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 5.7 million pounds in 1985 to 5.1 million pounds in 1996. Total phosphorus loads over the same time period decreased from 0.53 million pounds to 0.35 million pounds. In general, point source loads above the gage site decreased. In 1996, the total nitrogen point source load was 22% of the total load and the total phosphorus point source load was 28% of the total load. Estimated septic system total nitrogen loads increased 30%, from 0.31 million pounds in 1985 to 0.41 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 15%, and other agricultural loads (primarily pasture and manure loads) by 34%. Total phosphorus decreased for these land uses by 16% and 44% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 22% for total nitrogen and 23% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

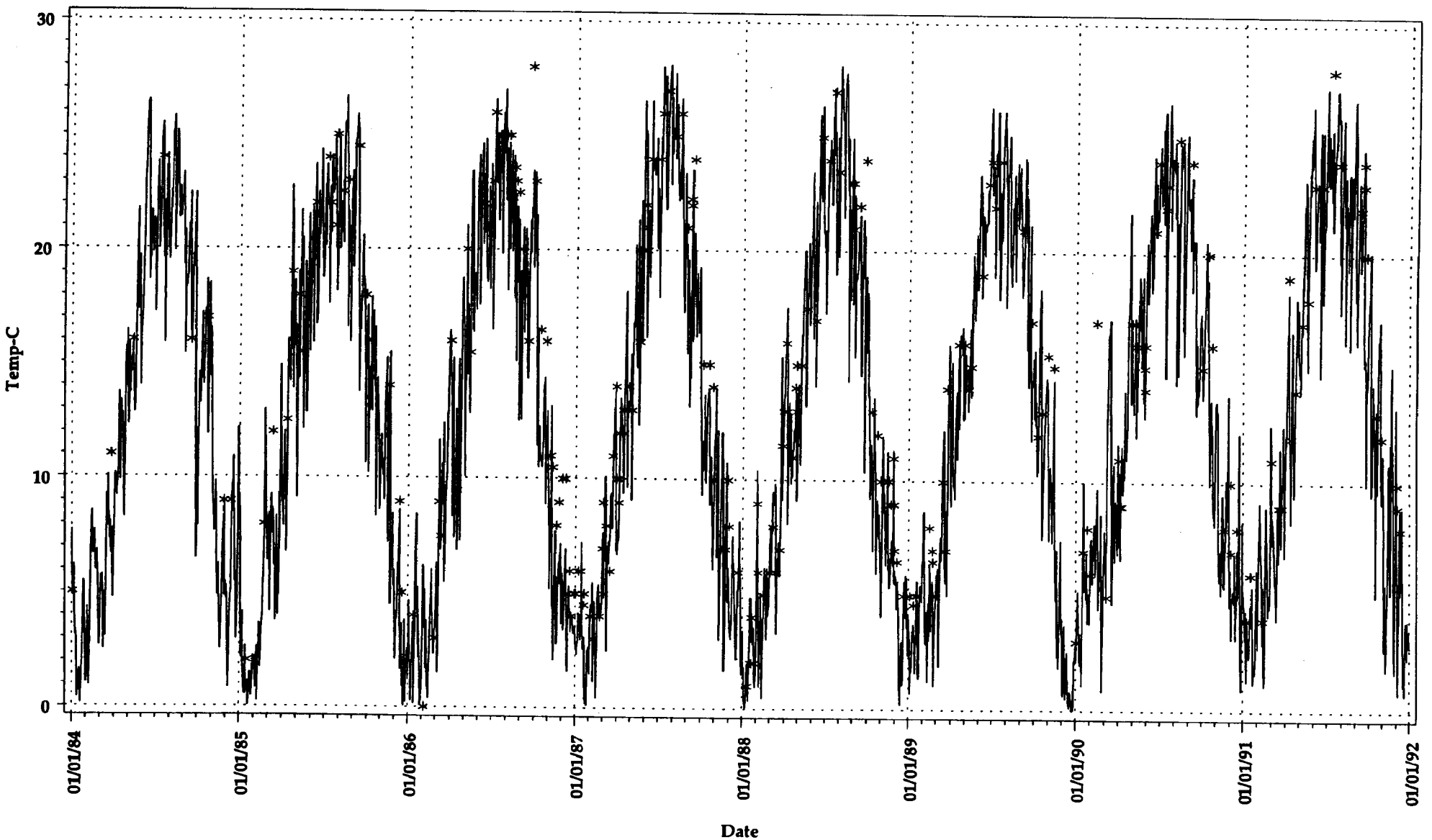
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

Patuxent River at Segment 340
Observed and Simulated versus Time
Temperature-C

(*=Observed, -=Simulated)

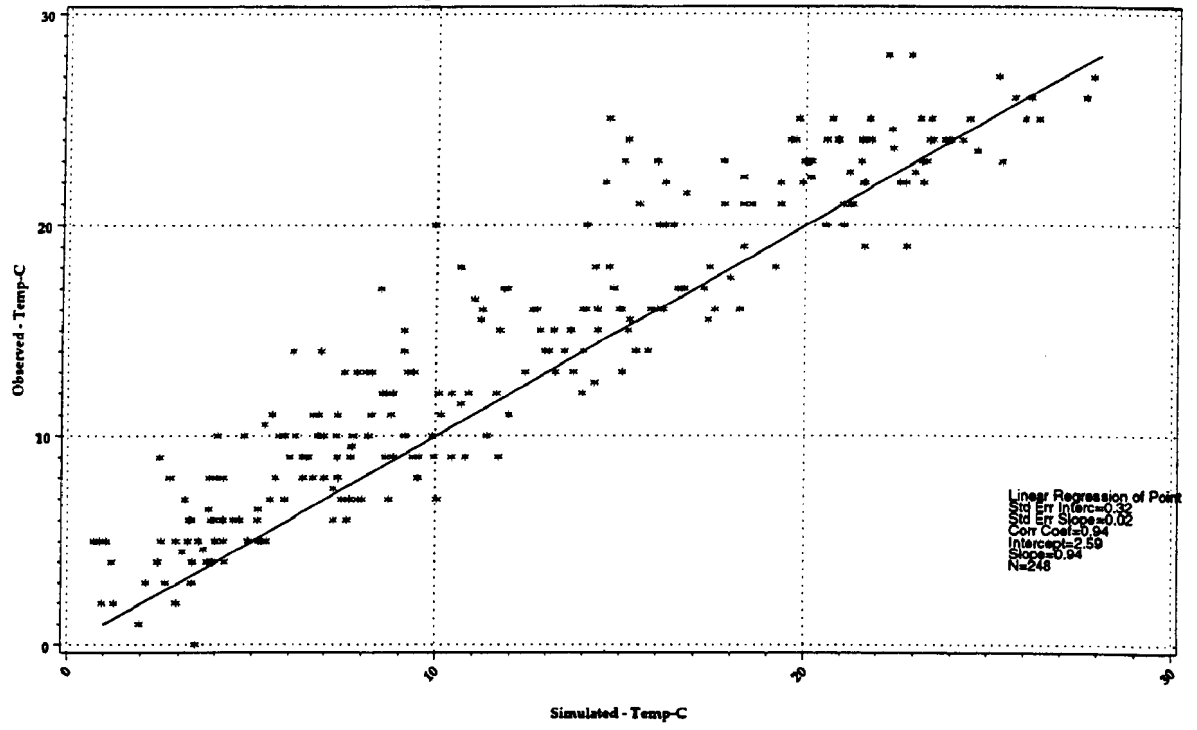


(y21_plotb.aes model3d:[pwang.dt] plotomt - omtime)
(petux340.drv 20FEB96 09:44)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

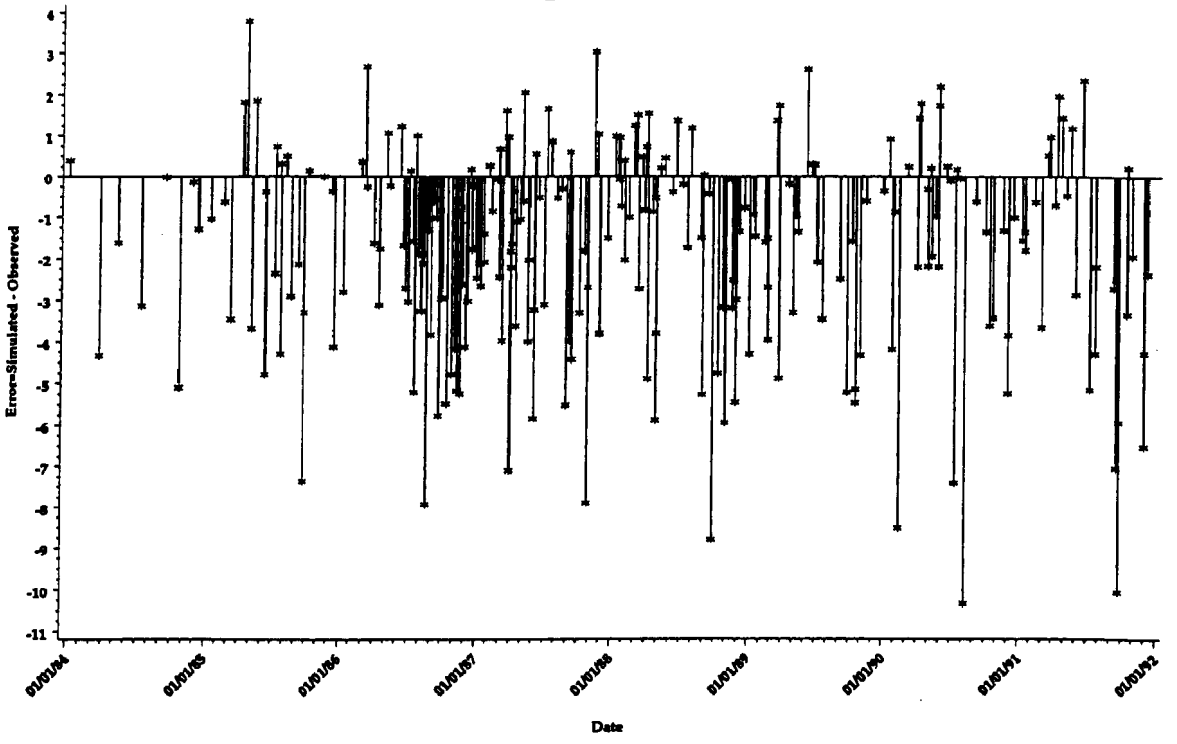
Temperature-C: 01JAN84 - 01JAN92



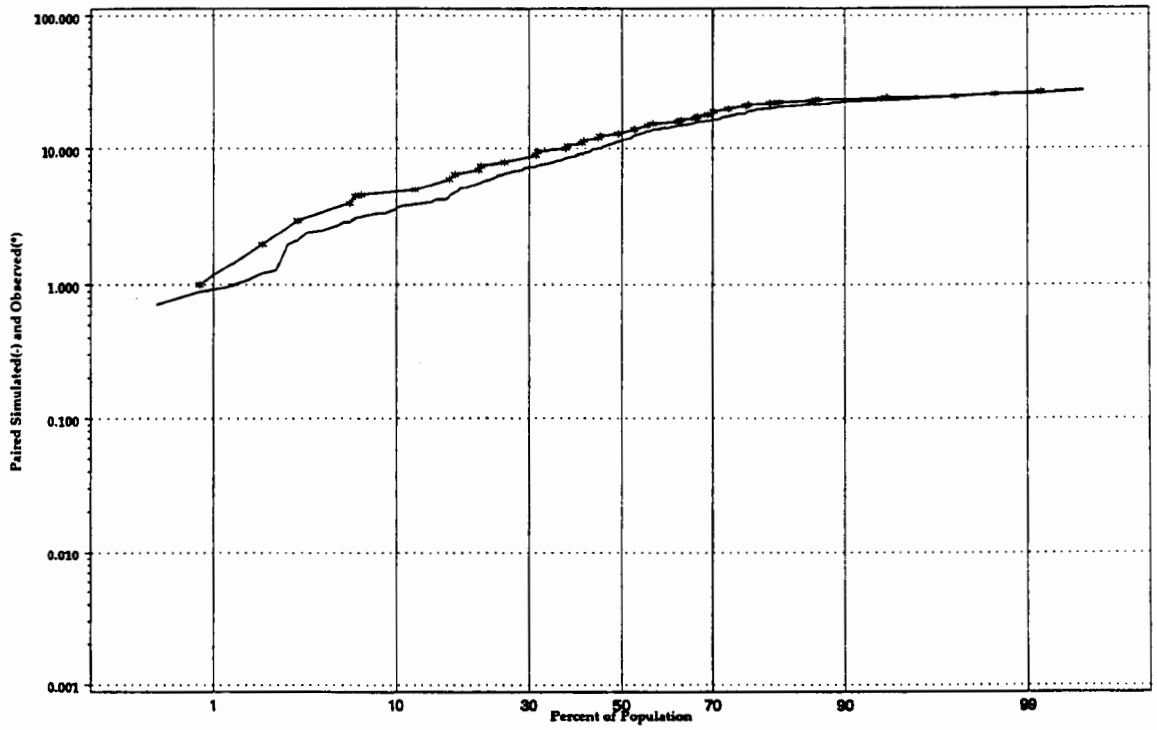
Patuxent River at Segment 340

Actual Error versus Time

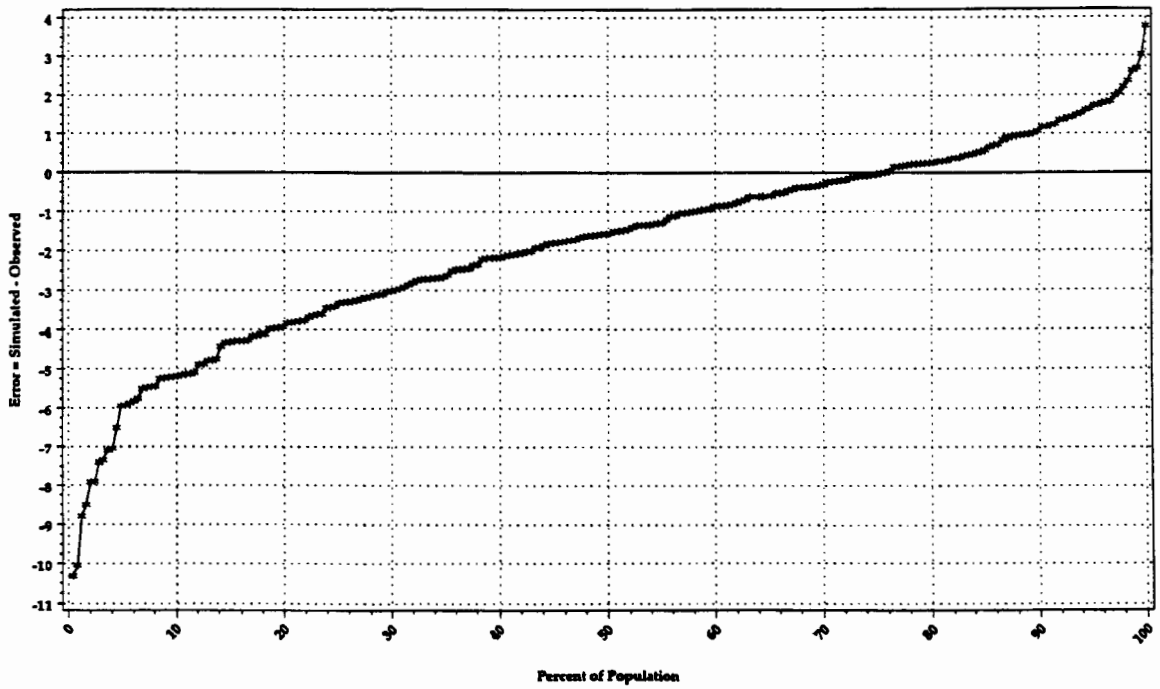
Temperature-C



Patuxent River at Segment 340
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

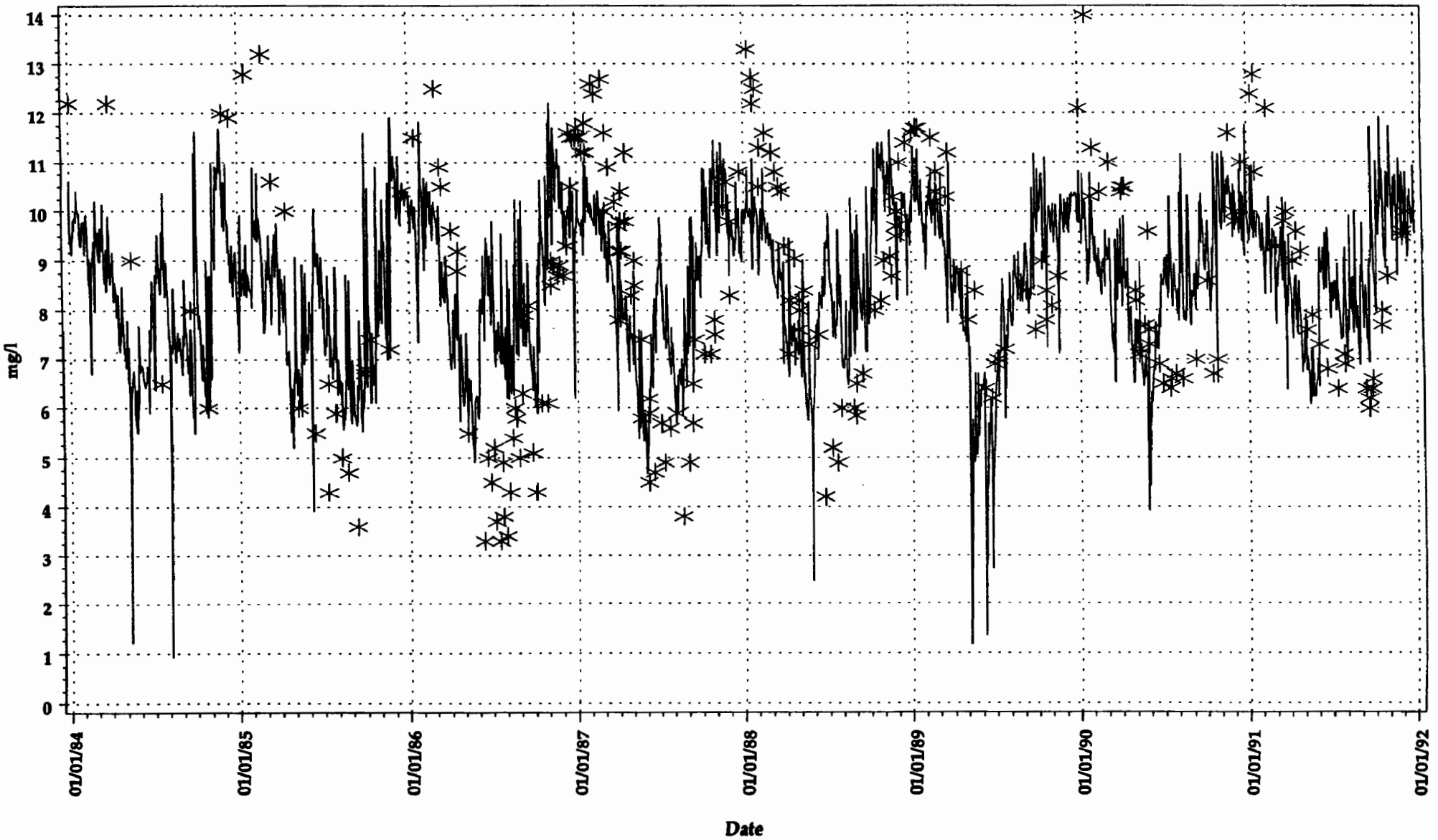


Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data

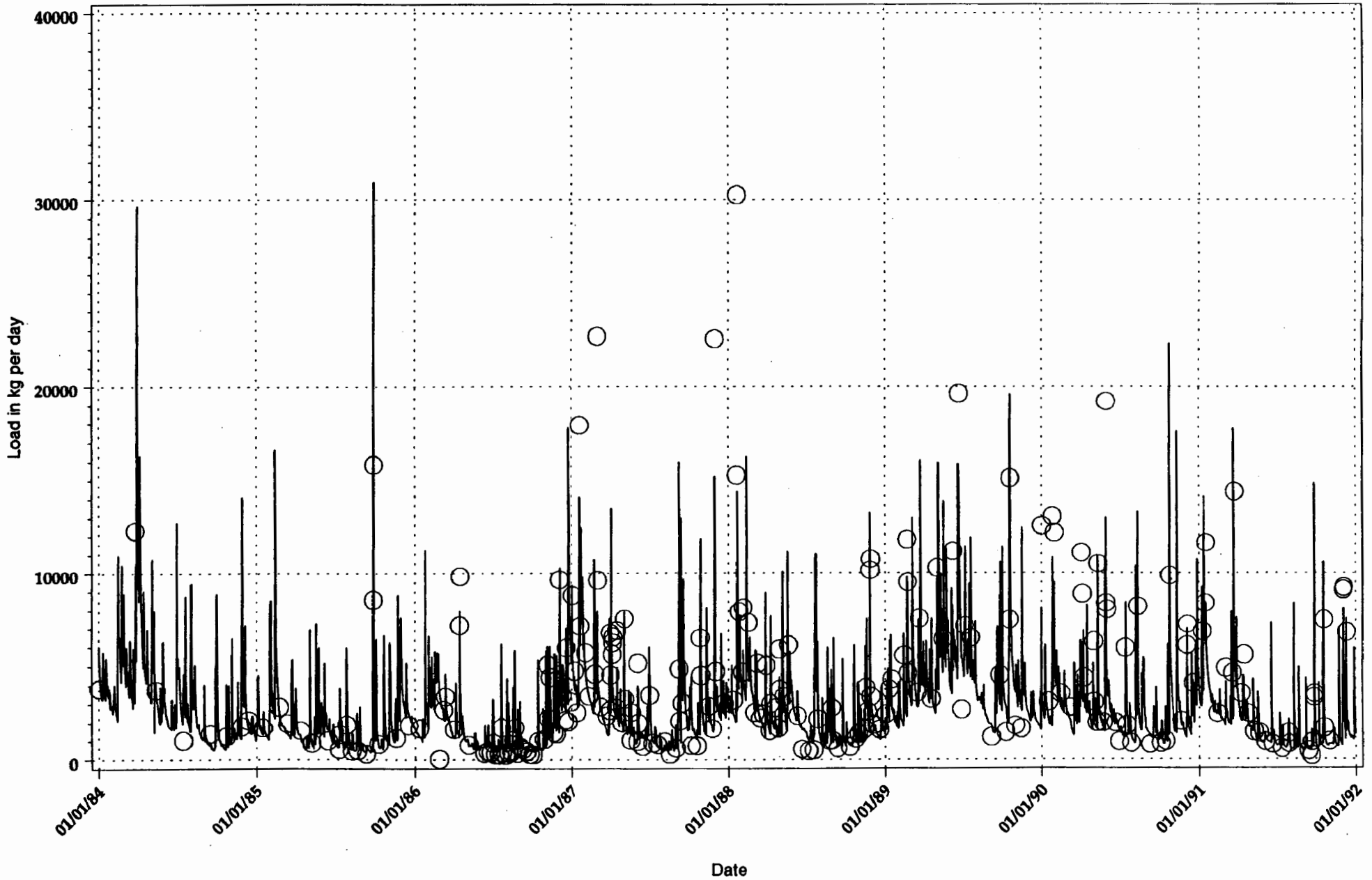


Patuxent River at Segment 340
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



Patuxent River at Segment 340
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)

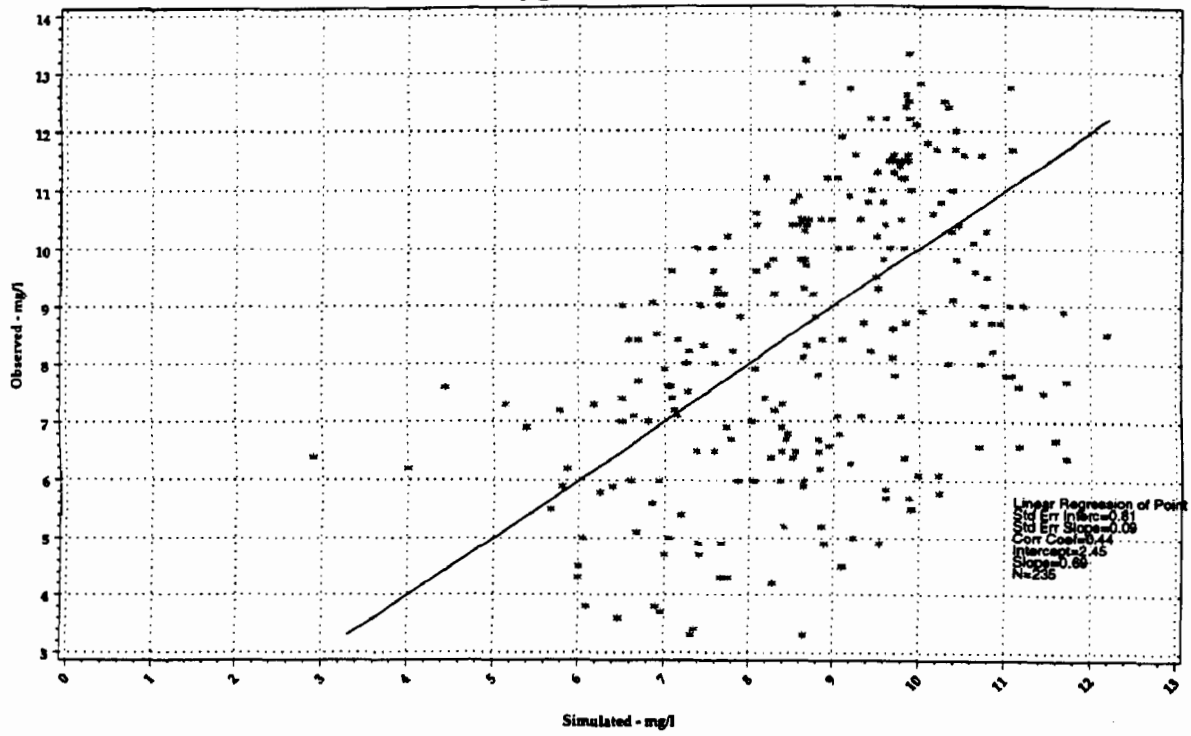


(y21_plot6.sas model3d[pwang.dl] ldlfes)
(patux340.drv 20FEB98 09:44,proc reg,model y=x)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

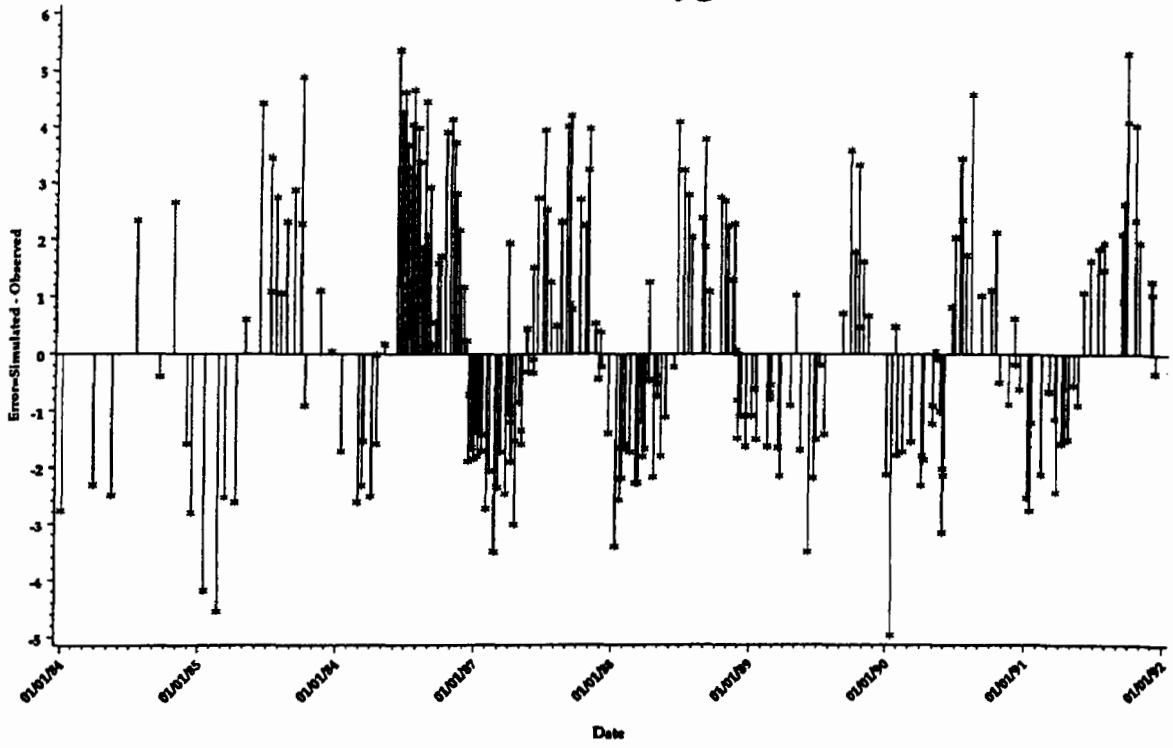
Dissolved Oxygen: 01JAN84 - 01JAN92



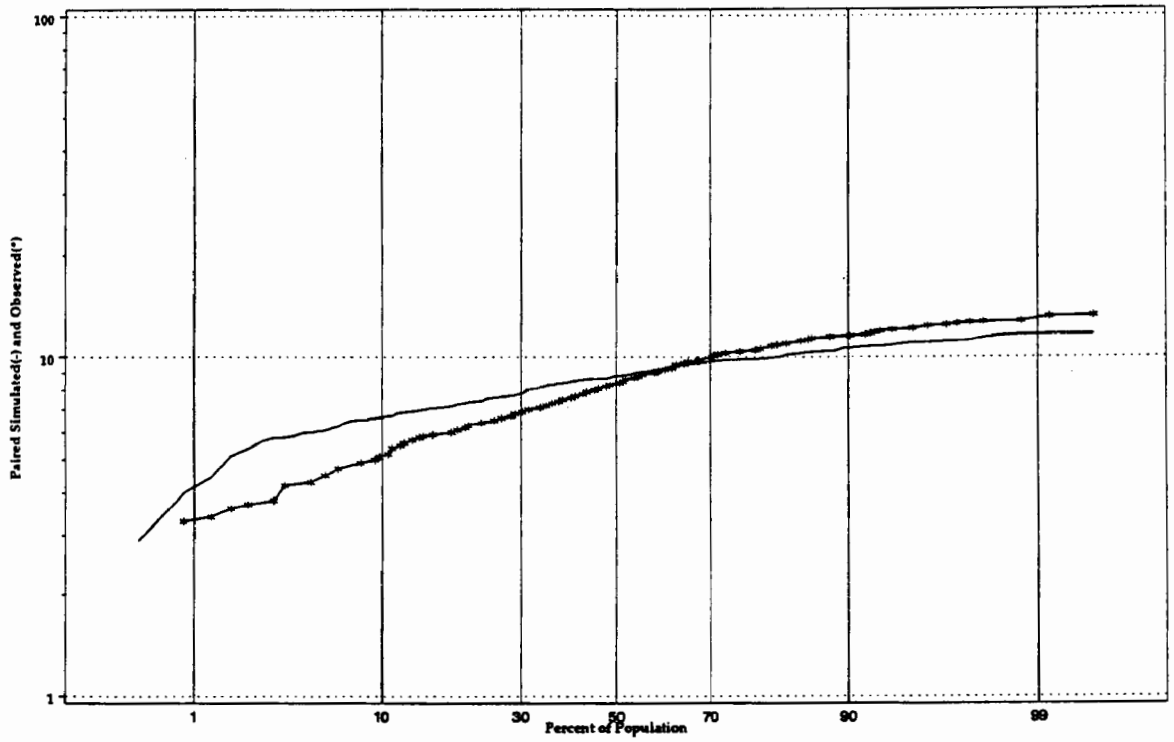
Patuxent River at Segment 340

Actual Error versus Time

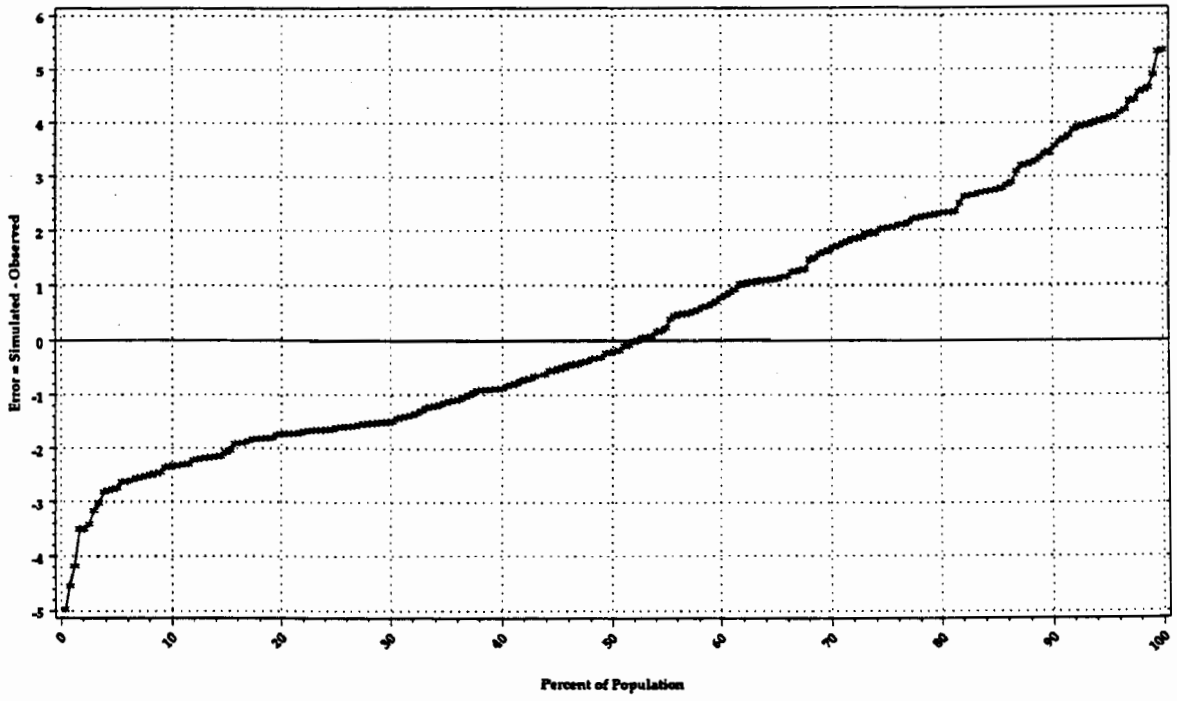
Dissolved Oxygen



Patuxent River at Segment 340
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

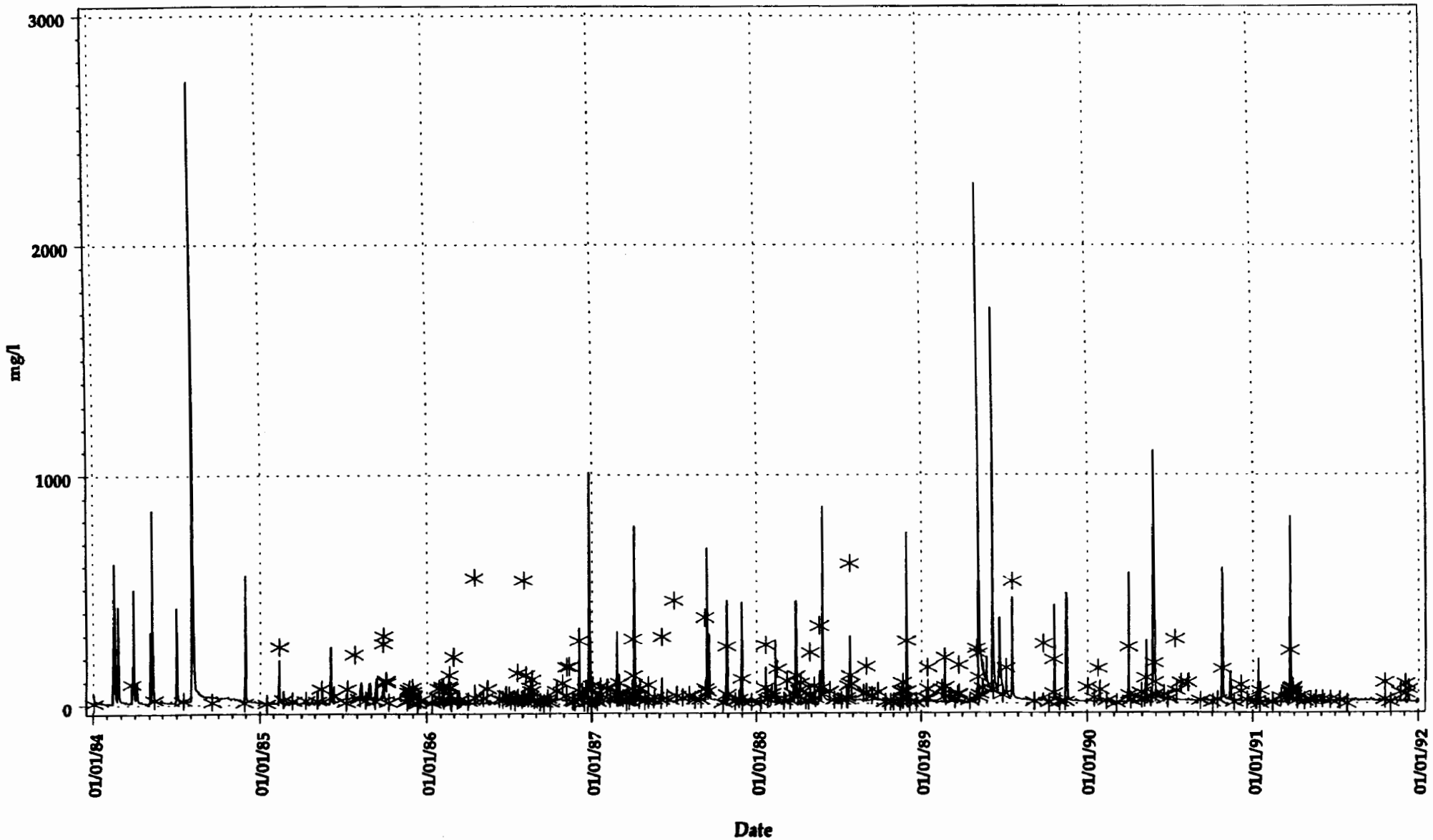


Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Patuxent River at Segment 340
Observed and Simulated versus Time
Total Suspended Sediment

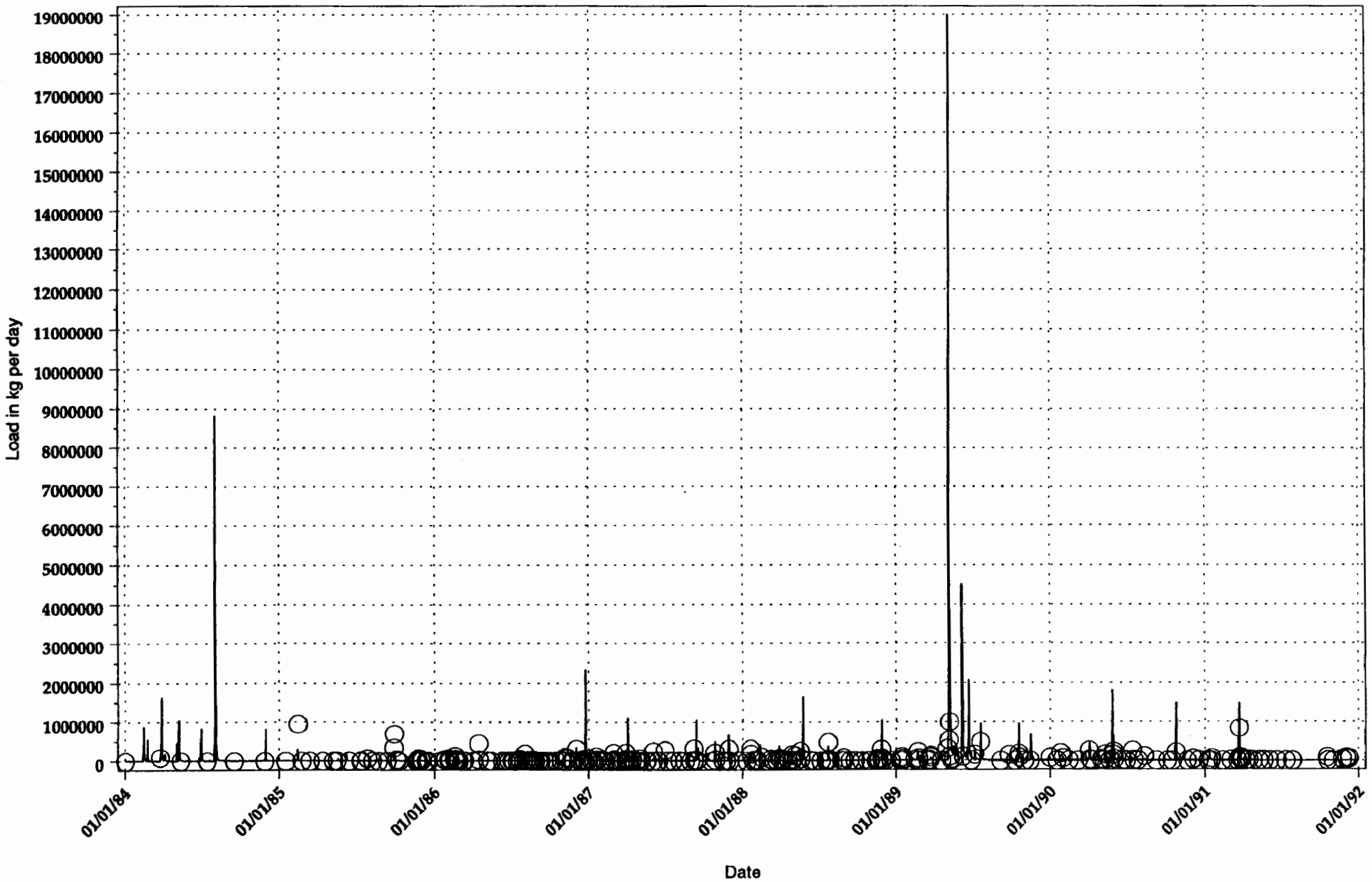
(*=Observed, -=Simulated)



Patuxent River at Segment 340

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

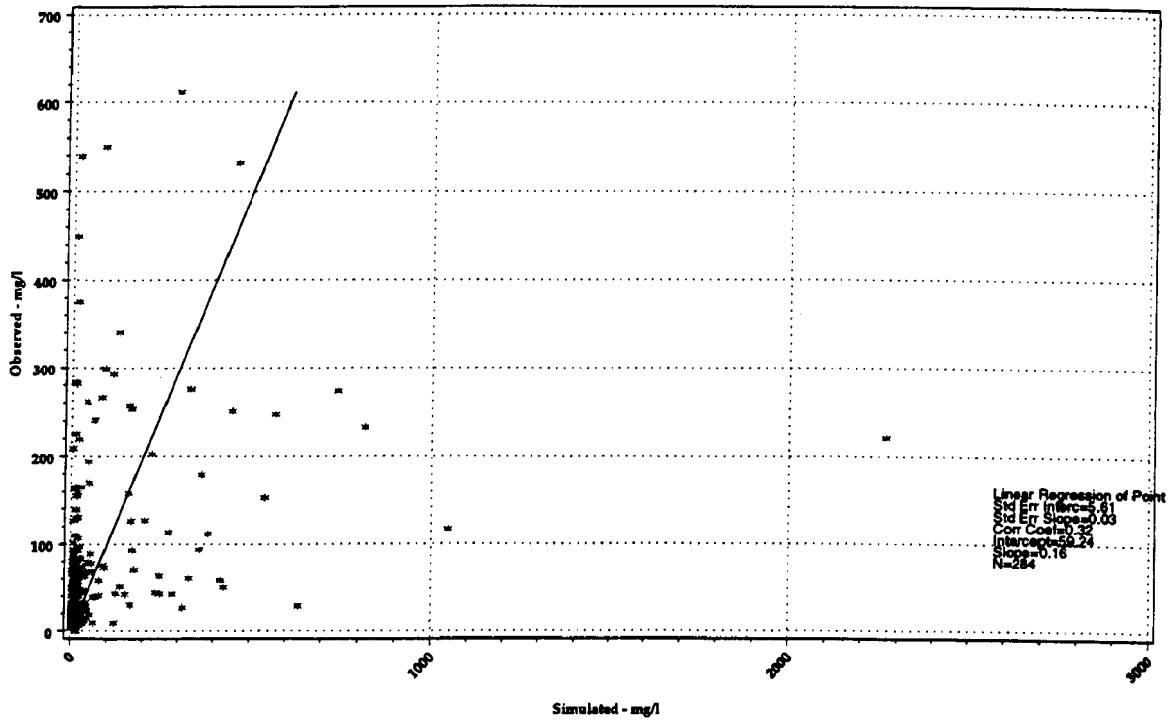


(y21_plotb.sas model3d:[pwang.dl] lidlise)
(patux340.dsv 20FEB96 09:44,proc reg,model y=x)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

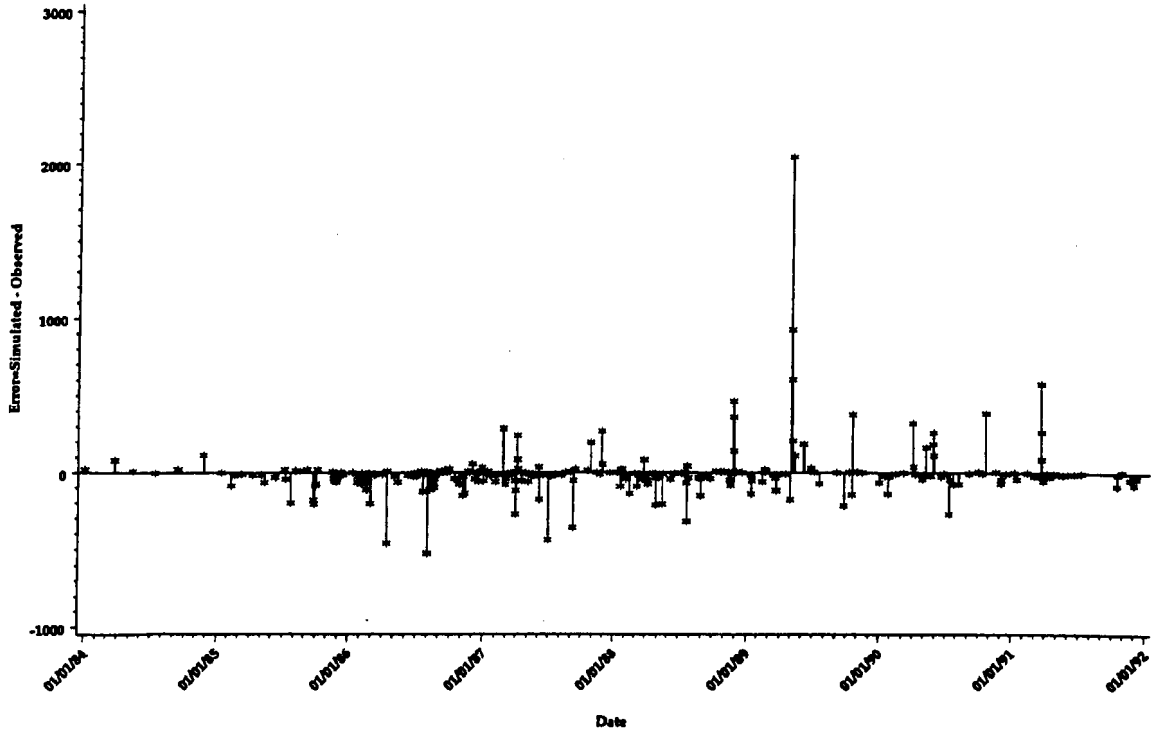
Total Suspended Sediment: 01JAN84 - 01JAN92



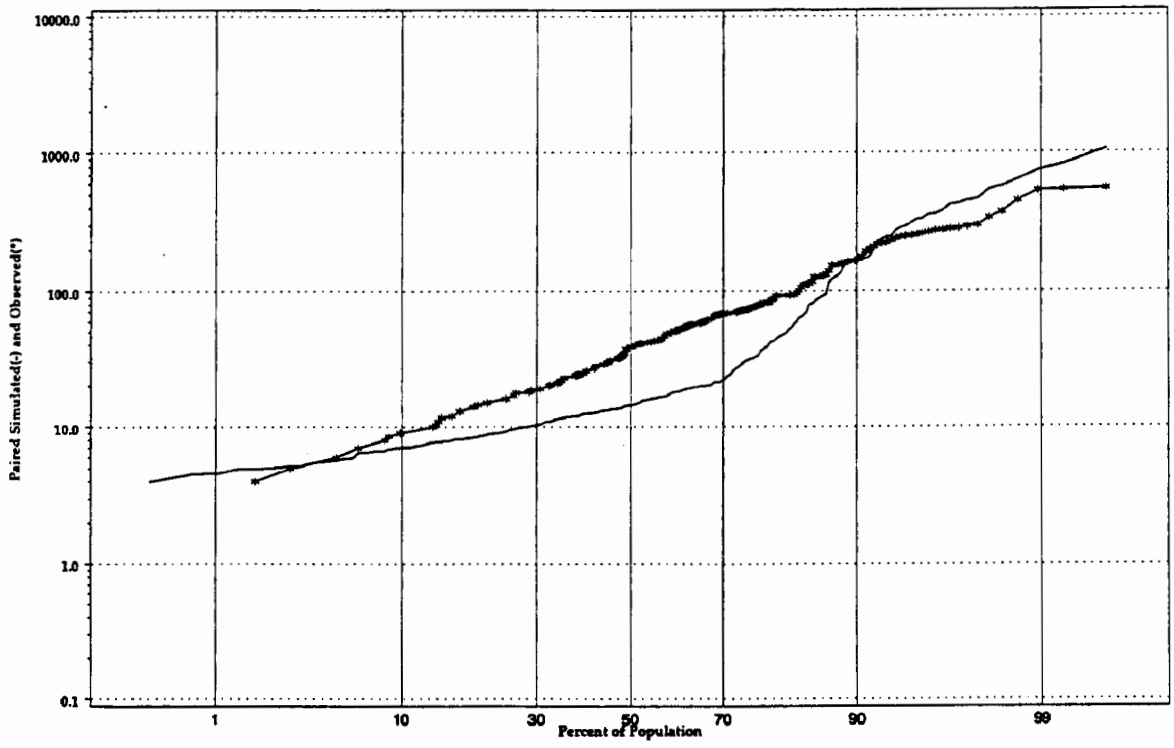
Patuxent River at Segment 340

Actual Error versus Time

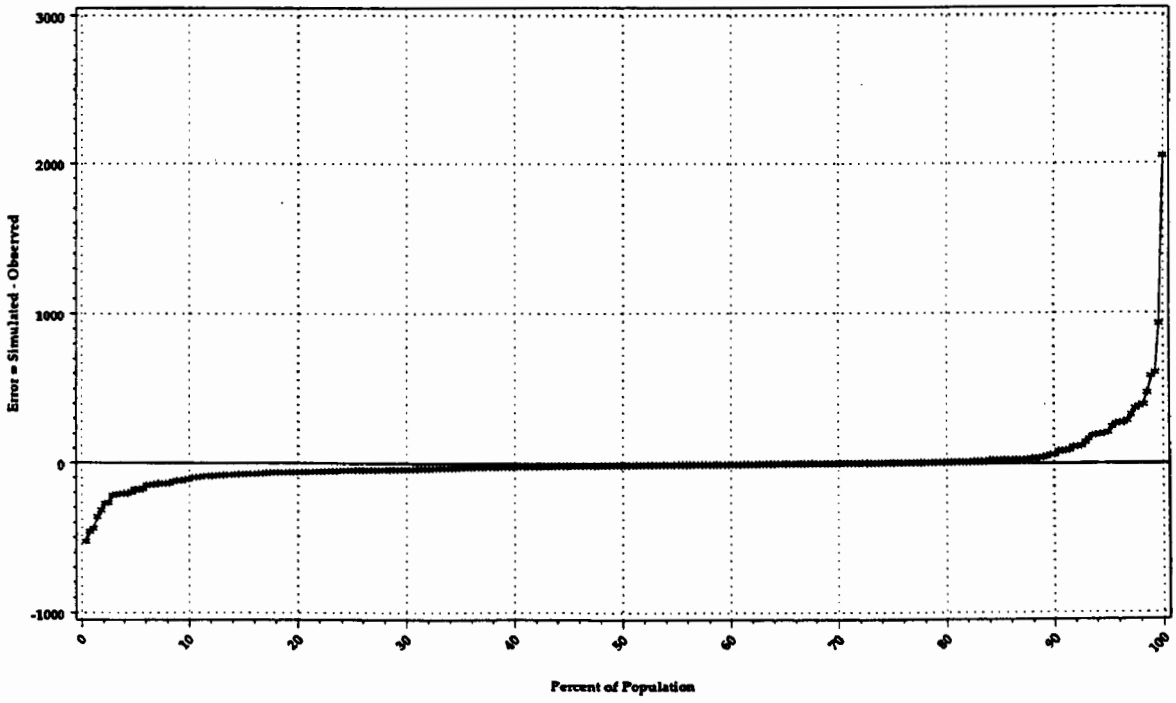
Total Suspended Sediment



Patuxent River at Segment 340
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

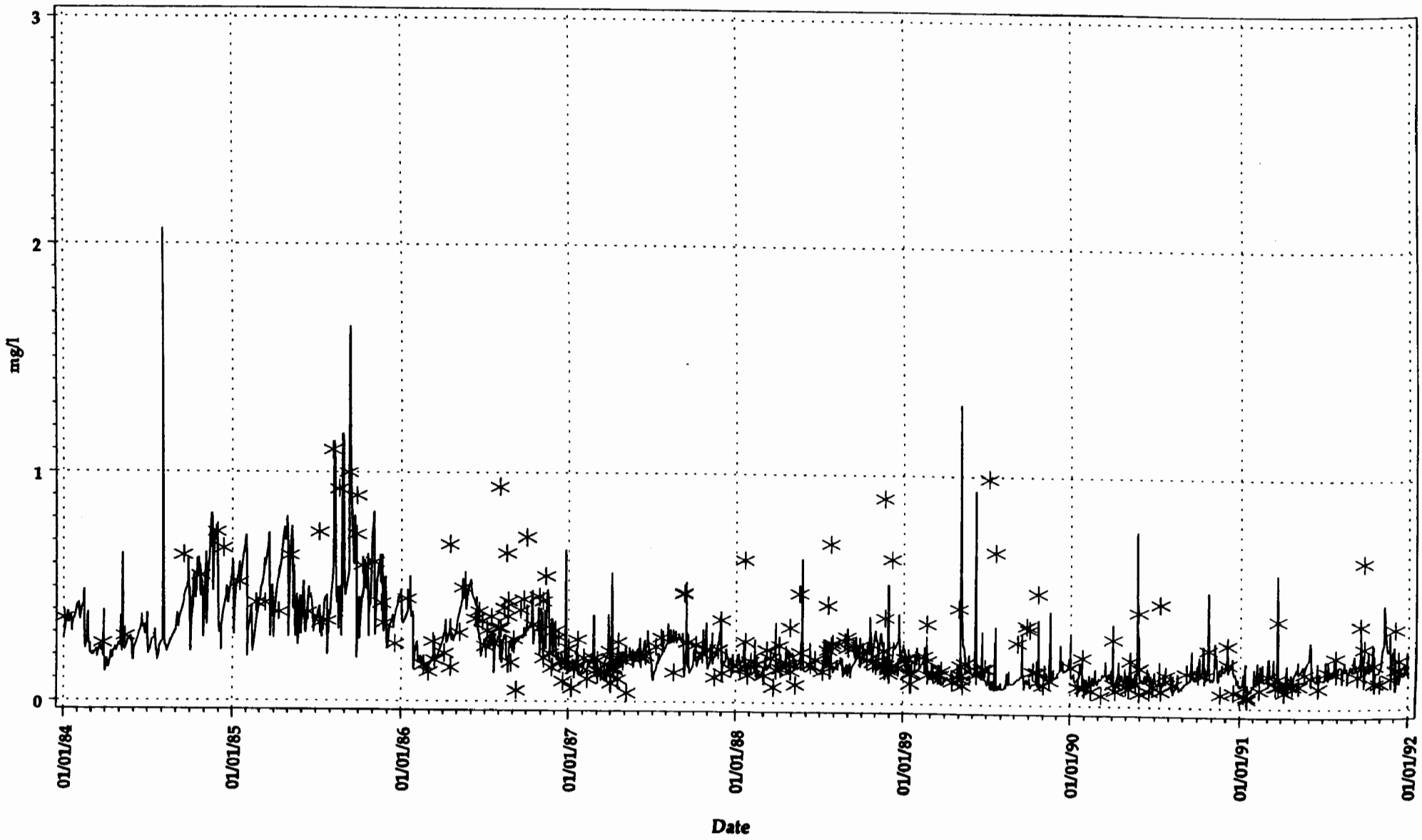


Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data

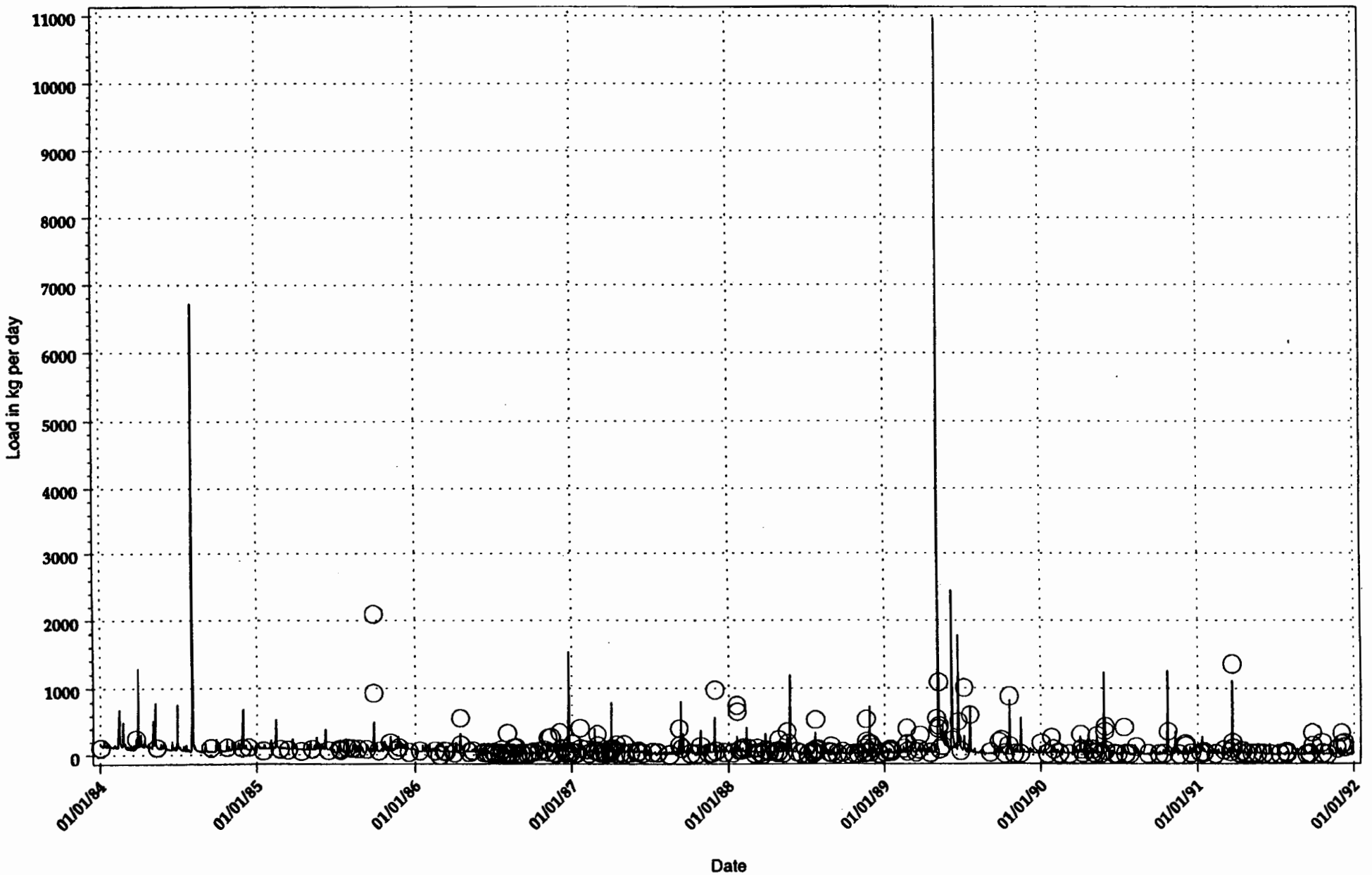


Patuxent River at Segment 340
Observed and Simulated versus Time
Total Phosphorus

(*=Observed, -=Simulated)



Patuxent River at Segment 340
Total Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

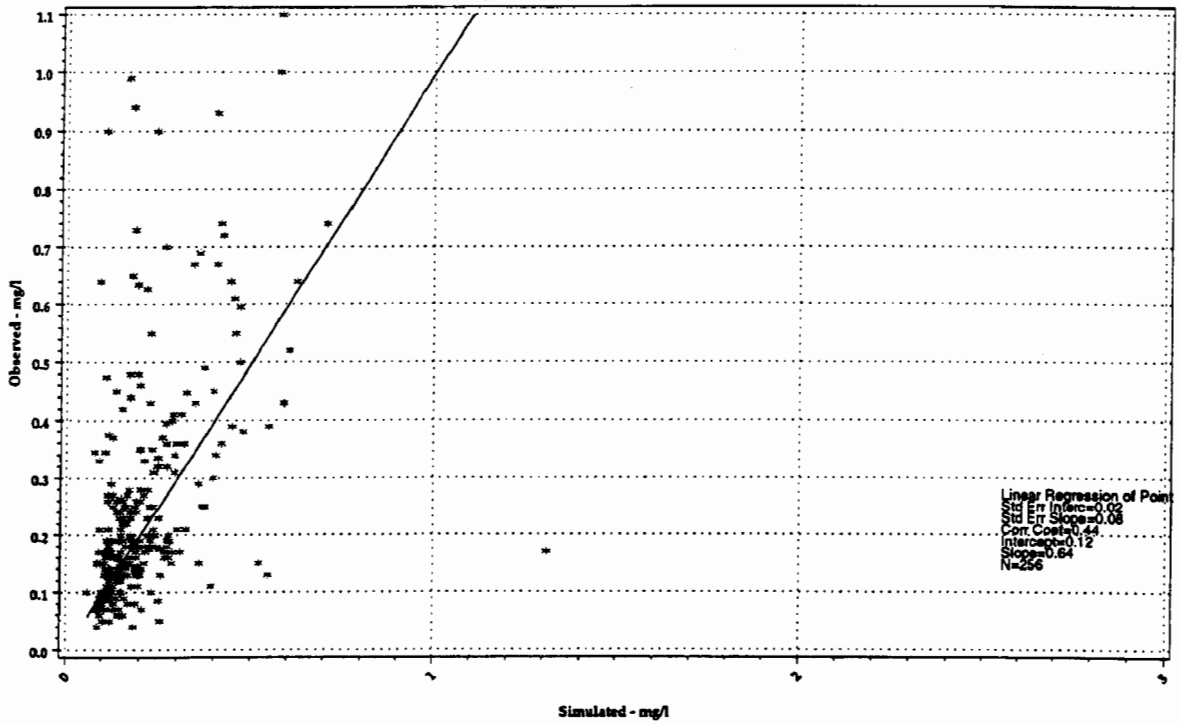


(y21_plotb.sas model3d [pwang.dl] ldlfles)
(patux340.dev 26FEB99 09:44,proc reg,model y=x)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

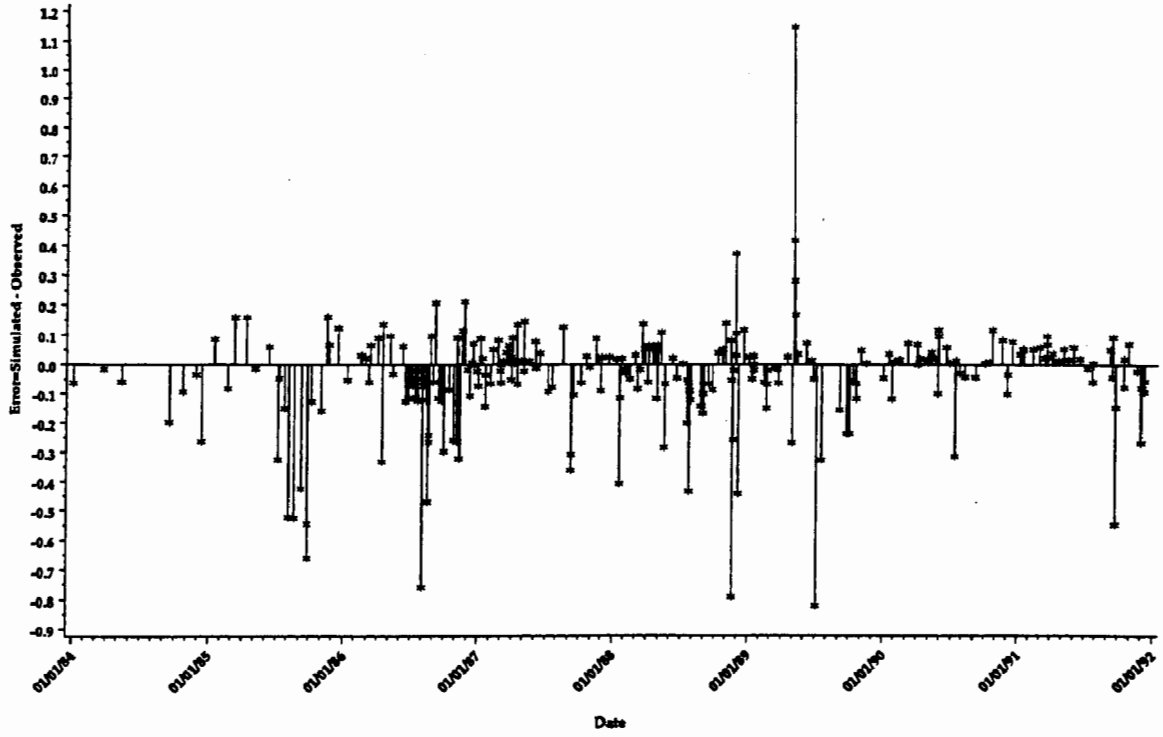
Total Phosphorus: 01JAN84 - 01JAN92



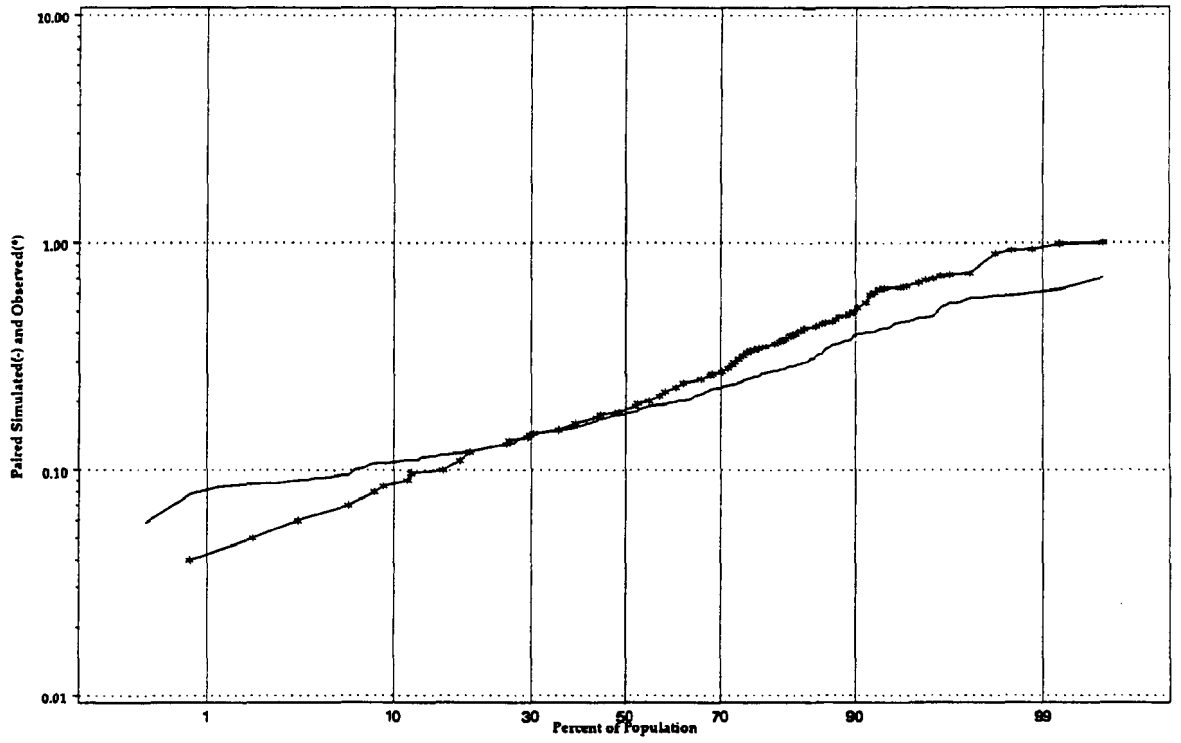
Patuxent River at Segment 340

Actual Error versus Time

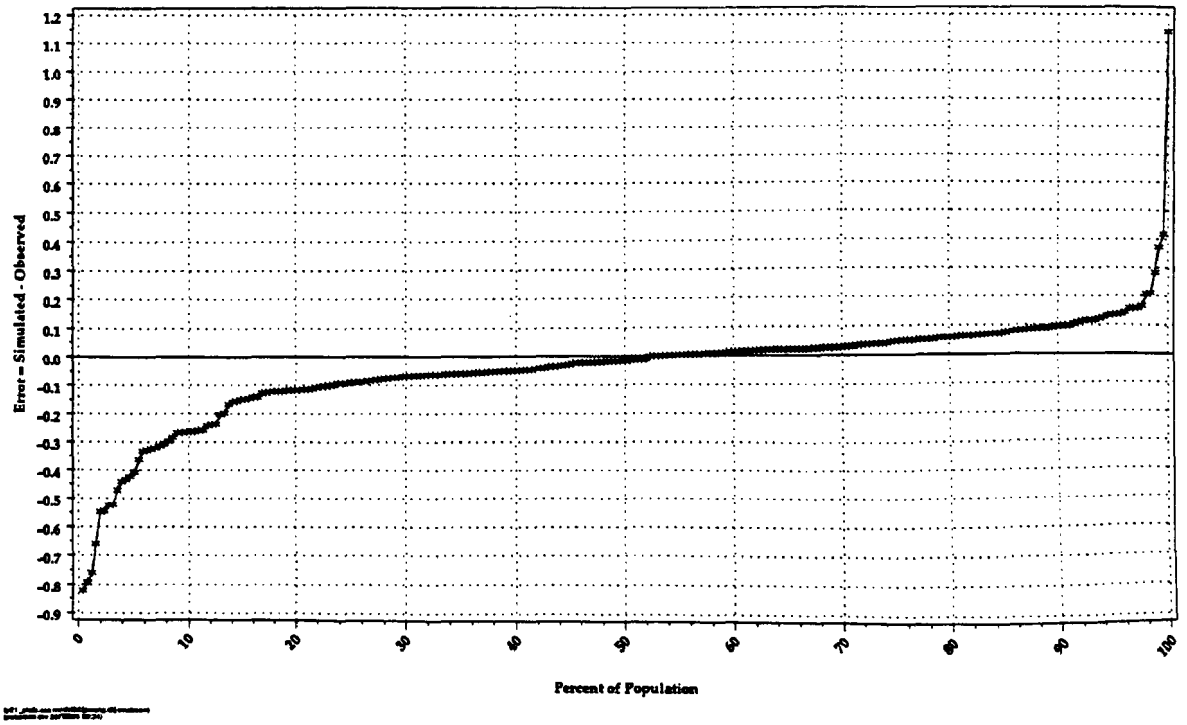
Total Phosphorus



Patuxent River at Segment 340
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

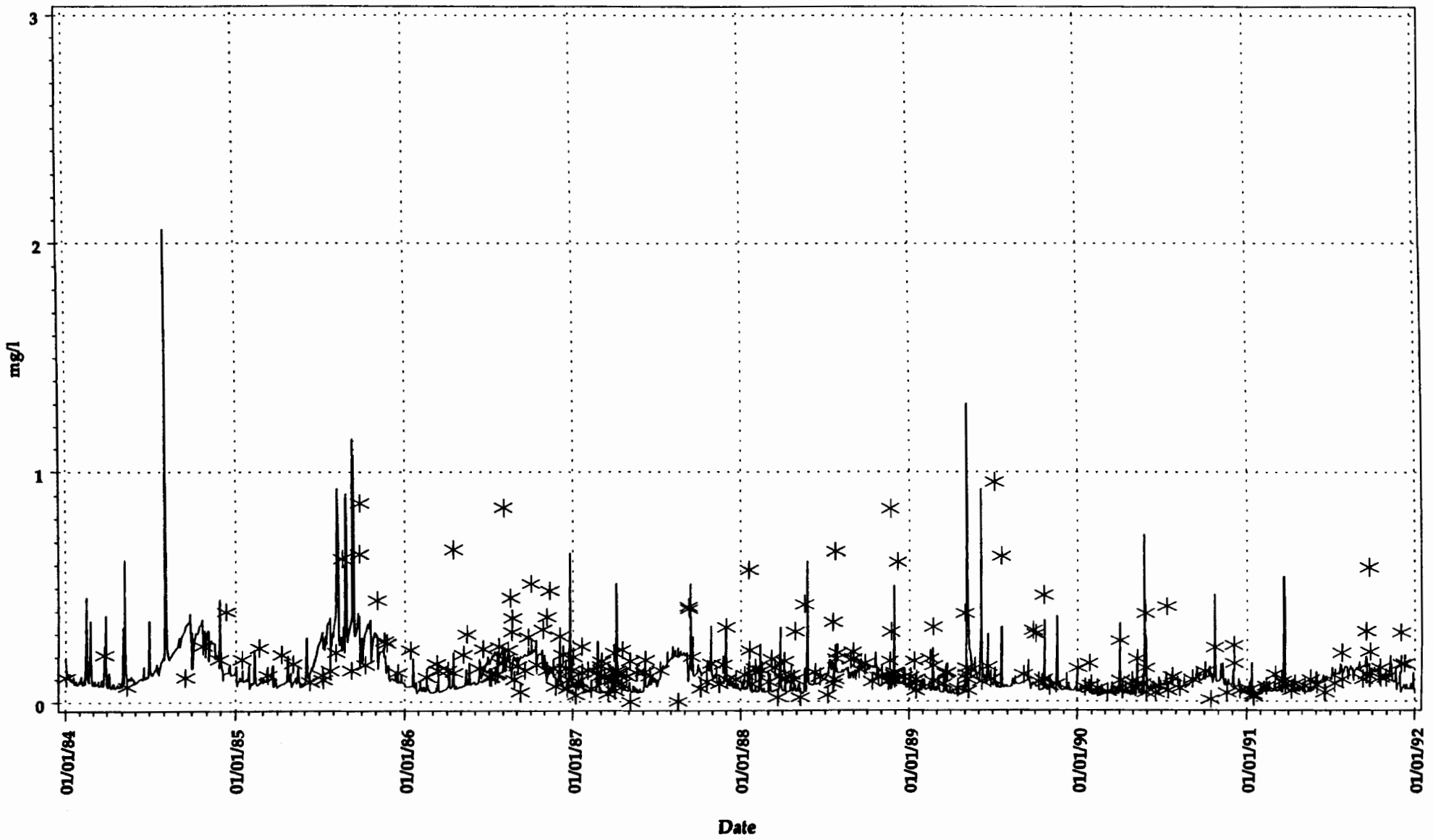


Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Patuxent River at Segment 340
Observed and Simulated versus Time
Organic and Particulate Phosphorus

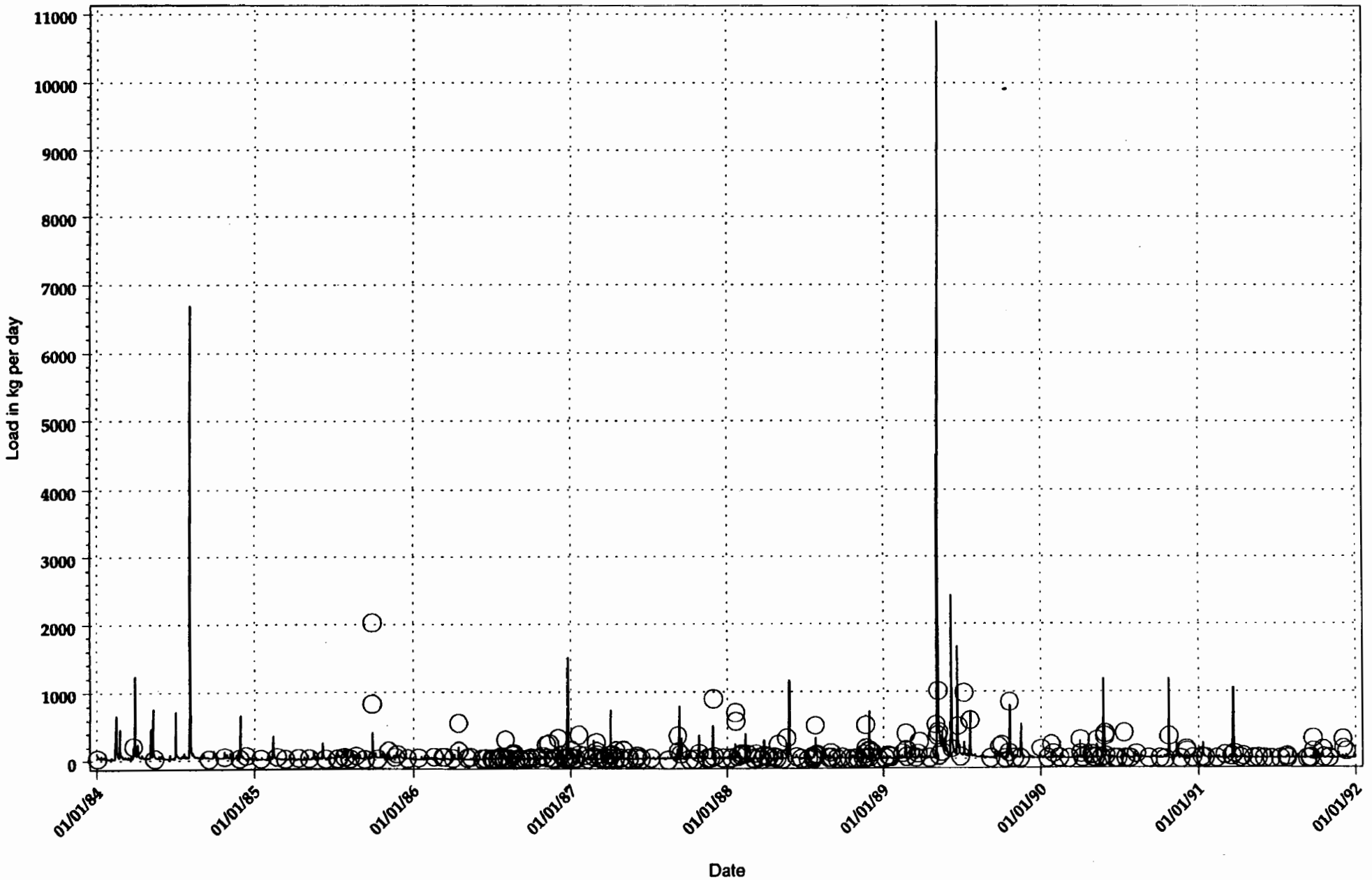
(*=Observed, -=Simulated)



Patuxent River at Segment 340

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

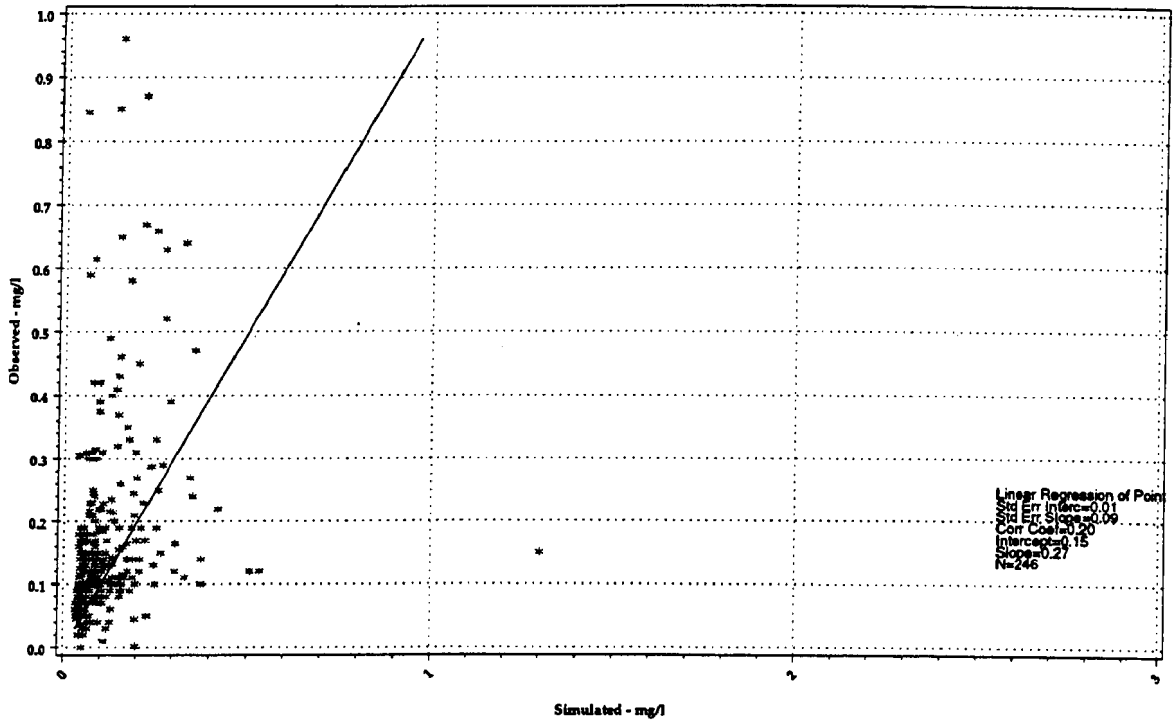


(y21_plotb.sas model3d [pwang.dl] ldlfas)
(petux340.div 20FEB96 09:44 proc reg,model y=x)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

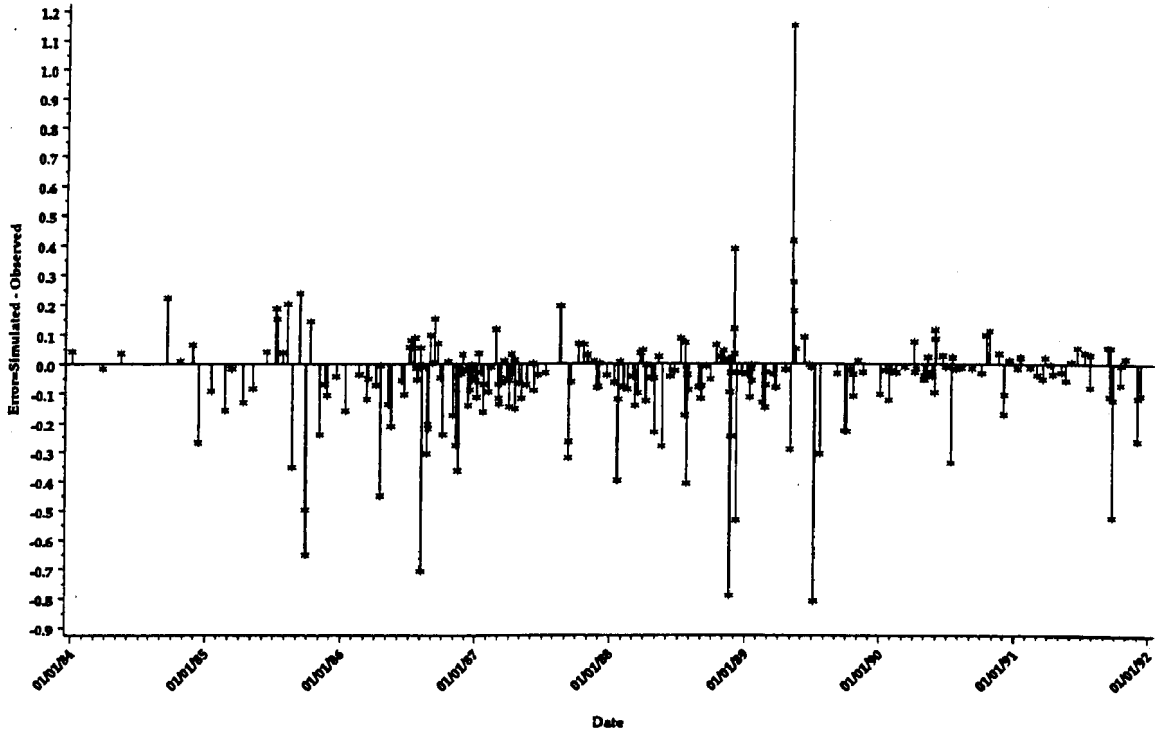
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



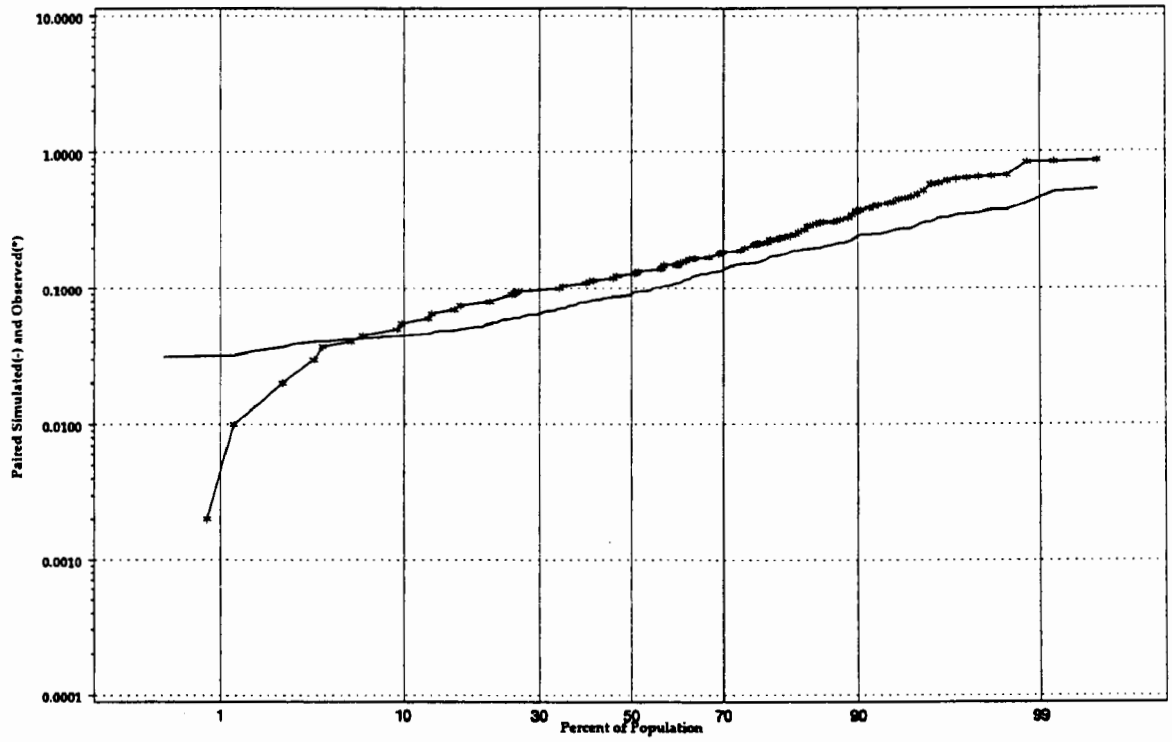
Patuxent River at Segment 340

Actual Error versus Time

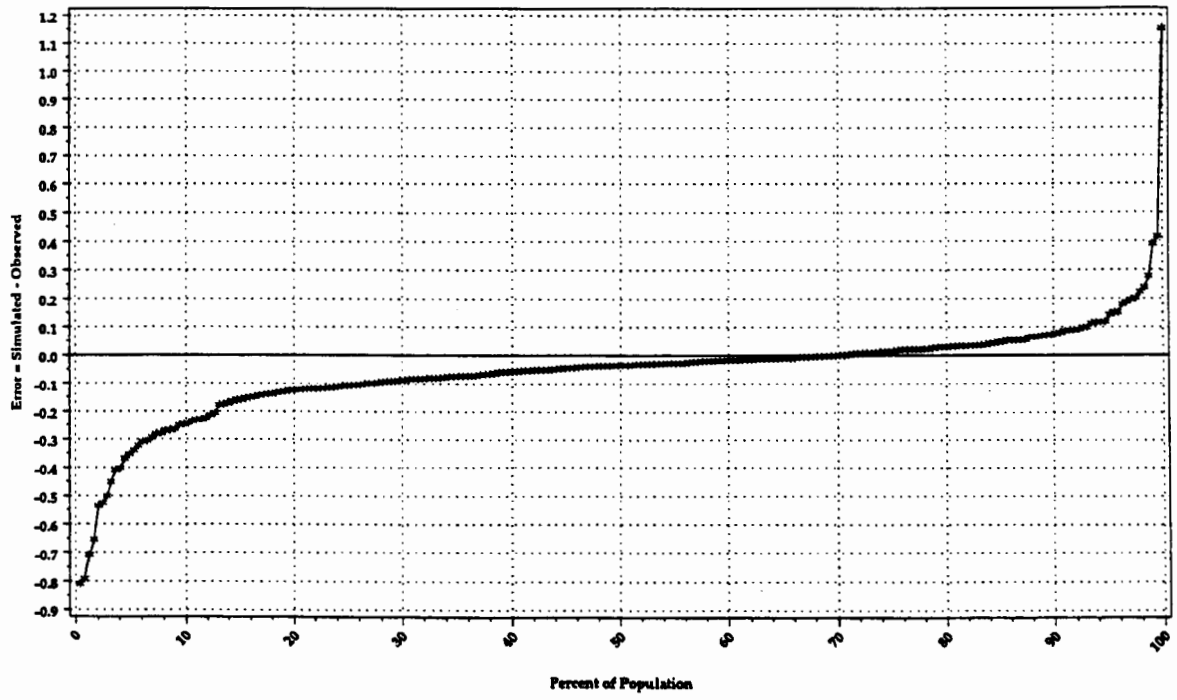
Organic and Particulate Phosphorus



Patuxent River at Segment 340
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

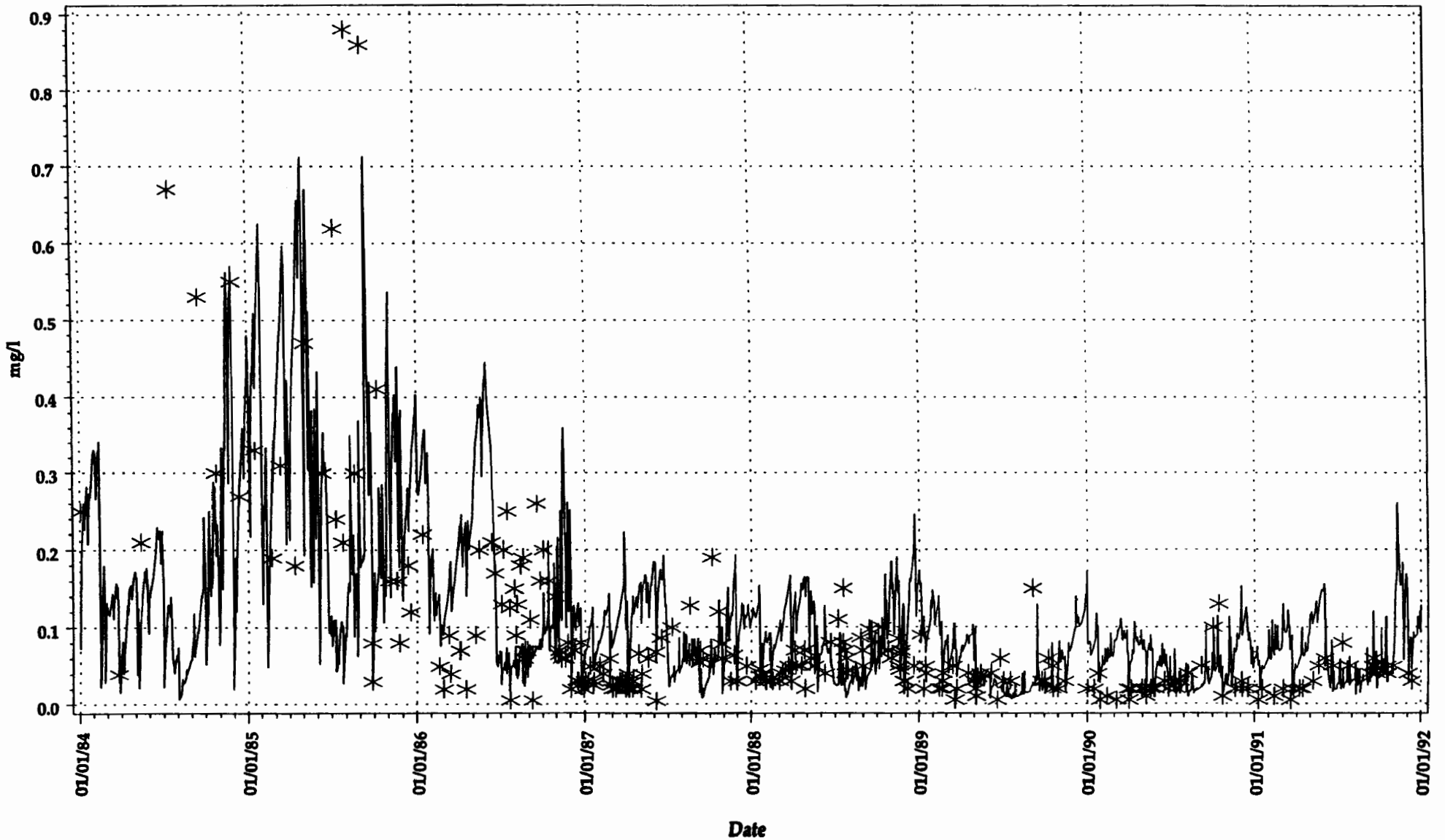


Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data

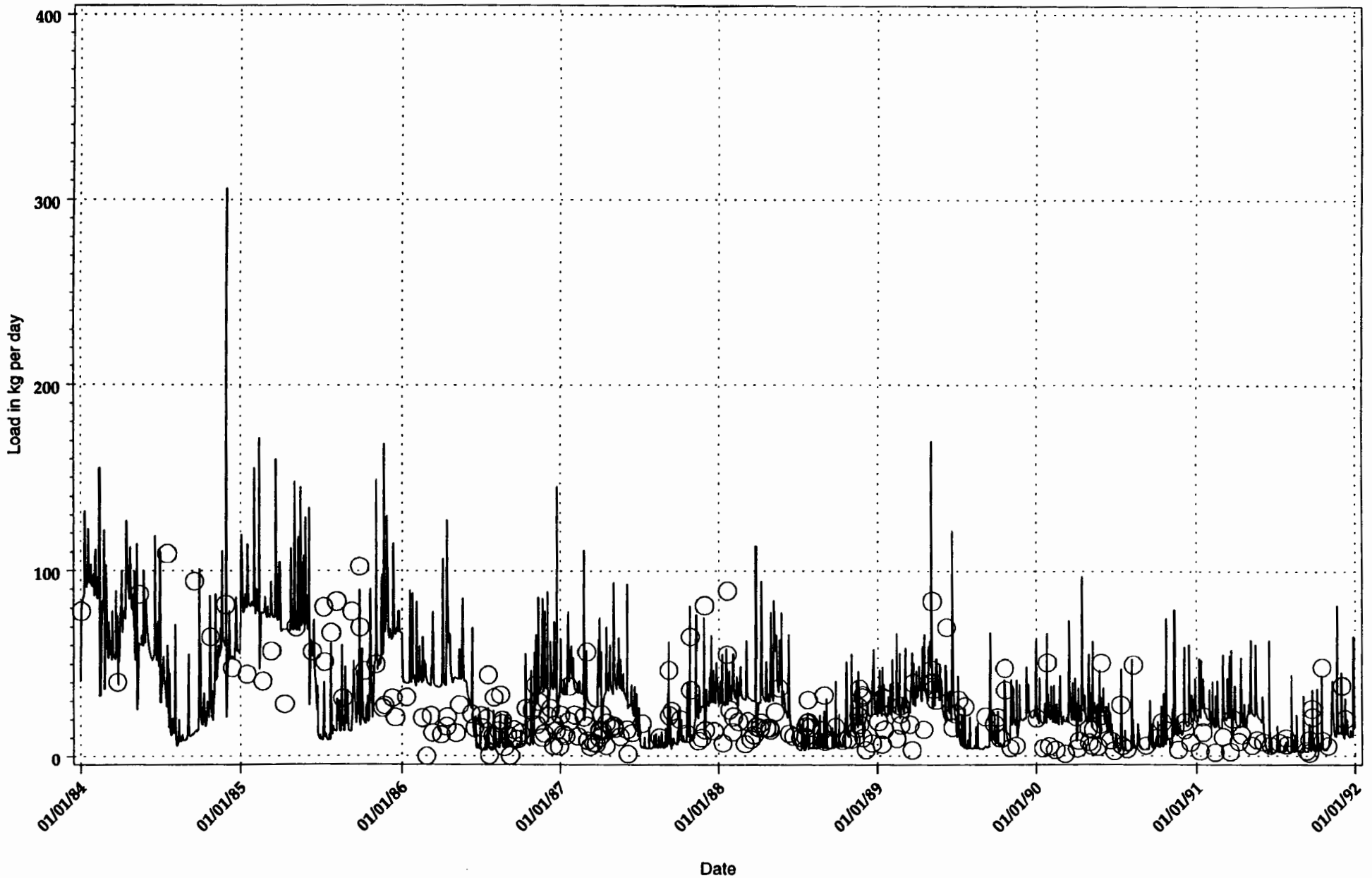


Patuxent River at Segment 340
Observed and Simulated versus Time
Dissolved Phosphorus

(*=Observed, -=Simulated)



Patuxent River at Segment 340
Dissolved Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

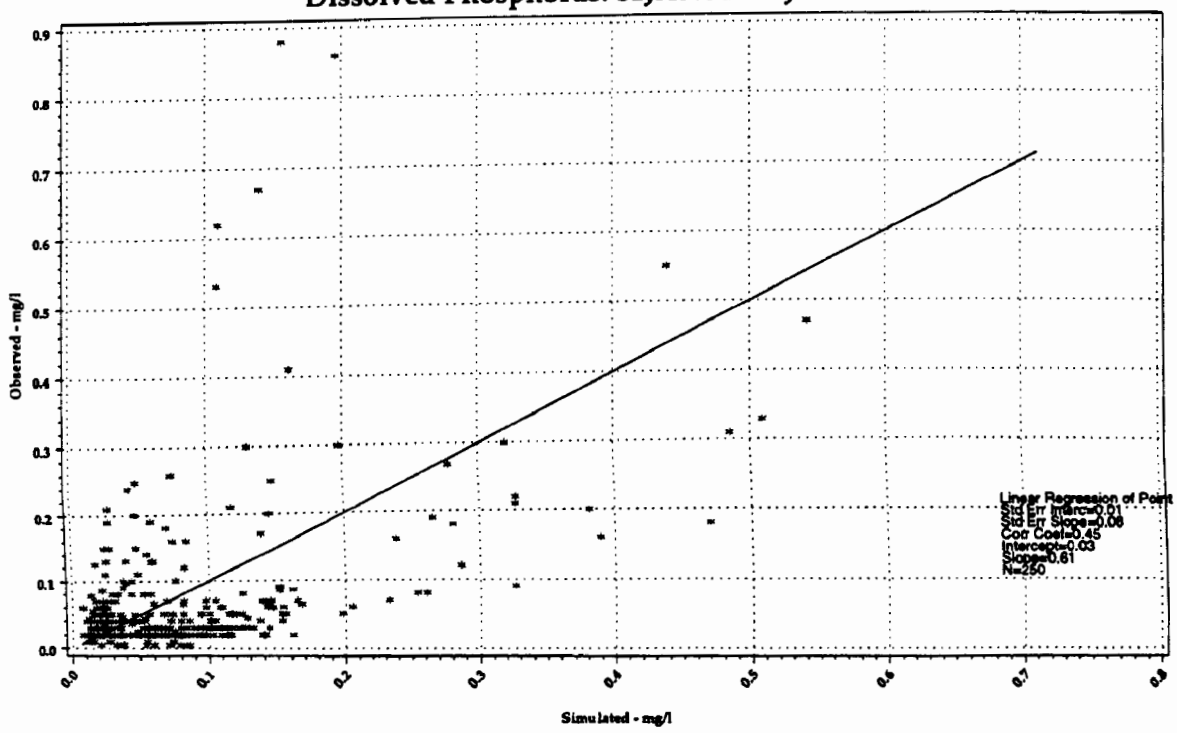


(y21_plotb.sas model3d:jpwang.dt| lidfles)
(paluz340.drv 20FEB96 09:44,proc reg,model y=x)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

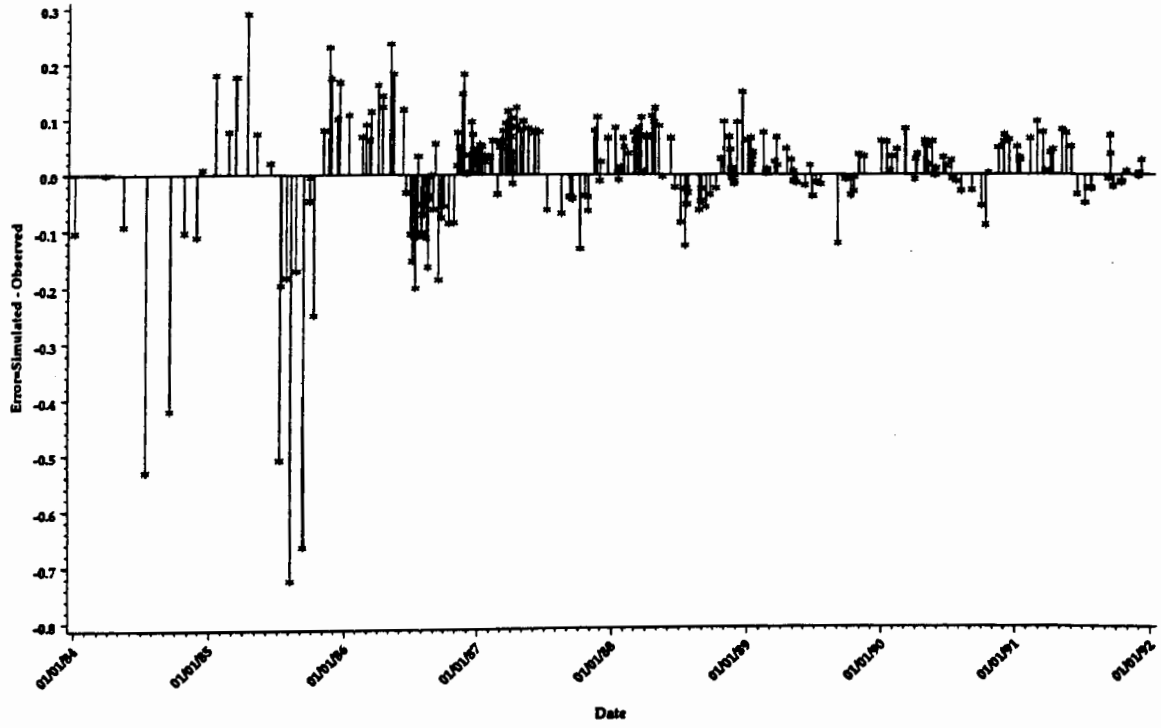
Dissolved Phosphorus: 01JAN84 - 01JAN92



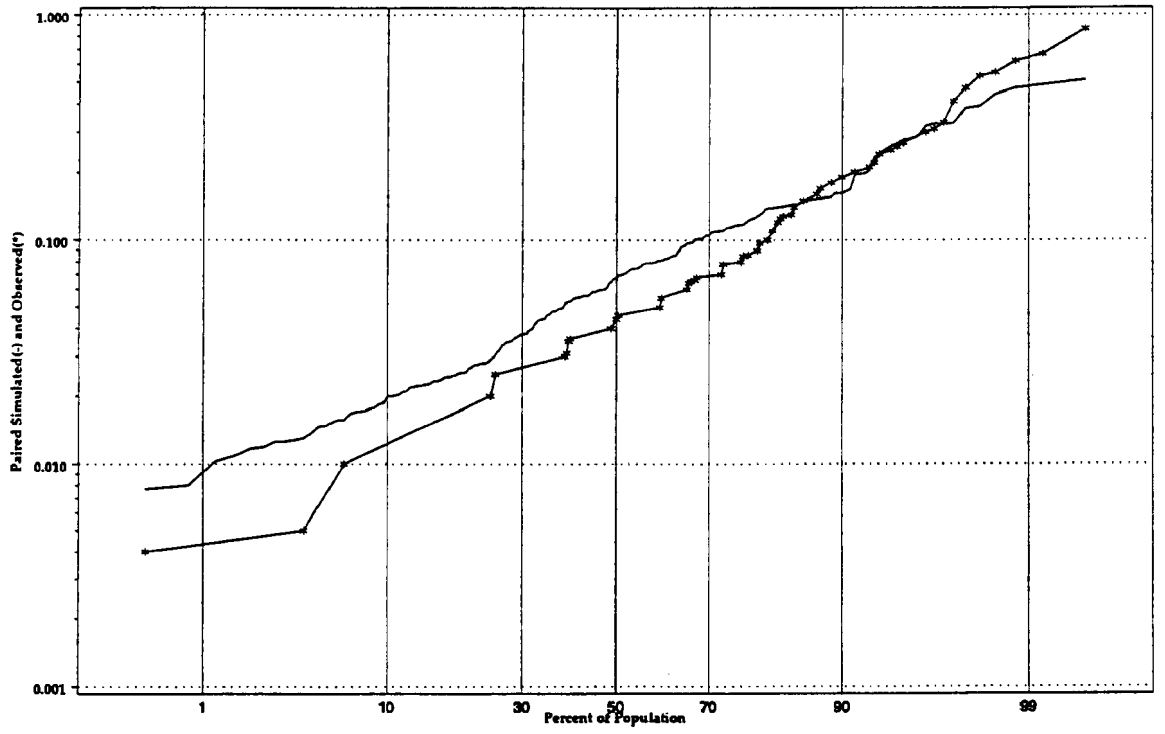
Patuxent River at Segment 340

Actual Error versus Time

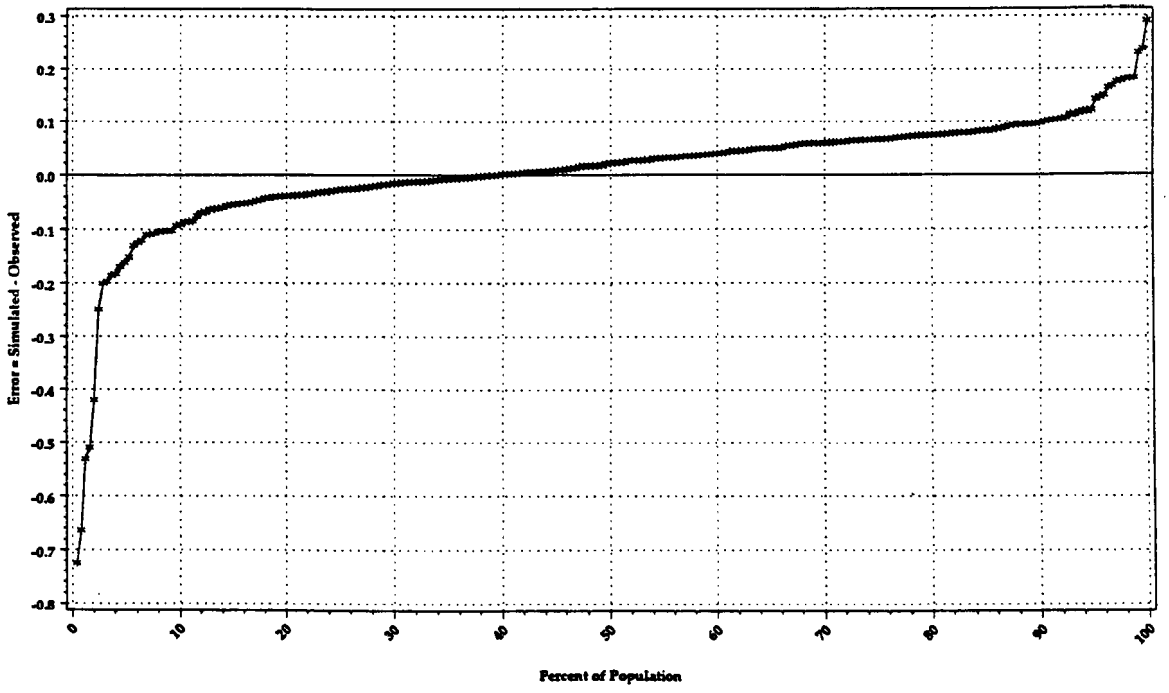
Dissolved Phosphorus



Patuxent River at Segment 340
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

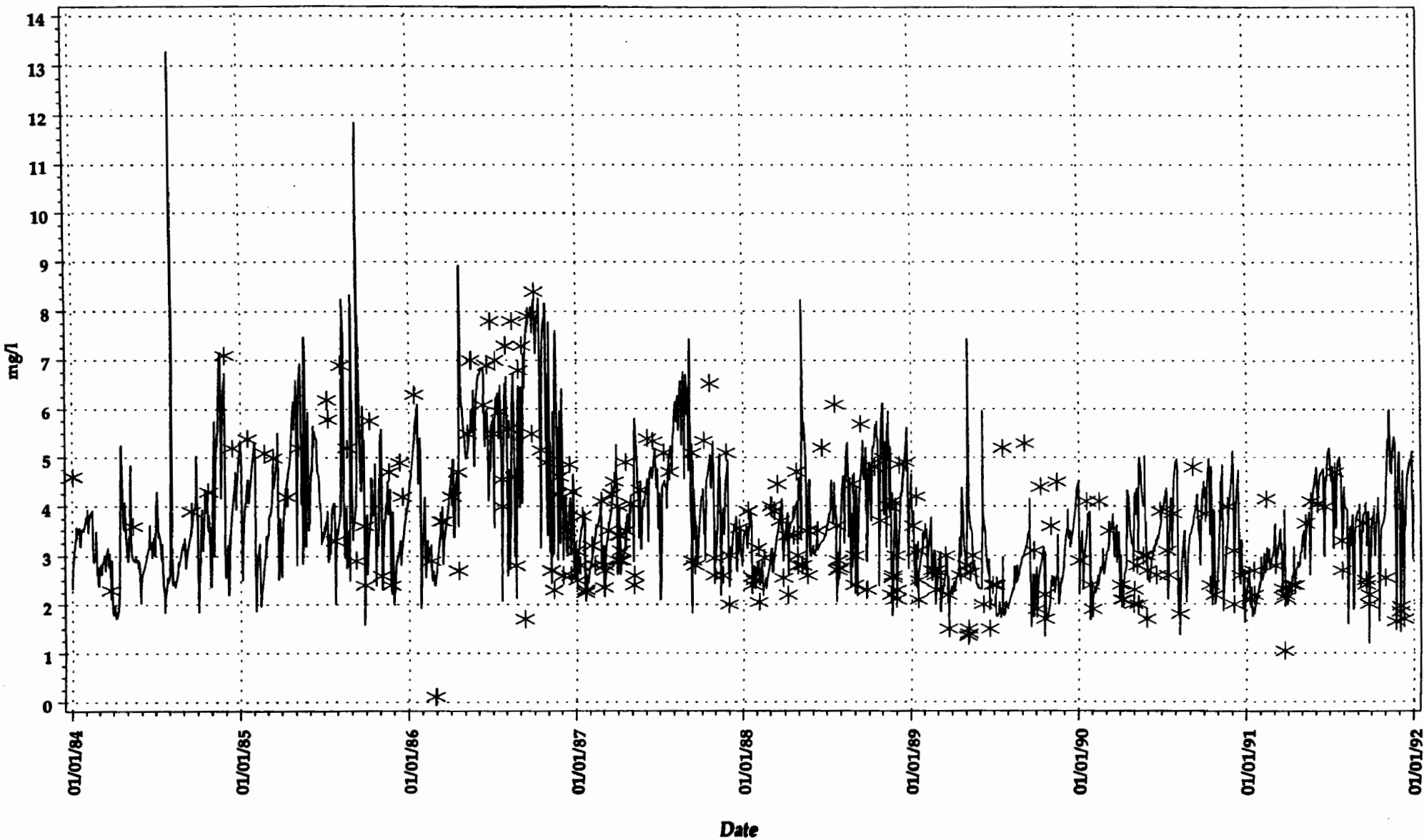


Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



Patuxent River at Segment 340
Observed and Simulated versus Time
Total Nitrogen

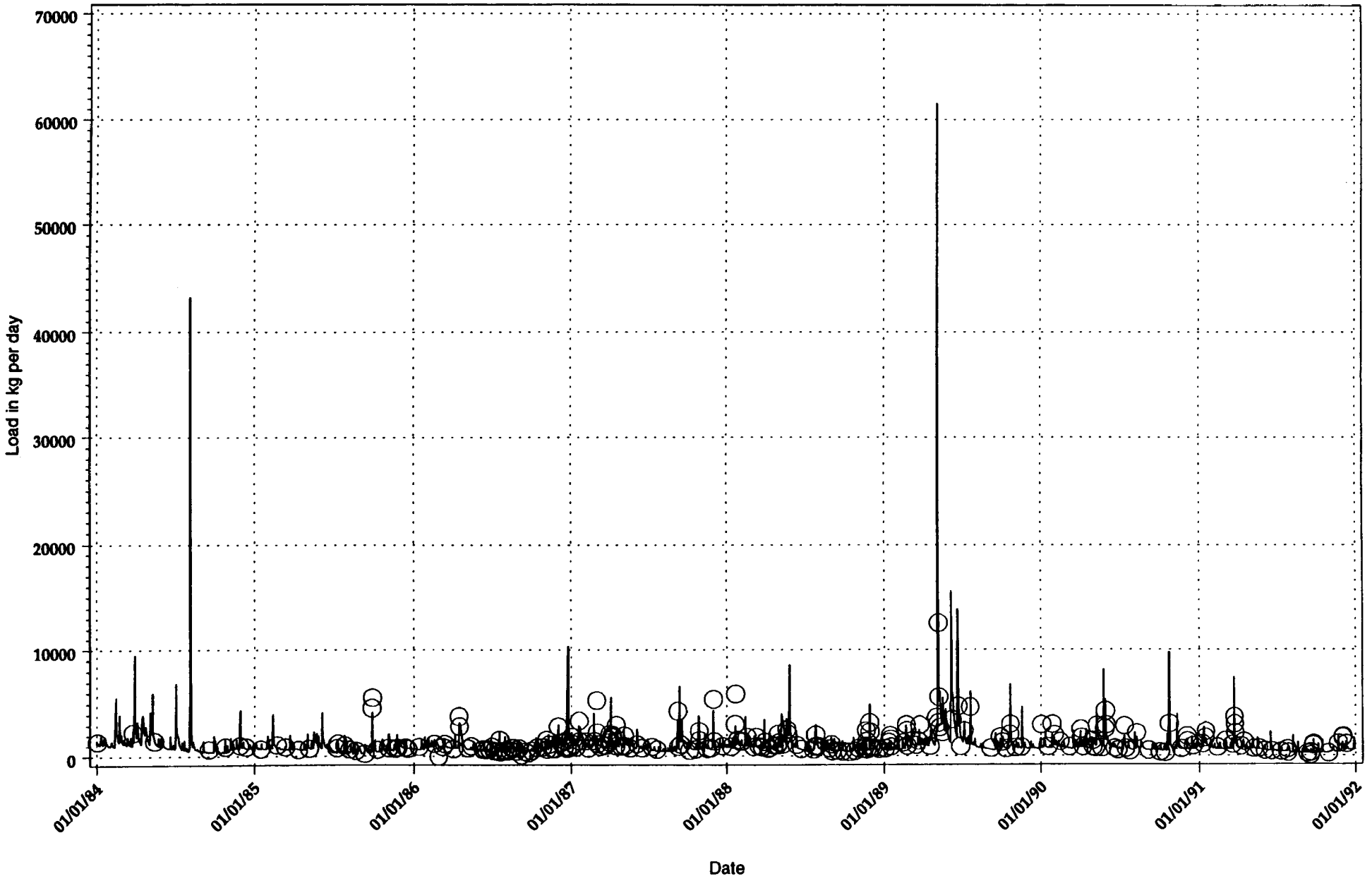
(*=Observed, -=Simulated)



Patuxent River at Segment 340

Total Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)

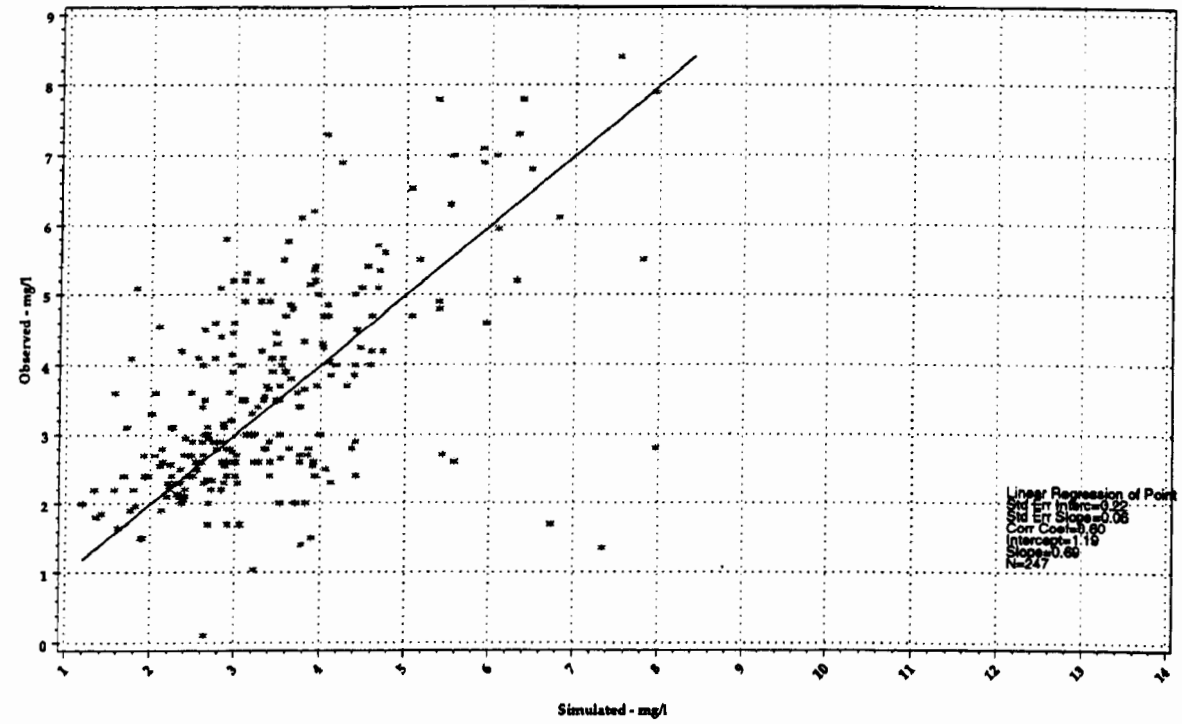


(y21_plotb.sas model3d:[pwang.dt] ldlise)
(patux340.drv 20FEB98 09:44.proc reg.model y=x)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

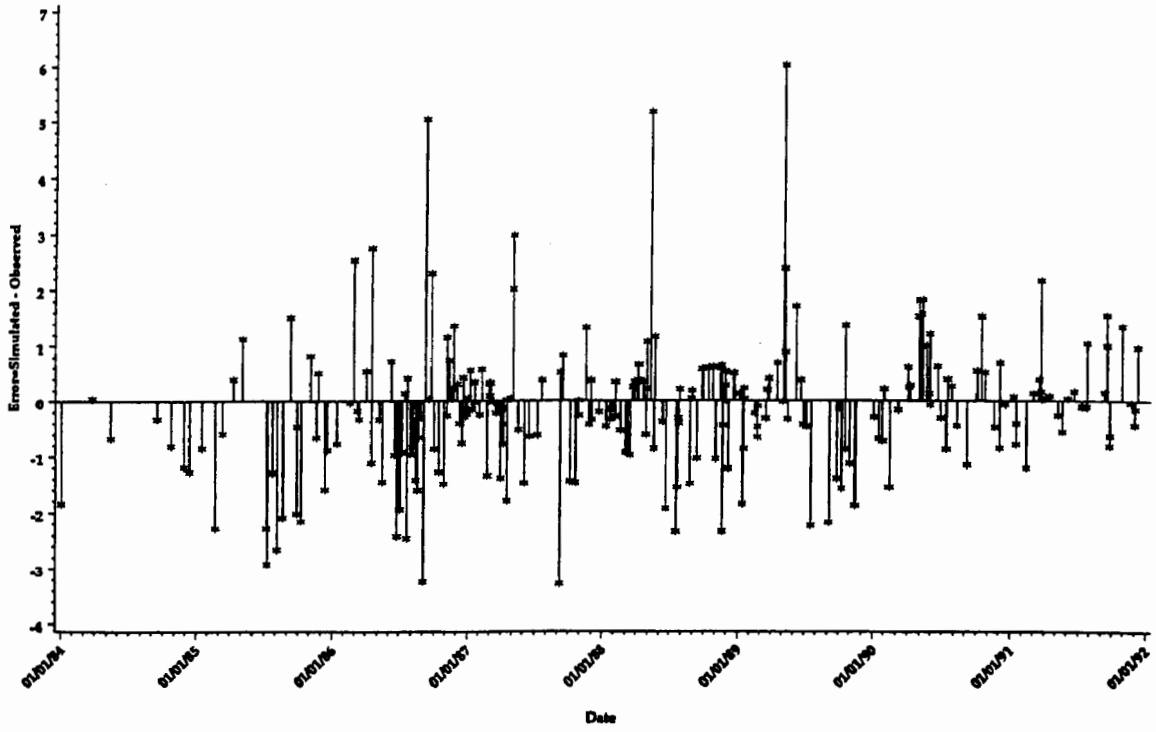
Total Nitrogen: 01JAN84 - 01JAN92



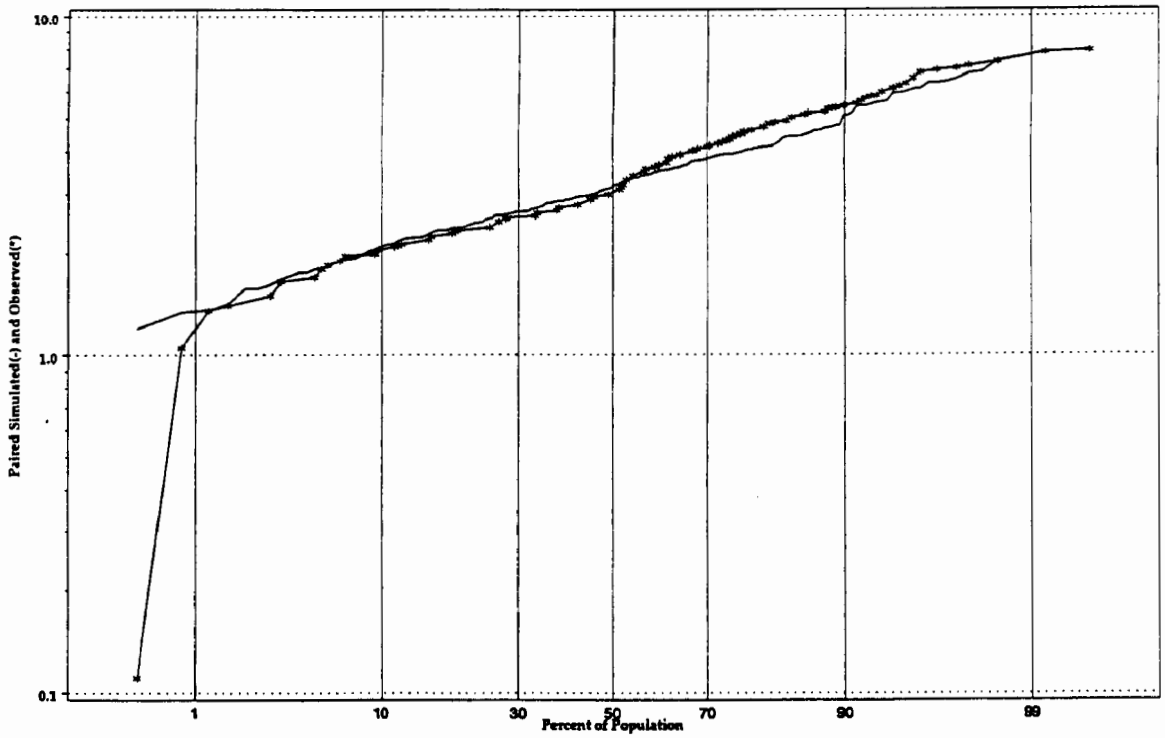
Patuxent River at Segment 340

Actual Error versus Time

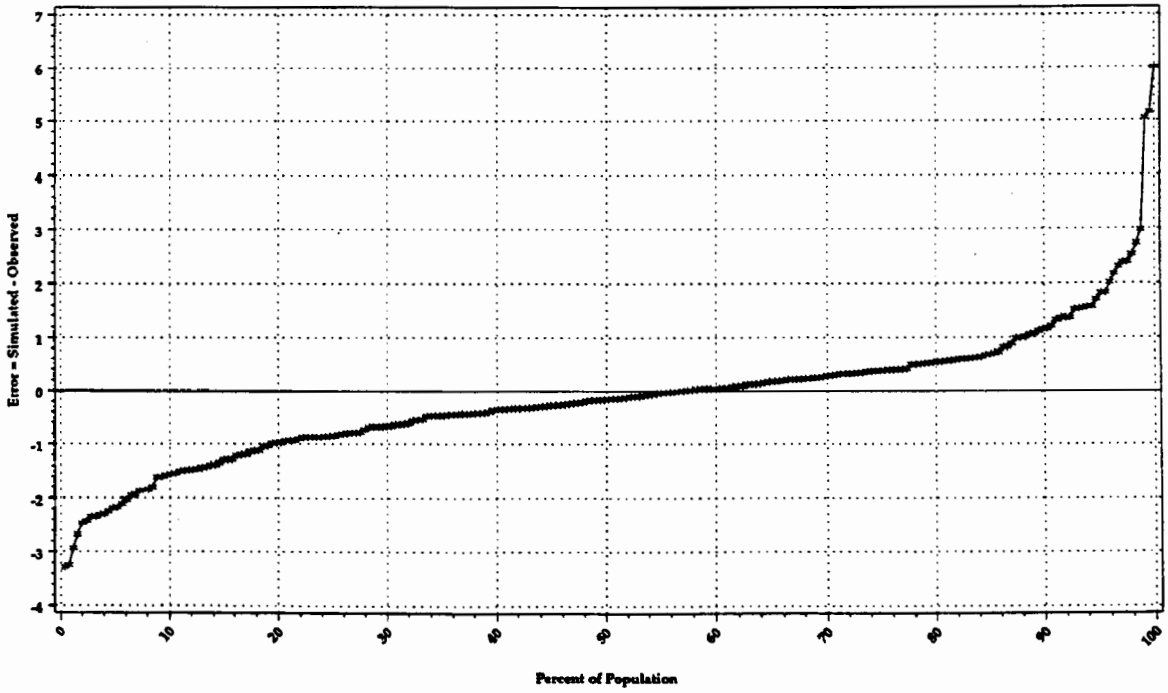
Total Nitrogen



Patuxent River at Segment 340
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

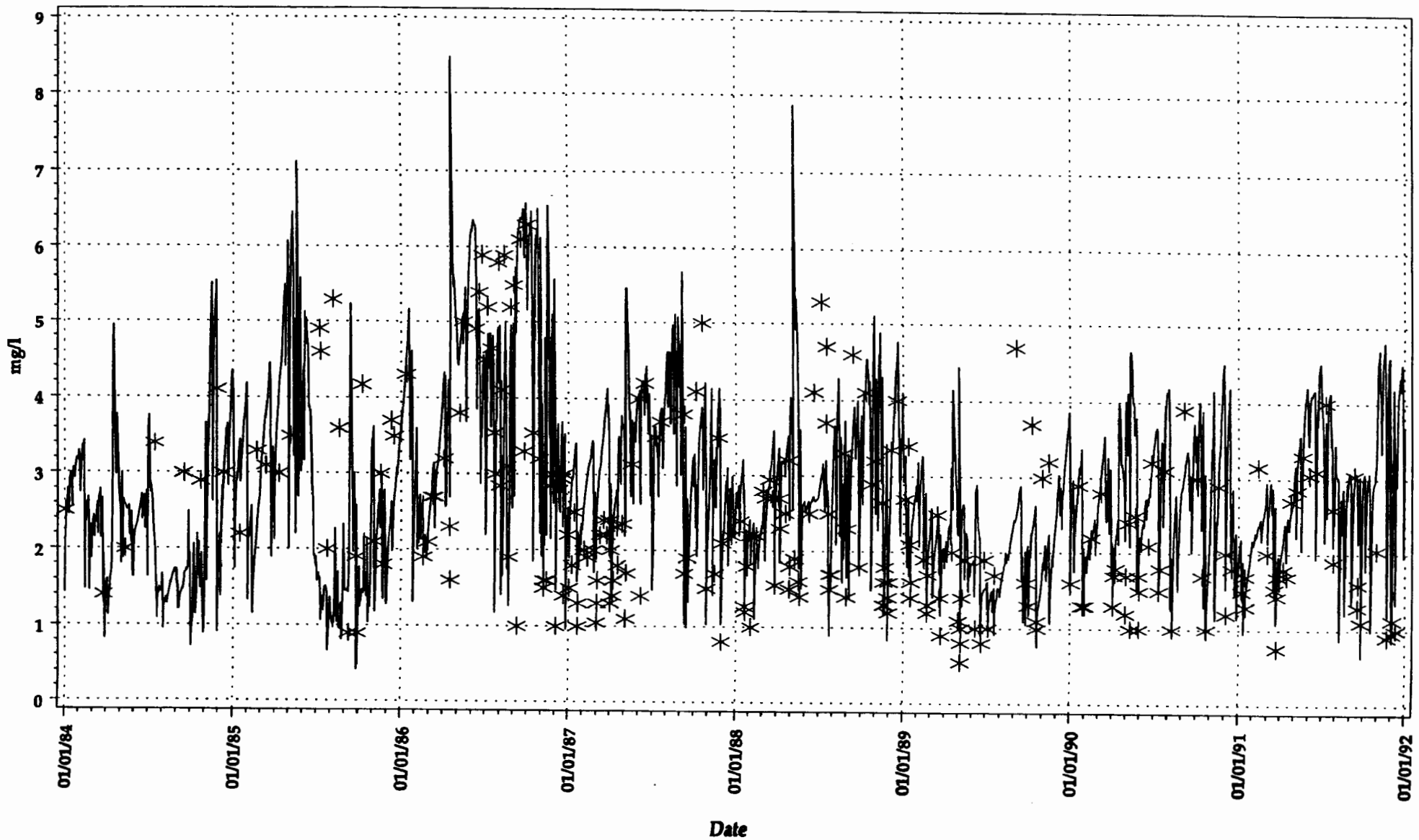


Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data

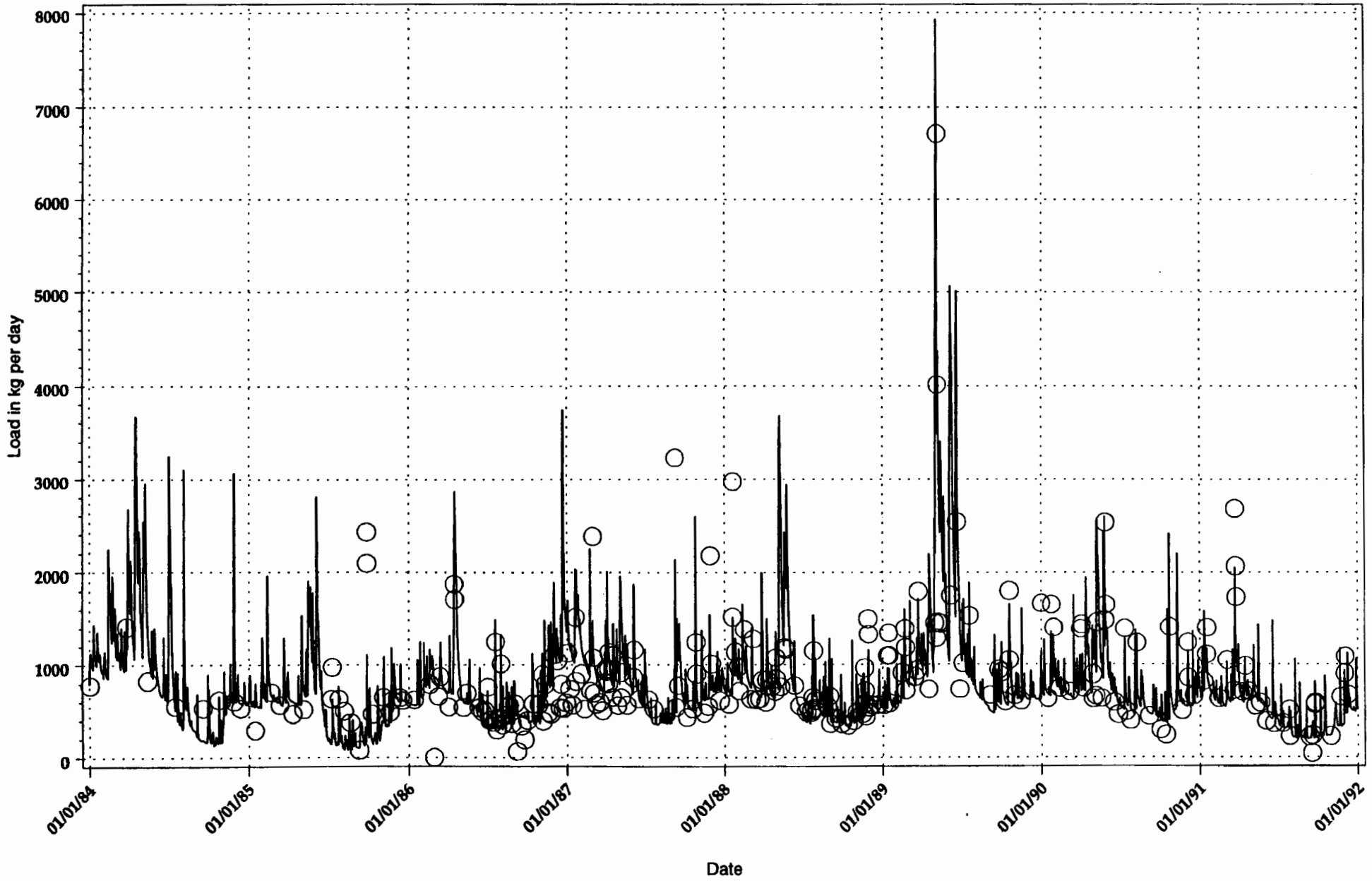


Patuxent River at Segment 340
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



Patuxent River at Segment 340
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

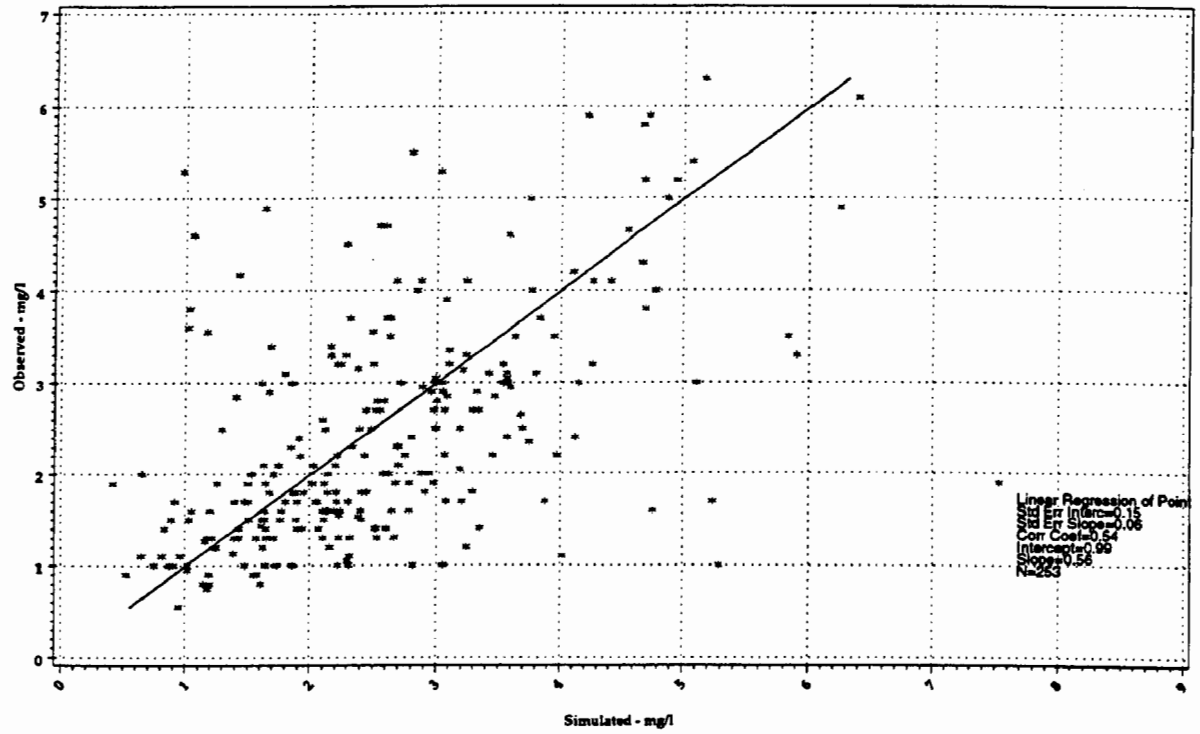


(y21_plotb.sas model3d:[pwang.dt] lldlles)
(pekuz340.drv 20FEB96 09:44,proc reg,model y=x)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

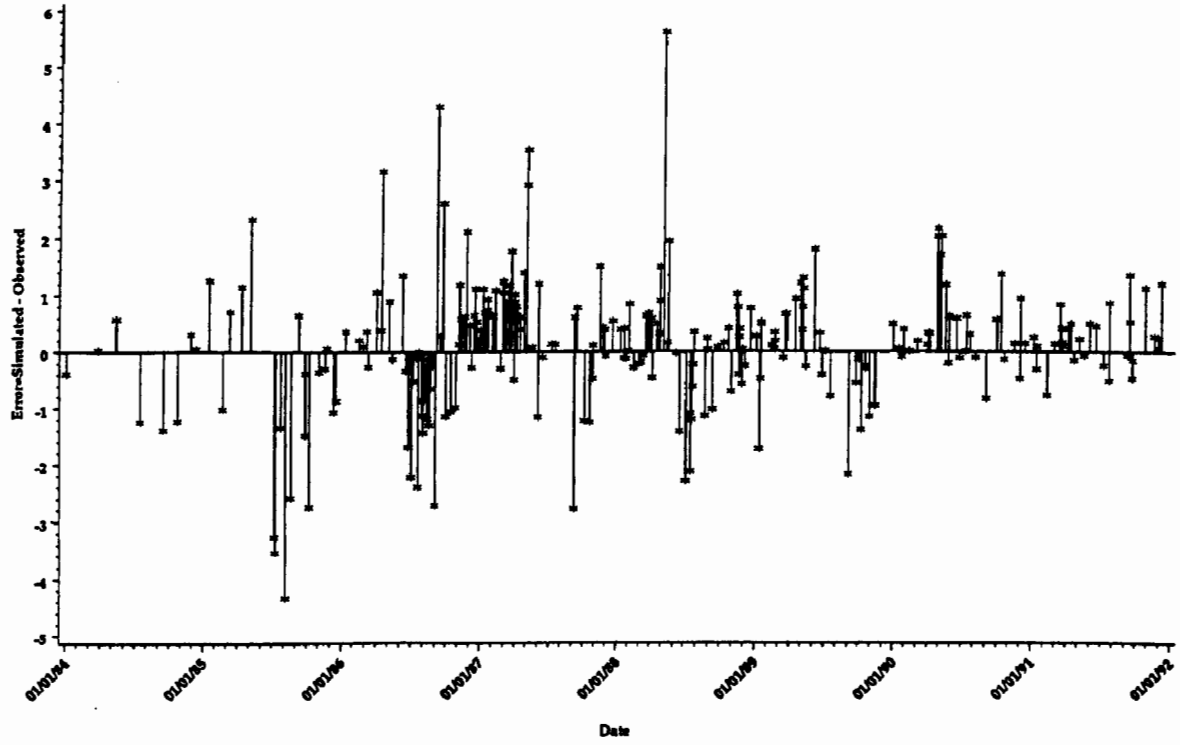
NO3: 01JAN84 - 01JAN92



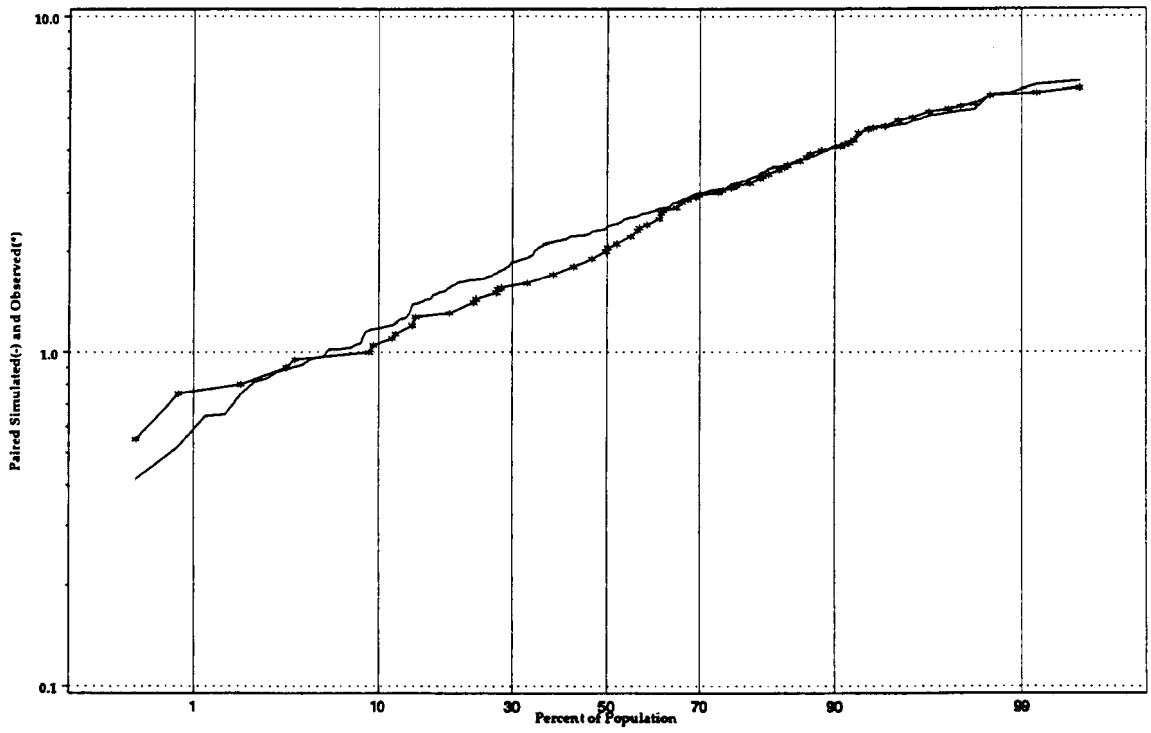
Patuxent River at Segment 340

Actual Error versus Time

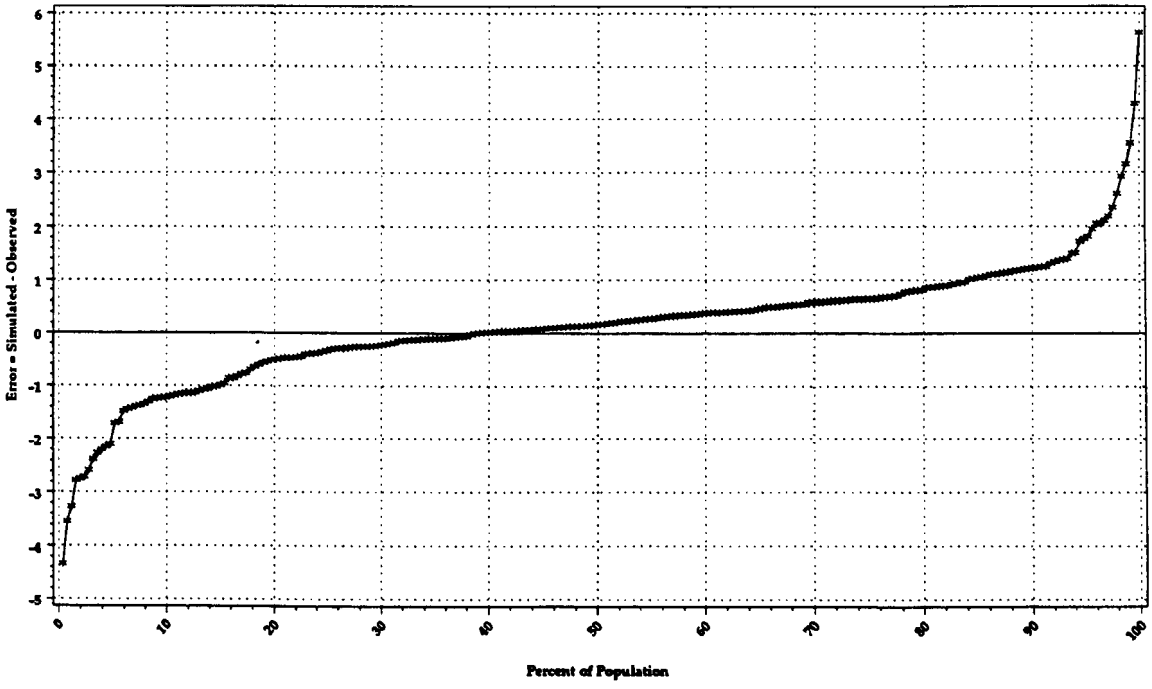
NO3



Patuxent River at Segment 340
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

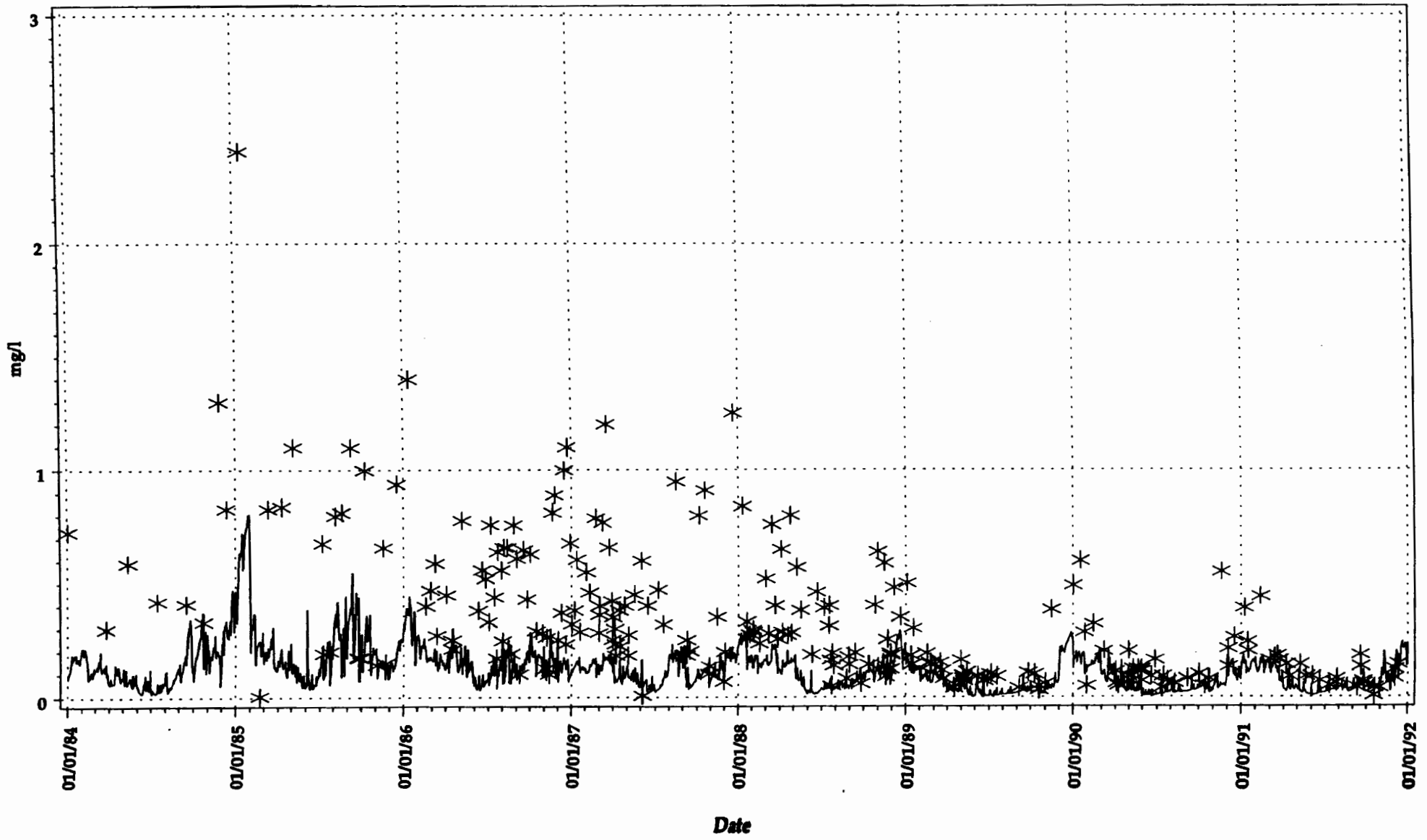


Patuxent River at Segment 340
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data



Patuxent River at Segment 340
Observed and Simulated versus Time
Total Ammonia

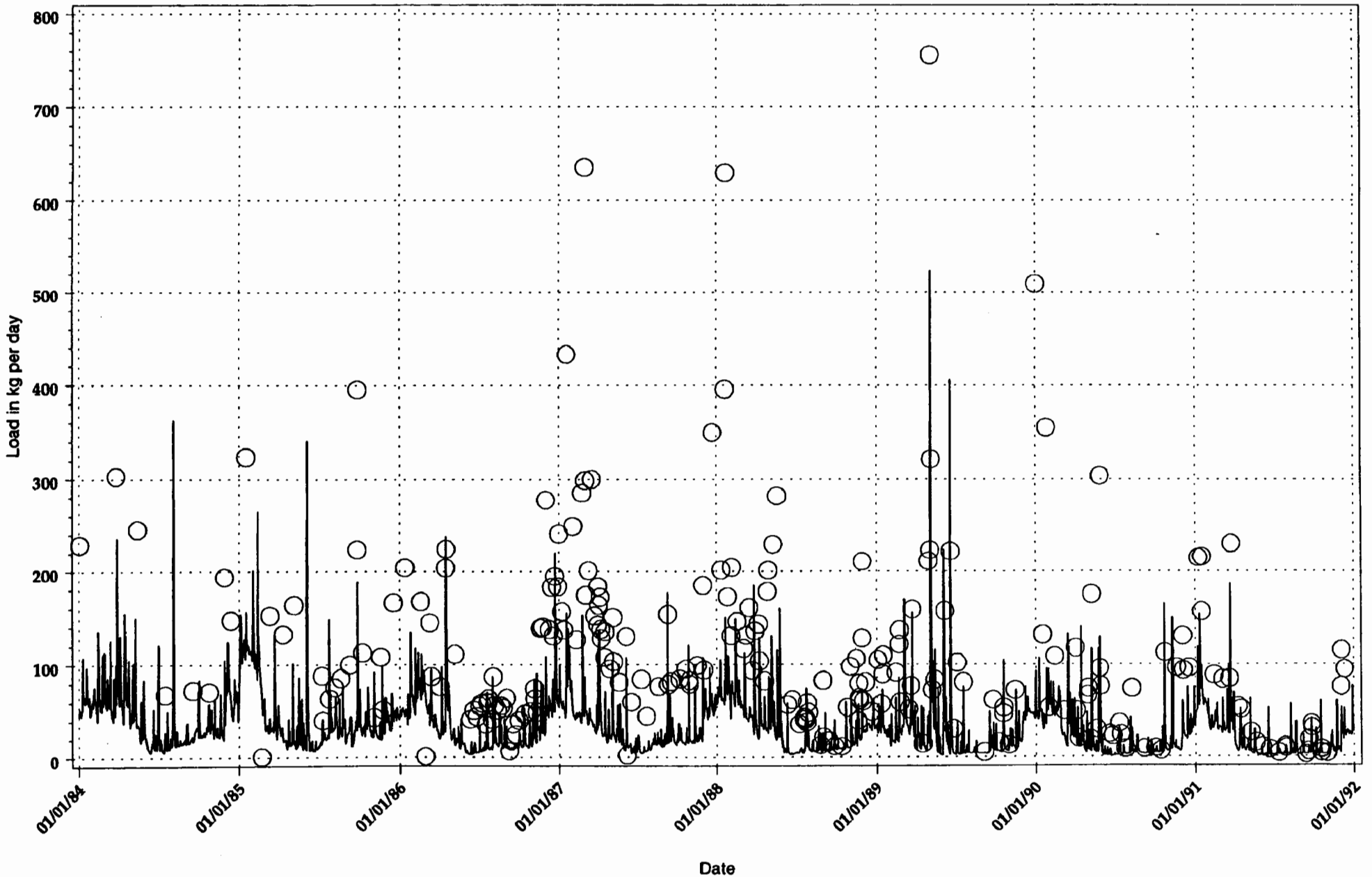
(*=Observed, -=Simulated)



Patuxent River at Segment 340

Total Ammonia Observed and Simulated Load vs Time

(line = simulated, O = observed)

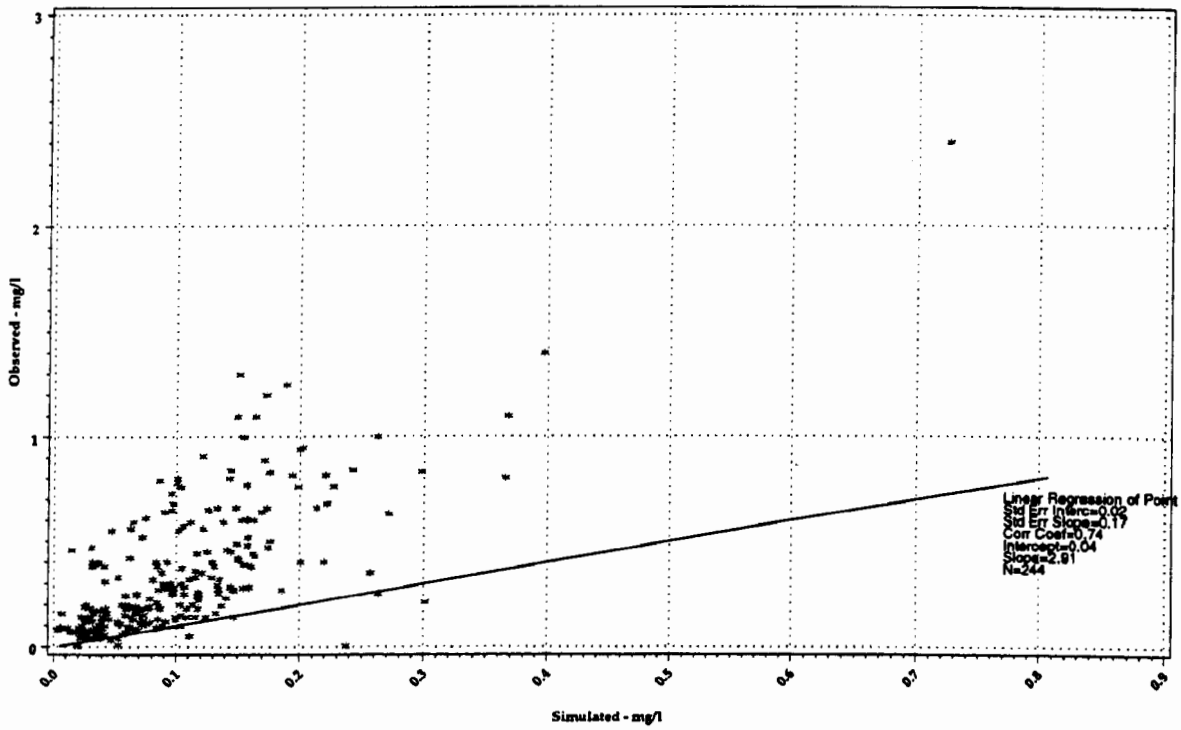


(y21_plotb.sas model3d:[pwang.dt] lldlsa)
(i:\stu340.drv 20FEB98 09:44,proc reg,model y=x)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

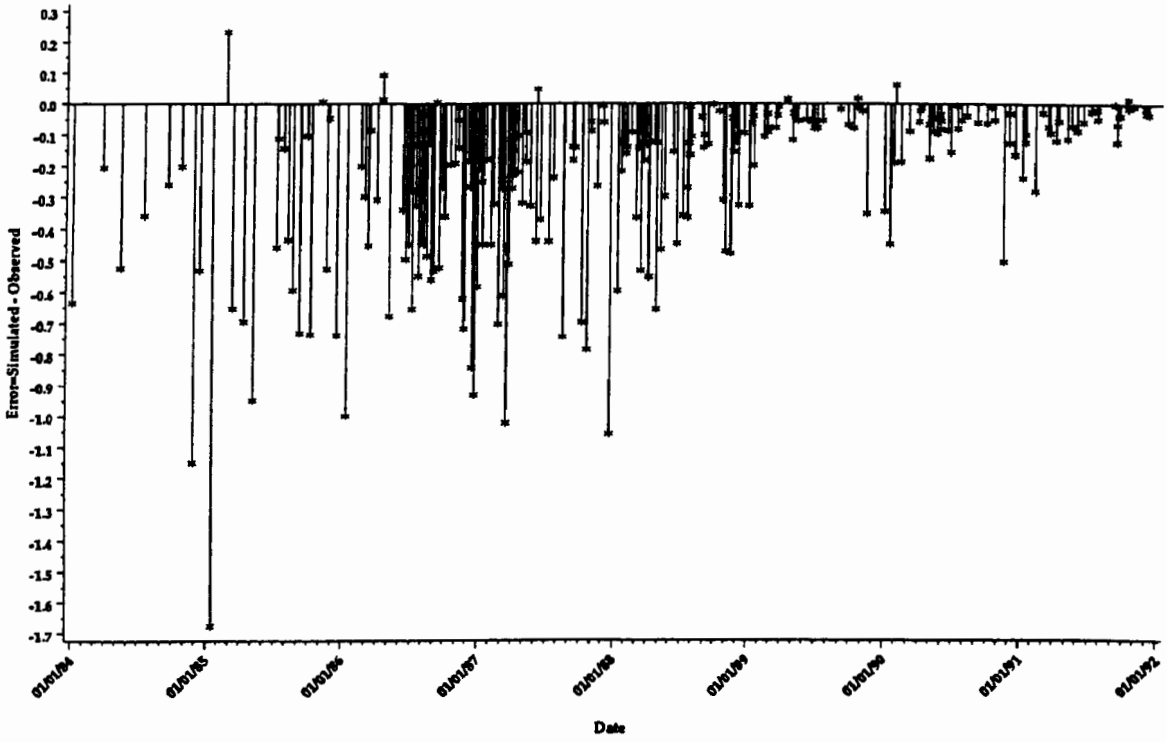
Total Ammonia: 01JAN84 - 01JAN92



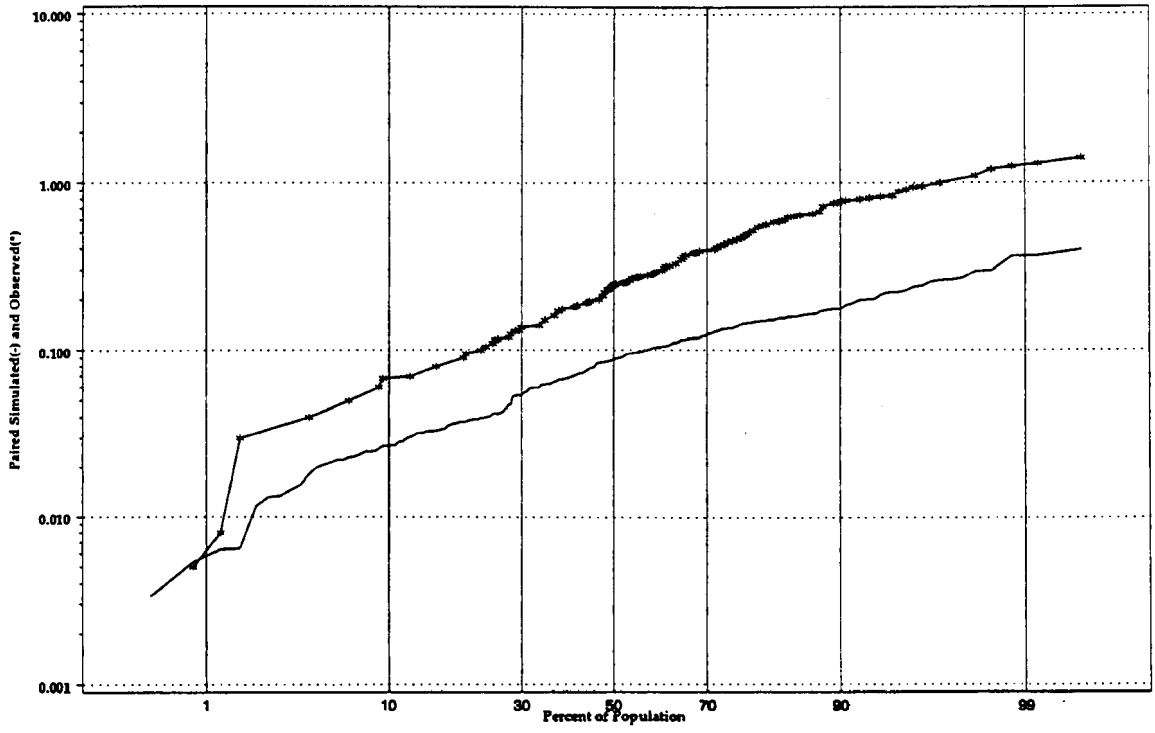
Patuxent River at Segment 340

Actual Error versus Time

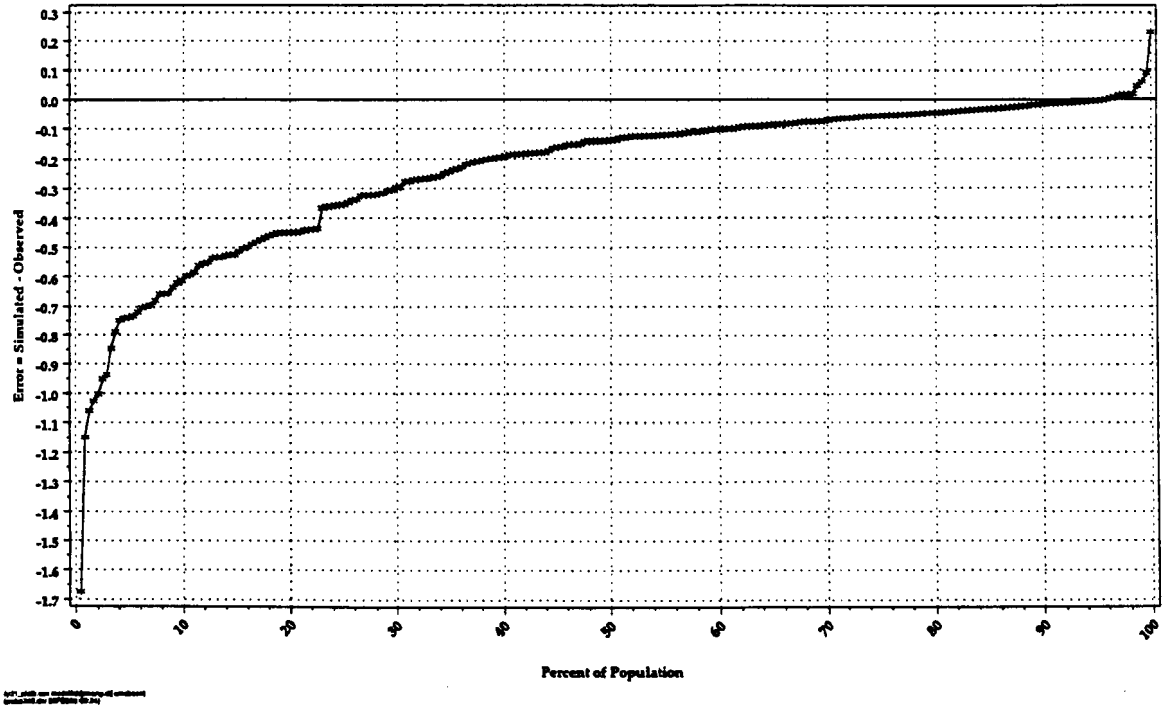
Total Ammonia



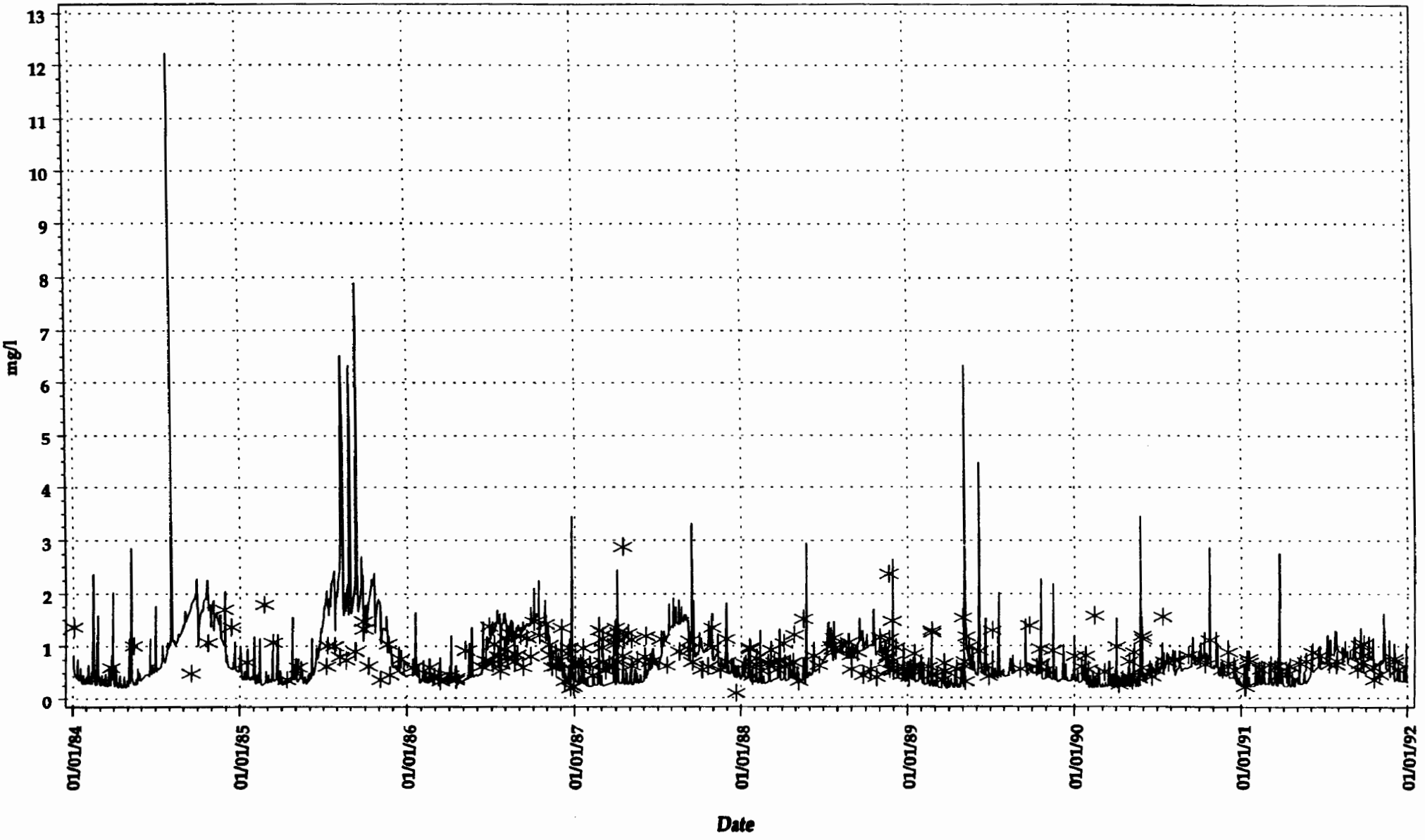
Patuxent River at Segment 340
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



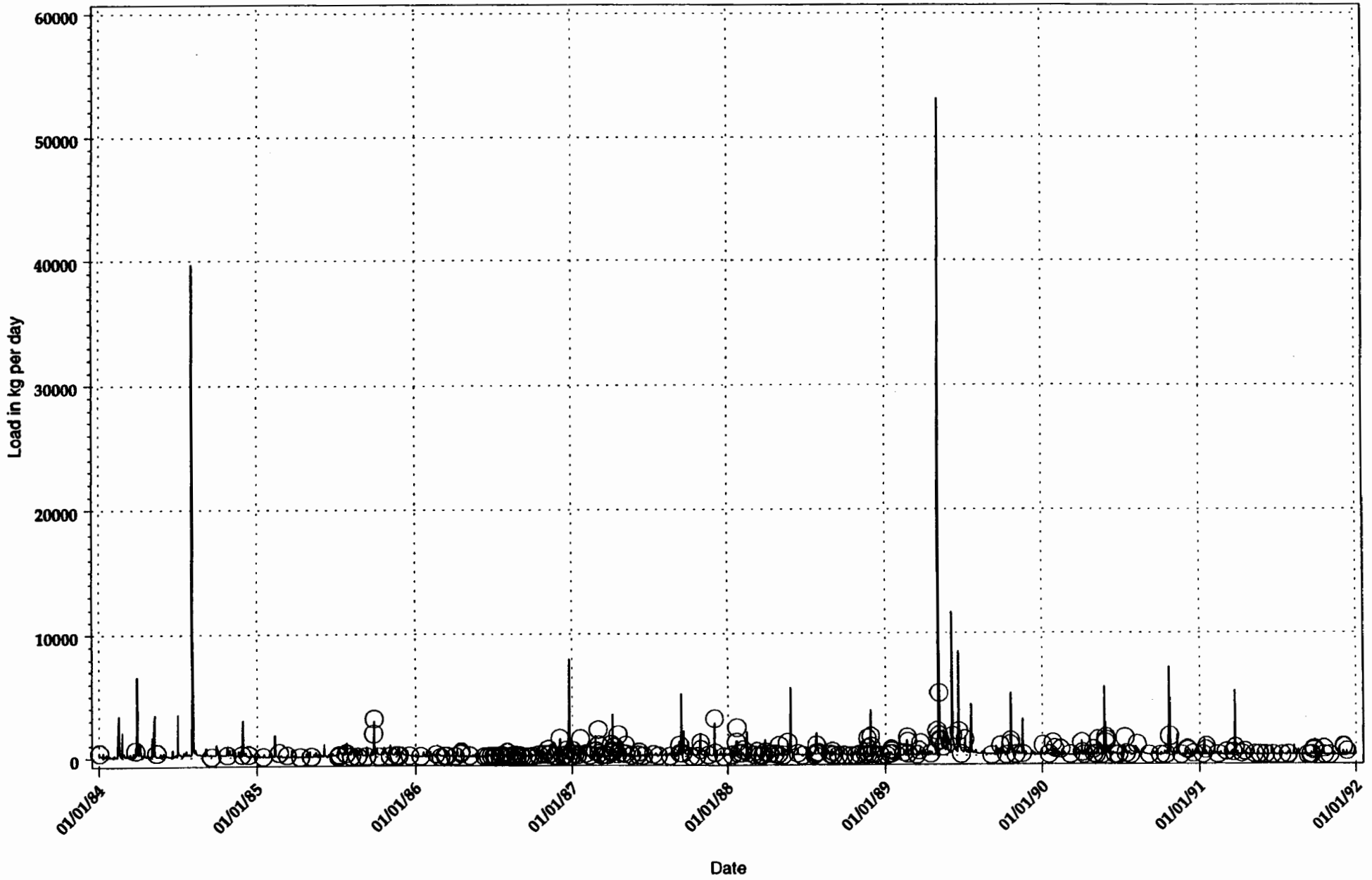
Patuxent River at Segment 340
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)



Patuxent River at Segment 340

Organic Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)

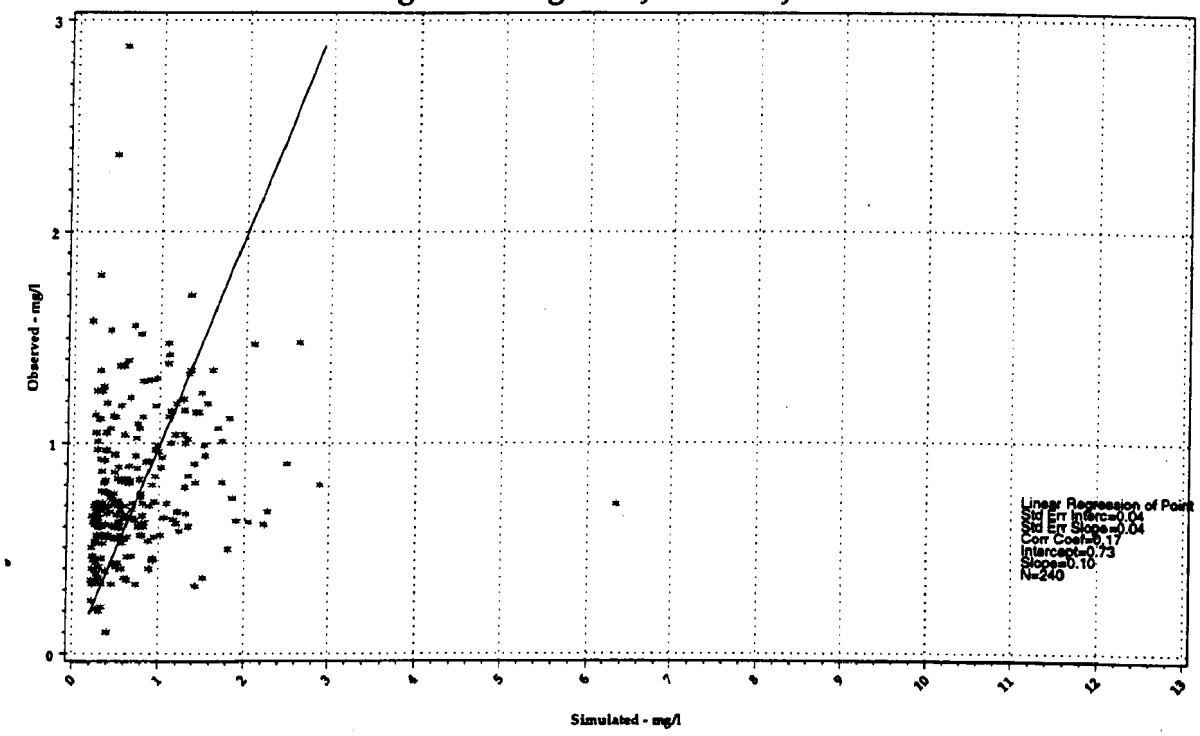


(y21_plotb.sas model3d [pwang.dl] lidlas)
(patux340.dev 20FEB98 09:44 proc reg model y=x)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

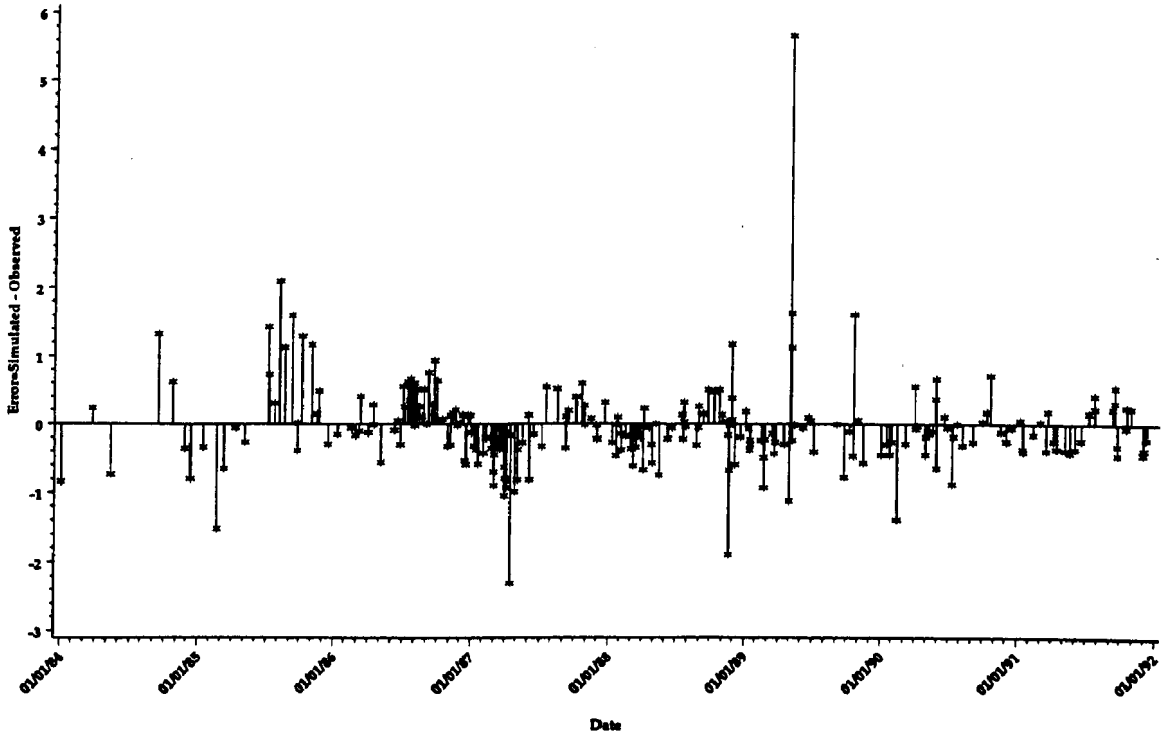
Organic Nitrogen: 01JAN84 - 01JAN92



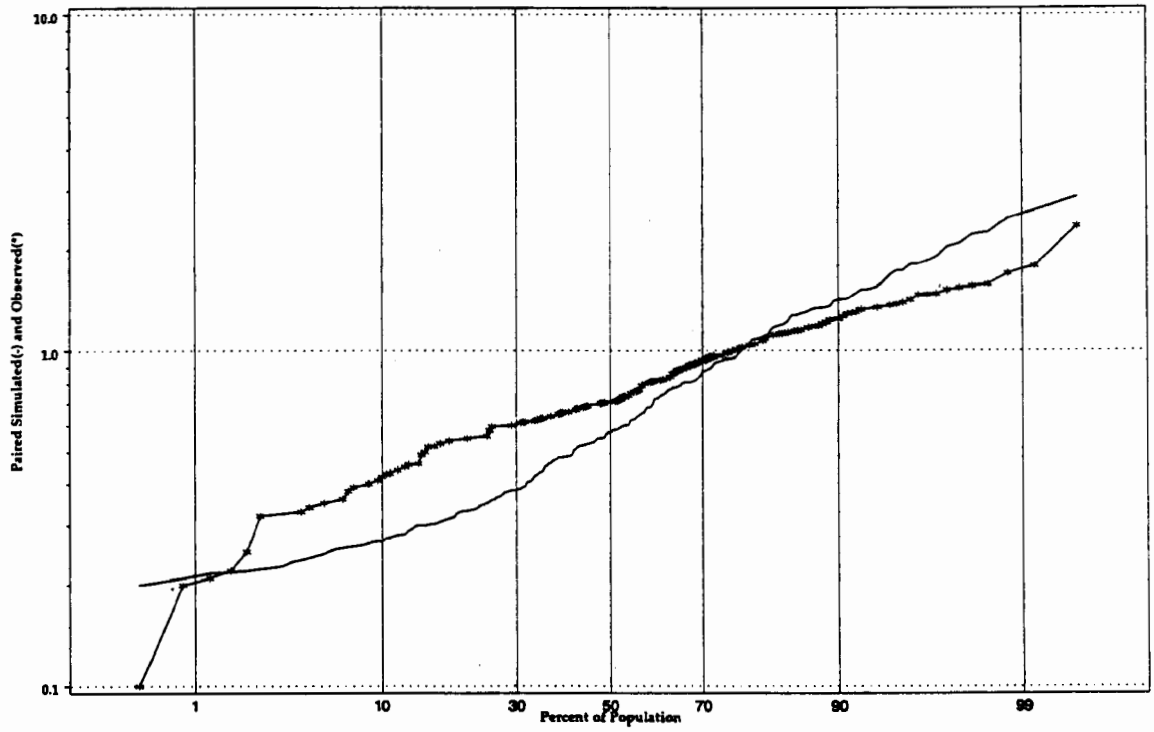
Patuxent River at Segment 340

Actual Error versus Time

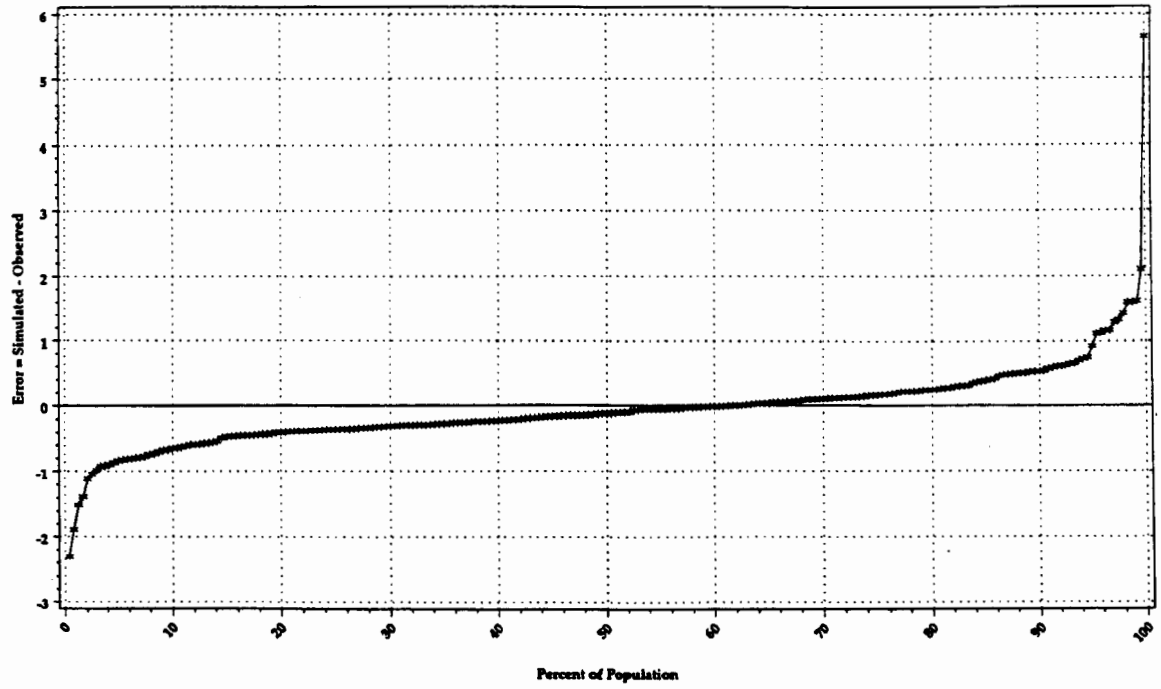
Organic Nitrogen



Patuxent River at Segment 340
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.3.0 Potomac River

Basin Segments:

Above Fall Line Basin Segments: 160, 170, 175, 180, 190, 200, 210, 220, 730, 740, and 750

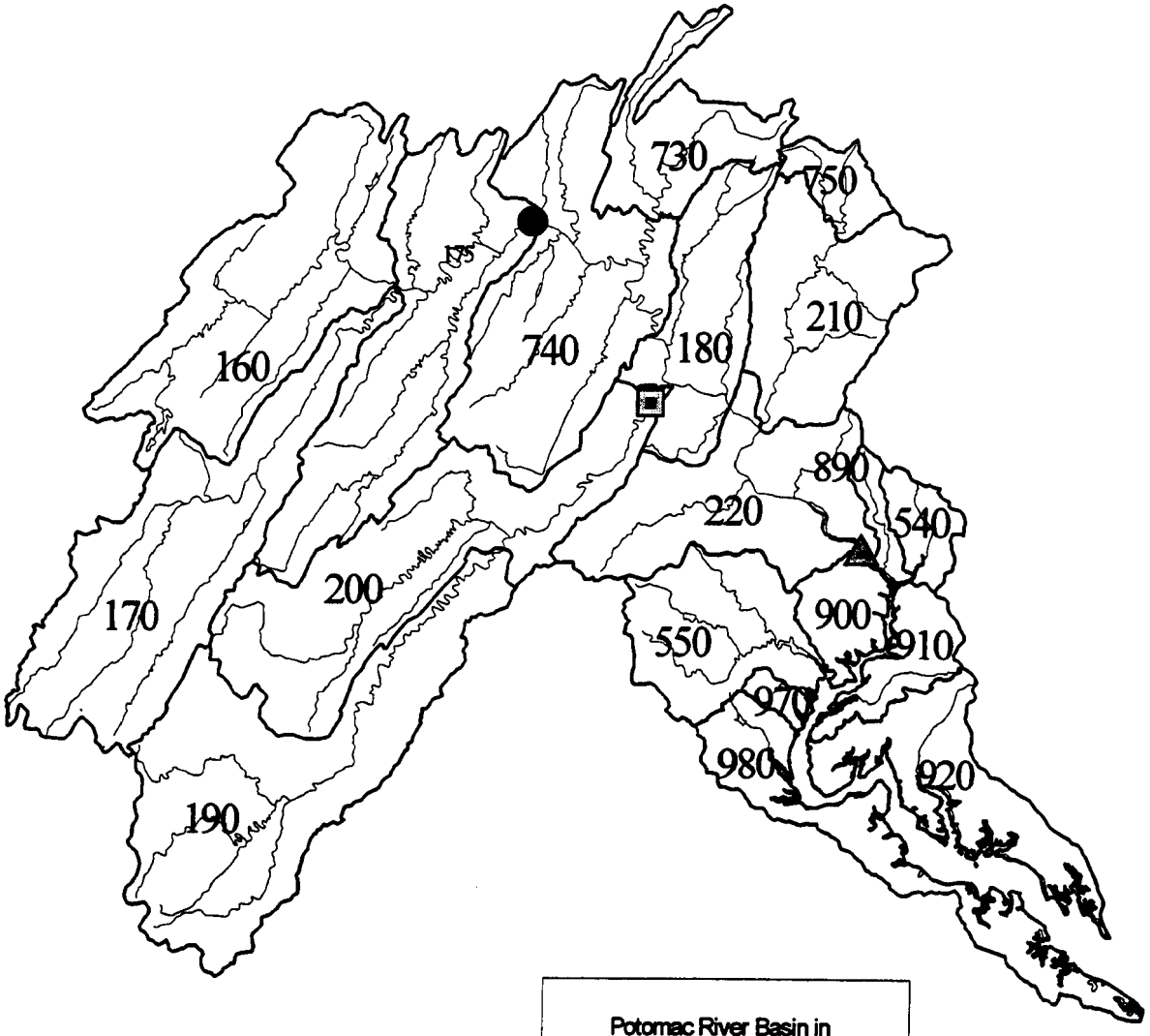
Below Fall Line Basin Segments: 540, 550, 890, 900, 910, 920, 970, and 980

Section Contents:

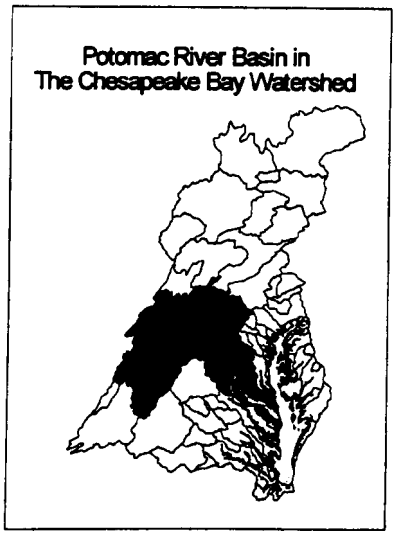
B.3.0 Monitoring Stations in the Potomac River Basin (Figure B.3.0)
B.3.1 Mid Potomac River (Monitoring Station: 1613000)
B.3.2 Shenandoah River (Monitoring Station: 1636500)
B.3.3 Lower Potomac River (Monitoring Station: 1646500)

Figure B.3

Monitoring Stations in the Potomac River Basin



Calibration Stations
- 1613000
- 1636500
- 1646500
- Streams
- Model Segments



Chesapeake Bay Program

Map Date: April 1998

Source: USGS and USEPA Chesapeake Bay Program

N

KJH

B.3.1 Mid Potomac River near Shepardstown, WV at Segment 740 (Monitoring Station: 1613000) (Above Fall Line Basin Segments: 160, 170, 175, 730, and 740)

Section Summary:

The mid-Potomac gage at Shepardstown, WV, is downstream of a largely forested basin which is rural in nature and is dominated by agricultural loads. The mid-Potomac basin above the gage covers an area of 5,961 square miles. At the midpoint of the simulation period, 1990, the land use for the basin was composed of 67% forest land, 7% cropland, 23% other agricultural areas, 3% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage increased from 18.8 million pounds in 1985 to 19.3 million pounds in 1996. Total phosphorus loads over the same time period decreased from 2.0 million pounds to 1.9 million pounds. In general, point source loads above the gage site decreased. In 1996, the total nitrogen point source load was 8% of the total load and the total phosphorus point source load was 21% of the total load. Estimated septic system total nitrogen loads increased 19%, from 0.5 million pounds in 1985 to 0.7 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation increased estimated cropland total nitrogen loads by 2%, and decreased other agricultural loads (primarily pasture and manure loads) by 10%. Total phosphorus increased for cropland by 9% and decreased for other agricultural loads by 6%. Urban loads were estimated to have increased over the 1985 to 1996 period by 12% for total nitrogen and 13% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

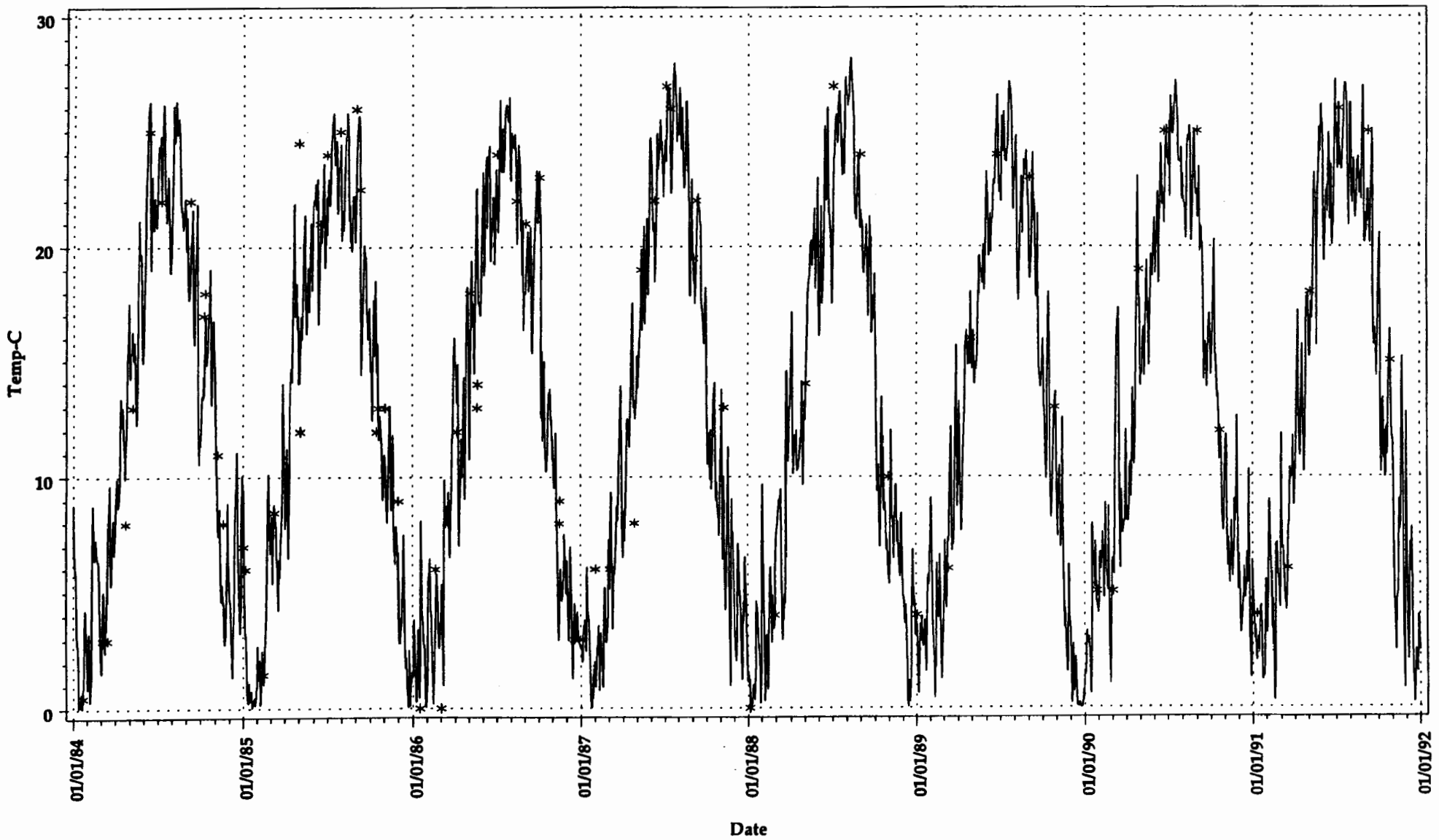
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date – Temperature

Mid Potomac River at Segment 740
Observed and Simulated versus Time
Temperature-C

(*=Observed, -=Simulated)

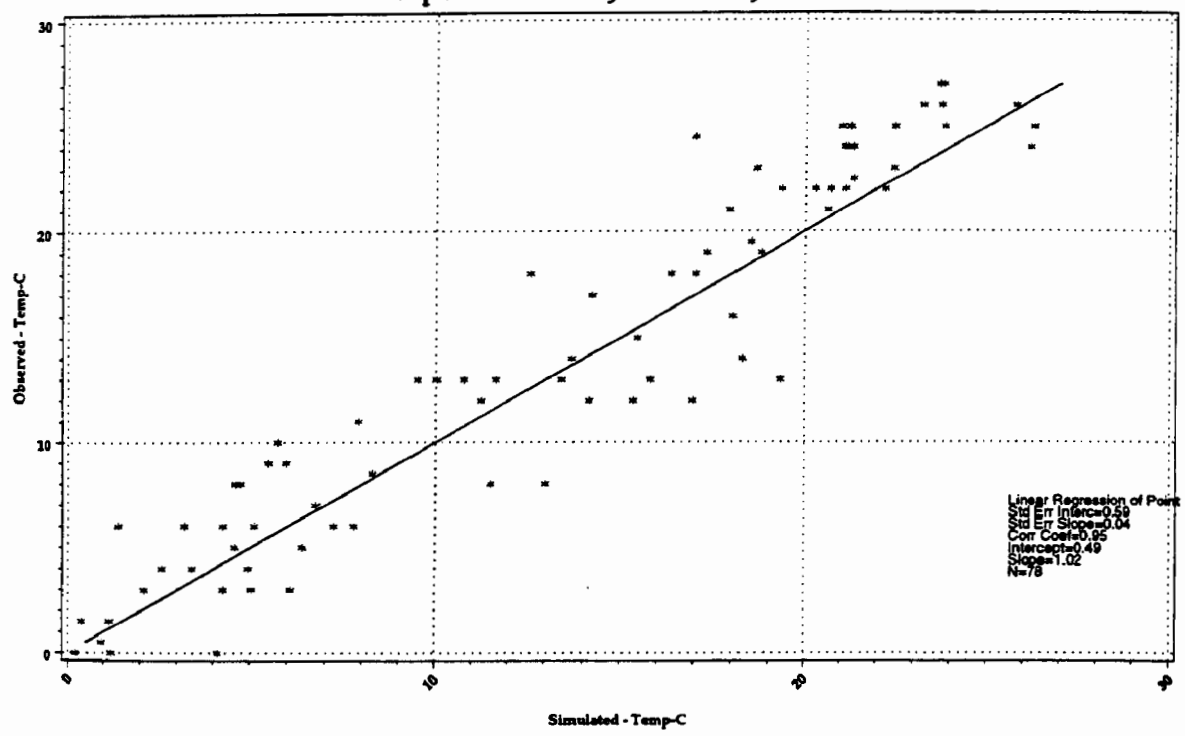


(y21_plotb.aas model3d:[pwang.dt] plotomt - omtime)
(mid.dv 12FEB96 11:34)

Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

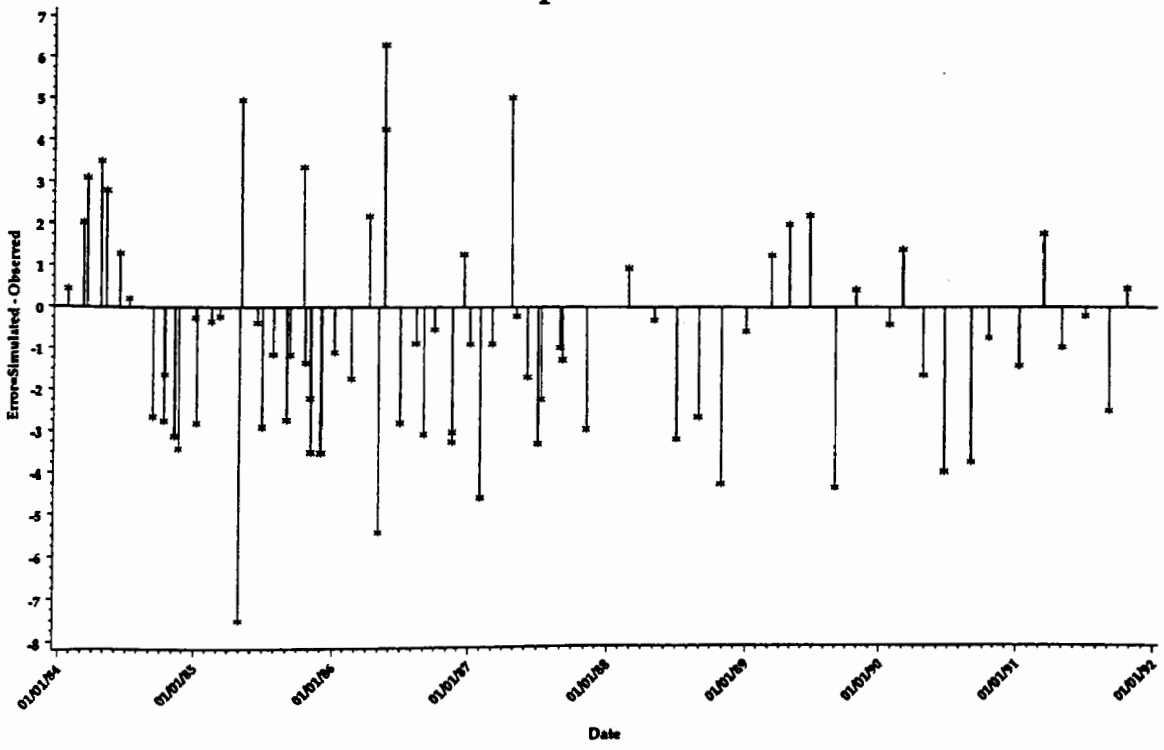
Temperature-C: 01JAN84 - 01JAN92



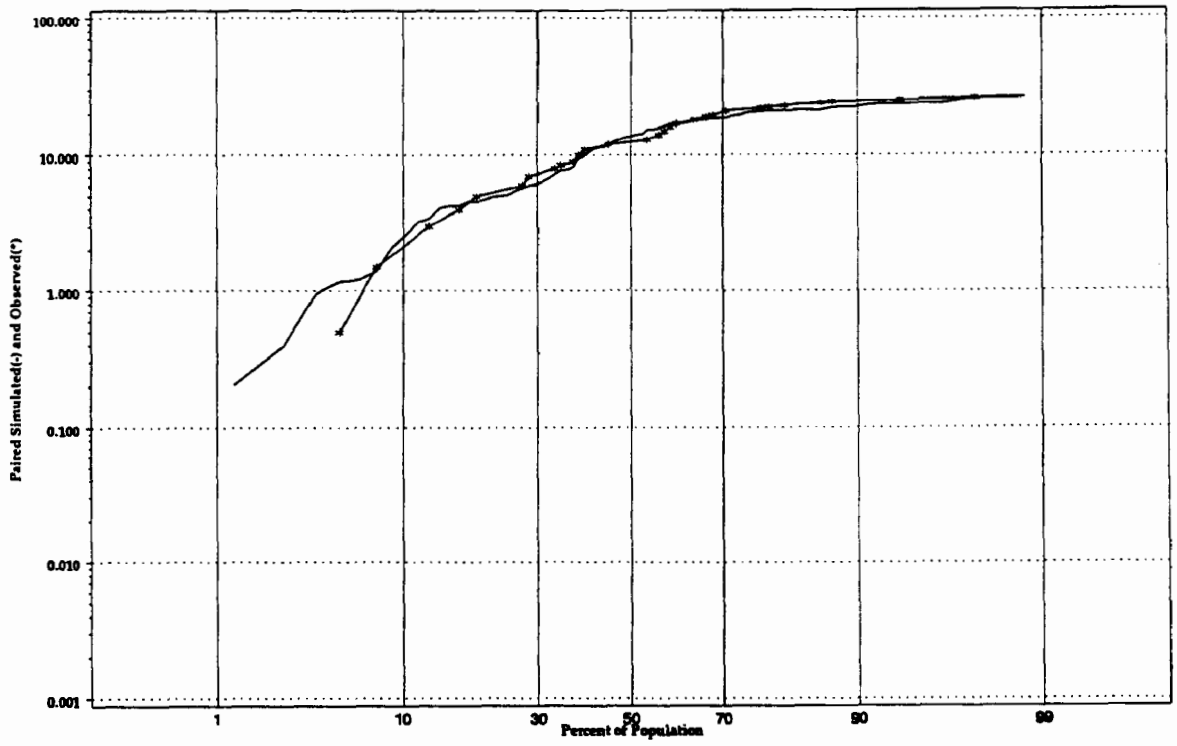
Mid Potomac River at Segment 740

Actual Error versus Time

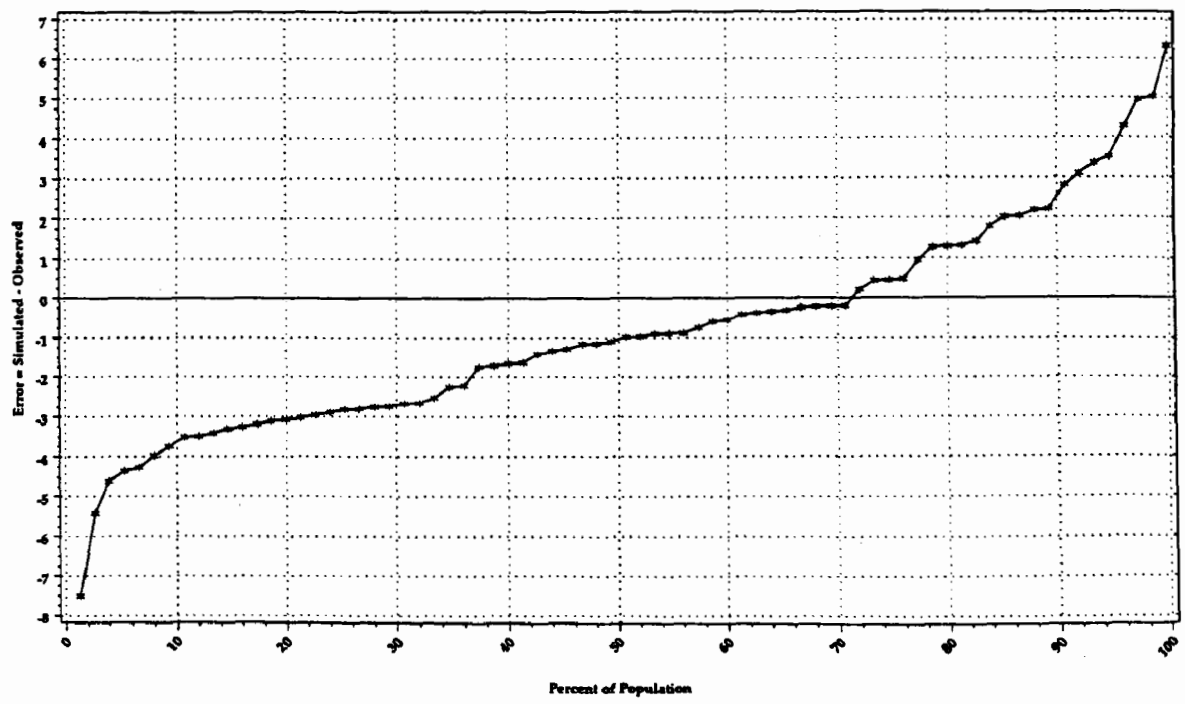
Temperature-C



Mid Potomac River at Segment 740
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

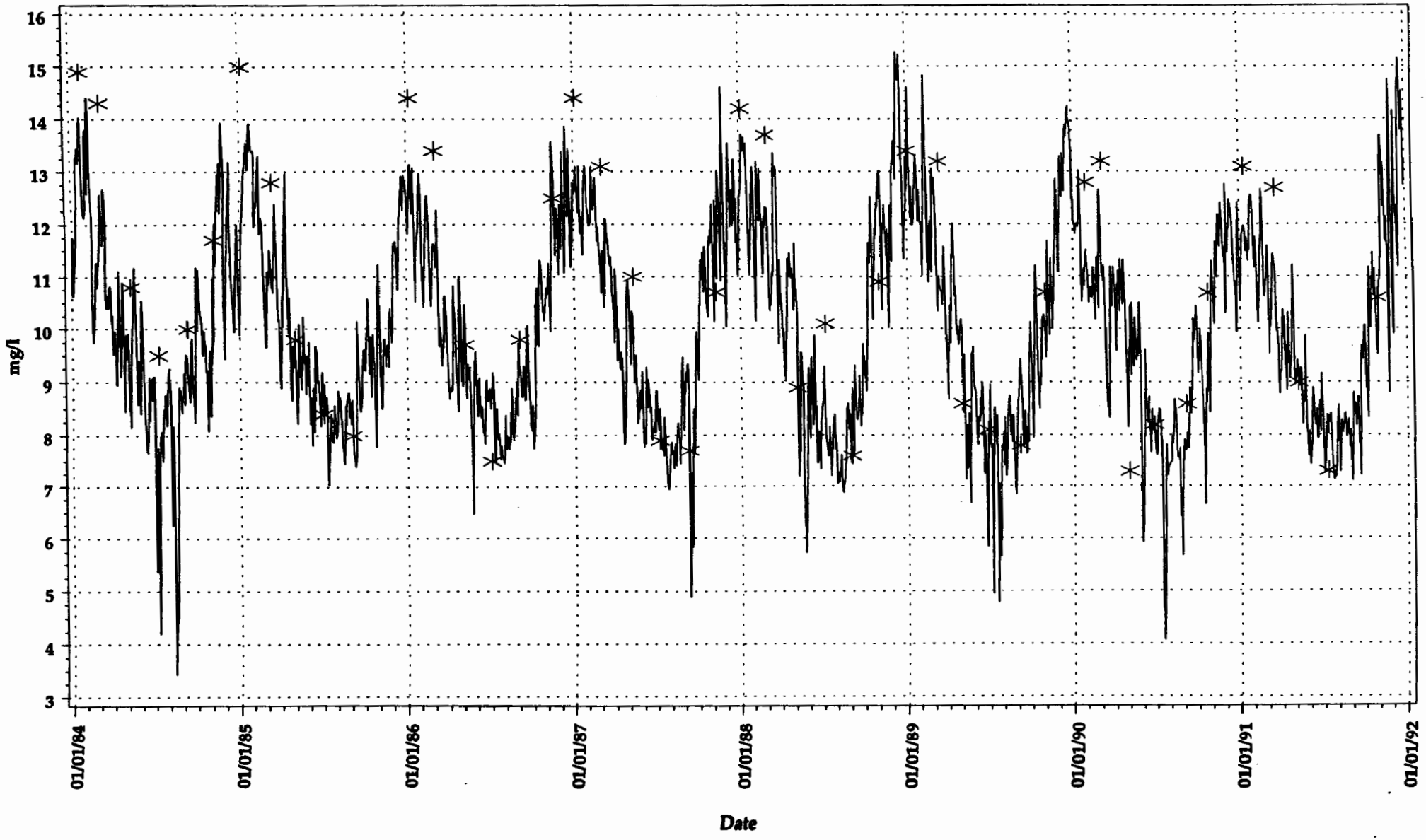


Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data



Mid Potomac River at Segment 740
Observed and Simulated versus Time
Dissolved Oxygen

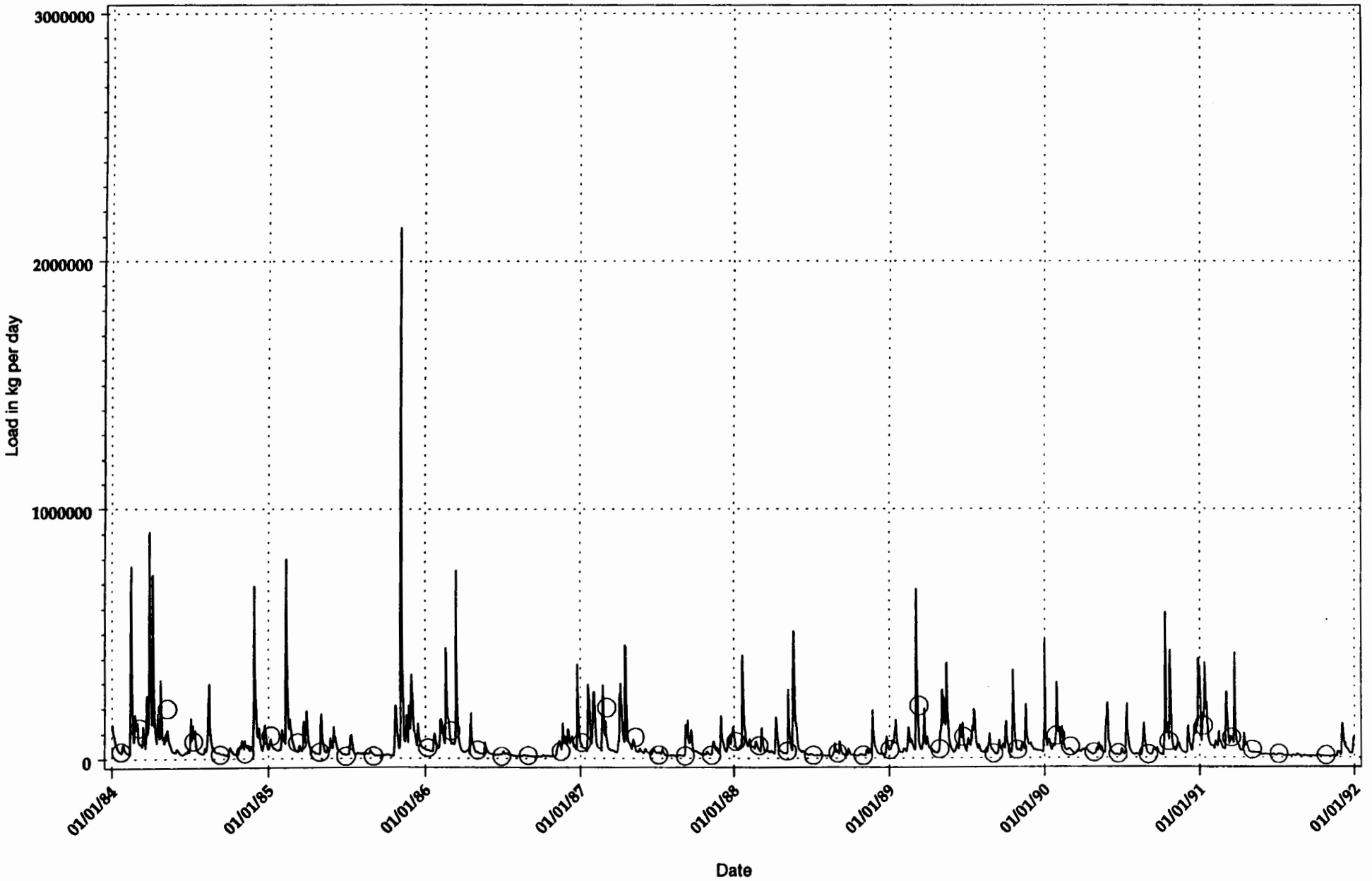
(*=Observed, -=Simulated)



Mid Potomac River at Segment 740

Dissolved Oxygen Observed and Simulated Load vs Time

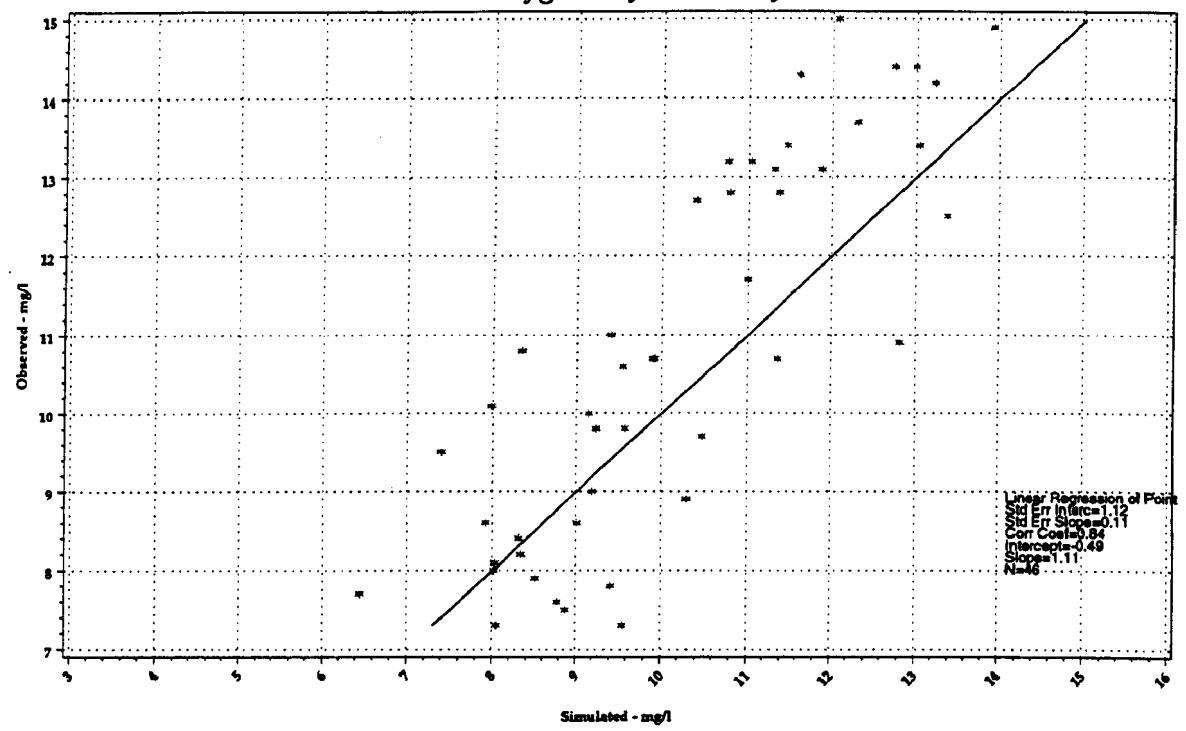
(line = simulated, O = observed)



(y21_plotb.sas model3d1[pwang.dt] lldflas)
(mid.div 12FEB96 11:34,proc reg,model y=x)

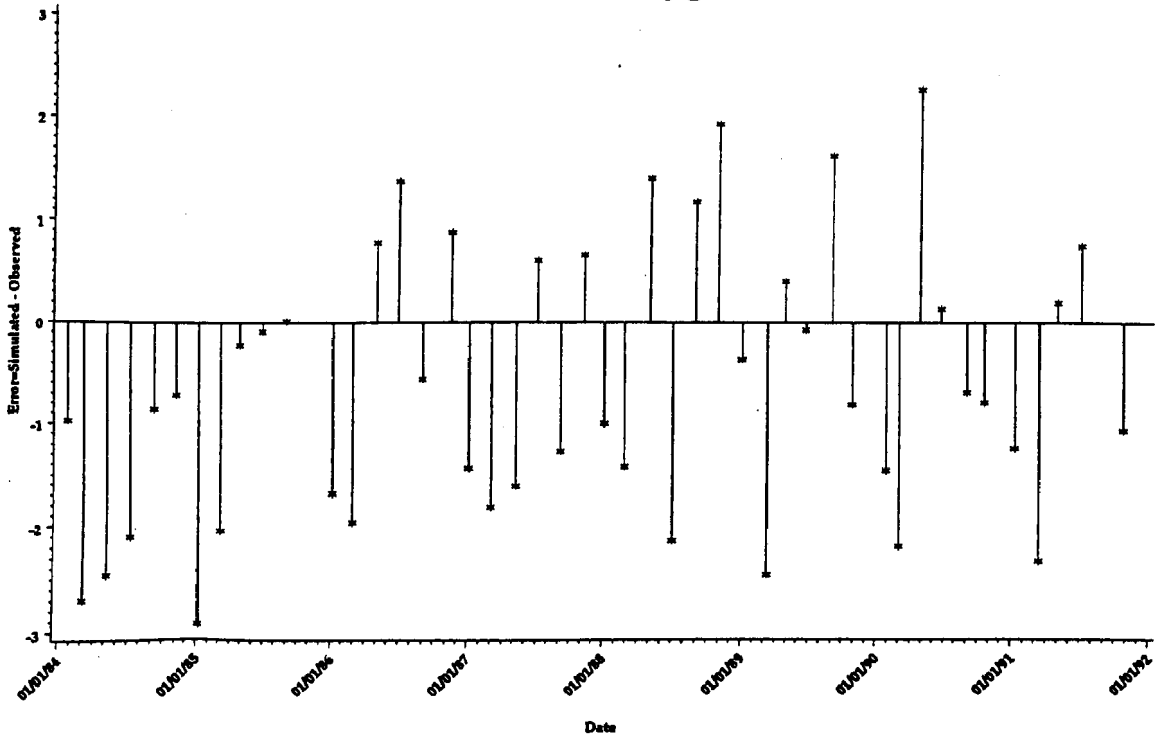
Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Dissolved Oxygen: 01JAN84 - 01JAN92

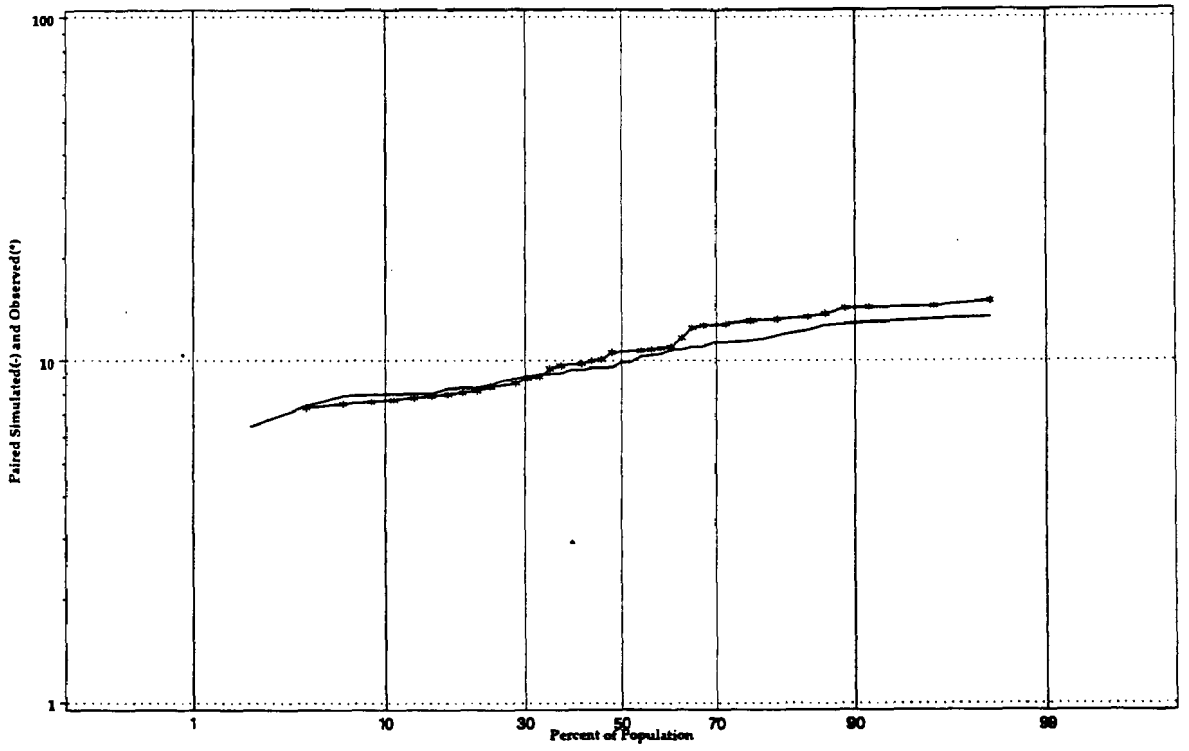


Mid Potomac River at Segment 740

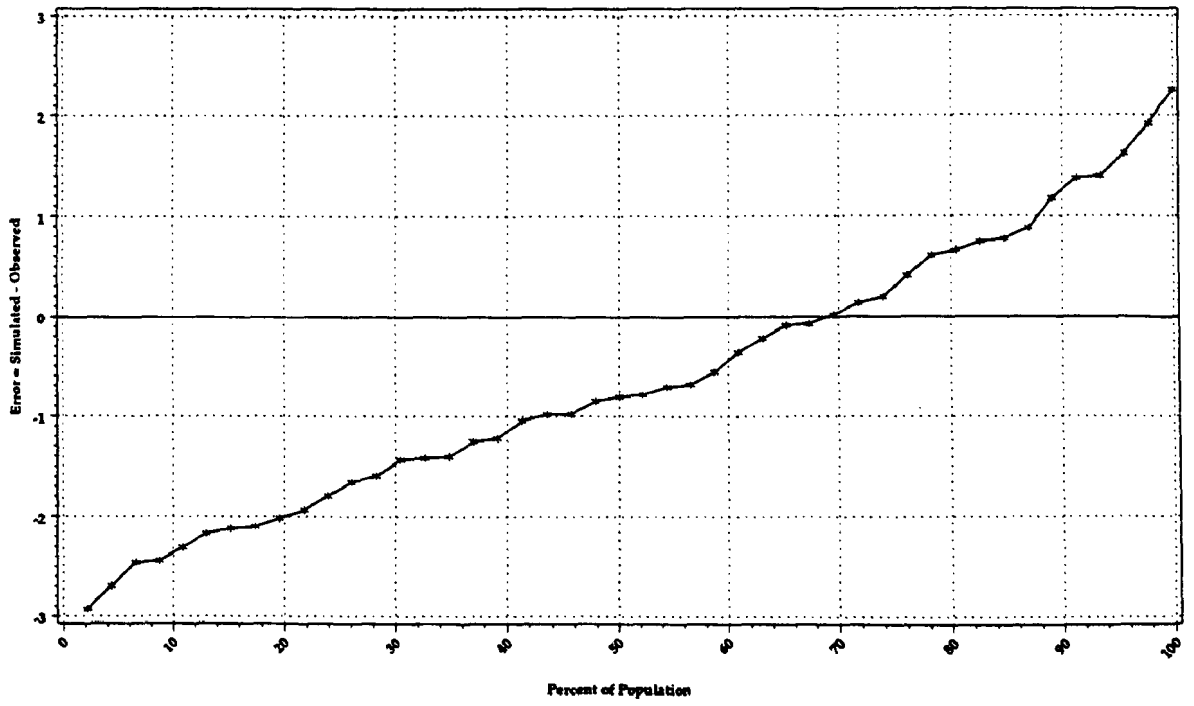
Actual Error versus Time
Dissolved Oxygen



Mid Potomac River at Segment 740
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

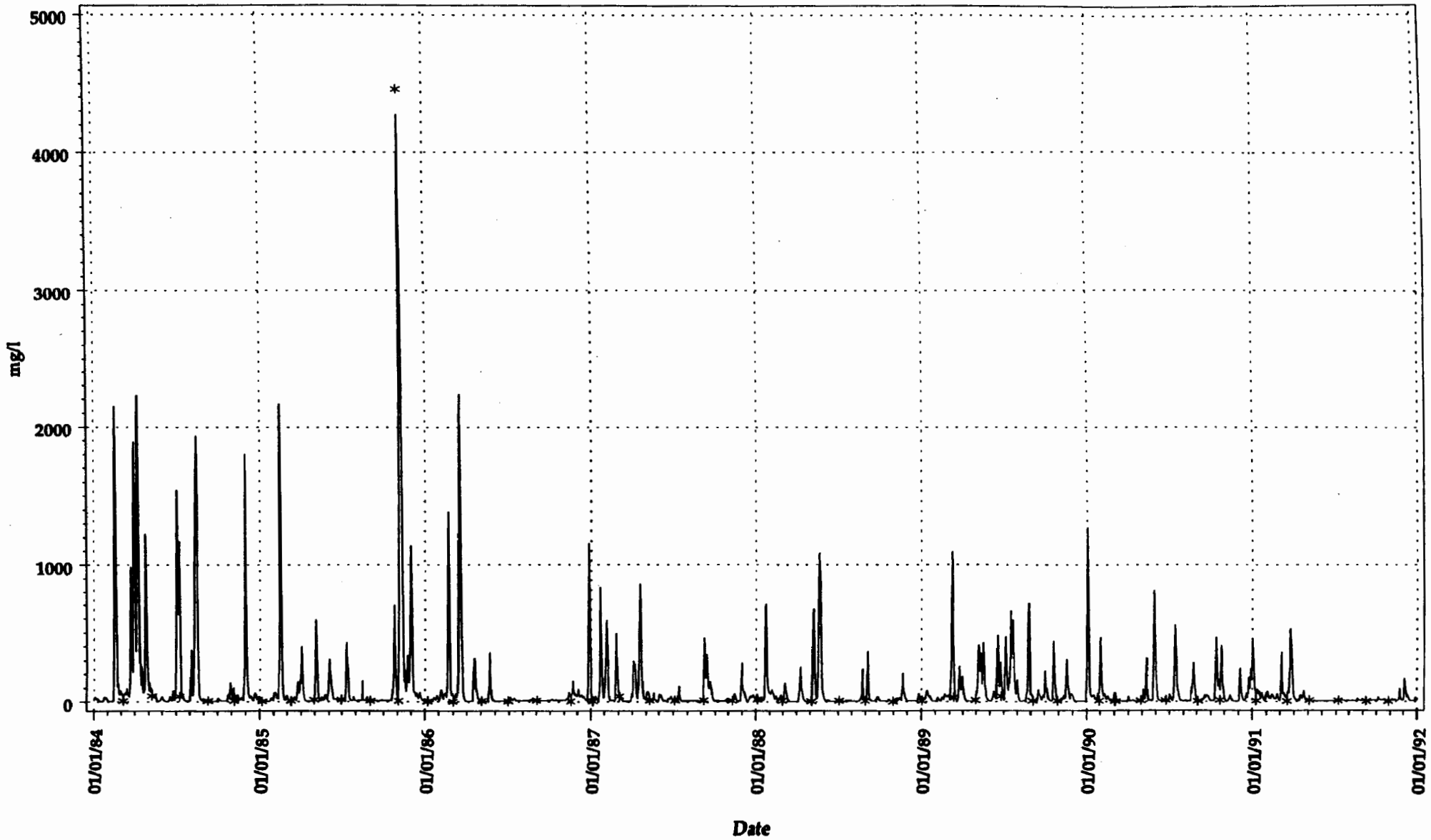


Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Mid Potomac River at Segment 740
Observed and Simulated versus Time
Total Suspended Sediment

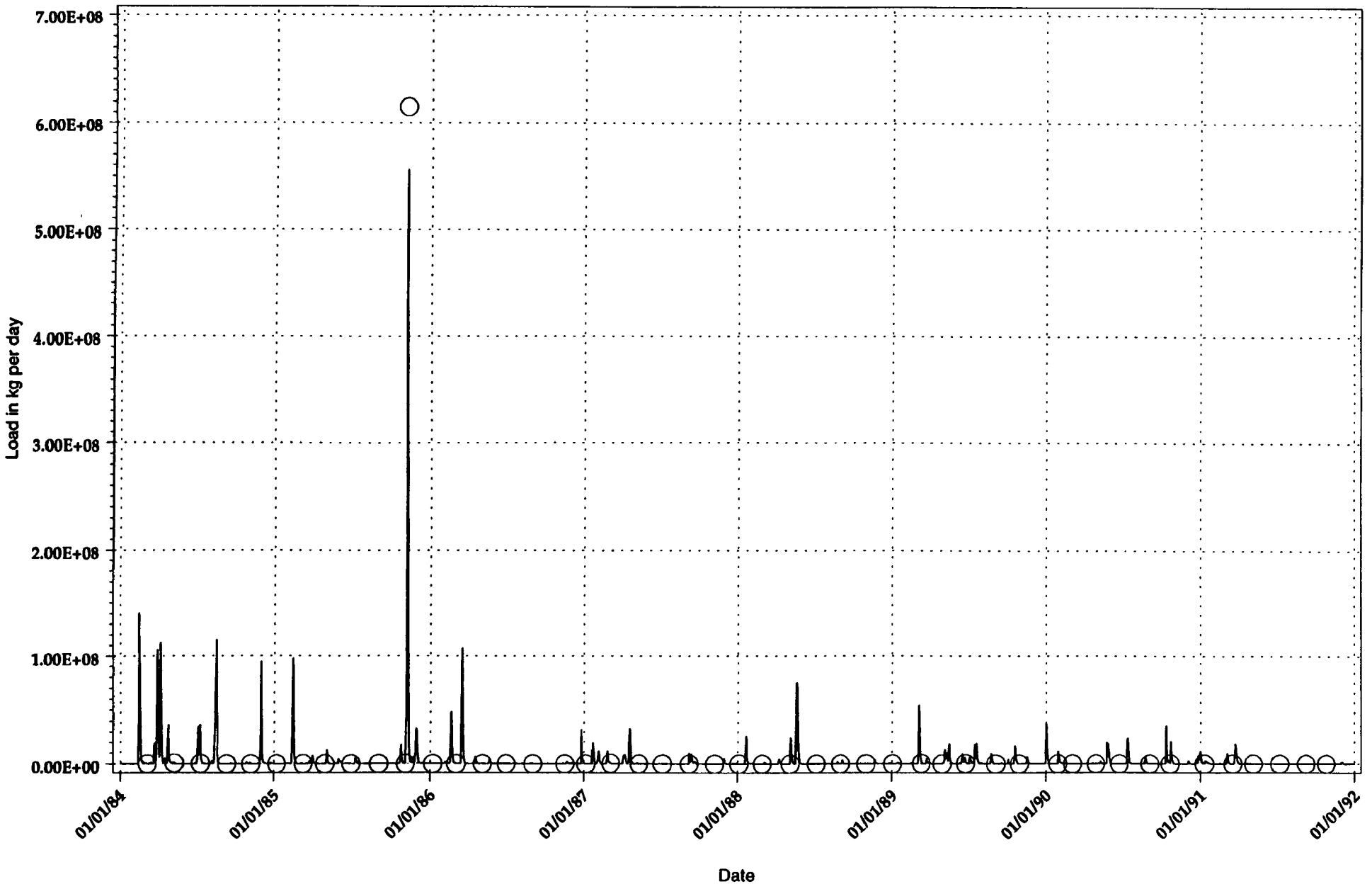
(*=Observed, -=Simulated)



Mid Potomac River at Segment 740

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

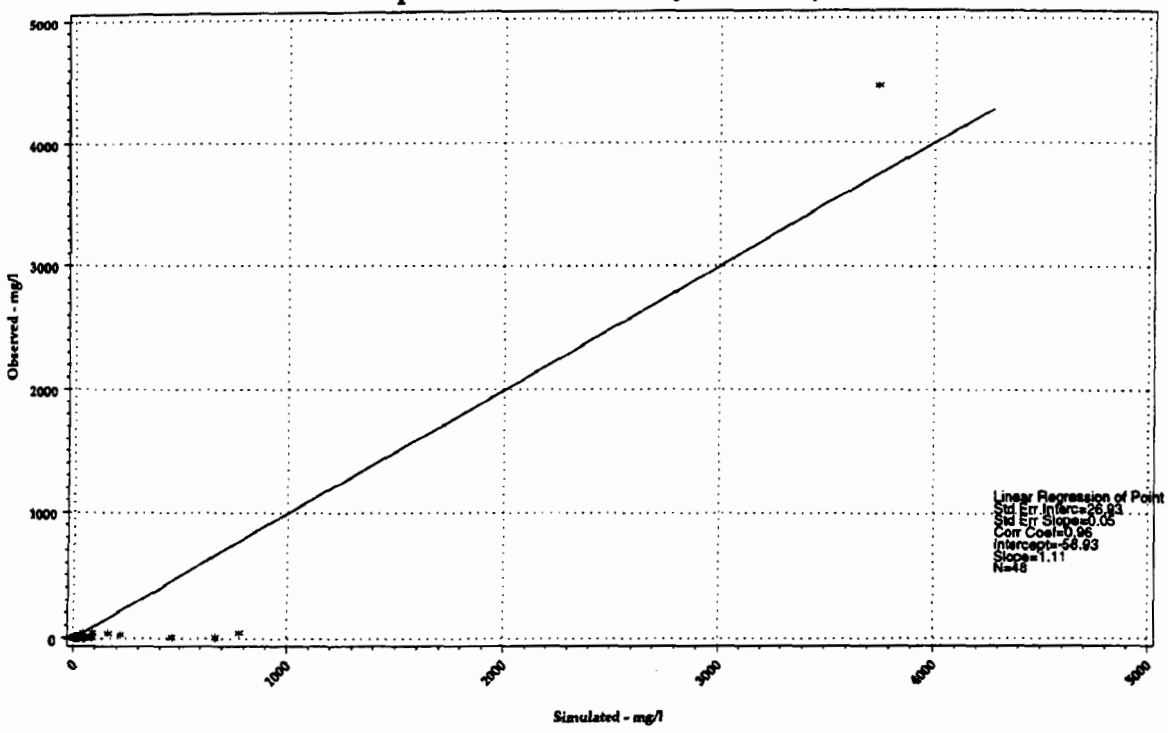


(y21_plotb.sas model3d:jpwang.dtj lidlas)
(mid.drv 23FEB98 16:04,proc reg,model y=x)

Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

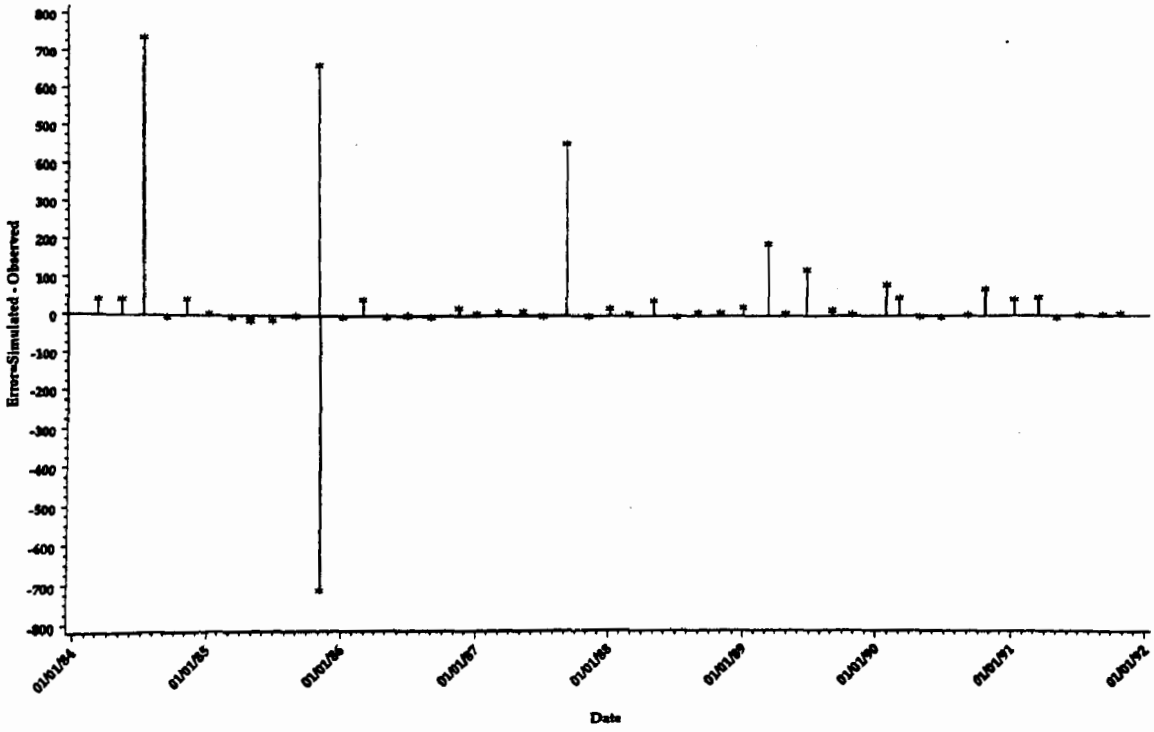
Total Suspended Sediment: 01JAN84 - 01JAN92



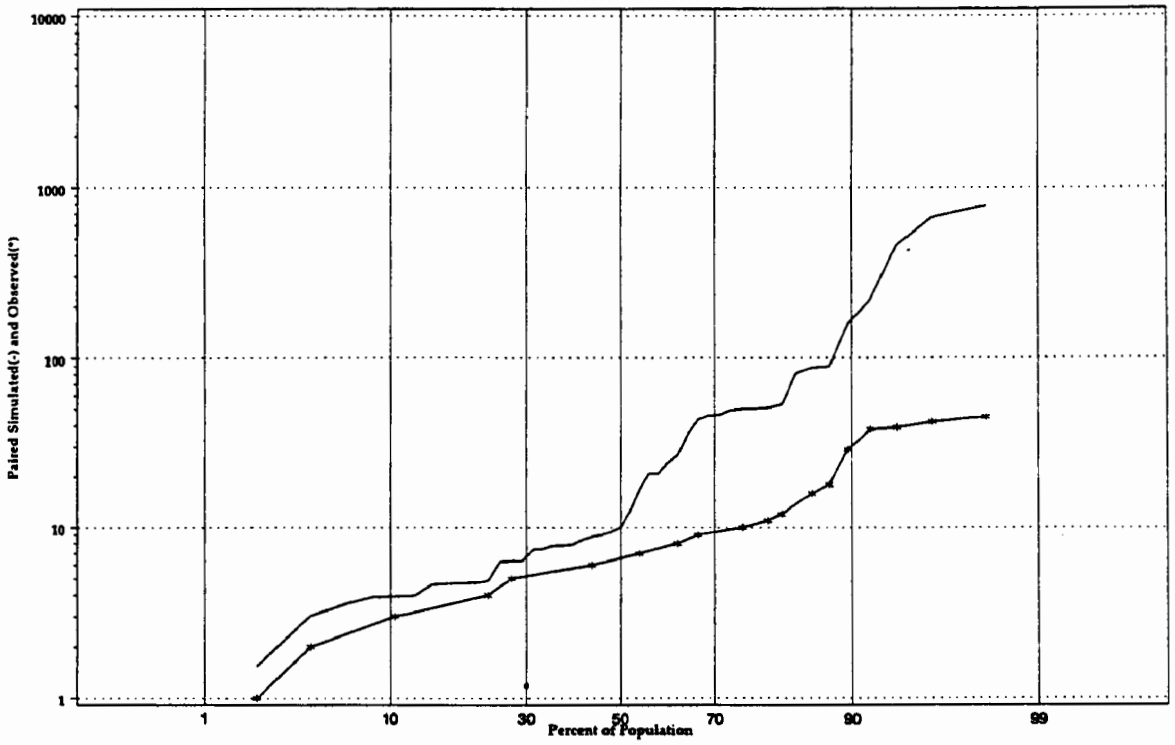
Mid Potomac River at Segment 740

Actual Error versus Time

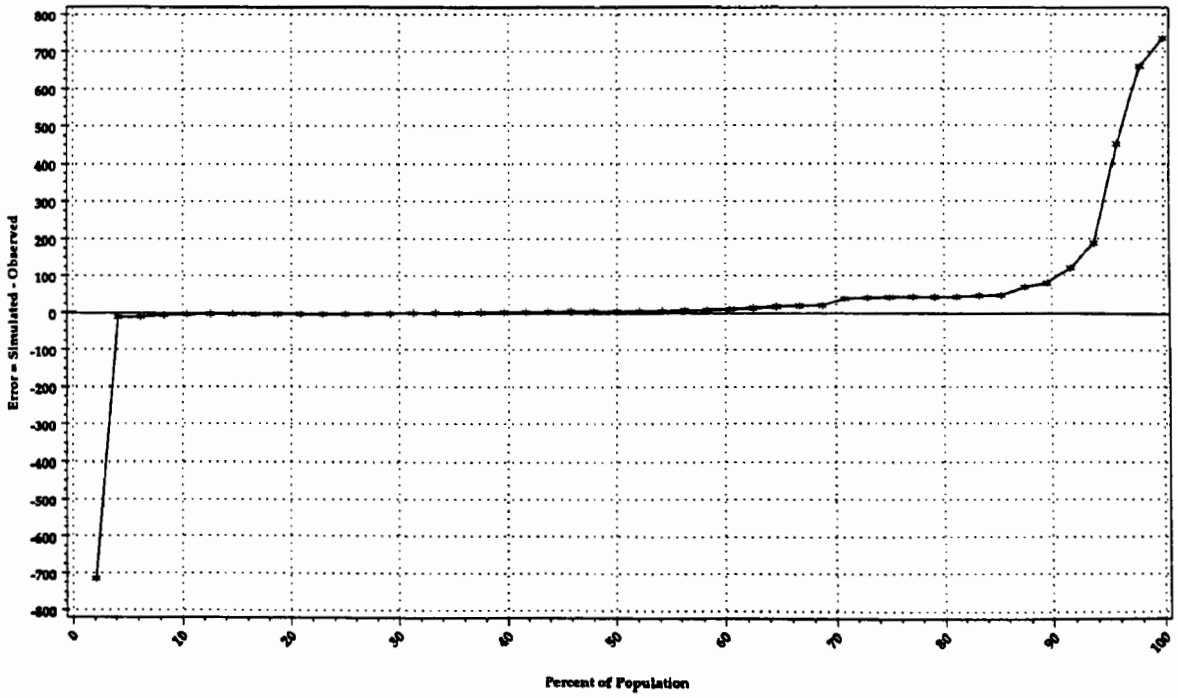
Total Suspended Sediment



Mid Potomac River at Segment 740
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

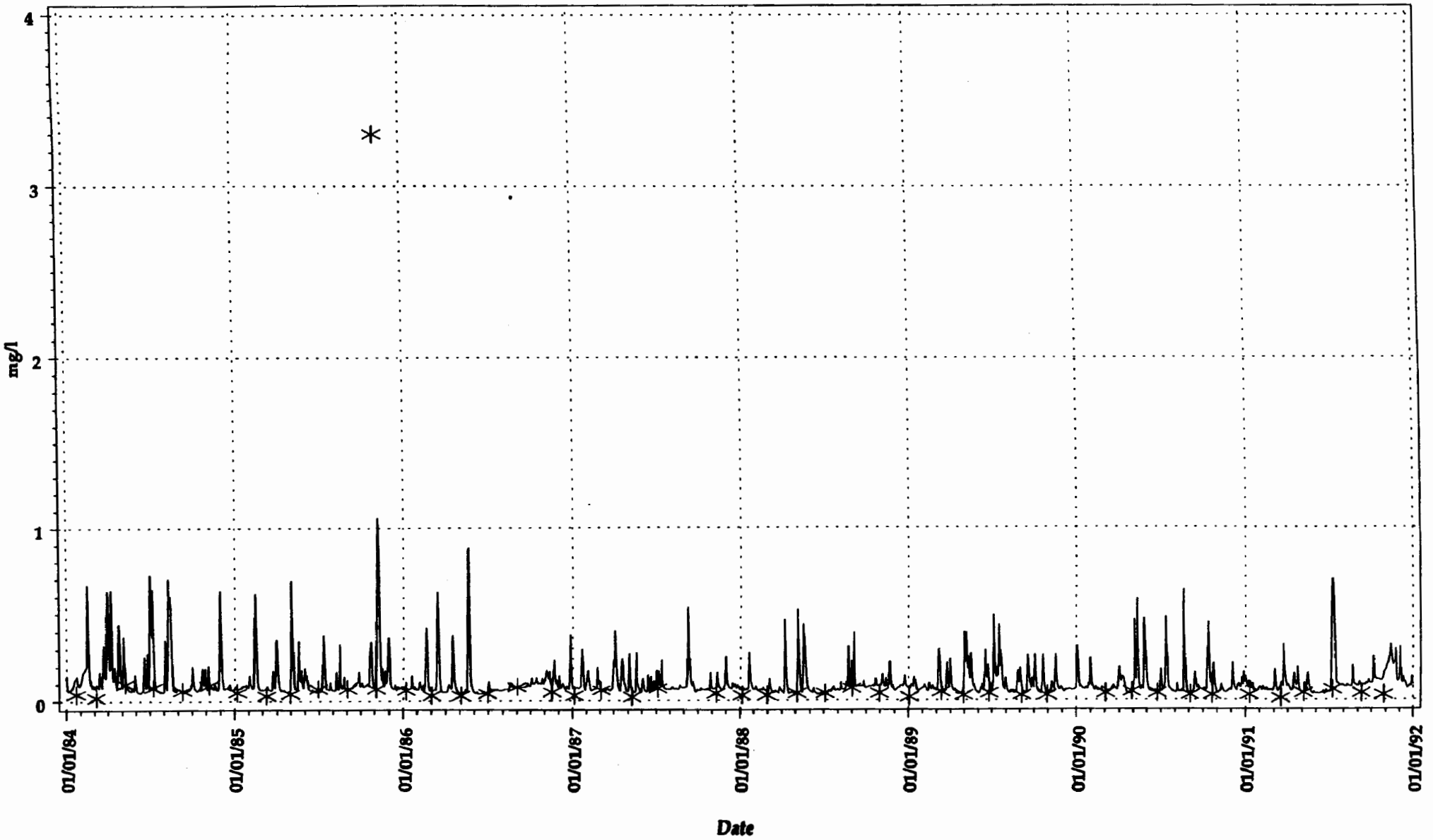


Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



Mid Potomac River at Segment 740
Observed and Simulated versus Time
Total Phosphorus

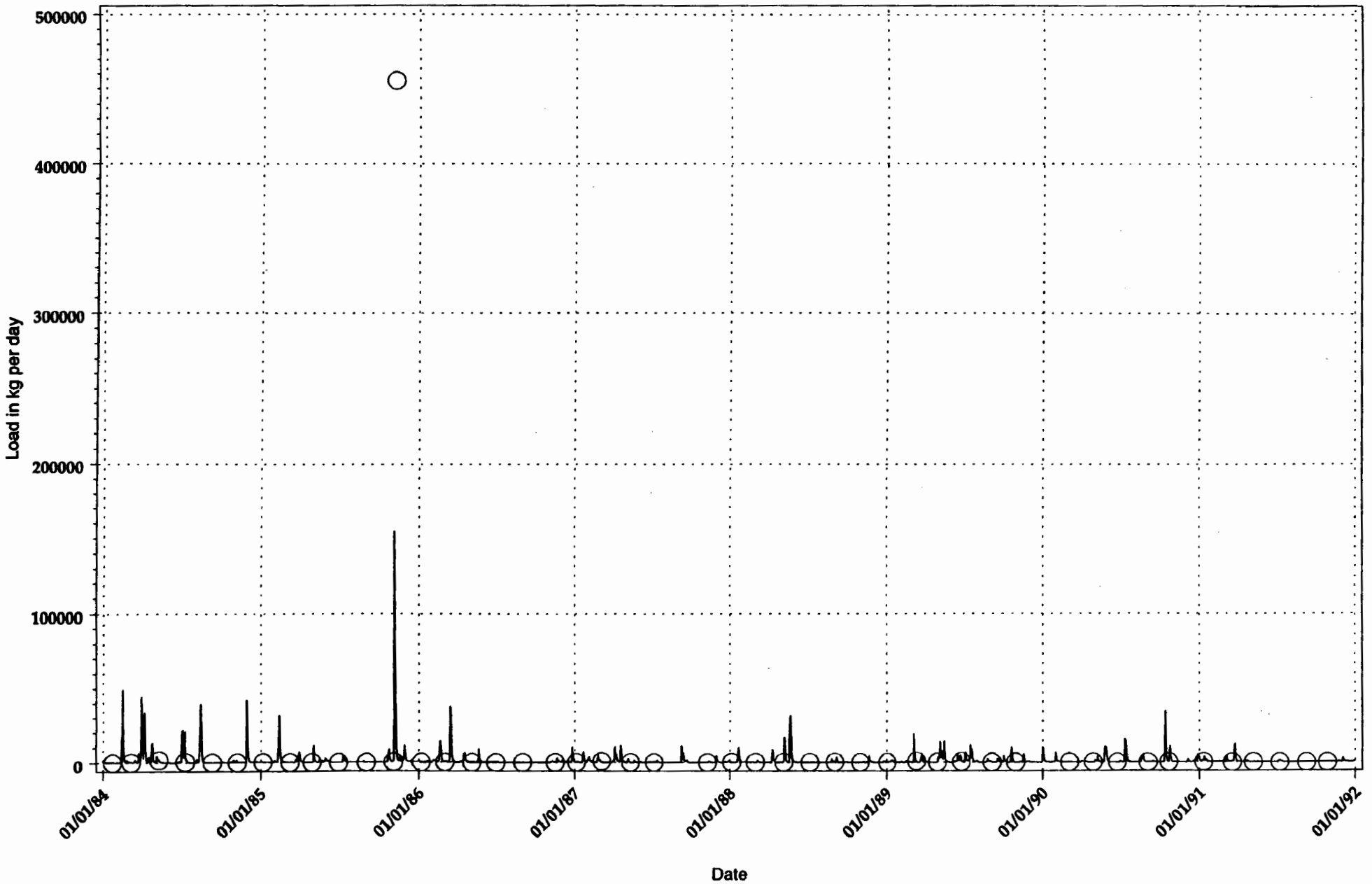
(*=Observed, -=Simulated)



Mid Potomac River at Segment 740

Total Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

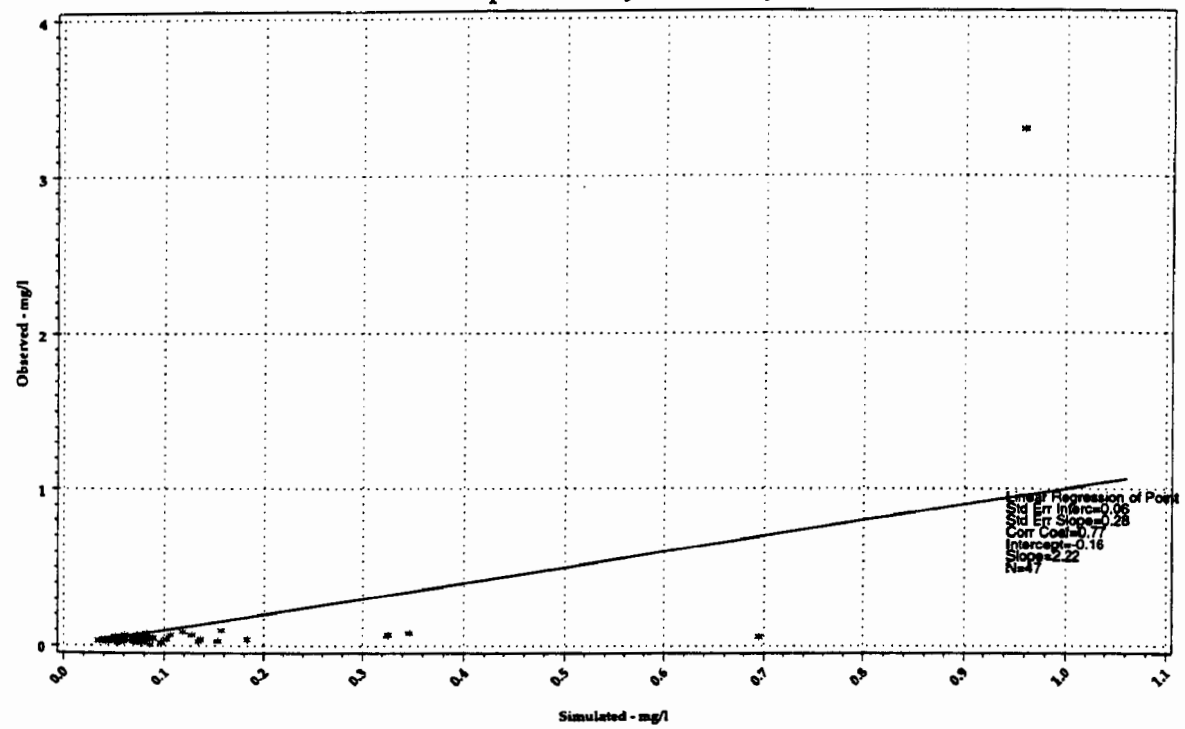


(y21_plotb.sas model3d:[pwang.dt] fdlfee)
(mid.dev 12FEB96 11:34,proc reg,model y=x)

Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

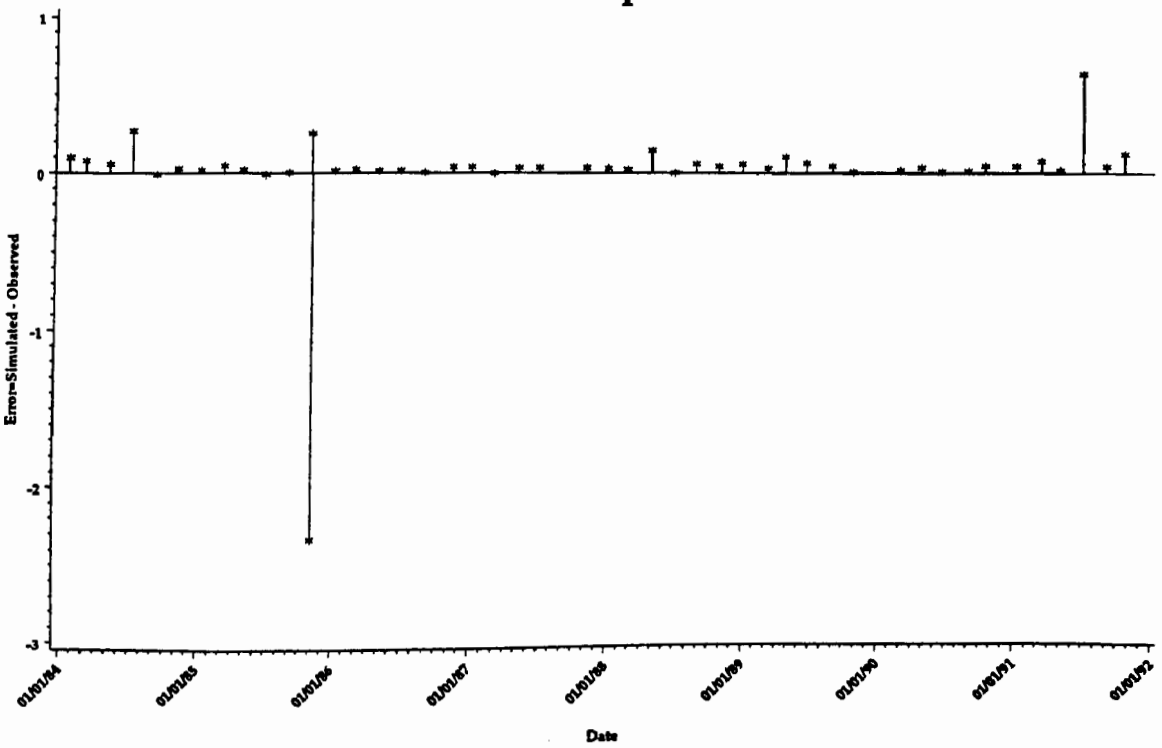
Total Phosphorus: 01JAN84 - 01JAN92



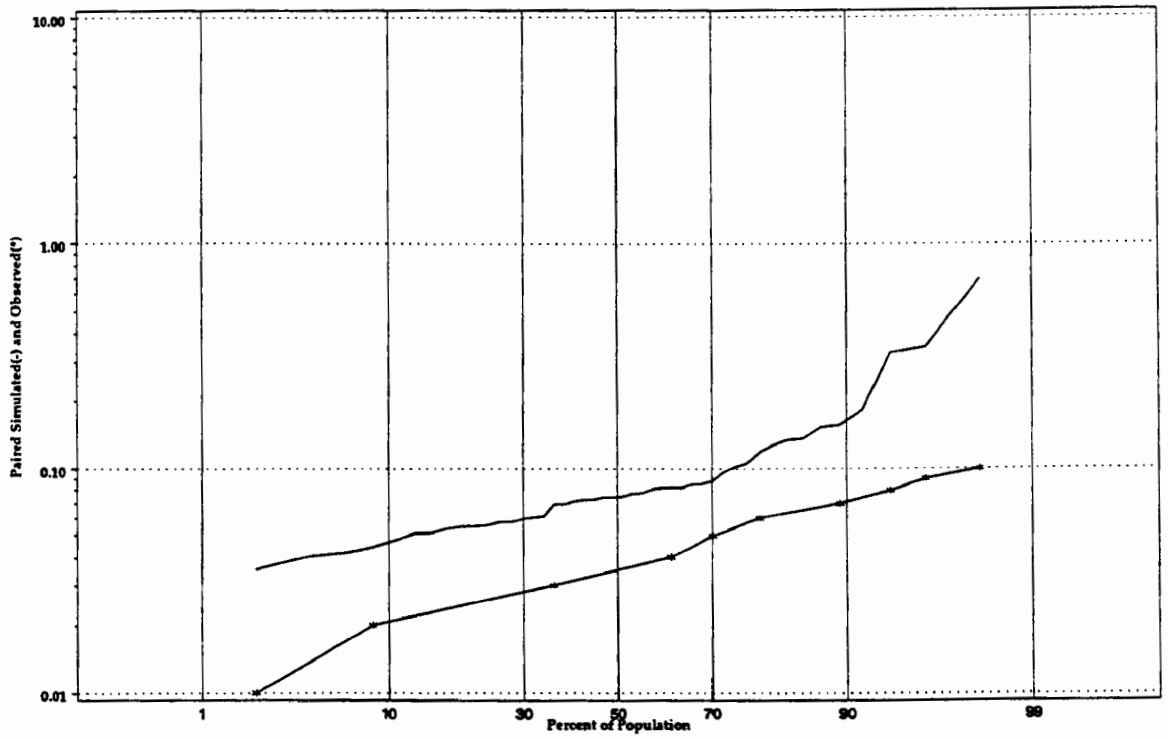
Mid Potomac River at Segment 740

Actual Error versus Time

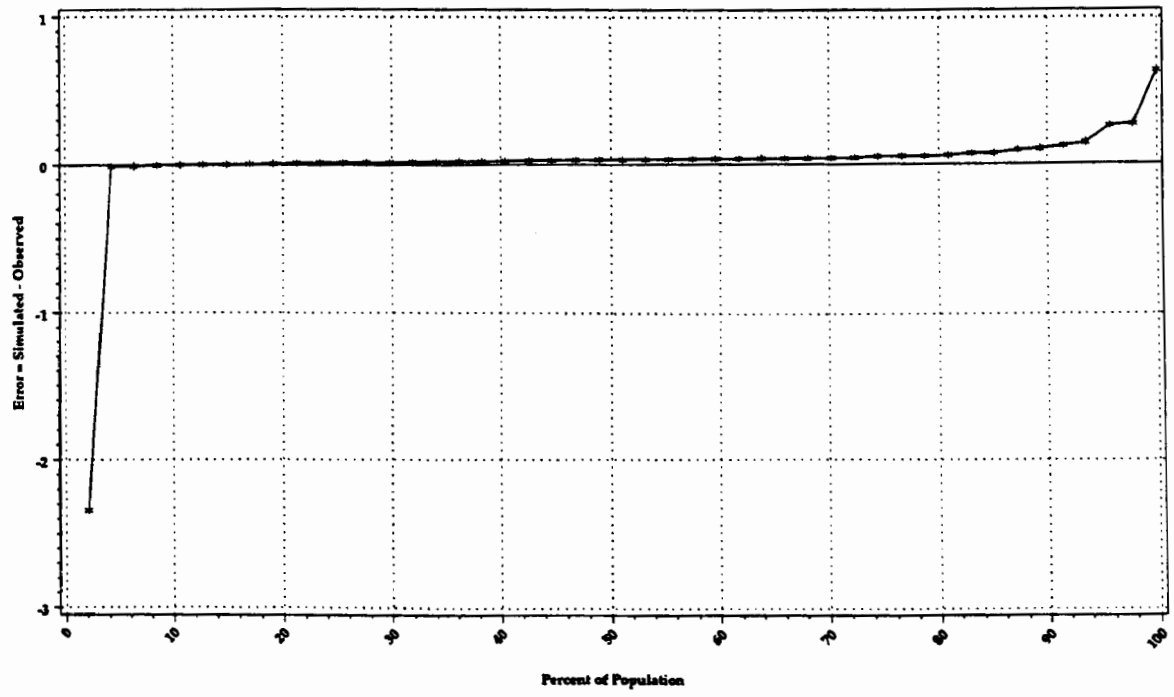
Total Phosphorus



Mid Potomac River at Segment 740
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

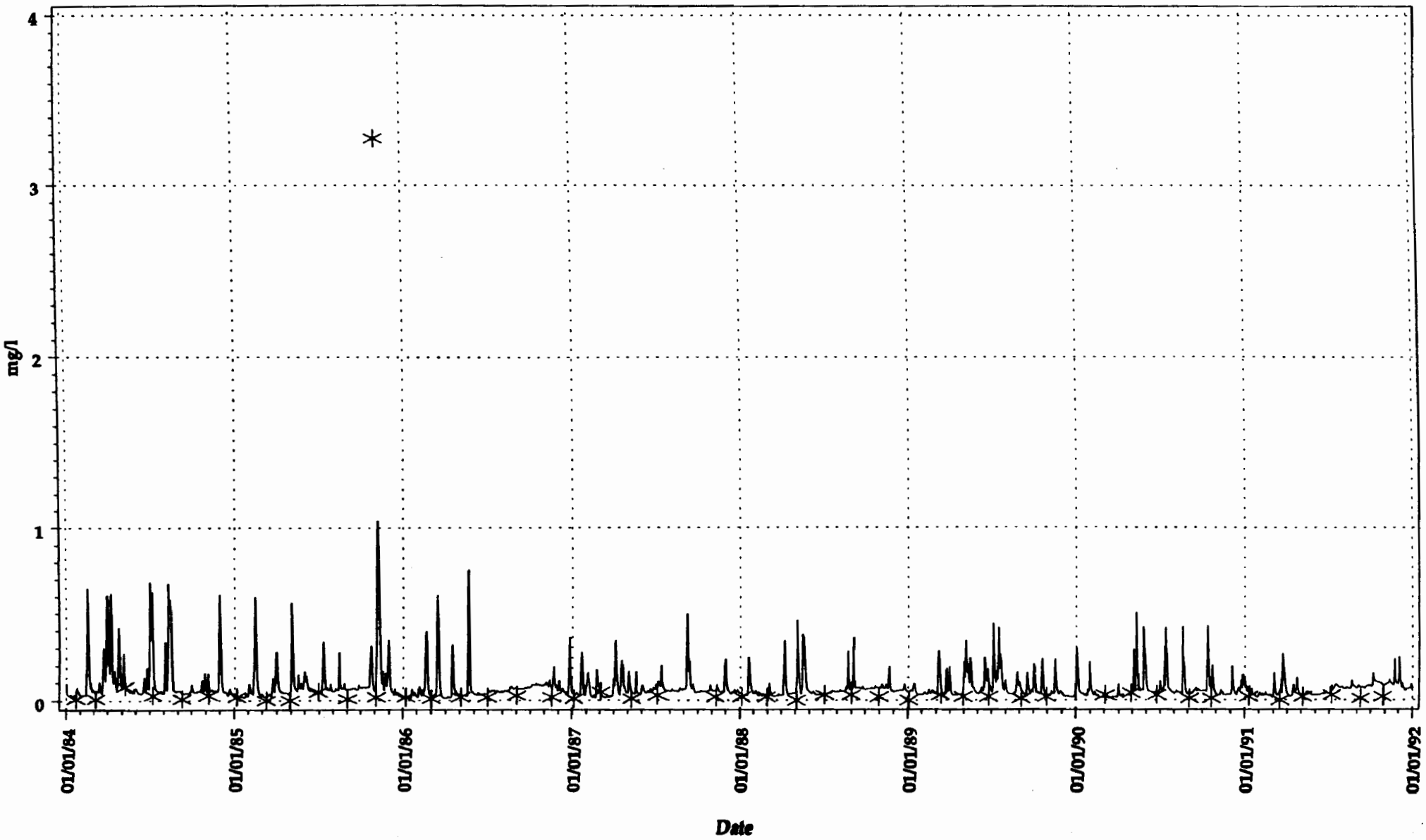


Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Mid Potomac River at Segment 740
Observed and Simulated versus Time
Organic and Particulate Phosphorus

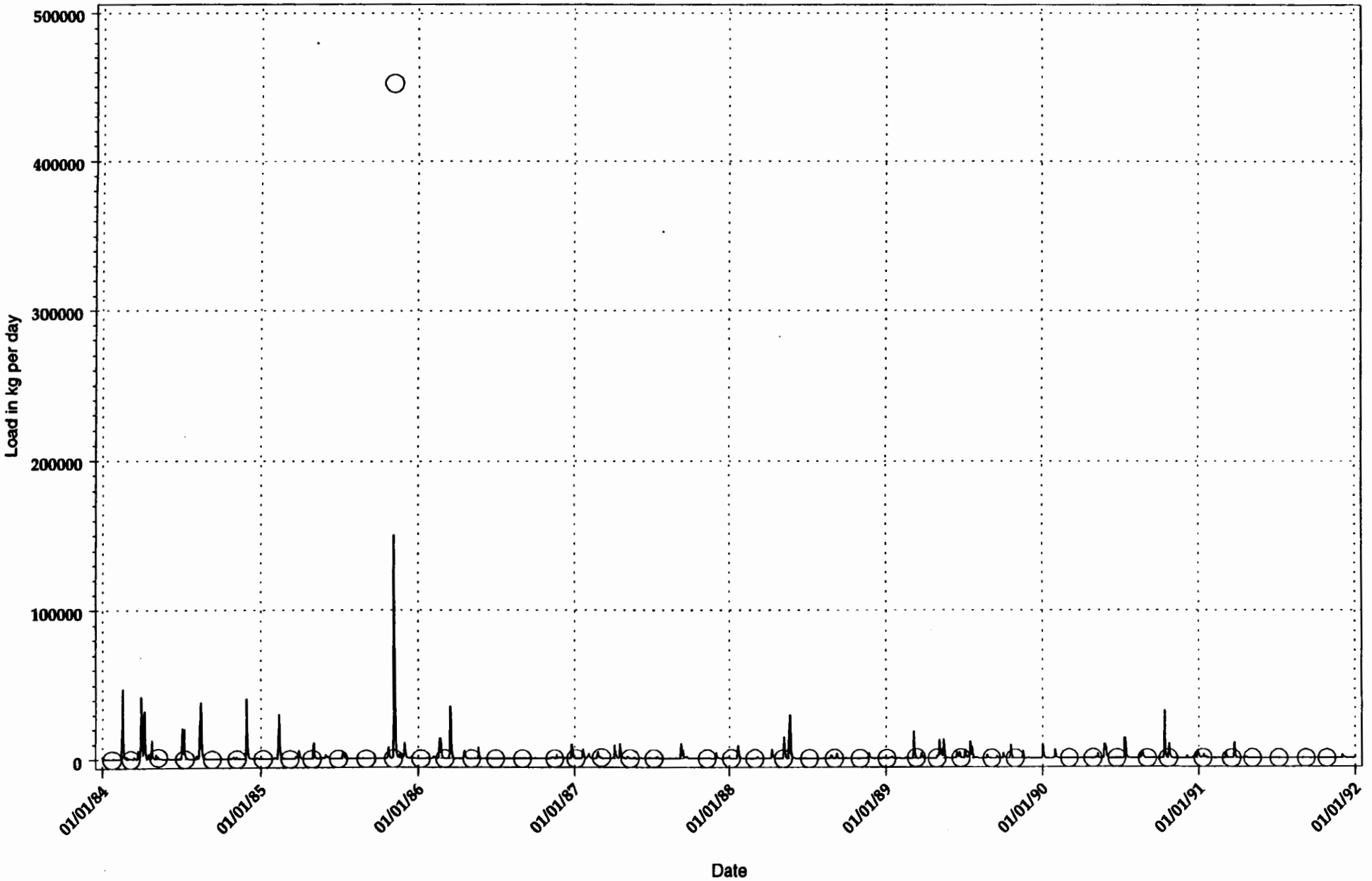
(*=Observed, -=Simulated)



Mid Potomac River at Segment 740

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

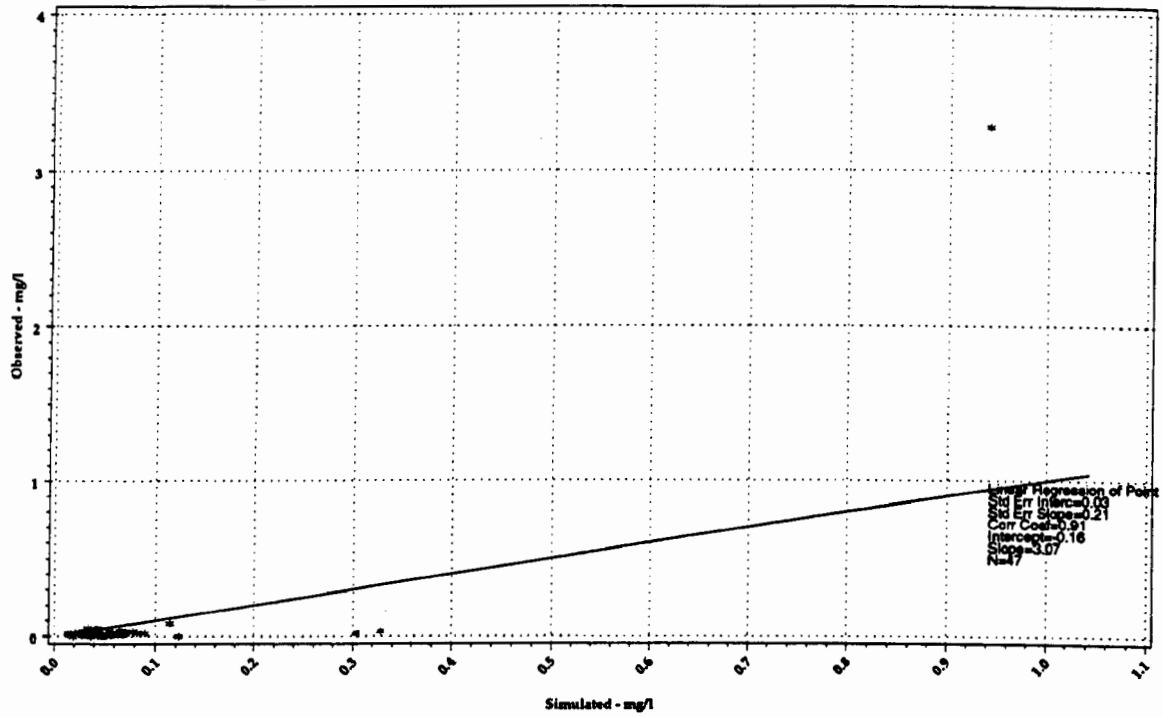


(y21_plotb.sas model3d:[pwang.dt] ldflas)
(mid.drv 12FEB96 11:34,proc reg,model y=x)

Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

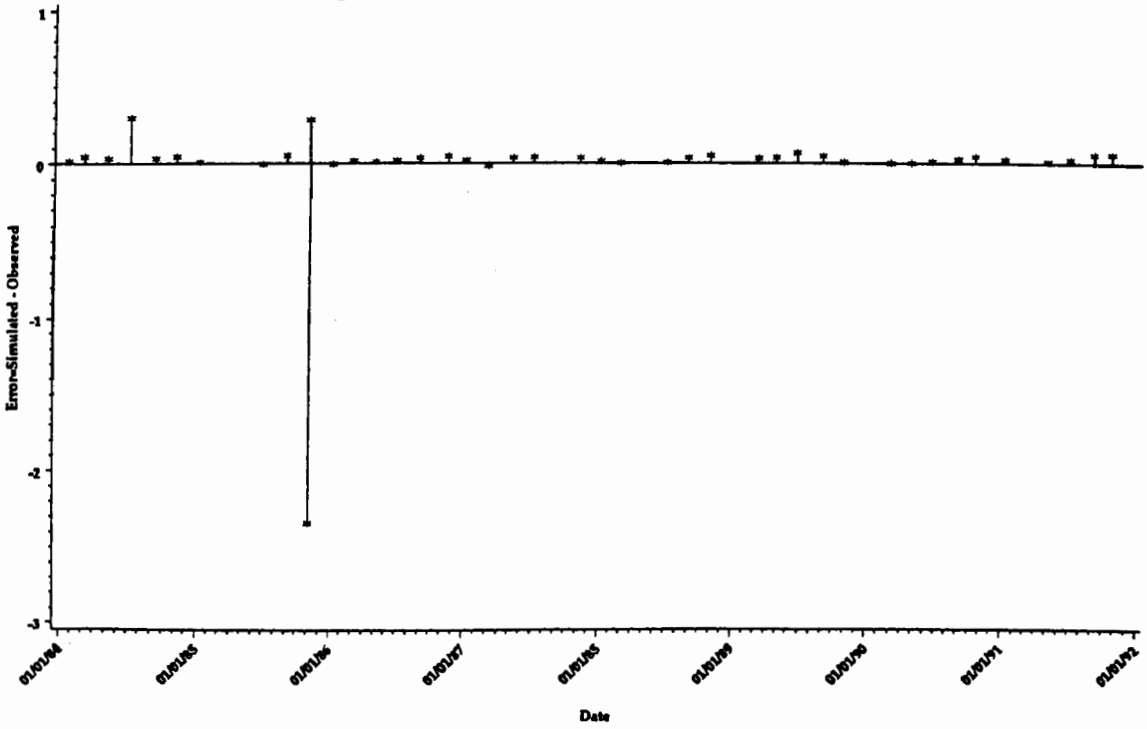
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



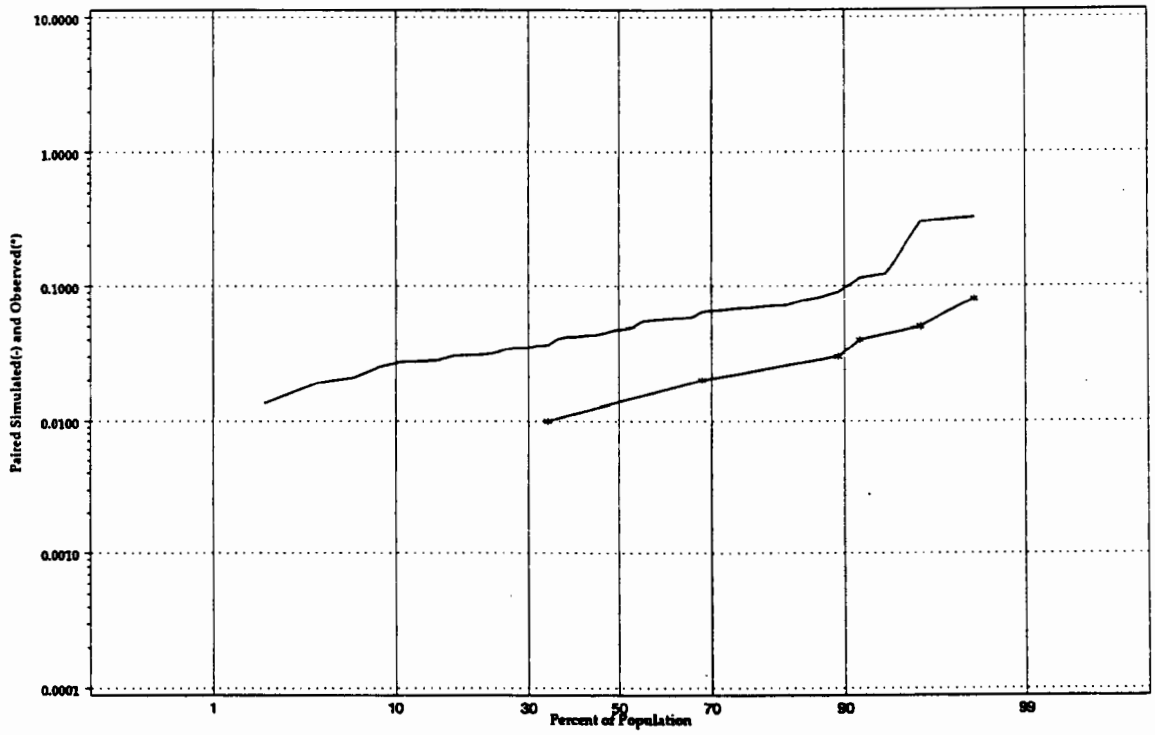
Mid Potomac River at Segment 740

Actual Error versus Time

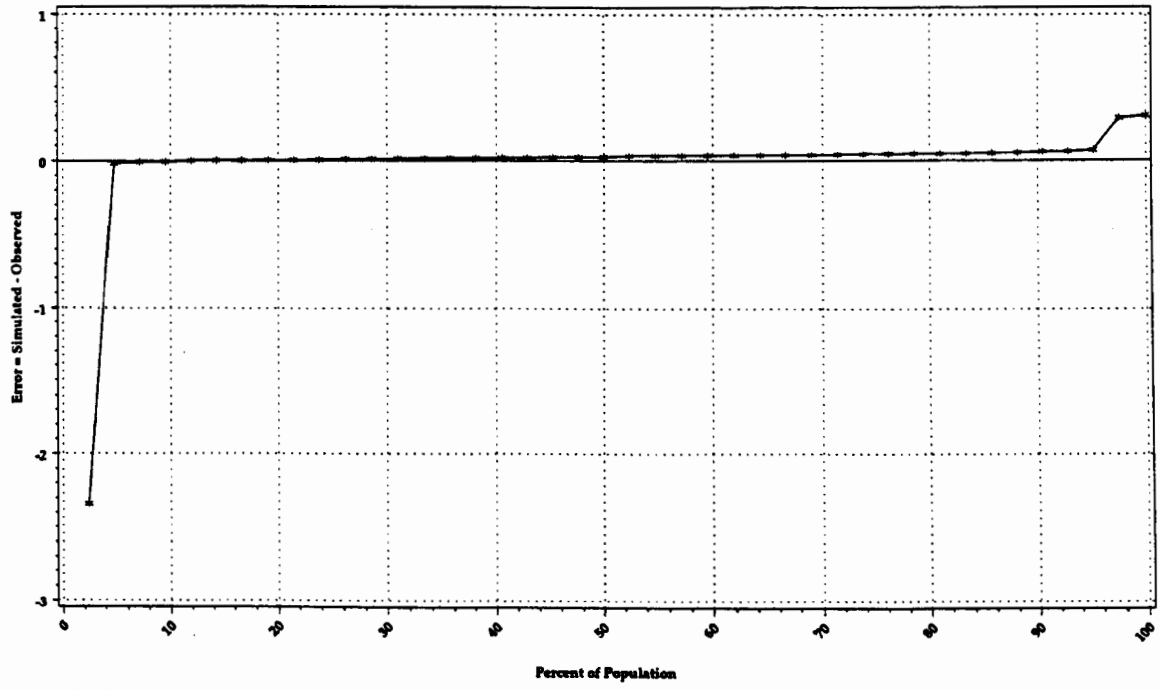
Organic and Particulate Phosphorus



Mid Potomac River at Segment 740
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

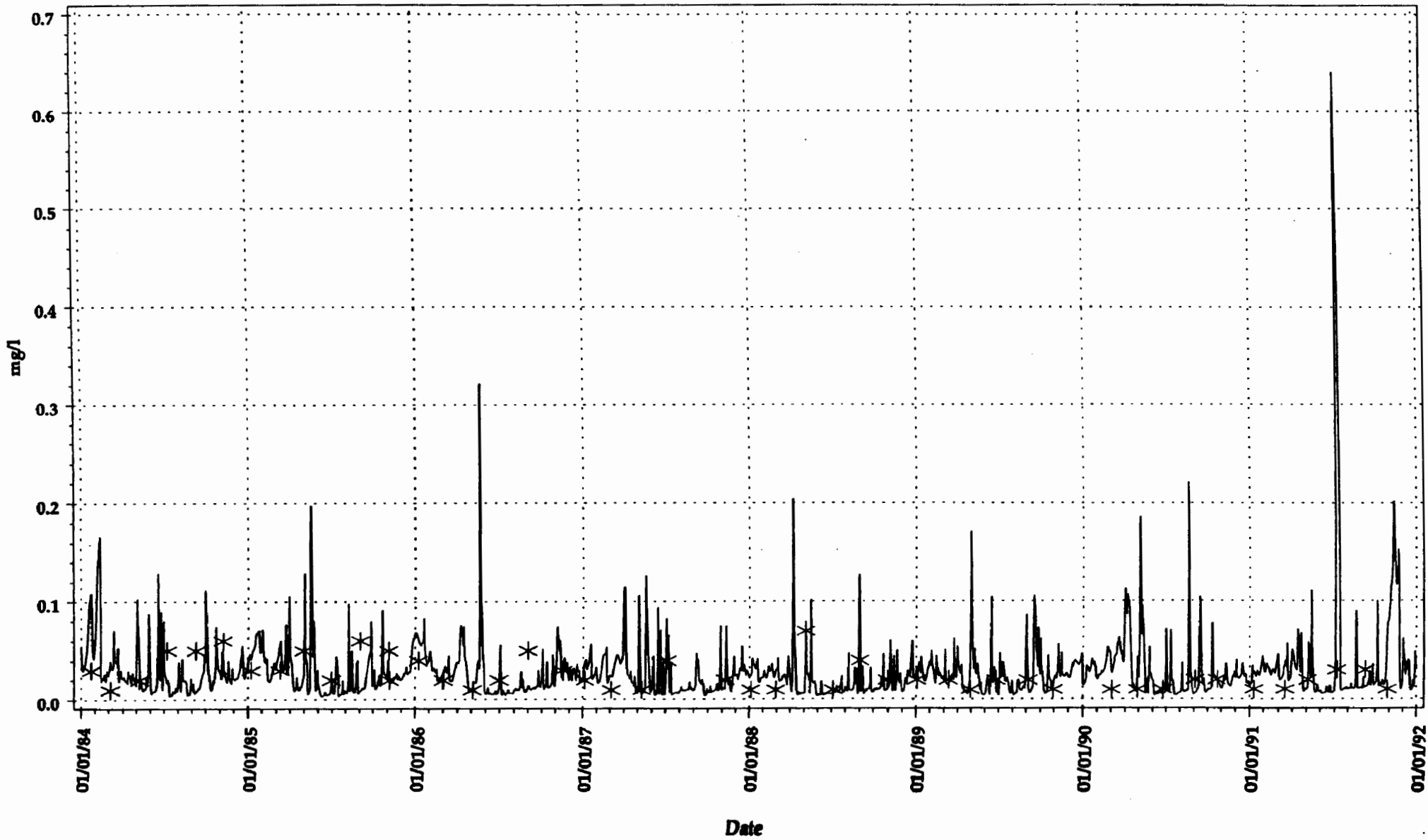


Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data



Mid Potomac River at Segment 740
Observed and Simulated versus Time
Dissolved Phosphorus

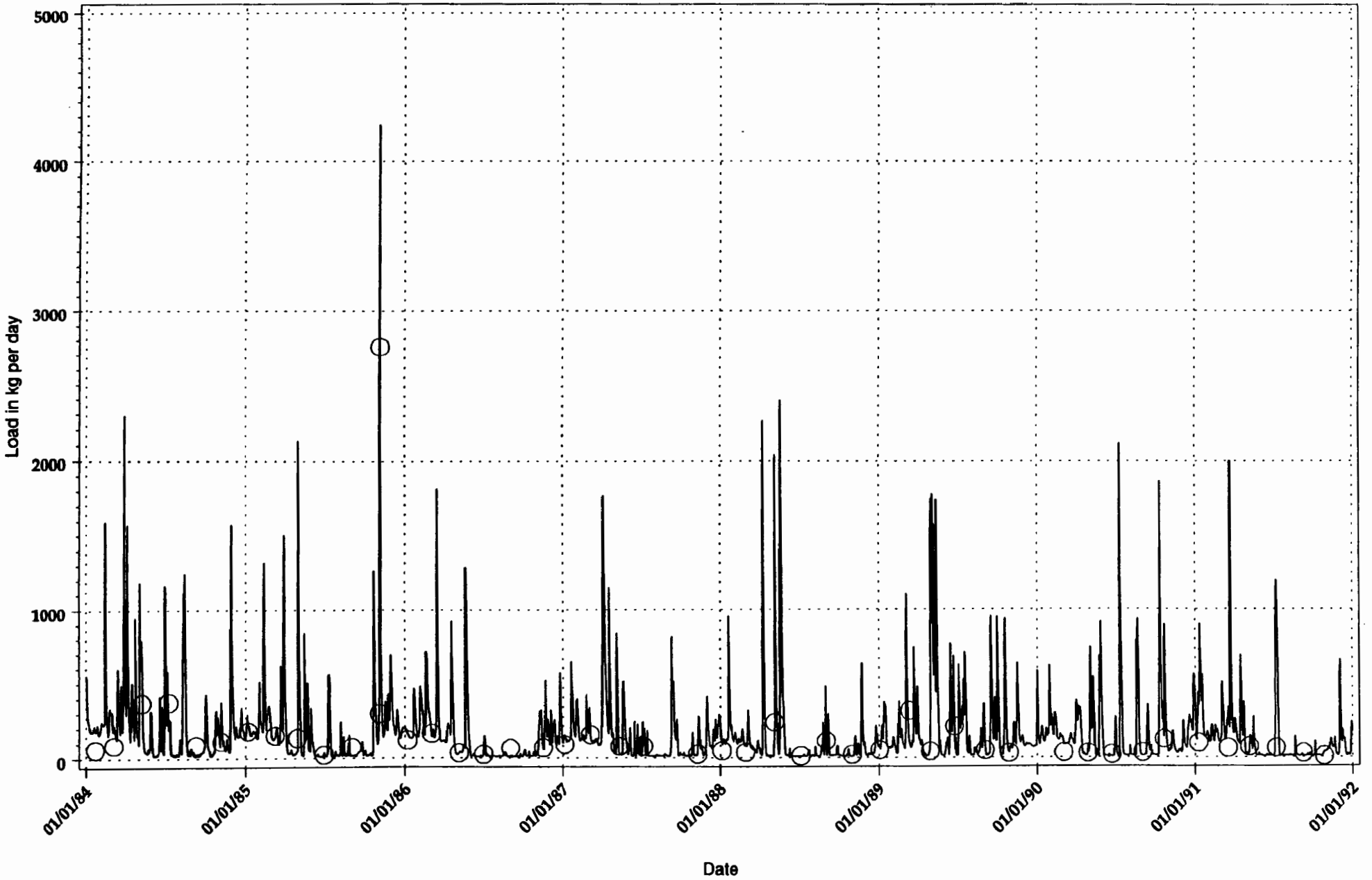
(*=Observed, -=Simulated)



Mid Potomac River at Segment 740

Dissolved Phosphorus Observed and Simulated Load vs Time

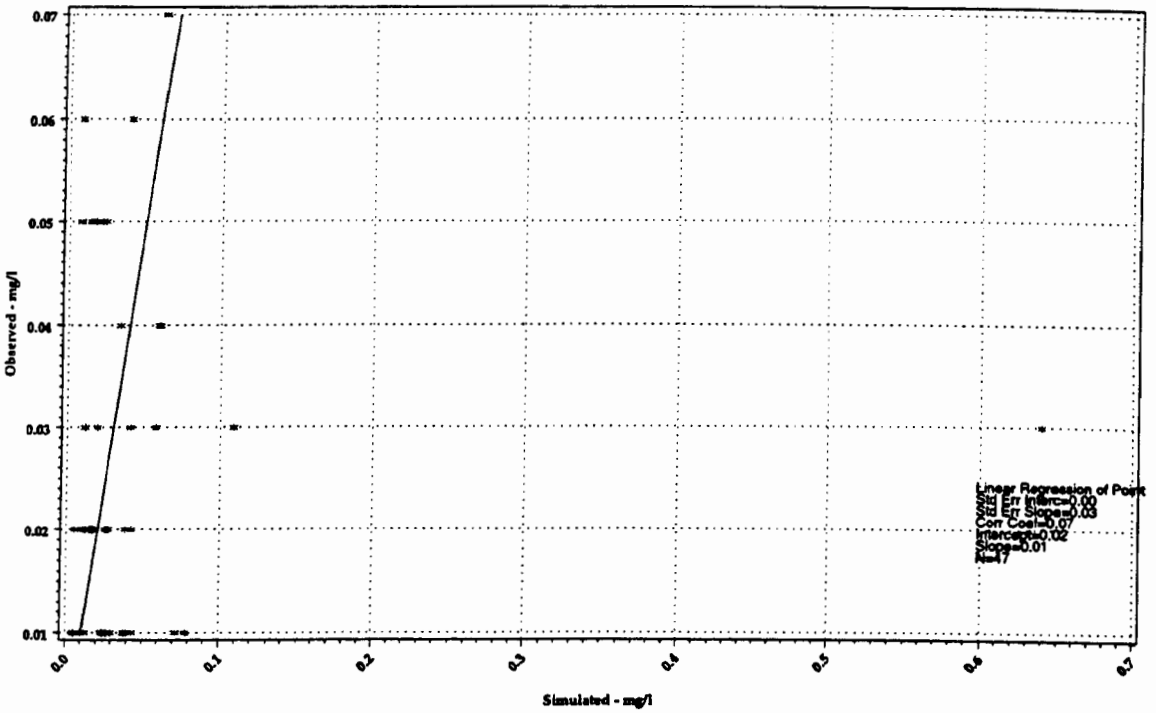
(line = simulated, O = observed)



(y21_plotb.sas model3d.jpwang.dll lidlise)
(mid.drv 12FEB98 11:34.proc reg.model y=x)

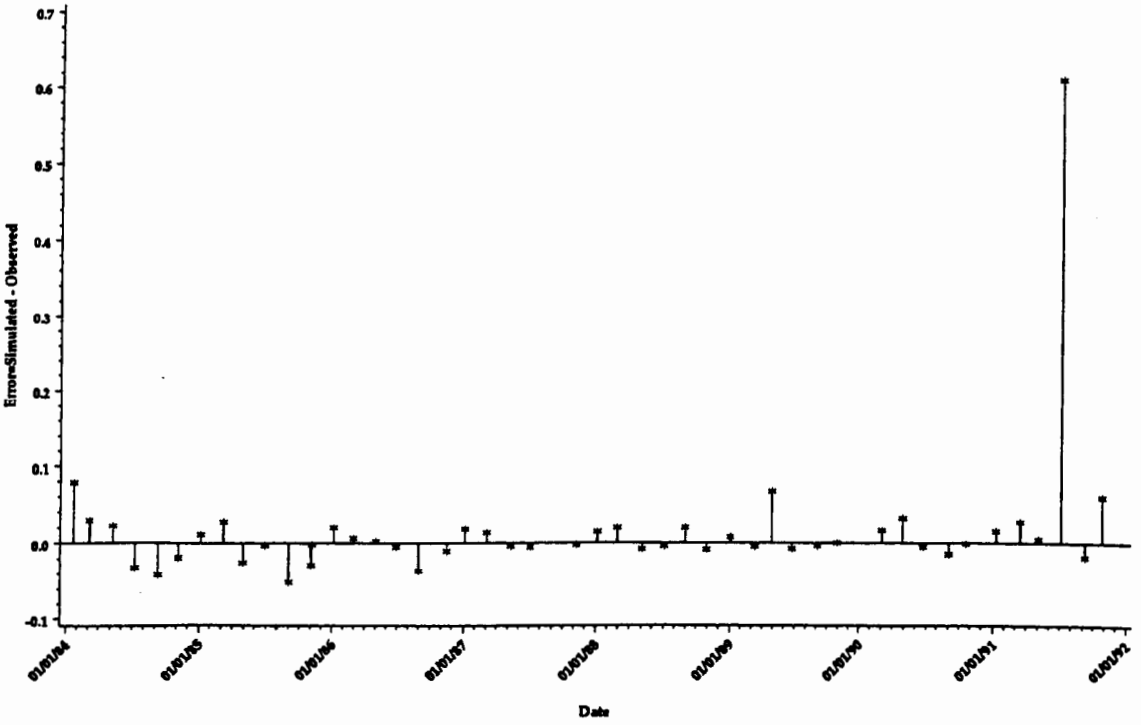
Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Dissolved Phosphorus: 01JAN84 - 01JAN92

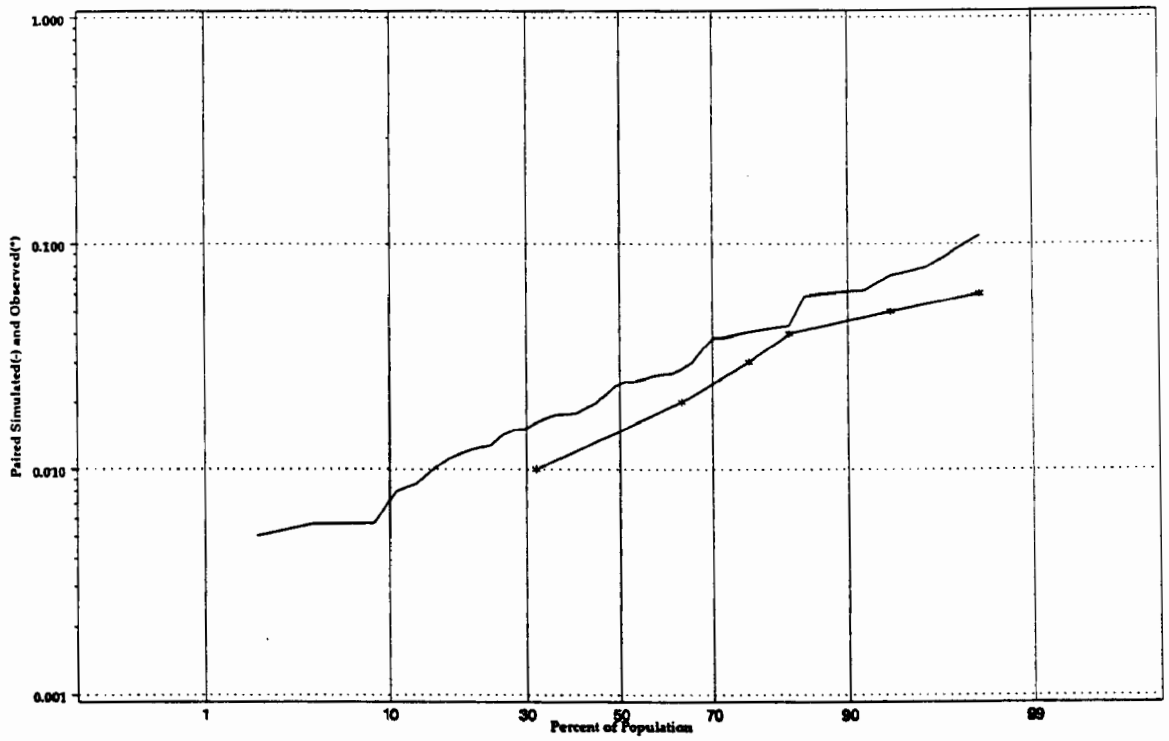


Mid Potomac River at Segment 740

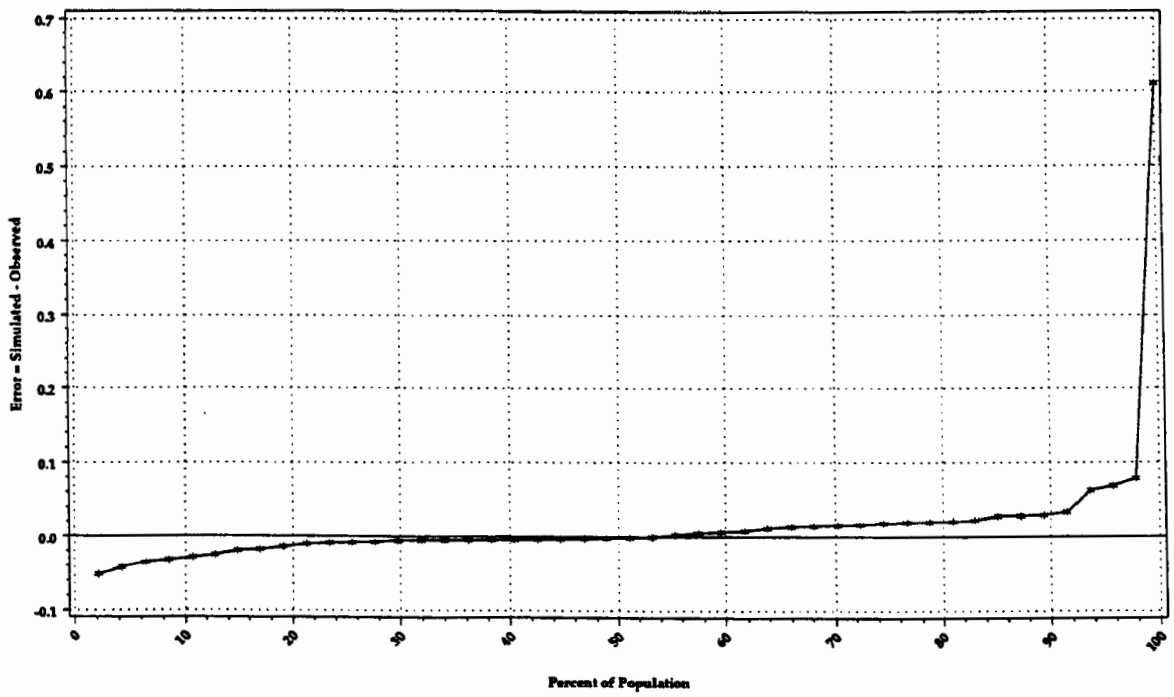
Actual Error versus Time
Dissolved Phosphorus



Mid Potomac River at Segment 740
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

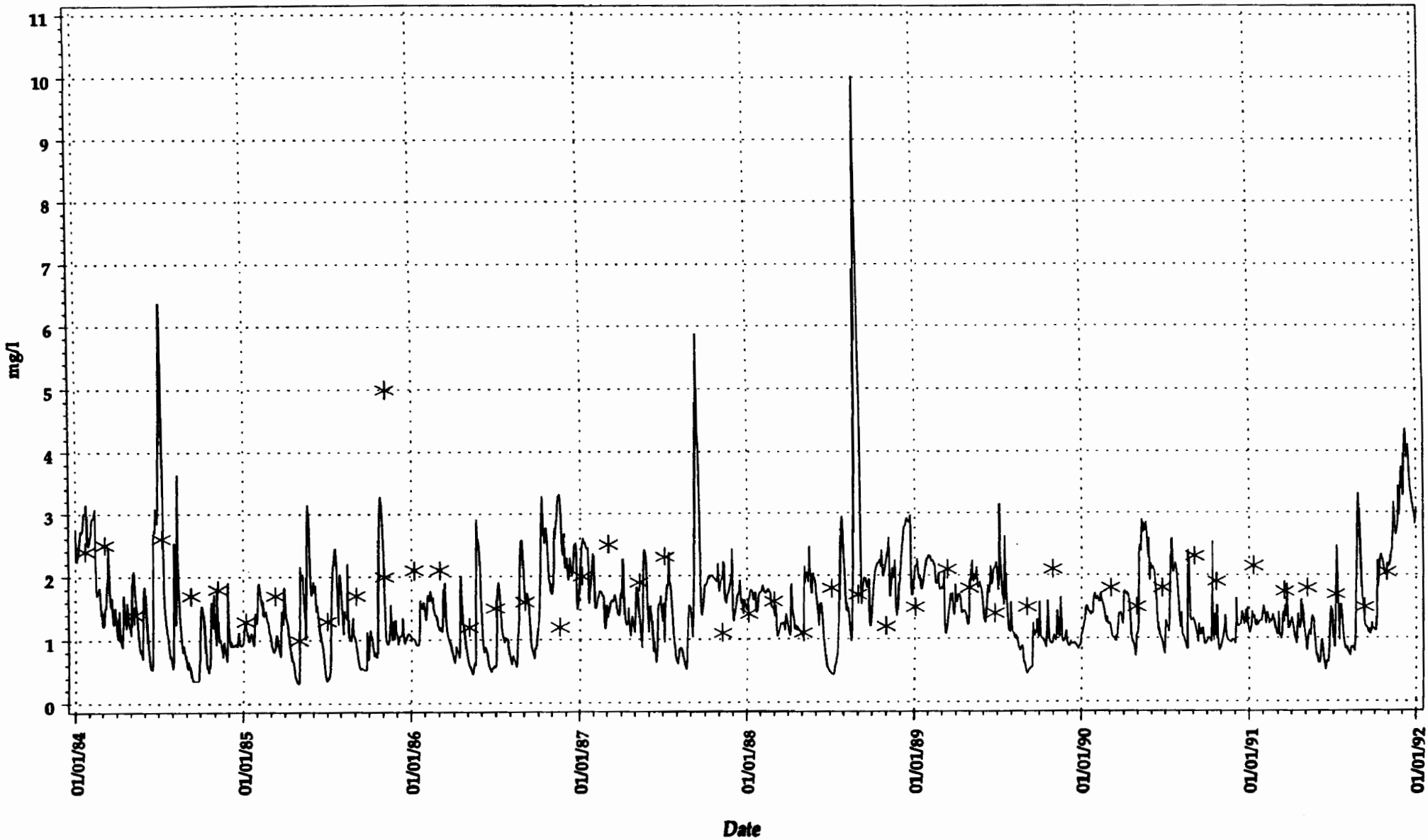


Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



Mid Potomac River at Segment 740
Observed and Simulated versus Time
Total Nitrogen

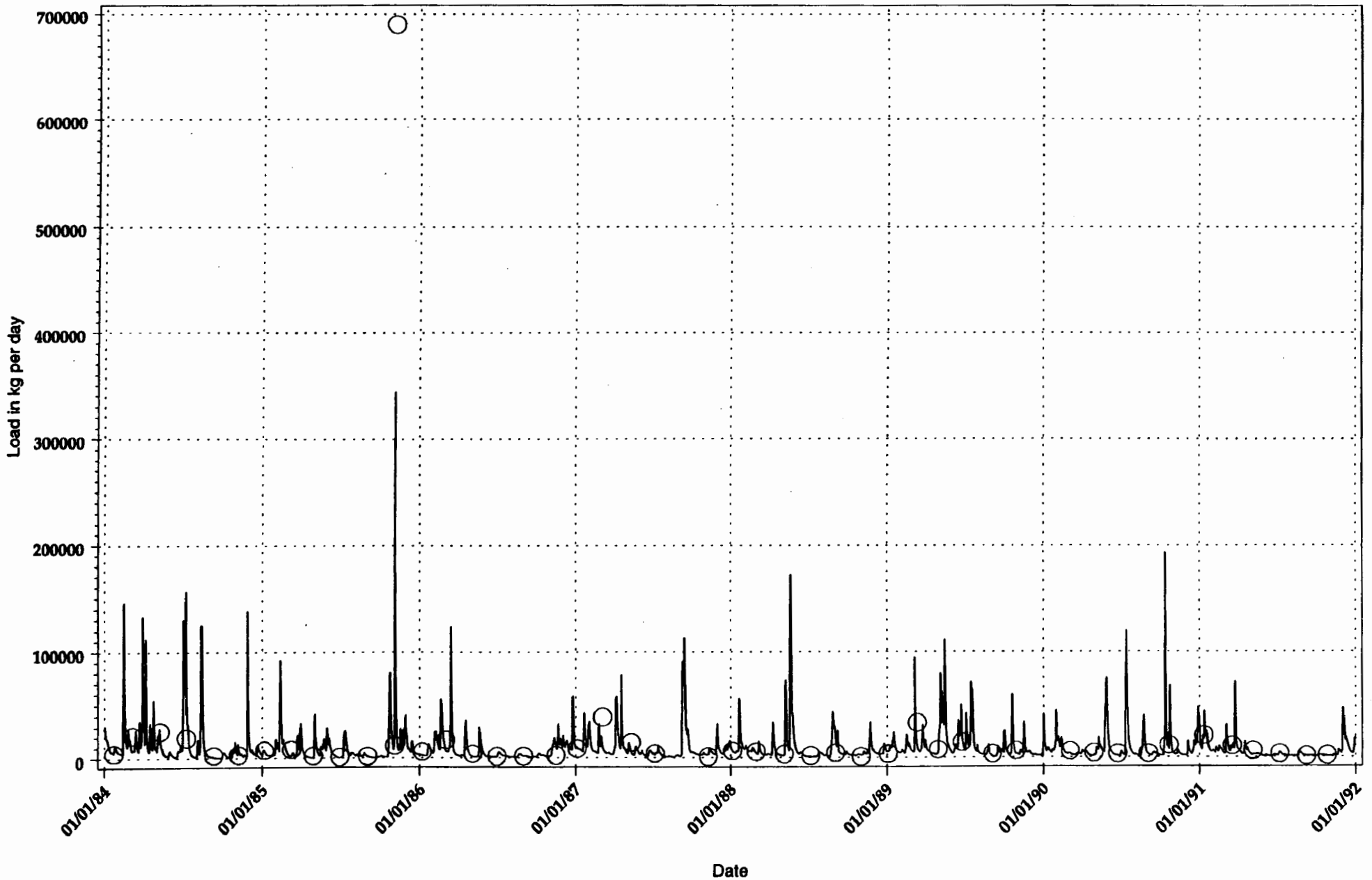
(*=Observed, -=Simulated)



Mid Potomac River at Segment 740

Total Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)

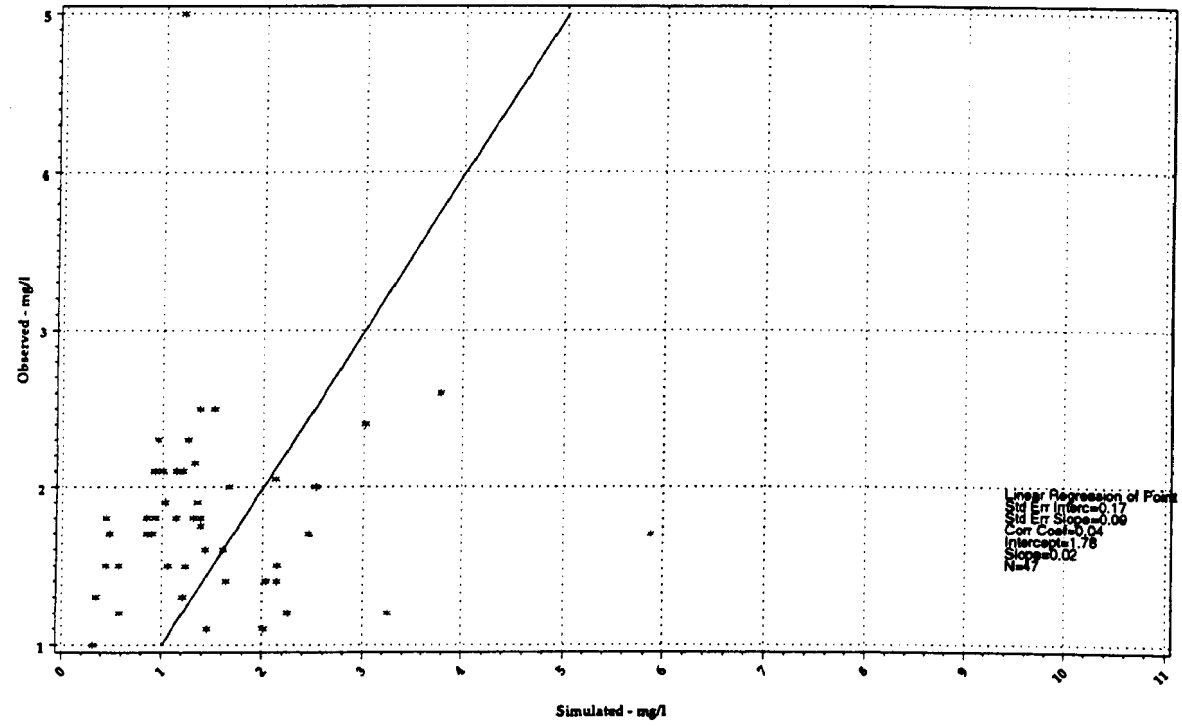


(y21_plotb.sas model3d.[pwang.dt] ltdlles)
(mid.dev 23FEB98 11:16,pecc reg,model y=x)

Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

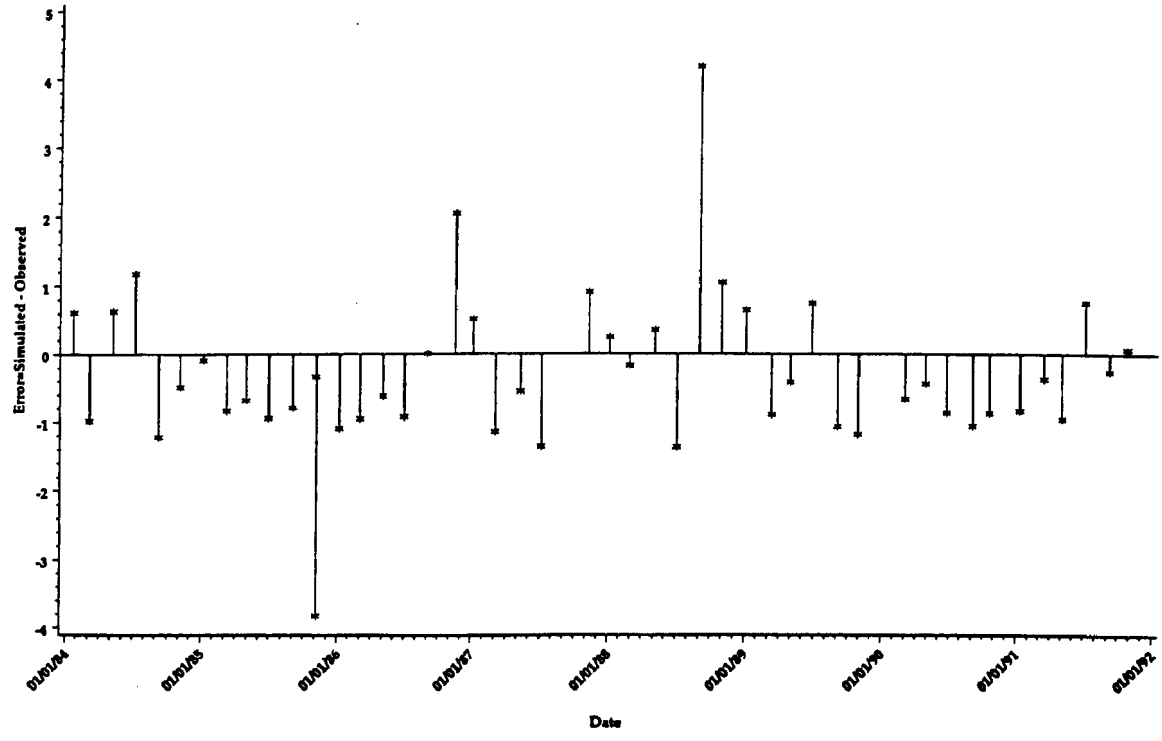
Total Nitrogen: 01JAN84 - 01JAN92



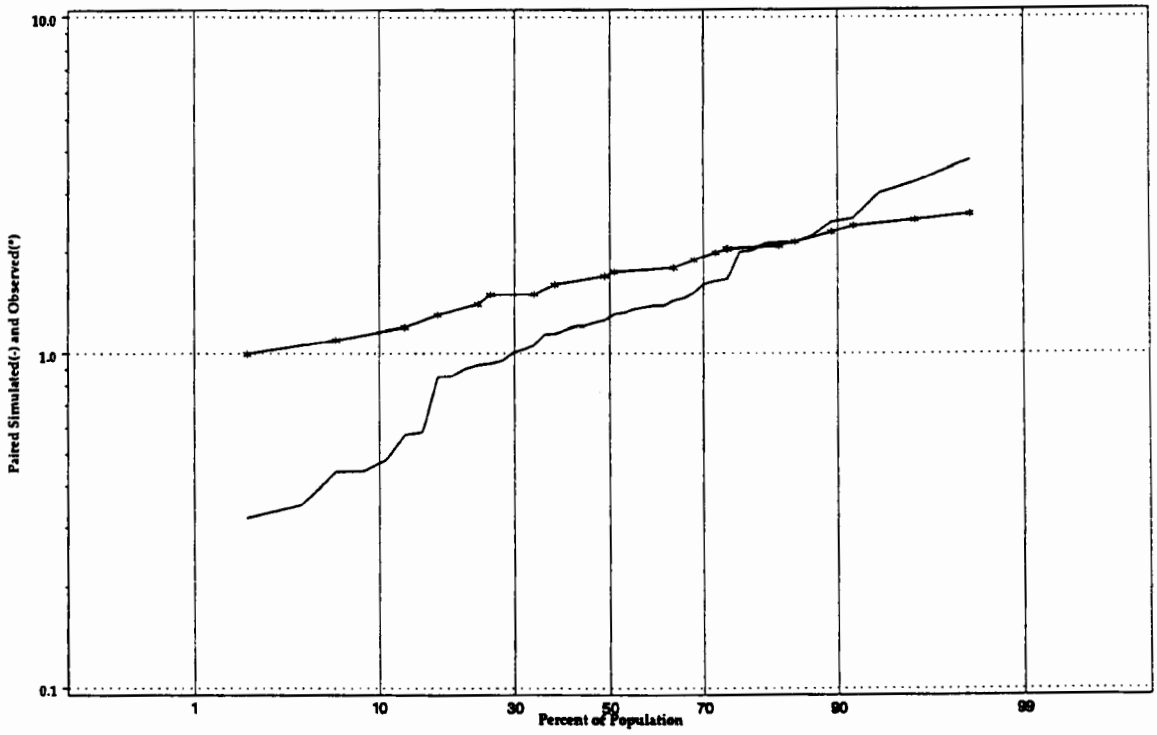
Mid Potomac River at Segment 740

Actual Error versus Time

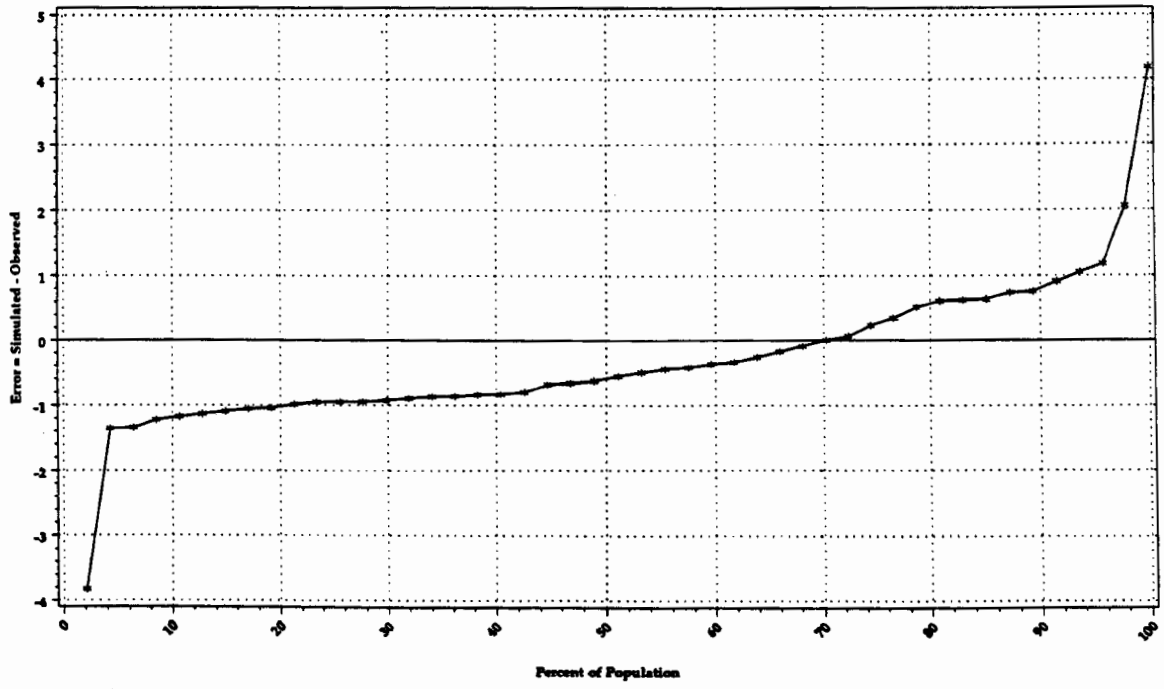
Total Nitrogen



Mid Potomac River at Segment 740
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

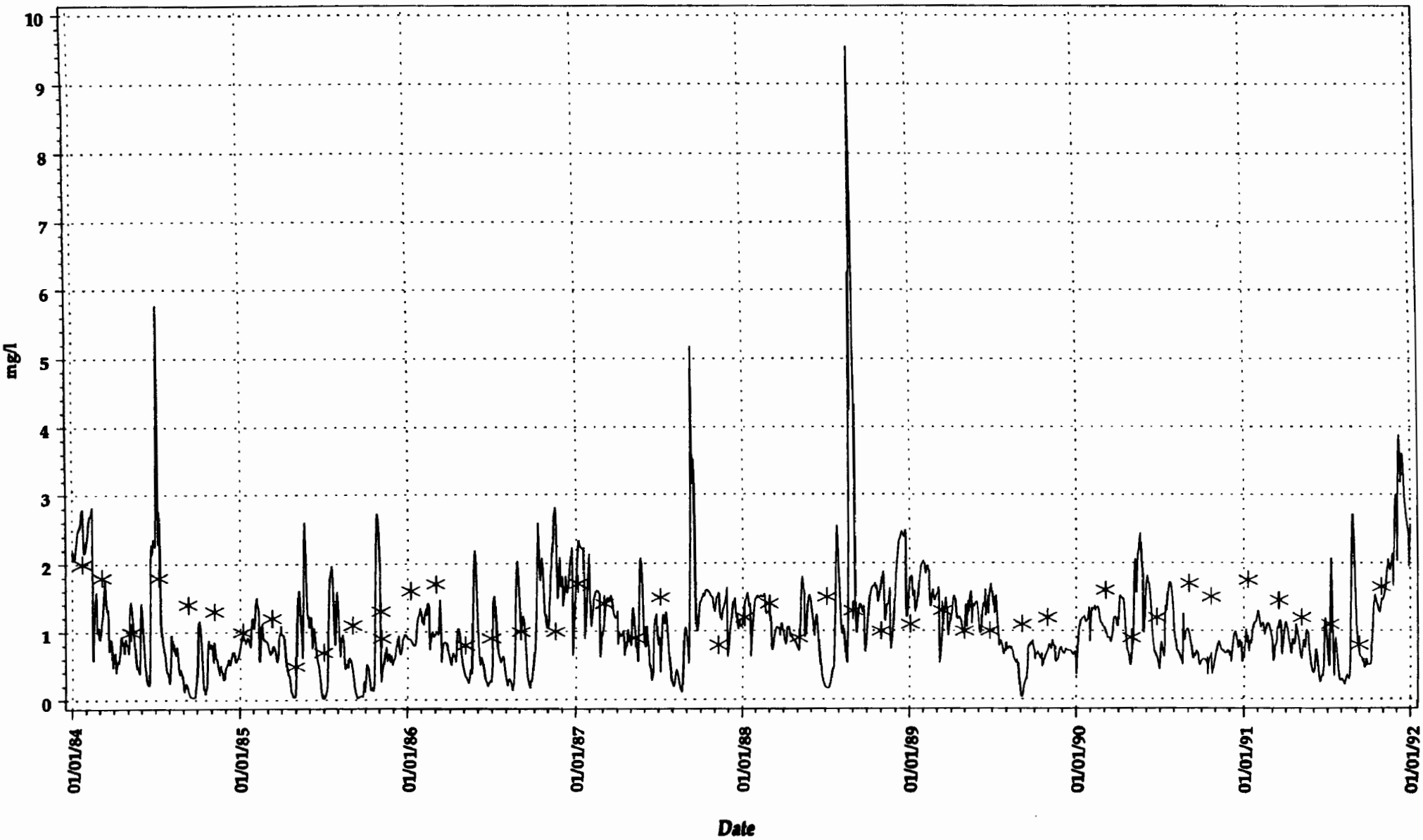


Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data



Mid Potomac River at Segment 740
Observed and Simulated versus Time
NO3

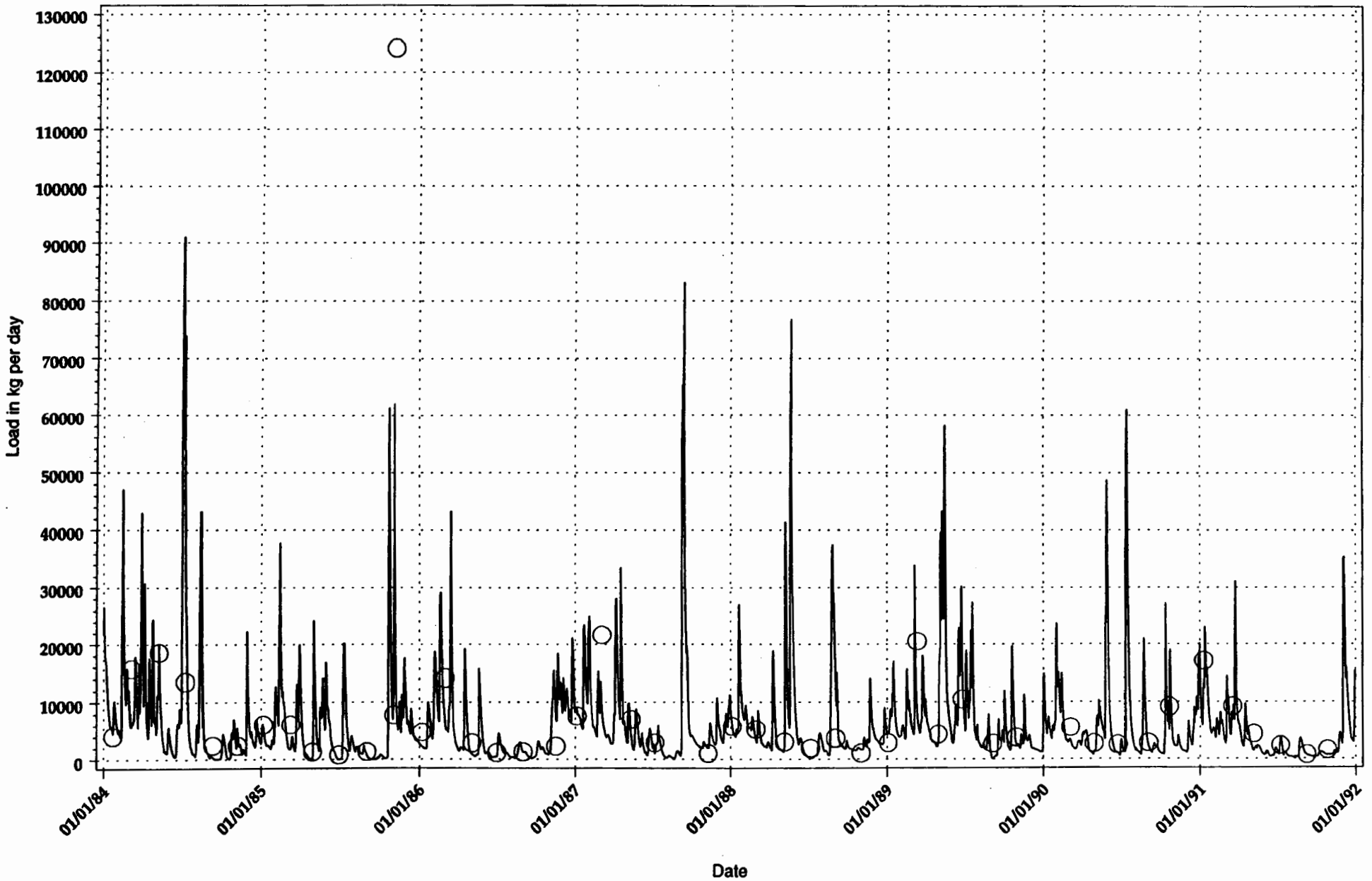
(*=Observed, -=Simulated)



Mid Potomac River at Segment 740

NO3 Observed and Simulated Load vs Time

(line = simulated, O = observed)

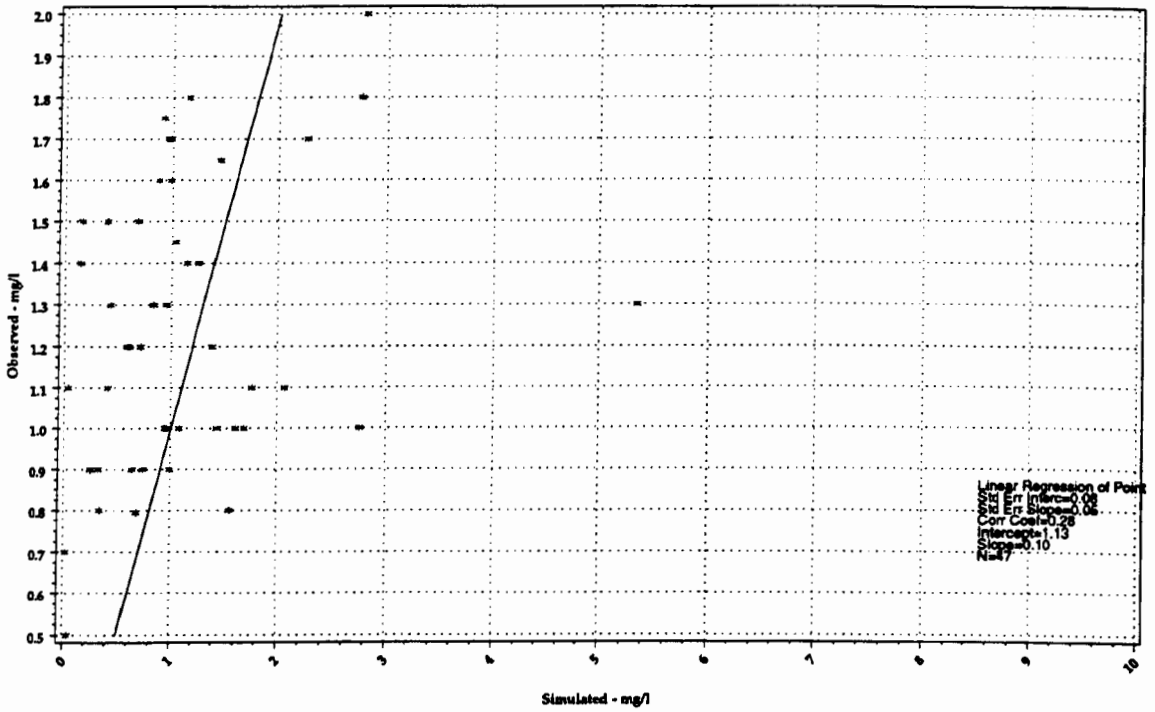


(y21_plotb.sas model3d:[pwang.dl] lldflae)
(mid.drv 12FEB98 11:34,proc reg,model y=x)

Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

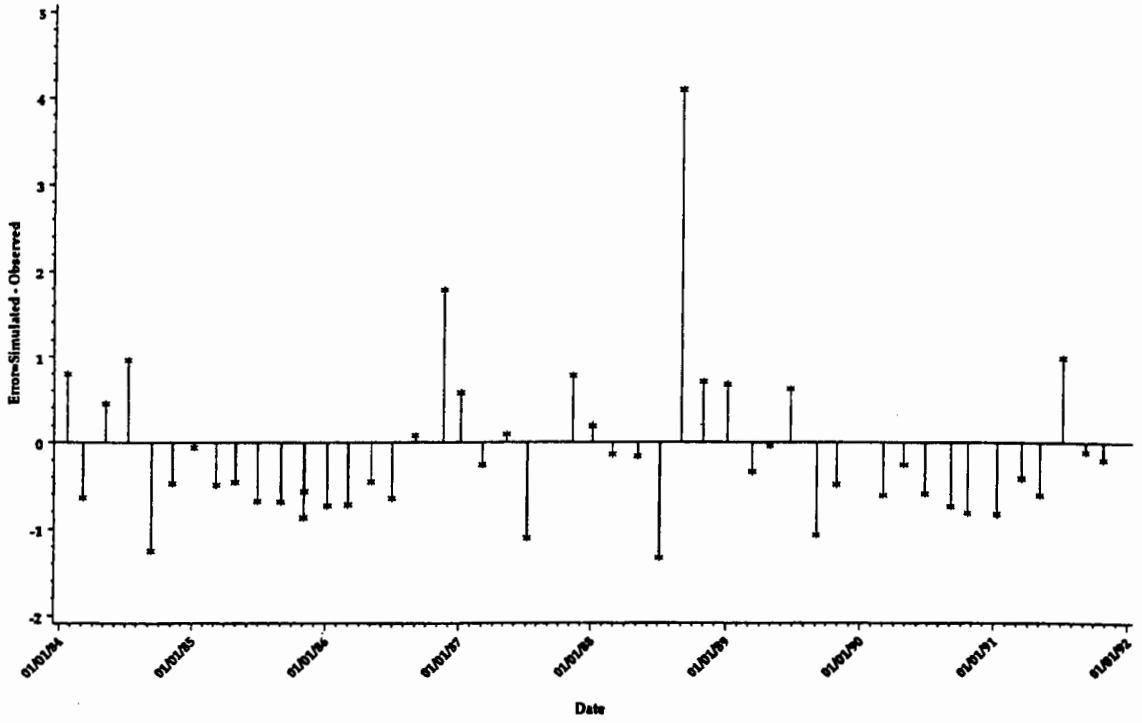
NO3: 01JAN84 - 01JAN92



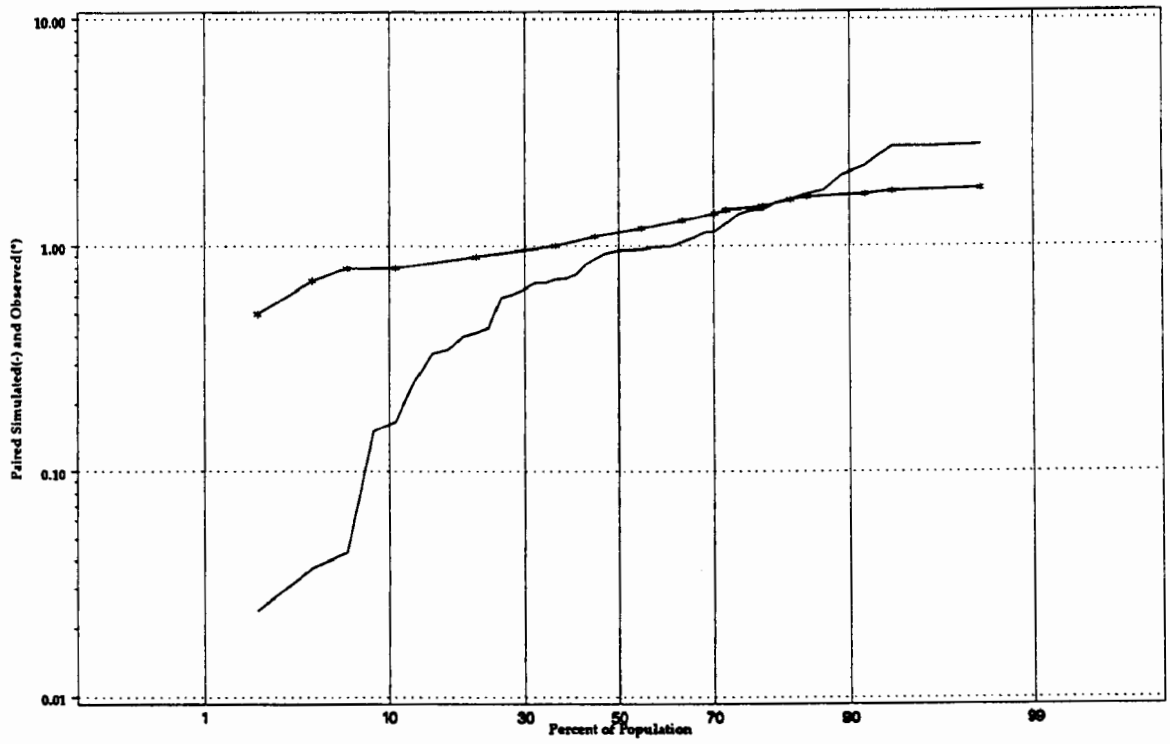
Mid Potomac River at Segment 740

Actual Error versus Time

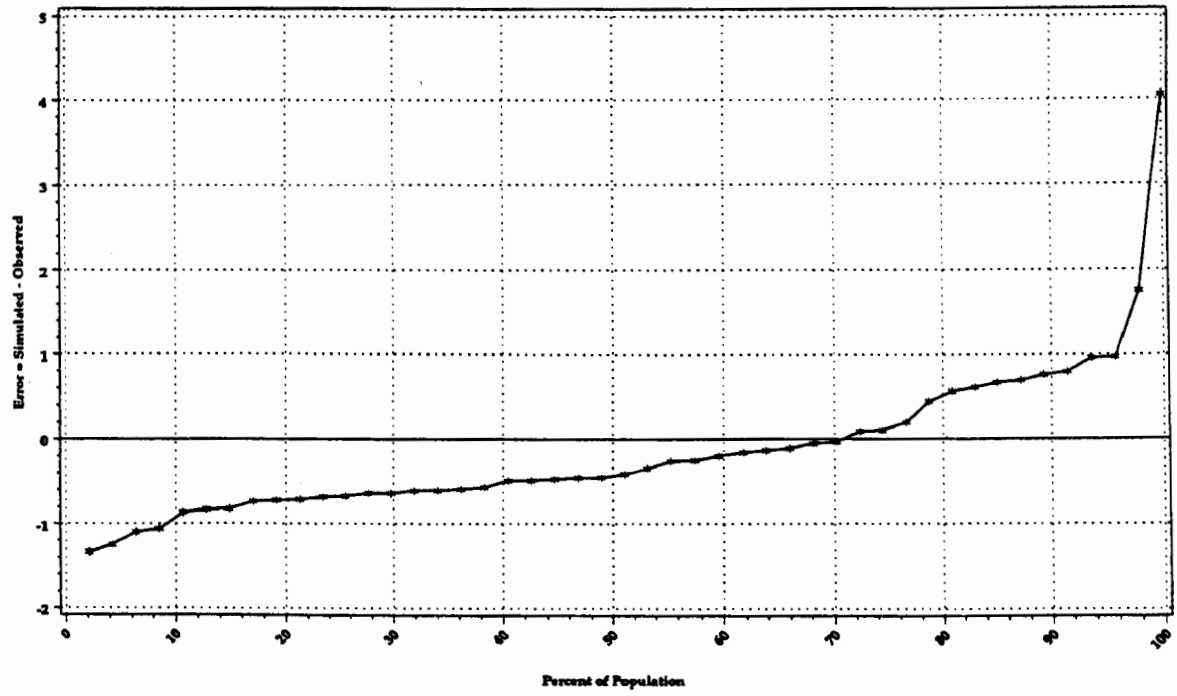
NO3



Mid Potomac River at Segment 740
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

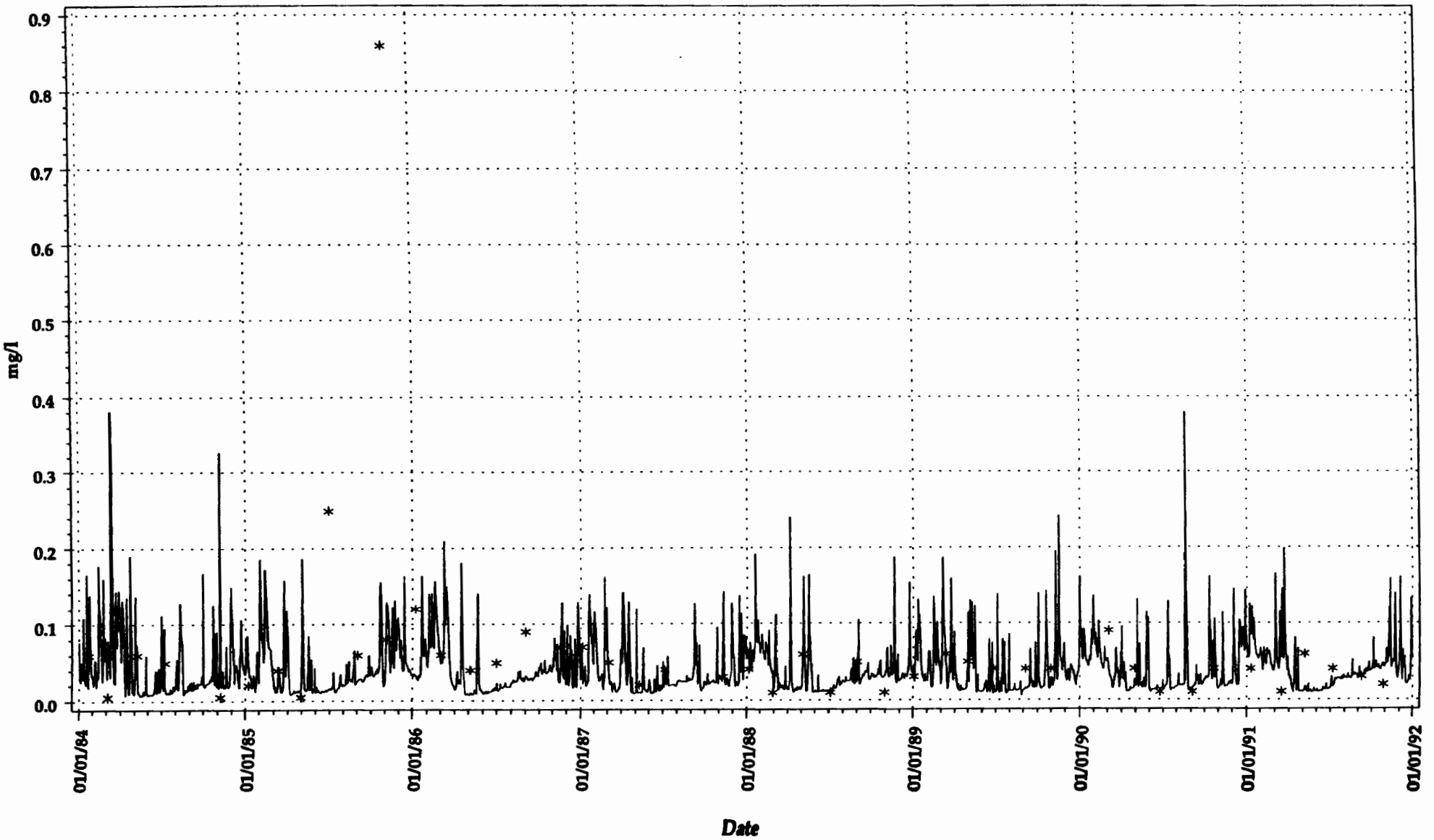


Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data



Mid Potomac River at Segment 740
Observed and Simulated versus Time
Total Ammonia

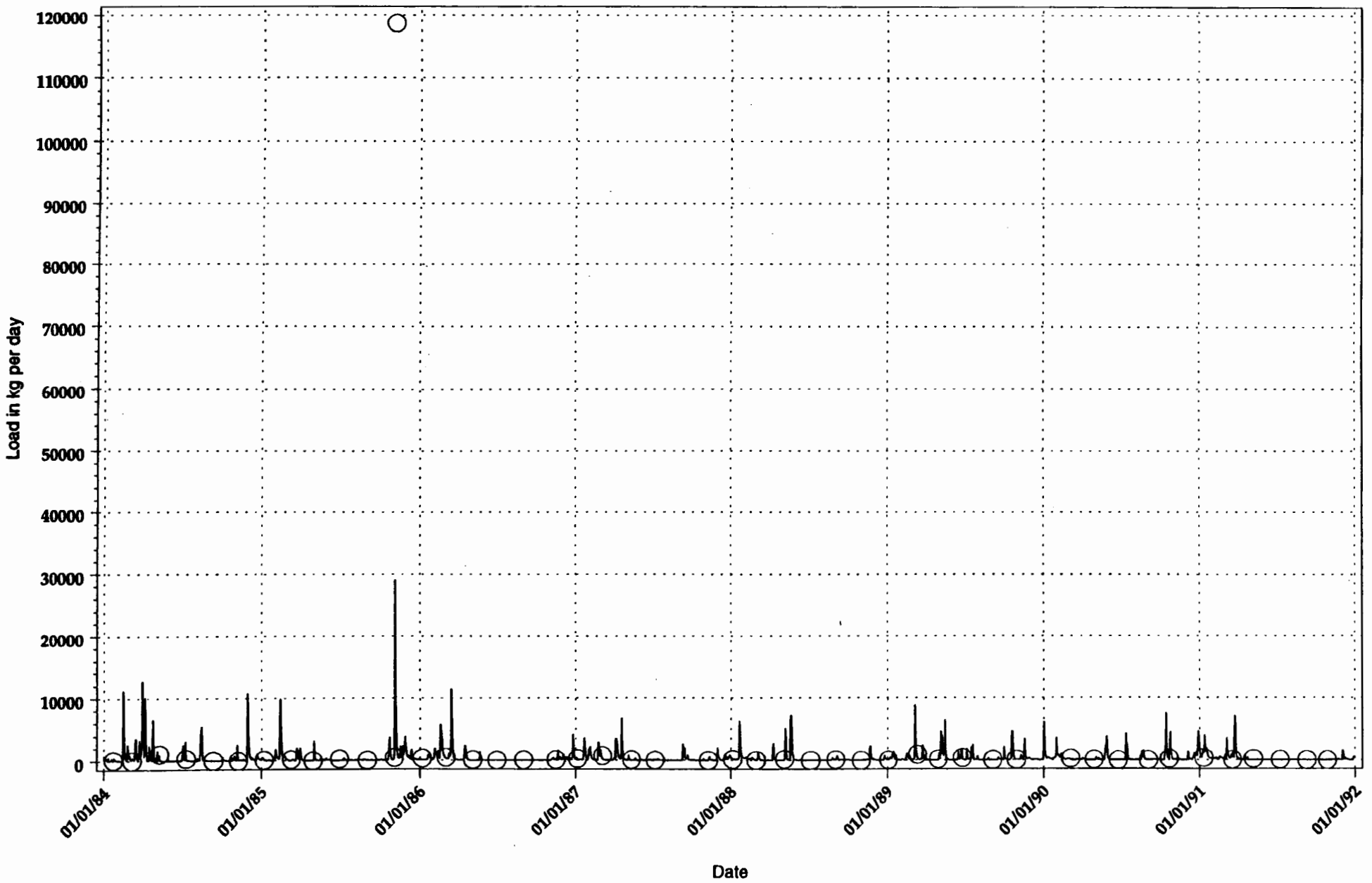
(*=Observed, -=Simulated)



Mid Potomac River at Segment 740

Total Ammonia Observed and Simulated Load vs Time

(line = simulated, O = observed)

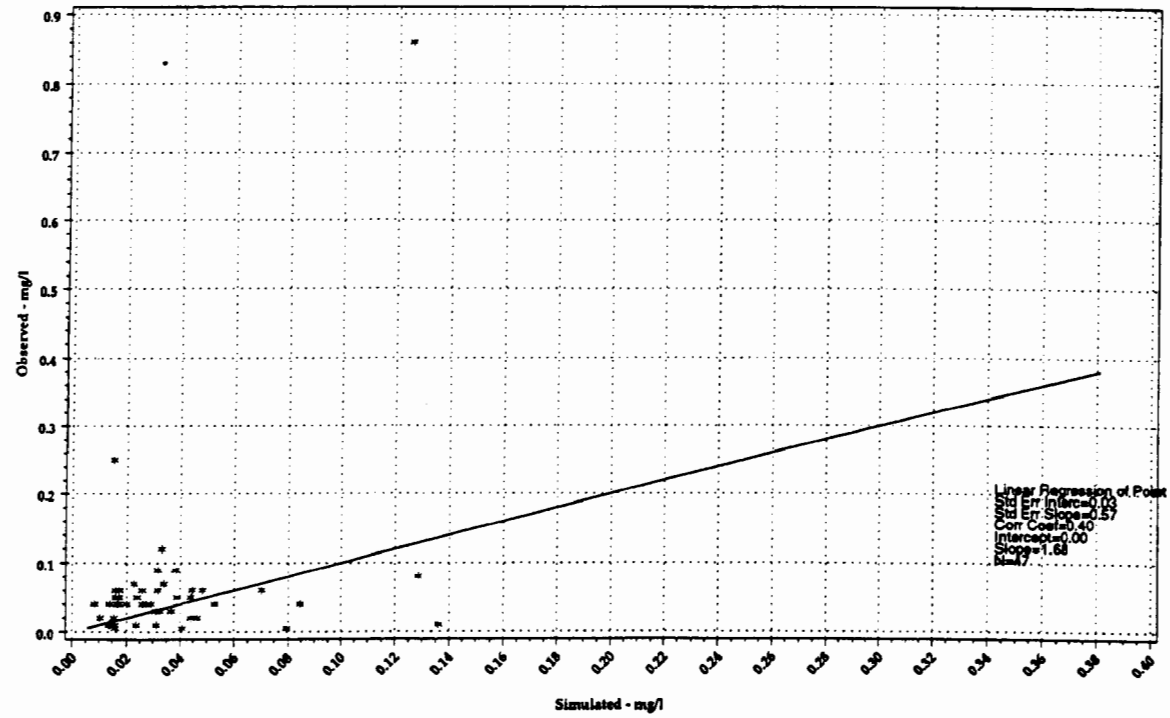


(y21_plotb.sas model3d:[pwang.dt] ldlles)
(mid.dev 23FEB98 11:18,proc reg,model y=x)

Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

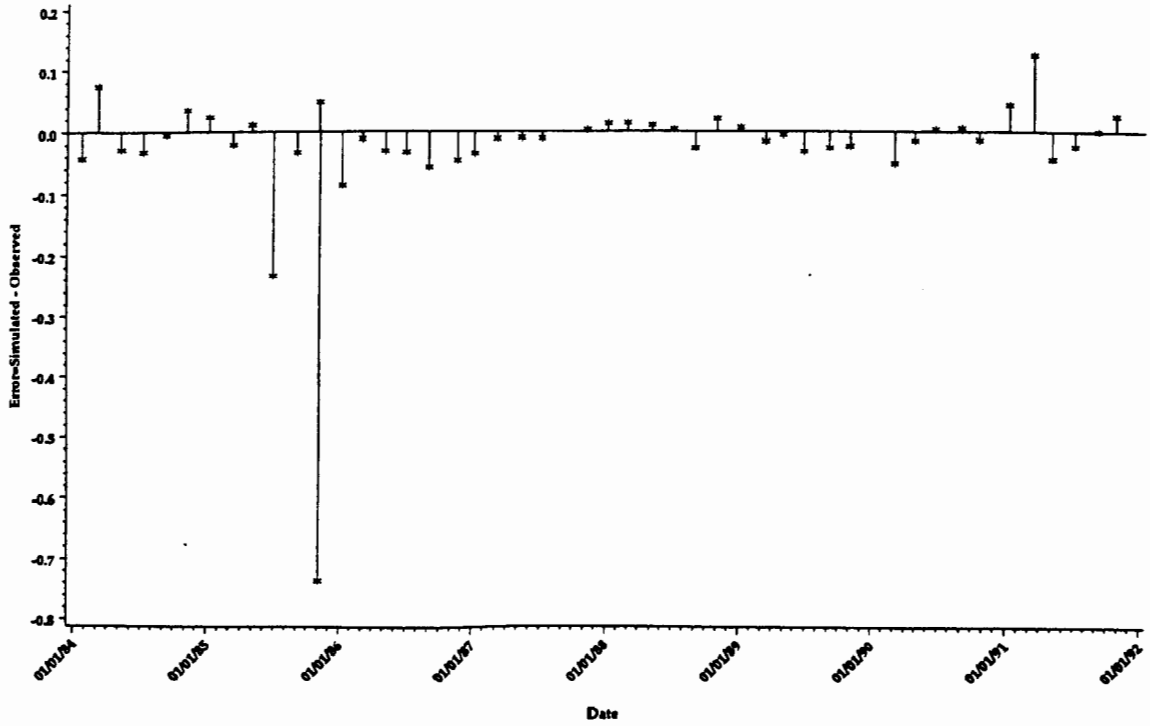
Total Ammonia: 01JAN84 - 01JAN92



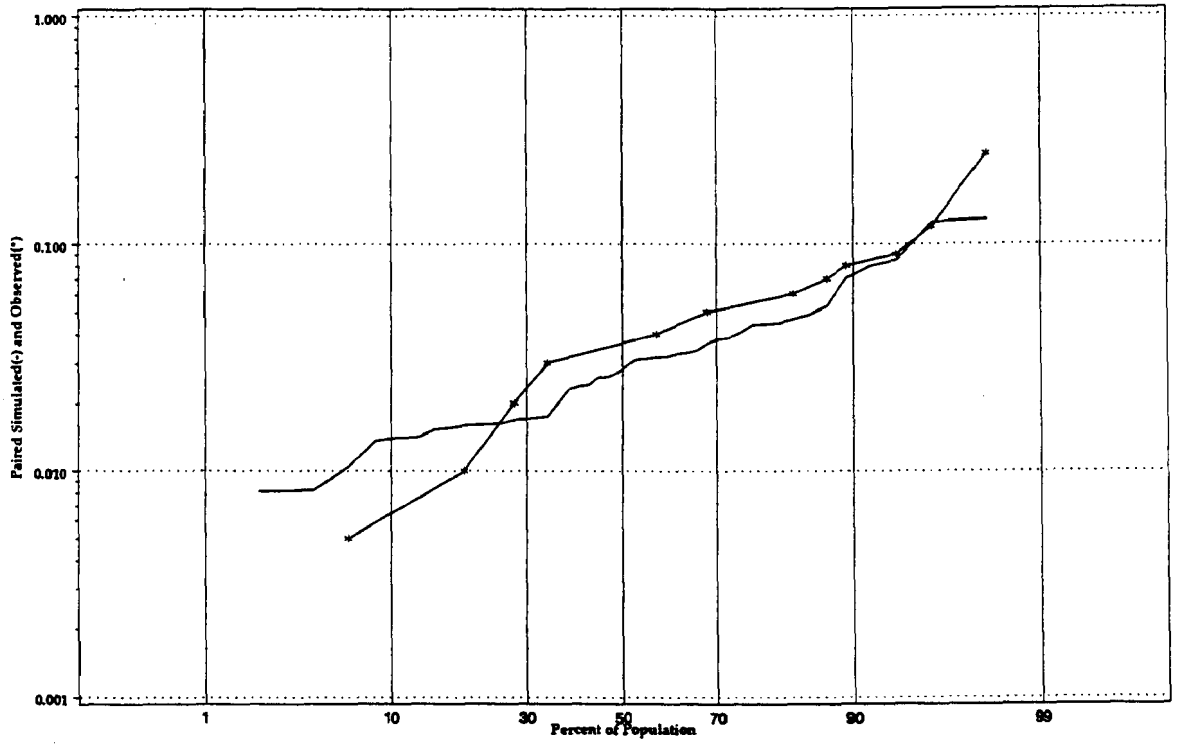
Mid Potomac River at Segment 740

Actual Error versus Time

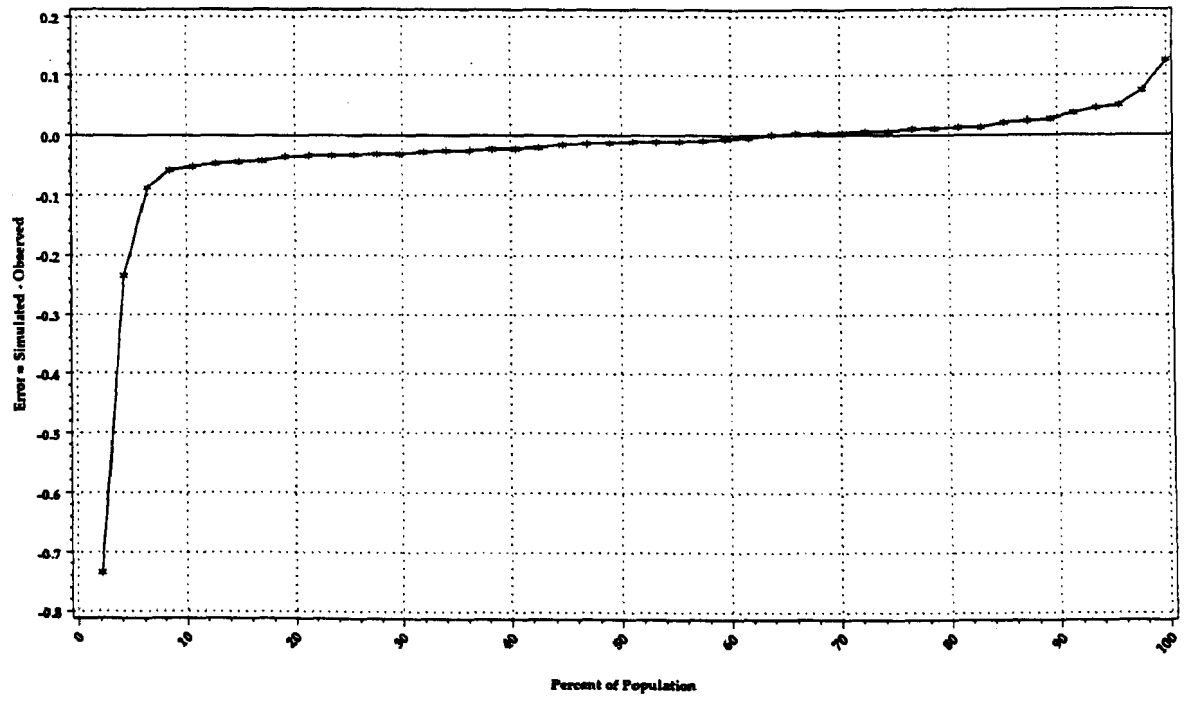
Total Ammonia



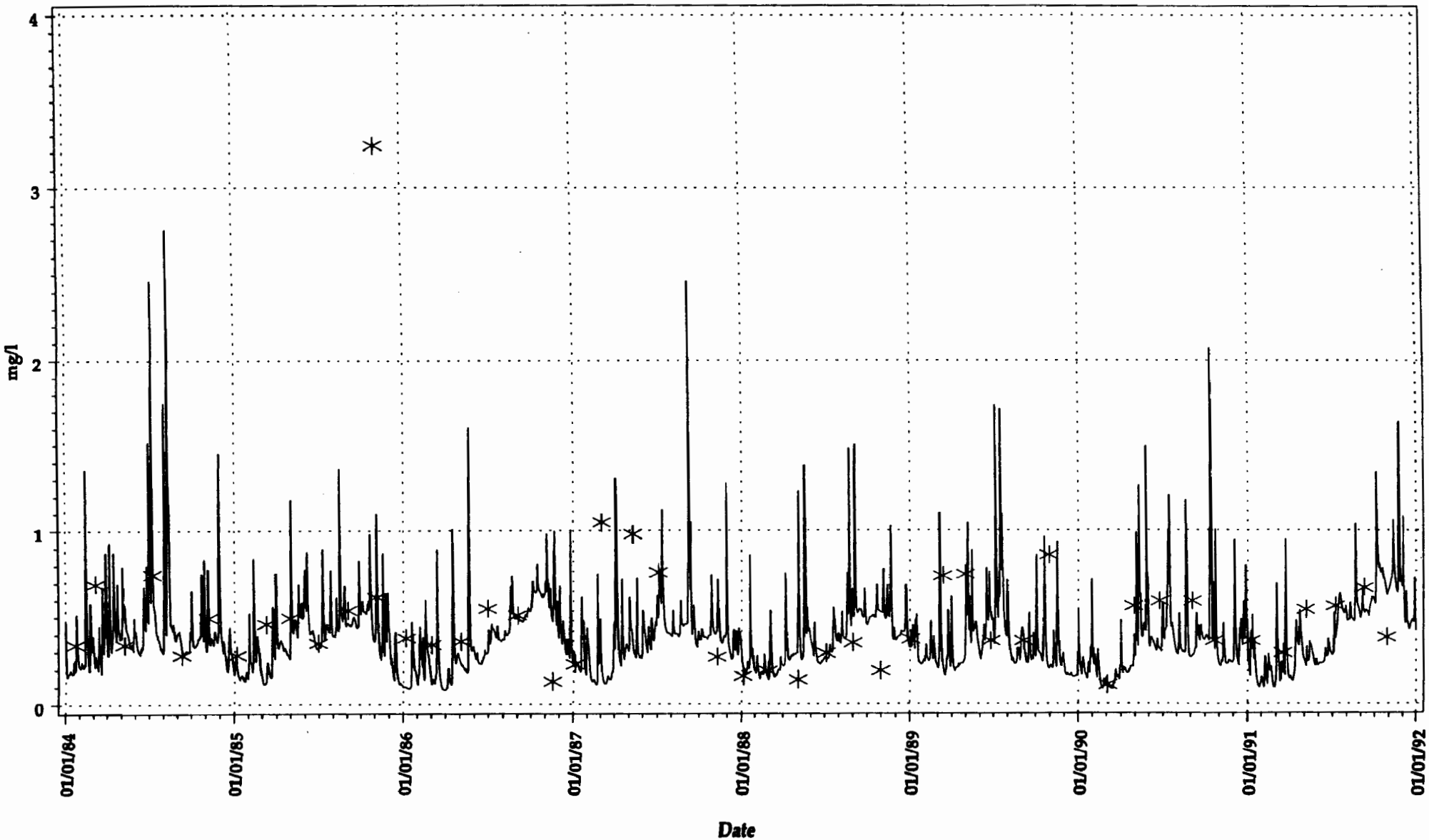
Mid Potomac River at Segment 740
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



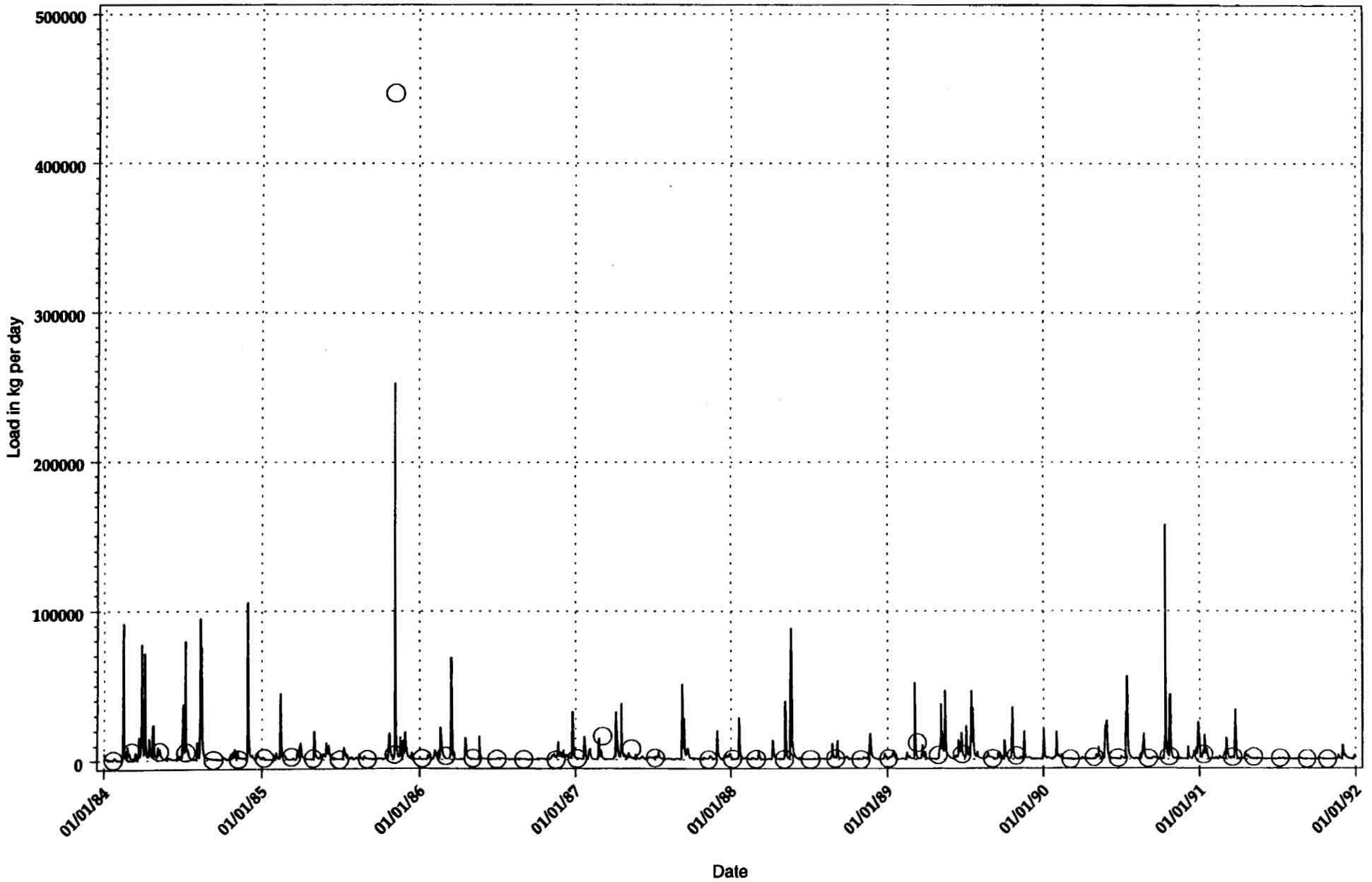
Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



Mid Potomac River at Segment 740
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)



Mid Potomac River at Segment 740
Organic Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)

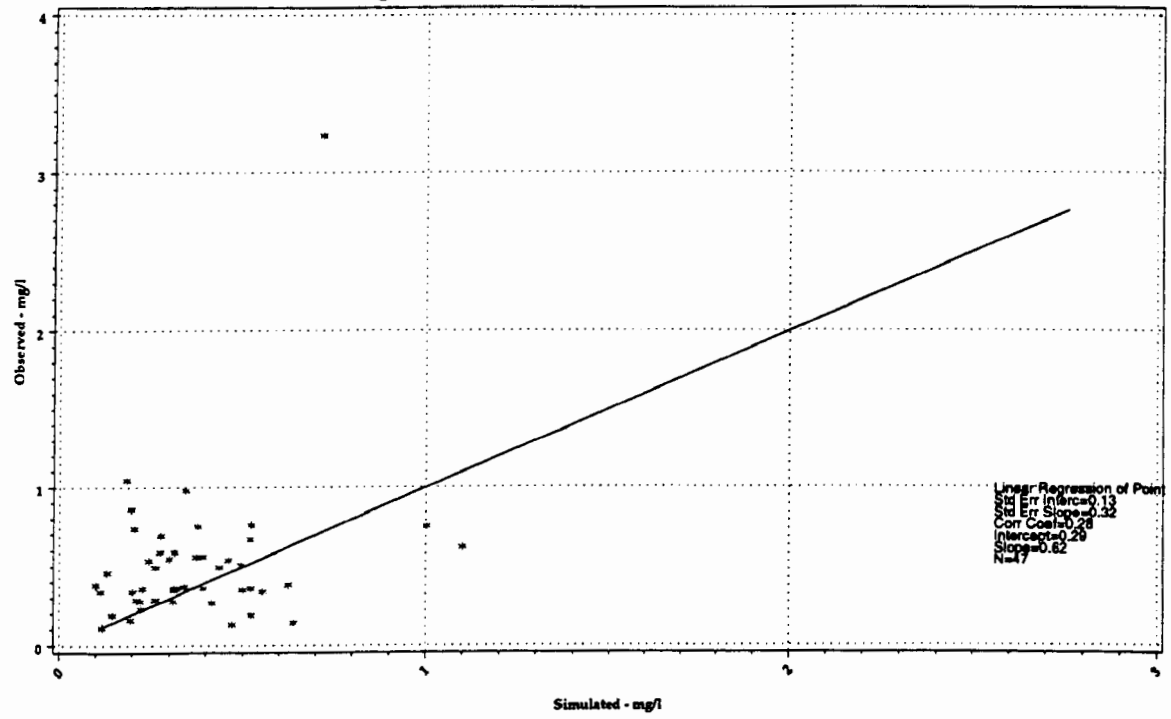


(y21_plotb.sas model3d[pwang.dt] lidlee)
(mid.dev 23FEB98 11:18,proc reg,model y=x)

Mid Potomac River at Segment 740

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

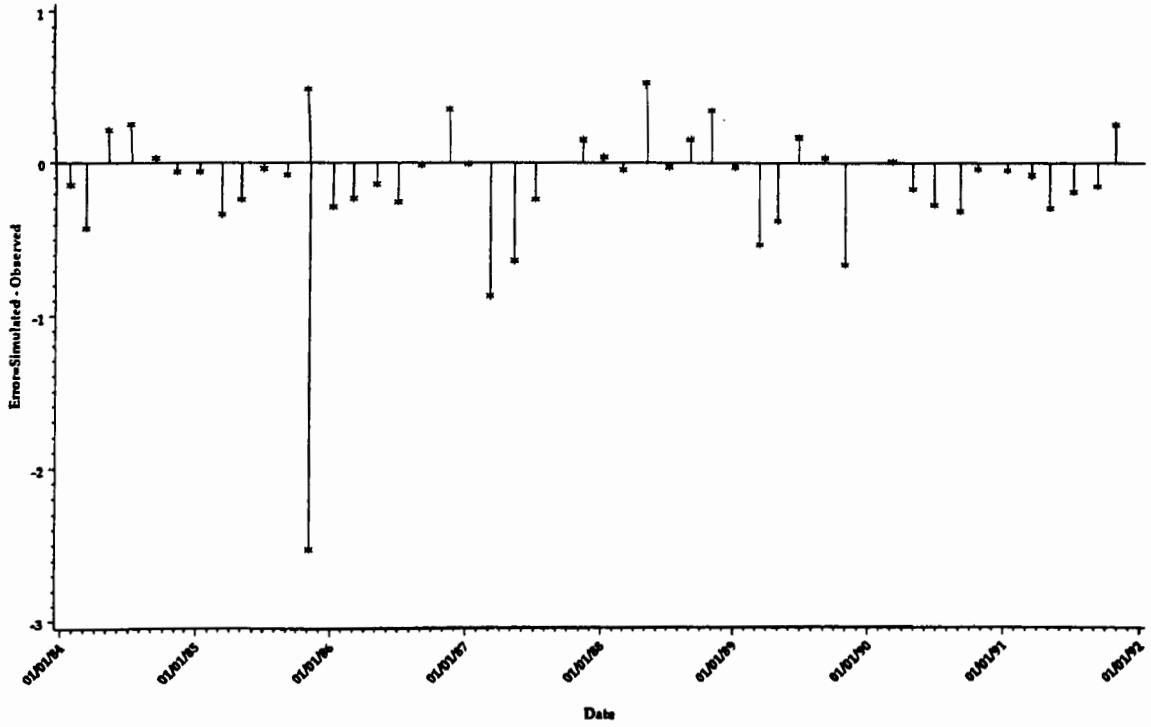
Organic Nitrogen: 01JAN84 - 01JAN92



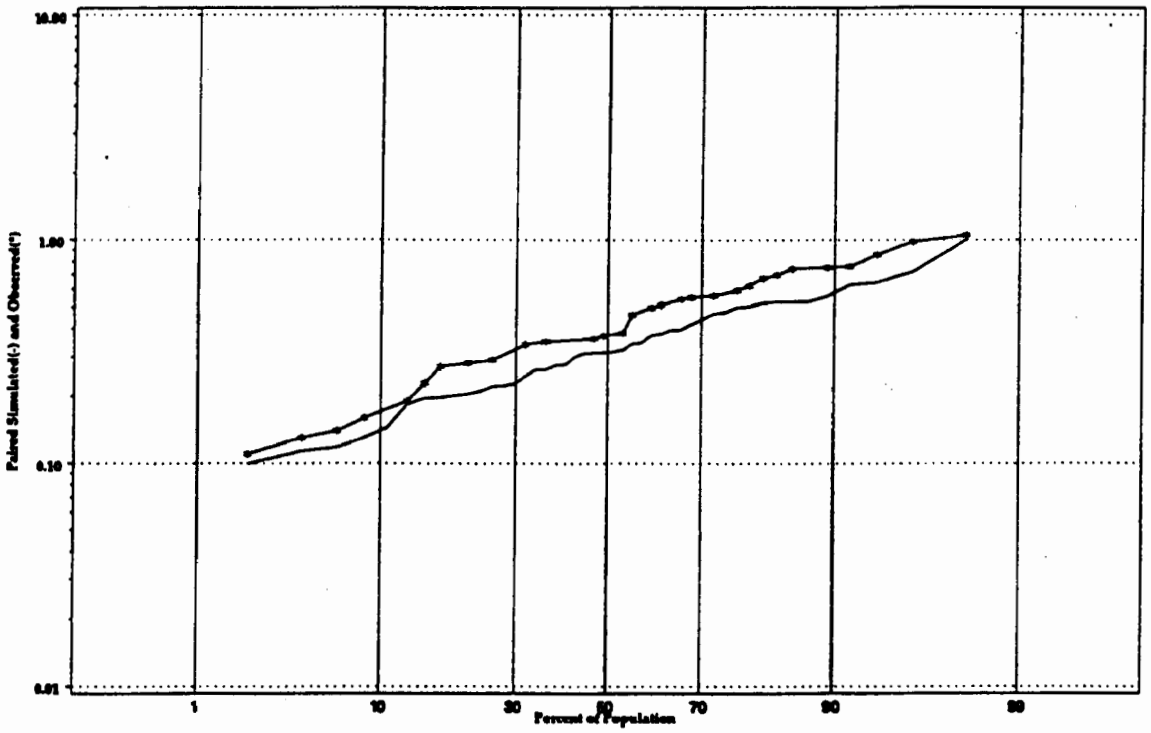
Mid Potomac River at Segment 740

Actual Error versus Time

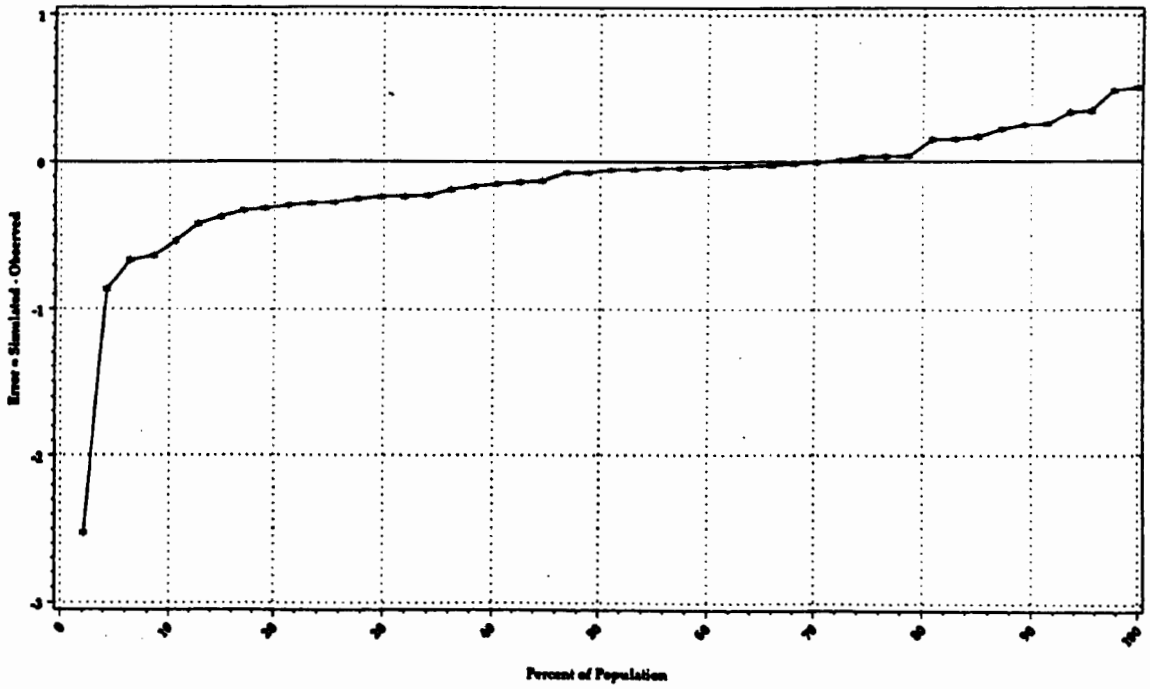
Organic Nitrogen



Mid Potomac River at Segment 740
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Mid Potomac River at Segment 740
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.3.2 Shenandoah River near Millville, WV at Segment 200 (Monitoring Station: 1636500) (Above Fall Line Basin Segments: 190 and 200)

Section Summary:

The Shenandoah basin is largely rural and is dominated by agricultural loads of the Shenandoah Valley. The Shenandoah basin above the gaged site covers an area of 3,033 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 51% forest land, 6% cropland, 34% other agricultural areas, 8% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 9.1 million pounds in 1985 to 8.4 million pounds in 1996. Total phosphorus loads over the same time period decreased from 1.5 million pounds to 1.2 million pounds. In general, point source loads above the gage site decreased. In 1996, the total nitrogen point source load was 16% of the total load and the total phosphorus point source load was 32% of the total load. Estimated septic system total nitrogen loads increased 28%, from 0.30 million pounds in 1985 to 0.38 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 32%, and other agricultural loads (primarily pasture and manure loads) by 11%. Total phosphorus decreased for these land uses by 23% and 25% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 35% for total nitrogen and 30% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

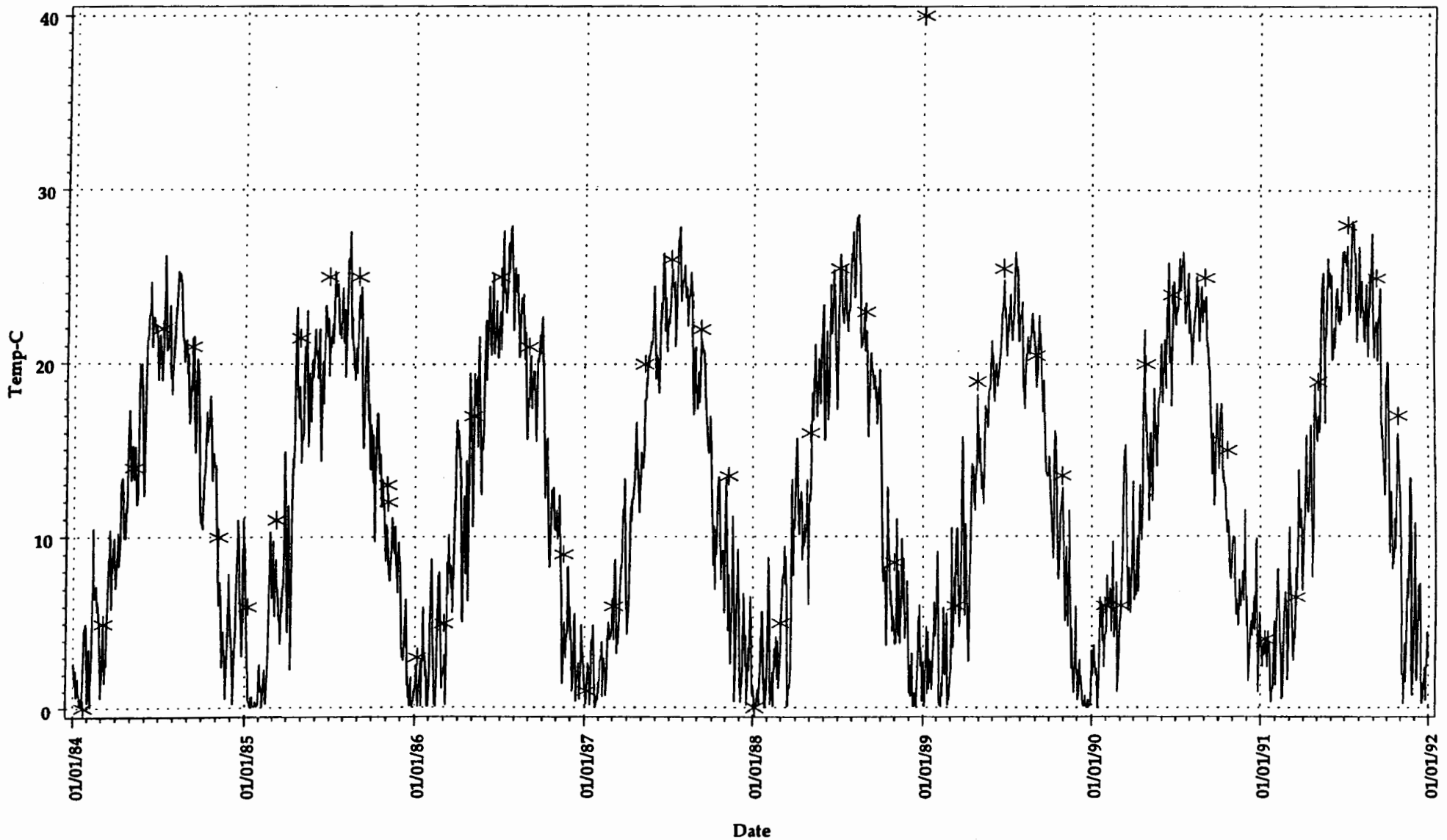
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

Shenandoah River at Segment 200
Observed and Simulated versus Time
Temperature-C

(*=Observed, -=Simulated)

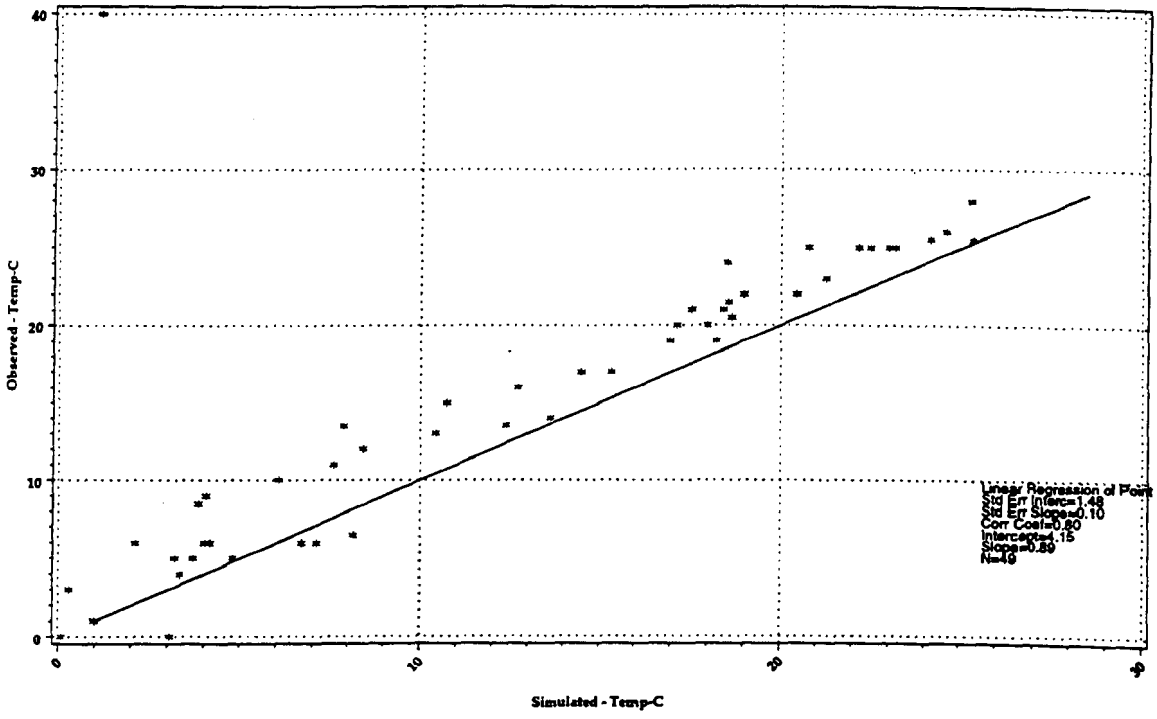


(r21_plot1.sas dataslore2 (nps p3 james sas) plotomi - omlime)
(graph_e dv 25AUG97 17:40)

Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

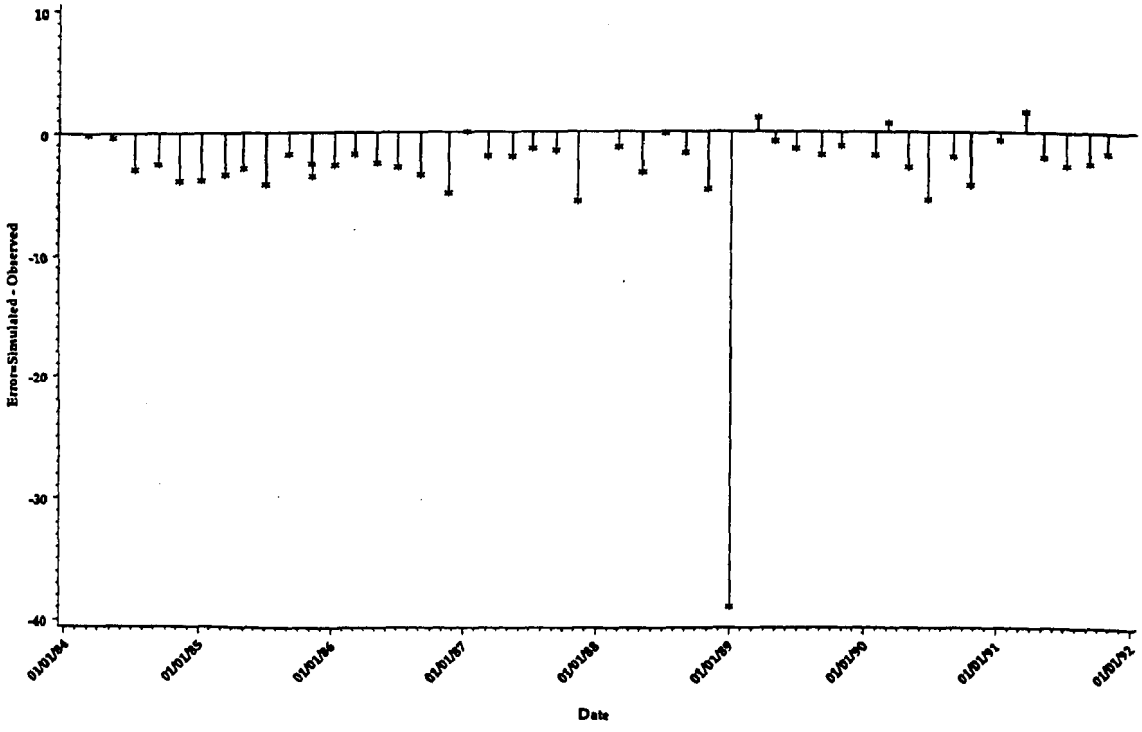
Temperature-C: 01JAN84 - 01JAN92



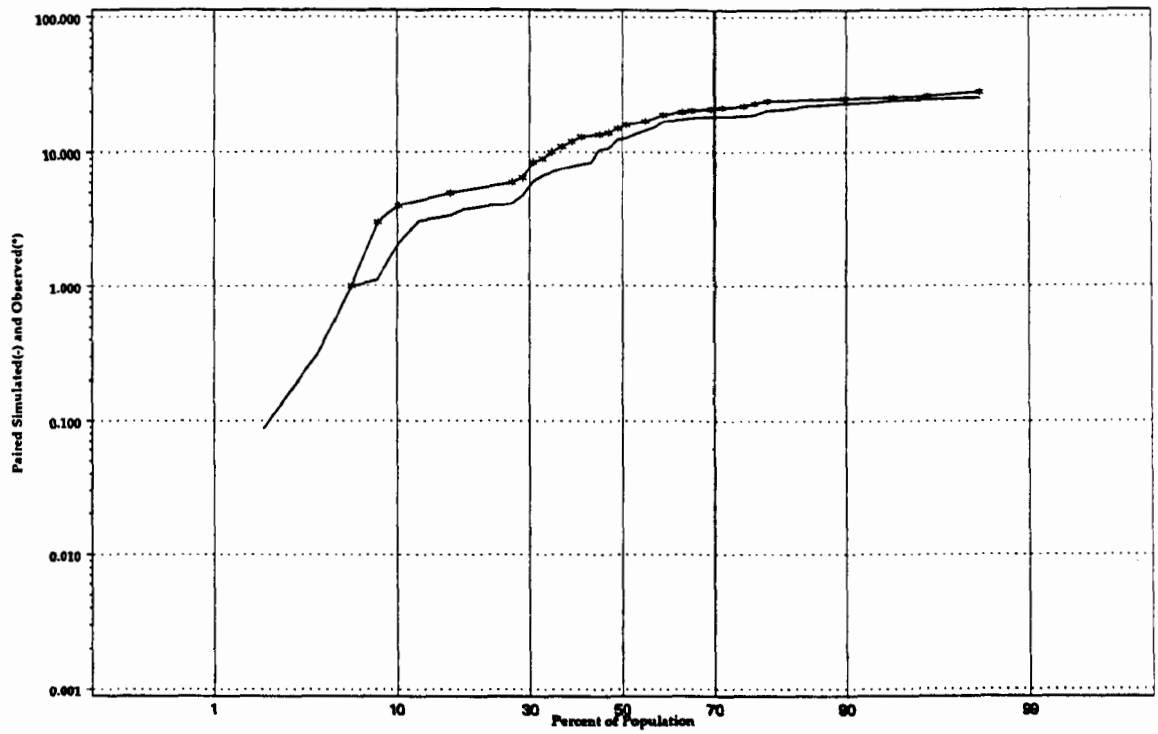
Shenadoah River at Segment 200

Actual Error versus Time

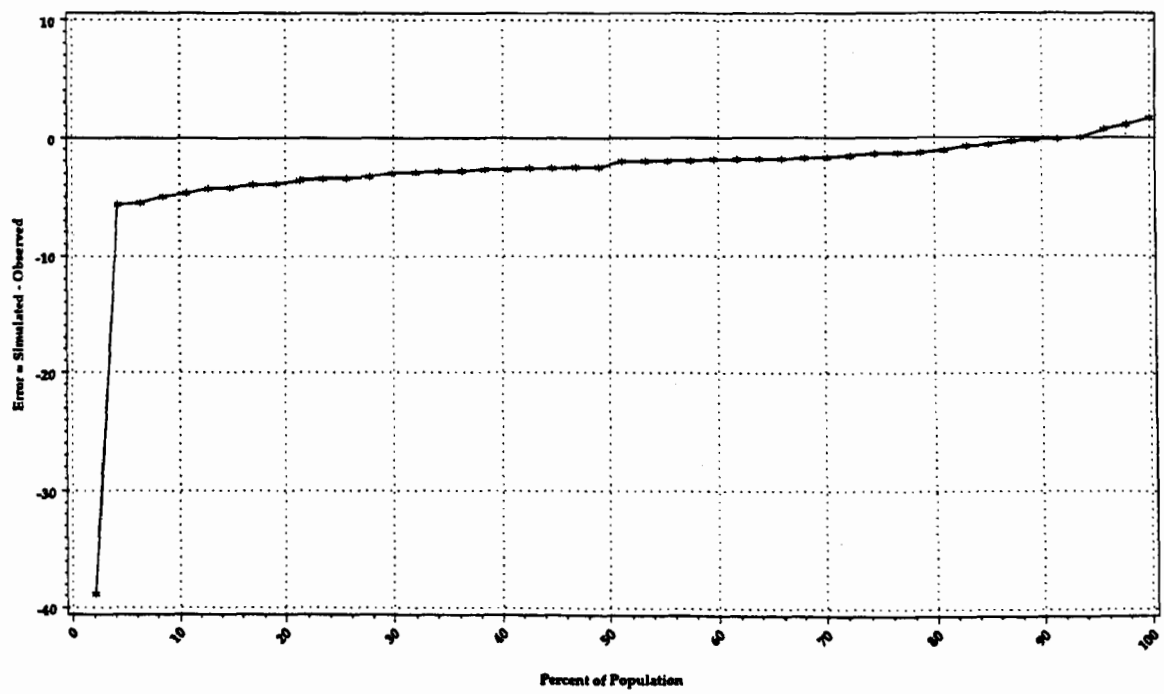
Temperature-C



Shenadoah River at Segment 200
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

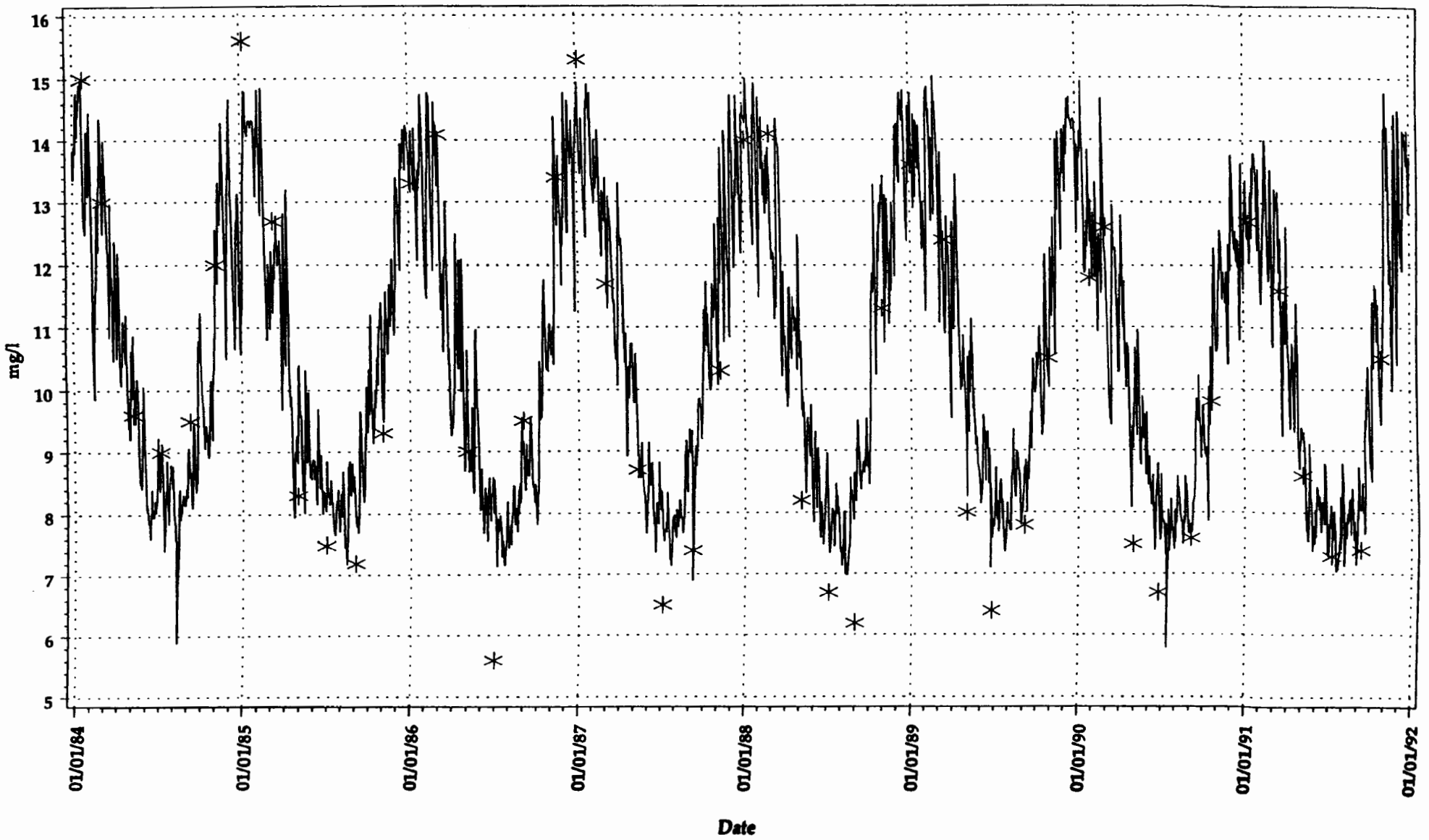


Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data

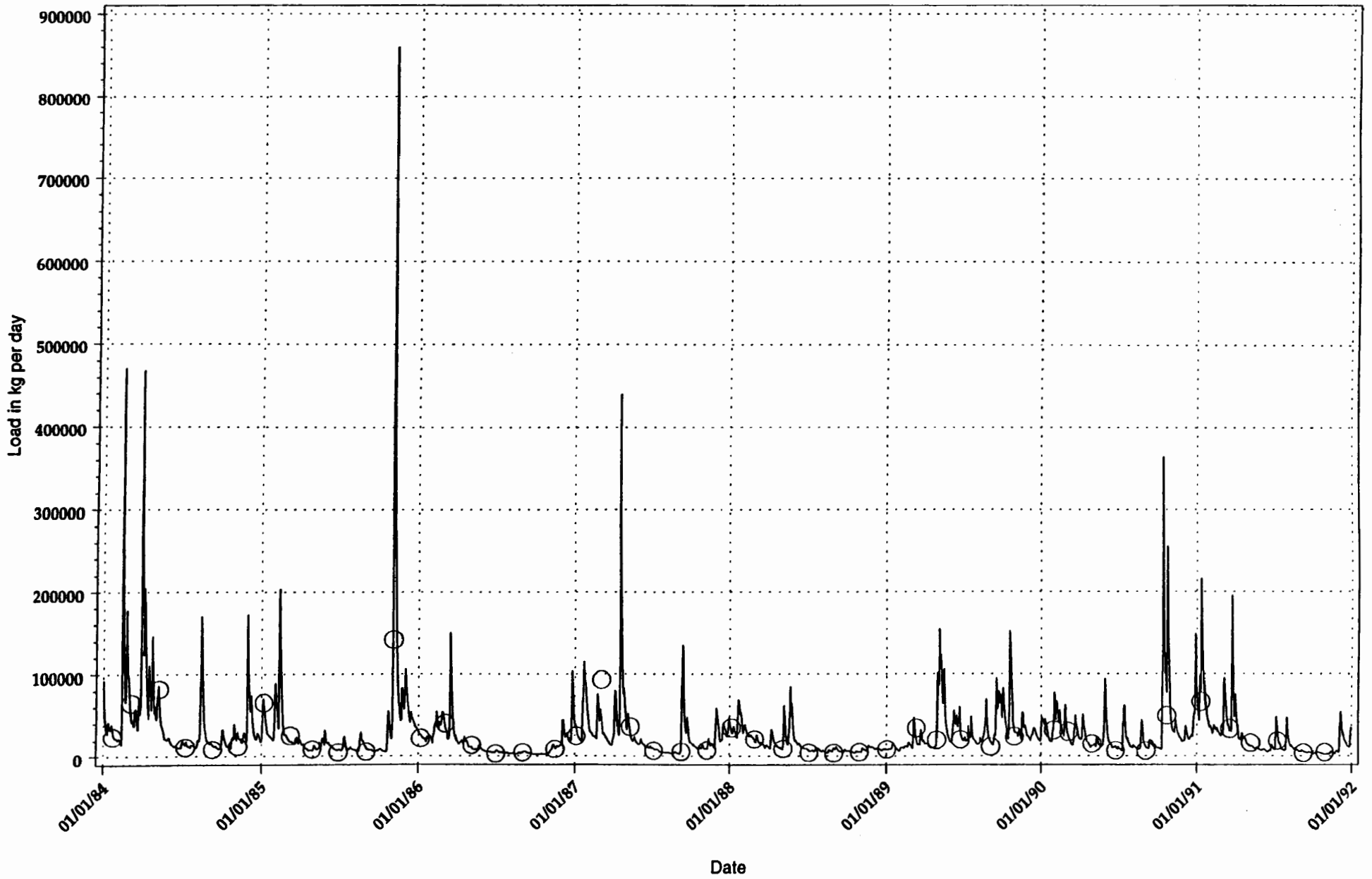


Shenandoah River at Segment 200
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



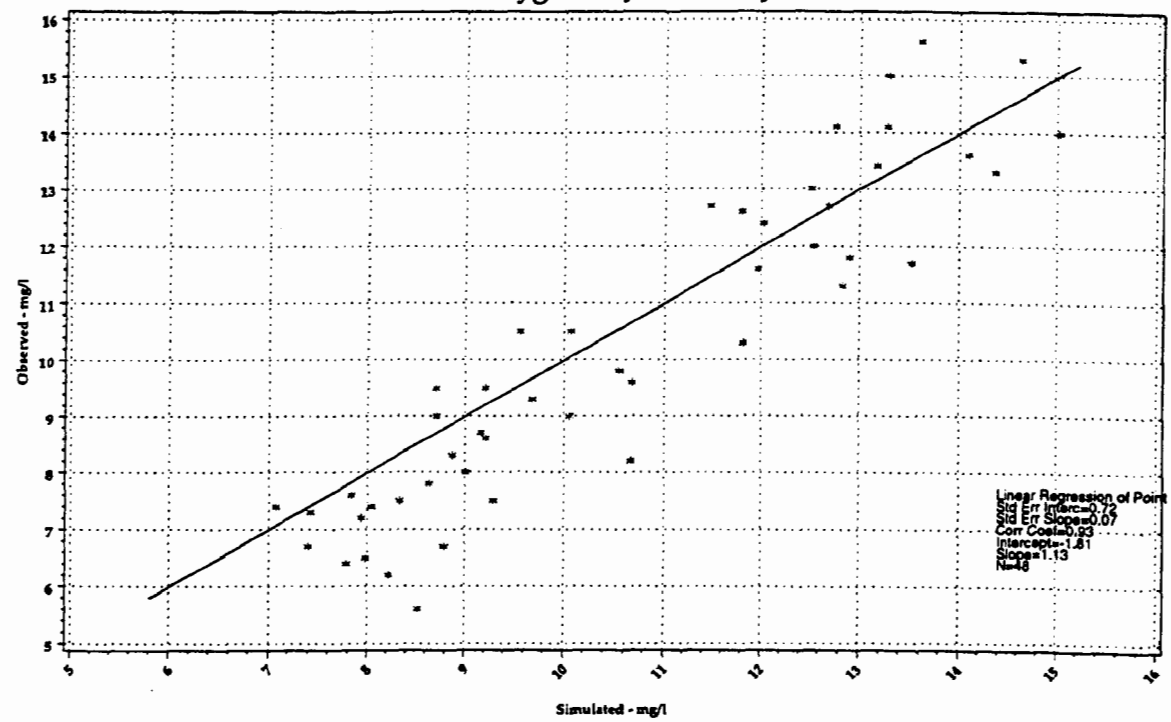
Shenandoah River at Segment 200
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plot1.sas datastore2 (rgs.p3 james.sas) fdflas)
(graph_e drv 25AUG97 17:40 proc reg model y=x)

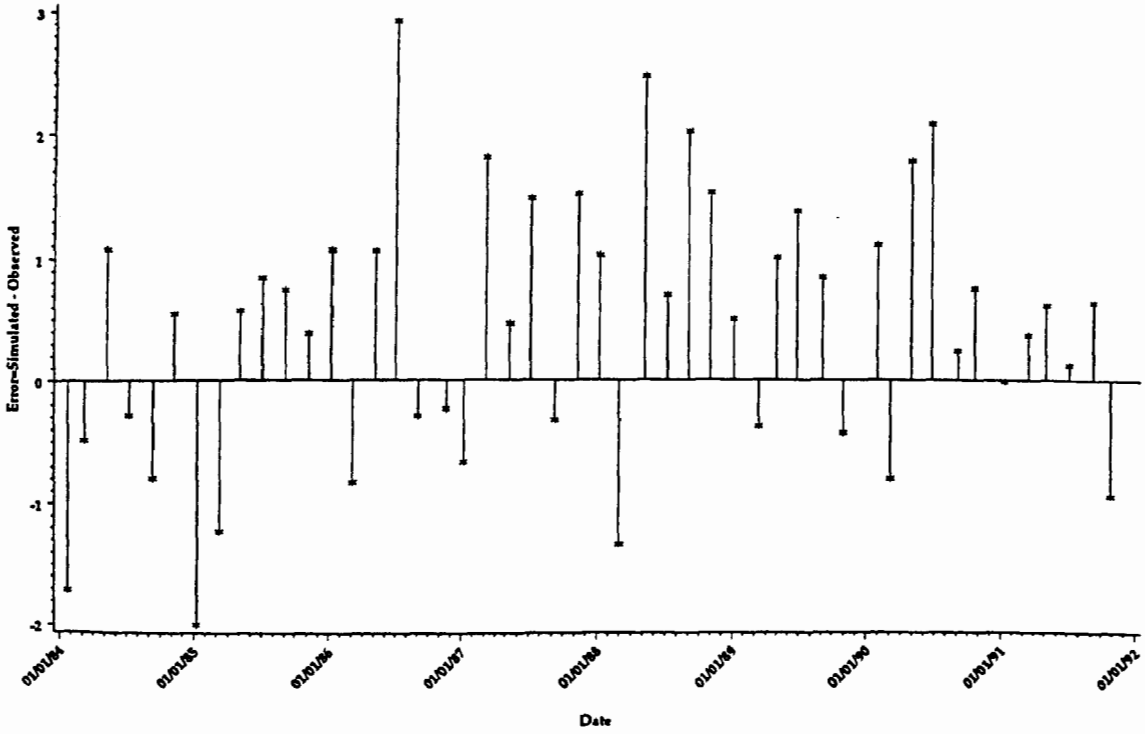
Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Dissolved Oxygen: 01JAN84 - 01JAN92

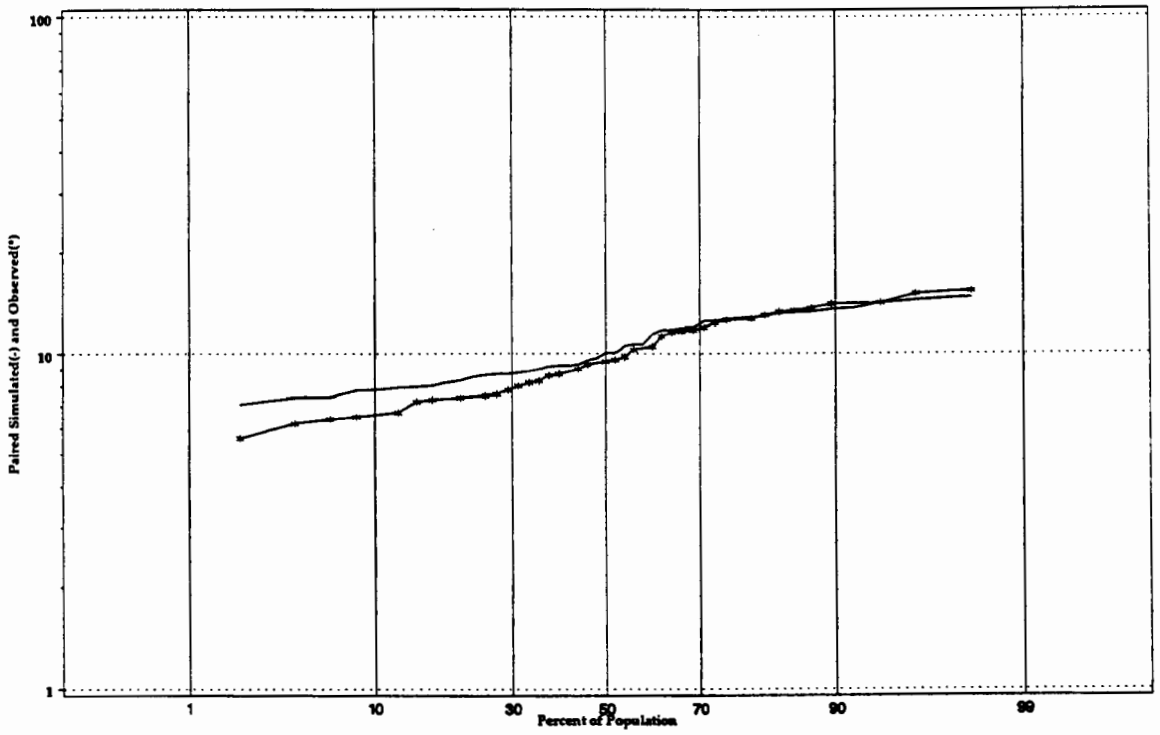


Shenadoah River at Segment 200

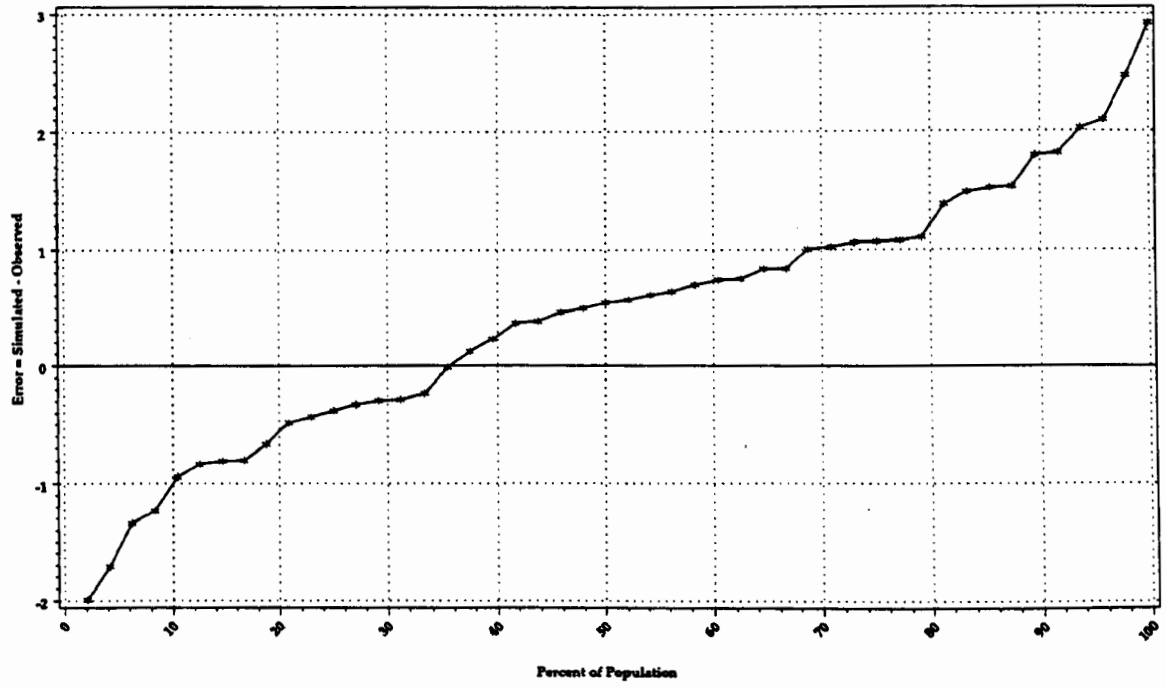
Actual Error versus Time
Dissolved Oxygen



Shenadoah River at Segment 200
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

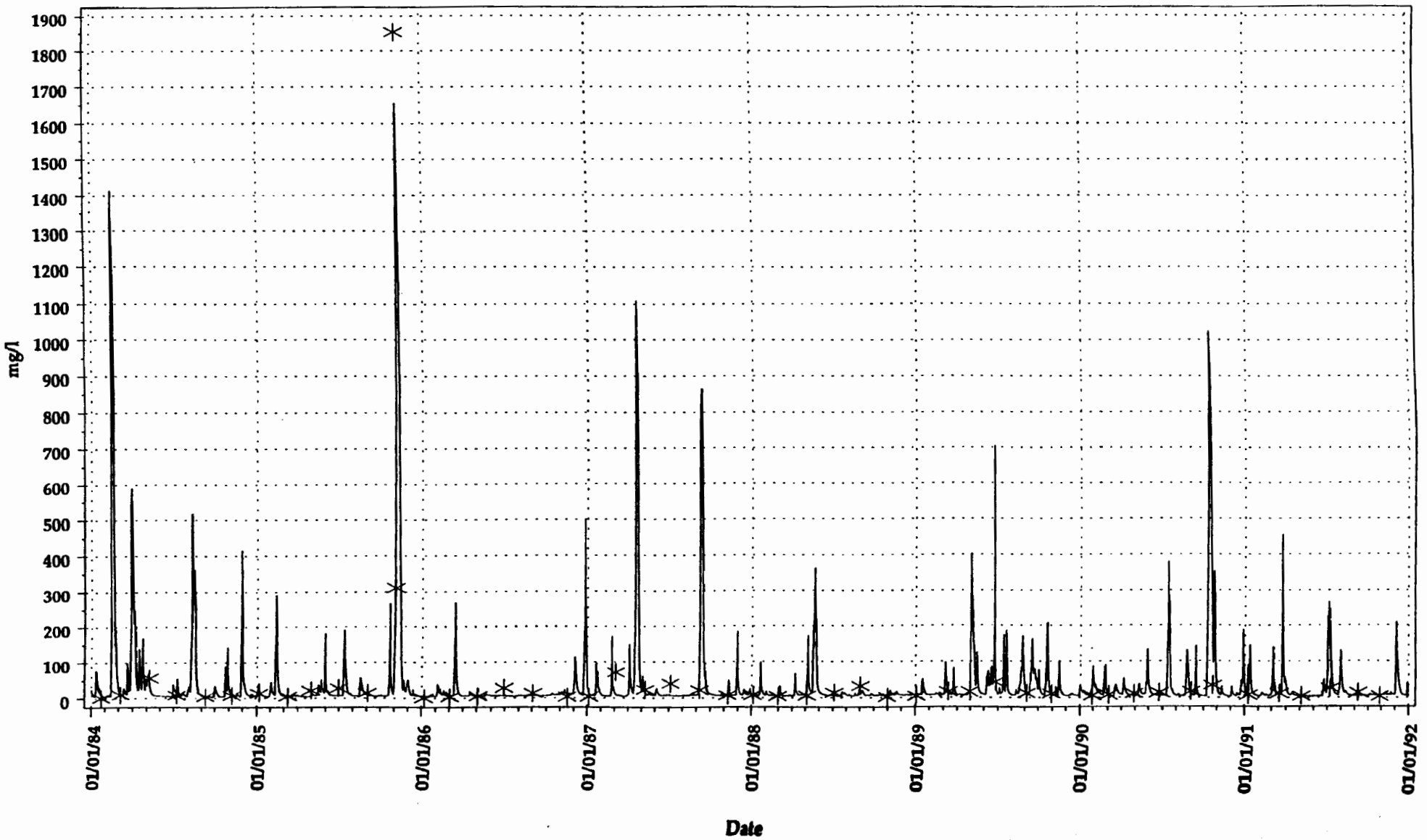


Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Shenandoah River at Segment 200
Observed and Simulated versus Time
Total Suspended Sediment

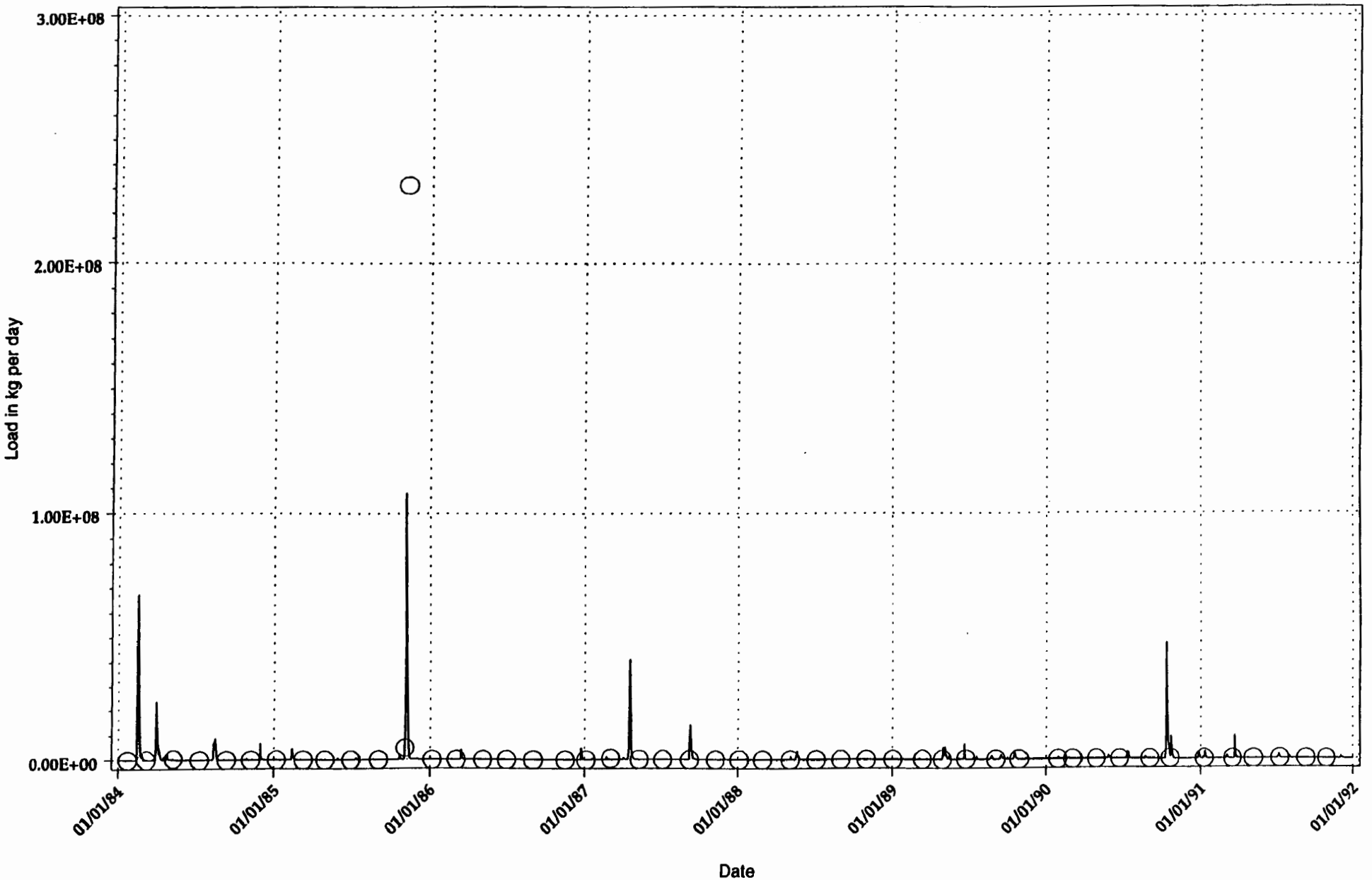
(*=Observed, -=Simulated)



Shenandoah River at Segment 200

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

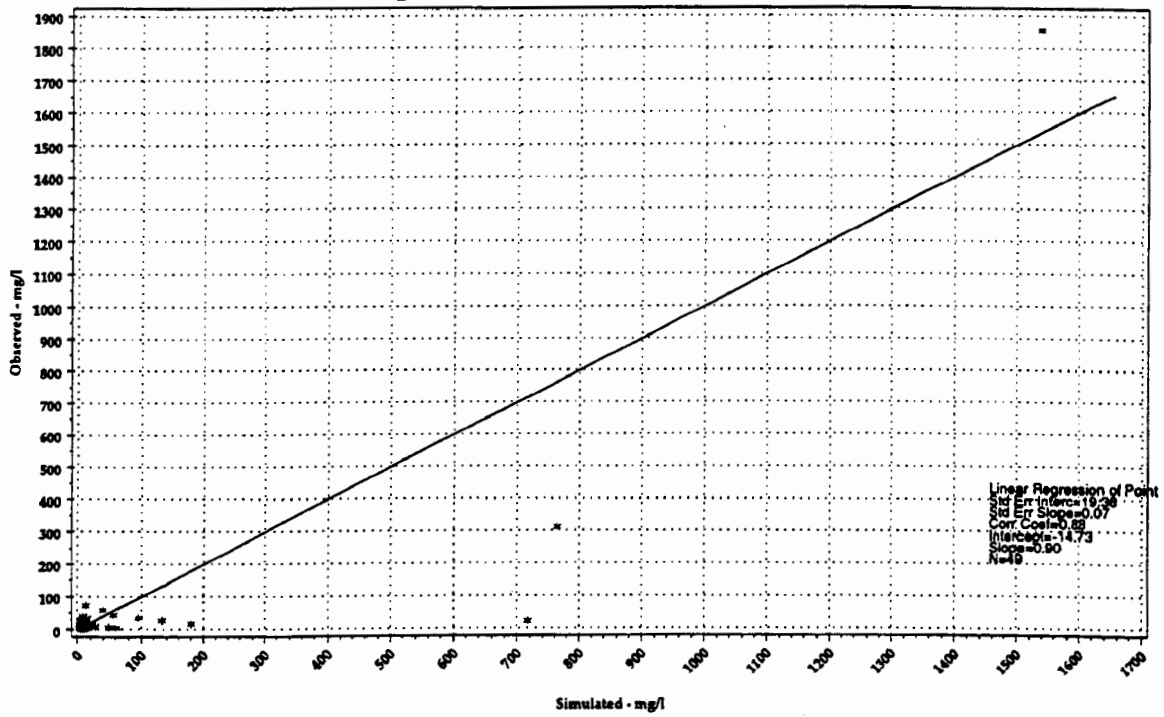


(y21_plot1 sas datastore2.jnpe.p3.jemes.sas) lldlles)
(graph_a drv 25AUG97 17:40.proc reg.model y=x)

Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

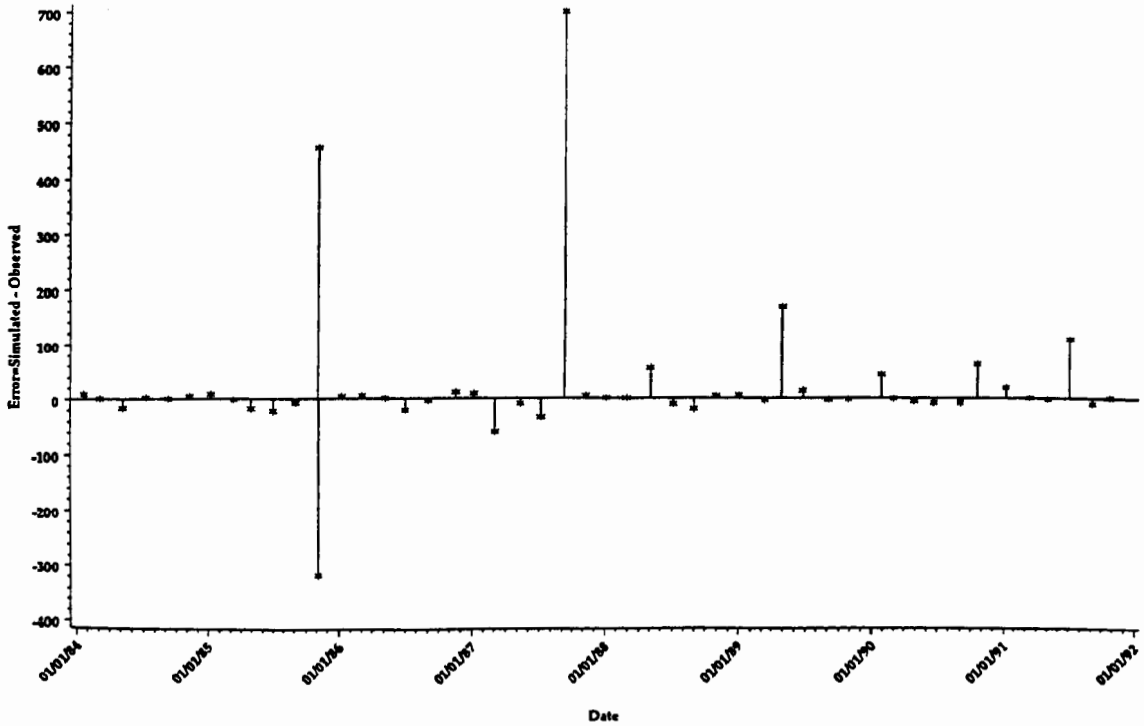
Total Suspended Sediment: 01JAN84 - 01JAN92



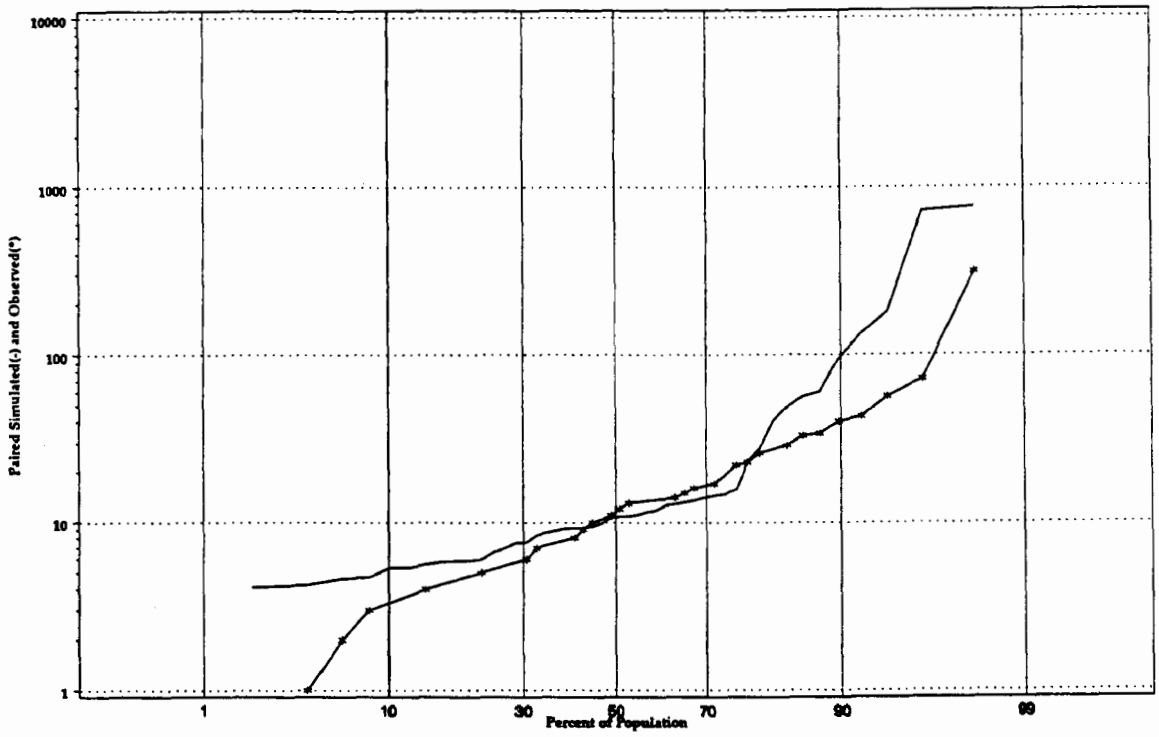
Shenadoah River at Segment 200

Actual Error versus Time

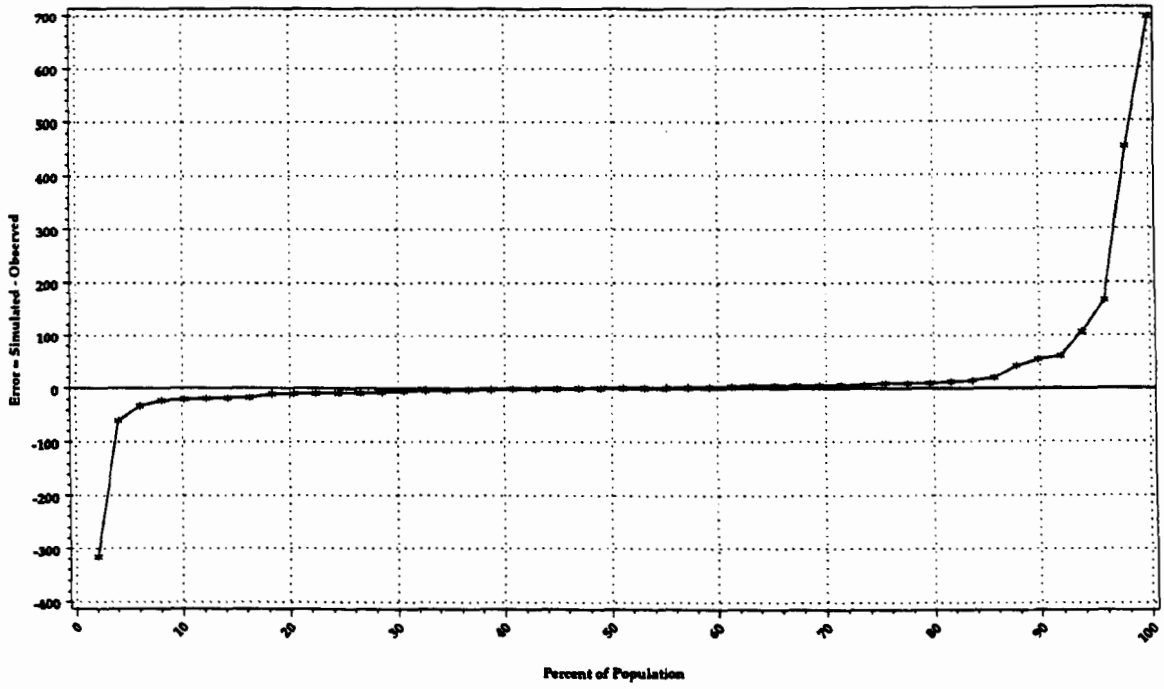
Total Suspended Sediment



Shenadoah River at Segment 200
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

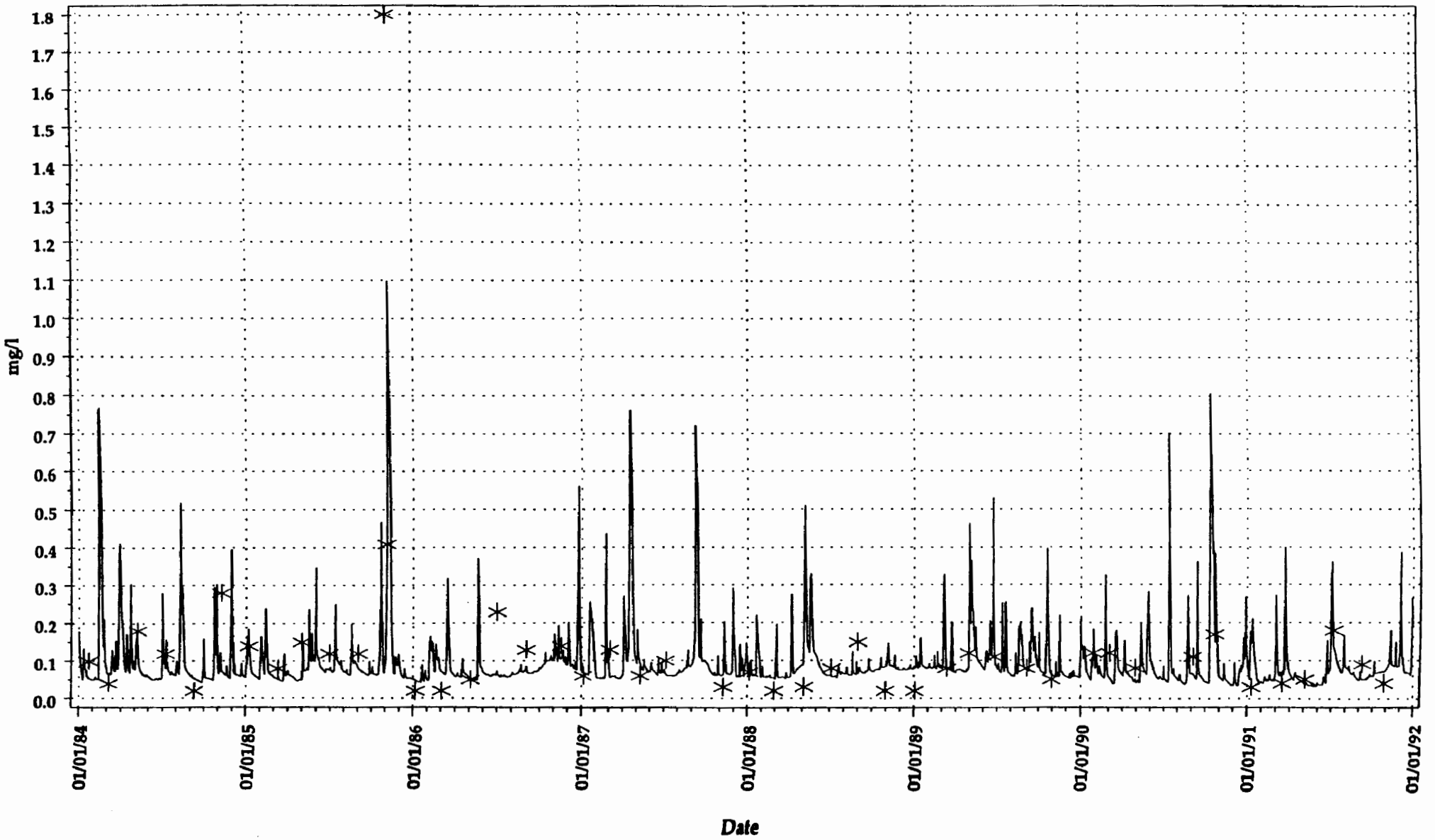


Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data

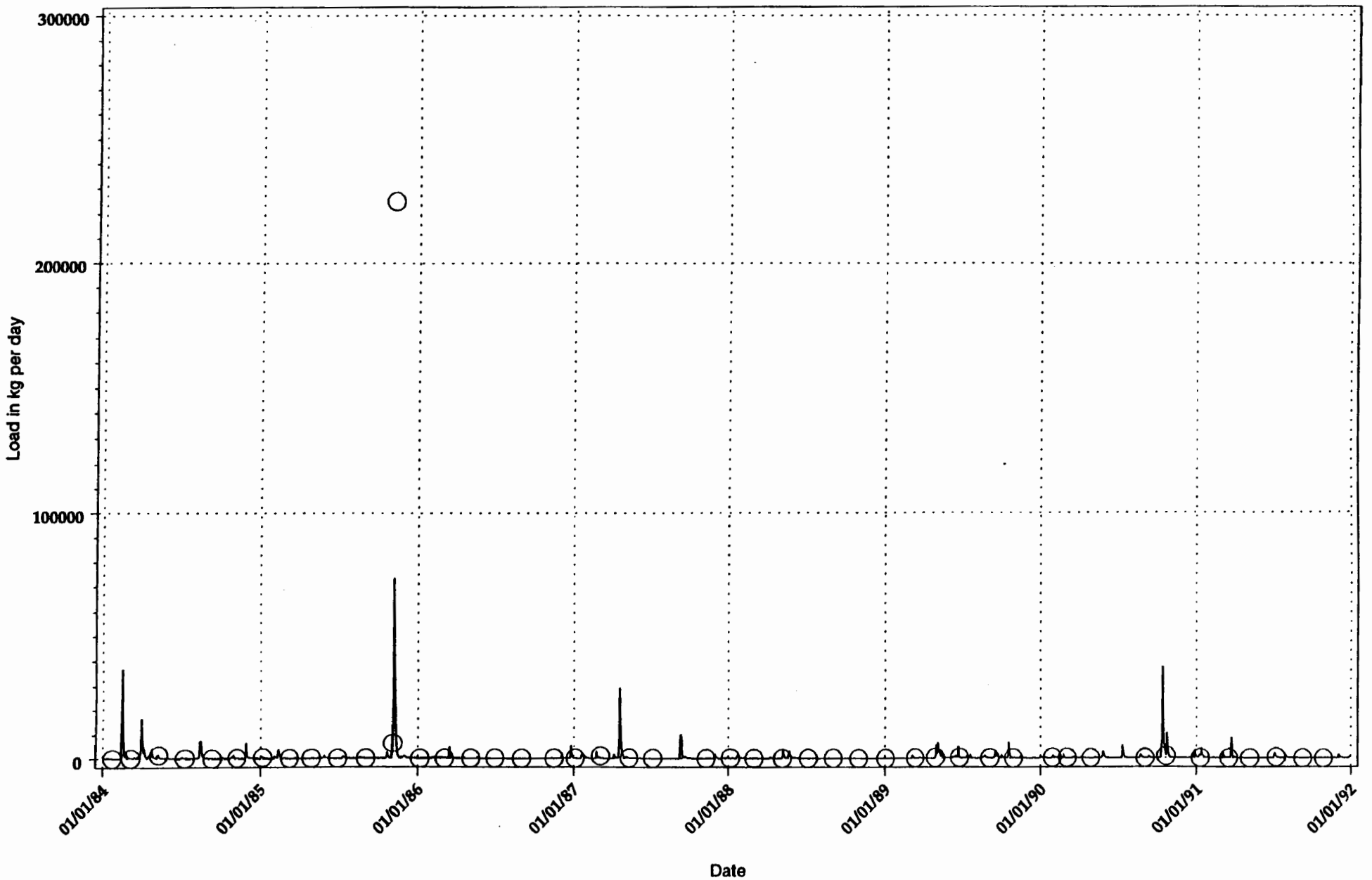


Shenandoah River at Segment 200
Observed and Simulated versus Time
Total Phosphorus

(*=Observed, -=Simulated)



Shenandoah River at Segment 200
Total Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

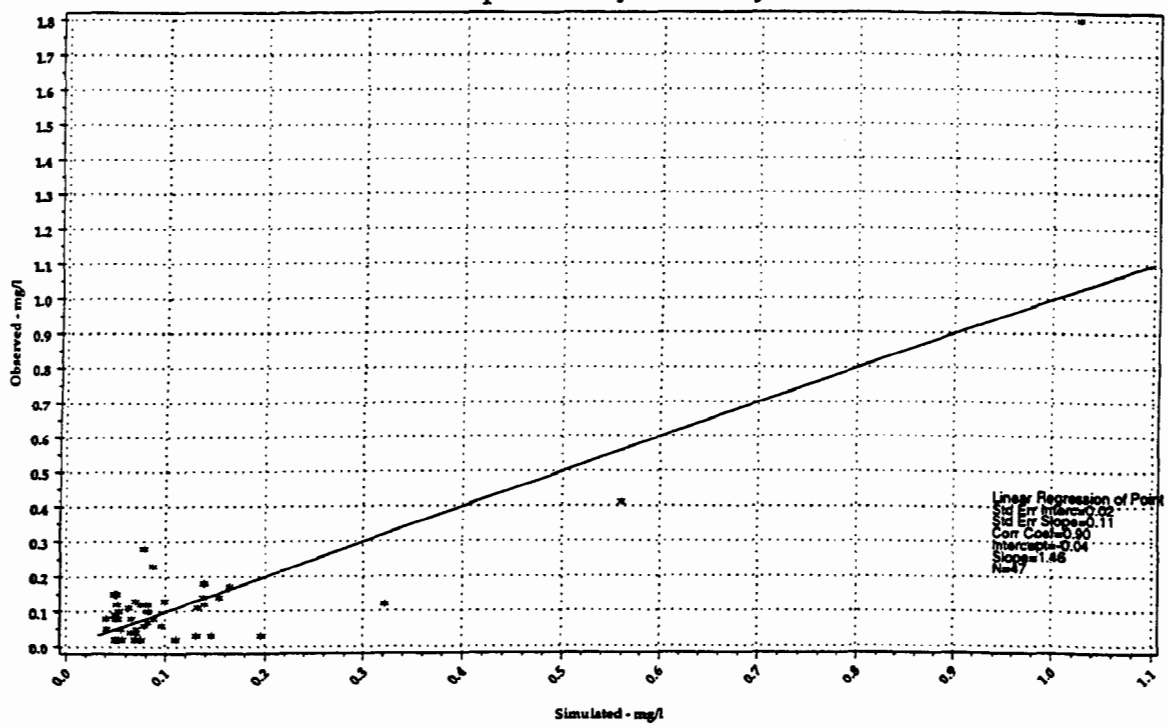


(y21_plot1.sas datastore2:jrps.p3.james.sas7bdat)
(graph_o drv 25AUG97 17:40,proc reg,model y=x)

Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

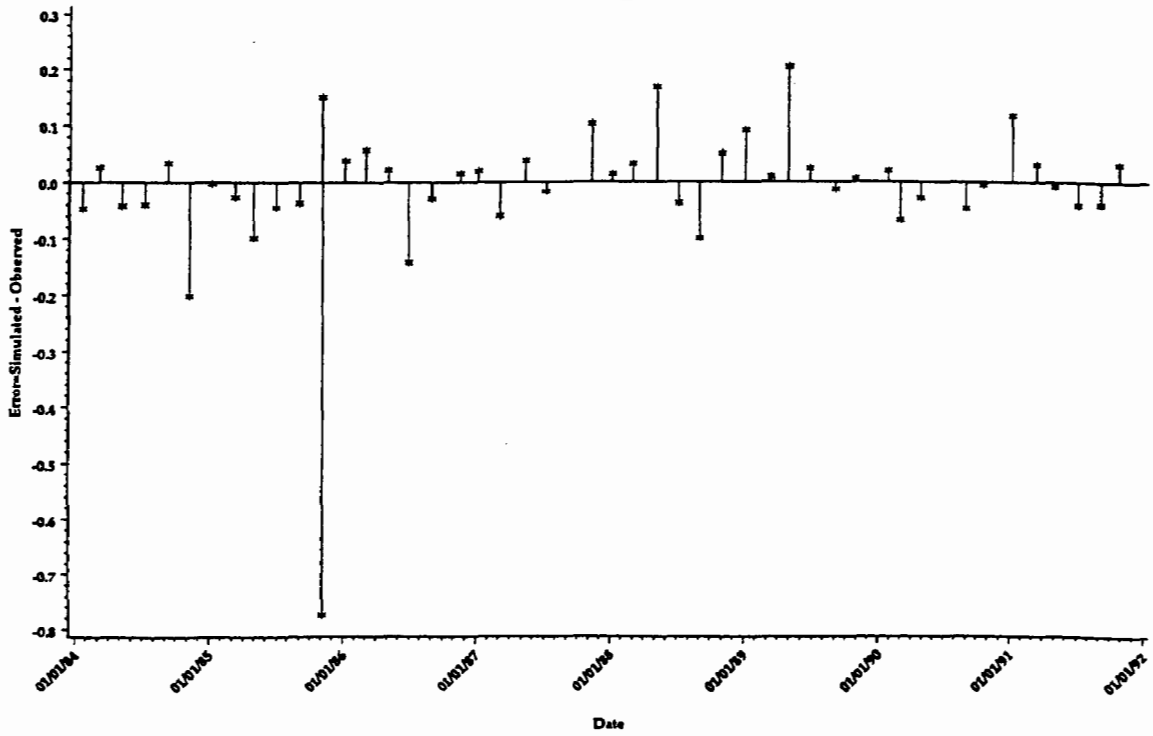
Total Phosphorus: 01JAN84 - 01JAN92



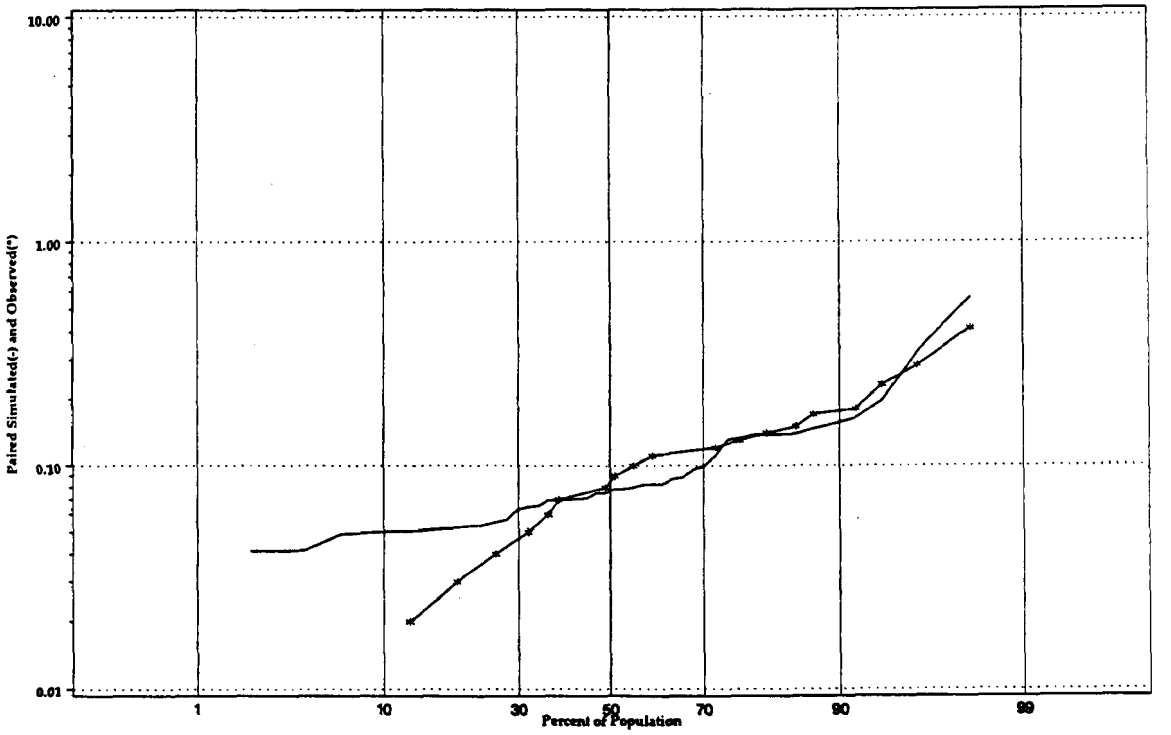
Shenadoah River at Segment 200

Actual Error versus Time

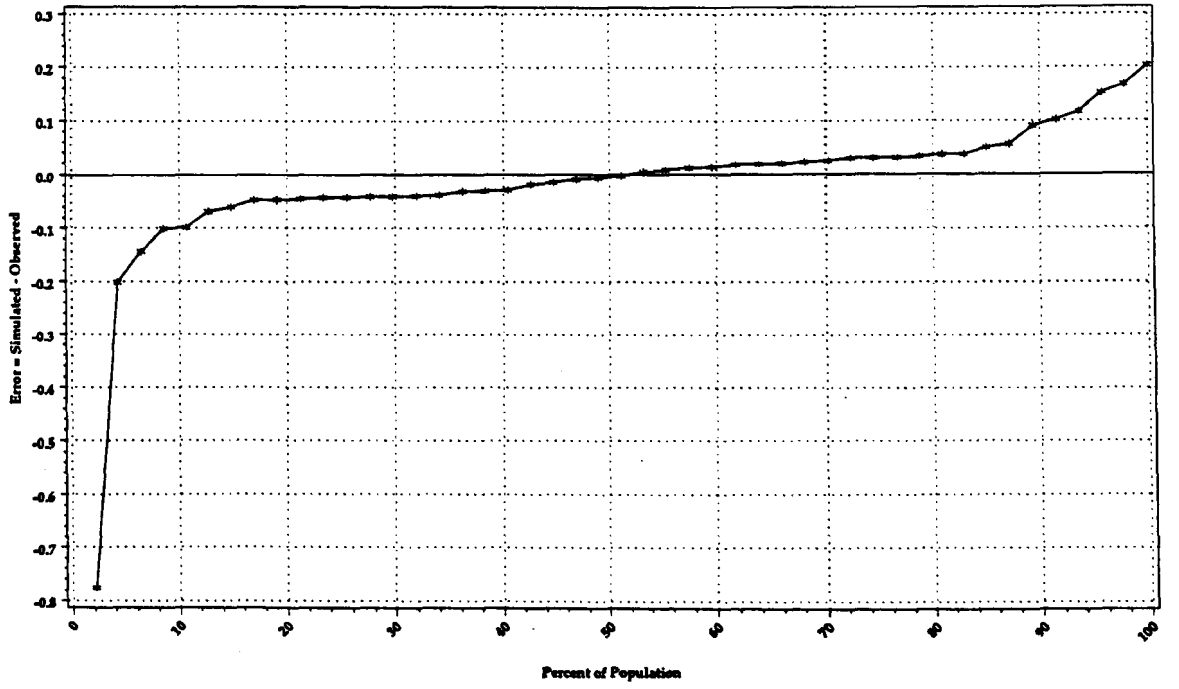
Total Phosphorus



Shenadoah River at Segment 200
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

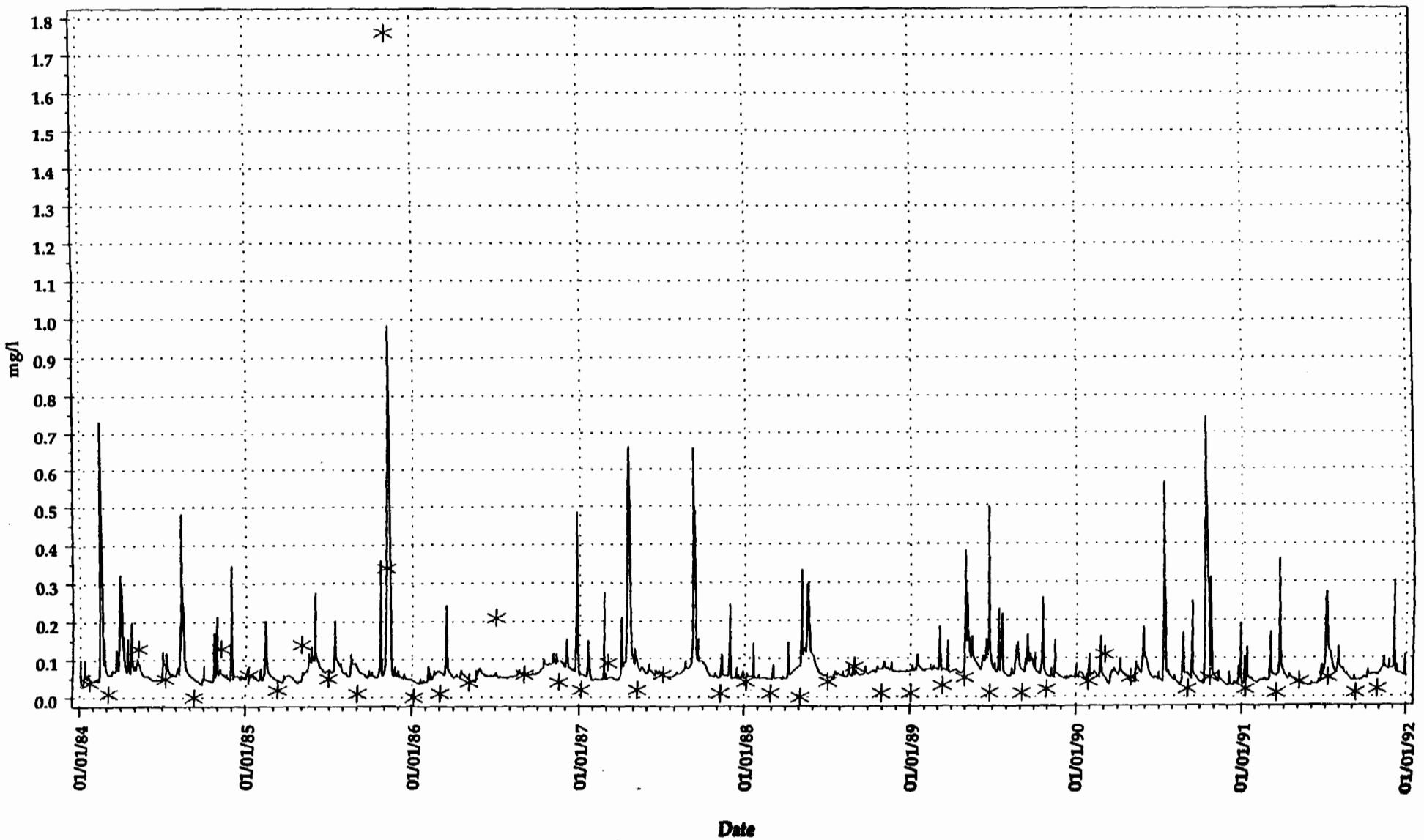


Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Shenandoah River at Segment 200
Observed and Simulated versus Time
Organic and Particulate Phosphorus

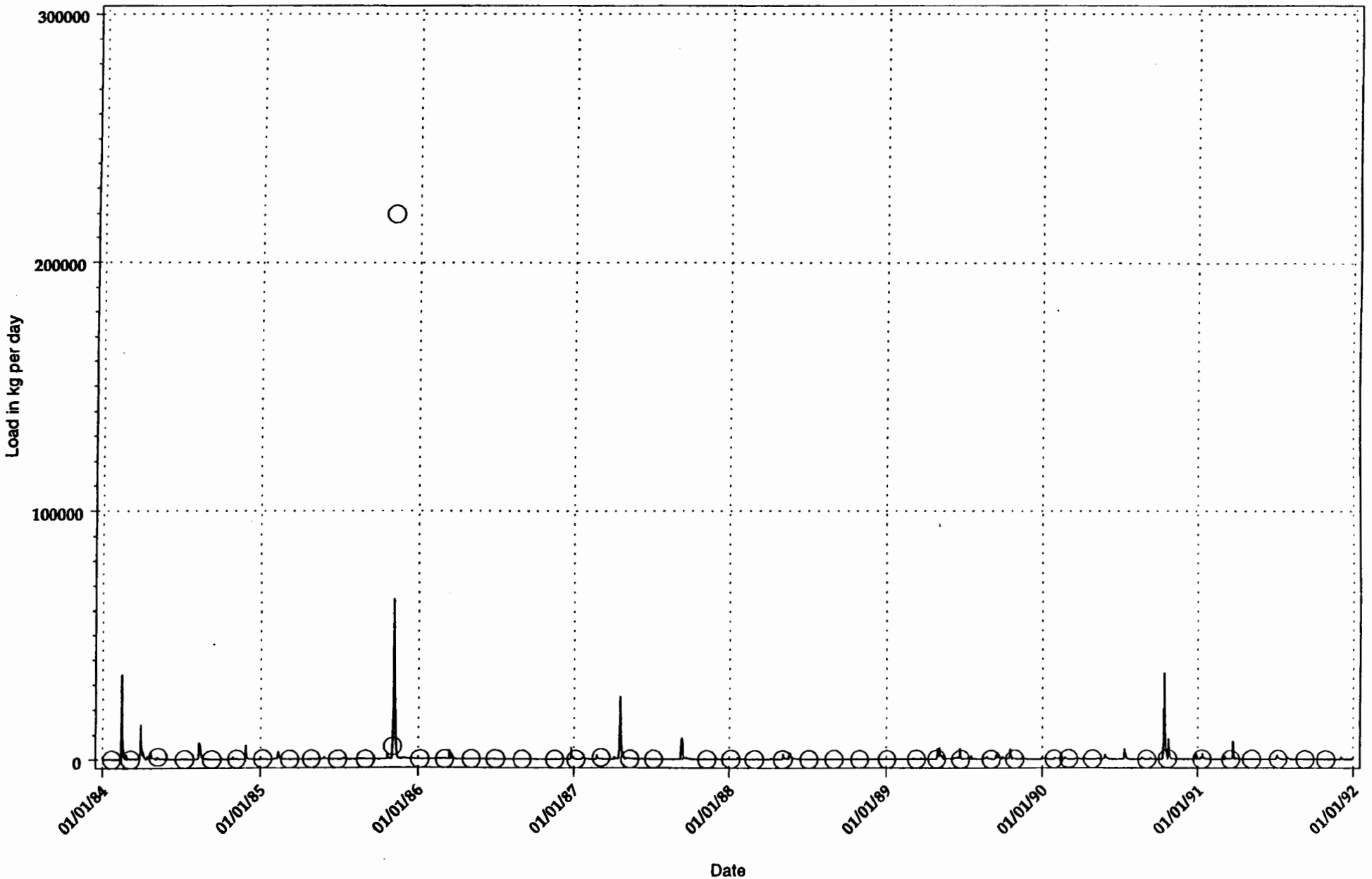
(*=Observed, -=Simulated)



Shenandoah River at Segment 200

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

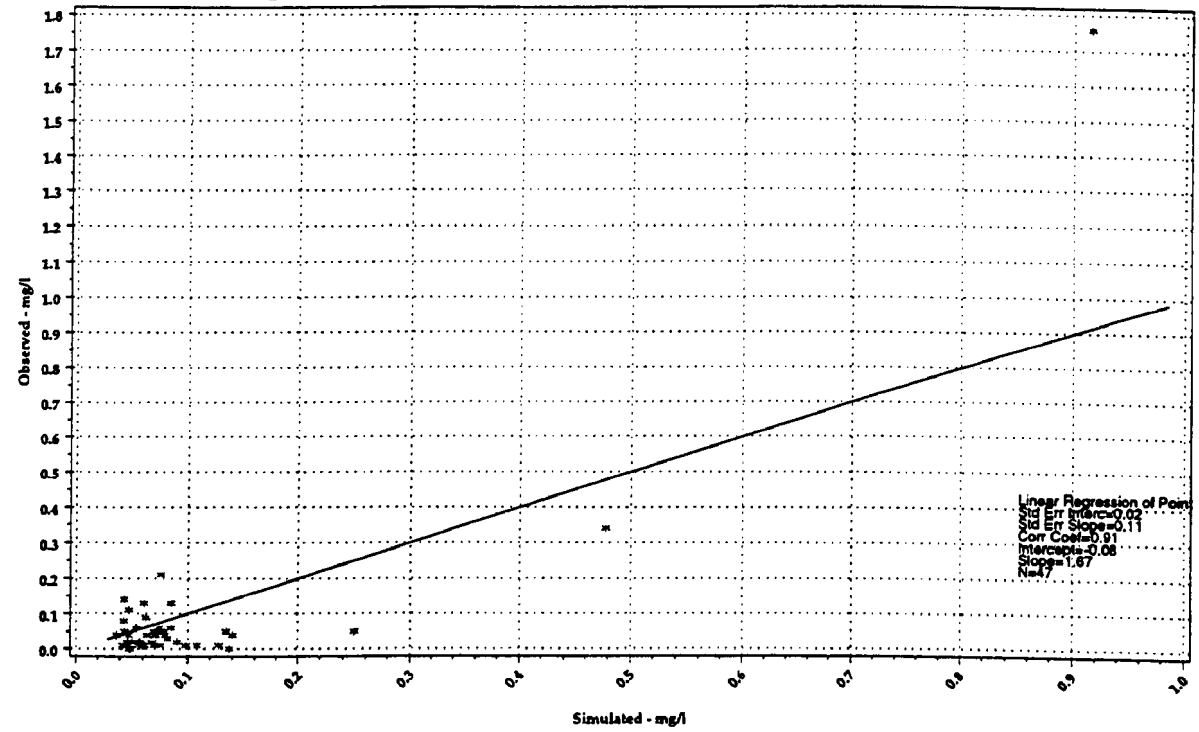


(y21_plot1.sas dataset2 jrpe.p3 james.sas) fdfles)
(graph_a.drv 25AUG97 17:40 proc reg model y=x)

Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

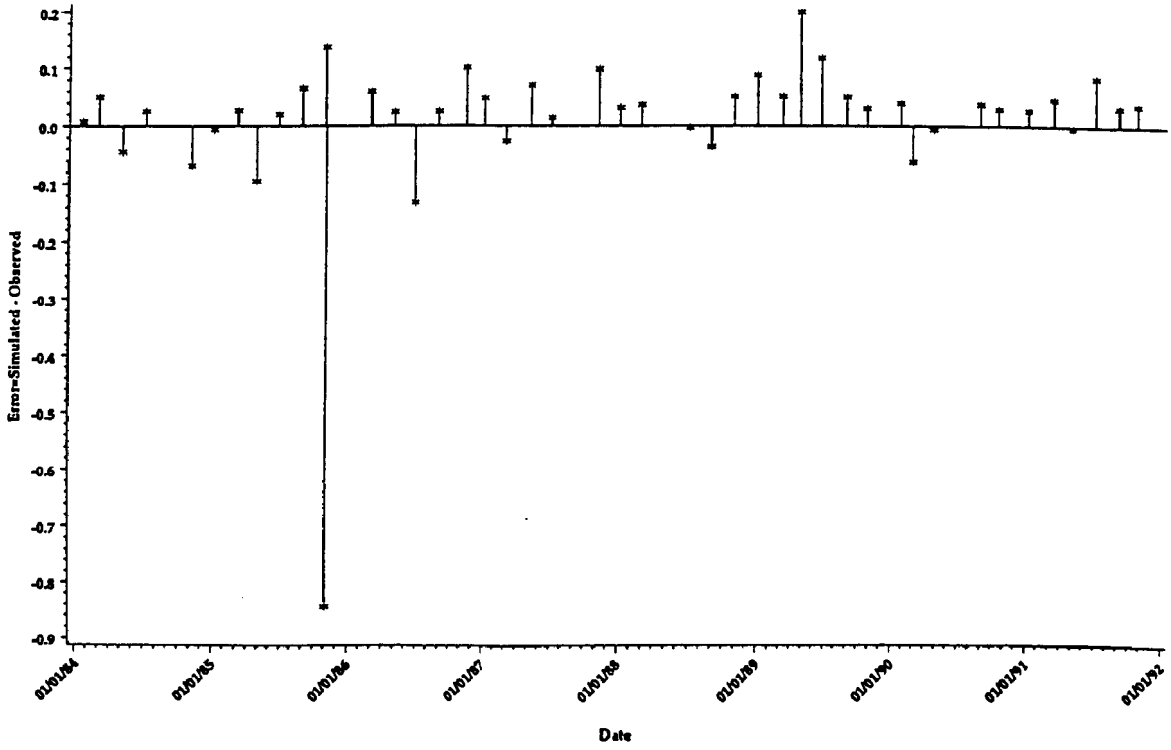
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



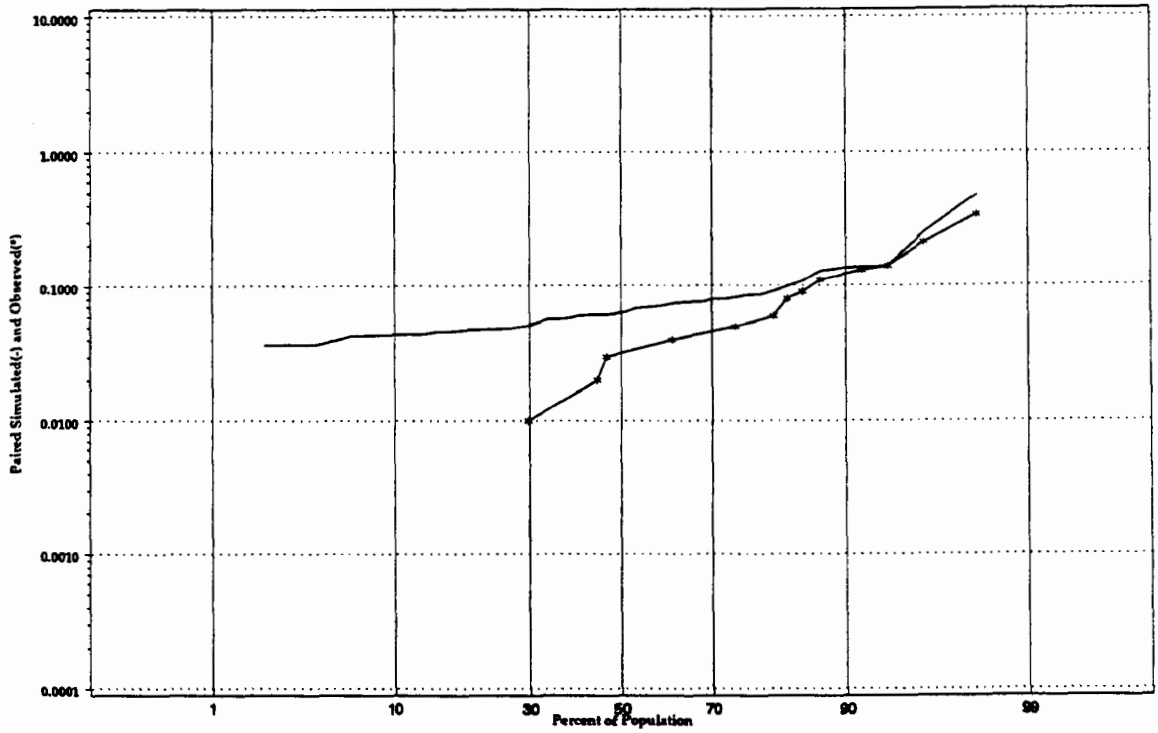
Shenadoah River at Segment 200

Actual Error versus Time

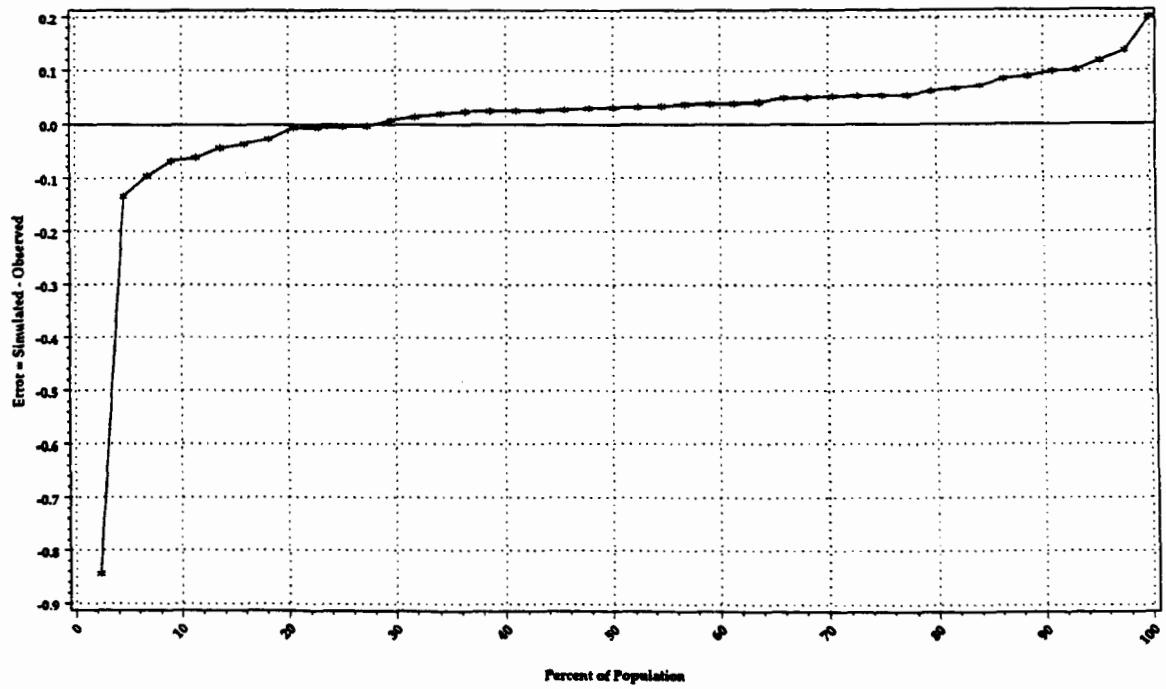
Organic and Particulate Phosphorus



Shenadoah River at Segment 200
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

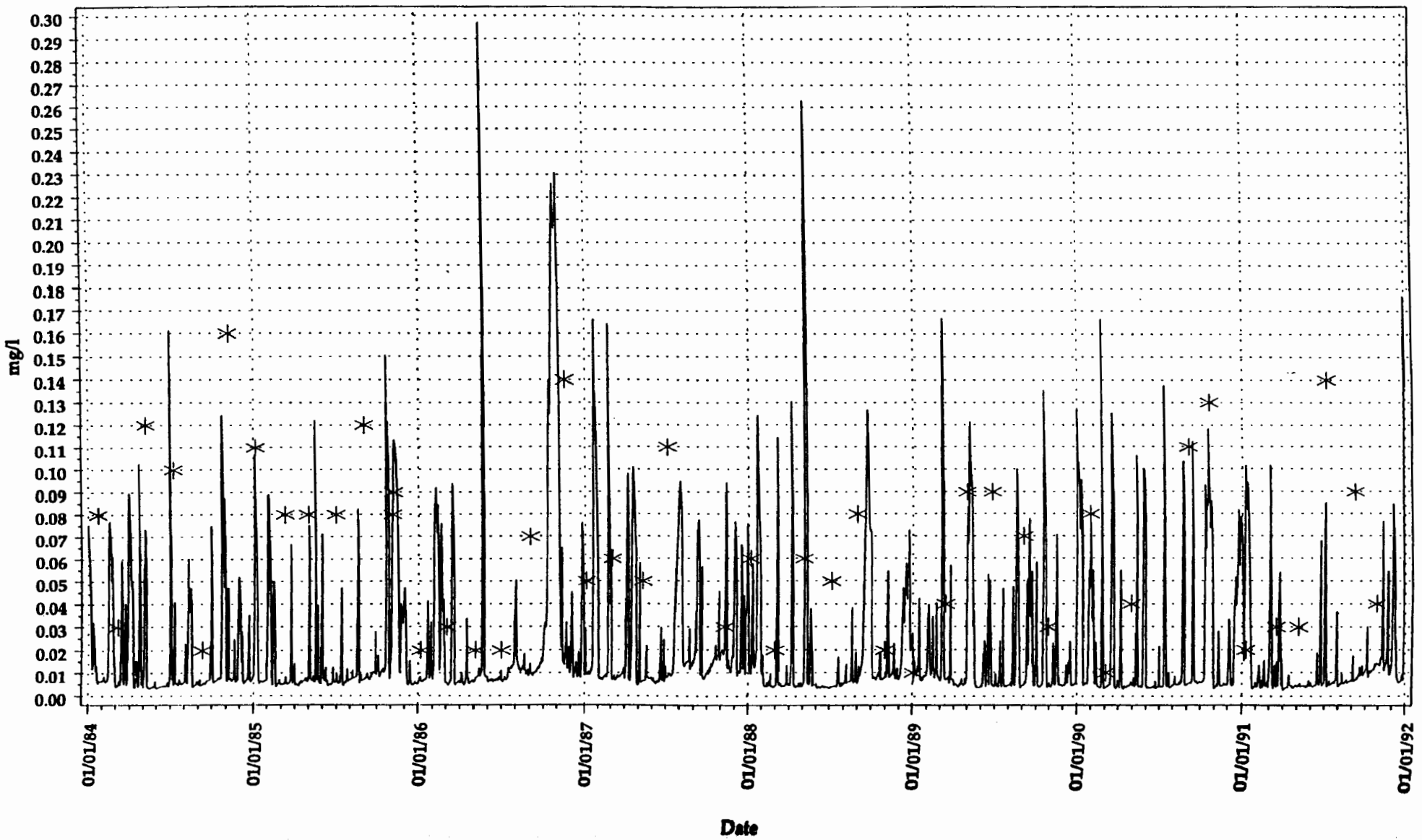


Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data



Shenadoah River at Segment 200
Observed and Simulated versus Time
Dissolved Phosphorus

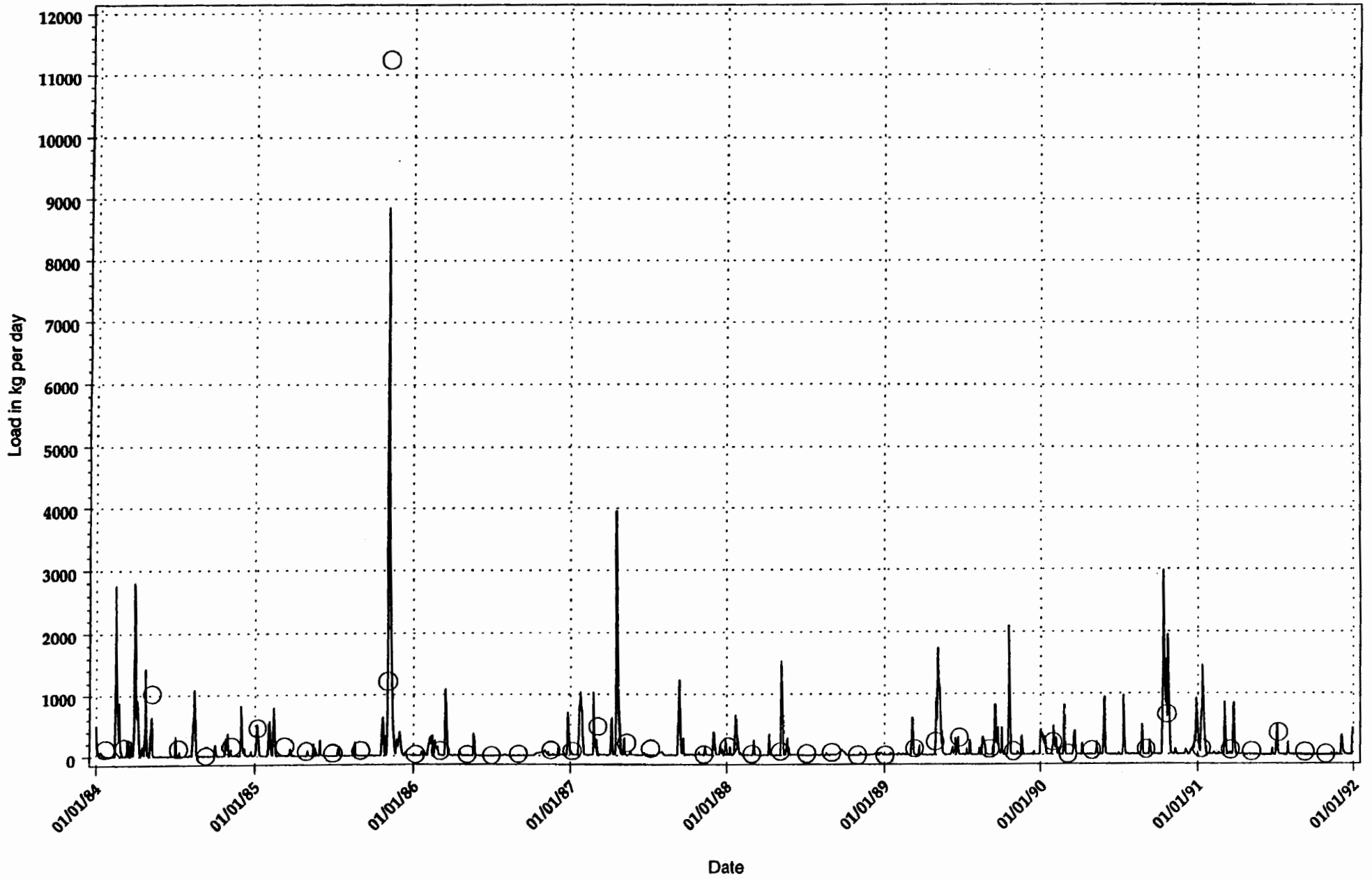
(*=Observed, -=Simulated)



Shenadoah River at Segment 200

Dissolved Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

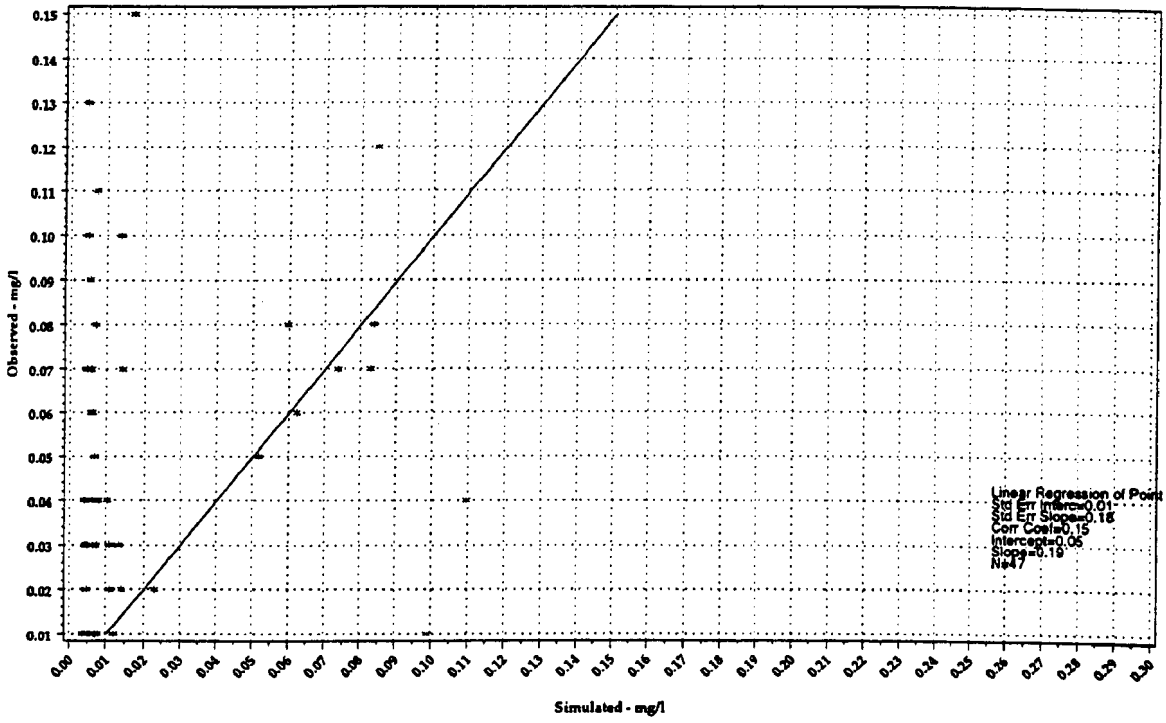


(y21_plot1.sas datastore2:[rpo.p3 james.sas] fdflas)
(sh dir 03FEB96 16:38,proc reg,model y=x)

Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

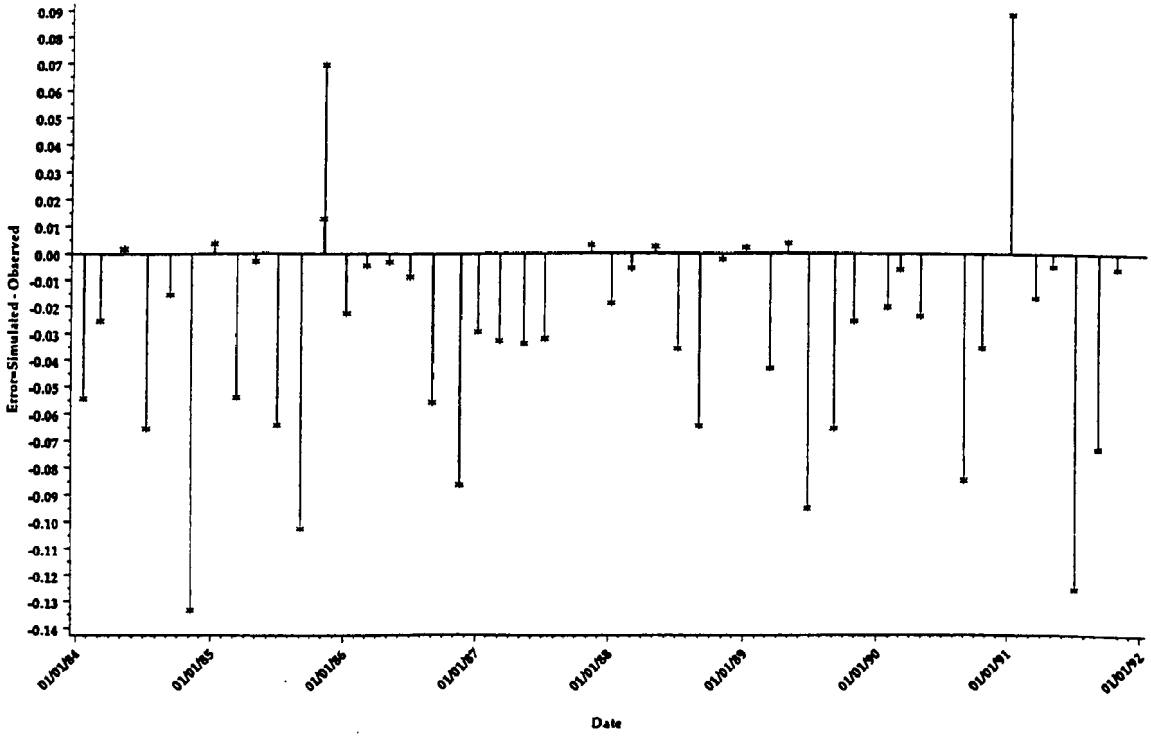
Dissolved Phosphorus: 01JAN84 - 01JAN92



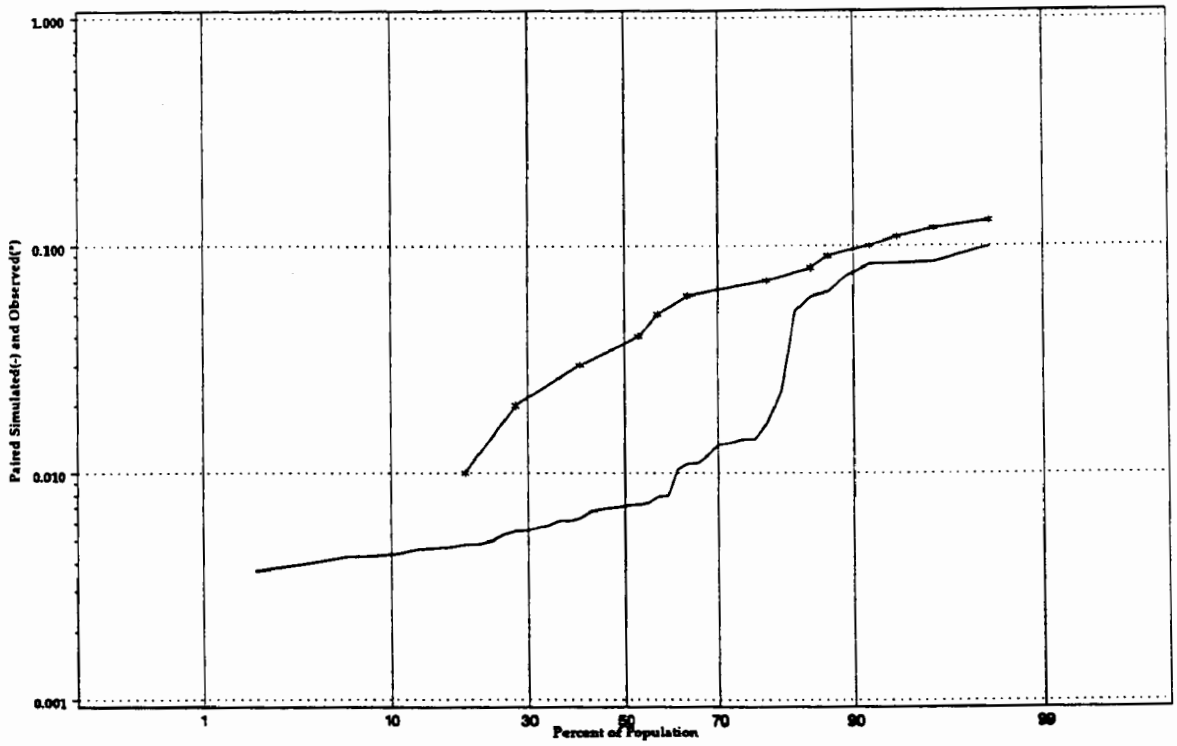
Shenadoah River at Segment 200

Actual Error versus Time

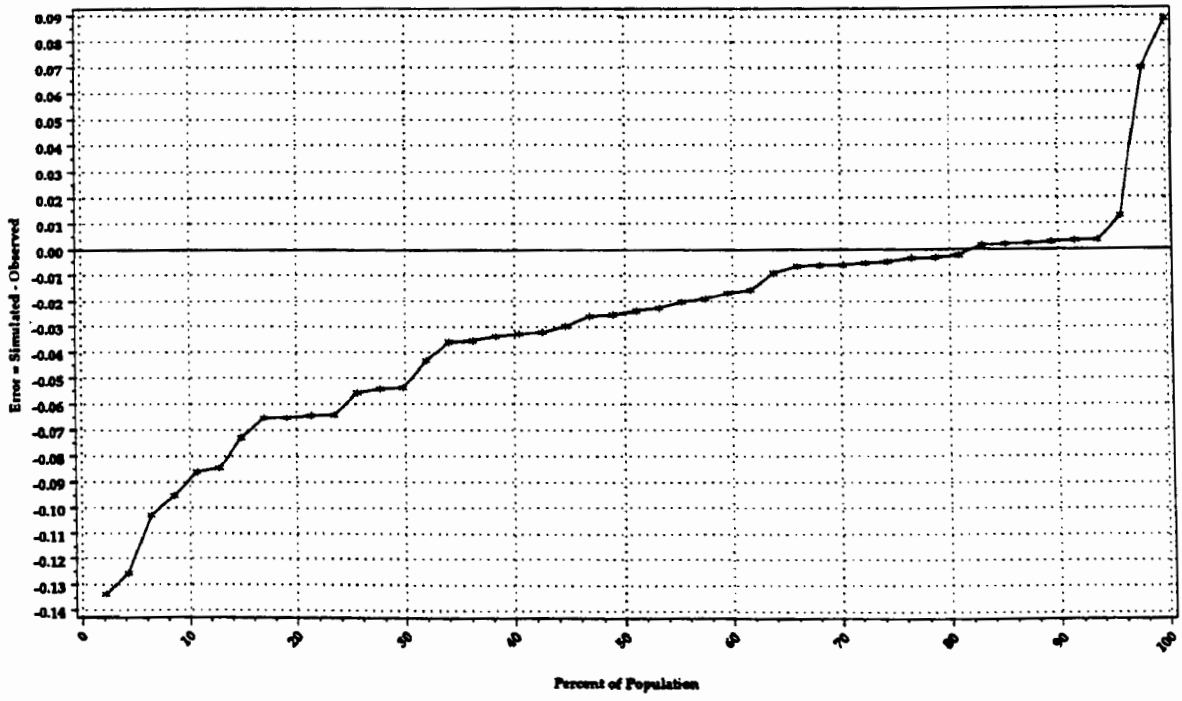
Dissolved Phosphorus



Shenadoah River at Segment 200
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

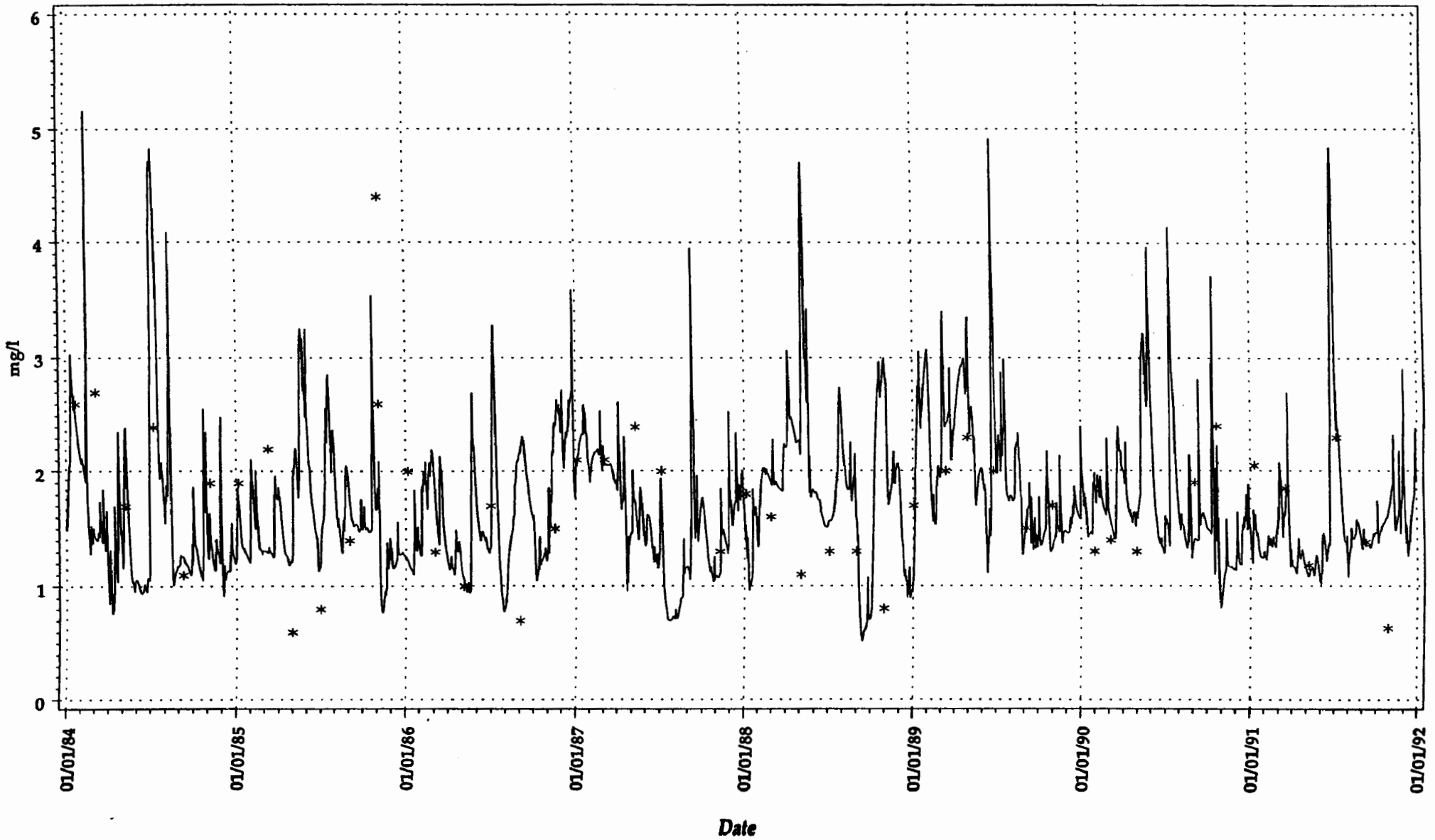


Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data

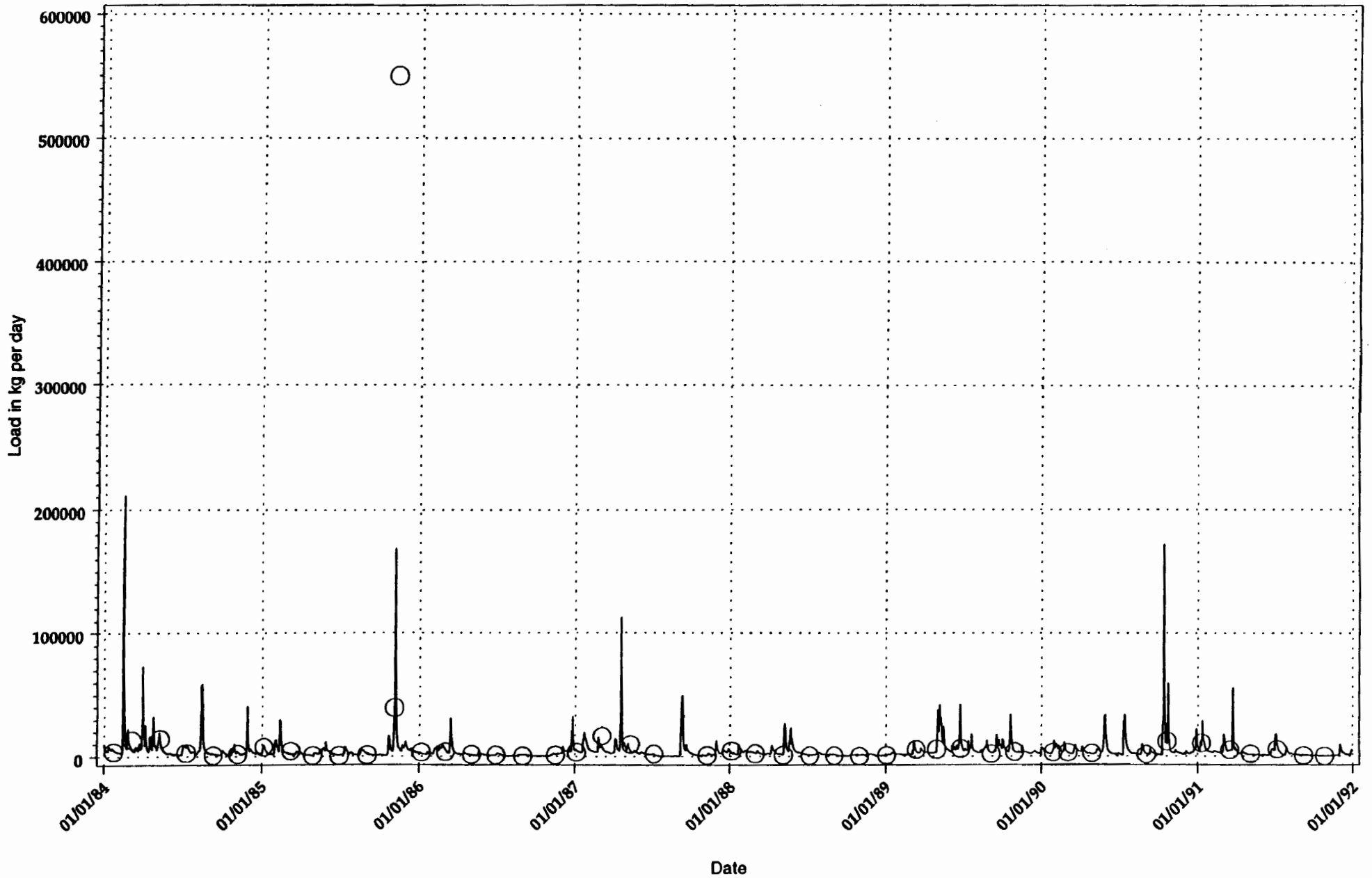


Shenadoah River at Segment 200
Observed and Simulated versus Time
Total Nitrogen

(*=Observed, -=Simulated)



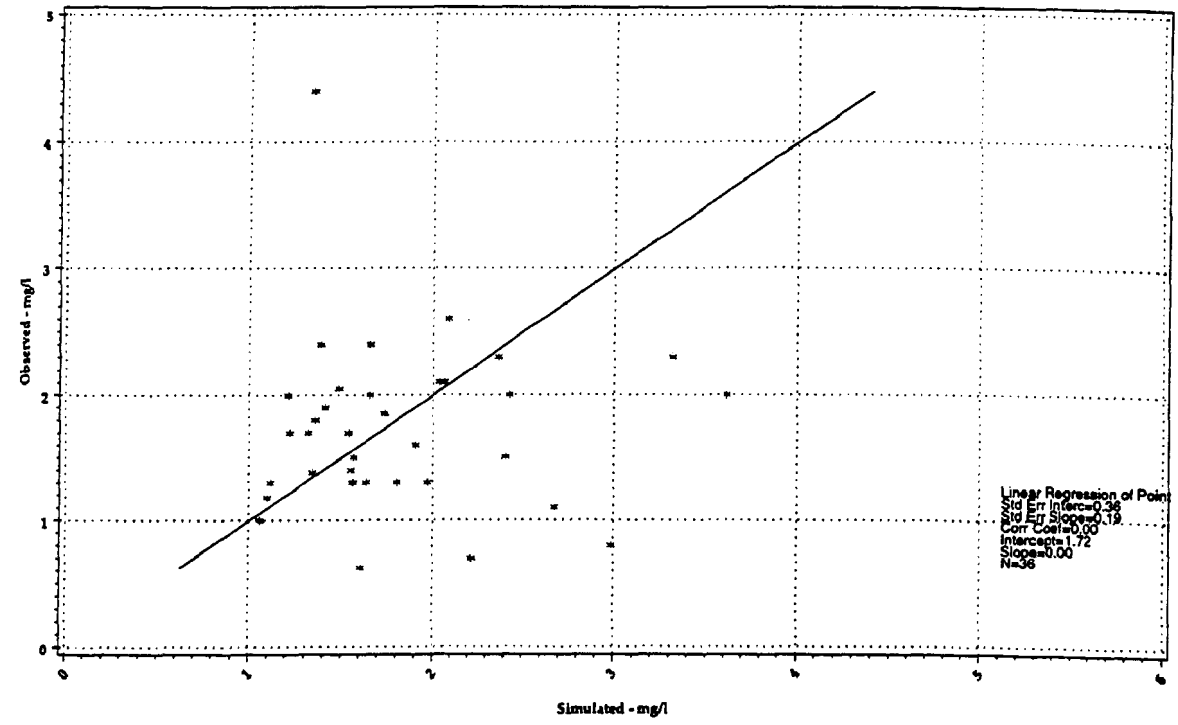
Shenadoah River at Segment 200
Total Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plot1.sas datastore2:[npo.p3.james.sas] fdfiles)
(sh.drv 03FEB98 15:36,proc reg,model y=x)

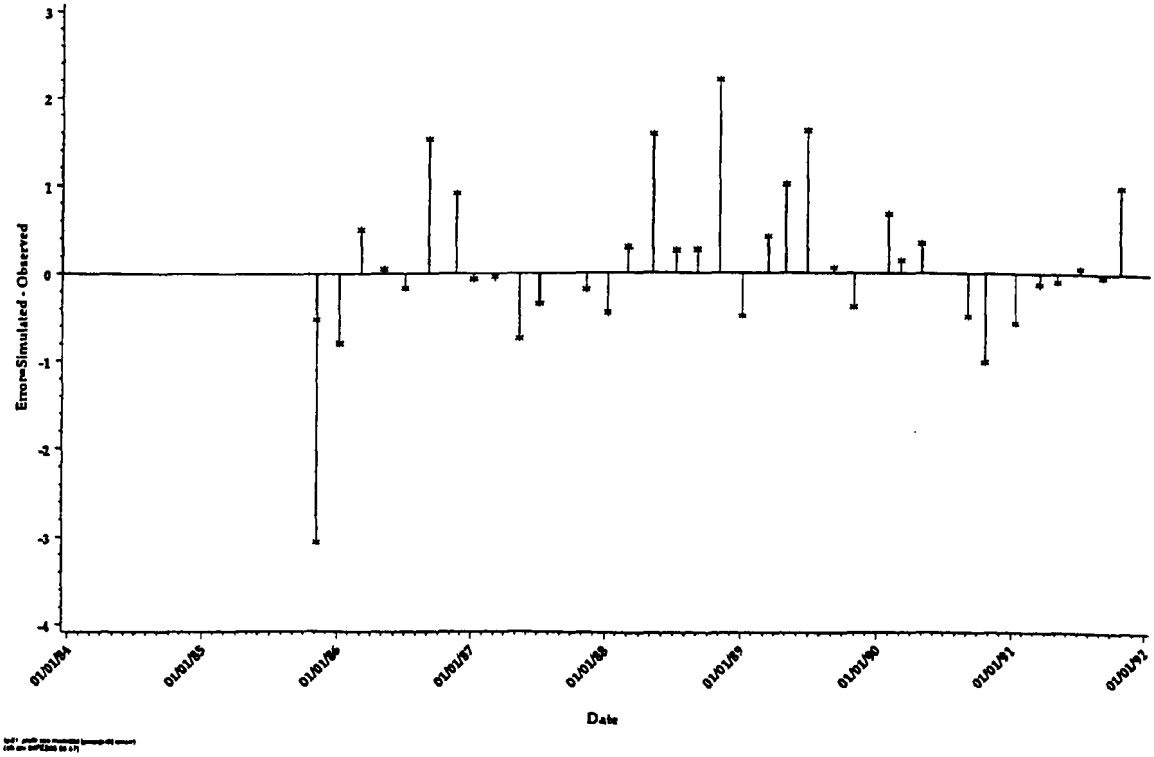
Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Nitrogen: 01JAN84 - 01JAN92

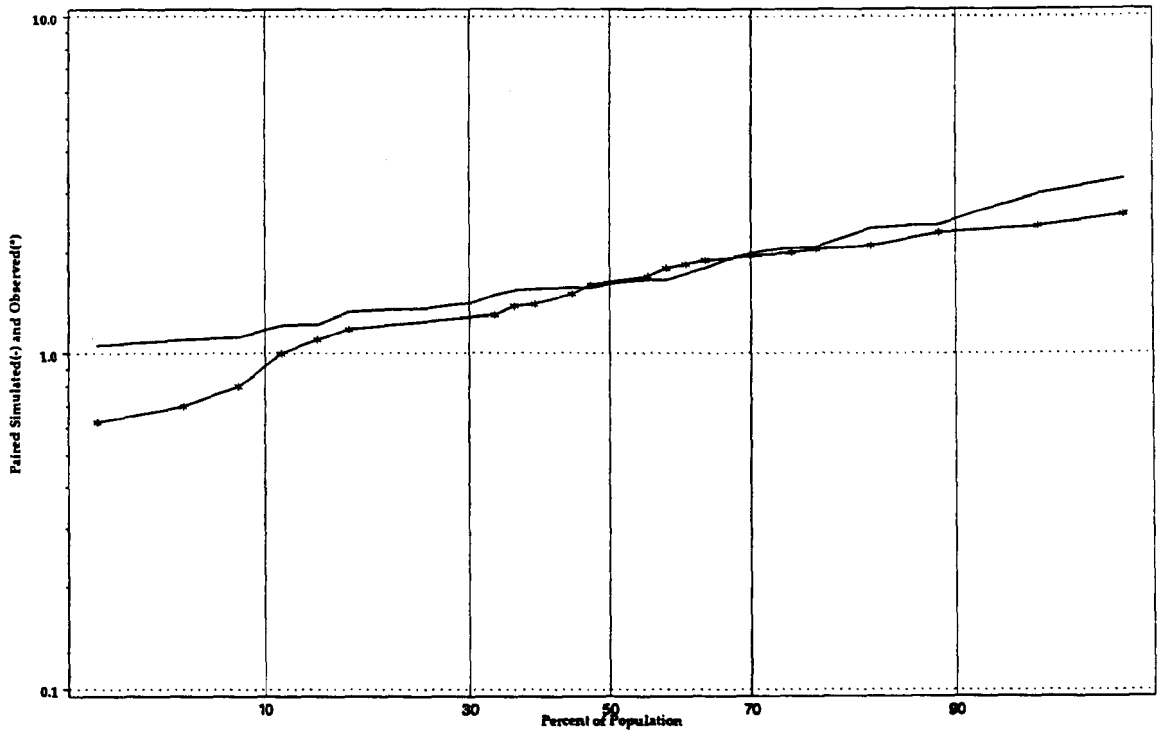


Shenadoah River at Segment 200

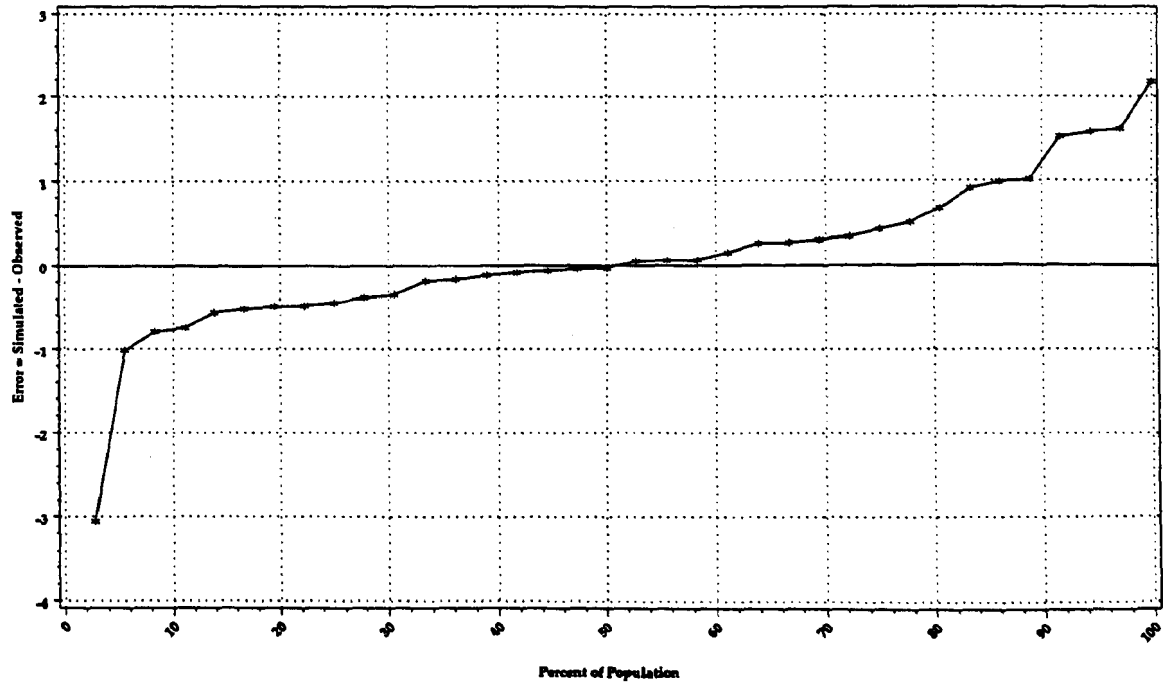
Actual Error versus Time
Total Nitrogen



Shenadoah River at Segment 200
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

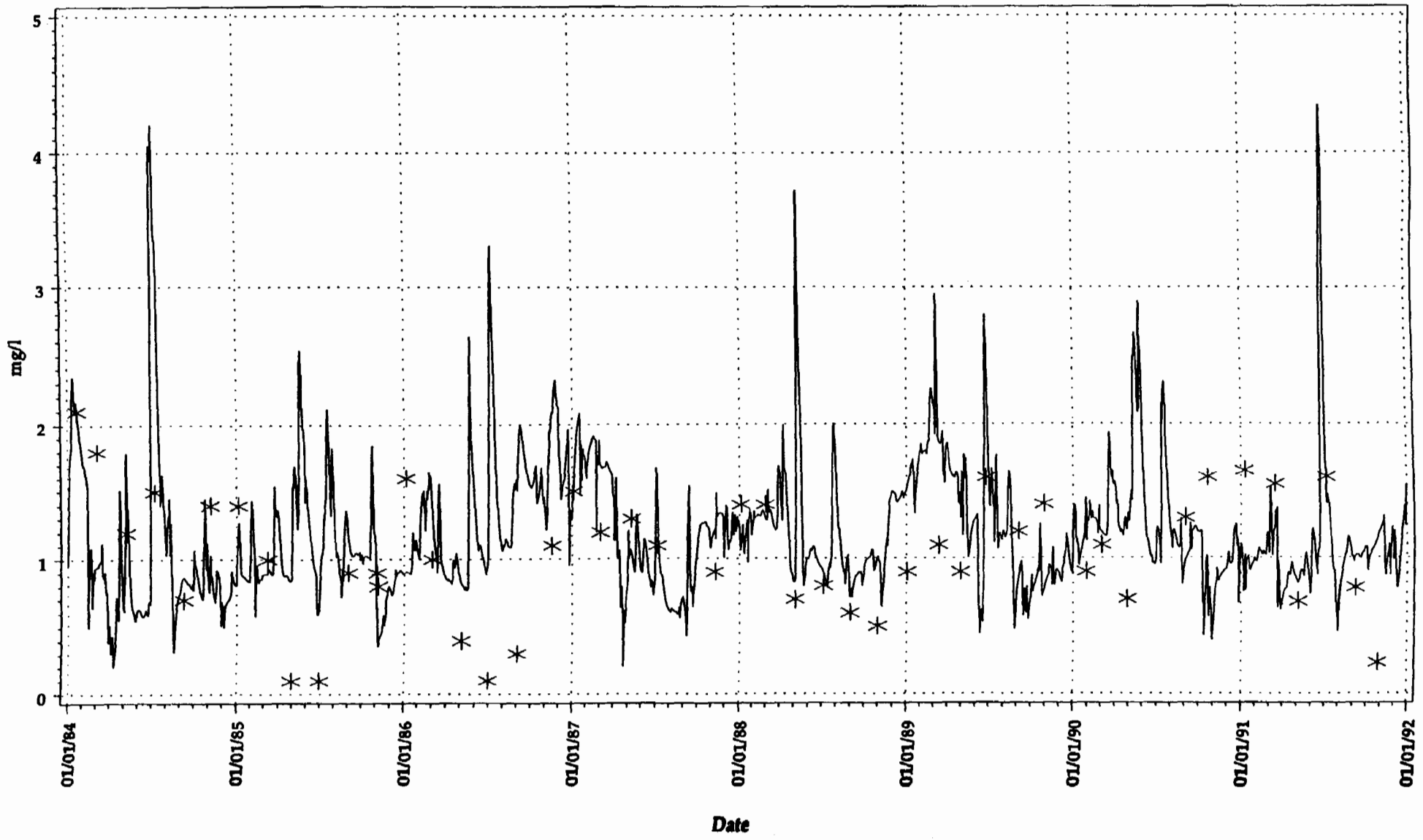


Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data

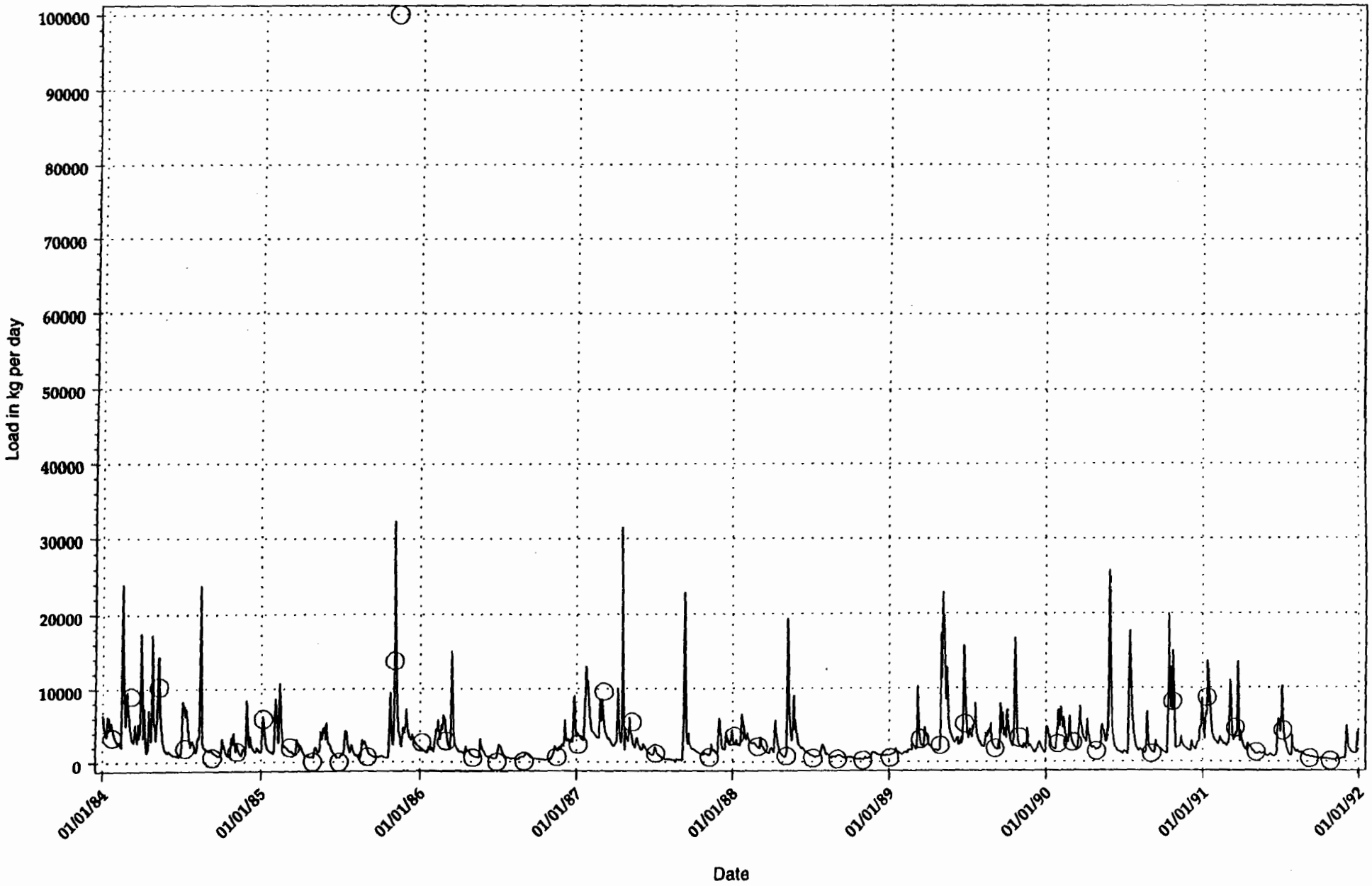


Shenandoah River at Segment 200
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



Shenandoah River at Segment 200
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

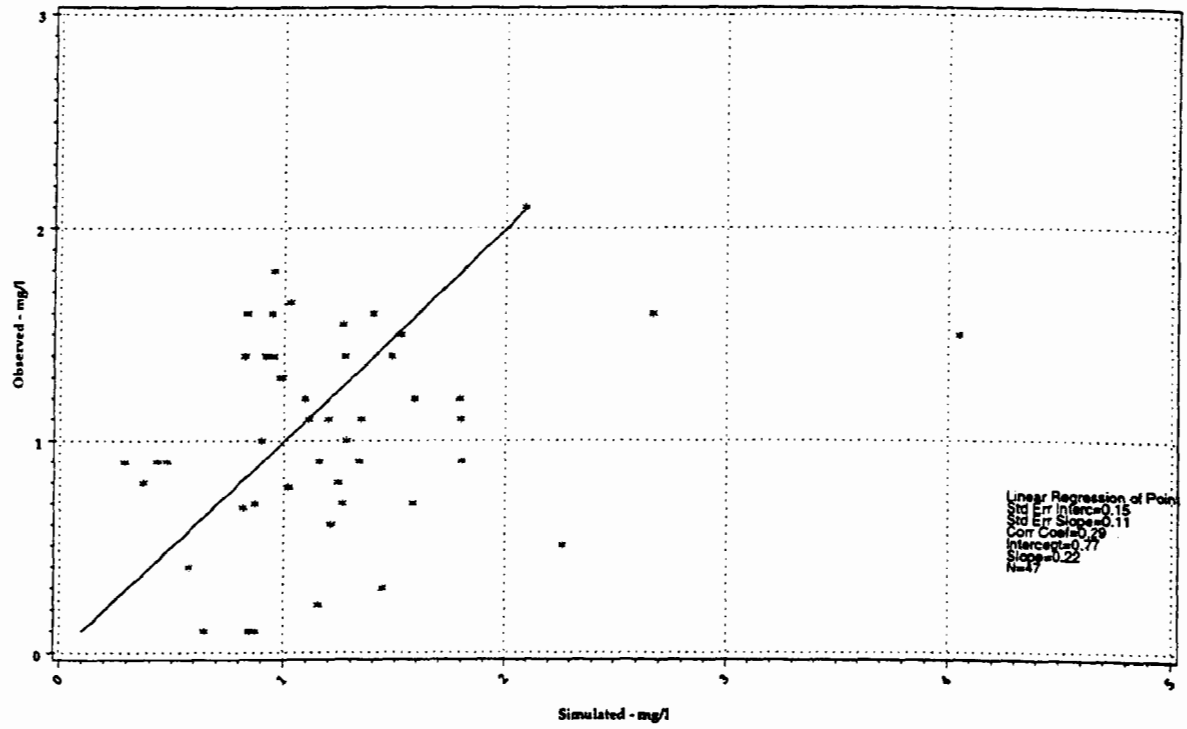


(y21_plot1.sas datastore2:[nps.p3.james.sas] 9dflars)
(graph_a.dev 25AUG97 17:40 proc reg,model y=x)

Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

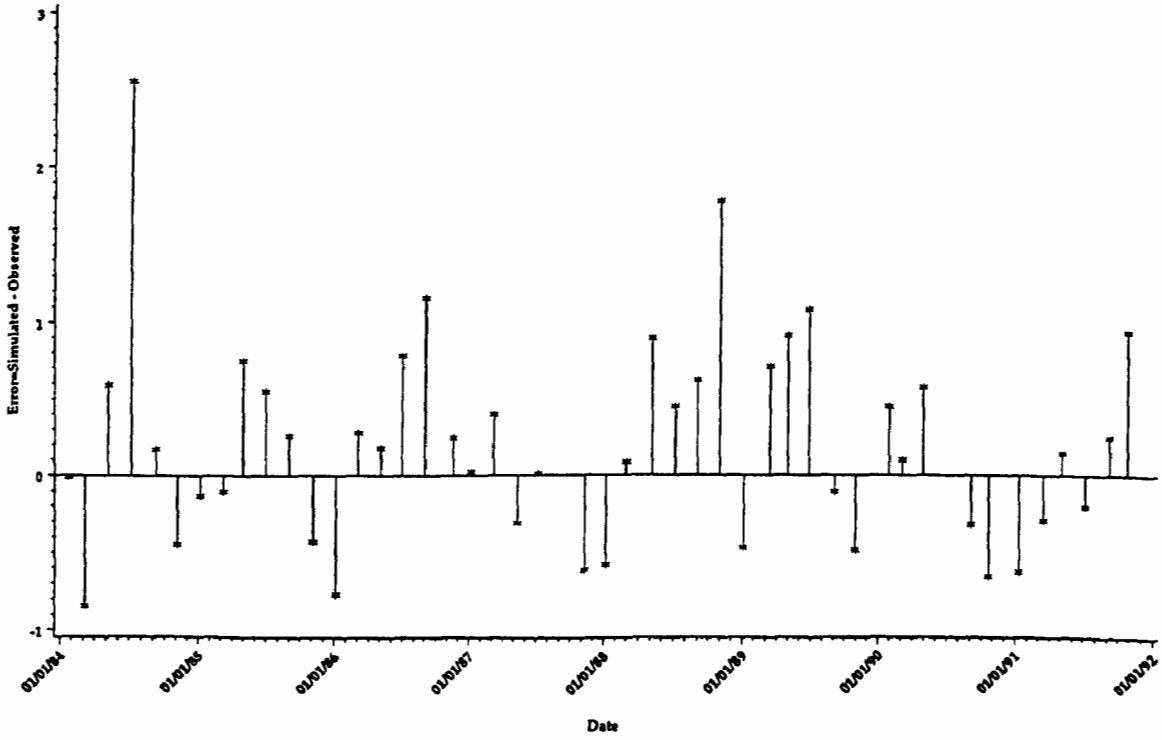
NO3: 01JAN84 - 01JAN92



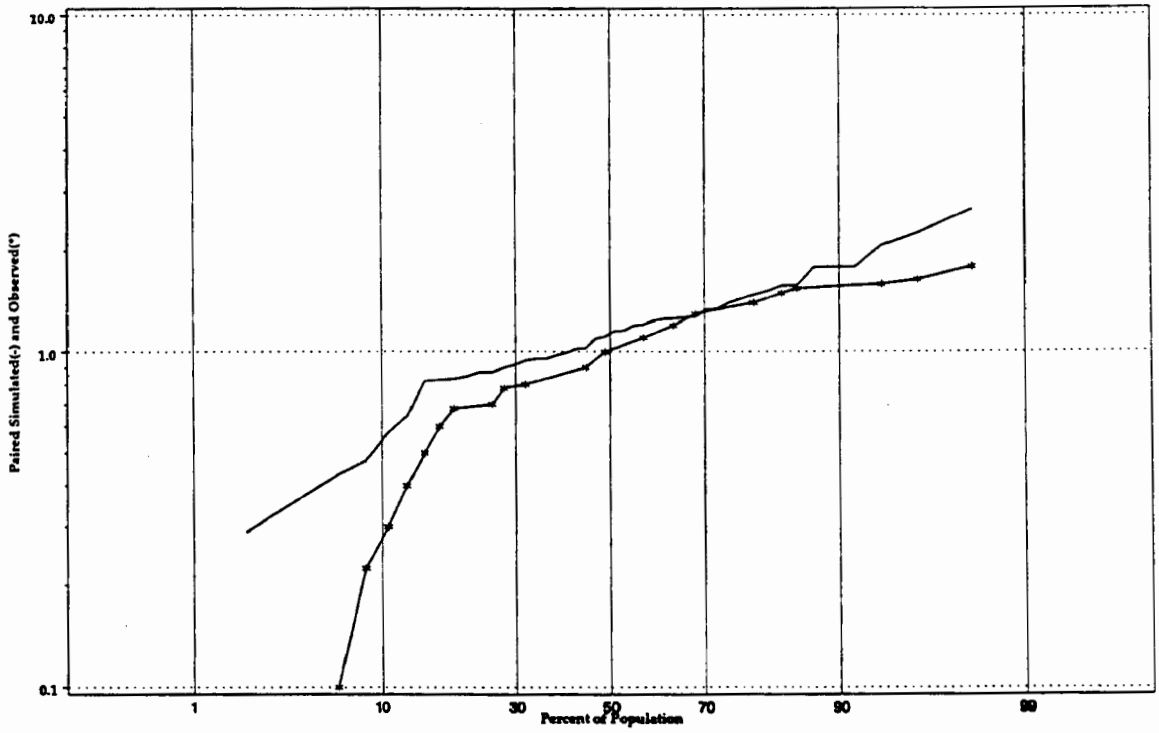
Shenadoah River at Segment 200

Actual Error versus Time

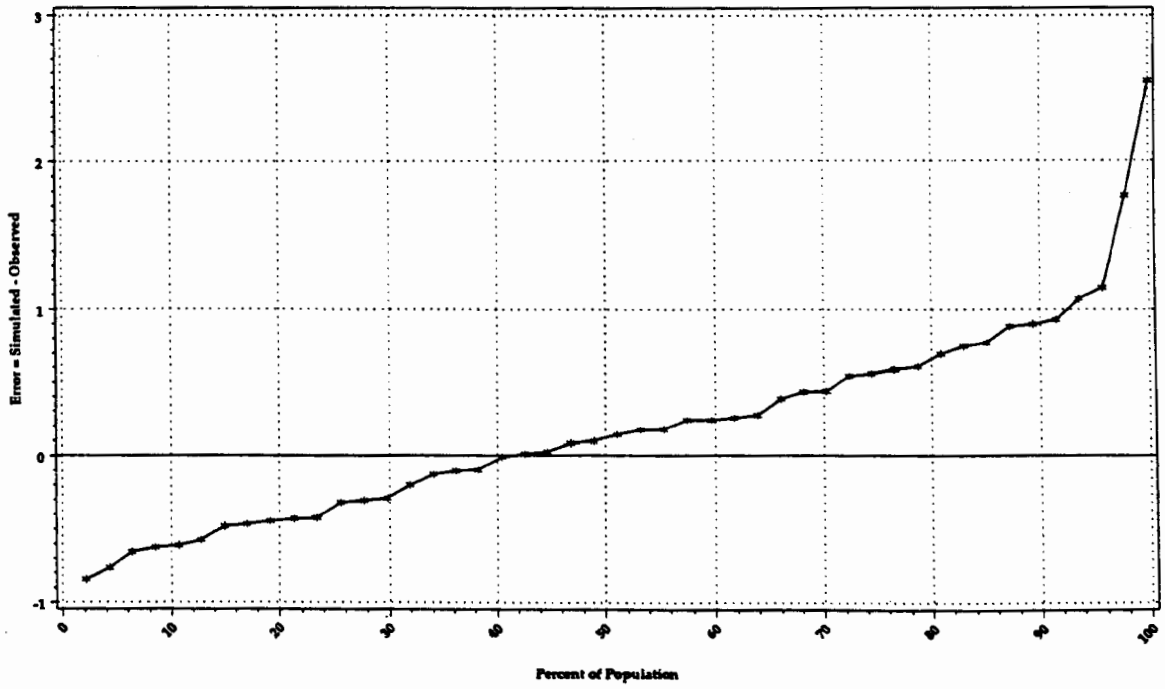
NO3



Shenadoah River at Segment 200
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

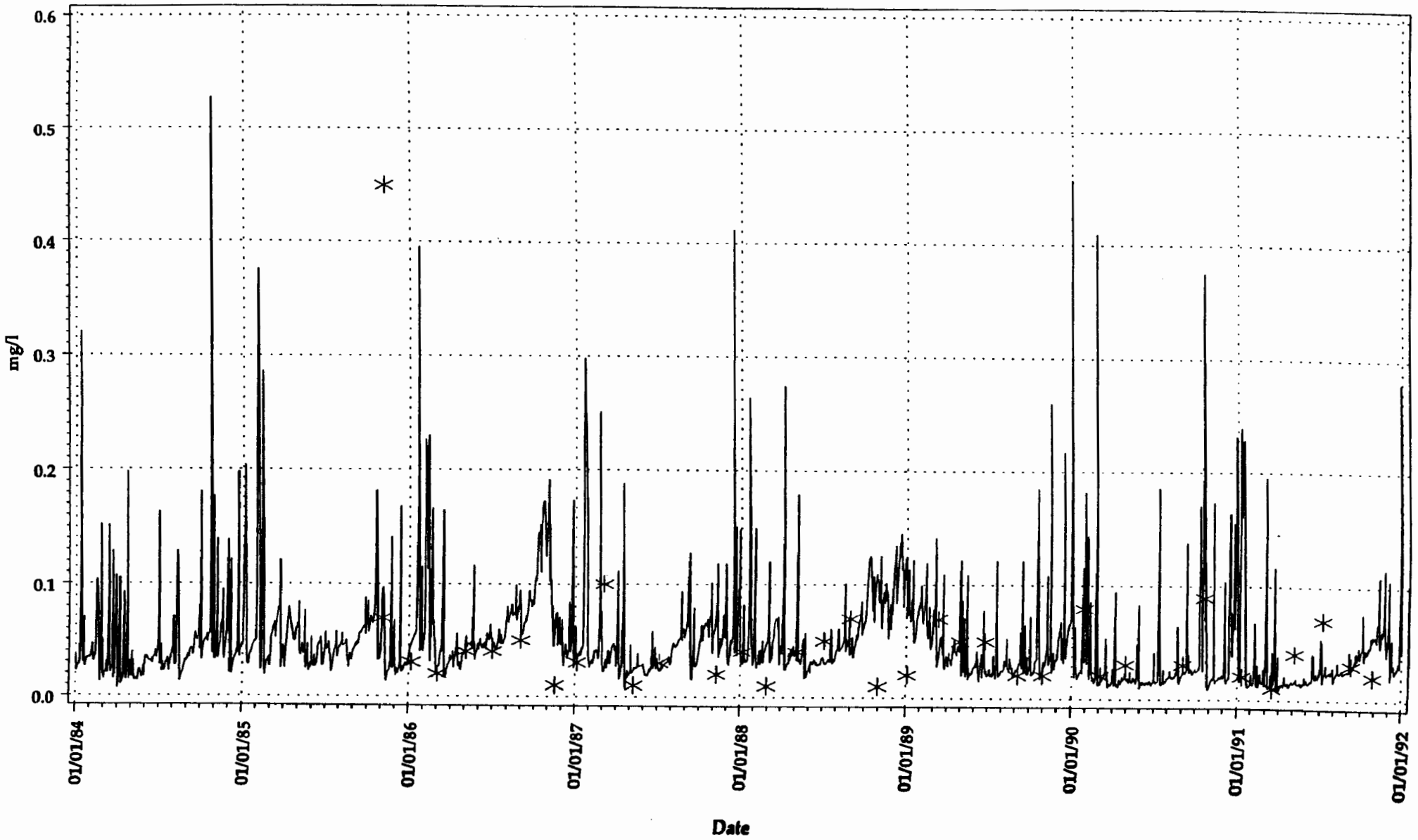


Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data

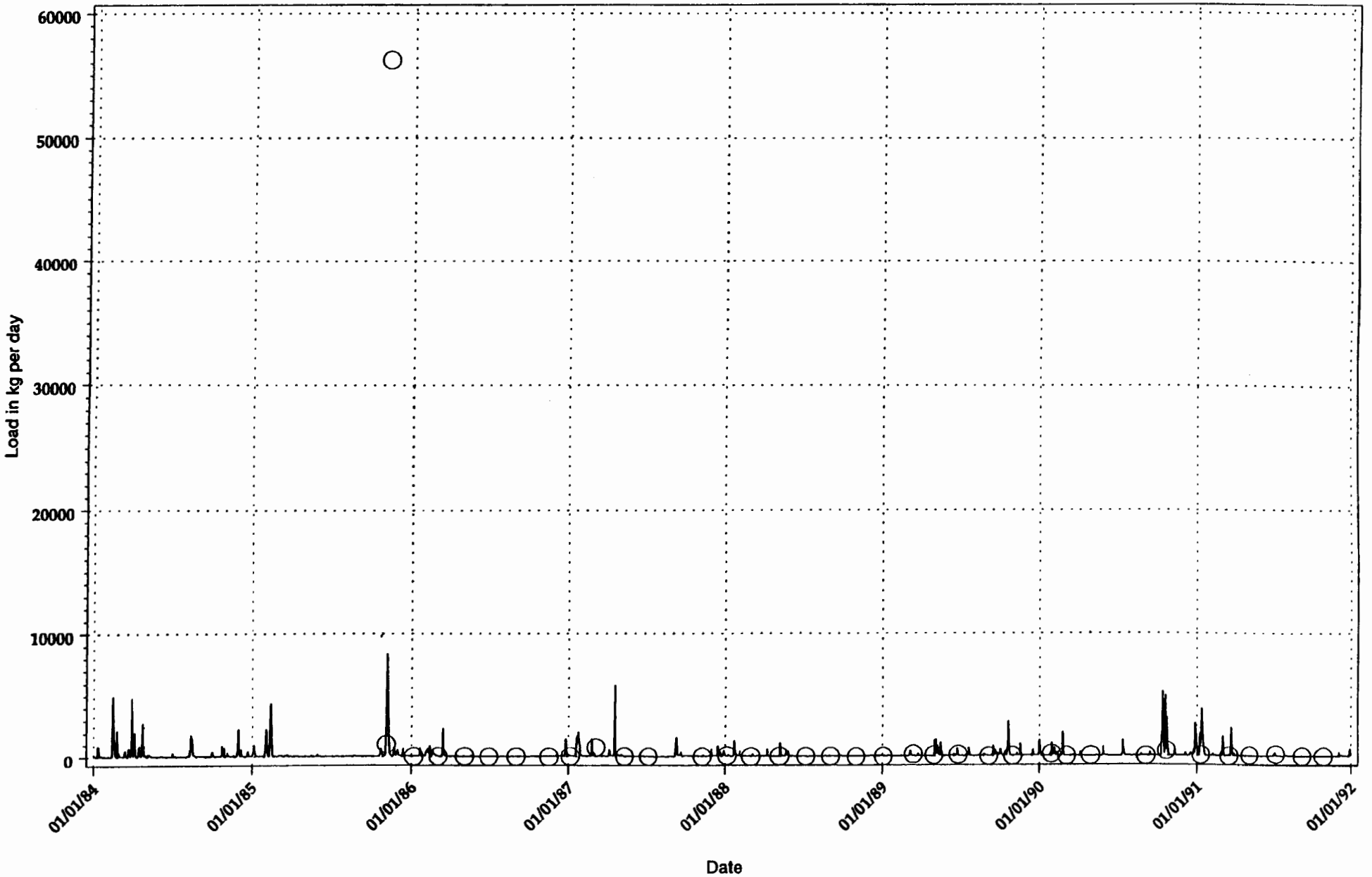


Shenandoah River at Segment 200
Observed and Simulated versus Time
Total Ammonia

(*=Observed, -=Simulated)



Shenandoah River at Segment 200
Total Ammonia Observed and Simulated Load vs Time
(line = simulated, O = observed)

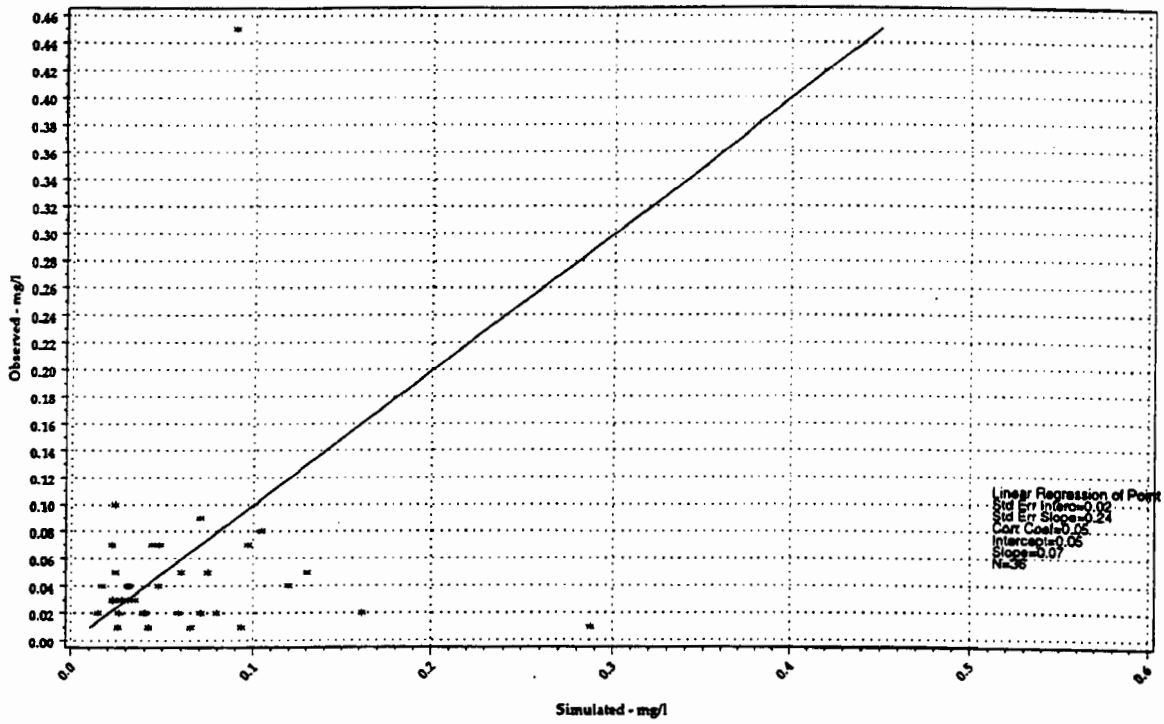


(y21_plot1.sas datastore2:jrgp.p3 james.sas) fdflos)
(graph_a.drv 25AUG97 17:40 proc reg model y=x)

Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

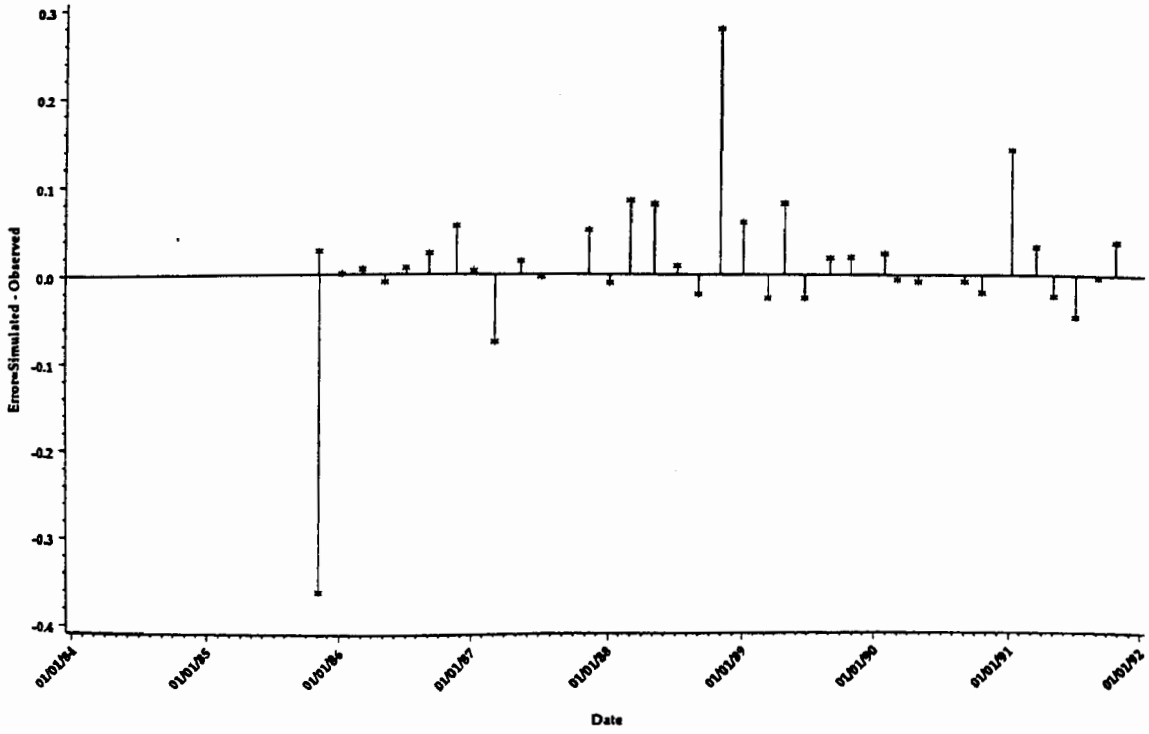
Total Ammonia: 01JAN84 - 01JAN92



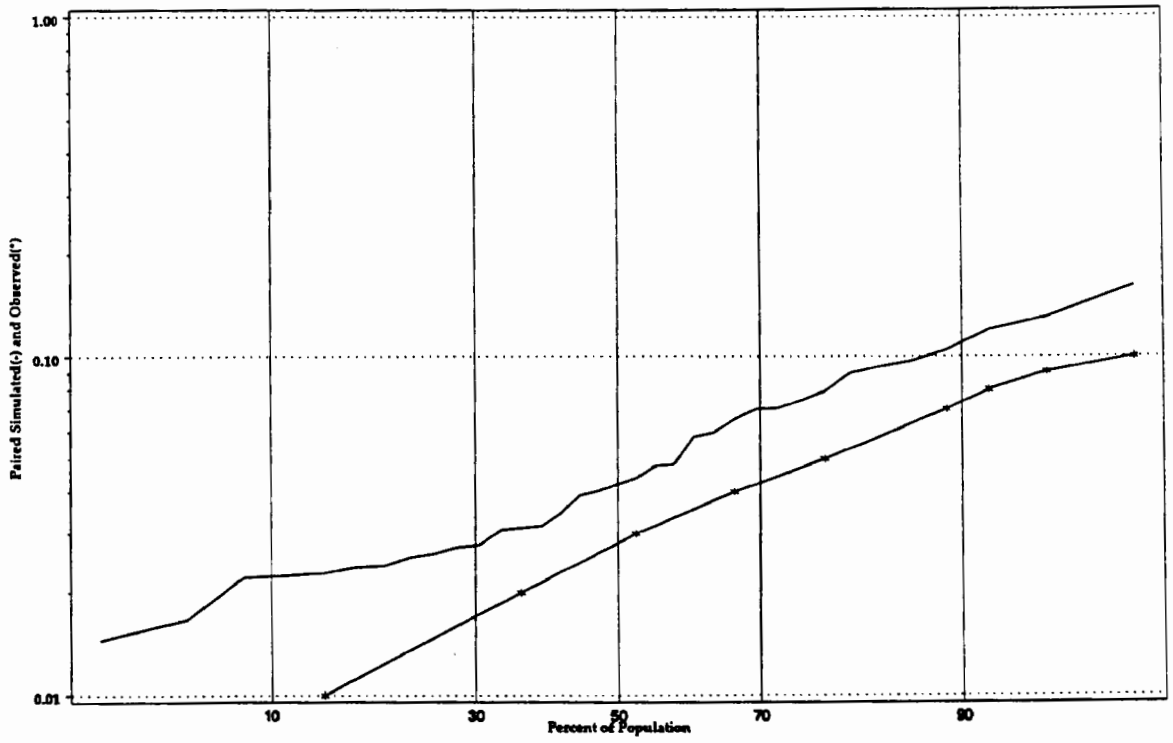
Shenadoah River at Segment 200

Actual Error versus Time

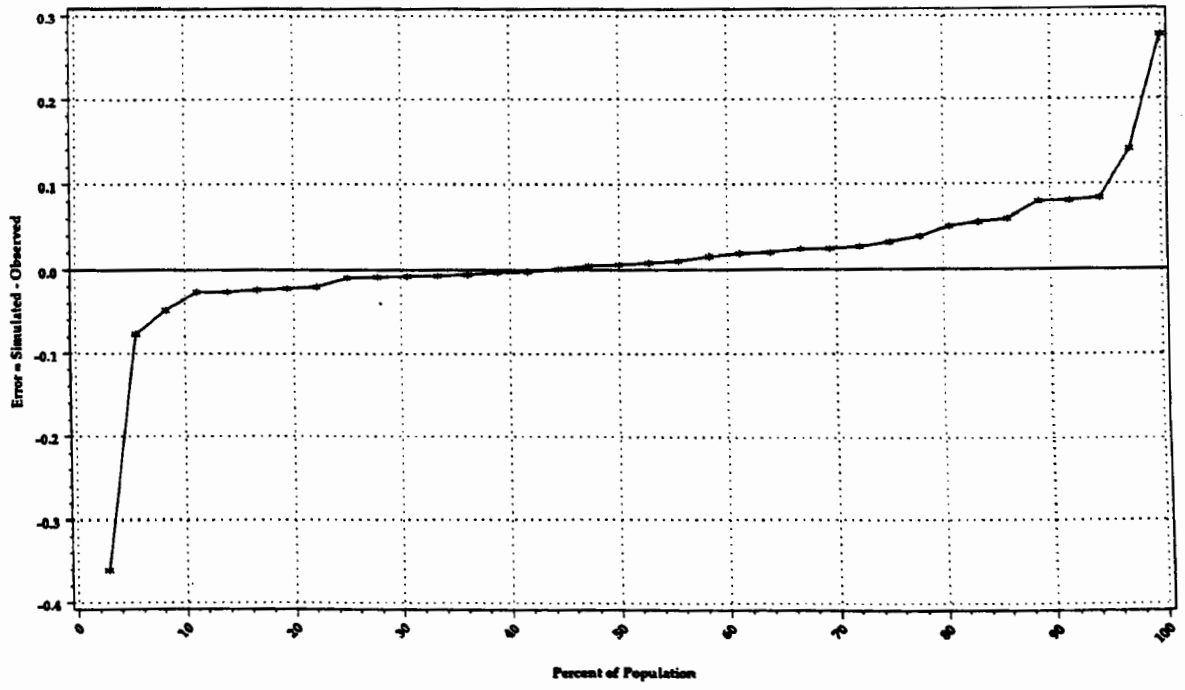
Total Ammonia



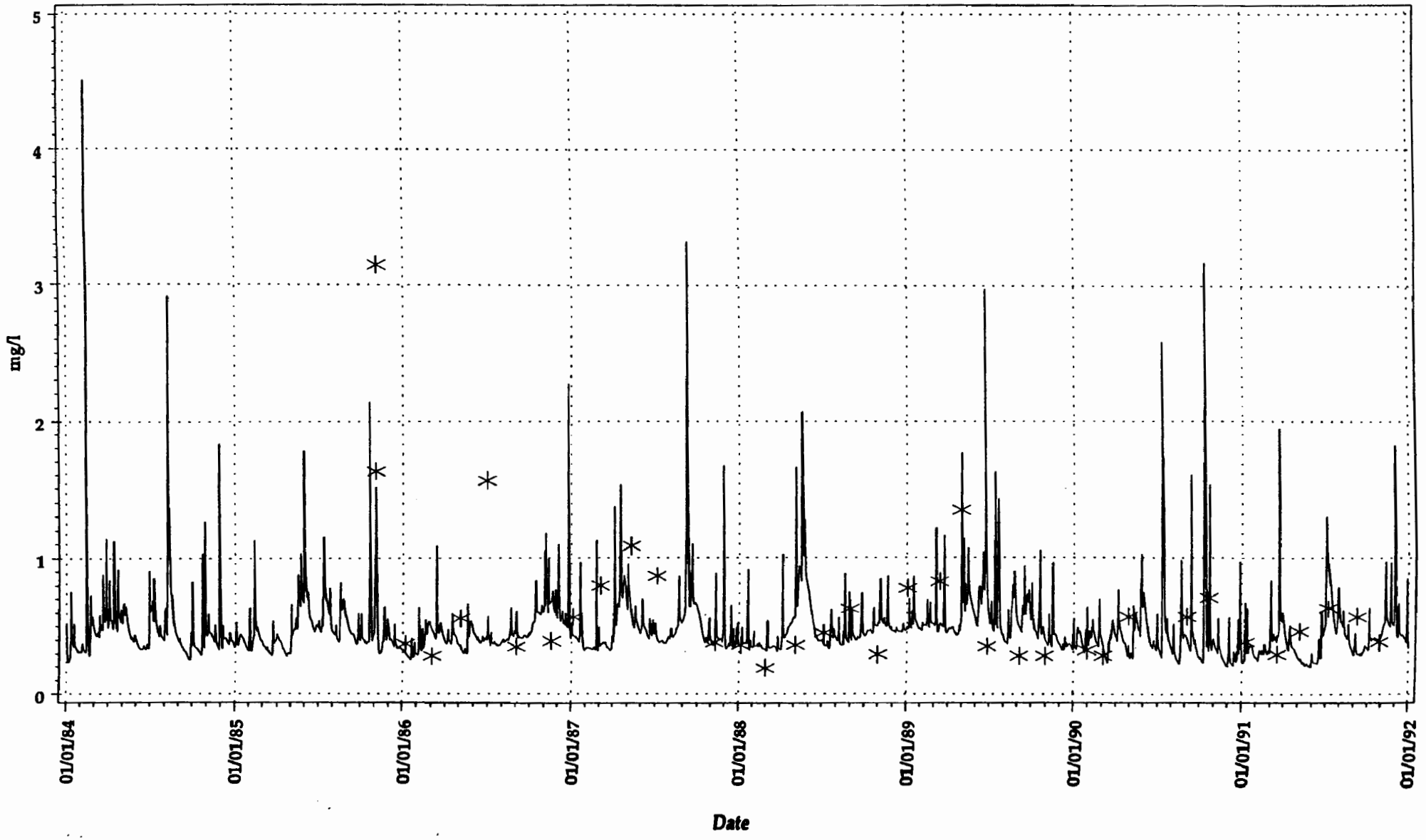
Shenadoah River at Segment 200
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



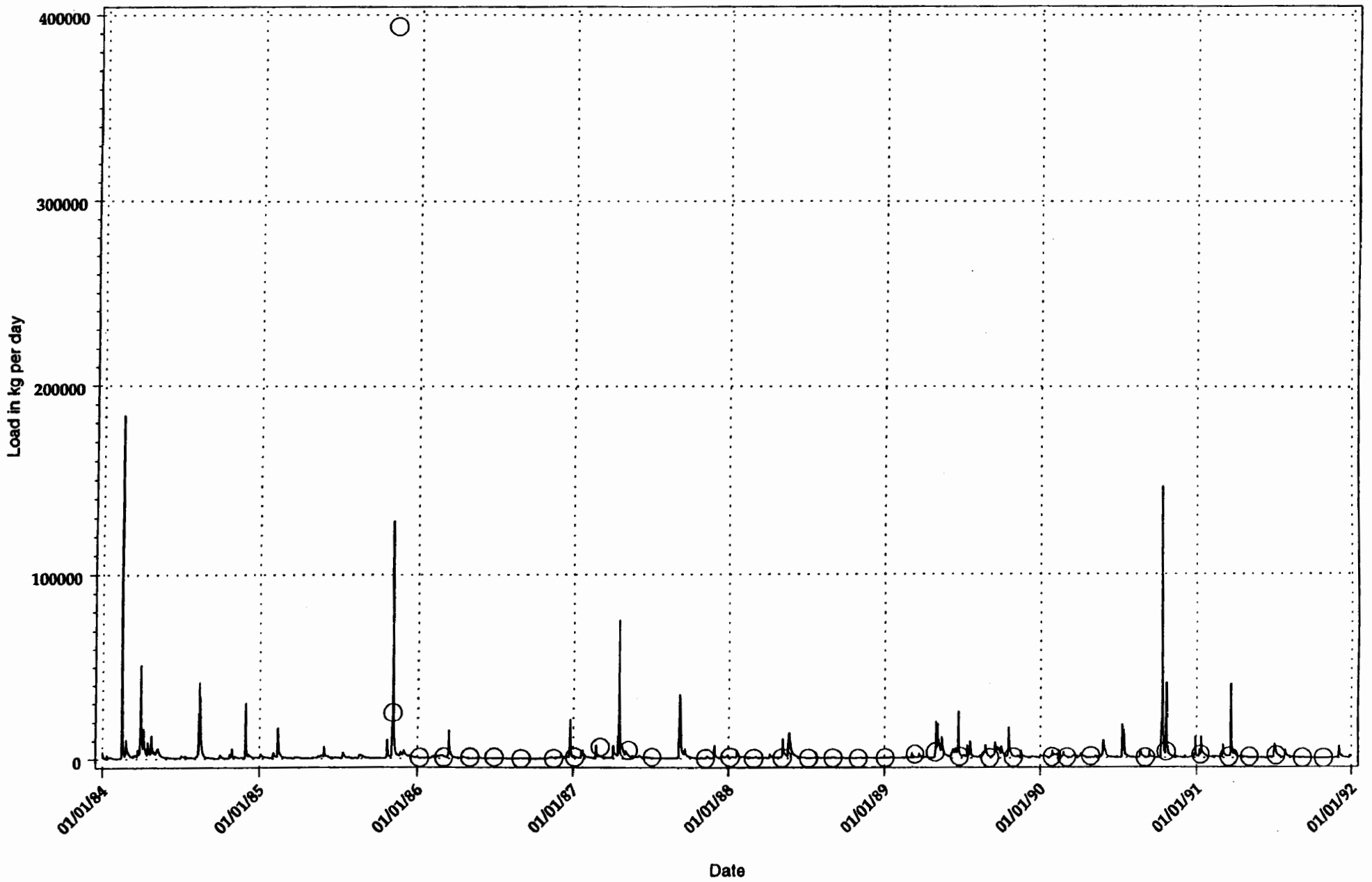
Shenandoah River at Segment 200
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)



Shenandoah River at Segment 200

Organic Nitrogen Observed and Simulated Load vs Time

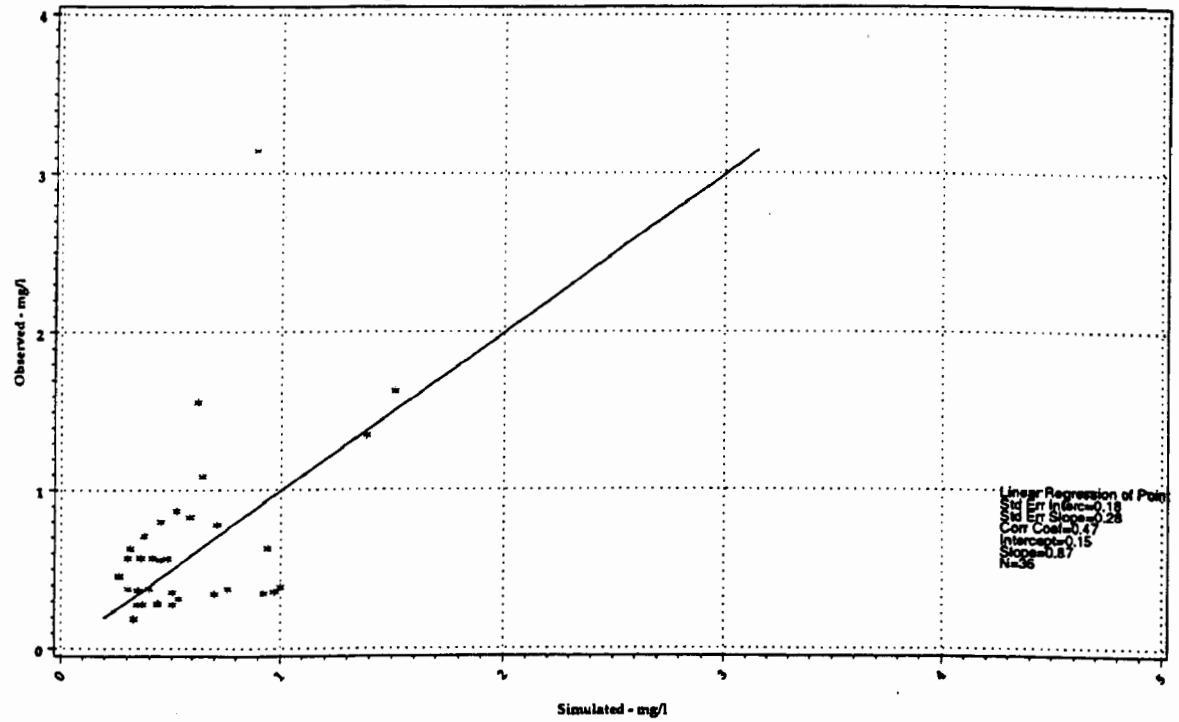
(line = simulated, O = observed)



(y21_plot1.sas datastore2:[jrps.p3.james.sas] lidflow)
(graph_a.drv 25AUG97 17:40,proc reg,model y=x)

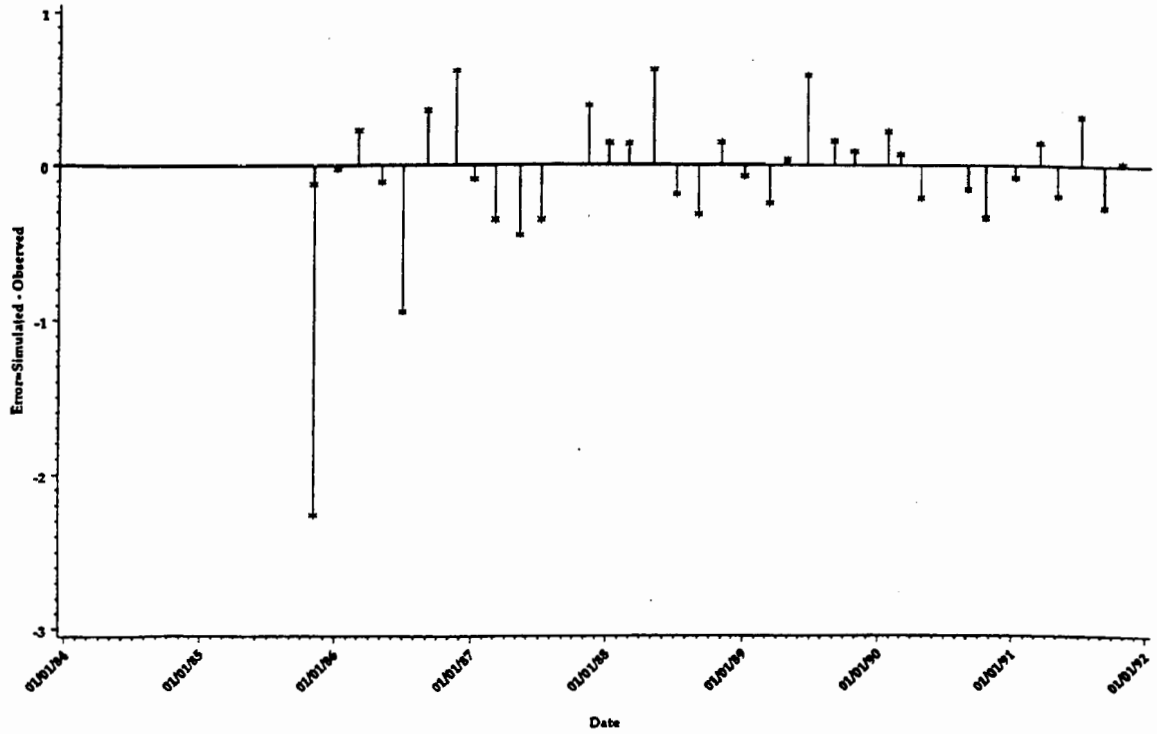
Shenadoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Organic Nitrogen: 01JAN84 - 01JAN92

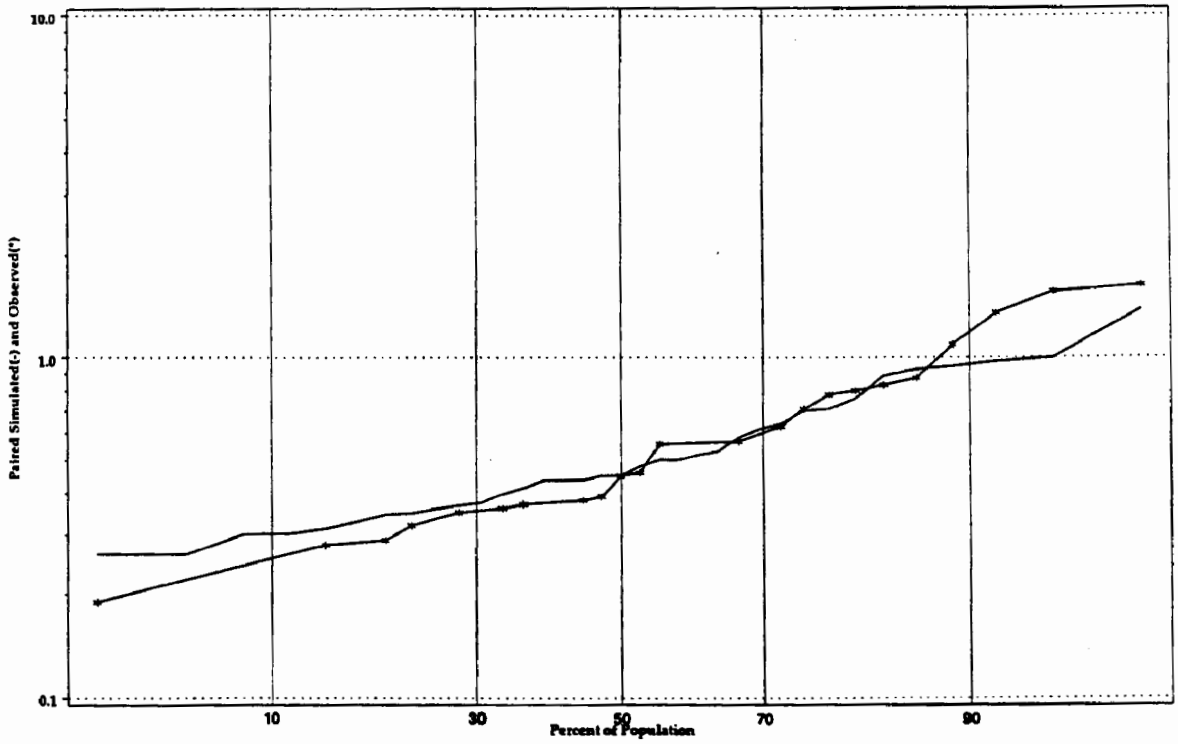


Shenadoah River at Segment 200

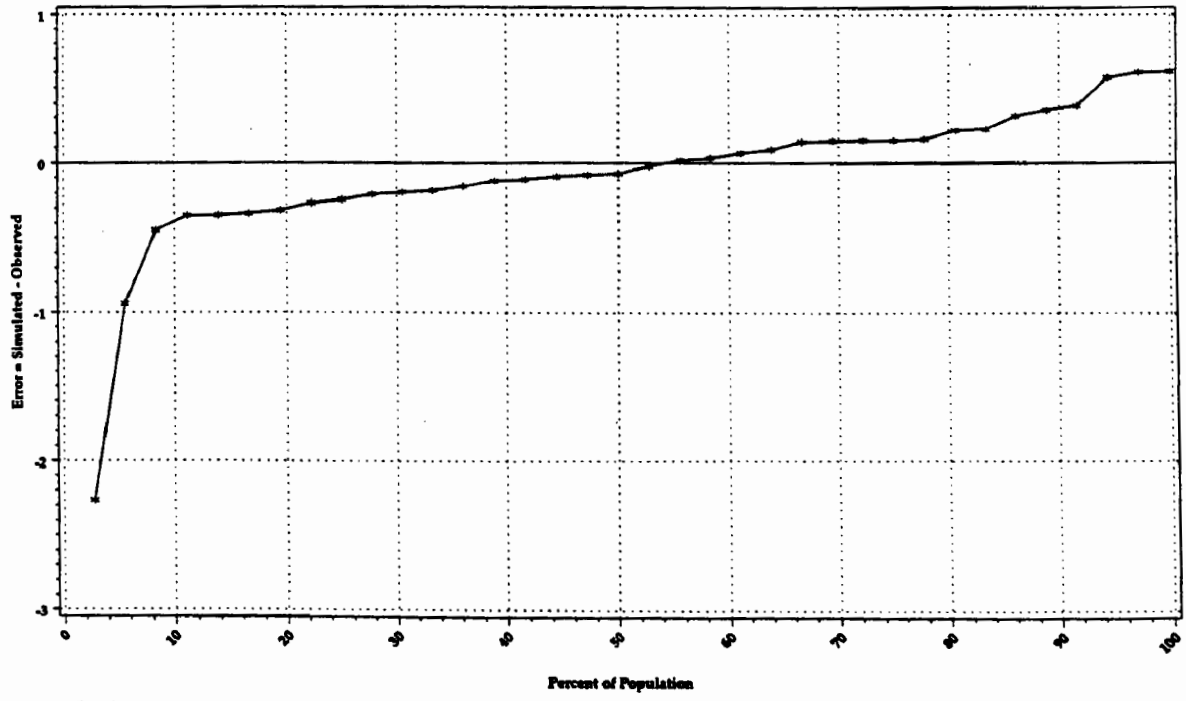
Actual Error versus Time
Organic Nitrogen



Shenadoah River at Segment 200
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Shenadoah River at Segment 200
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.3.3 Lower Potomac River at Chain Bridge near Washington, DC at Segment 220 (Monitoring Station: 1646580) (Above Fall Line Basin Segments: 160, 170, 175, 180, 190, 200, 210, 220, 730, 740, and 750)

Section Summary:

The Potomac River at the fall line is primarily rural, with the lowest portions of the basin changing to the urban character of the Washington Metropolitan region. Land use upstream is predominantly forest with agricultural loads from the Piedmont and the Great Valley the primary influence on water quality. The upstream basins of the upper Potomac and Shenandoah contribute to the water quality characteristics at the Potomac fall line. Nitrate comprises the greatest part of total nitrogen and is highly seasonal with nitrate concentrations highest in winter and lowest in summer. An unusual feature of the water quality time series at the Potomac is a 100-year storm in November, 1985. Total suspended sediment increased to about 4,500 mg/l at the Shepardstown gage, the highest observed total suspended sediment concentrations recorded in the Chesapeake watershed.

The Potomac basin above the gaged site covers an area of 8,744 square miles. At the midpoint of the simulation period, 1990, the land use for the basin was composed of 36% forest land, 22% cropland, 30% other agricultural areas, 11% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 42.8 million pounds in 1985 to 41.1 million pounds in 1996. Total phosphorus loads over the same time period decreased from 5.0 million pounds to 4.3 million pounds. In general, point source loads above the gage site decreased. In 1996, the total nitrogen point source load was 11% of the total load and the total phosphorus point source load was 25% of the total load. Estimated septic system total nitrogen loads increased 28%, from 1.5 million pounds in 1985 to 1.9 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 18%, and other agricultural loads (primarily pasture and manure loads) by 12%. Total phosphorus decreased for these land uses by 10% and 17% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 24% for total nitrogen and 26% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

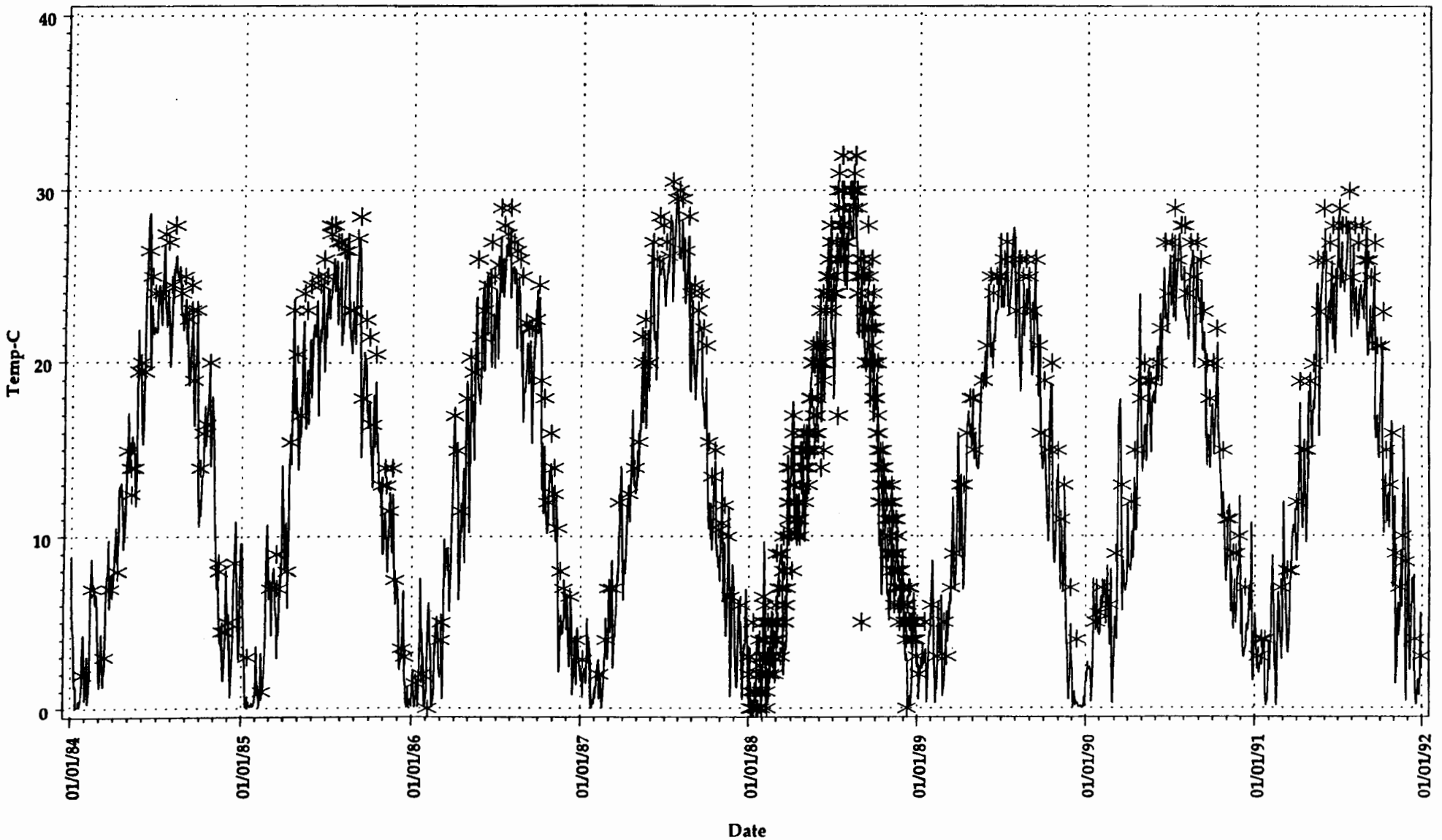
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

Lower Potomac River at Segment 220
Observed and Simulated versus Time
Temperature-C

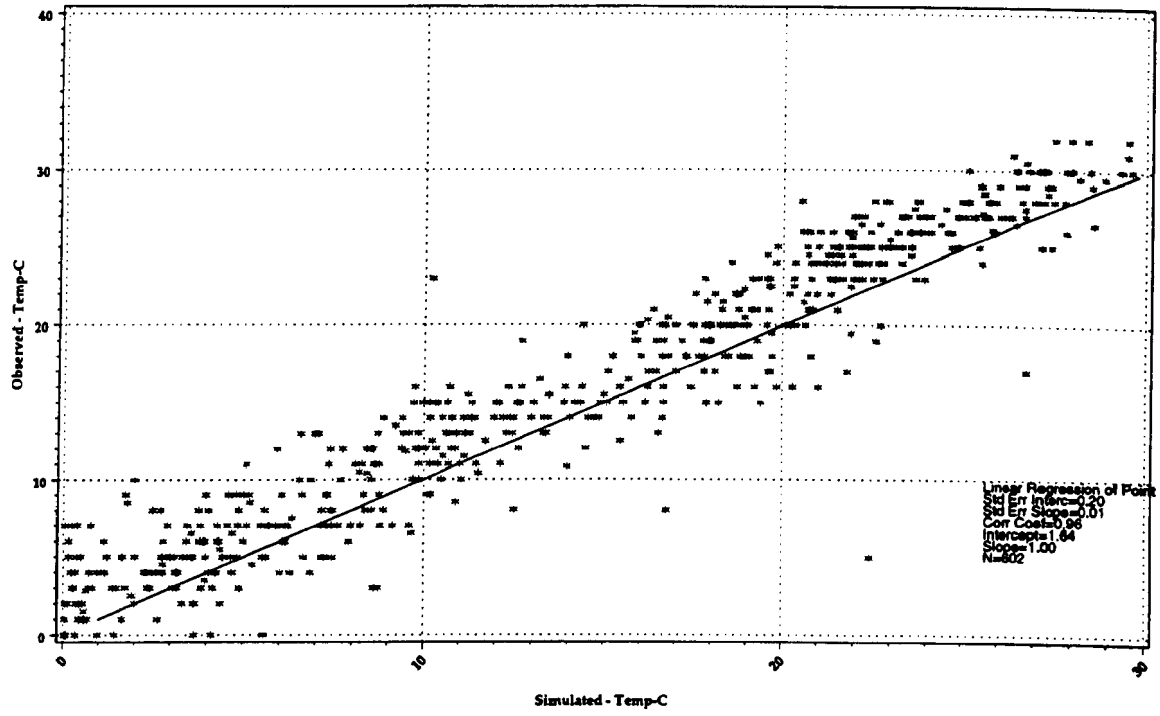
(*=Observed, -=Simulated)



(y21_plot1.sas dataseteve2 [type p3 james.sas] plotcmt - omtime)
(graph_s.drv 03OCT97 12:27)

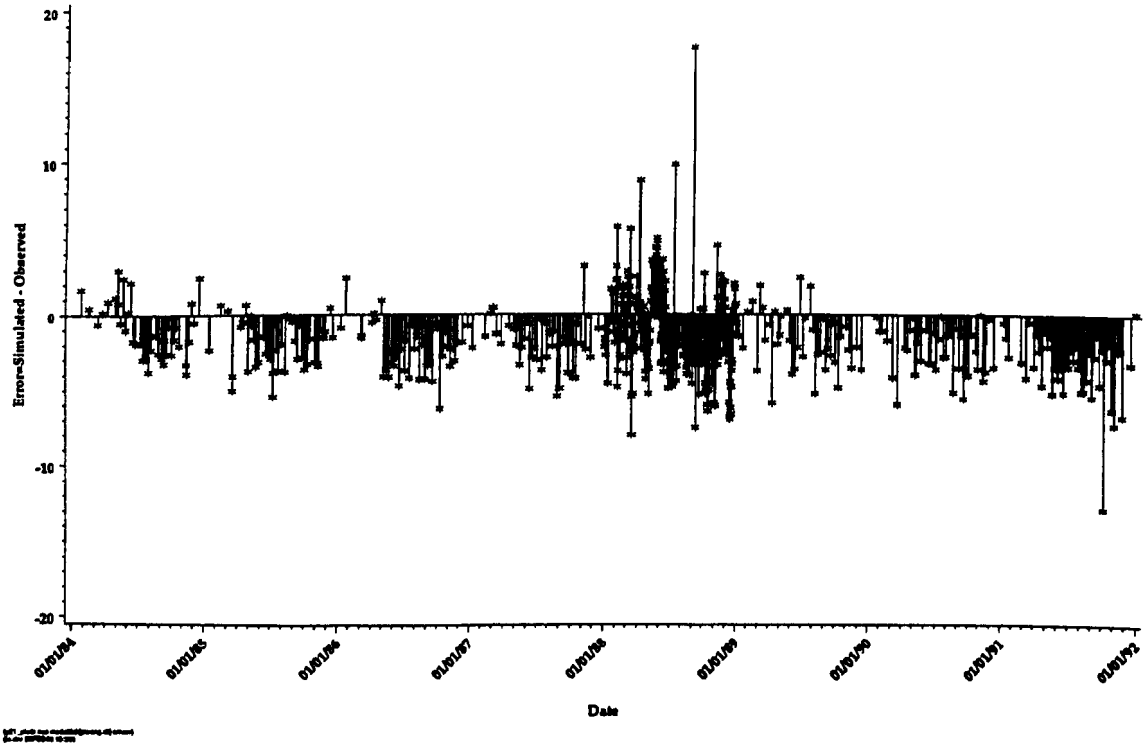
Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Temperature-C: 01JAN84 - 01JAN92

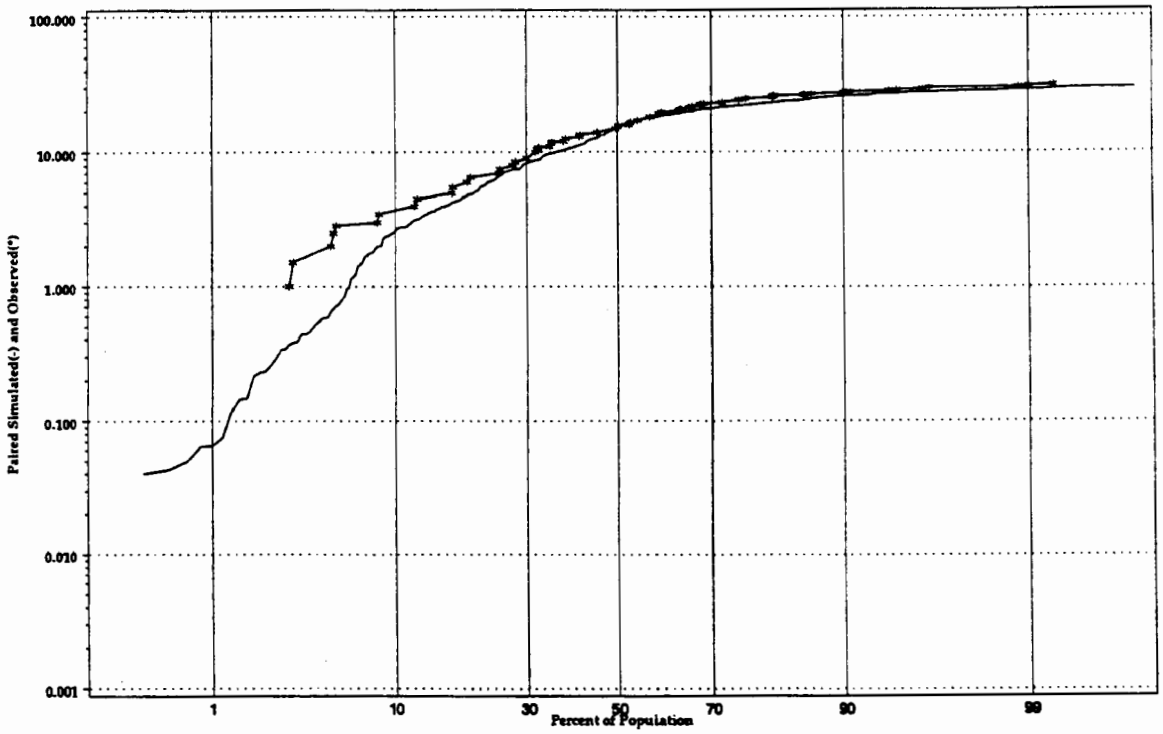


Lower Potomac River at Segment 220

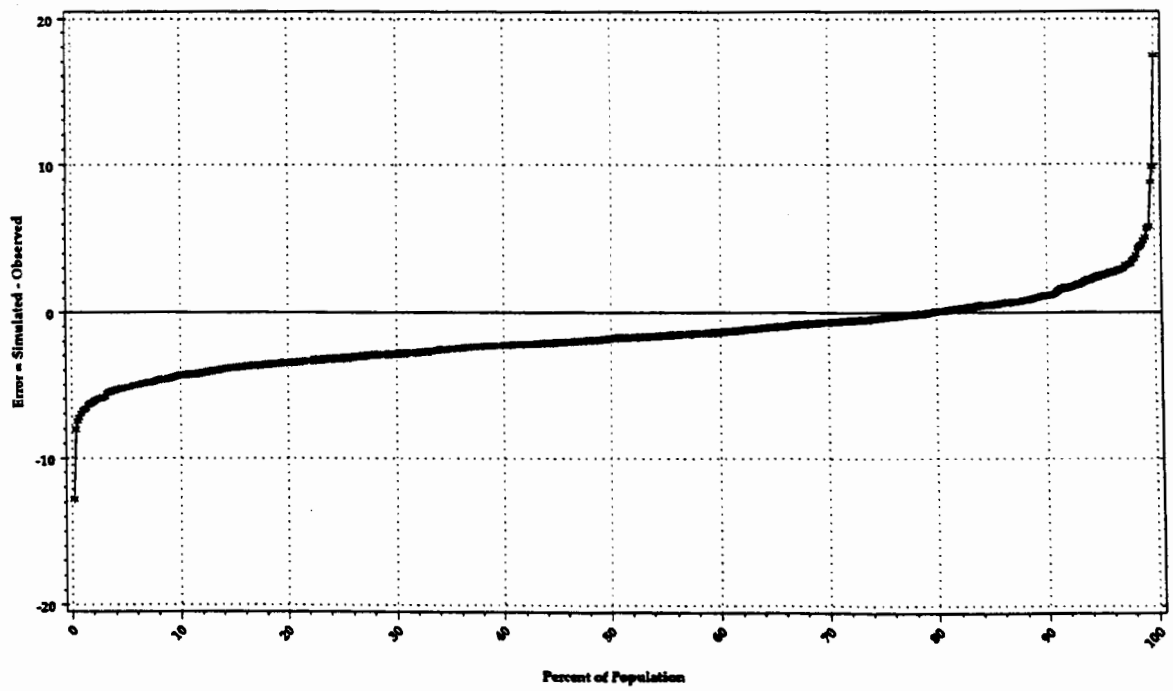
Actual Error versus Time
Temperature-C



Lower Potomac River at Segment 220
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

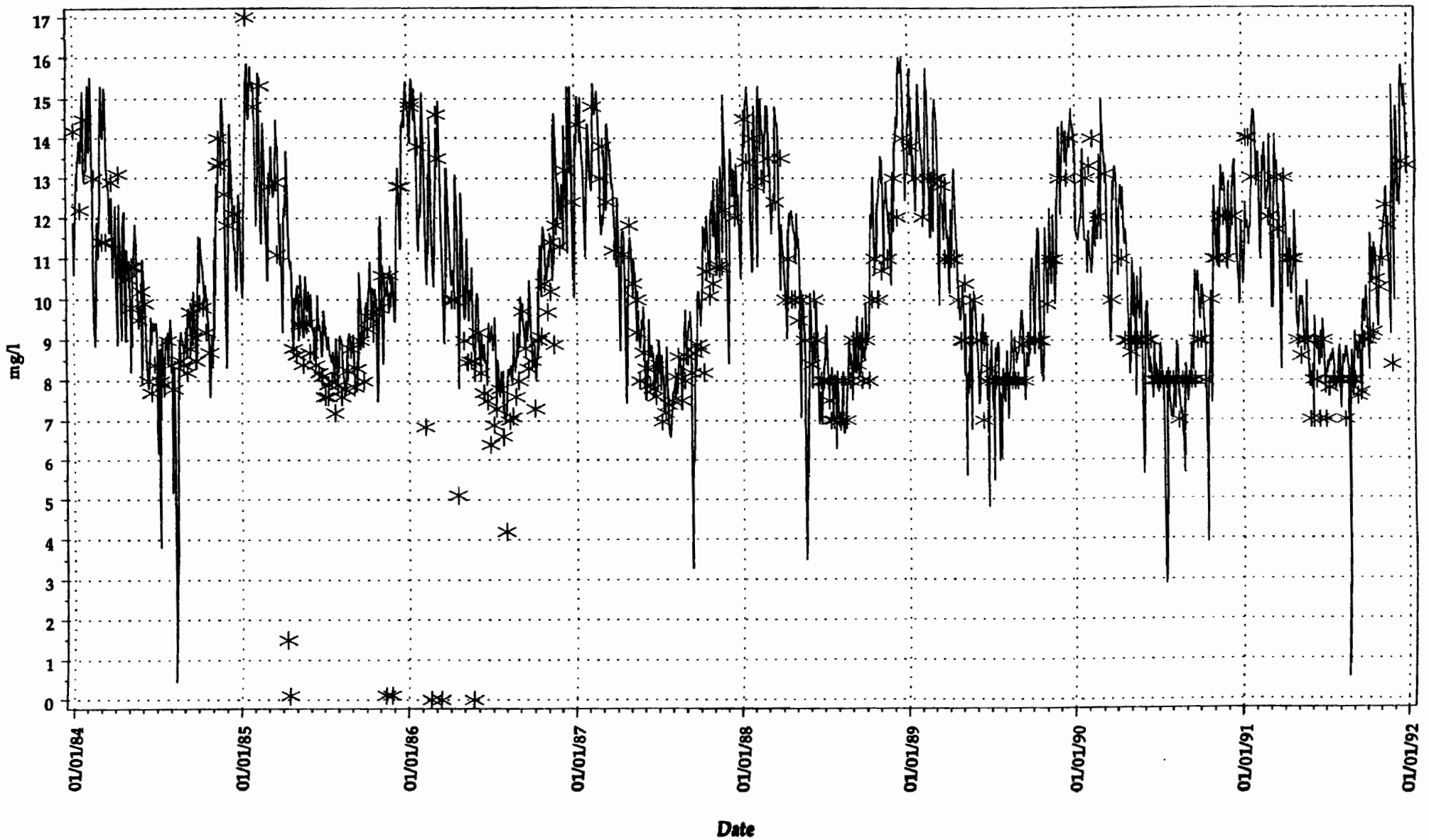


Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data



Lower Potomac River at Segment 220
Observed and Simulated versus Time
Dissolved Oxygen

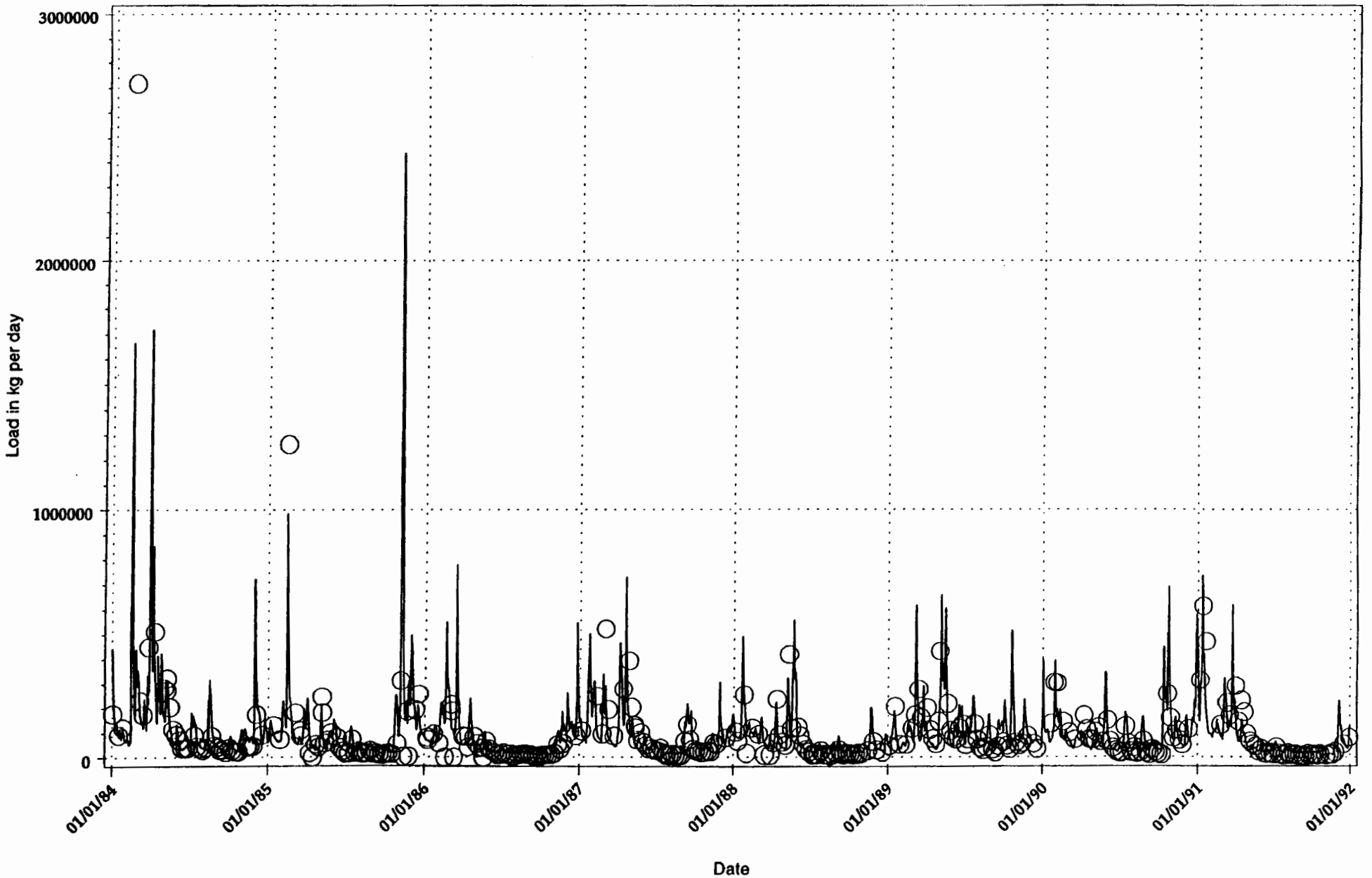
(*=Observed, -=Simulated)



Lower Potomac River at Segment 220

Dissolved Oxygen Observed and Simulated Load vs Time

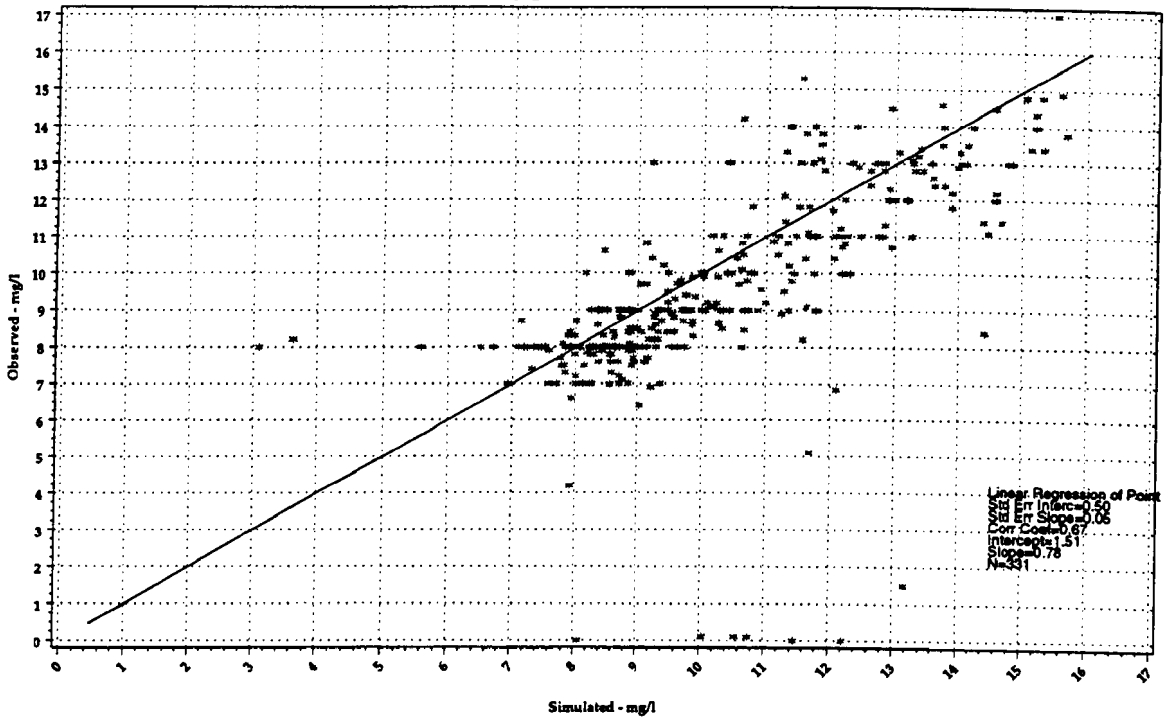
(line = simulated, O = observed)



(y21_plot1 sas datastore2 (nps p3 james.sas) fdfiles)
(graph_a dev 03OCT97 12:27 proc reg model y=x)

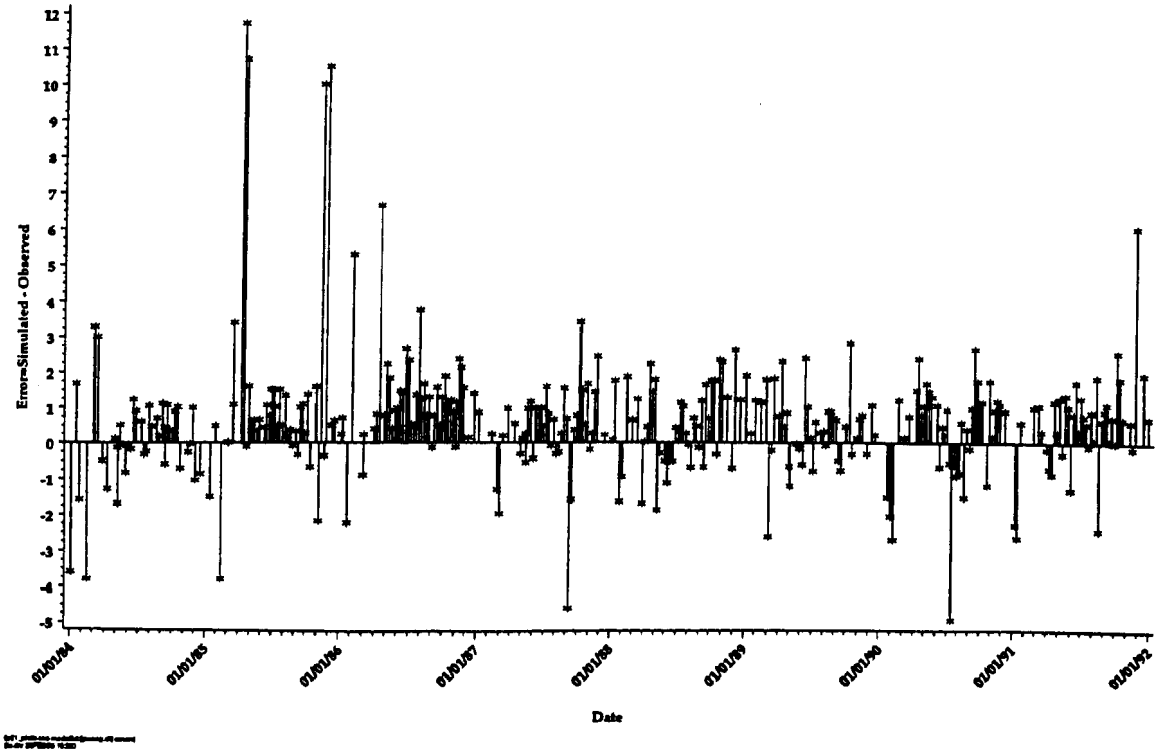
Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Dissolved Oxygen: 01JAN84 - 01JAN92

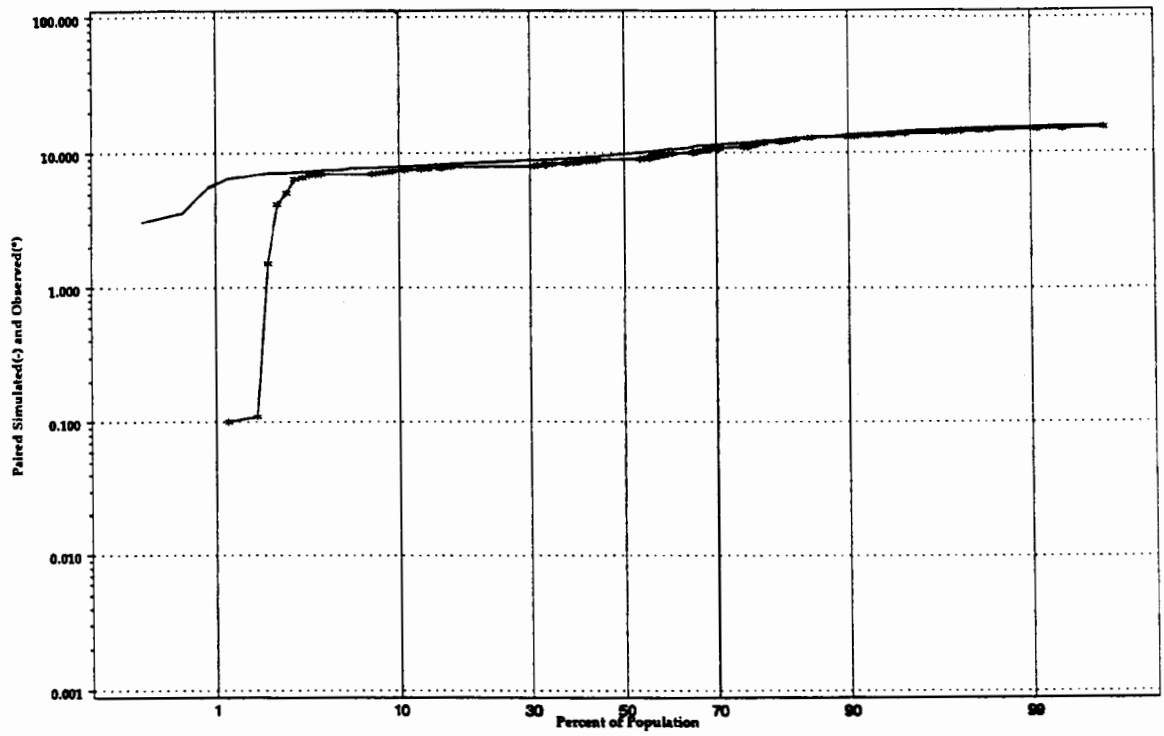


Lower Potomac River at Segment 220

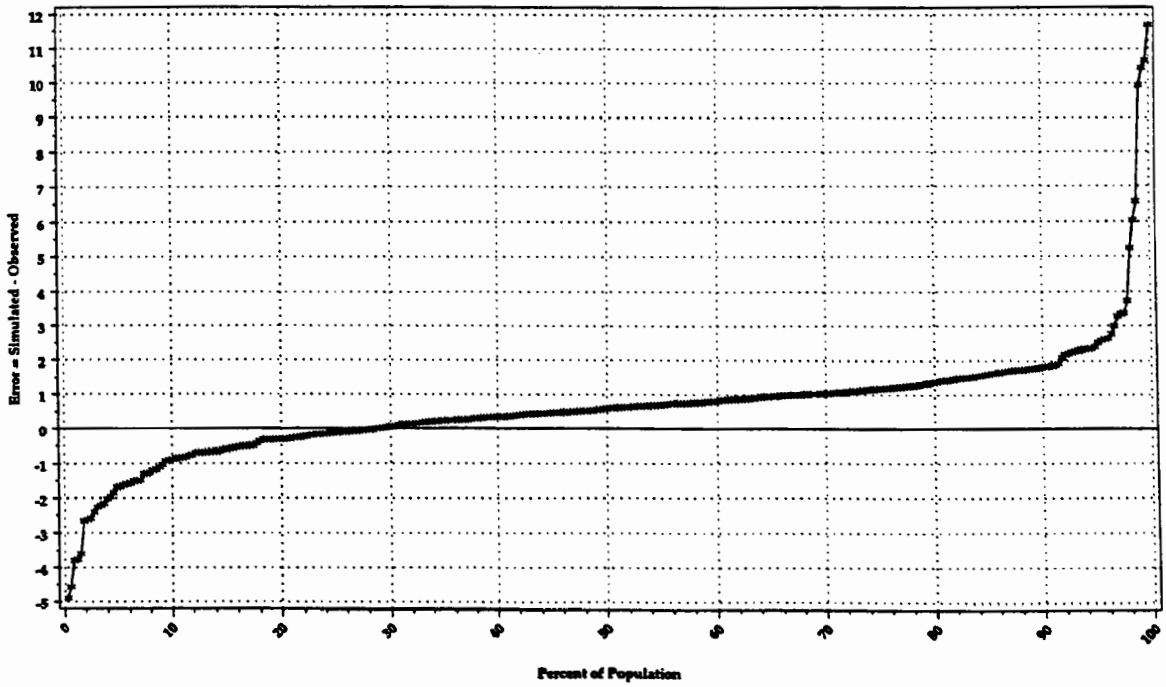
Actual Error versus Time
Dissolved Oxygen



Lower Potomac River at Segment 220
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

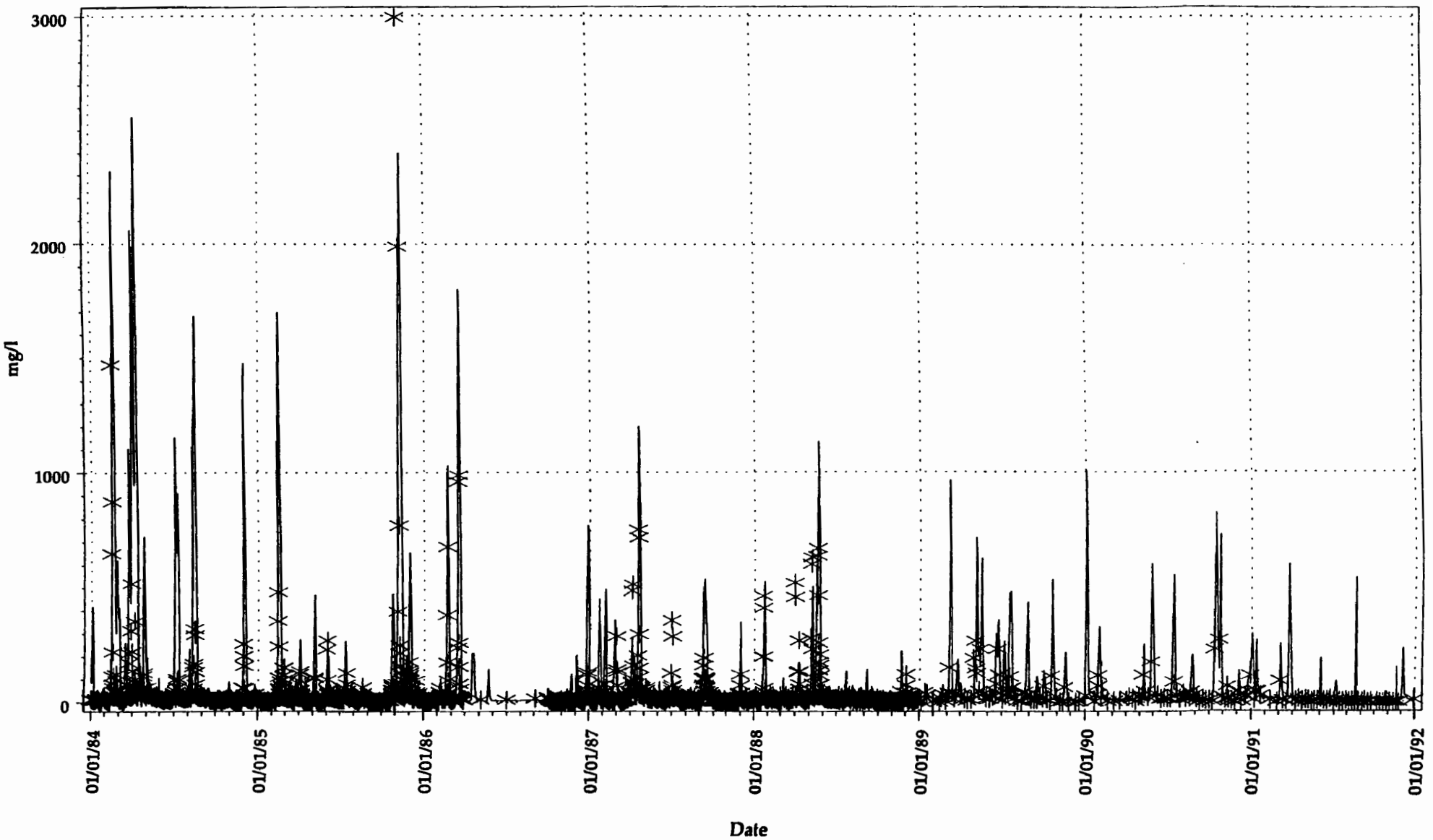


Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Lower Potomac River at Segment 220
Observed and Simulated versus Time
Total Suspended Sediment

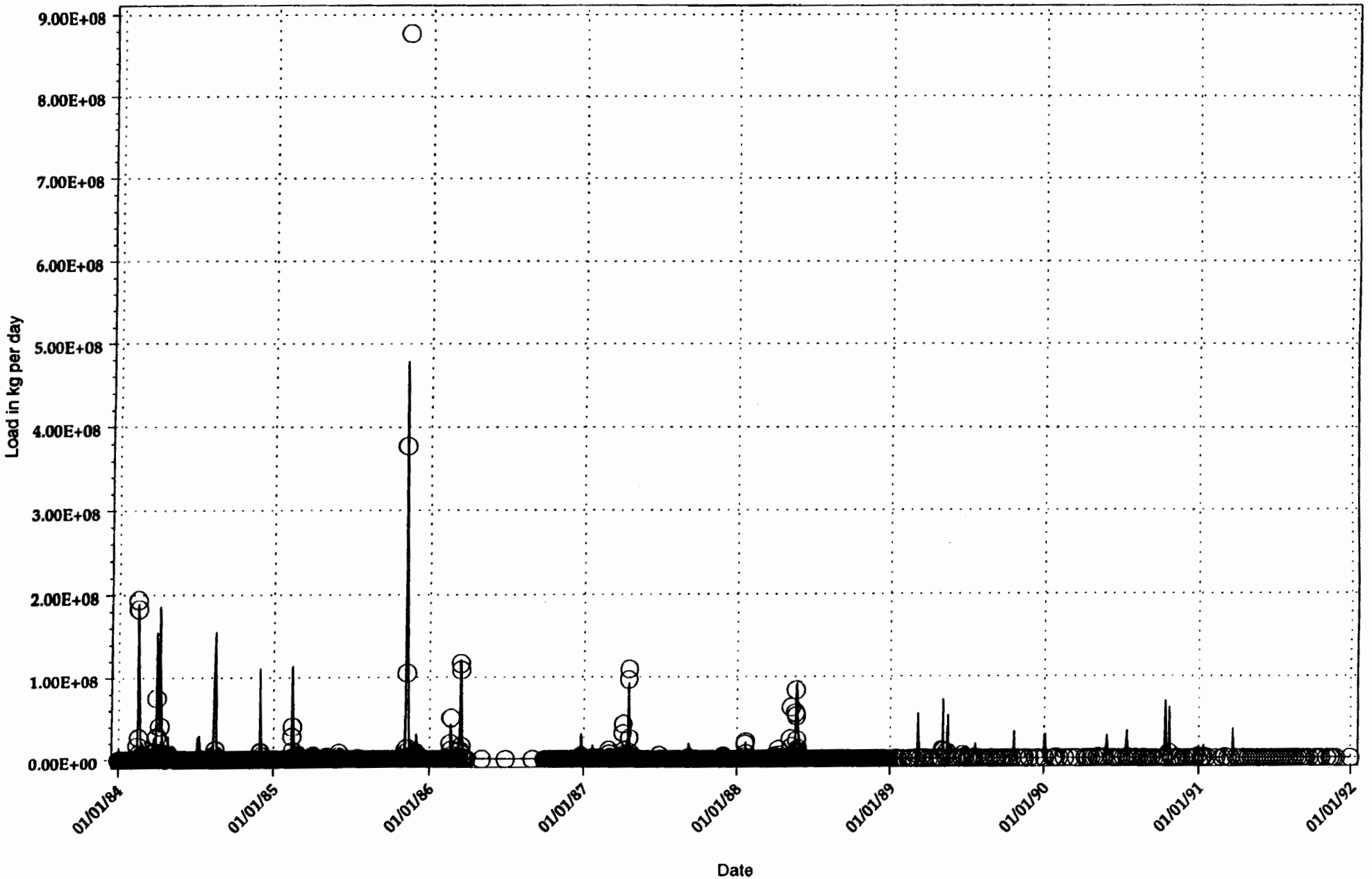
(*=Observed, -=Simulated)



Lower Potomac River at Segment 220

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

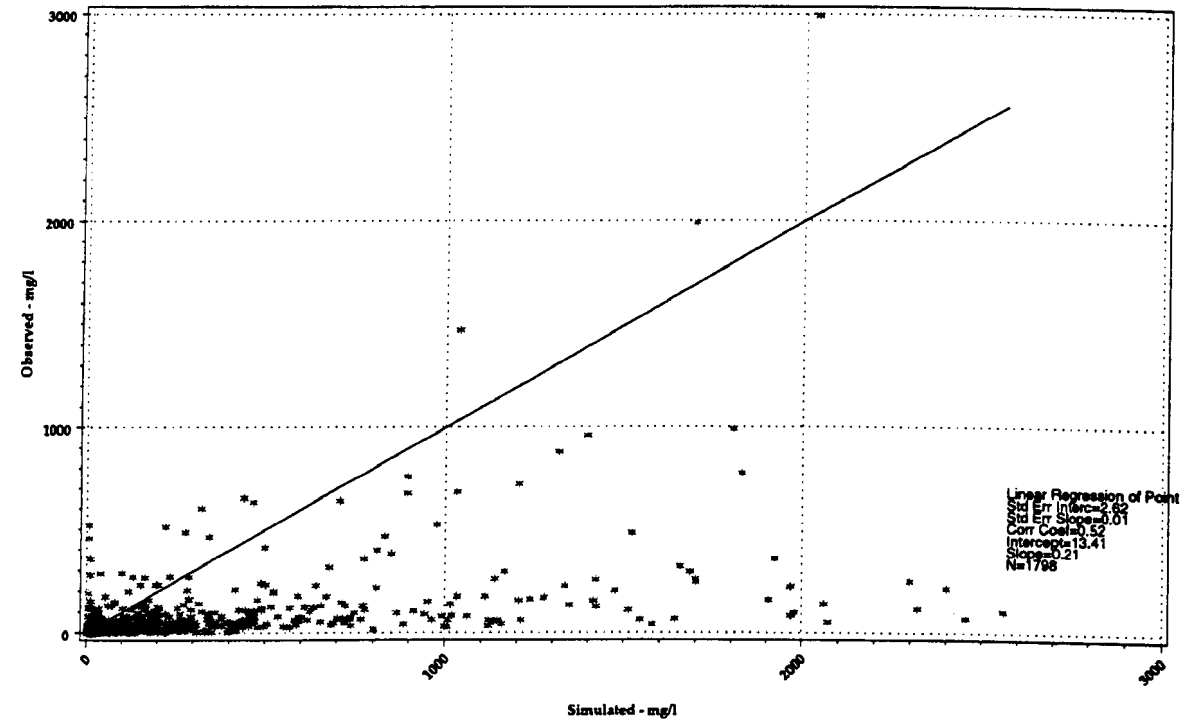


(y21_plot1.sas datastore2 (rps p3 james sas) 8dlos)
(graph_a div 03OCT97 12:27 proc reg model y=x)

Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

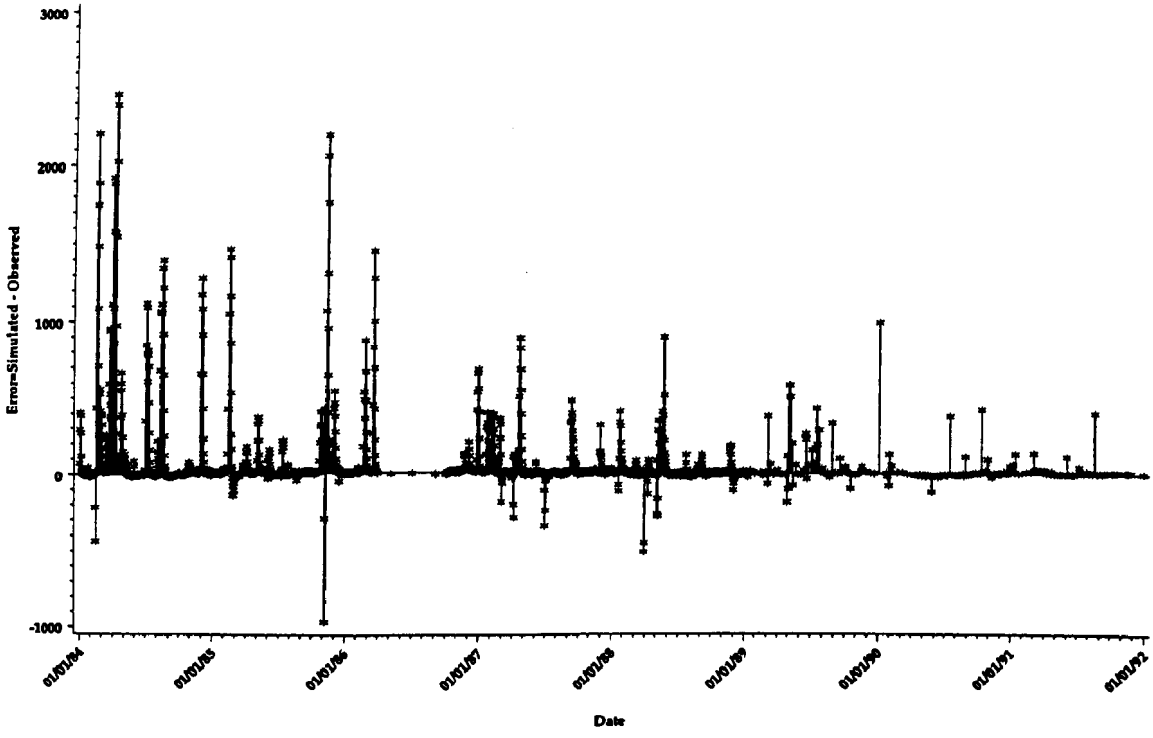
Total Suspended Sediment: 01JAN84 - 01JAN92



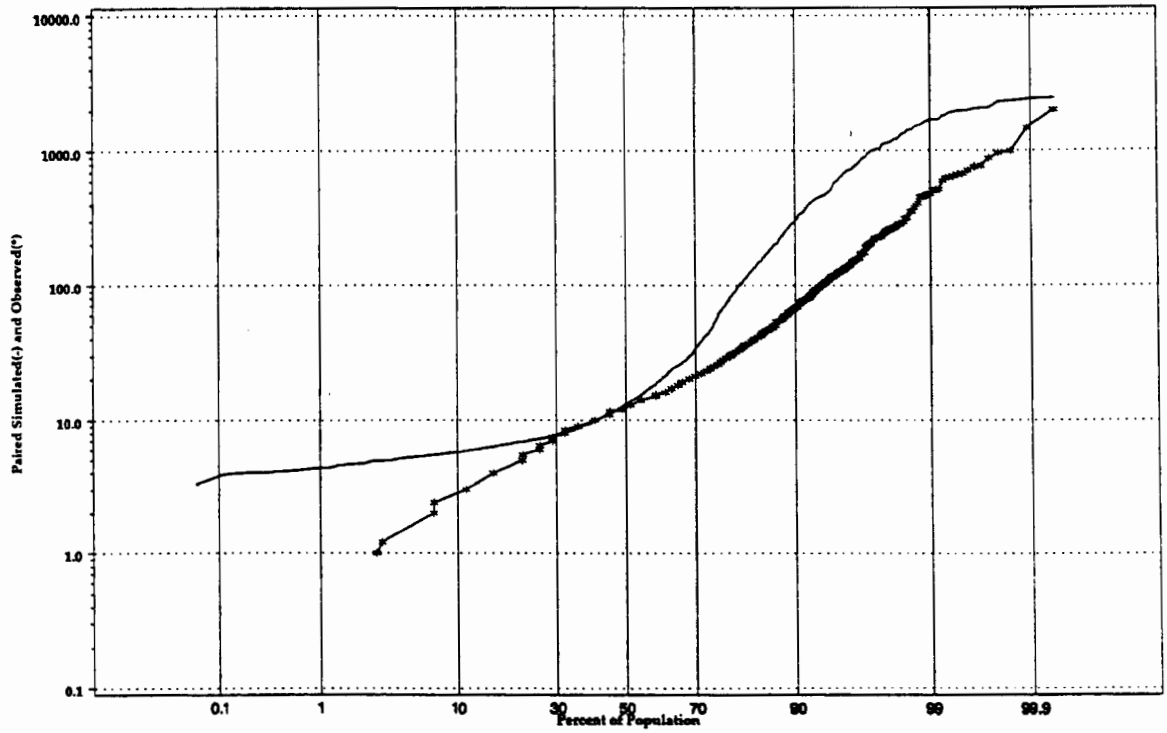
Lower Potomac River at Segment 220

Actual Error versus Time

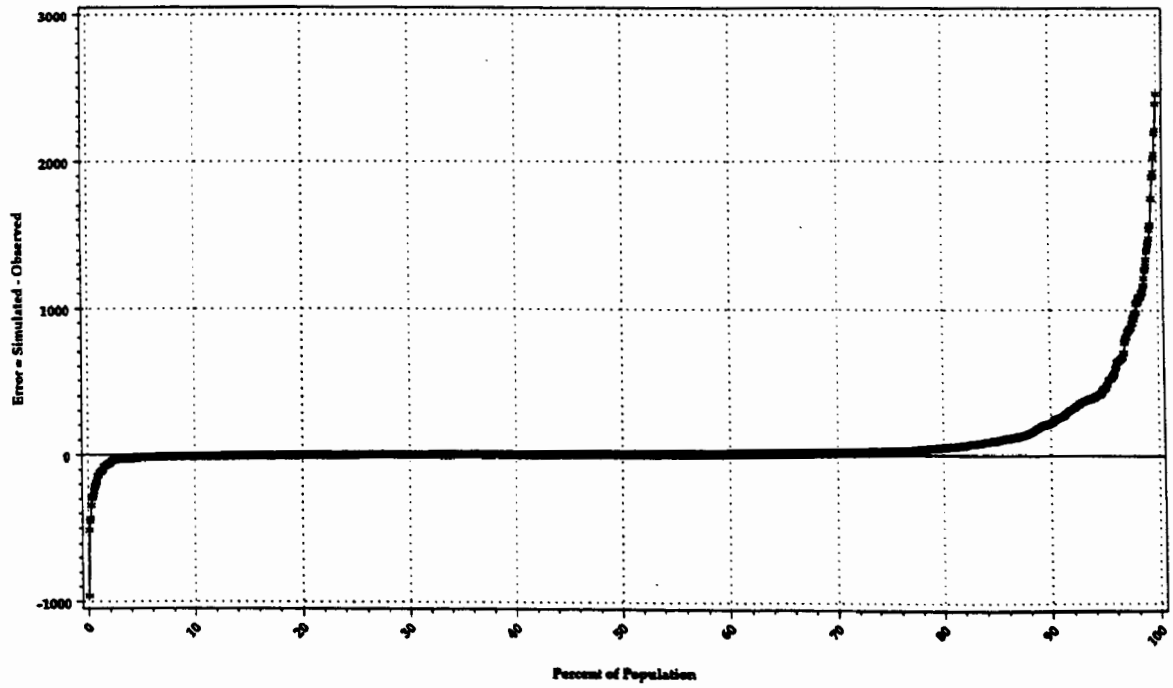
Total Suspended Sediment



Lower Potomac River at Segment 220
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

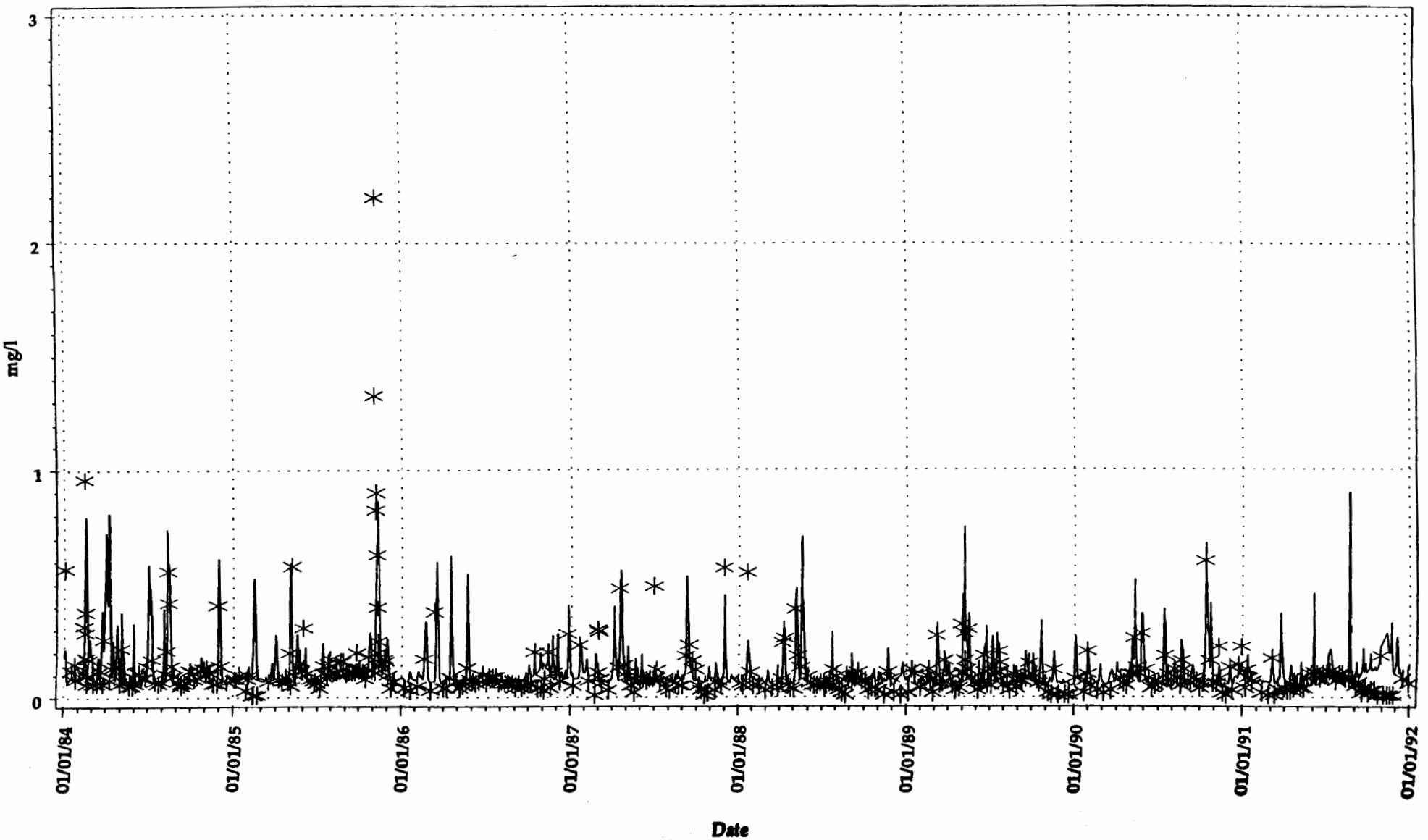


Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data

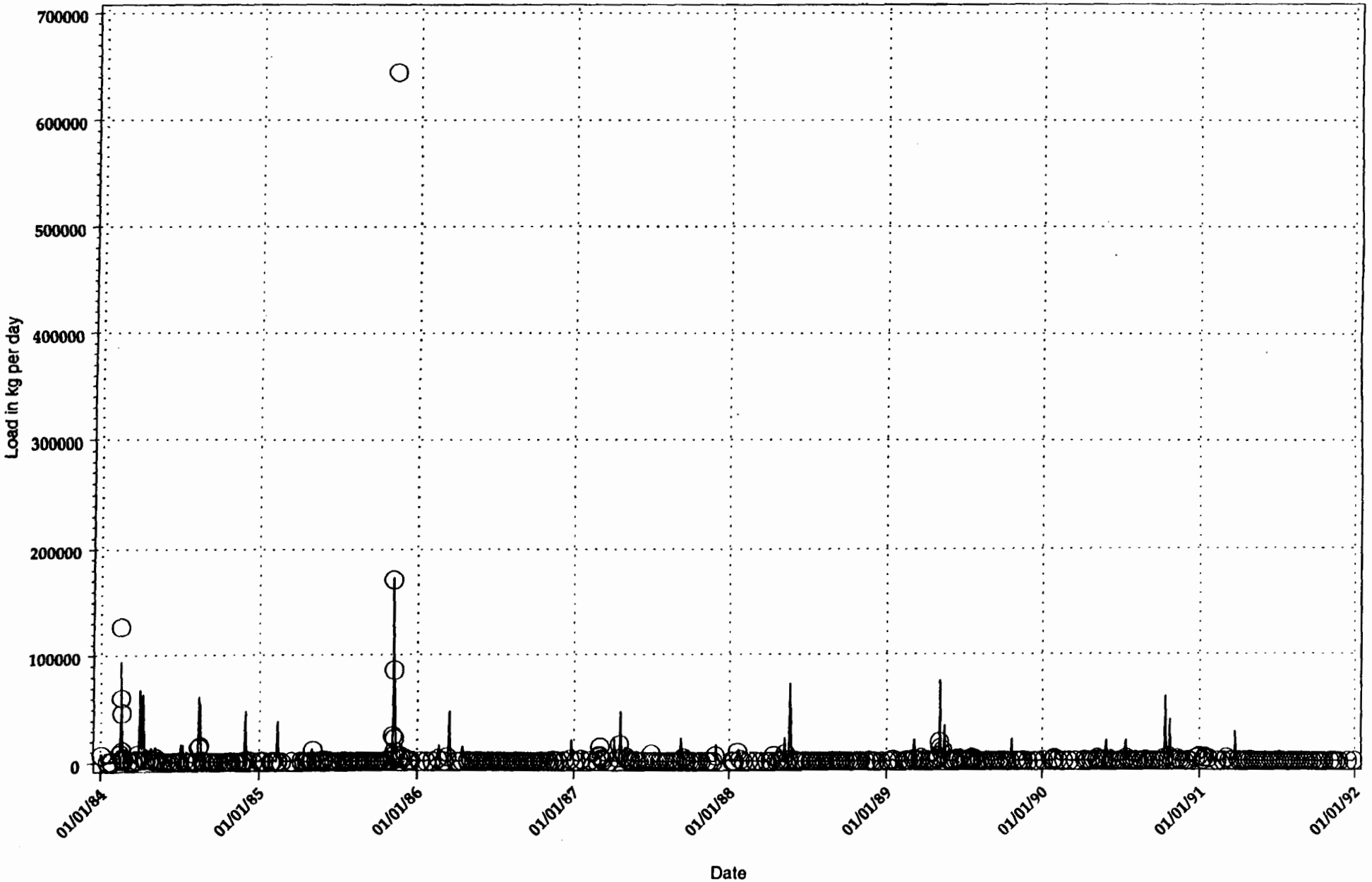


Lower Potomac River at Segment 220
Observed and Simulated versus Time
Total Phosphorus

(*=Observed, -=Simulated)



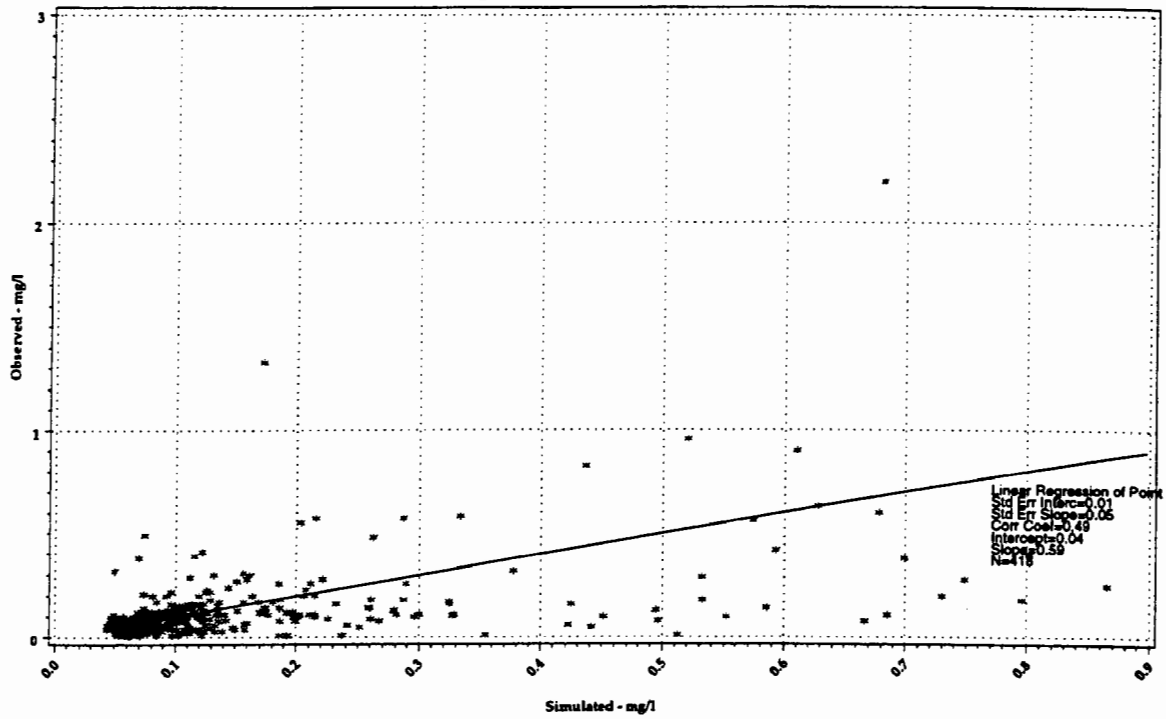
Lower Potomac River at Segment 220
Total Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)



(p21_plot1.sas datastore2(rps.p3 james.sas) 8dflas)
(graph_s div 03OCT97 12:27 proc reg,model y=x)

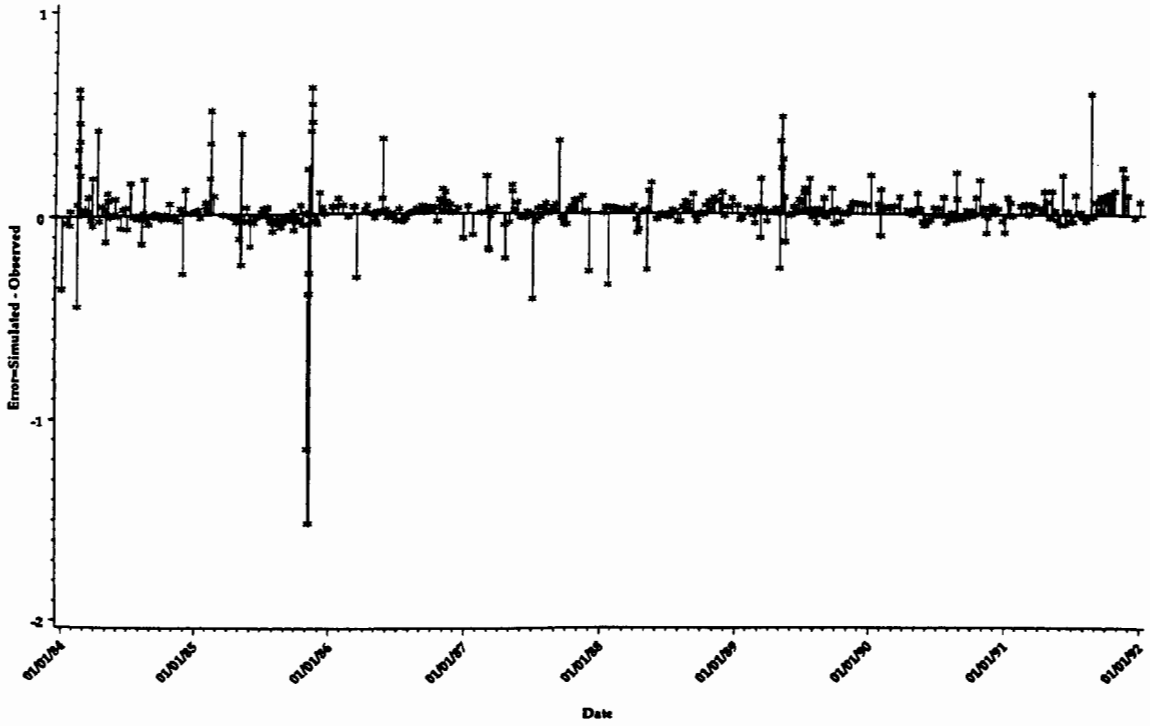
Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Phosphorus: 01JAN84 - 01JAN92

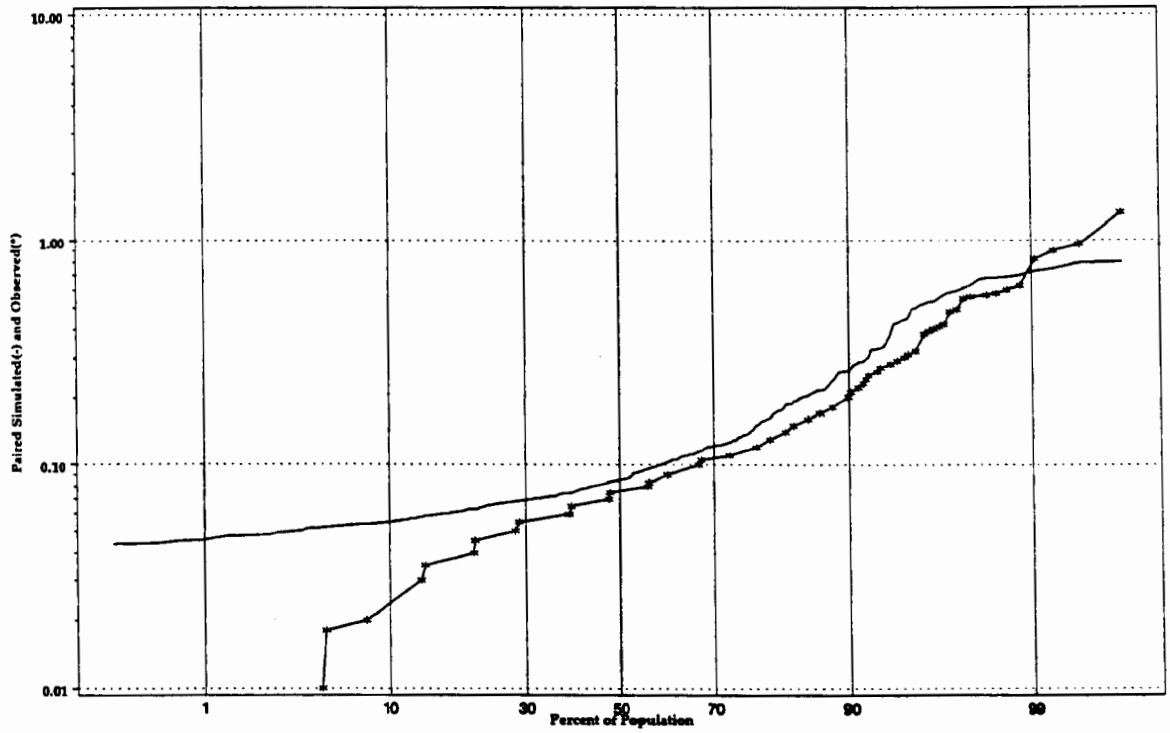


Lower Potomac River at Segment 220

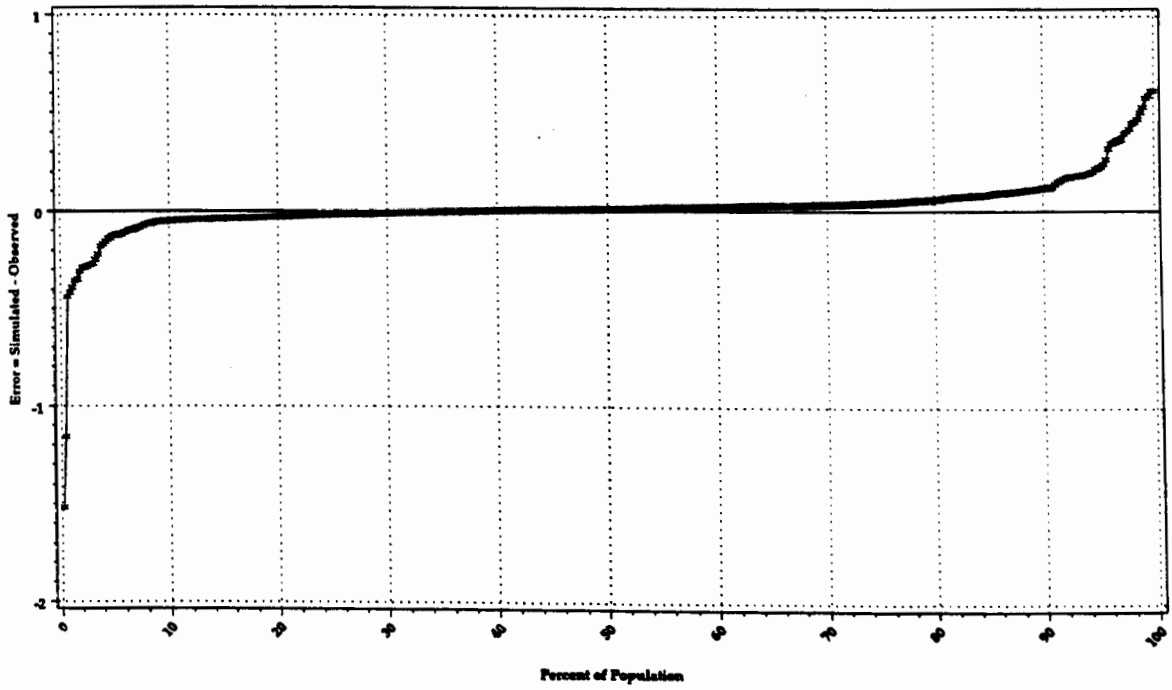
Actual Error versus Time
Total Phosphorus



Lower Potomac River at Segment 220
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

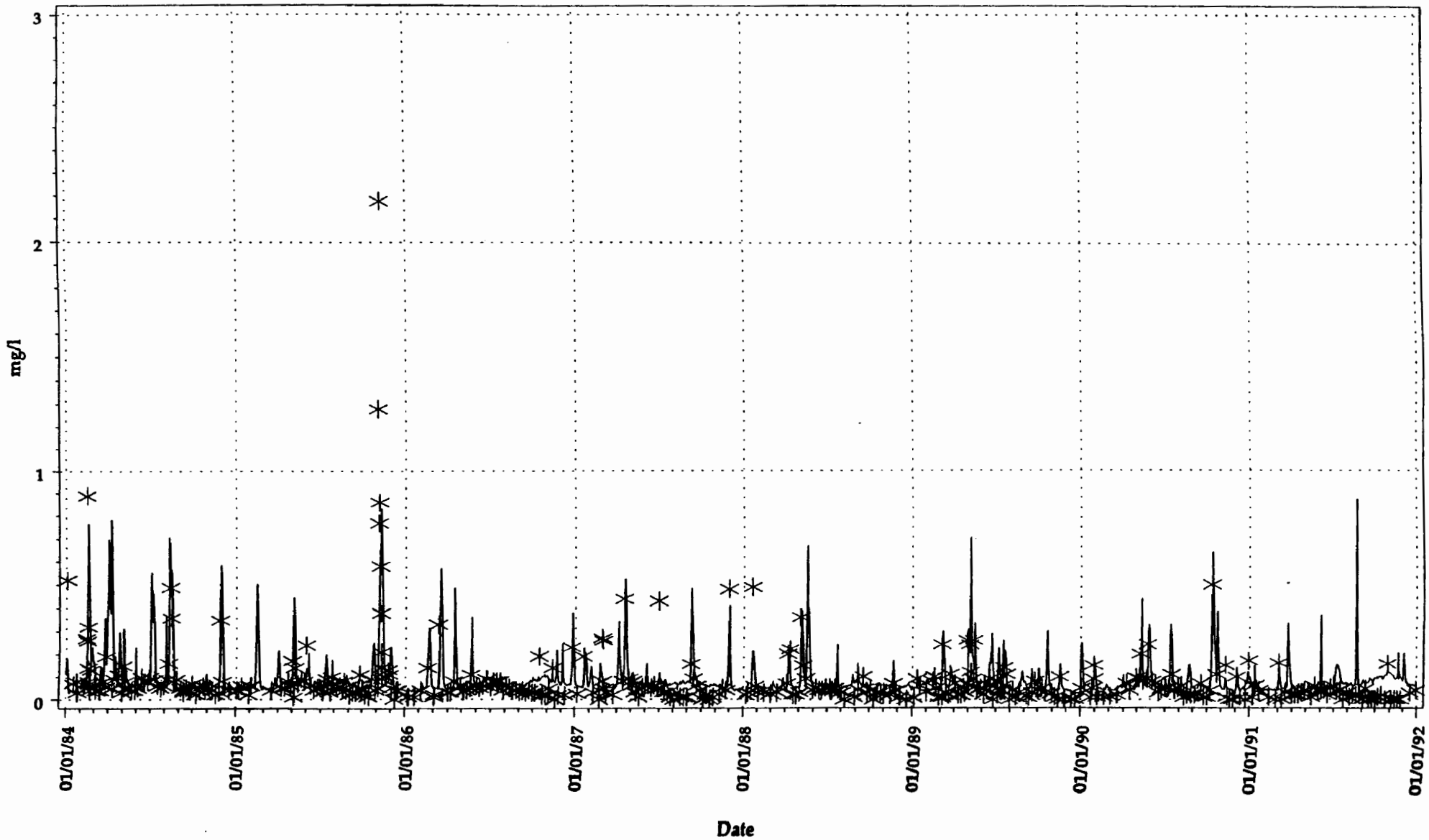


Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Lower Potomac River at Segment 220
Observed and Simulated versus Time
Organic and Particulate Phosphorus

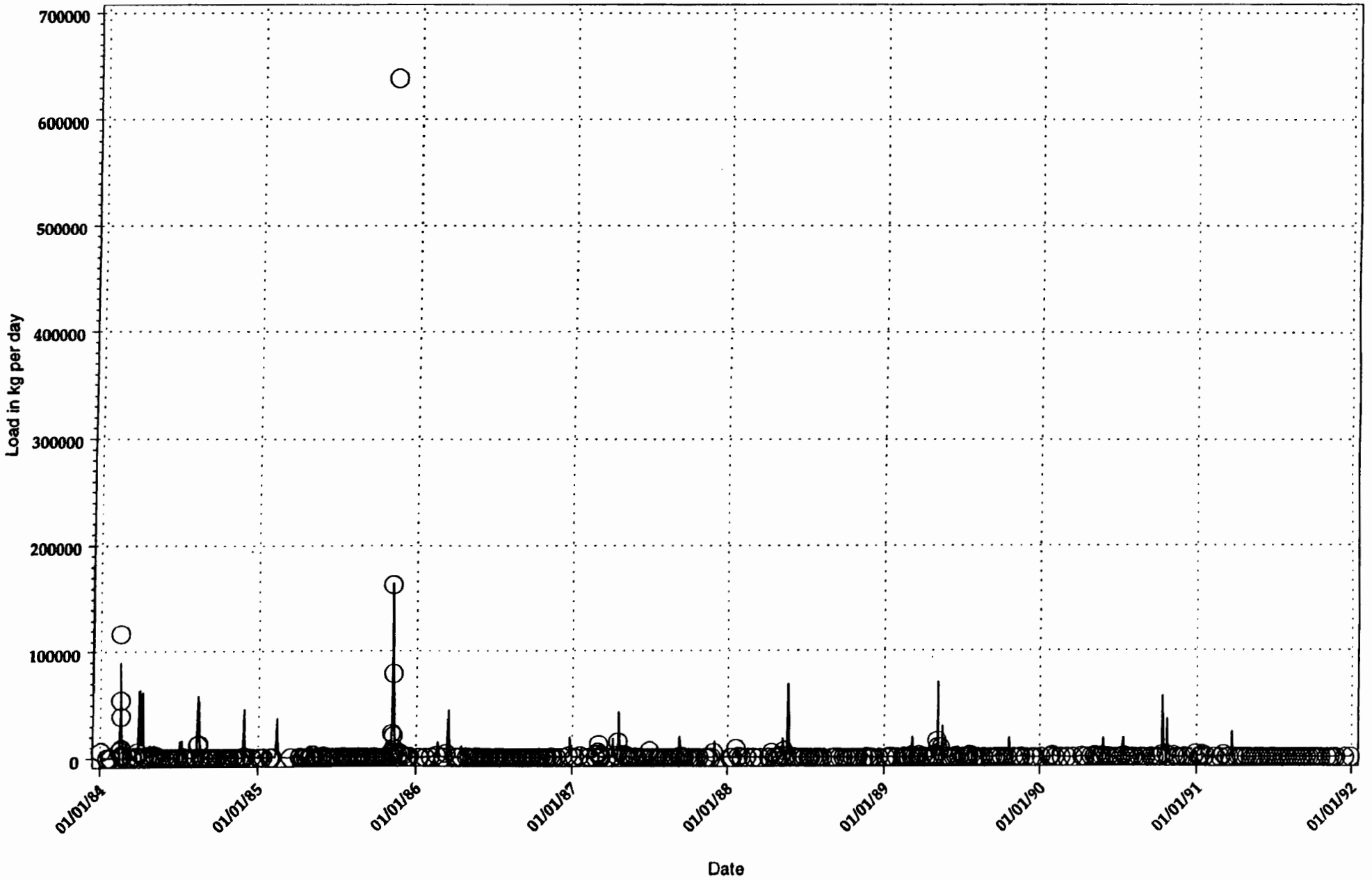
(*=Observed, -=Simulated)



Lower Potomac River at Segment 220

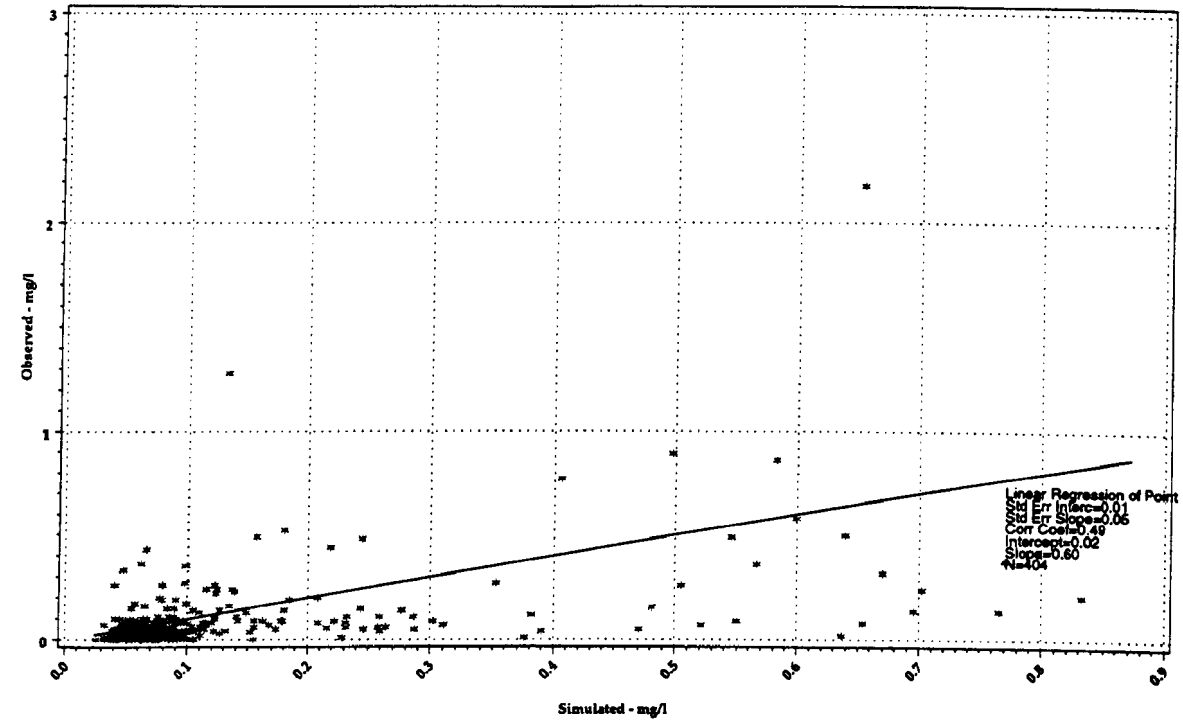
Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)



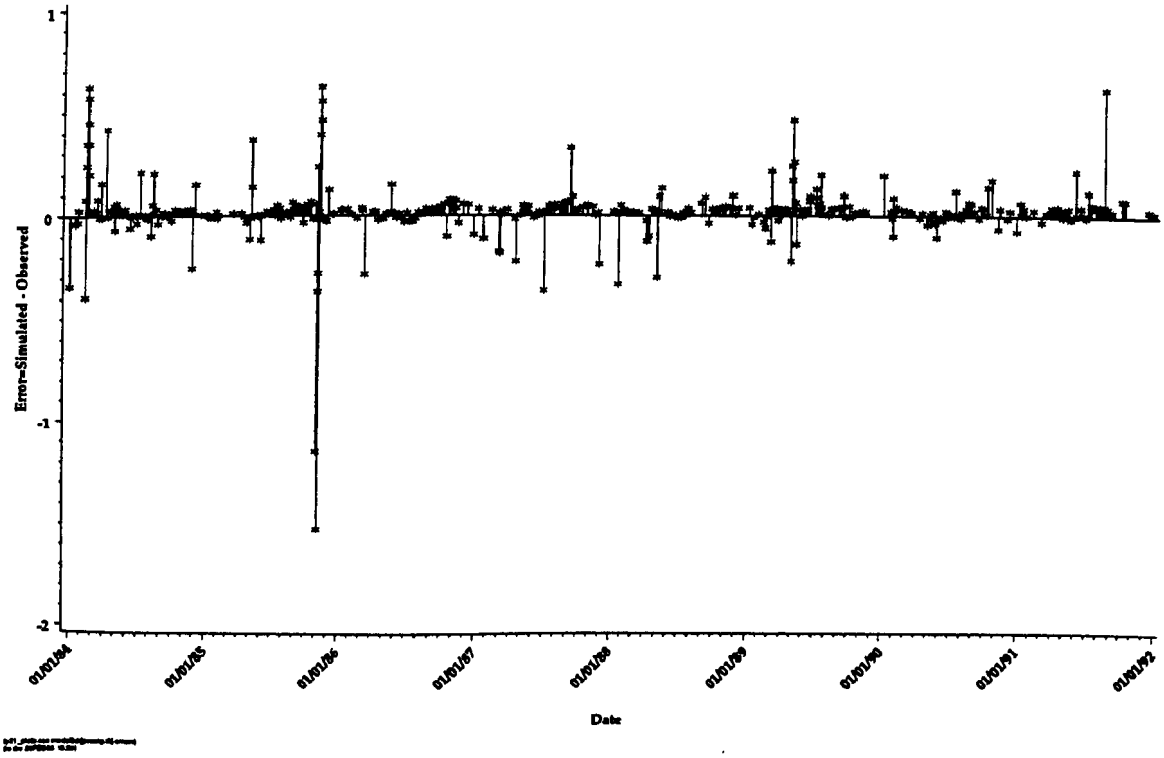
Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92

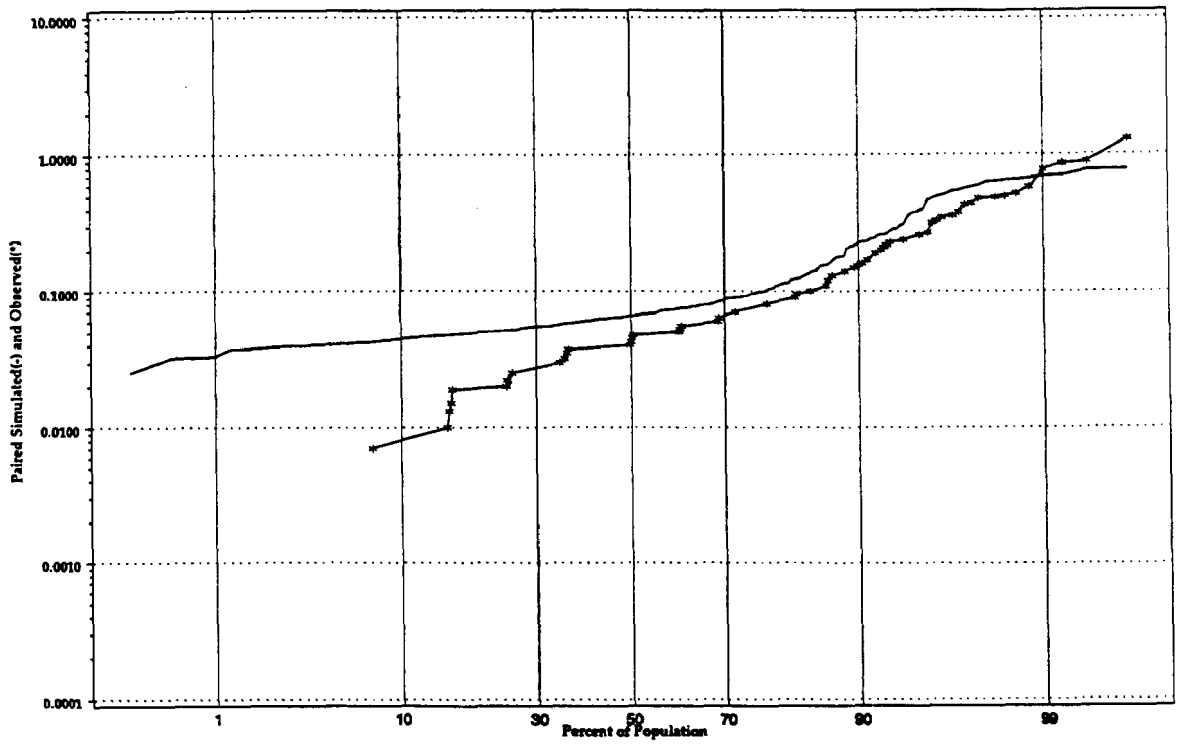


Lower Potomac River at Segment 220

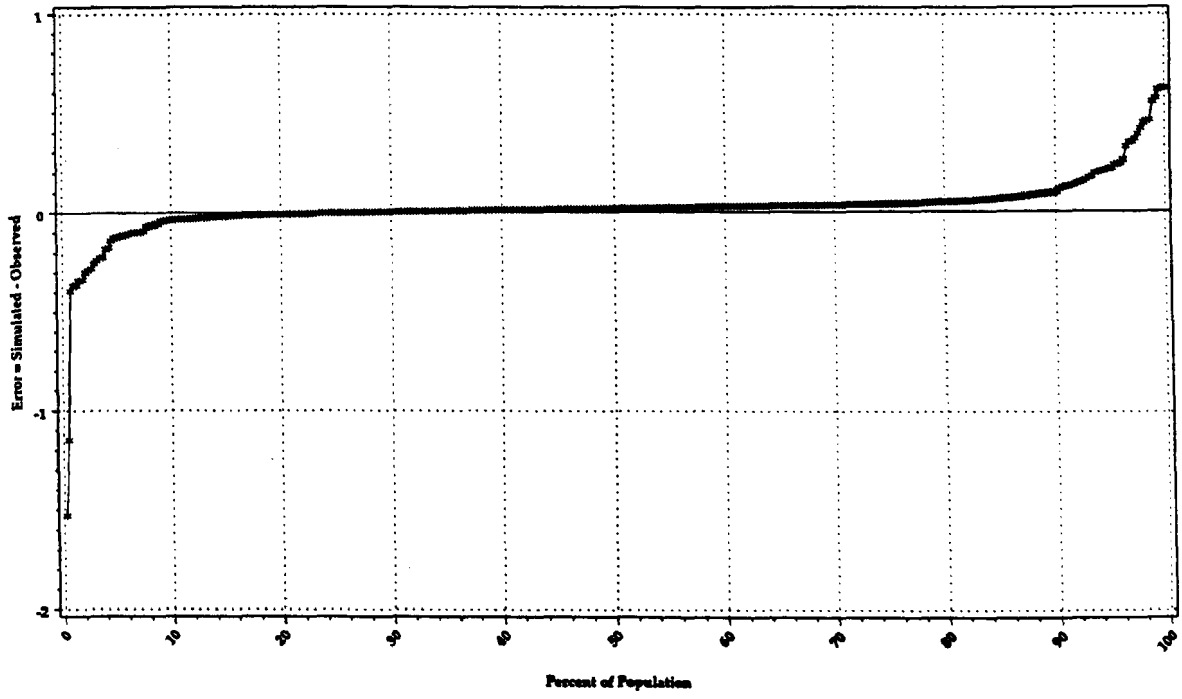
Actual Error versus Time
Organic and Particulate Phosphorus



Lower Potomac River at Segment 220
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

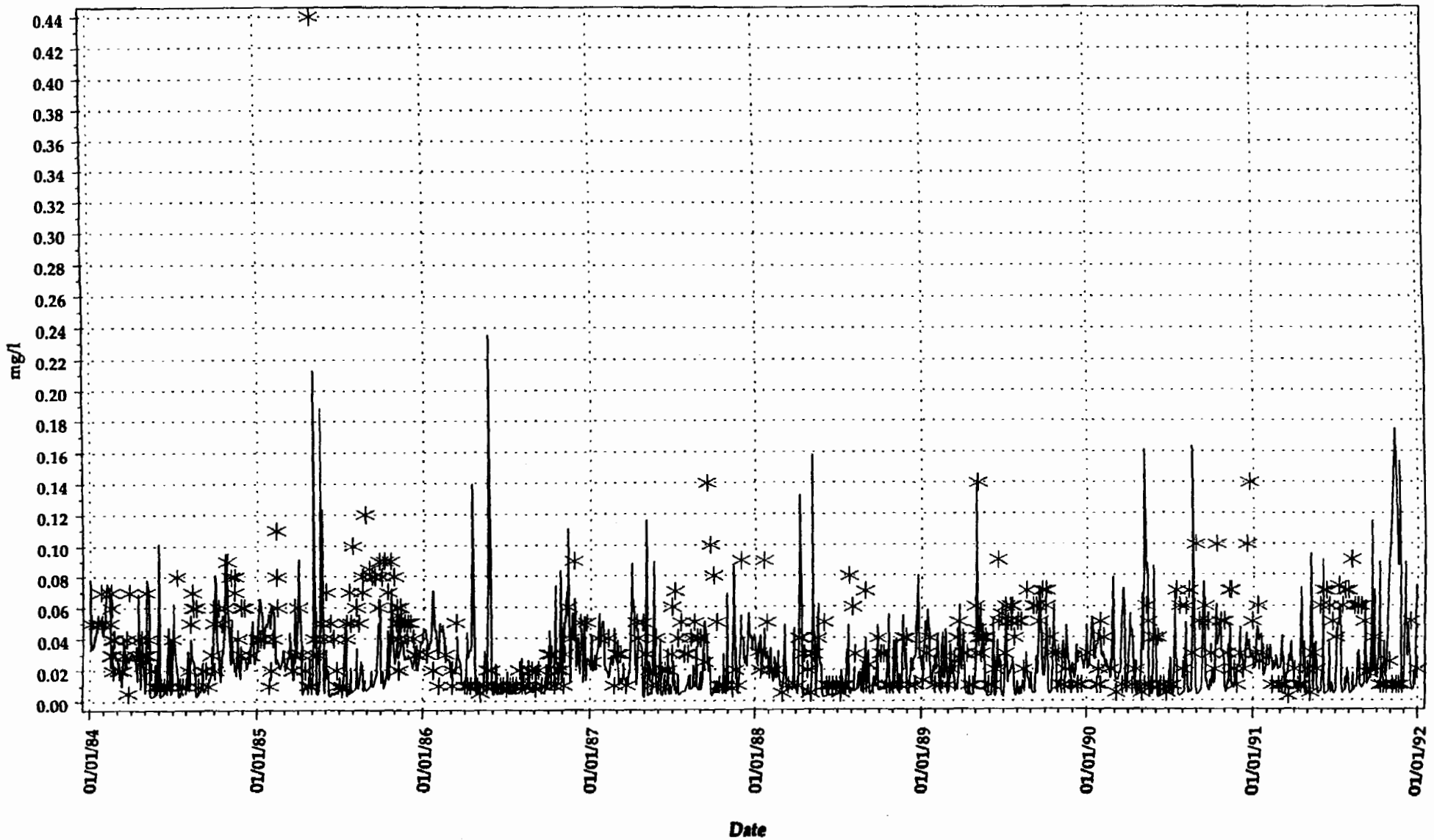


Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data

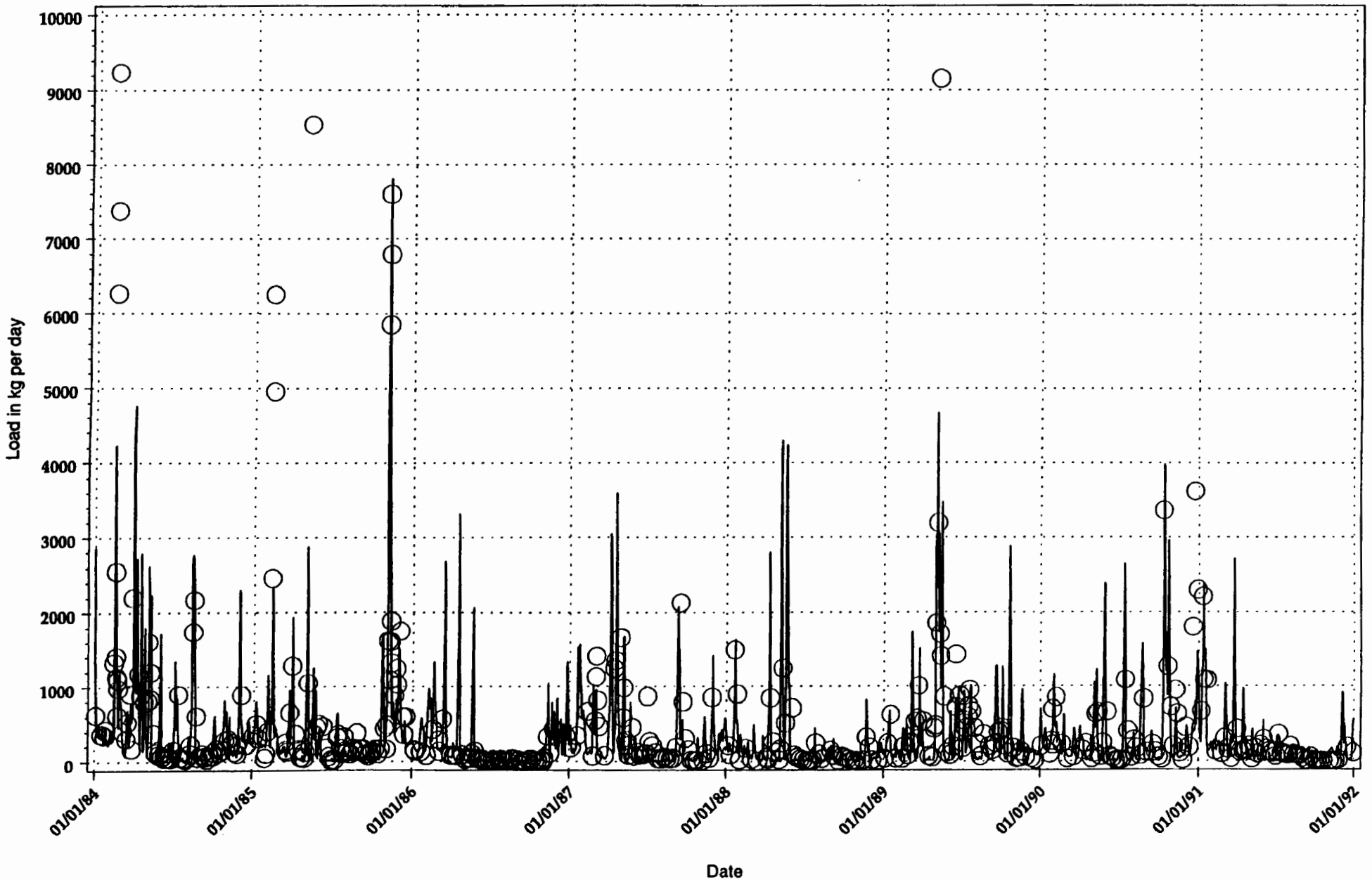


Lower Potomac River at Segment 220
Observed and Simulated versus Time
Dissolved Phosphorus

(*=Observed, -=Simulated)



Lower Potomac River at Segment 220
Dissolved Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

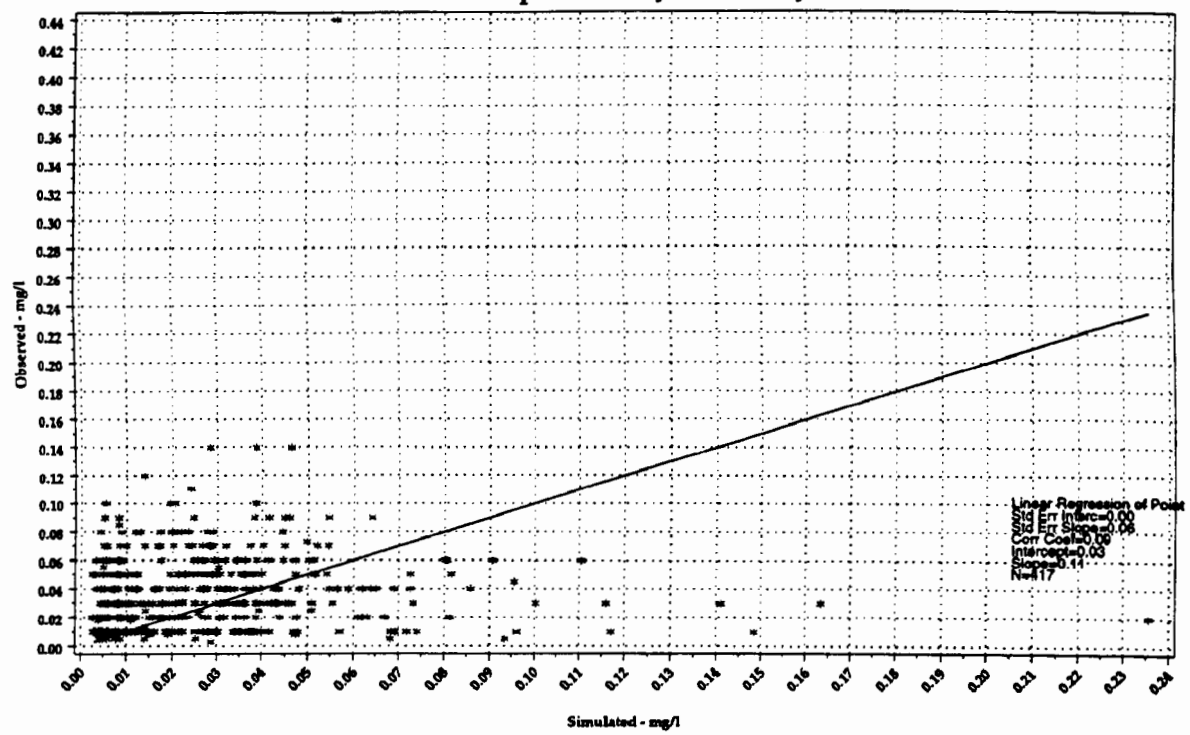


(y21_plot1.sas datastore2.jrps.p3 (jones.sas) lidlas)
(lo dv 03FEB96 15:48 proc reg,model y=x)

Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

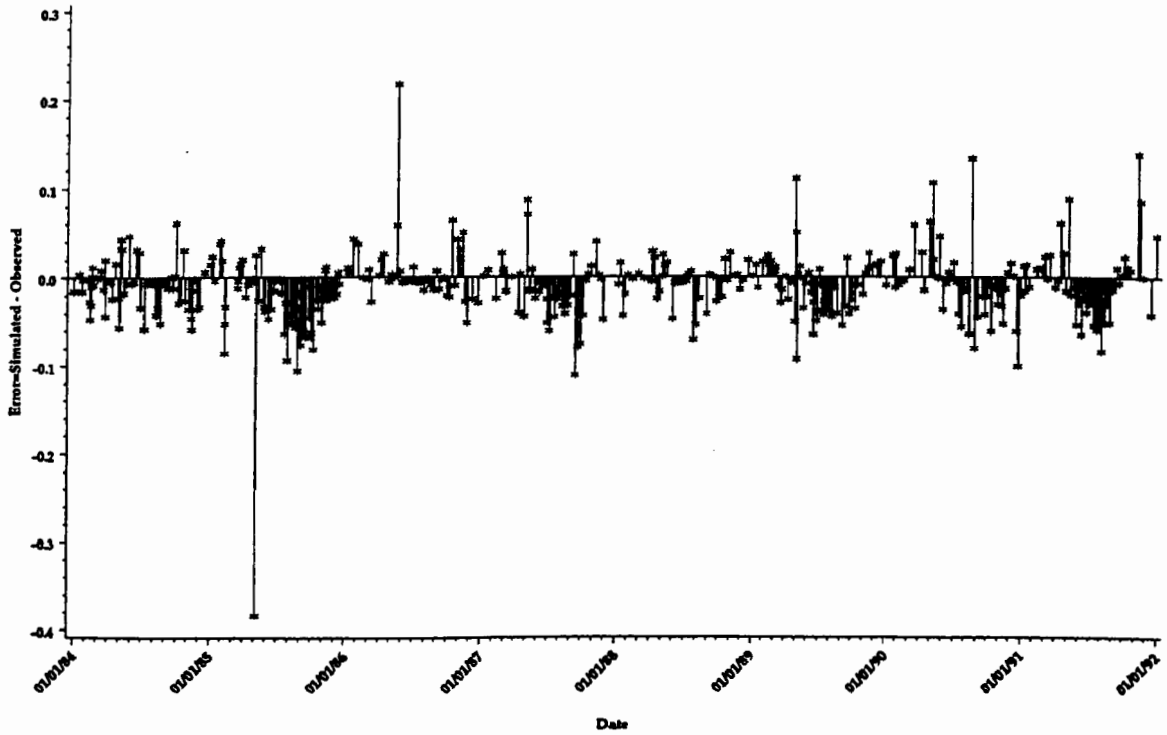
Dissolved Phosphorus: 01JAN84 - 01JAN92



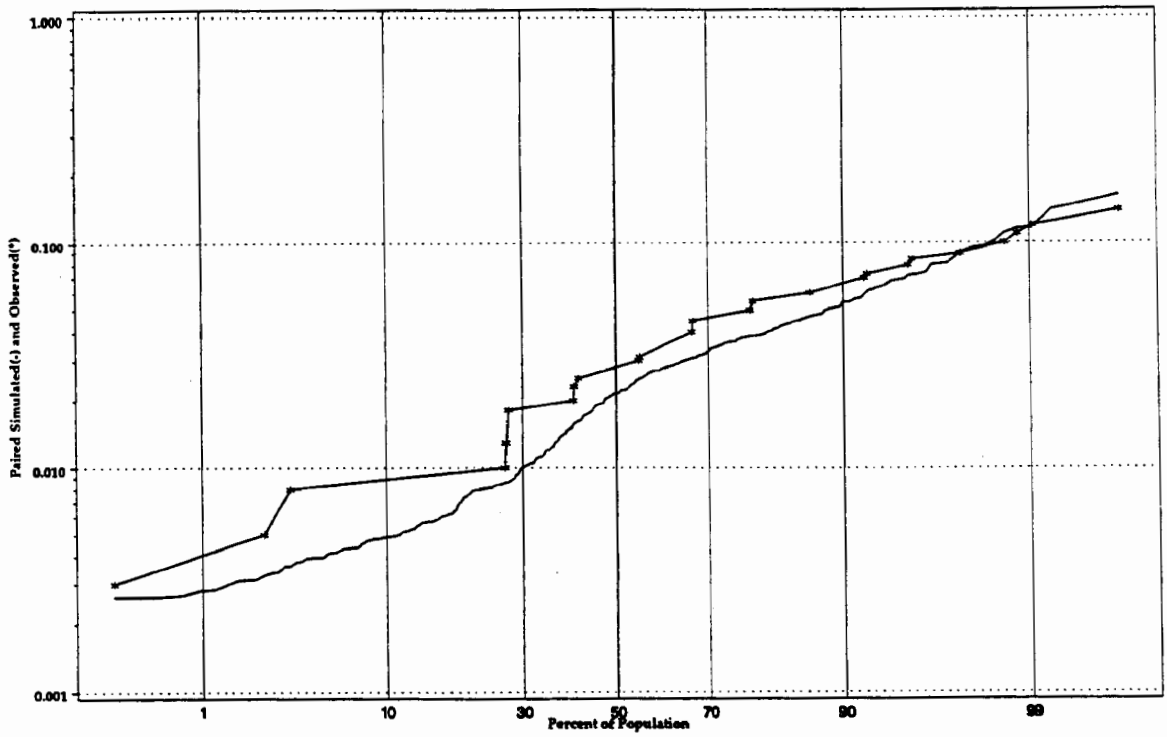
Lower Potomac River at Segment 220

Actual Error versus Time

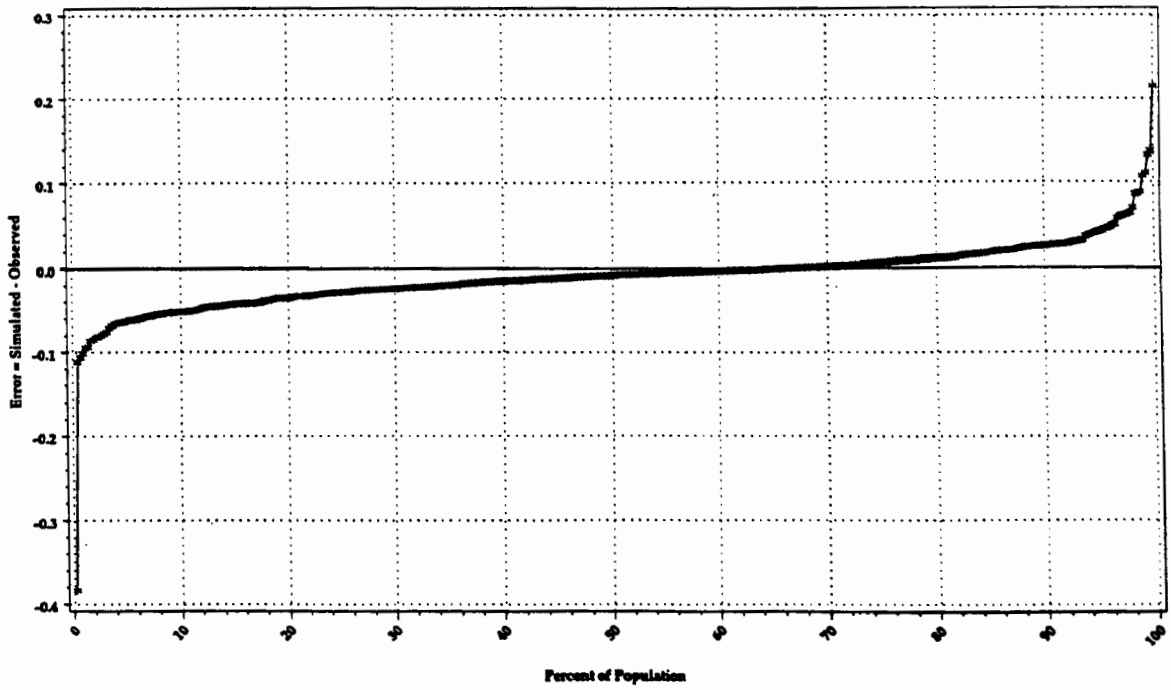
Dissolved Phosphorus



Lower Potomac River at Segment 220
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

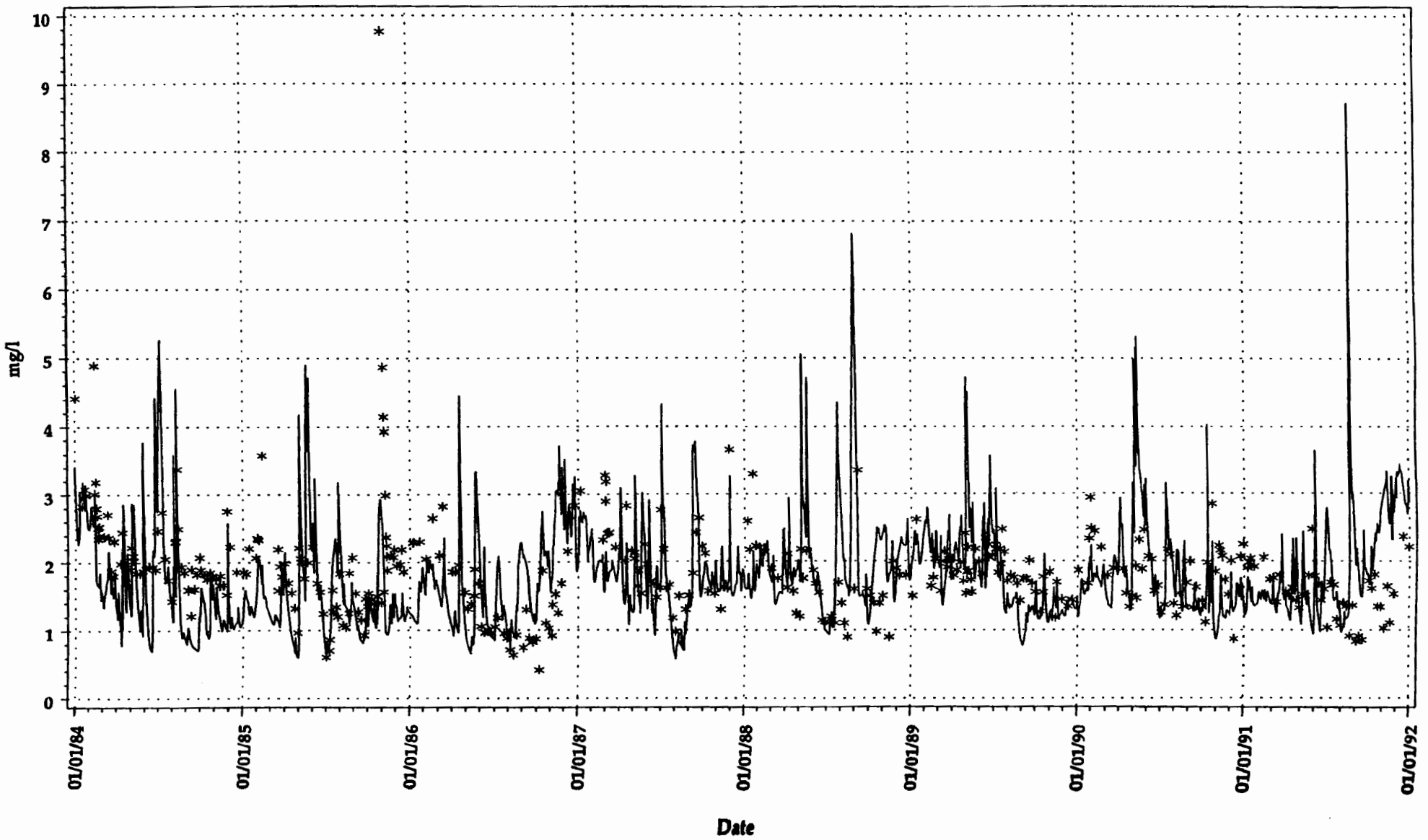


Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



Lower Potomac River at Segment 220
Observed and Simulated versus Time
Total Nitrogen

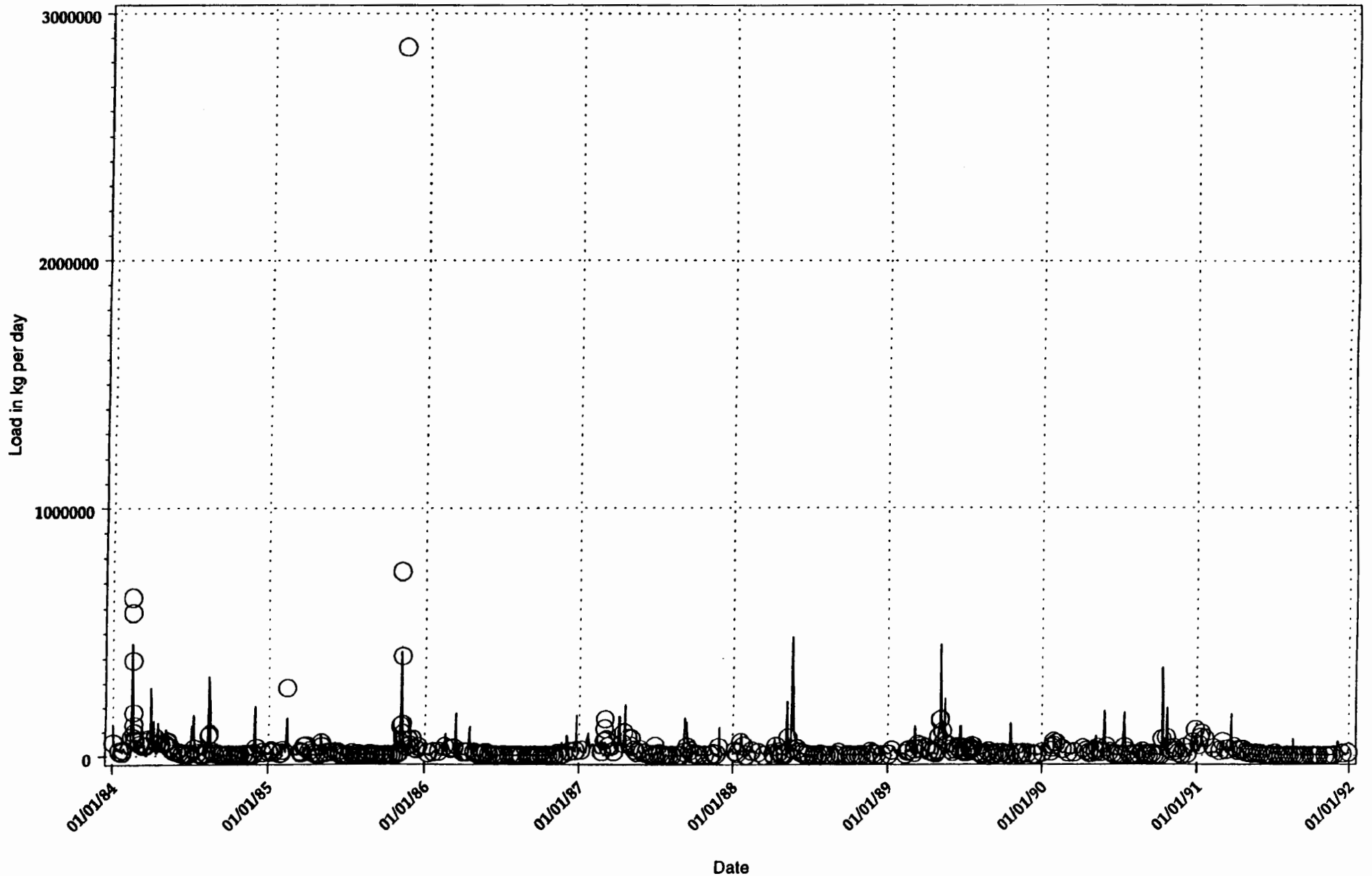
(*=Observed, -=Simulated)



Lower Potomac River at Segment 220

Total Nitrogen Observed and Simulated Load vs Time

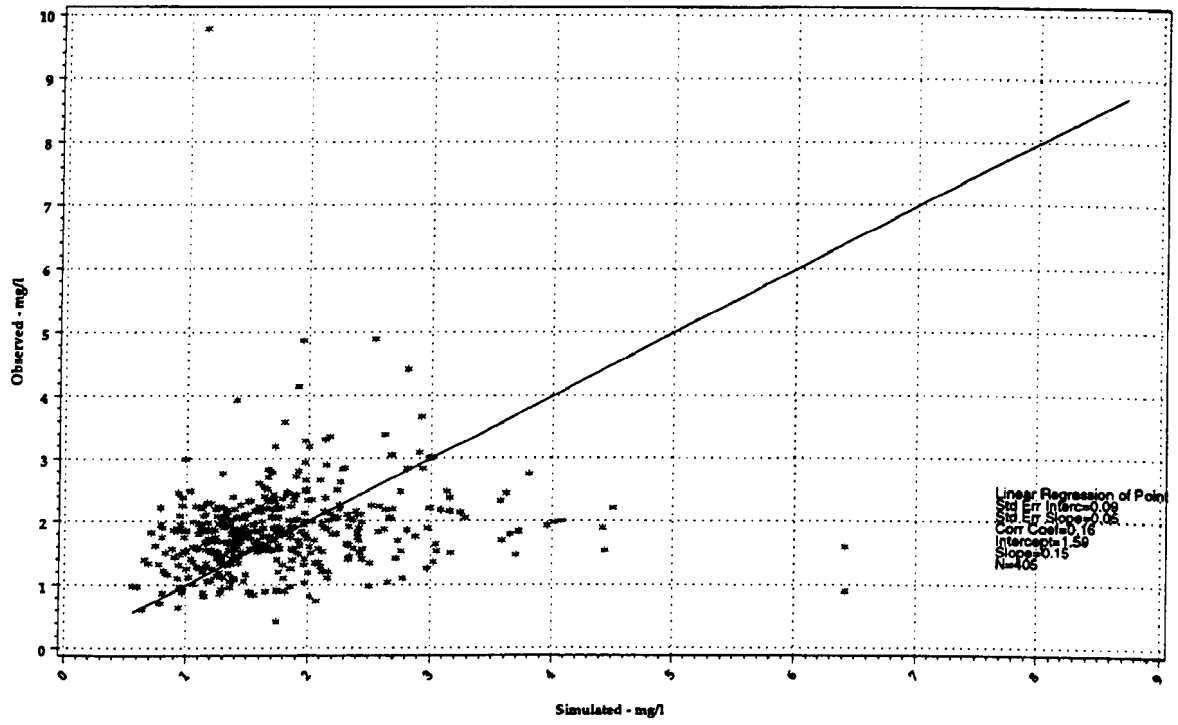
(line = simulated, O = observed)



(y21_plot1 sas datastore2 jrps p3 james.sas) lidlos)
(lo.drv 03FEB96 15:48 proc reg model y=x)

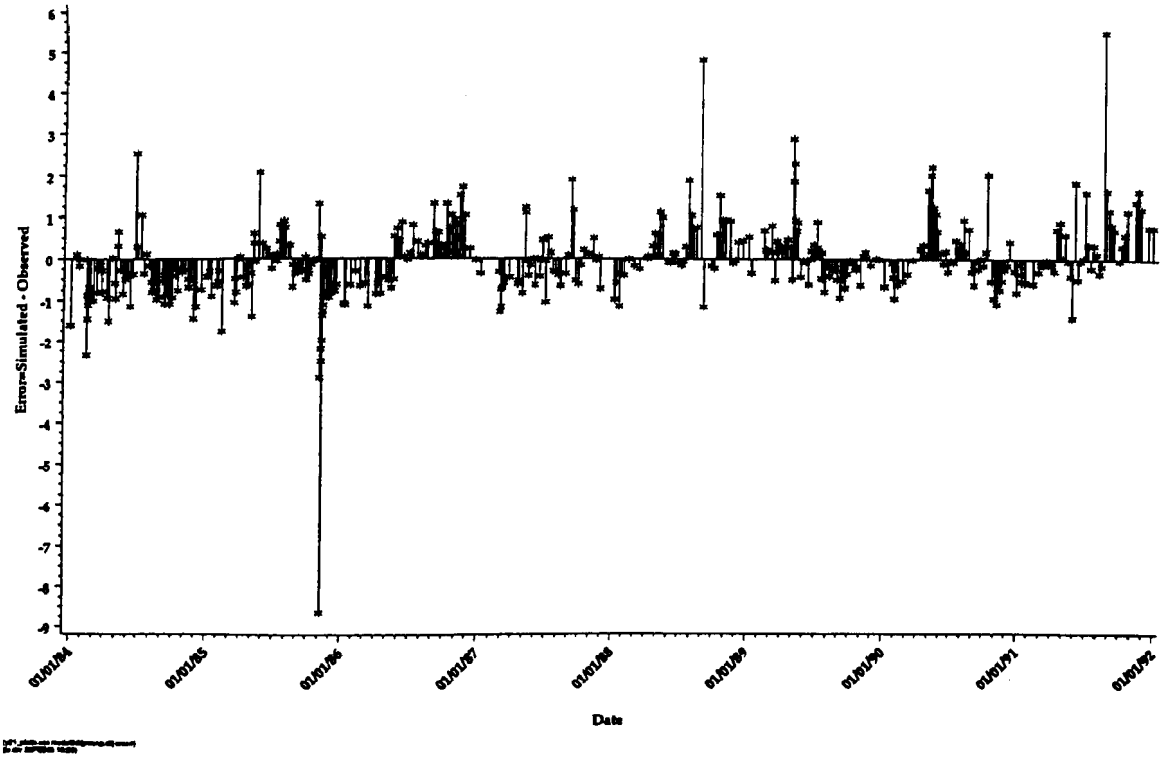
Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Nitrogen: 01JAN84 - 01JAN92

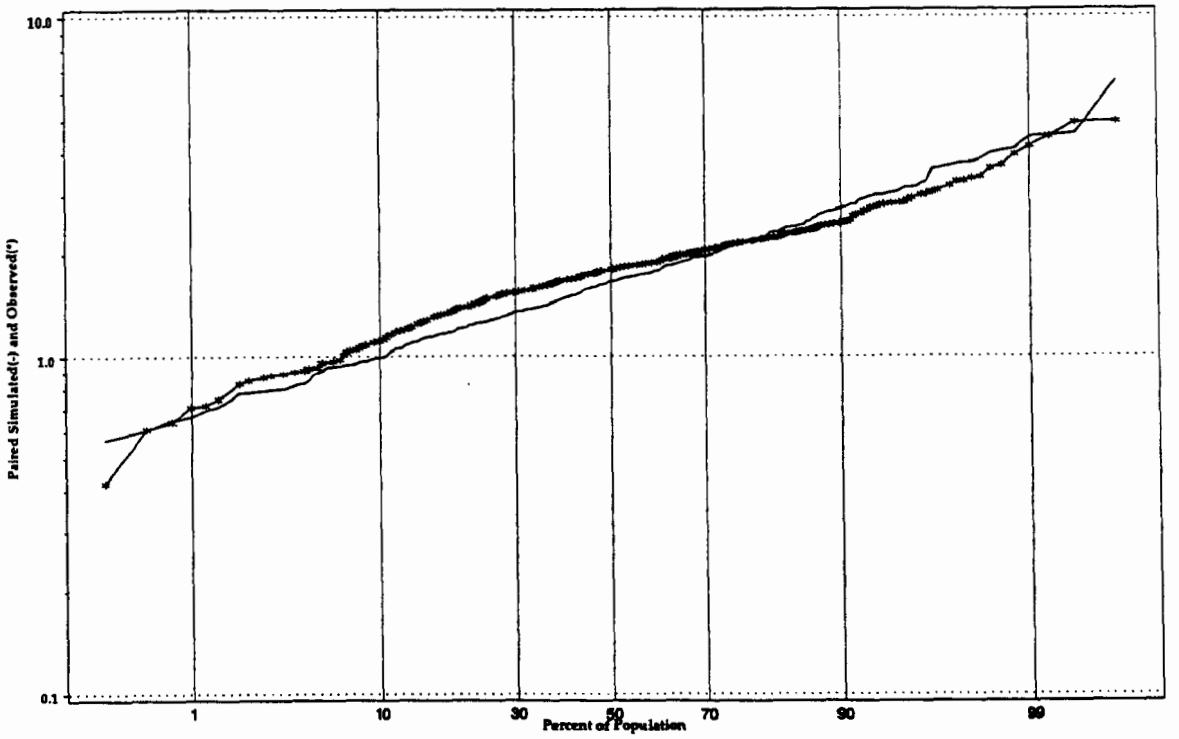


Lower Potomac River at Segment 220

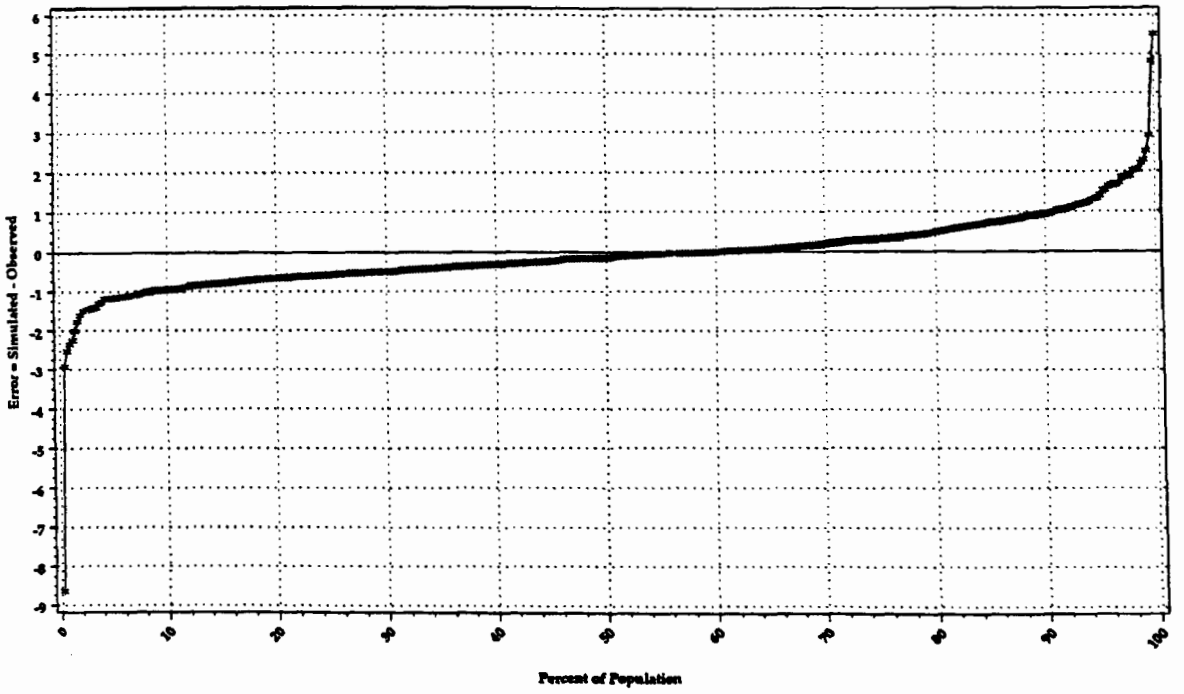
Actual Error versus Time
Total Nitrogen



Lower Potomac River at Segment 220
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

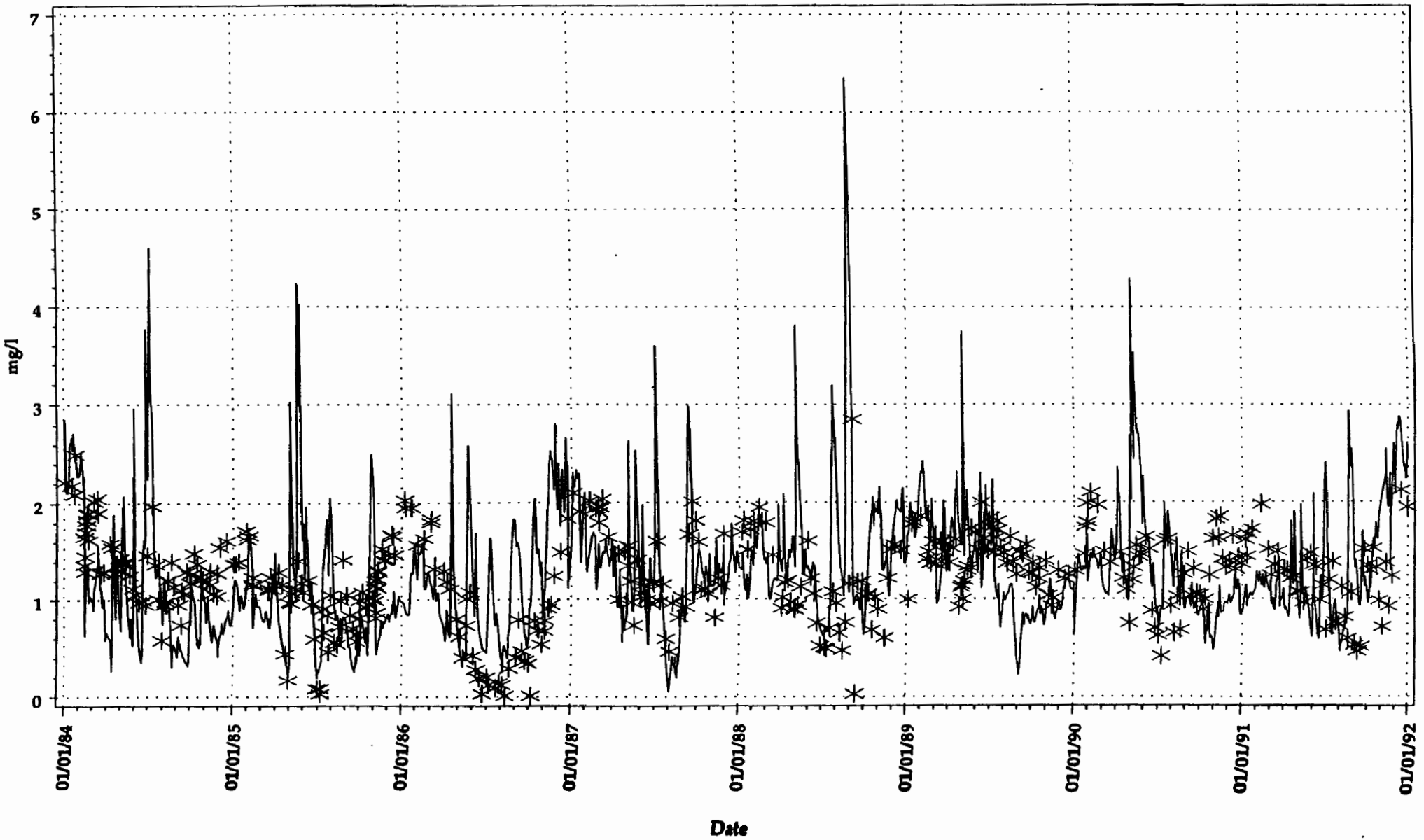


Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data

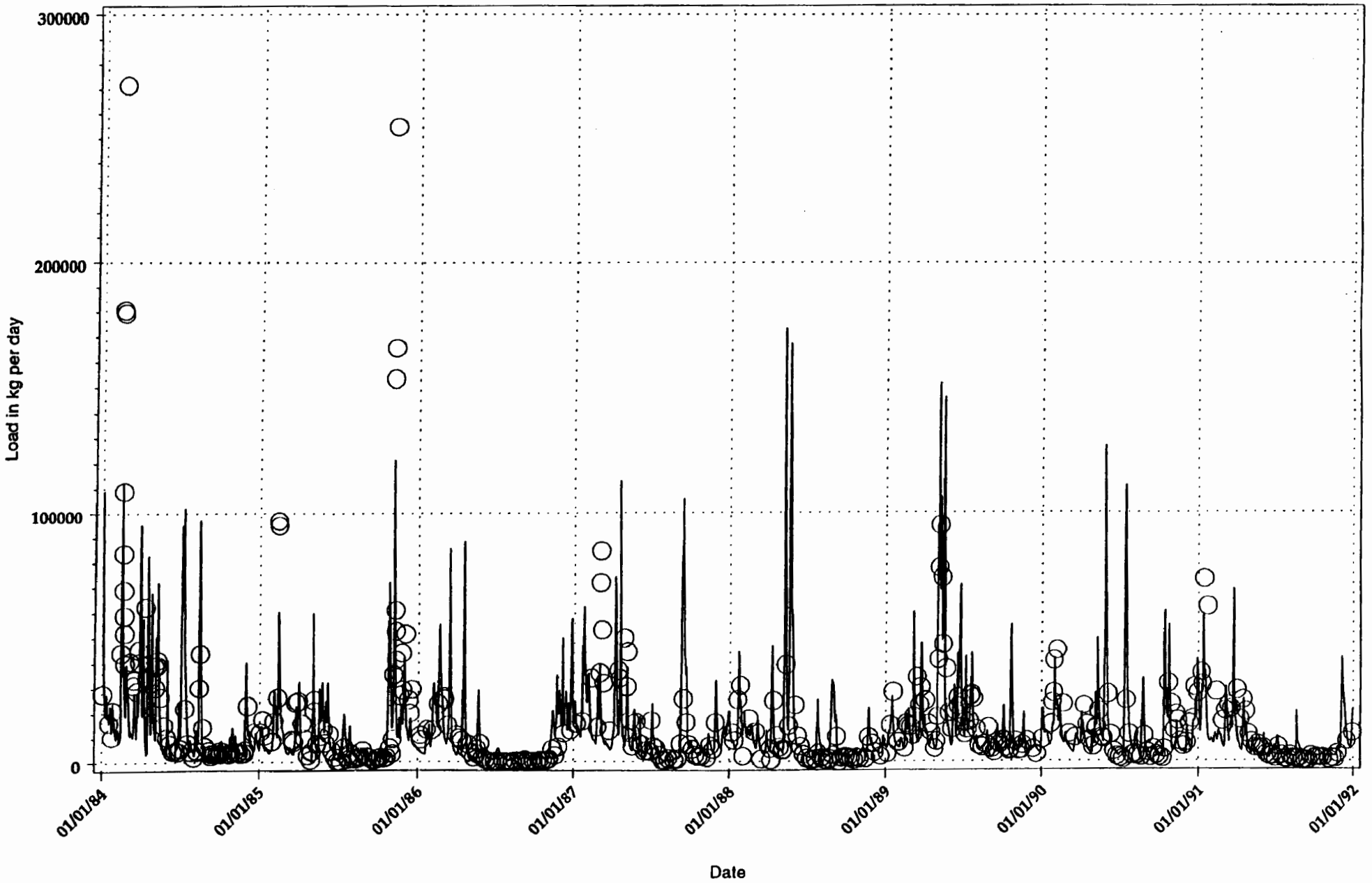


Lower Potomac River at Segment 220
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



Lower Potomac River at Segment 220
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

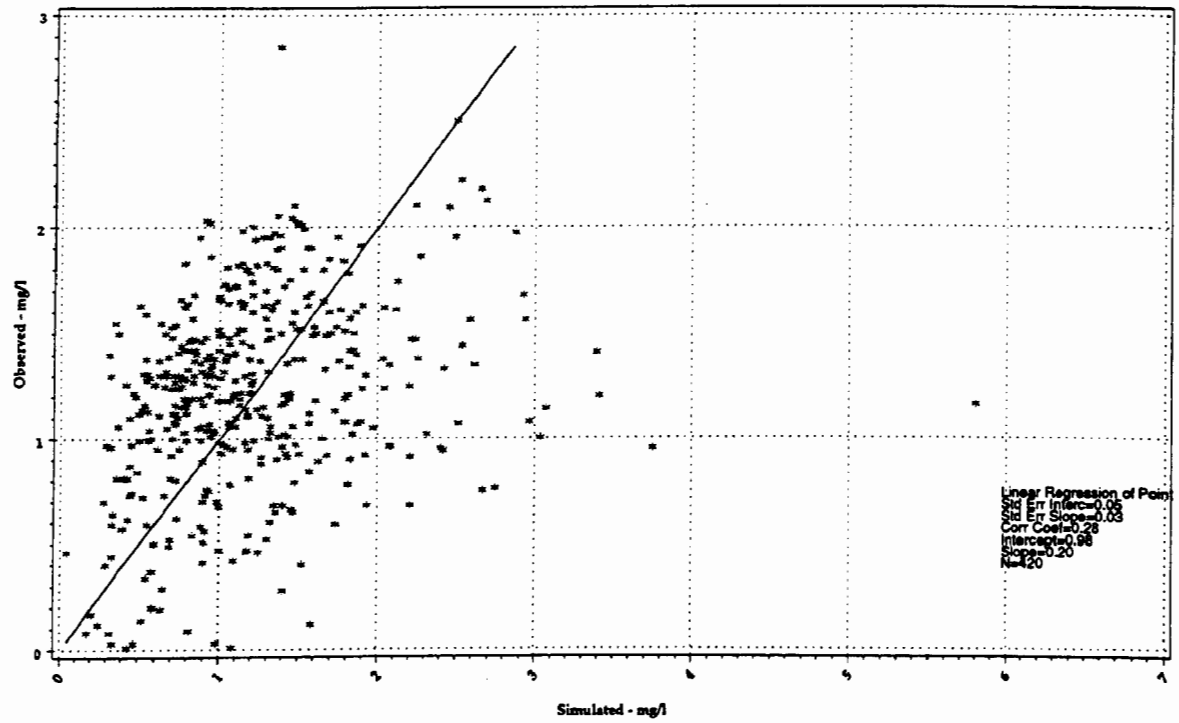


(y21_plot1.sas dataestore2 (npo p3 james.sas) lidlas)
(graph_a drv 03OCT97 12:27 proc reg model y=x)

Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

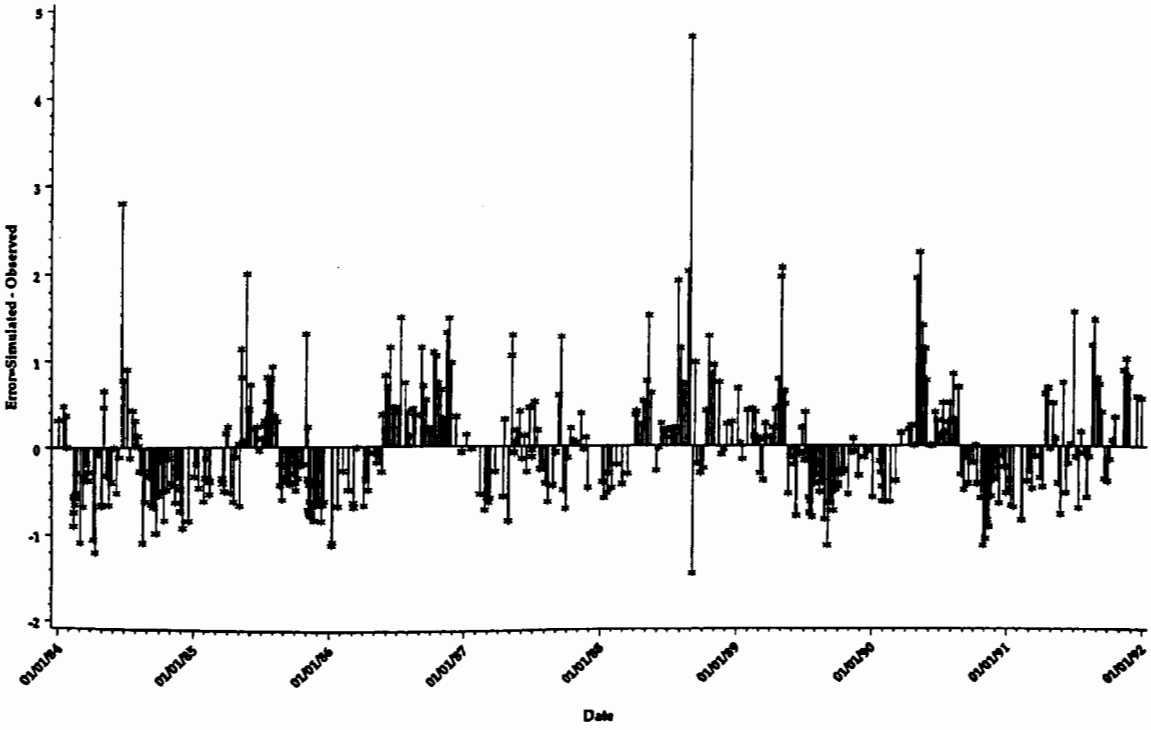
NO3: 01JAN84 - 01JAN92



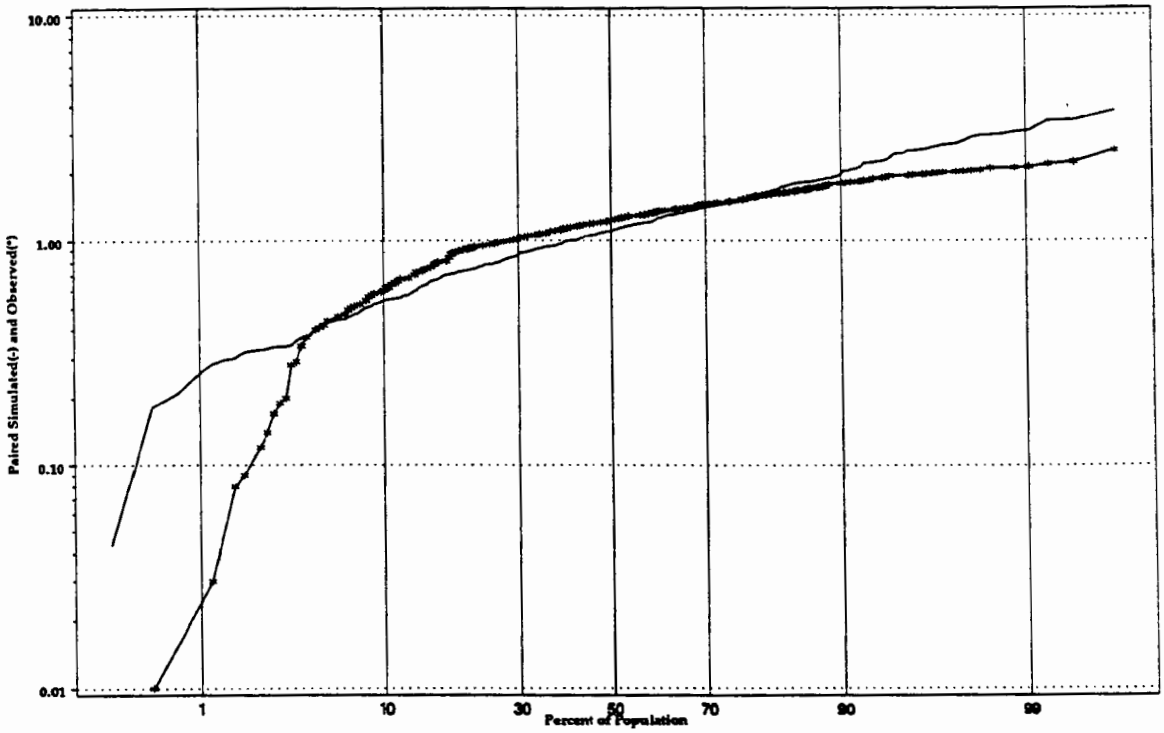
Lower Potomac River at Segment 220

Actual Error versus Time

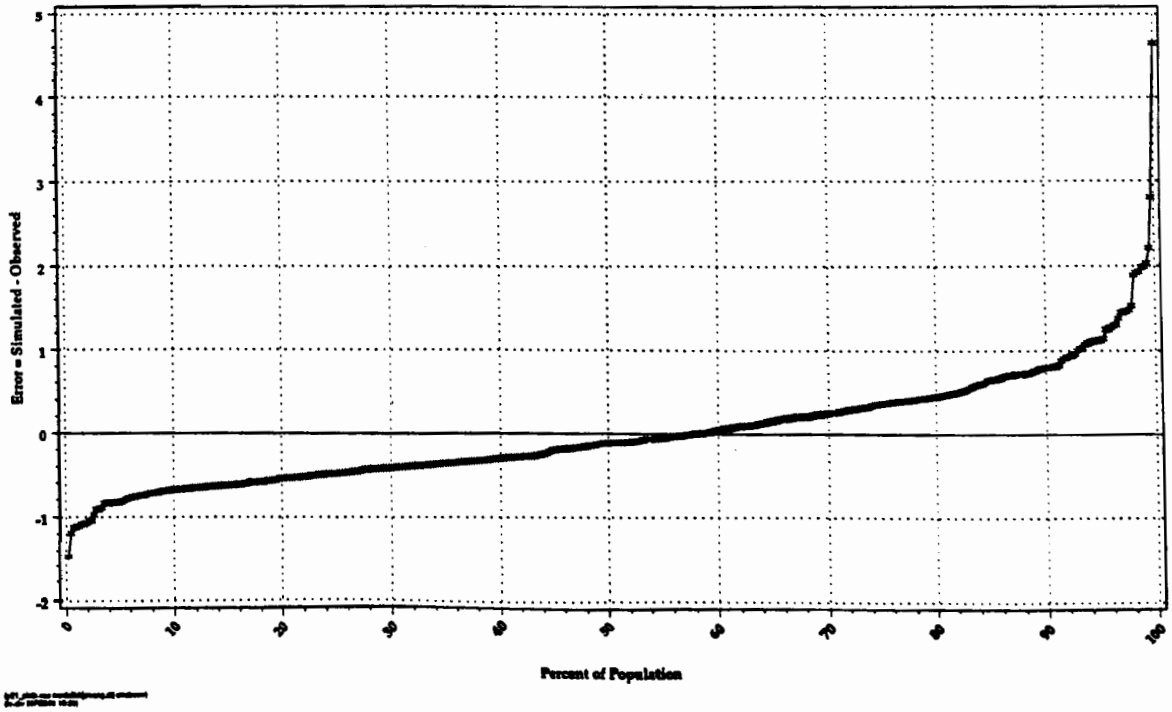
NO3



Lower Potomac River at Segment 220
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

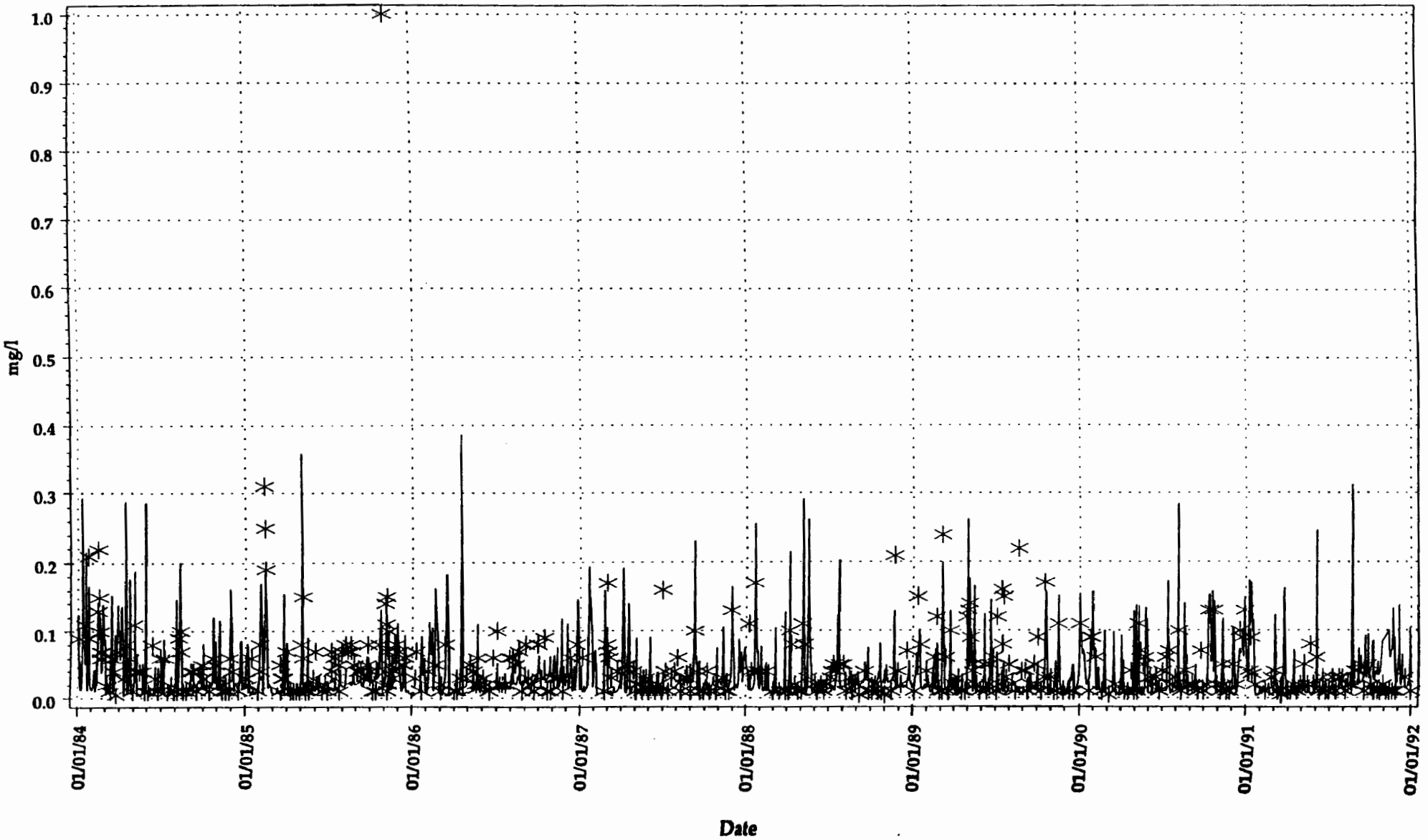


Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data

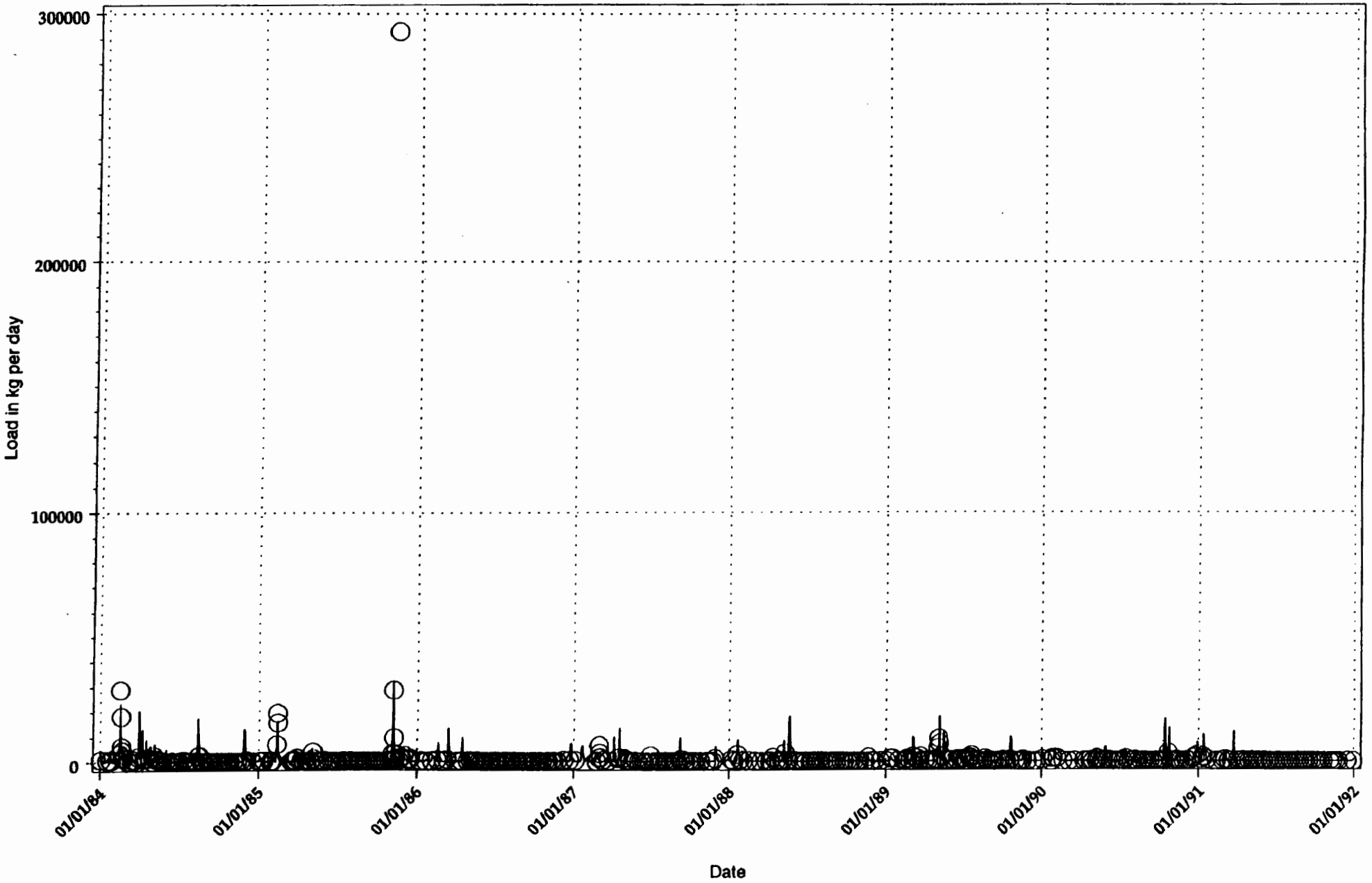


Lower Potomac River at Segment 220
Observed and Simulated versus Time
Total Ammonia

(*=Observed, -=Simulated)



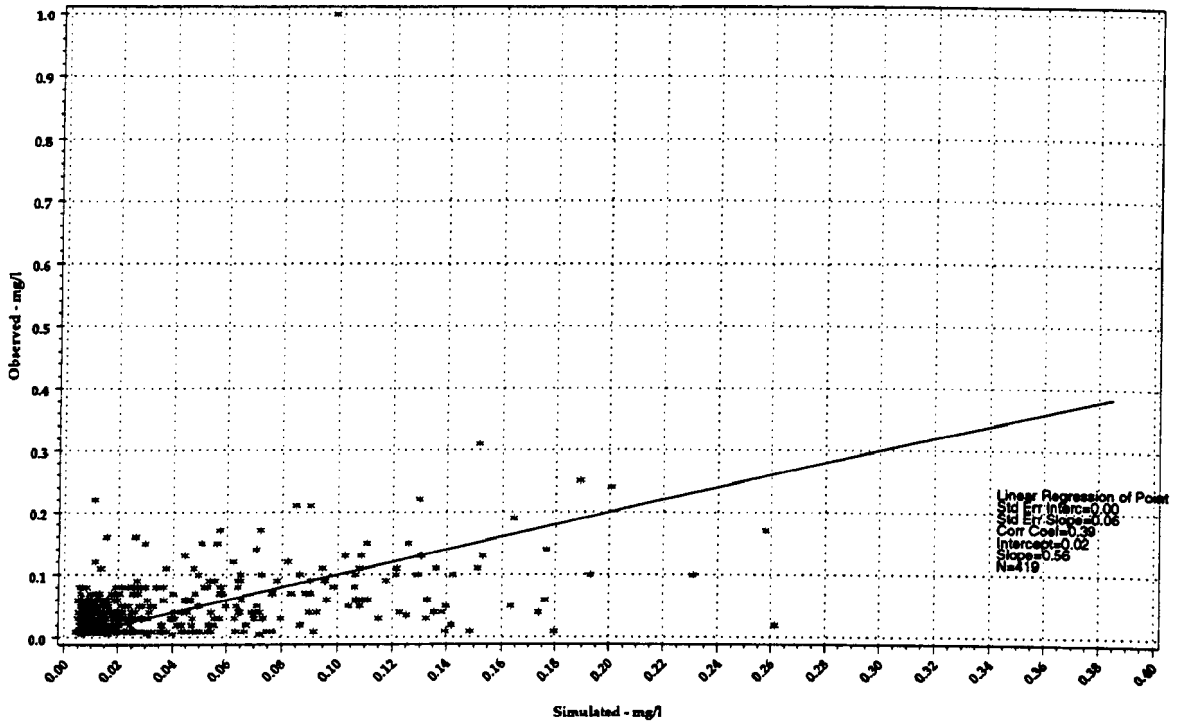
Lower Potomac River at Segment 220
Total Ammonia Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plot1.sas datastore2.jnpc.p3.james.sas) 8dflat)
(graph_a drv 03OCT97 12:27.psoc reg.model y=x)

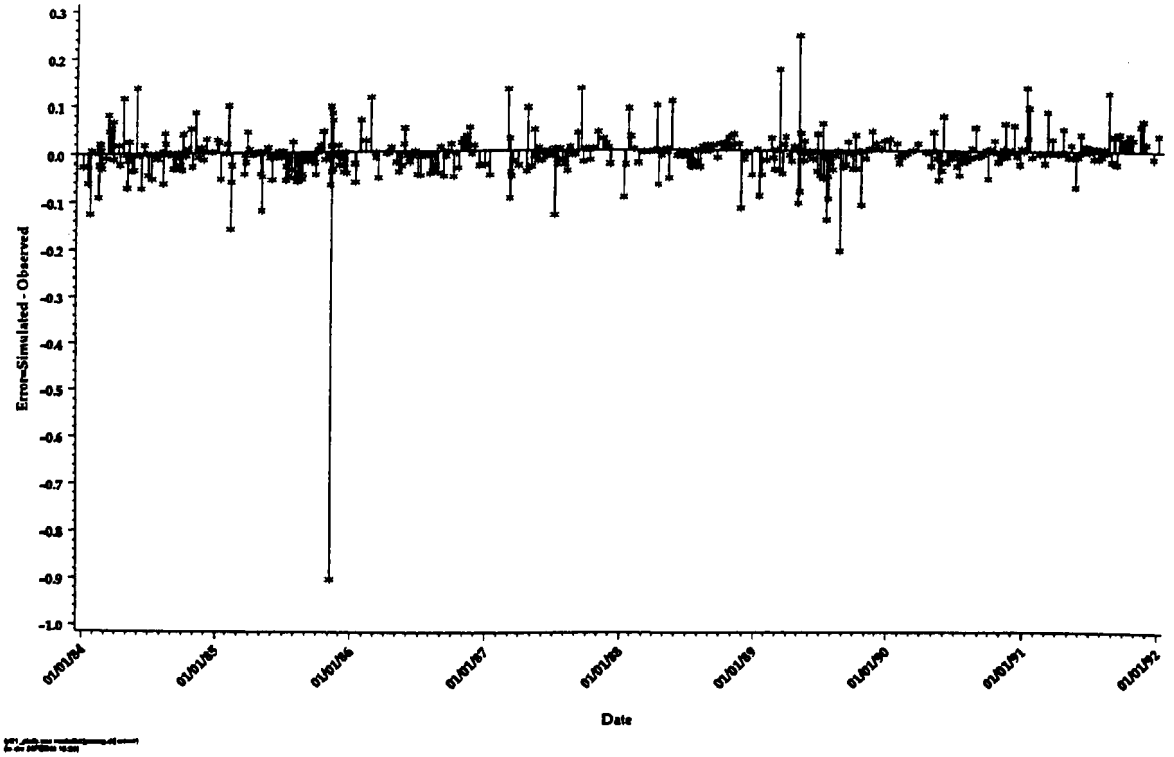
Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Ammonia: 01JAN84 - 01JAN92

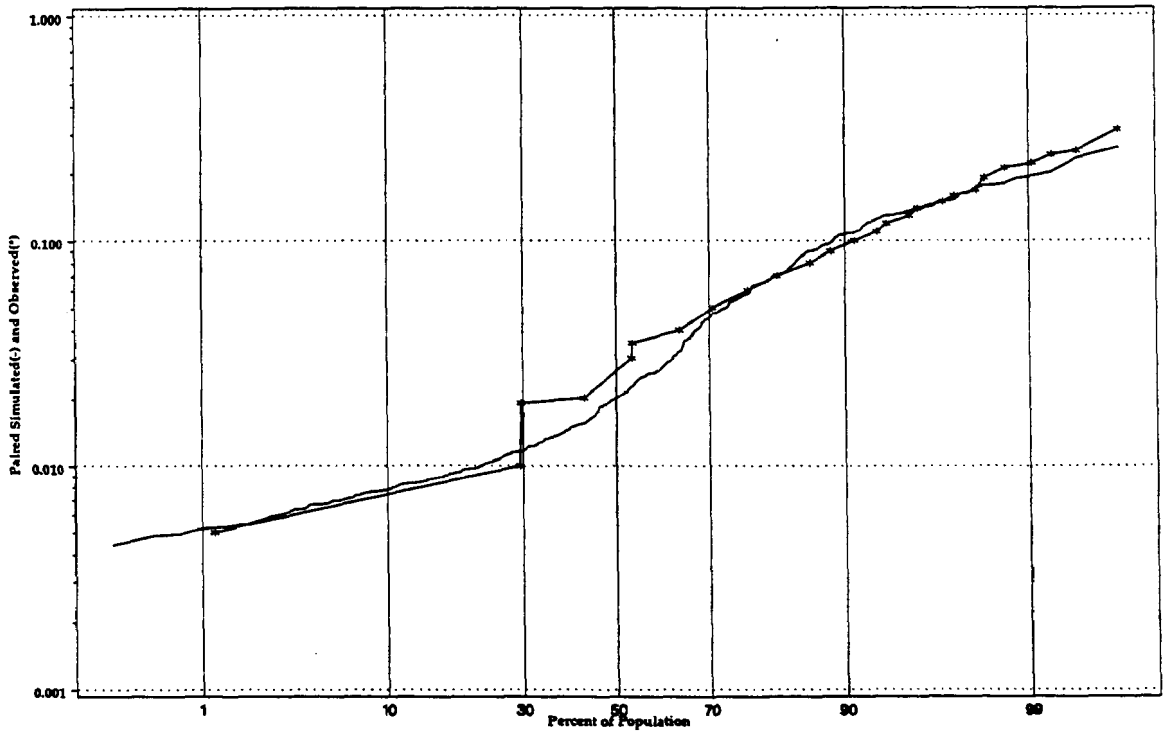


Lower Potomac River at Segment 220

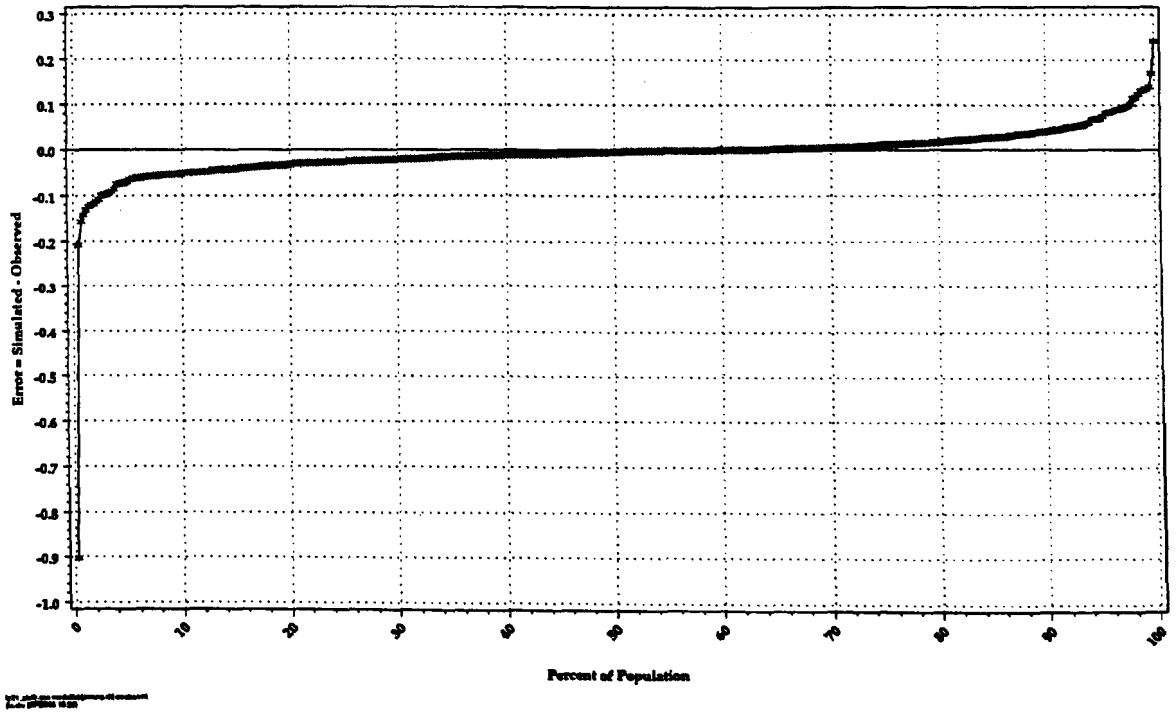
Actual Error versus Time
Total Ammonia



Lower Potomac River at Segment 220
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data

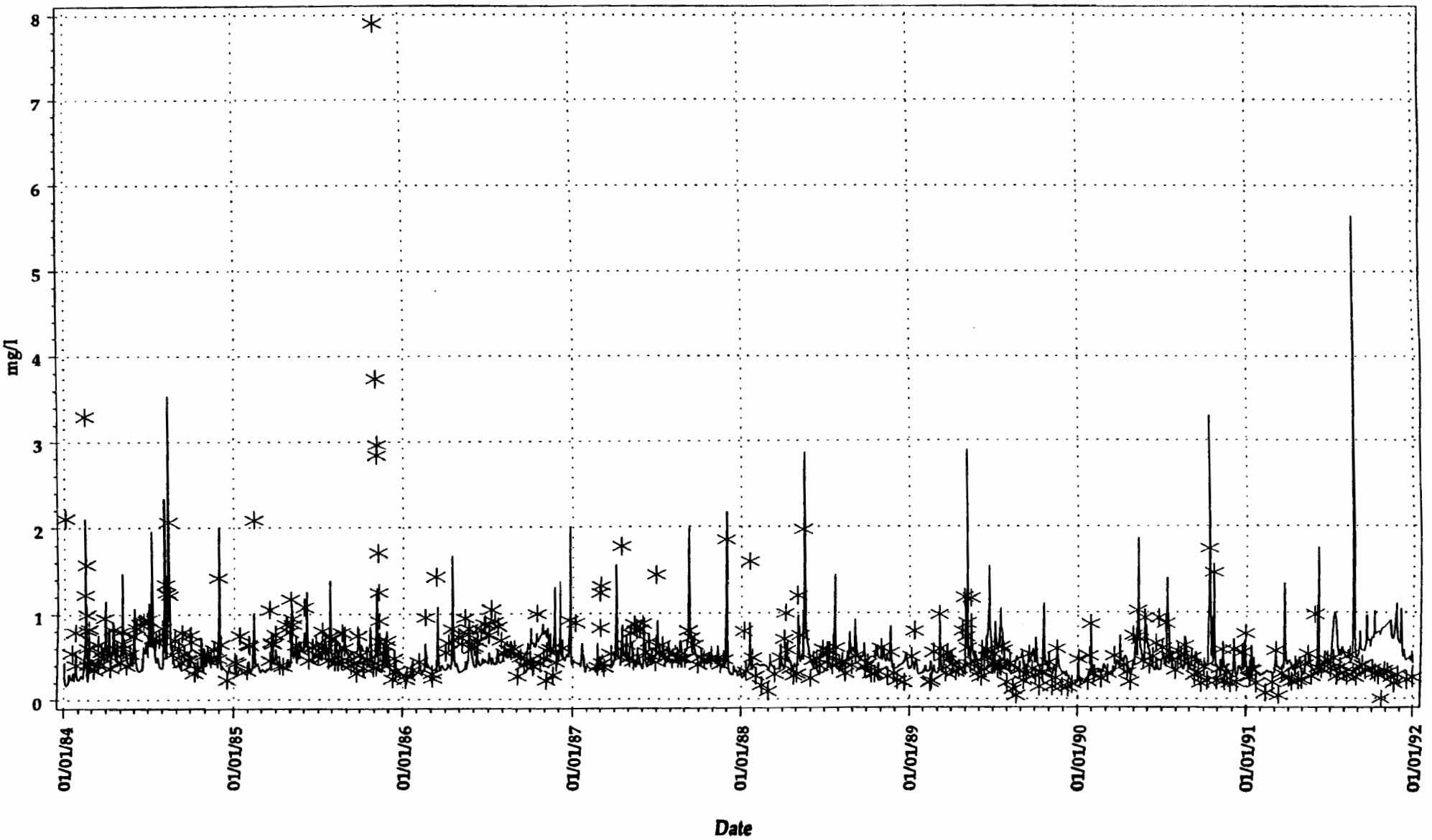


Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



Lower Potomac River at Segment 220
Observed and Simulated versus Time
Organic Nitrogen

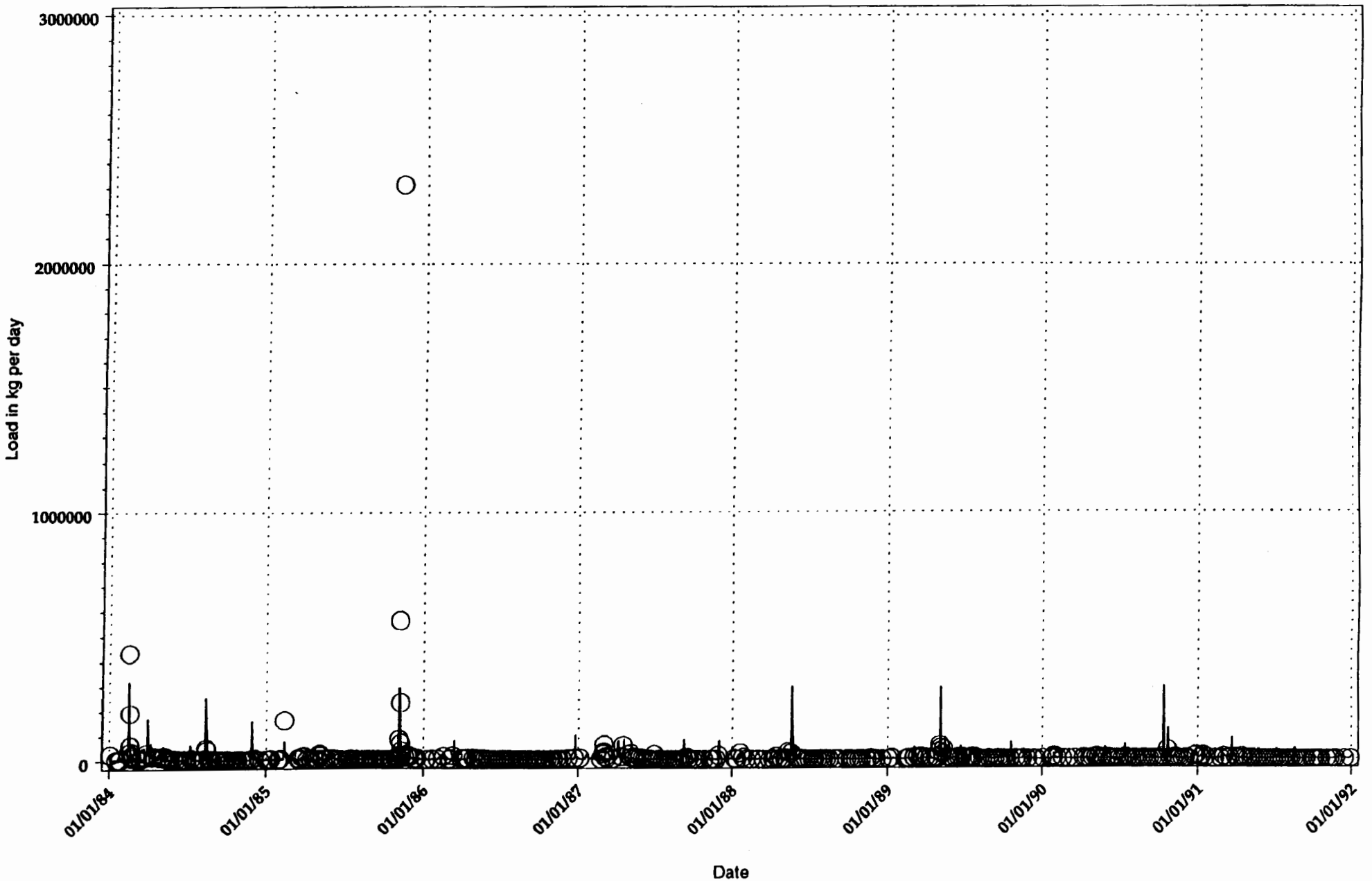
(*=Observed, -=Simulated)



Lower Potomac River at Segment 220

Organic Nitrogen Observed and Simulated Load vs Time

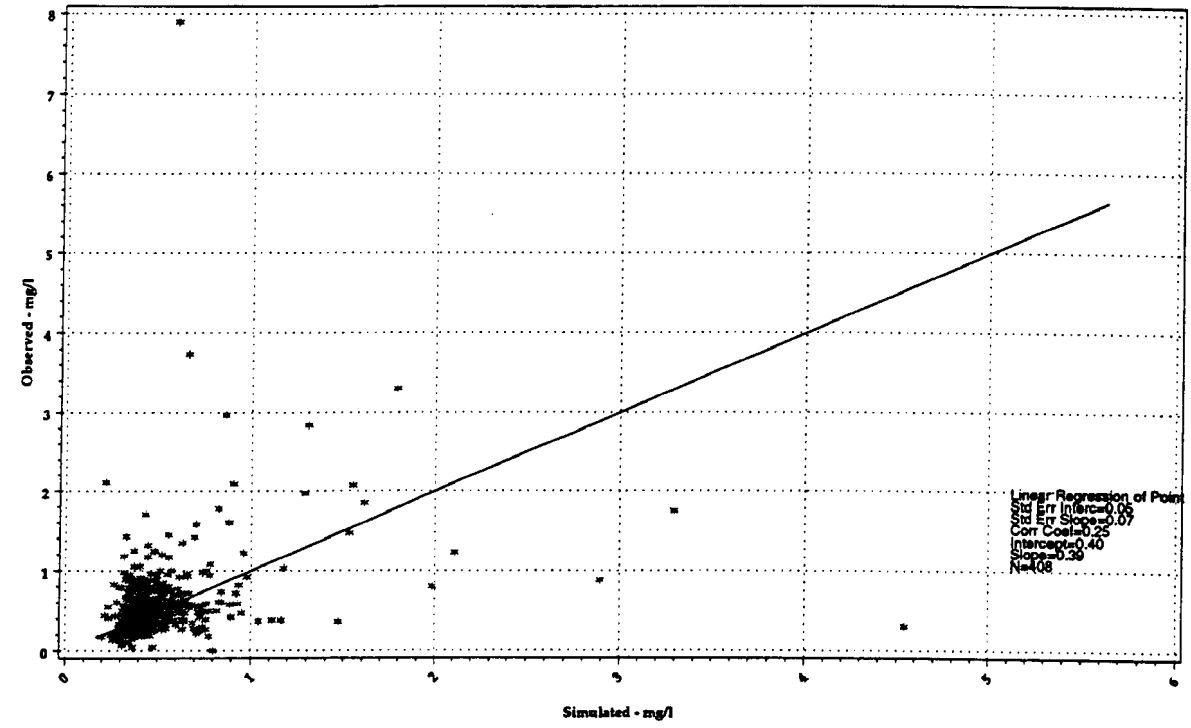
(line = simulated, O = observed)



(y21_plot1.sas dataslore2 (ppc p3 james sas) 8dflos)
(graph_a.dev 02OCT97 12:27 proc reg model y=x)

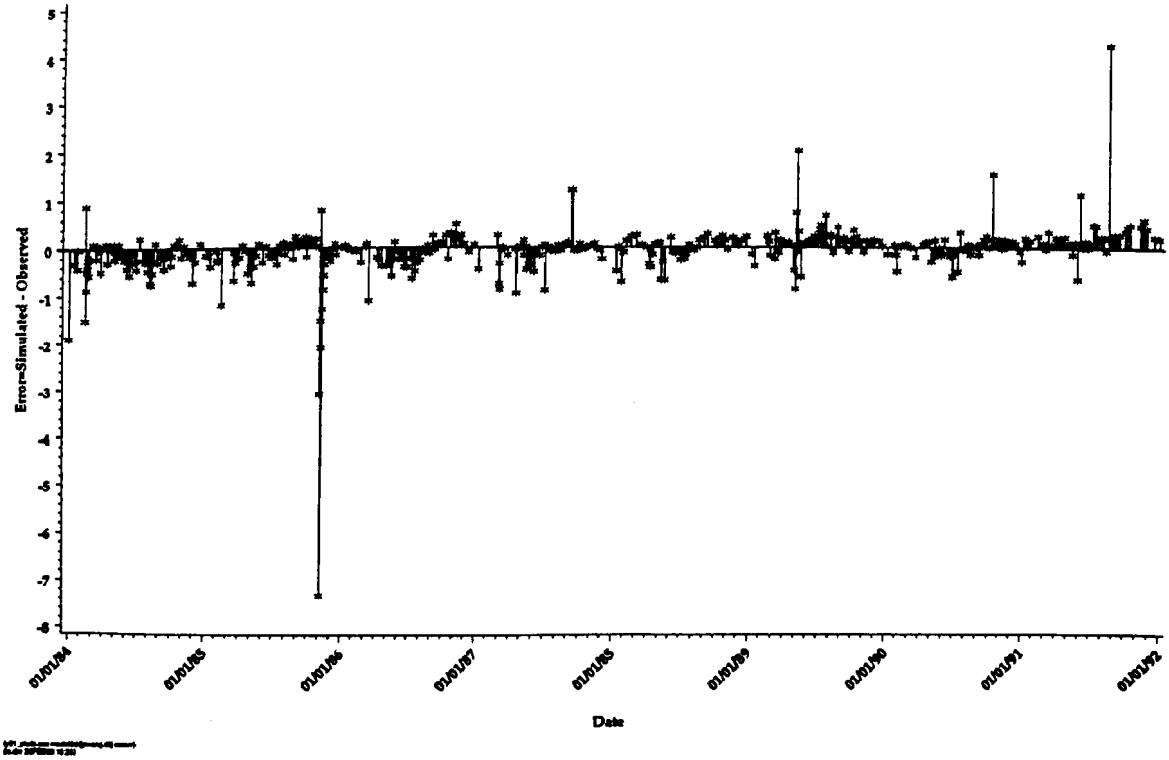
Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Organic Nitrogen: 01JAN84 - 01JAN92

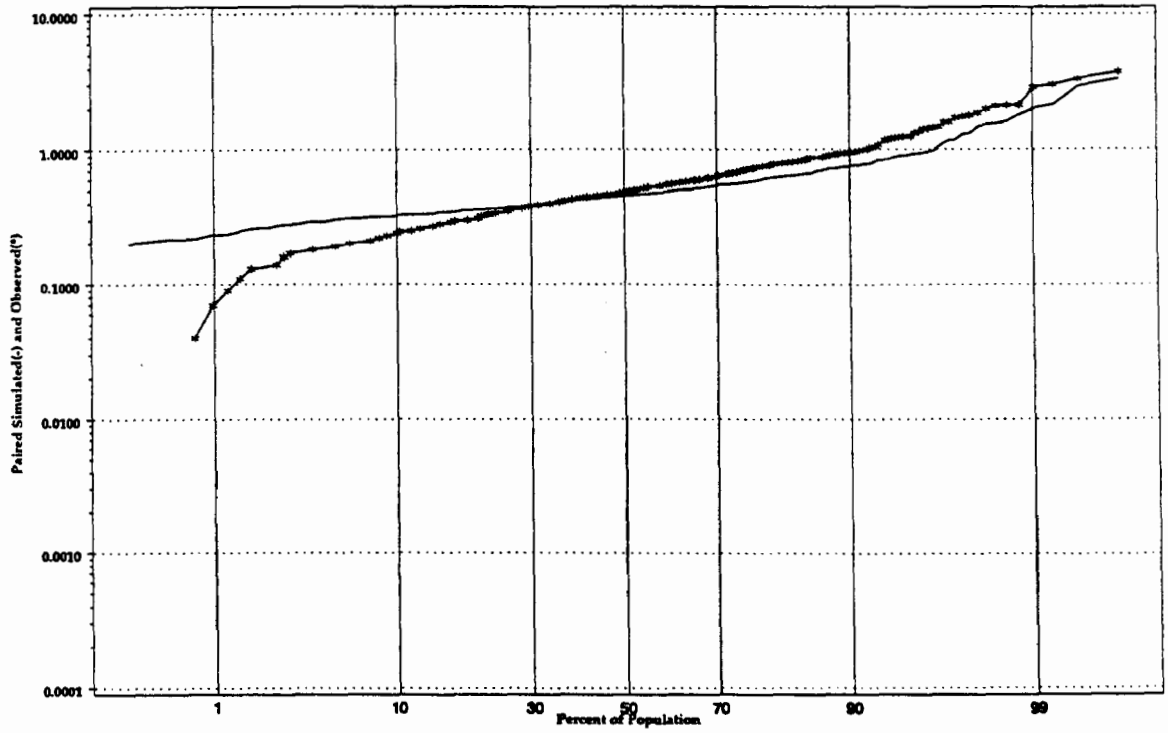


Lower Potomac River at Segment 220

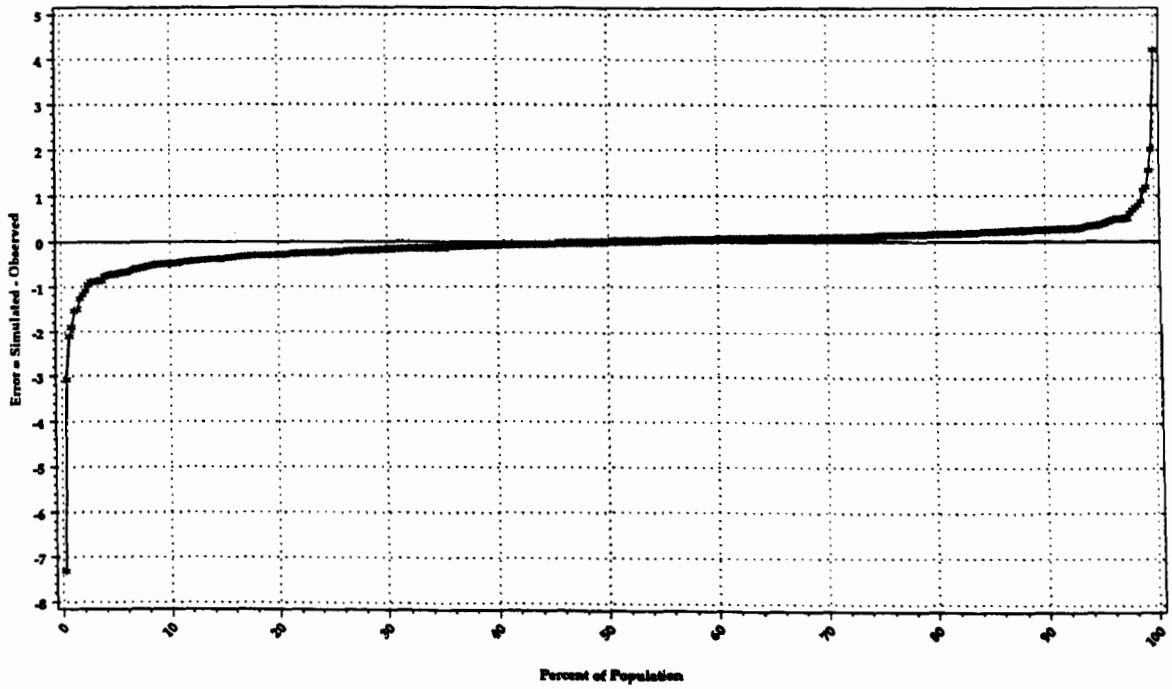
Actual Error versus Time
Organic Nitrogen



Lower Potomac River at Segment 220
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.4.0 Rappahannock River Basin

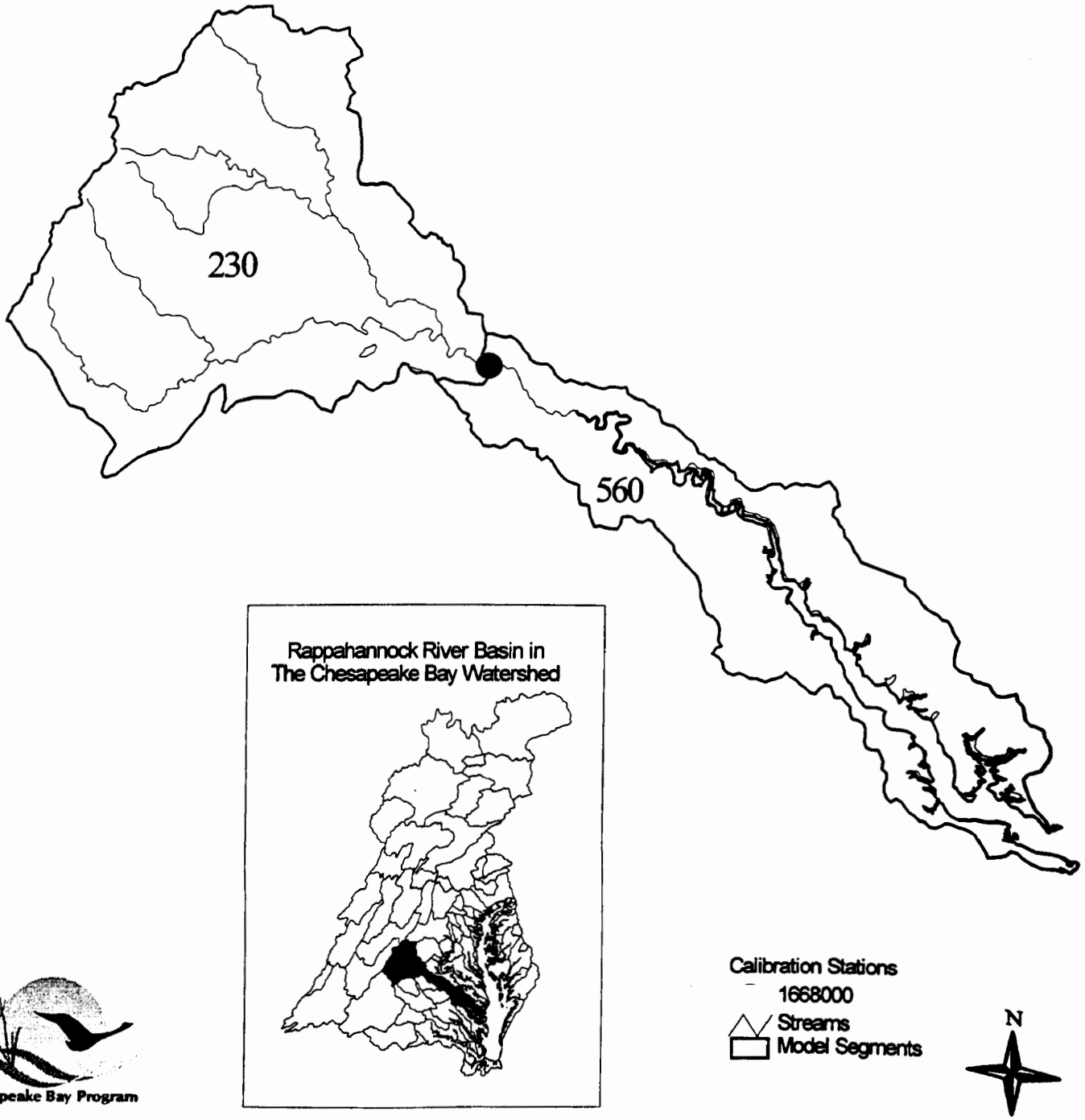
Basin Segments:

Above Fall Line Basin Segments: 230
Below Fall Line Basin Segments: 560

Section Contents:

B.4.0 Monitoring Stations in the Rappahannock River Basin (Figure B.4.0)
B.4.1 Rappahannock River (Monitoring Station: 1668000)

Monitoring Stations in the Rappahannock River Basin



Chesapeake Bay Program

Map Date: April 1998

Source: USGS and USEPA Chesapeake Bay Program

B.4.1 Rappahannock River near Fredericksburg, VA at Segment 230 (Monitoring Station: 1668000) (Above Fall Line Basin Segments: 230)

Section Summary:

The Rappahannock basin is largely rural in character and is dominated by agricultural loads. Concentrations of total nitrogen, total phosphorus, and total suspended solids are generally low. Water quality observations increased and were oriented toward storm weighted sampling after 1989. Model calibration focused primarily on the refined, storm weighted sampling after 1989.

The Rappahannock basin above the gaged site covers an area of 2,582 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 55% forest land, 12% cropland, 26% other agricultural areas, 6% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 5.3 million pounds in 1985 to 5.0 million pounds in 1996. Total phosphorus loads over the same time period decreased from 0.55 million pounds to 0.46 million pounds. In general, point source loads above the gage site decreased. In 1996, the total nitrogen point source load was 4% of the total load and the total phosphorus point source load was 7% of the total load. Estimated septic system total nitrogen loads increased 38%, from 0.13 million pounds in 1985 to 0.18 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 18%, and other agricultural loads (primarily pasture and manure loads) by 5%. Total phosphorus decreased for these land uses by 25% and 2% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 23% for total nitrogen and 25% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

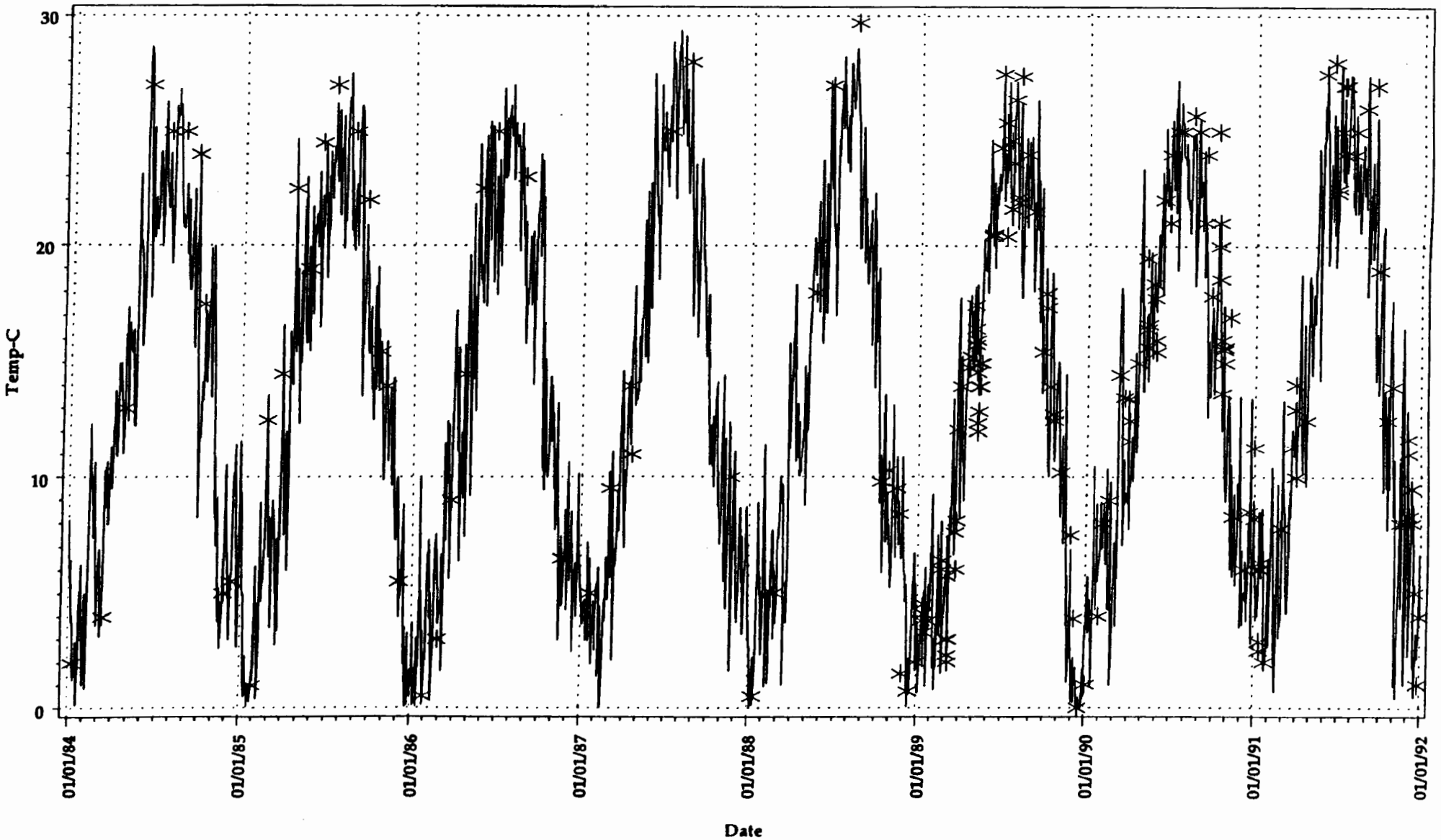
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

Rappahannock River at Segment 230
Observed and Simulated versus Time
Temperature-C

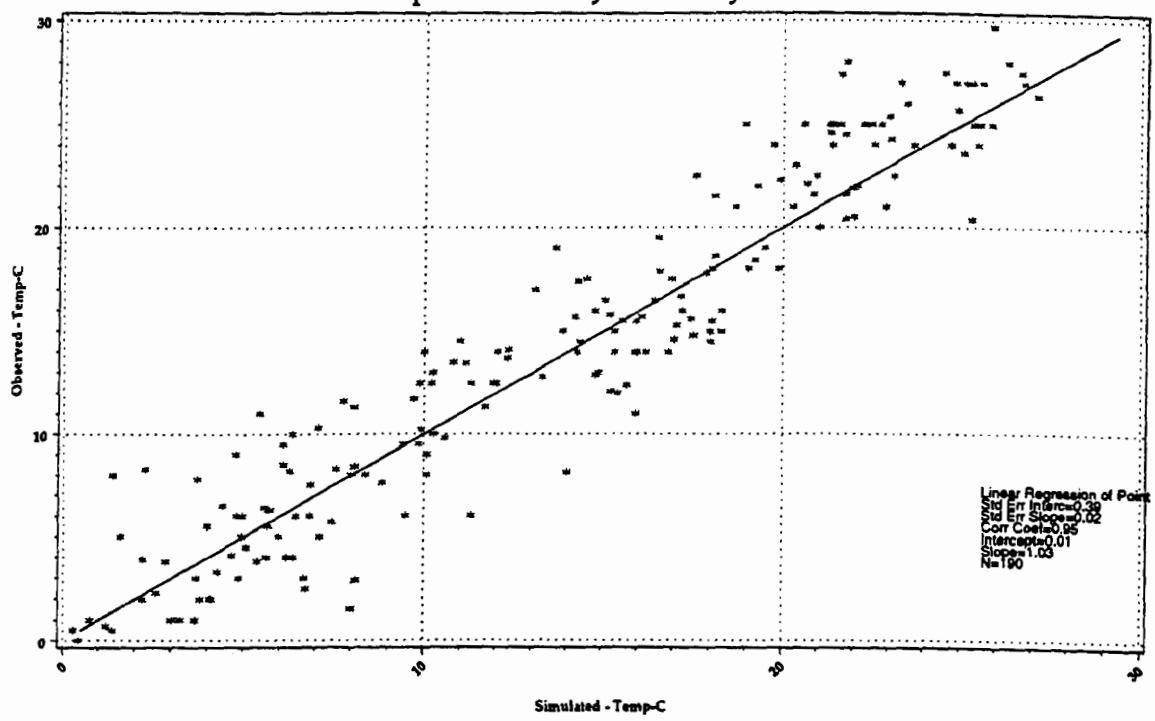
(*=Observed, -=Simulated)



Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

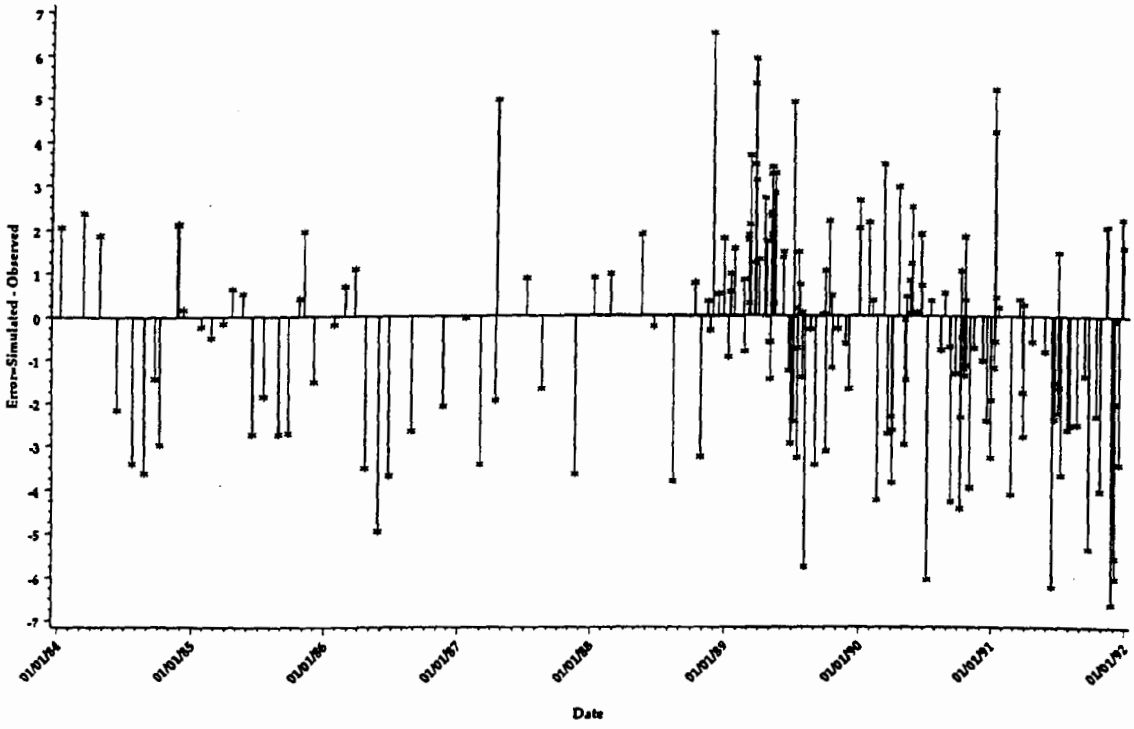
Temperature-C: 01JAN84 - 01JAN92



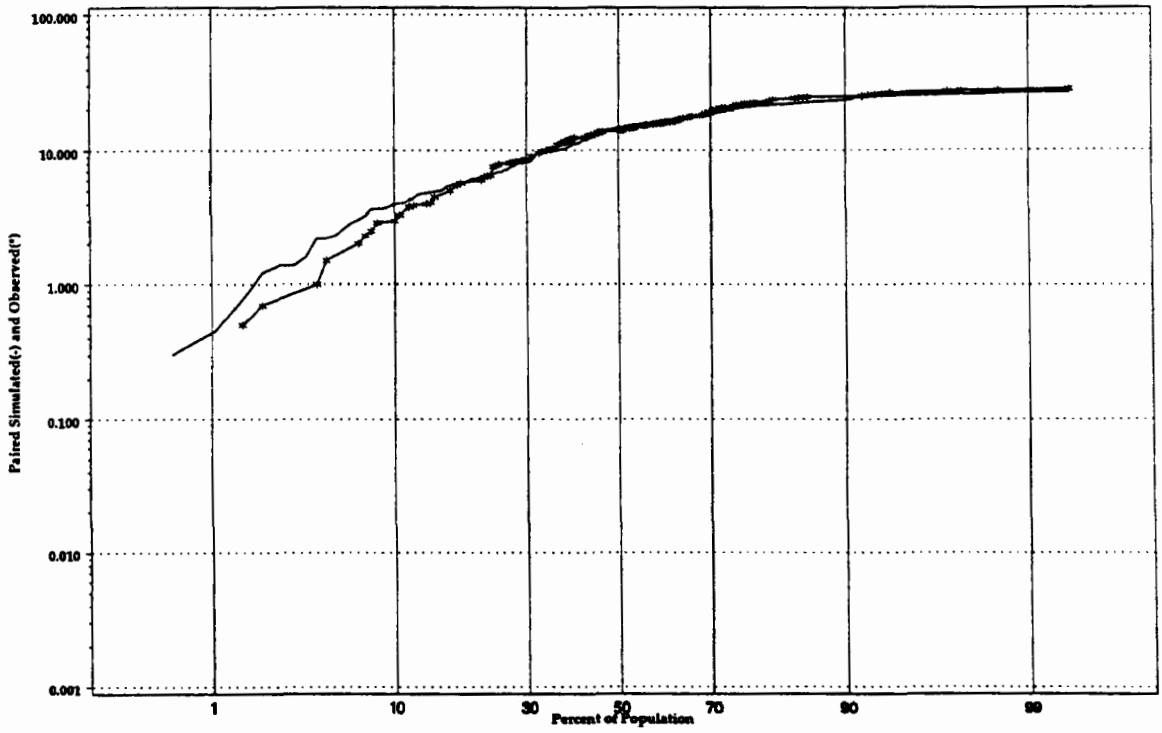
Rappahannock River at Segement 230

Actual Error versus Time

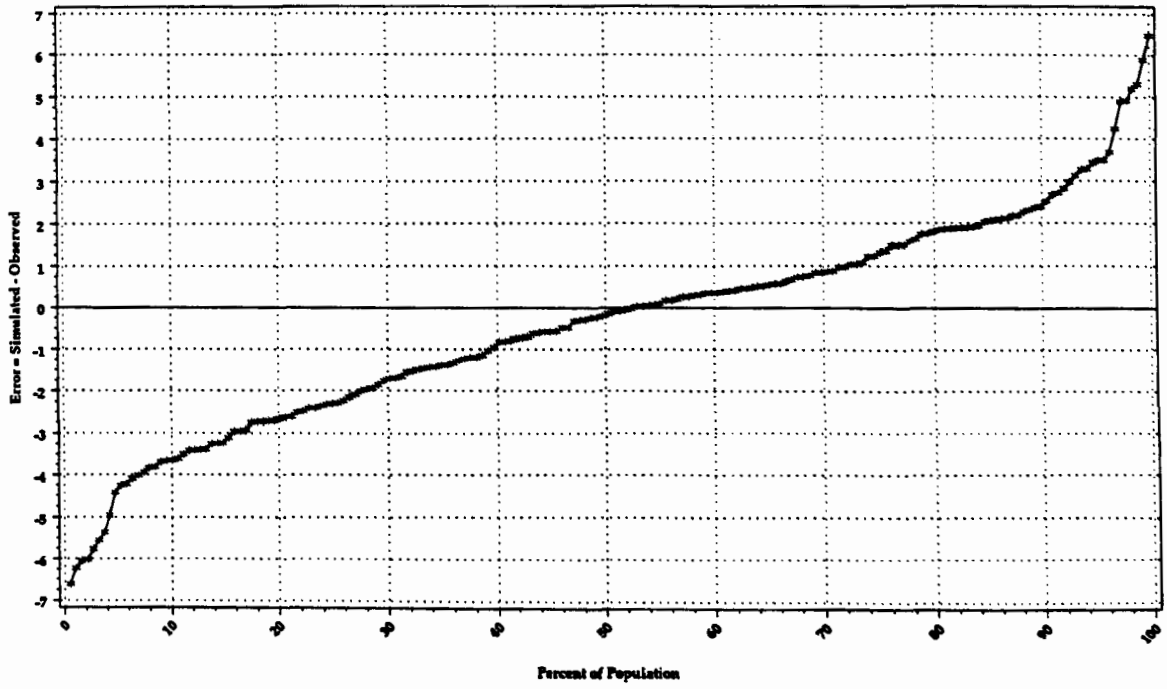
Temperature-C



Rappahannock River at Segement 230
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

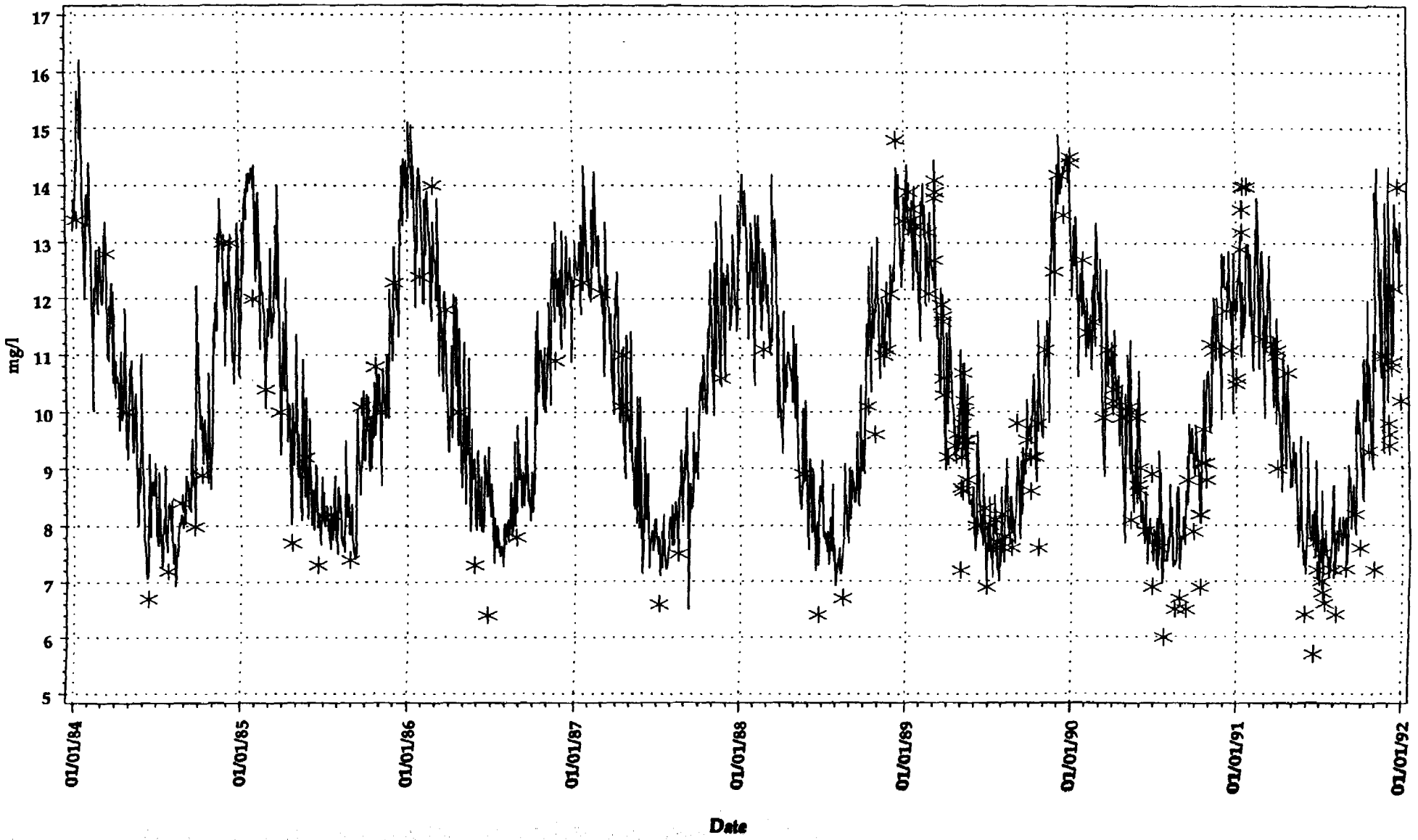


Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data

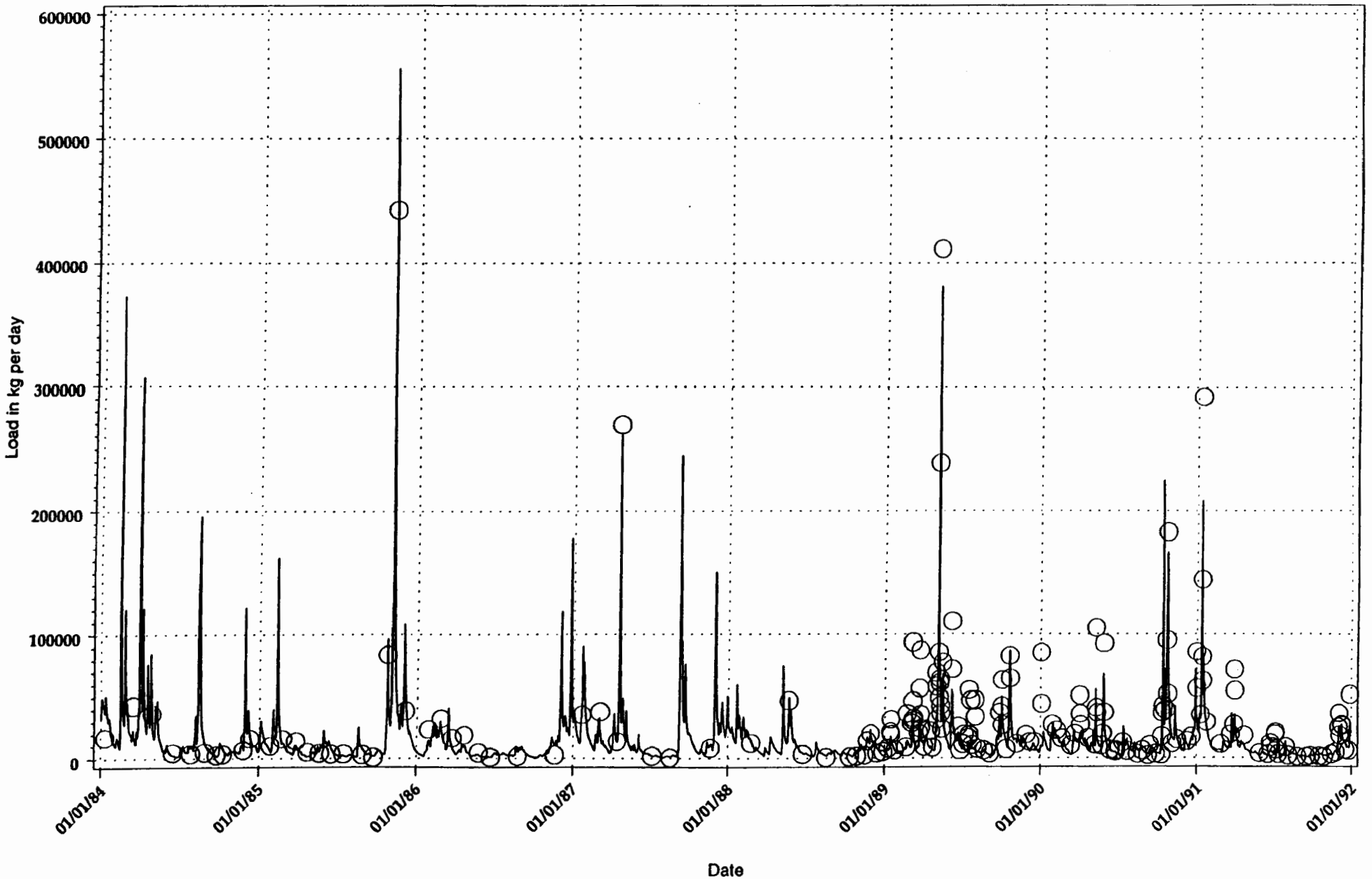


Rappahannock River at Segment 230
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



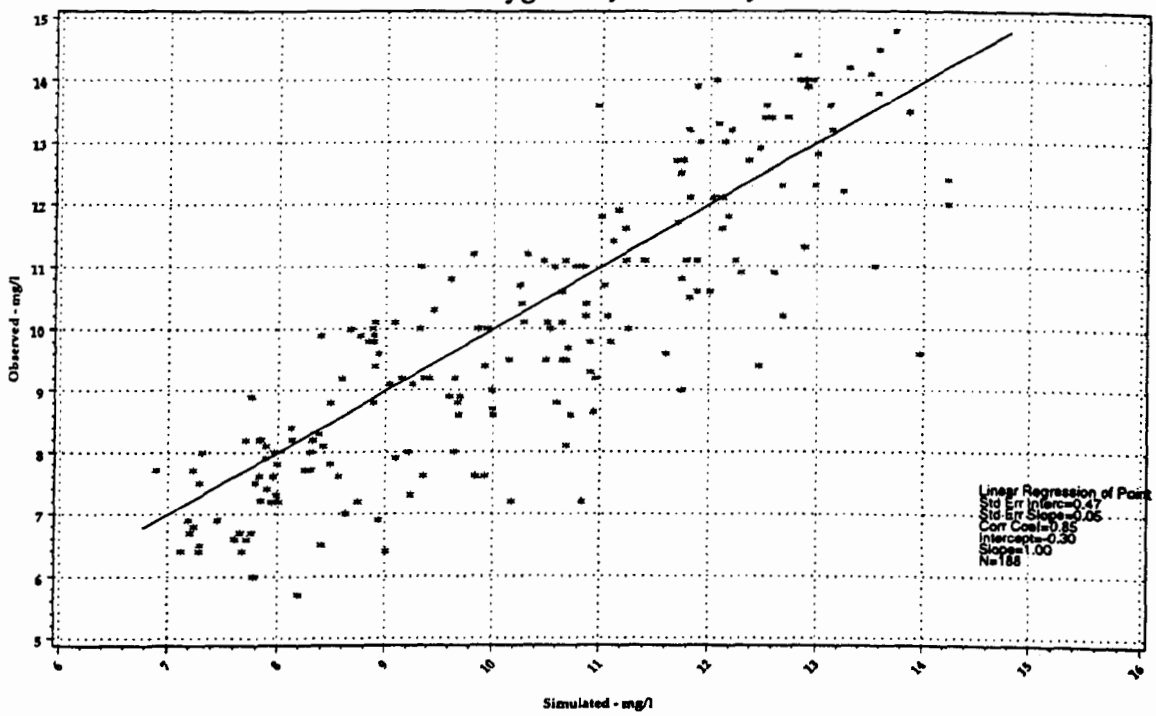
Rappahannock River at Segment 230
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plot1.sas datastore2 [rps p3 james sas] 8dflas)
(graph_s.drv 27AUG97 12:31 proc reg,model y=x)

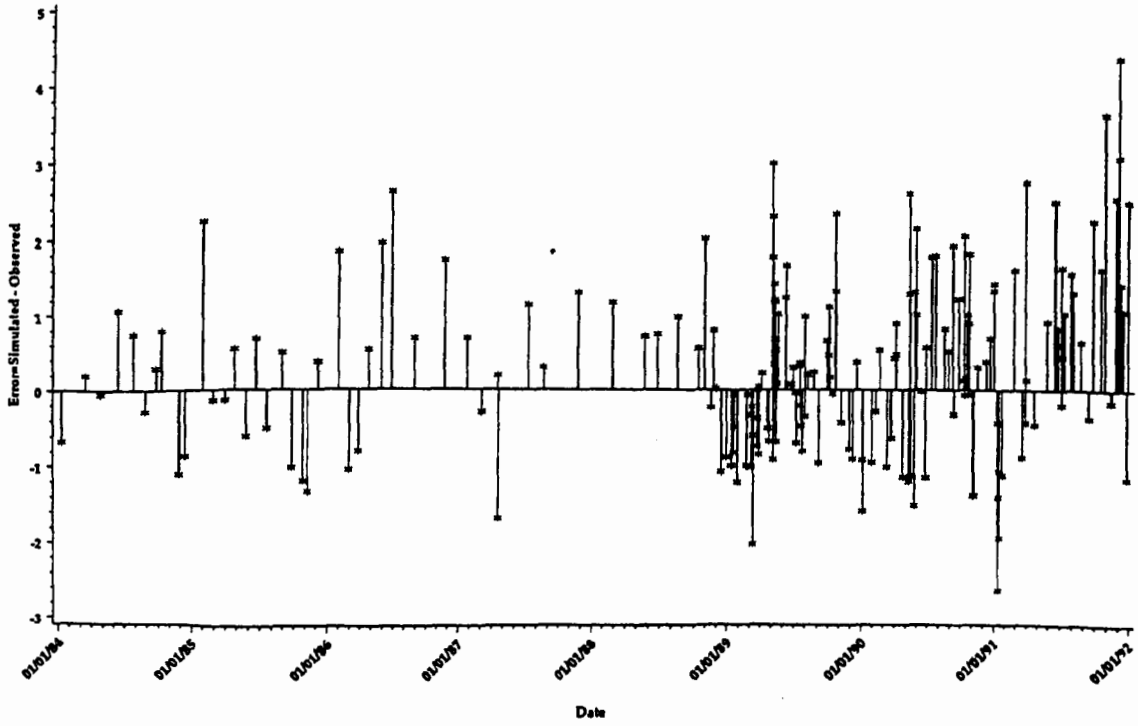
Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Dissolved Oxygen: 01JAN84 - 01JAN92

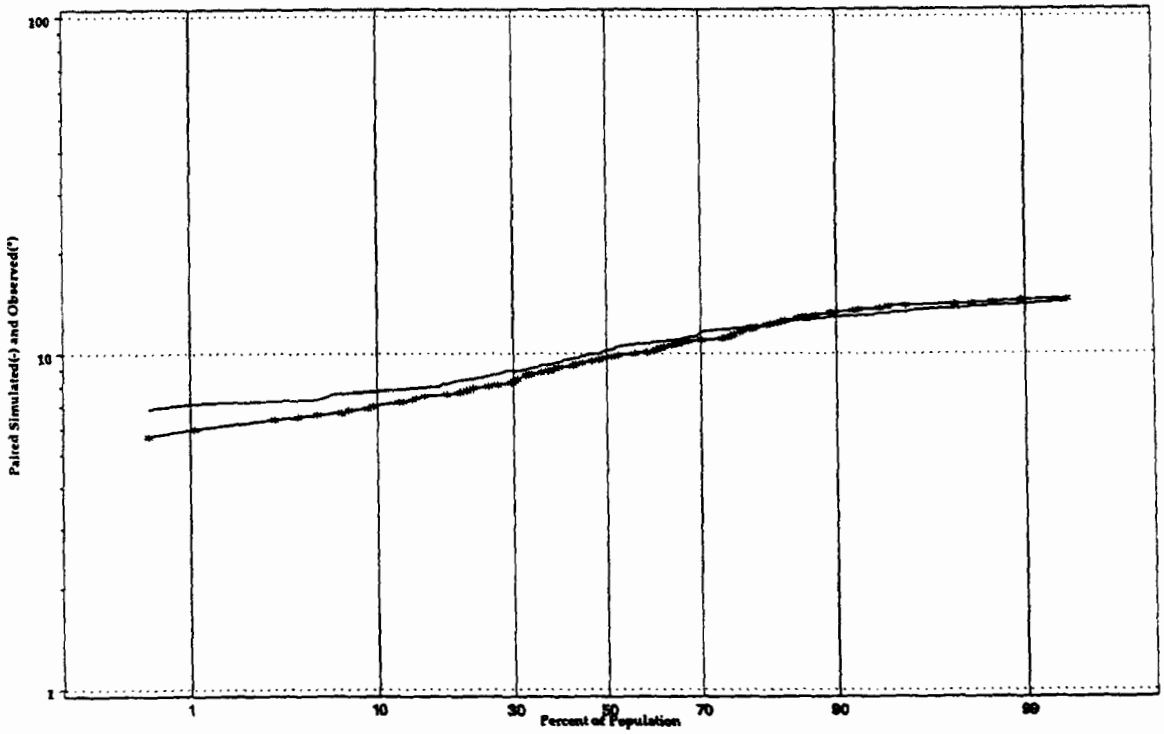


Rappahannock River at Segement 230

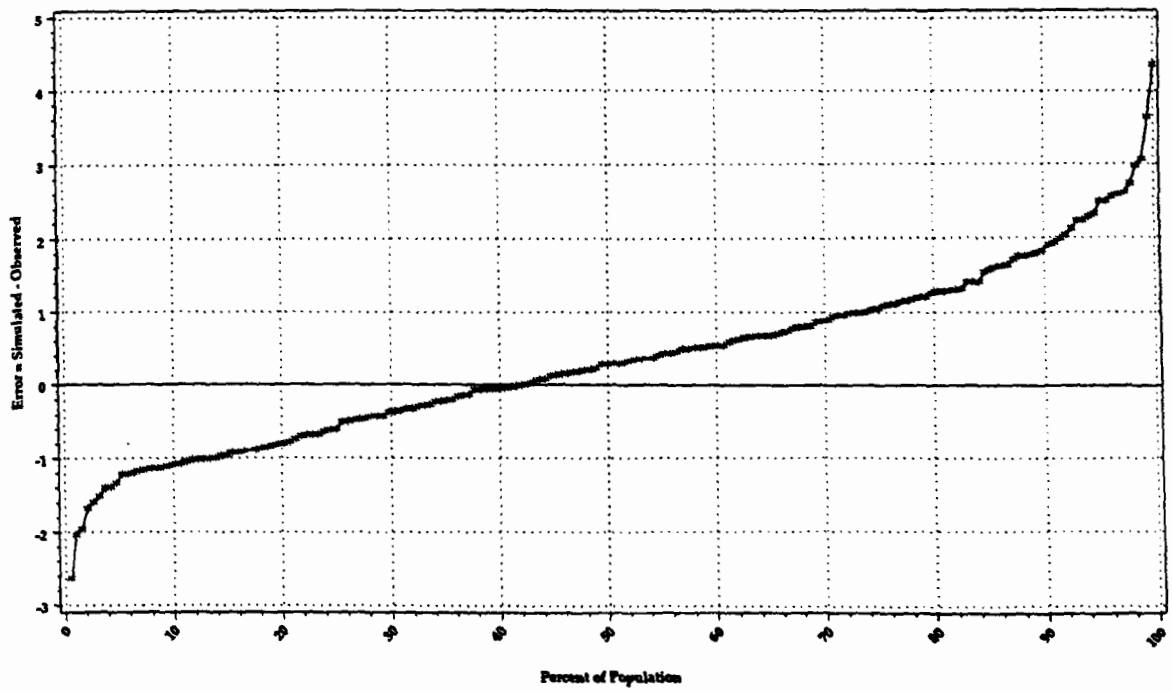
Actual Error versus Time
Dissolved Oxygen



Rappahannock River at Segement 230
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

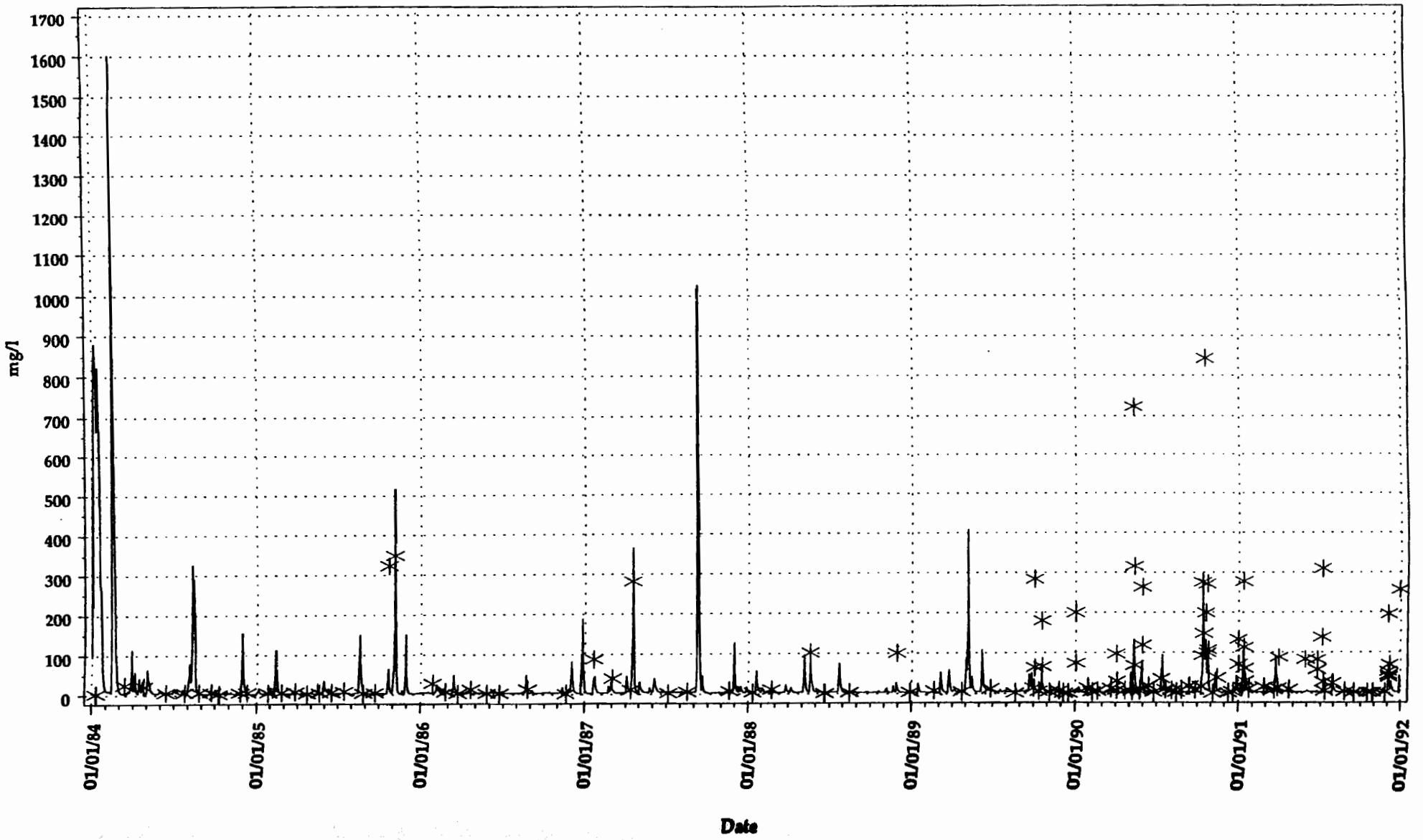


Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Rappahannock River at Segment 230
Observed and Simulated versus Time
Total Suspended Sediment

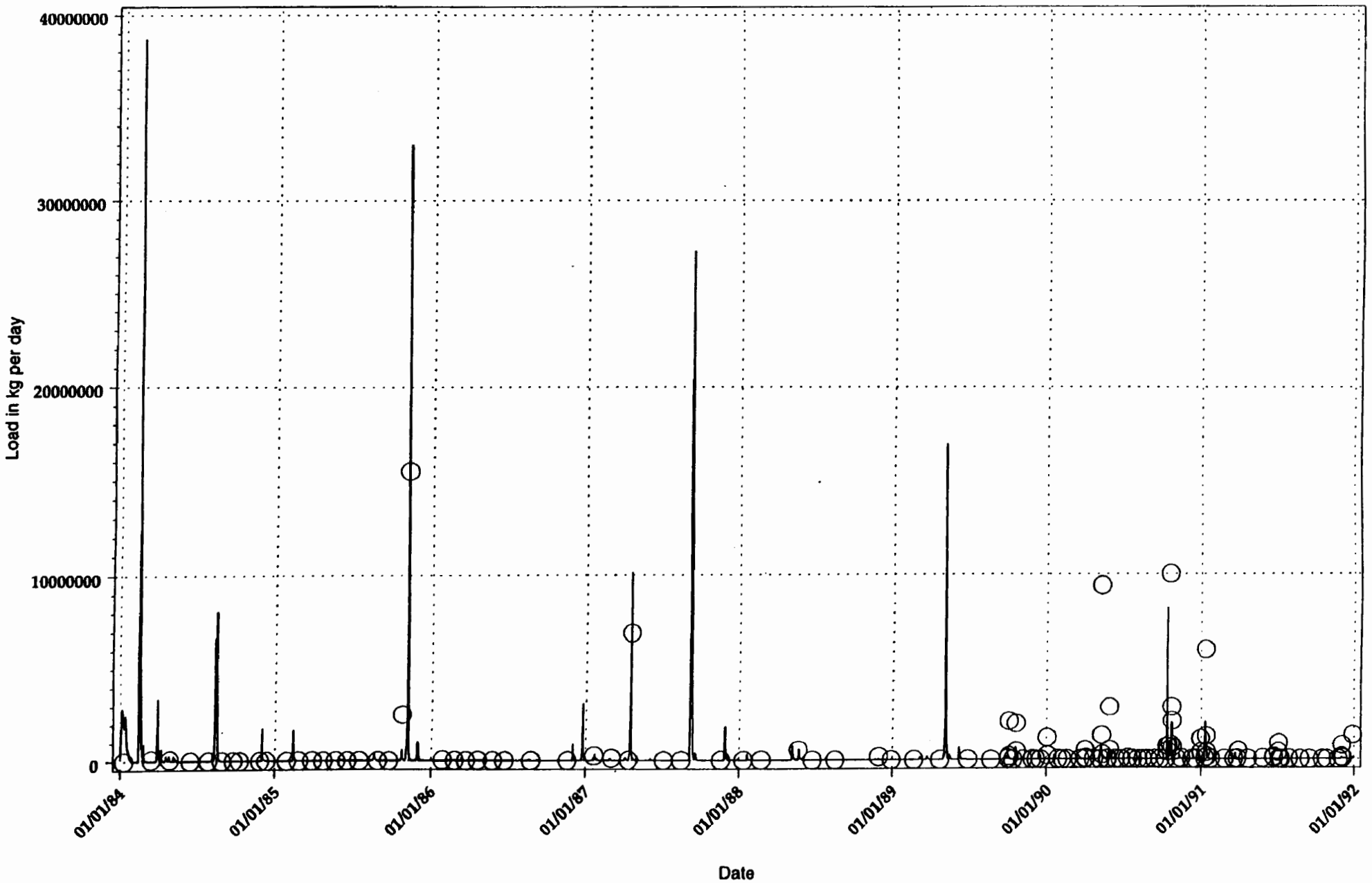
(*=Observed, -=Simulated)



Rappahannock River at Segment 230

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

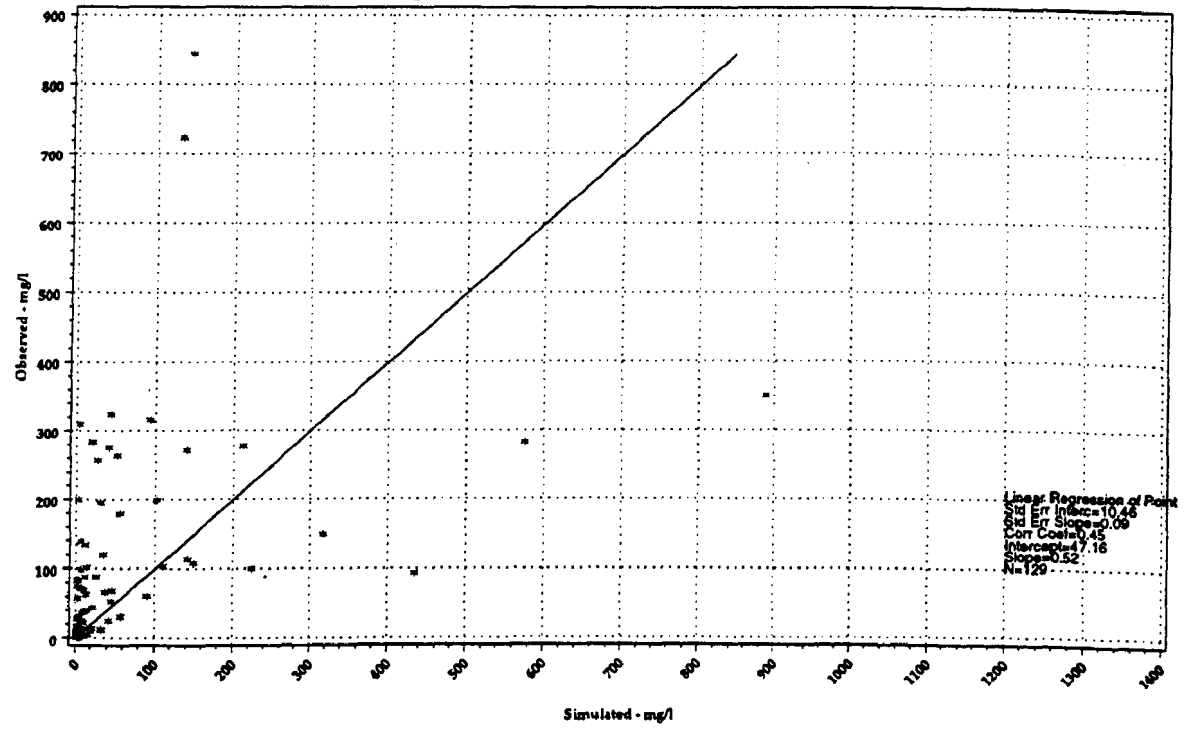


(y21_plot1.sas dataotore2 jops p3 james sas) Billion)
(graph_a.div 27AUG97 12:31 proc reg model y=x)

Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

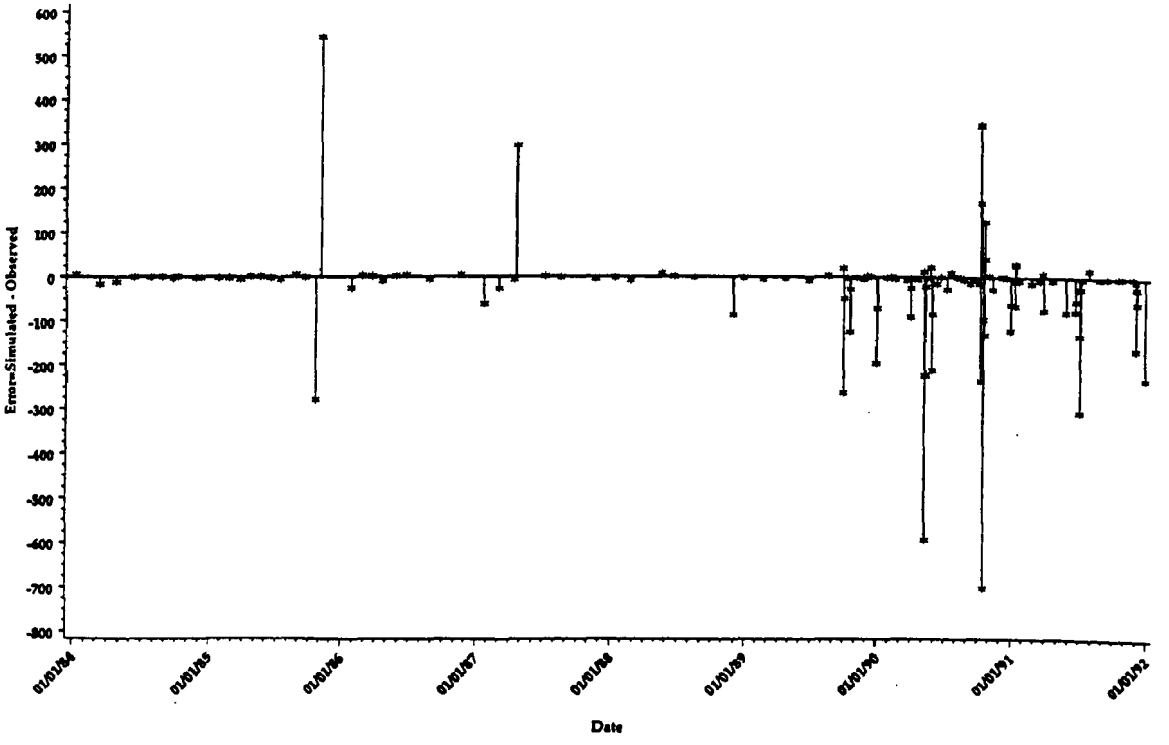
Total Suspended Sediment: 01JAN84 - 01JAN92



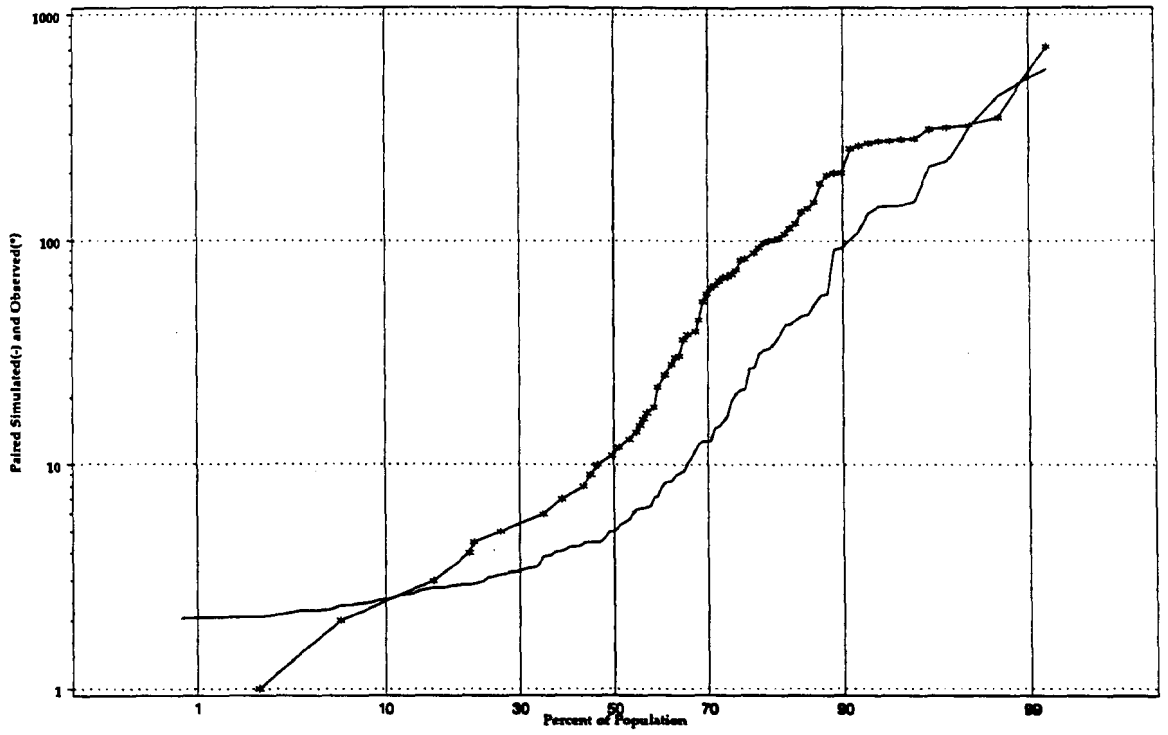
Rappahannock River at Segement 230

Actual Error versus Time

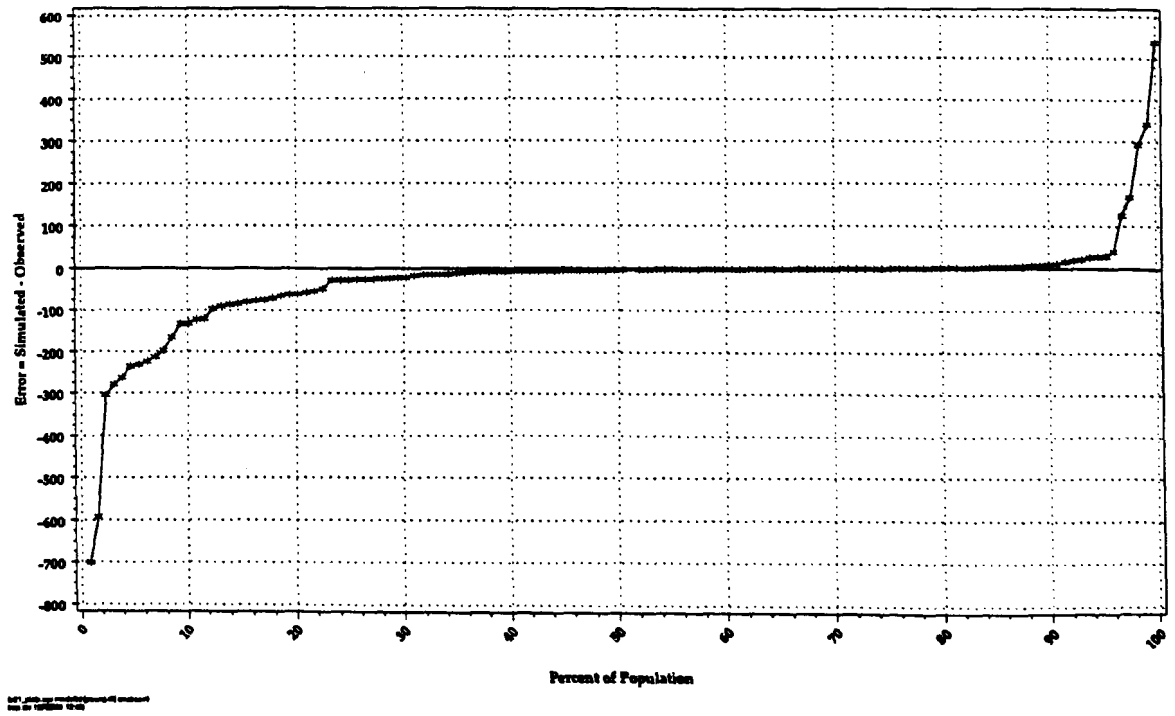
Total Suspended Sediment



Rappahannock River at Segement 230
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

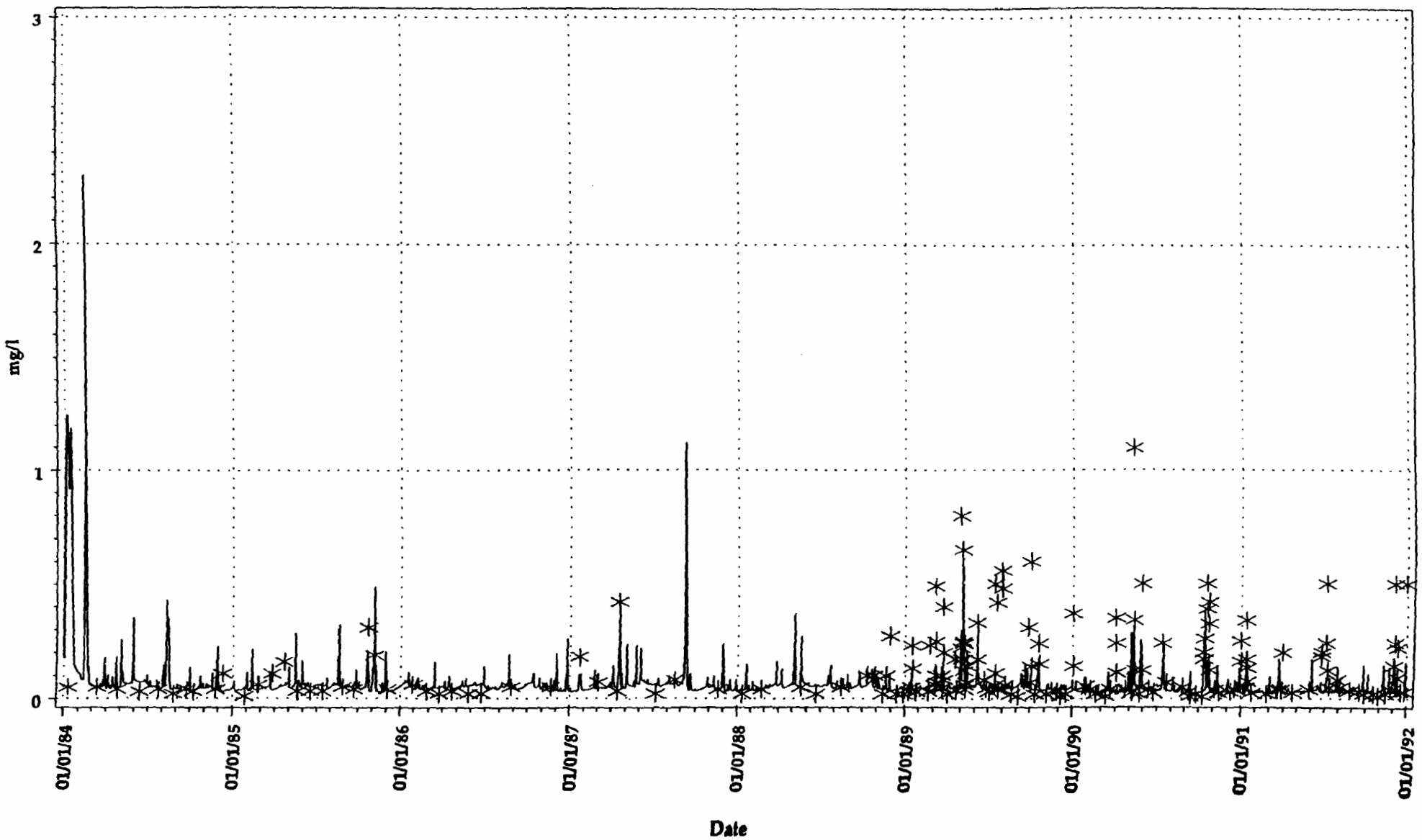


Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data

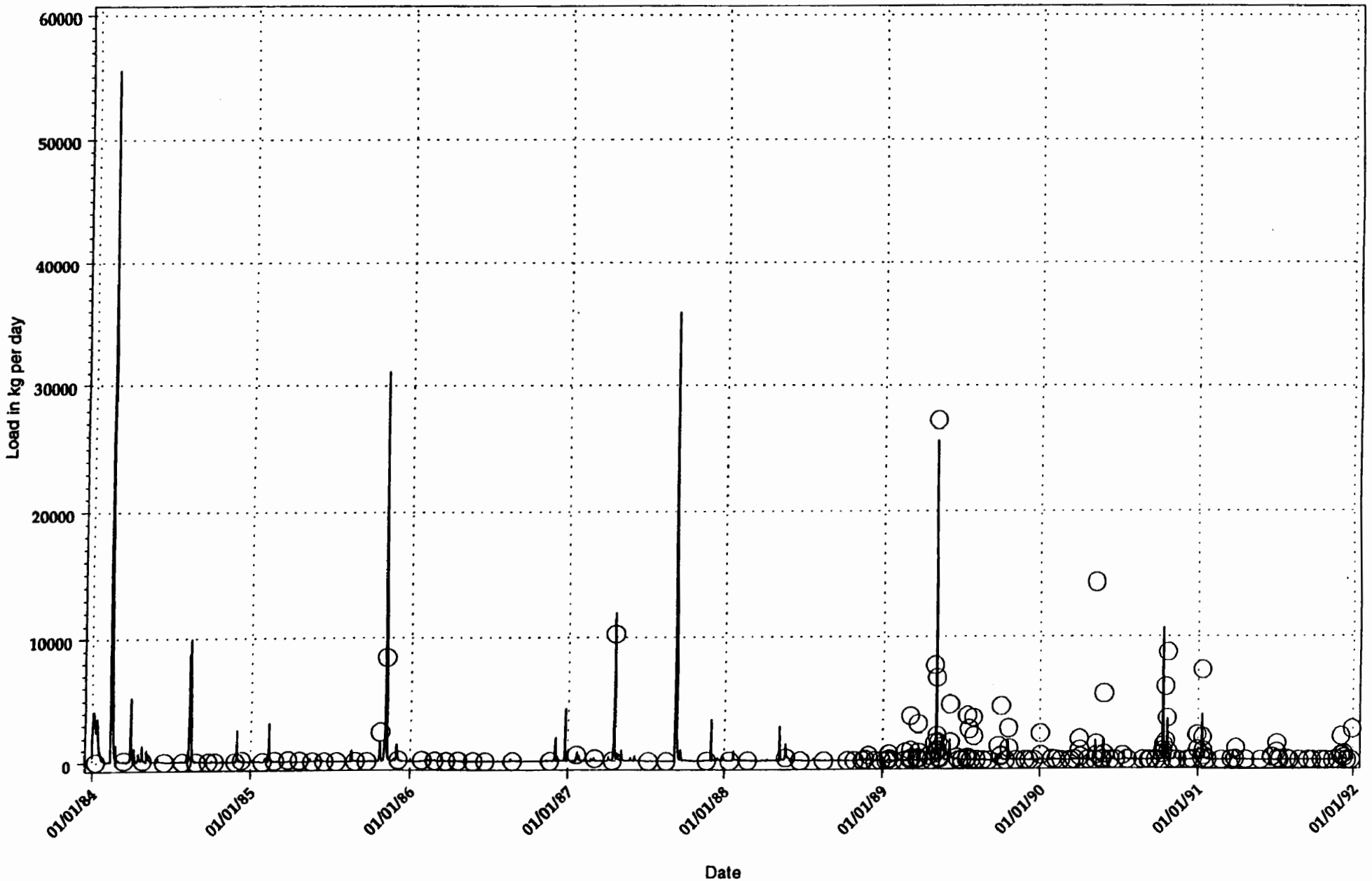


Rappahannock River at Segment 230
Observed and Simulated versus Time
Total Phosphorus

(*=Observed, -=Simulated)

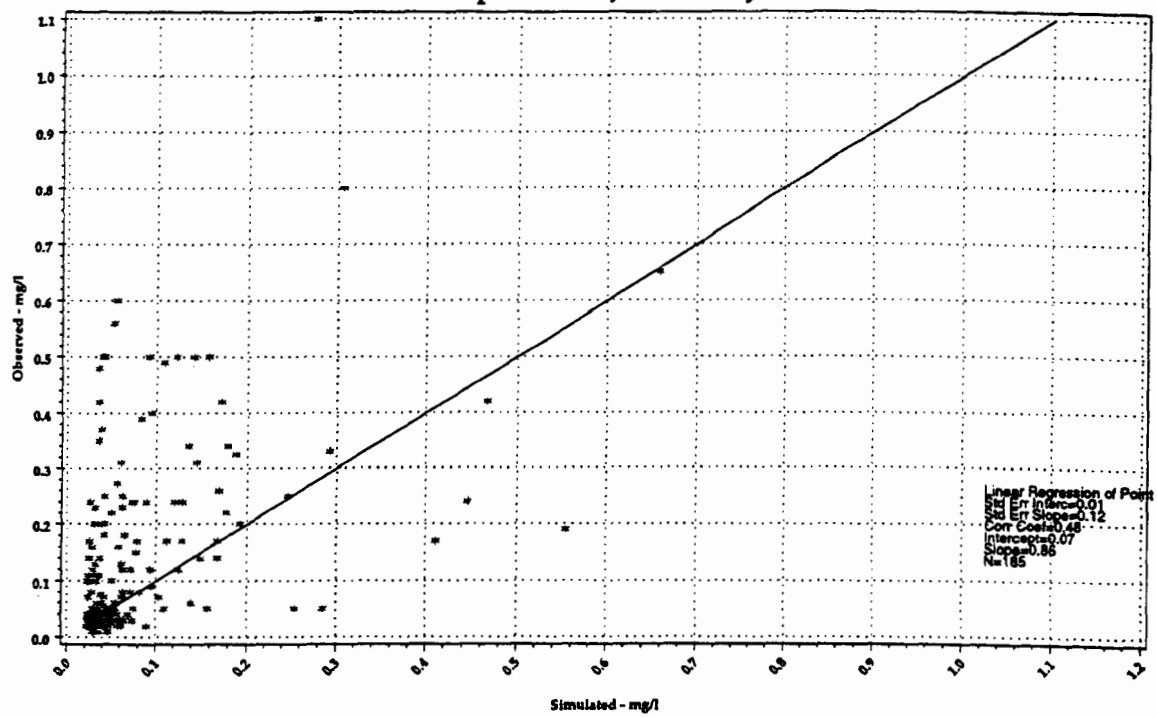


Rappahannock River at Segment 230
Total Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)



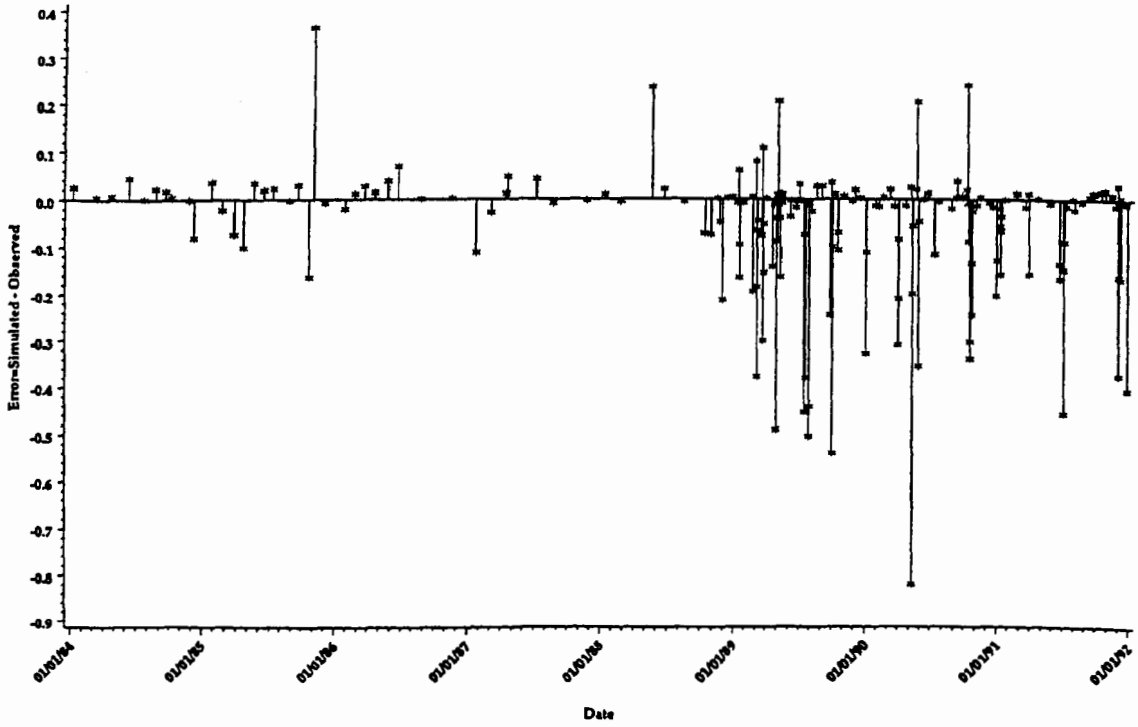
Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Phosphorus: 01JAN84 - 01JAN92

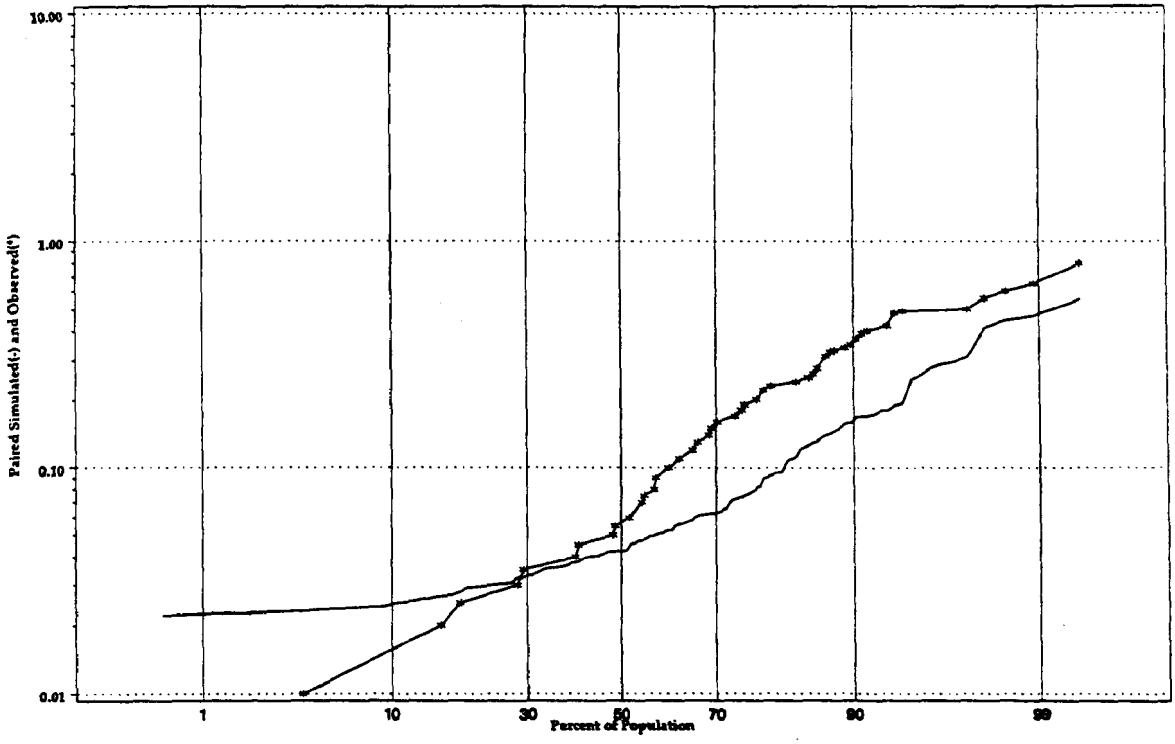


Rappahannock River at Segement 230

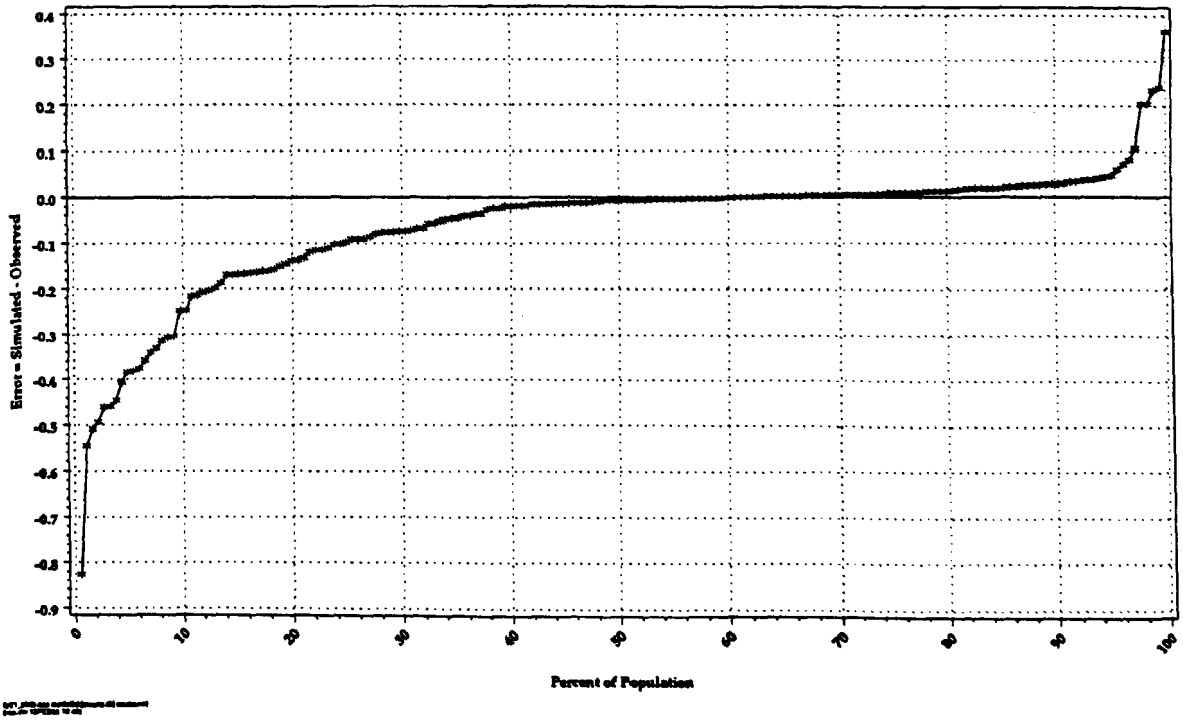
Actual Error versus Time
Total Phosphorus



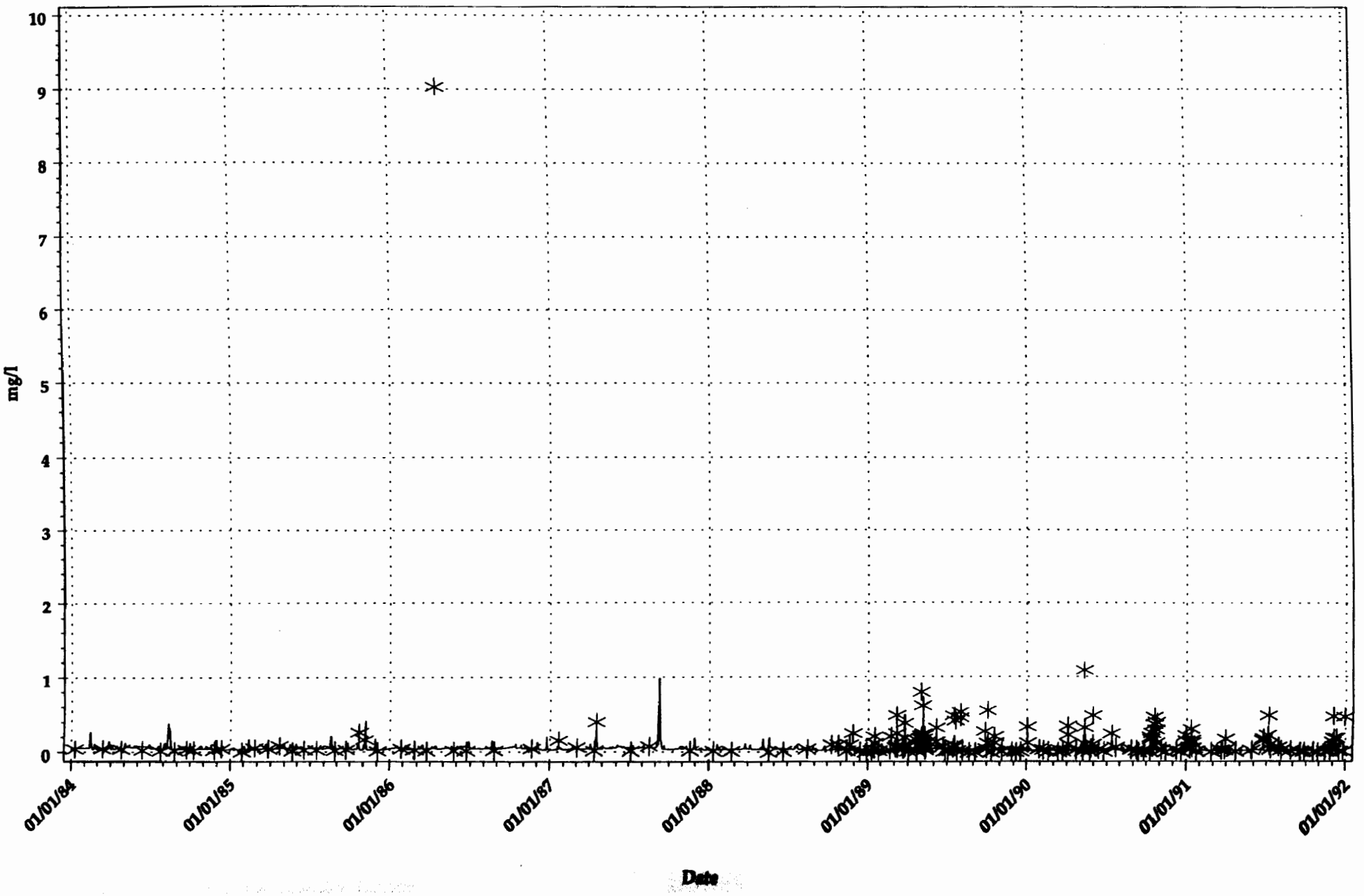
Rappahannock River at Segement 230
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data



Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



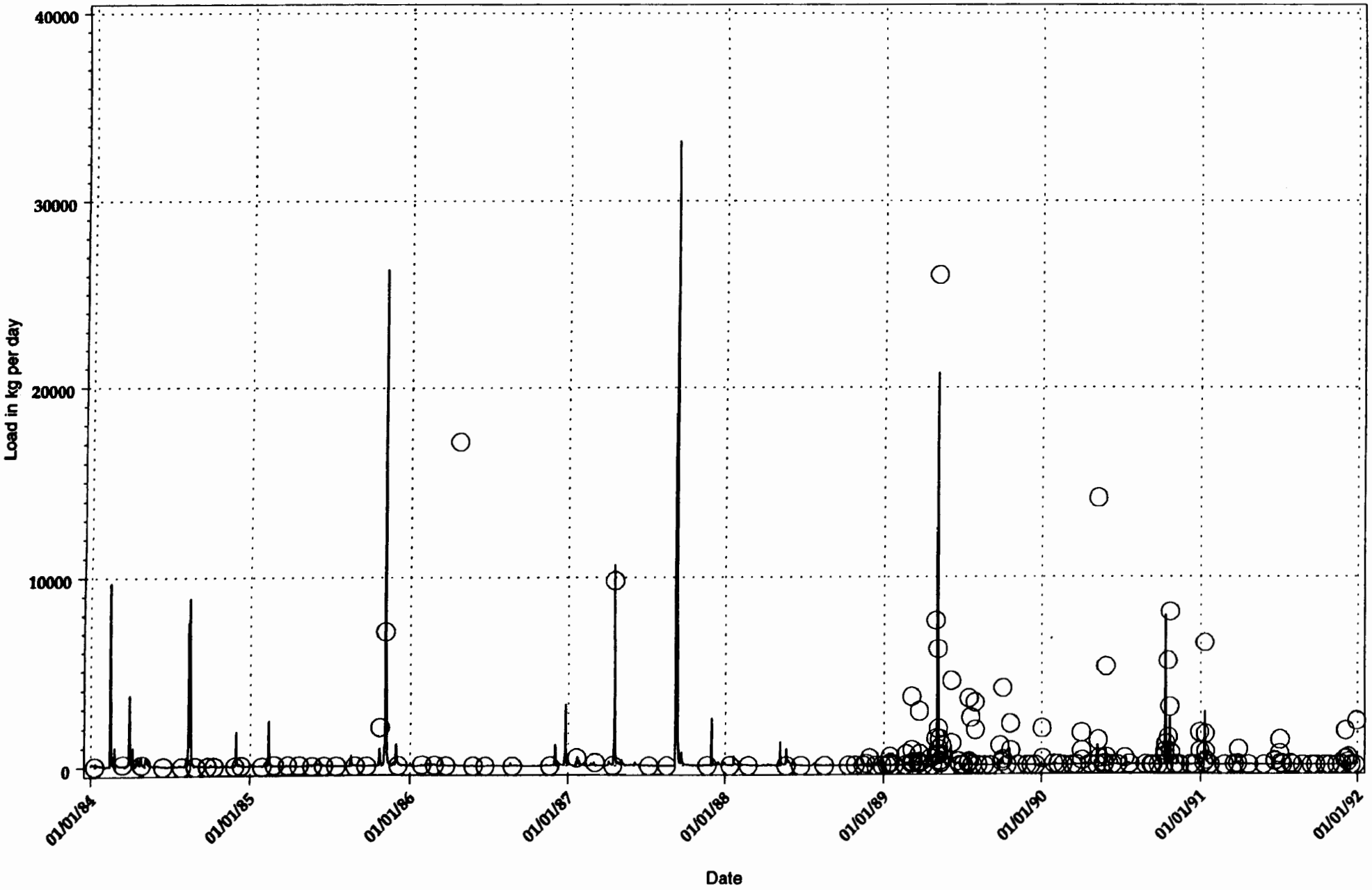
Rappahannock River at Segement 230
Organic and Particulate Phosphorus
(*=Observed, -=Simulated)



Rappahannock River at Segement 230

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

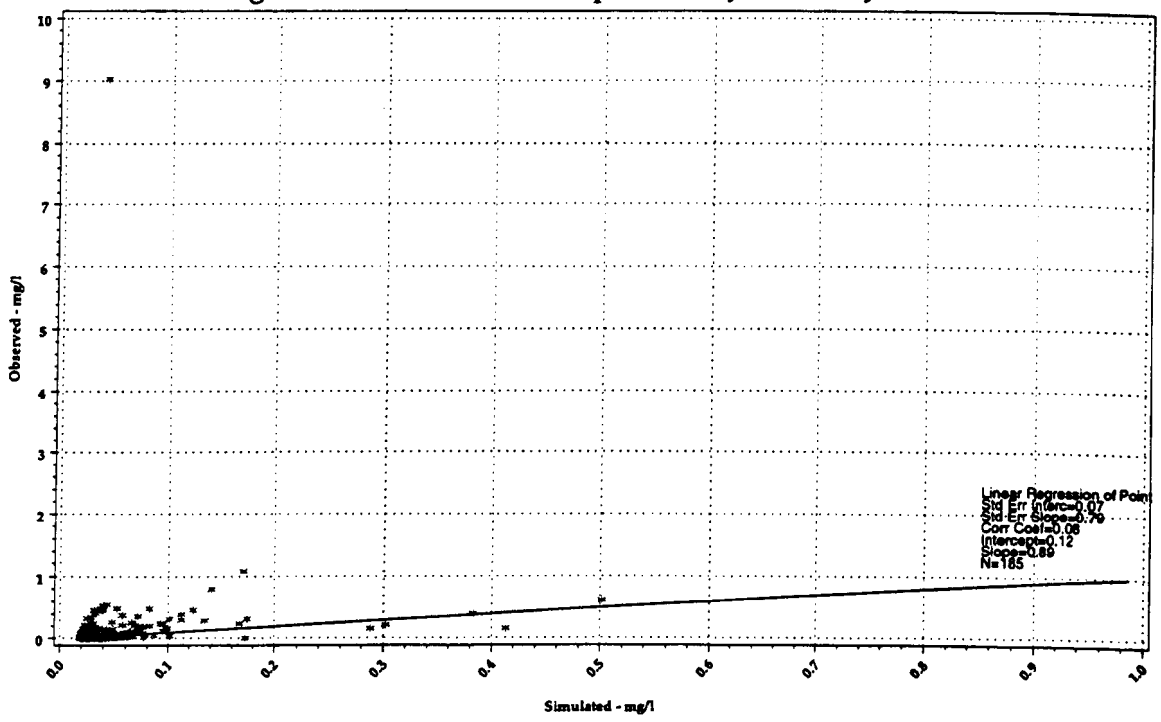
(line = simulated, O = observed)



Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

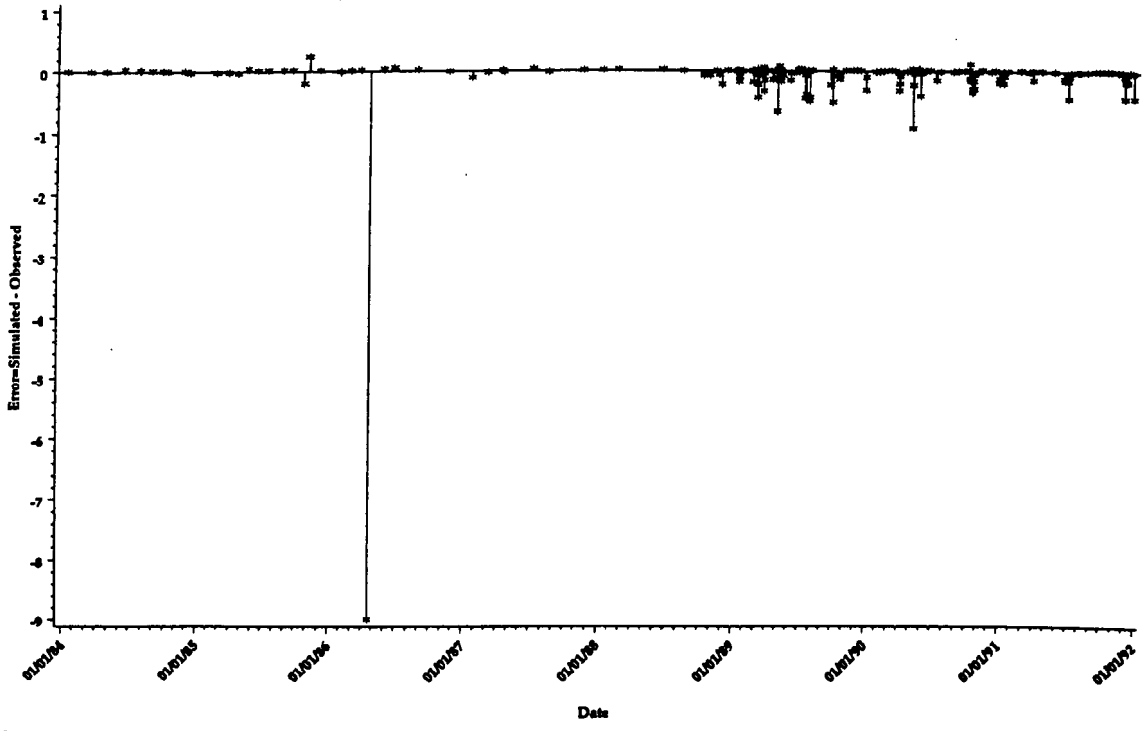
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



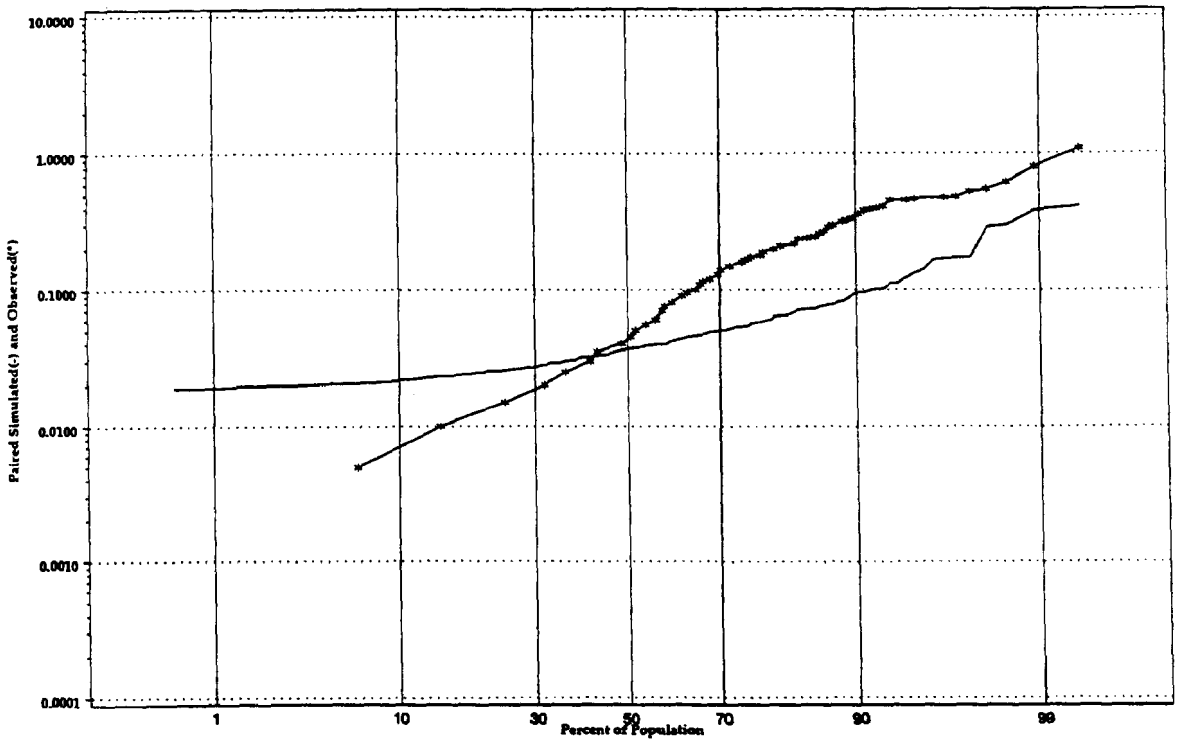
Rappahannock River at Segement 230

Actual Error versus Time

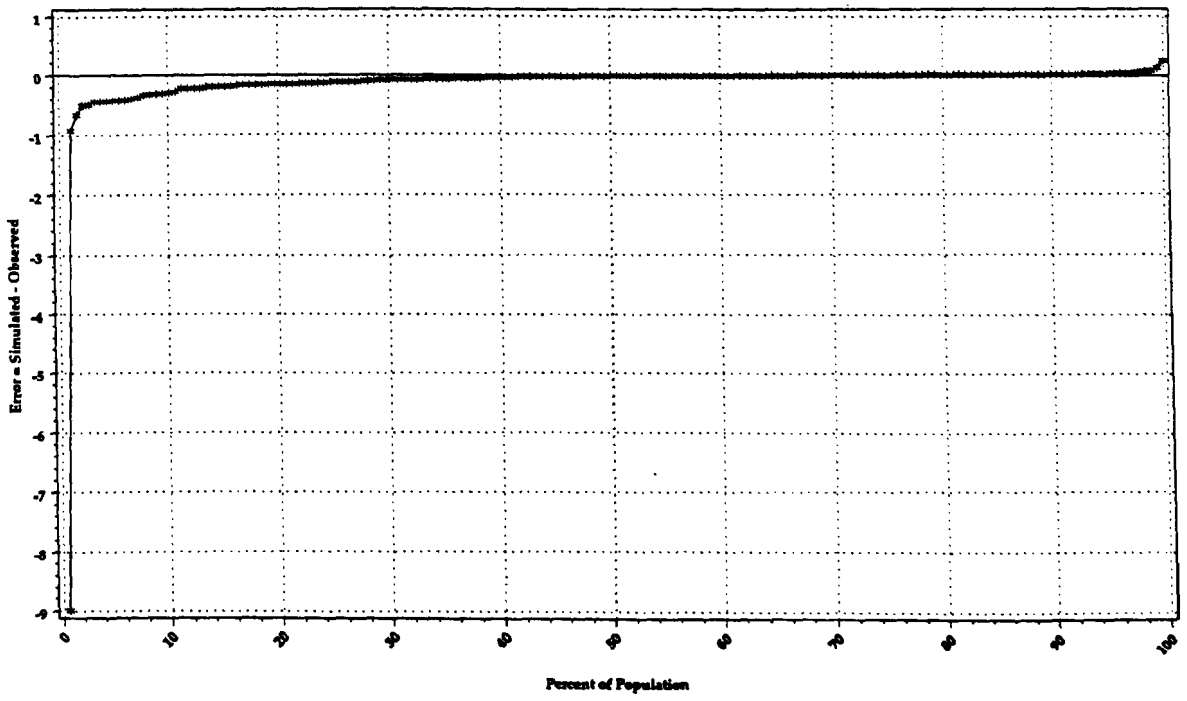
Organic and Particulate Phosphorus



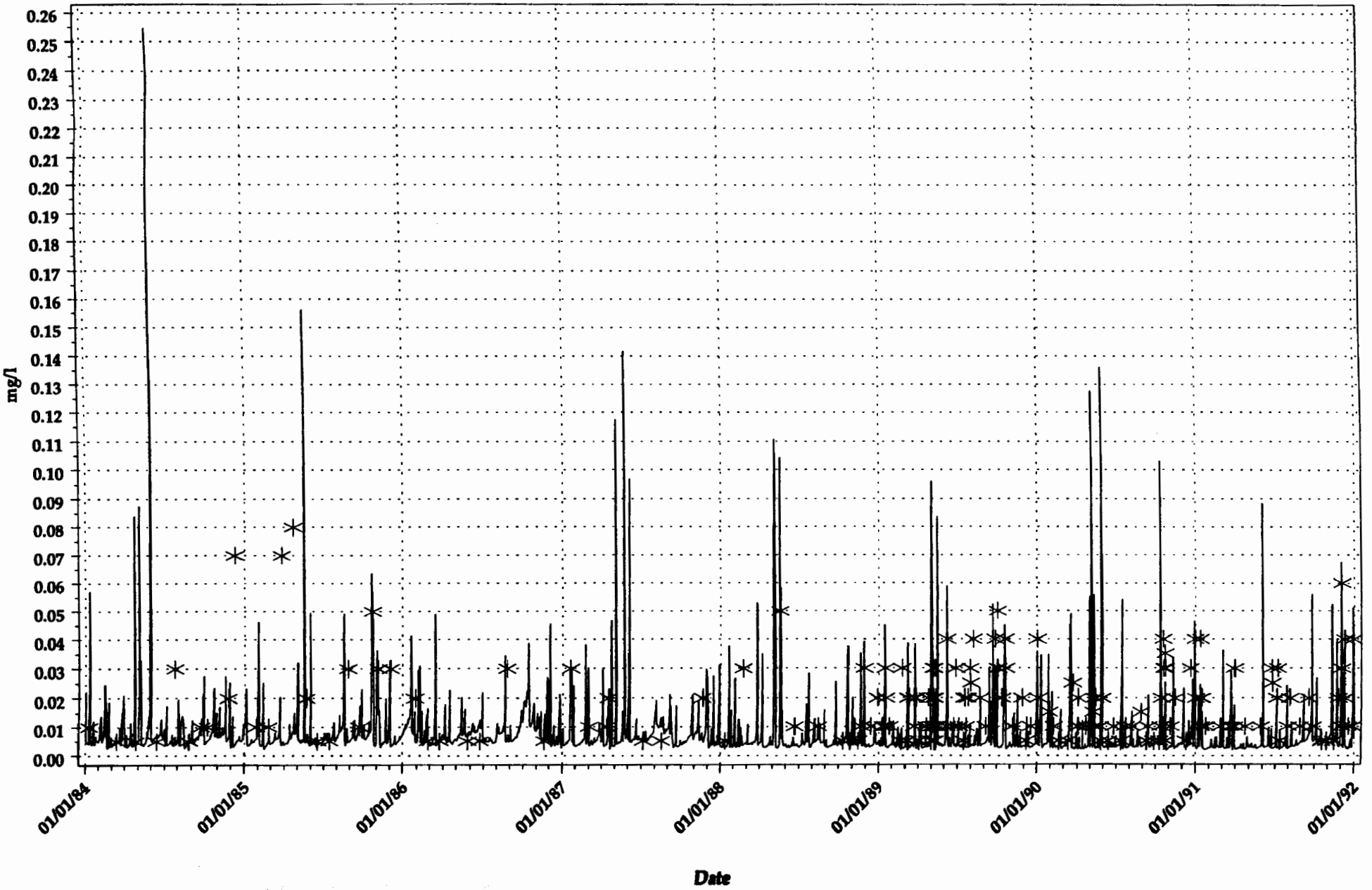
Rappahannock River at Segement 230
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data



Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data



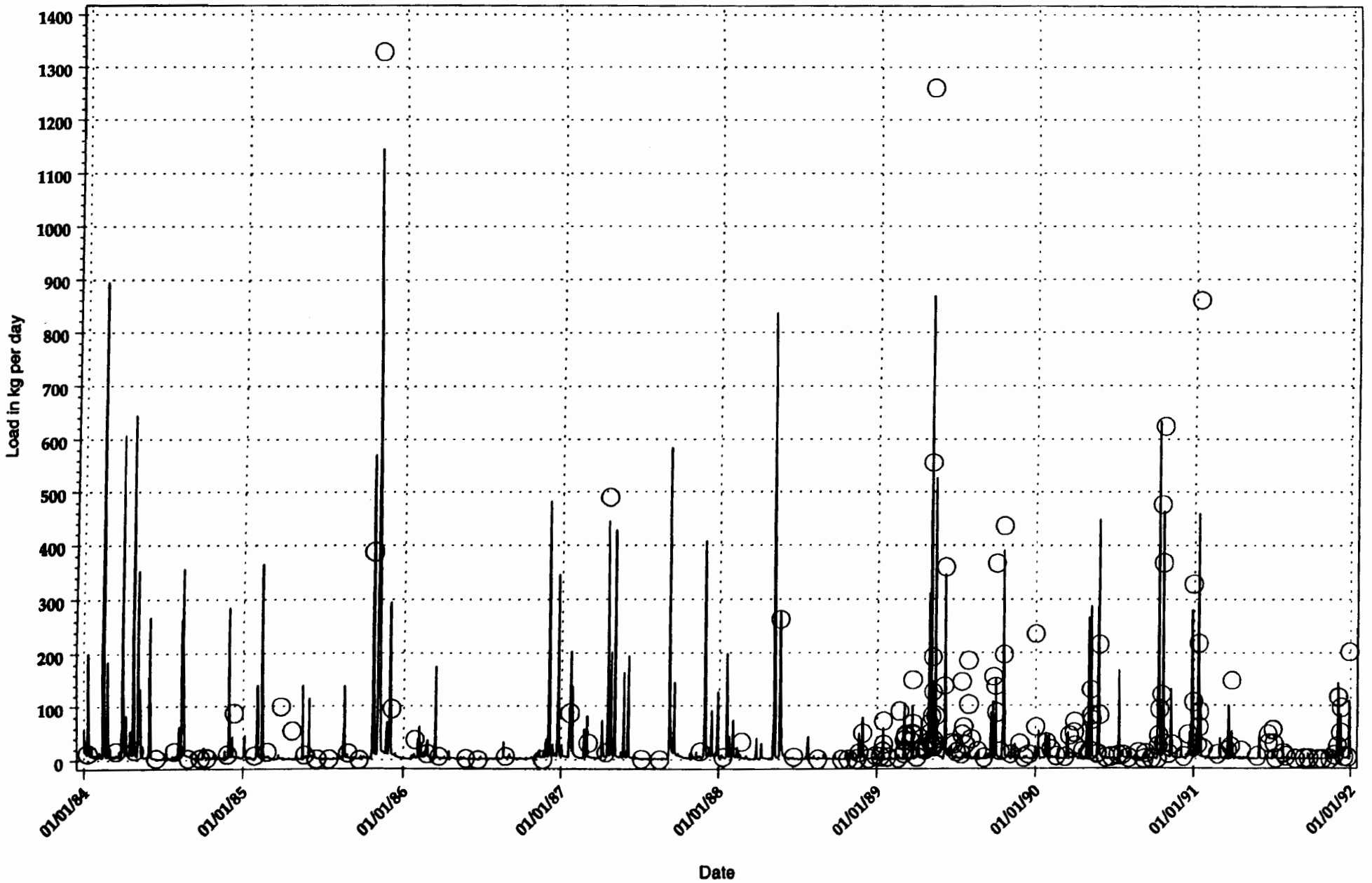
Rappahannock River at Segement 230
Dissolved Phosphorus
(*=Observed, -=Simulated)



Rappahannock River at Segement 230

Dissolved Phosphorus Observed and Simulated Load vs Time

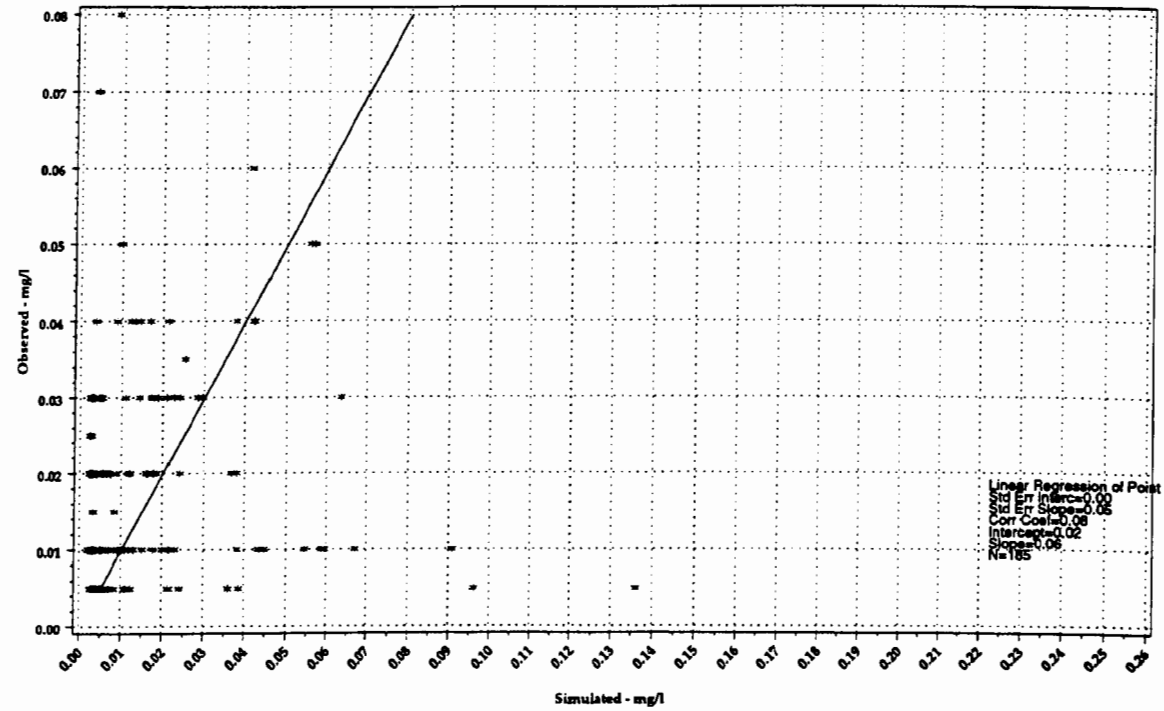
(line = simulated, O = observed)



Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

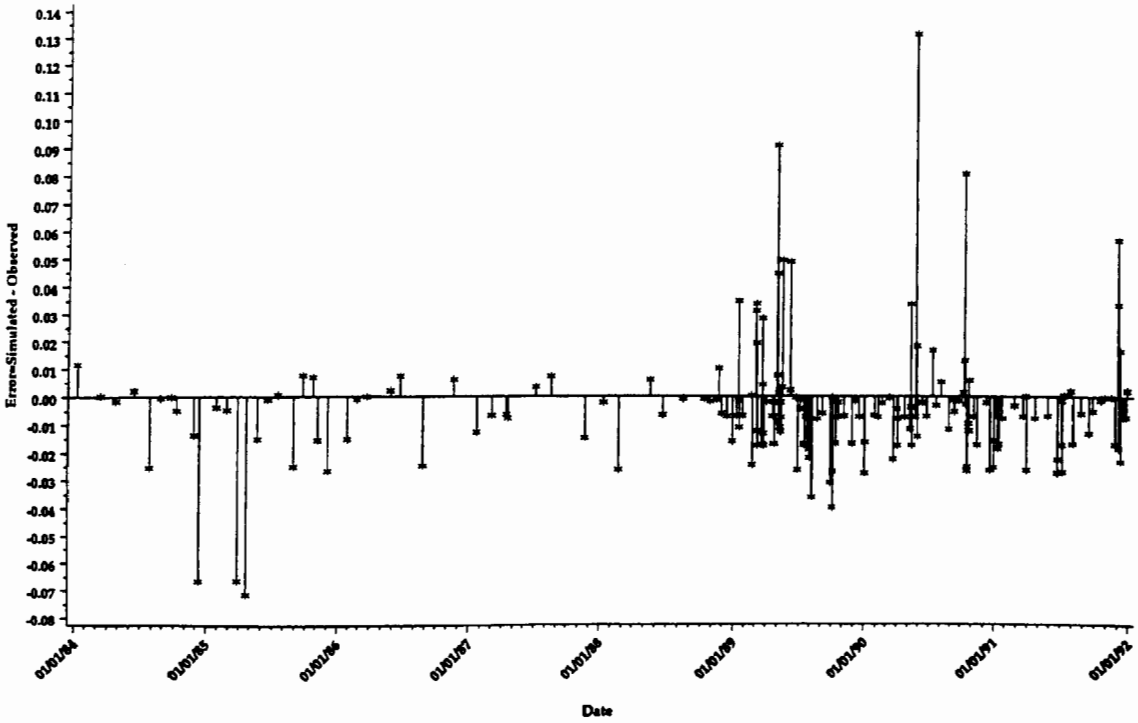
Dissolved Phosphorus: 01JAN84 - 01JAN92



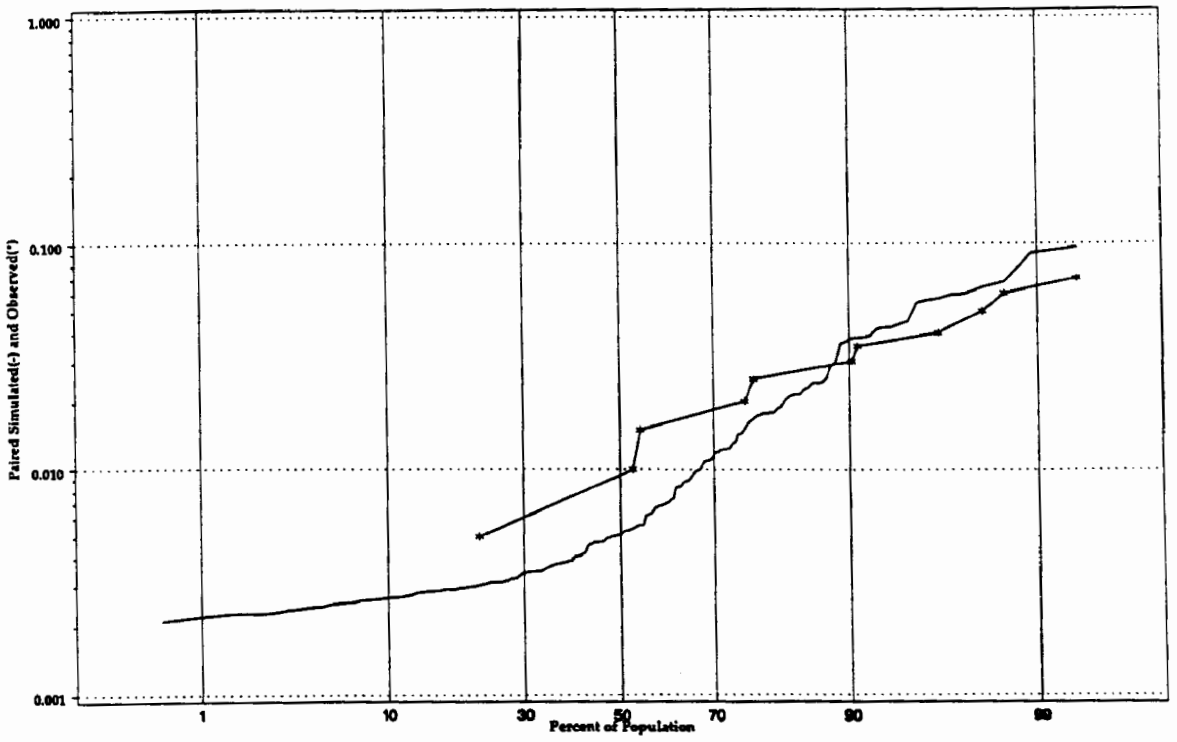
Rappahannock River at Segement 230

Actual Error versus Time

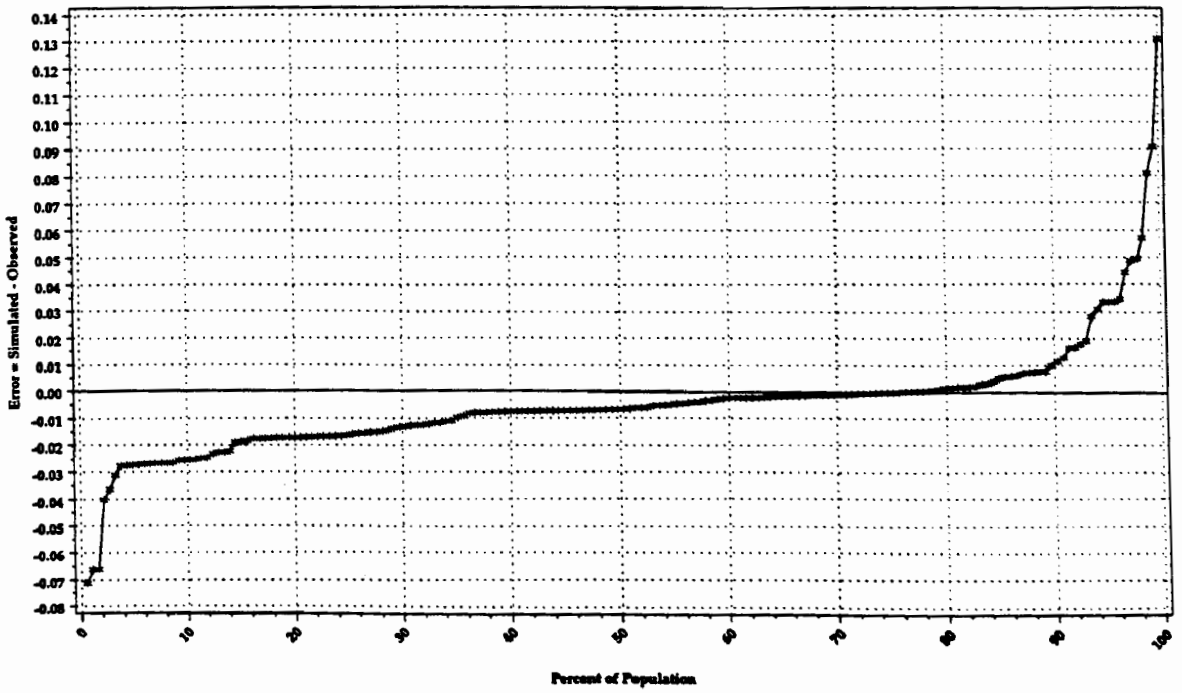
Dissolved Phosphorus



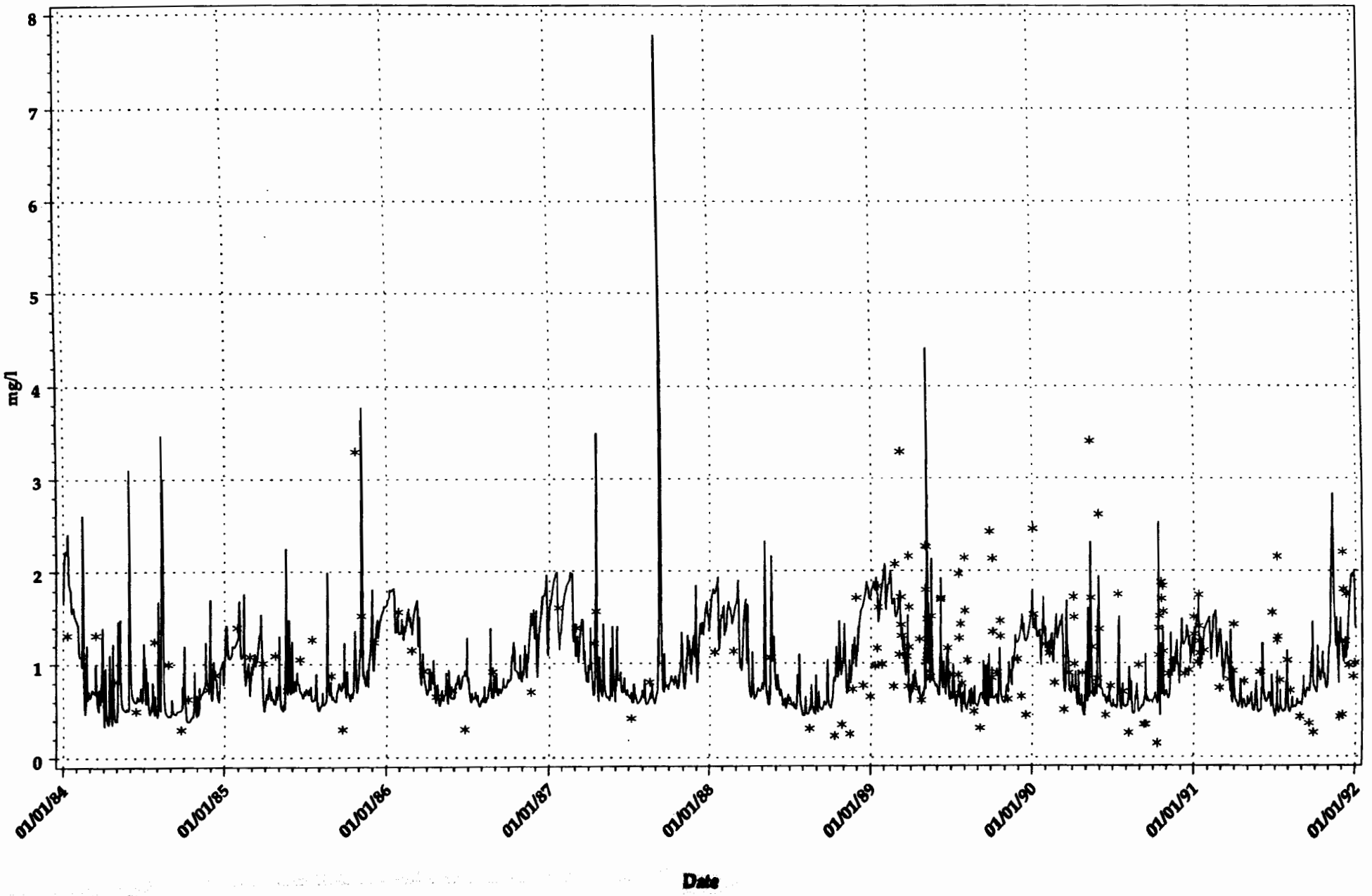
Rappahannock River at Segement 230
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data



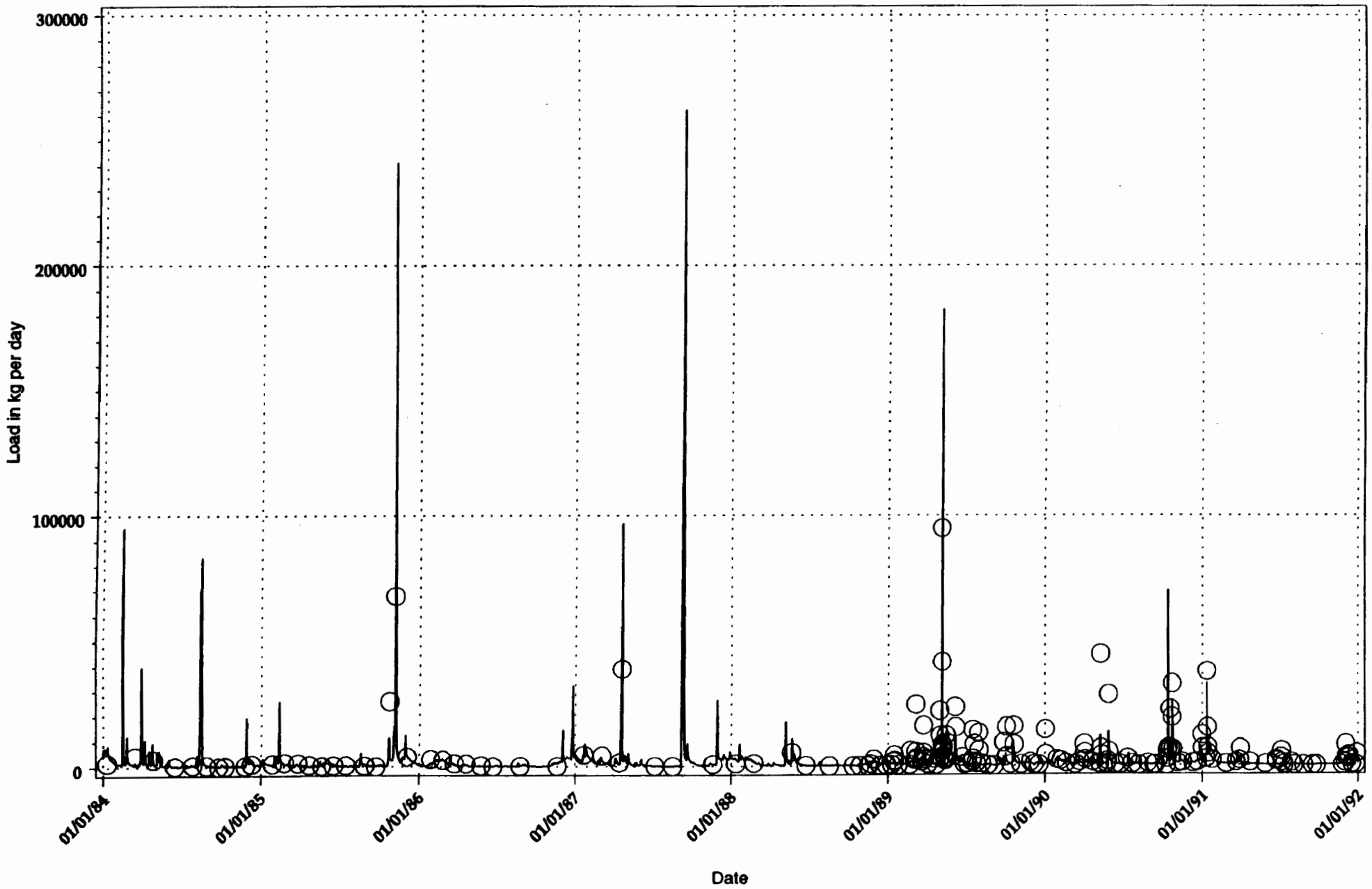
Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



Rappahannock River at Segement 230
Total Nitrogen
(*=Observed, -=Simulated)



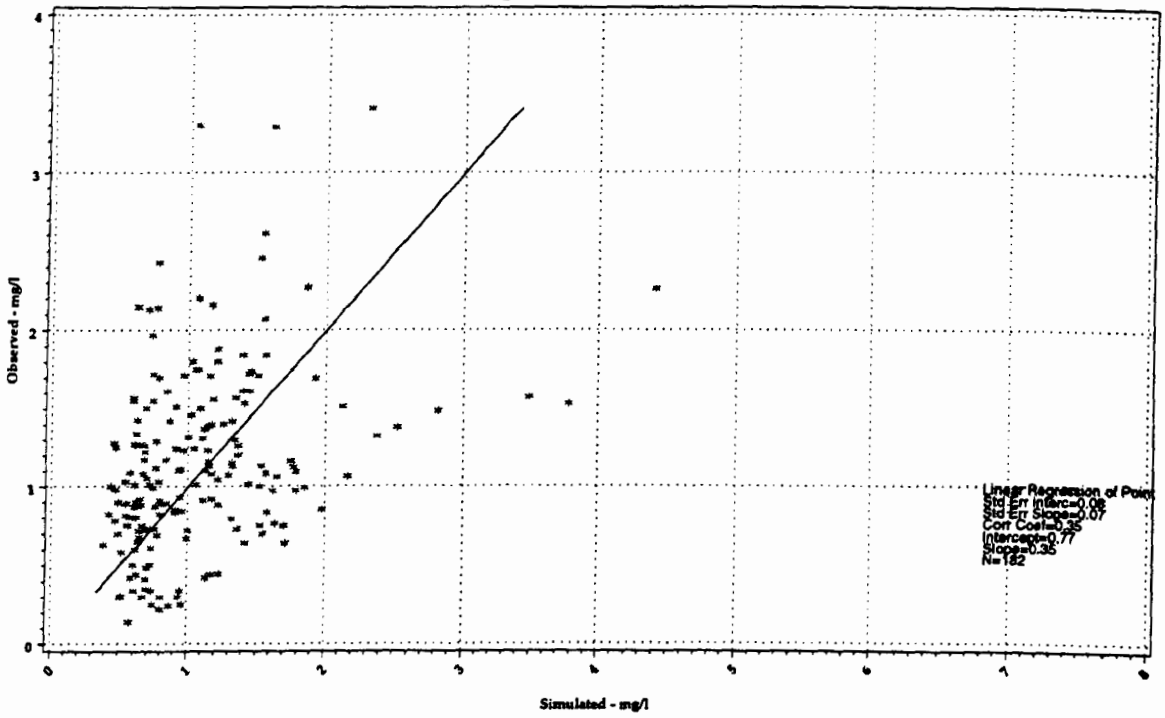
Rappahannock River at Segement 230
Total Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)



Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

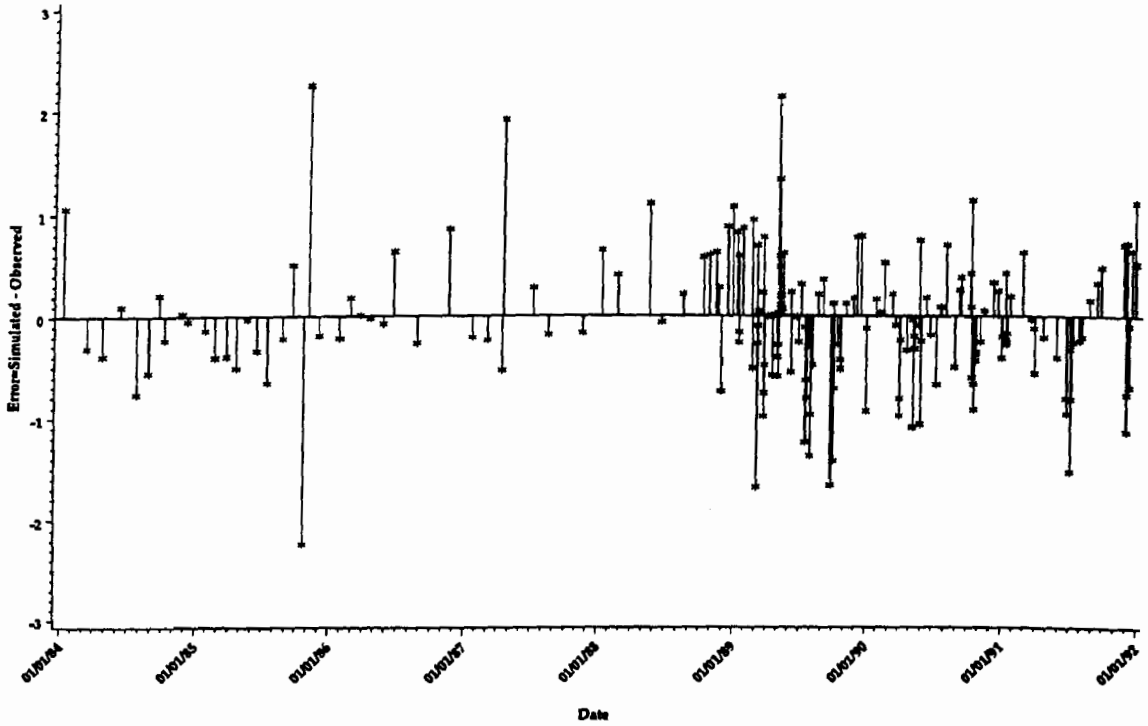
Total Nitrogen: 01JAN84 - 01JAN92



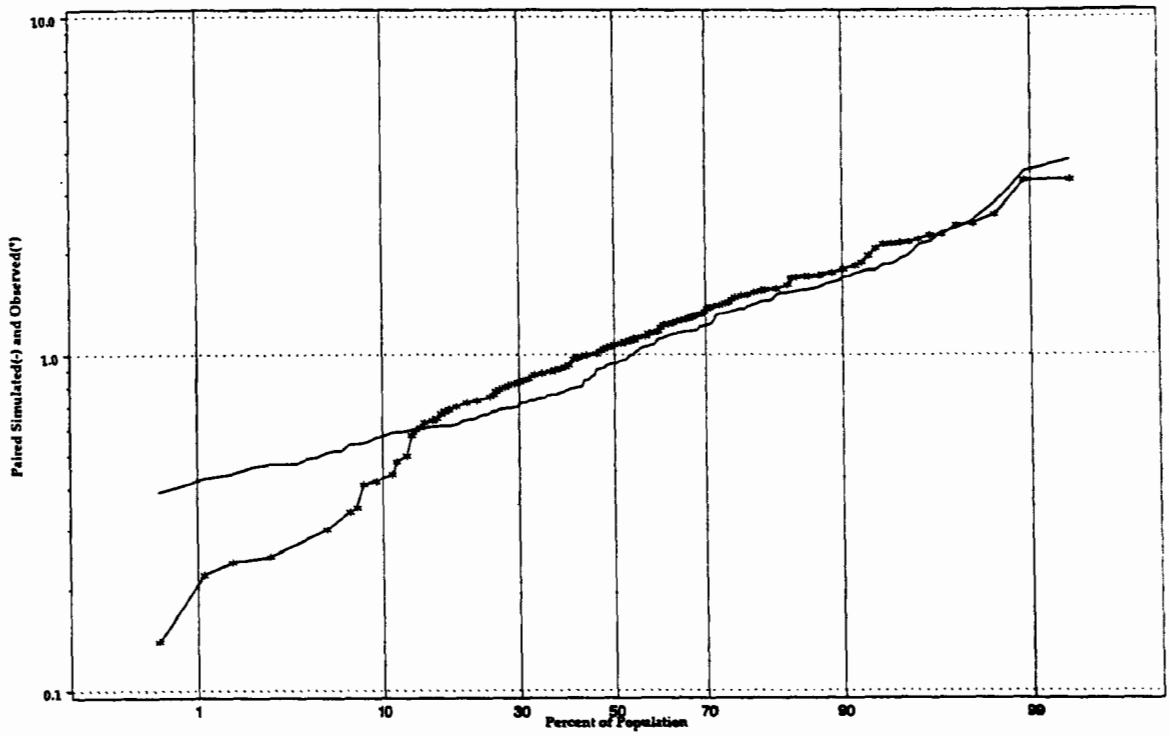
Rappahannock River at Segement 230

Actual Error versus Time

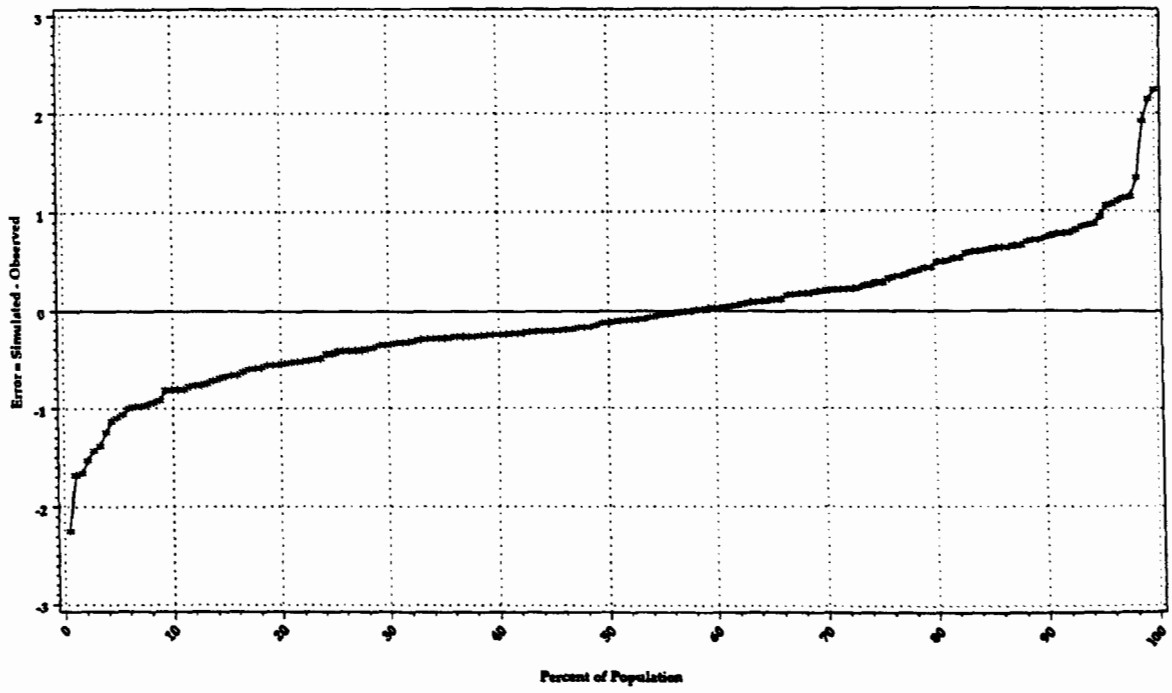
Total Nitrogen



Rappahannock River at Segement 230
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

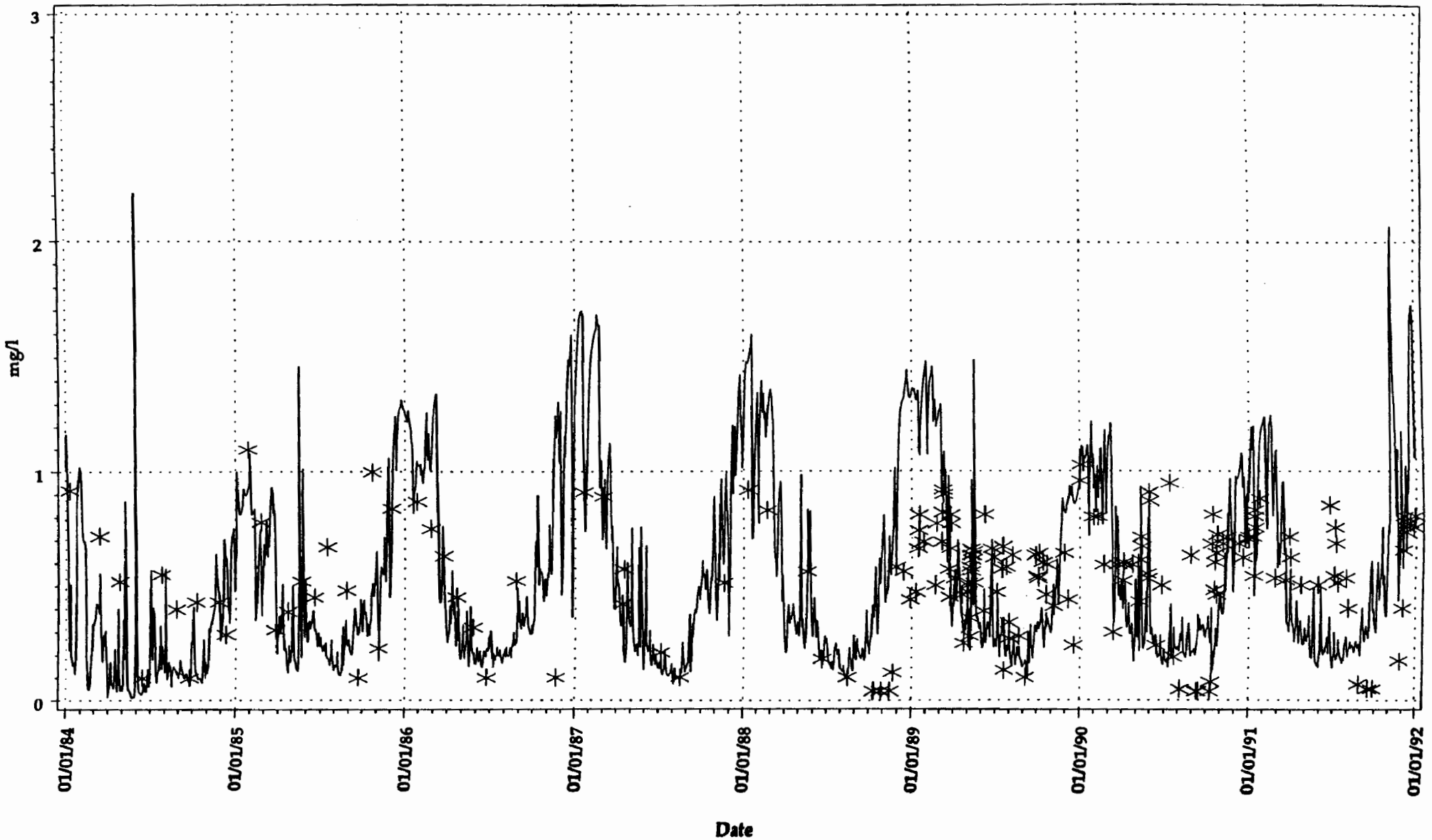


Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data

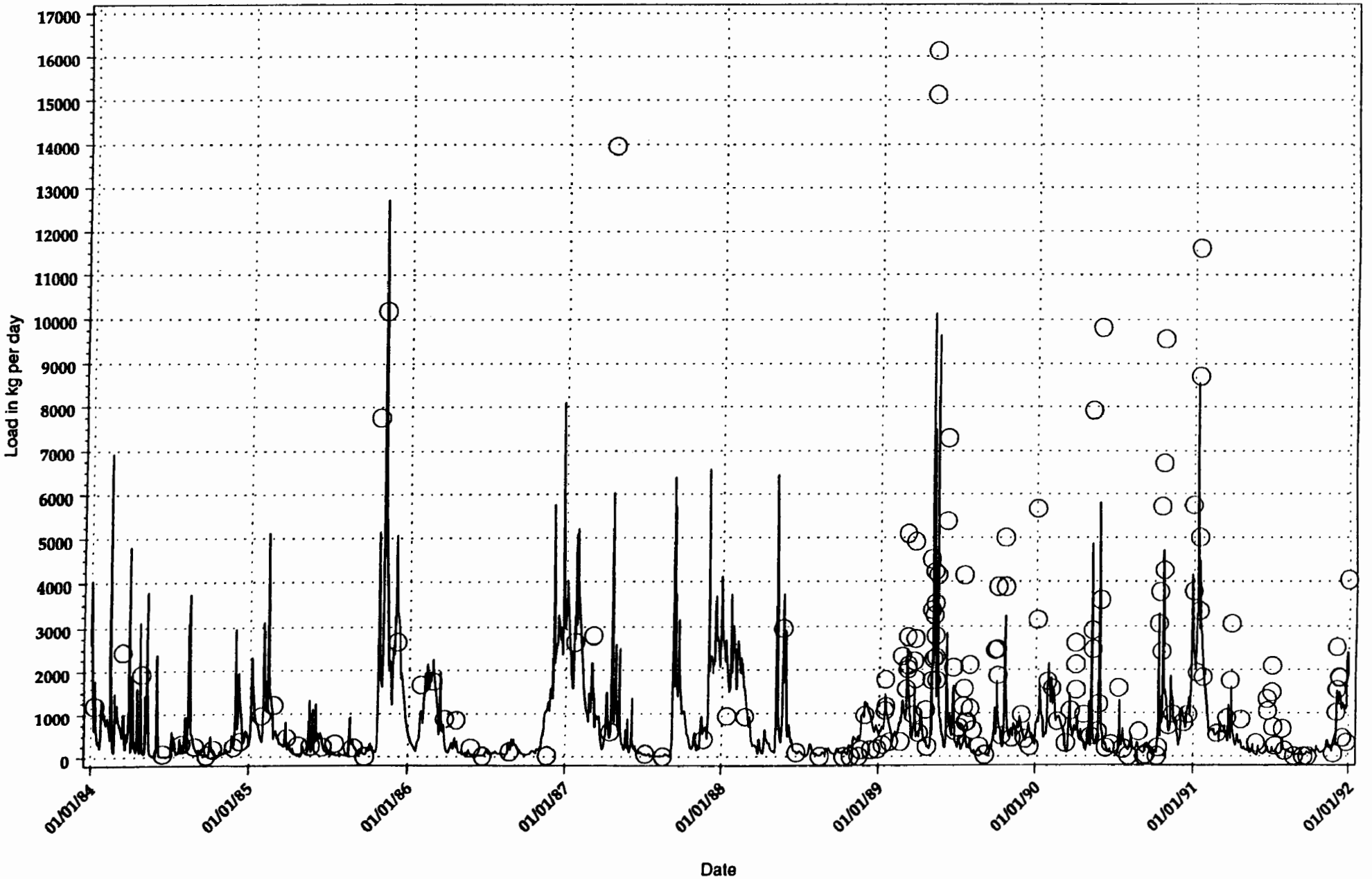


Rappahannock River at Segment 230
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



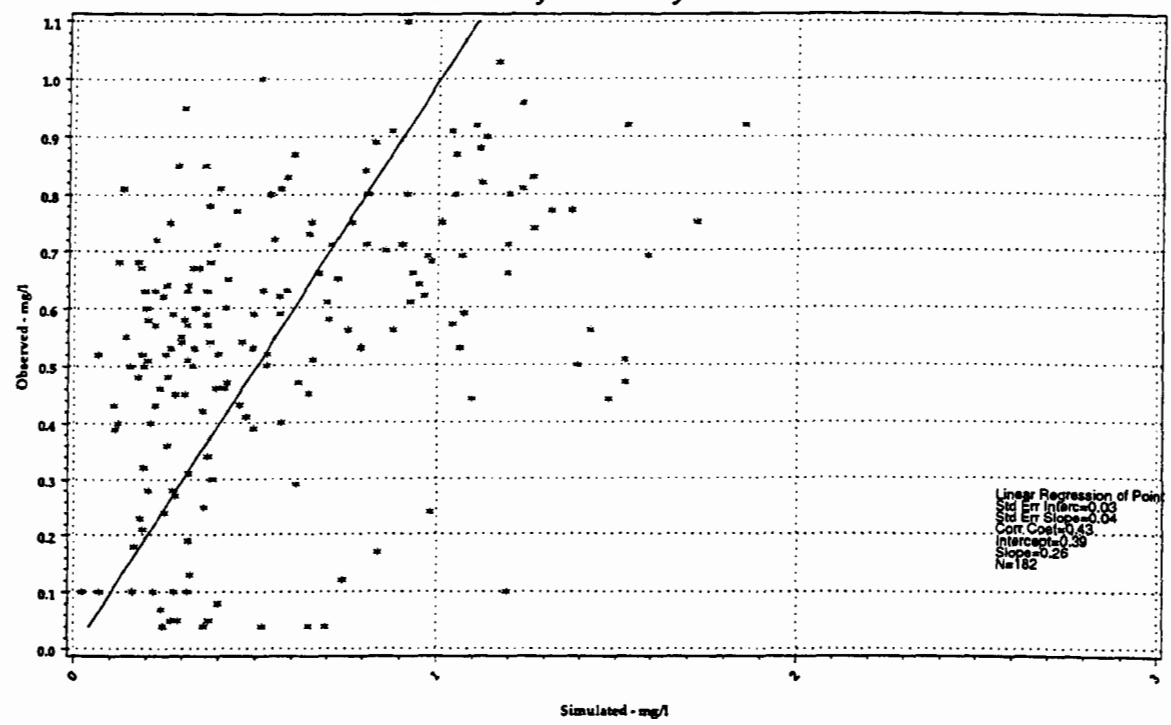
Rappahannock River at Segment 230
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)



Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

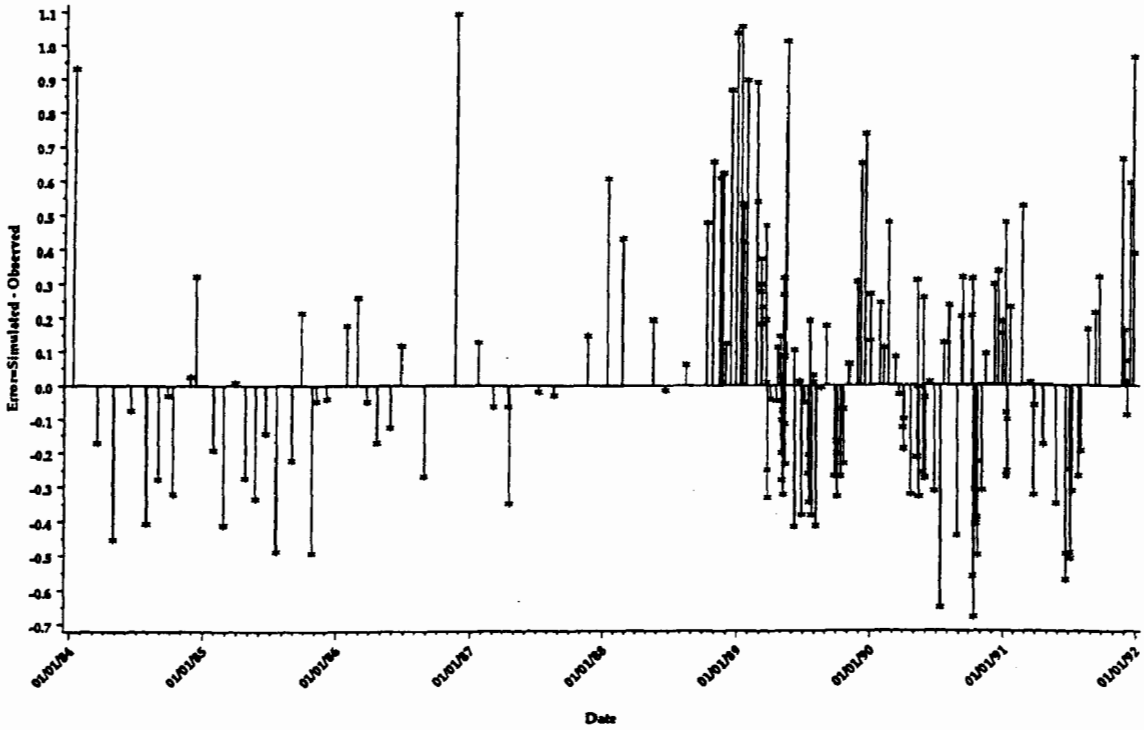
NO3: 01JAN84 - 01JAN92



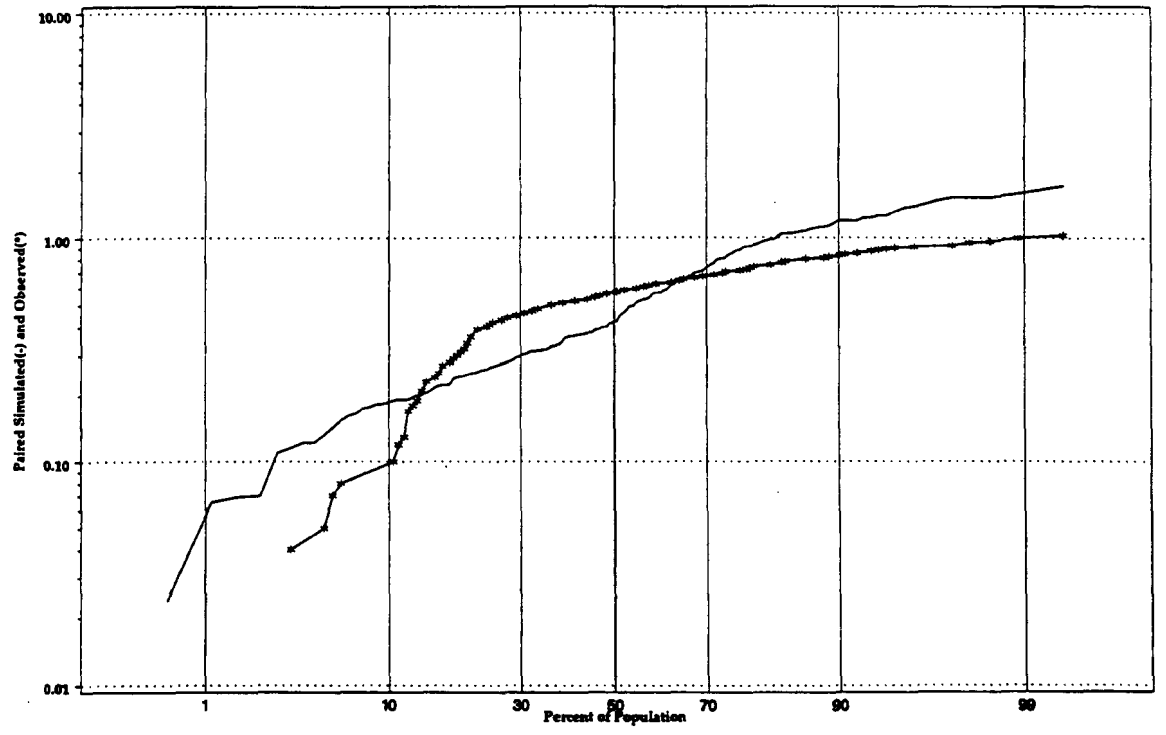
Rappahannock River at Segement 230

Actual Error versus Time

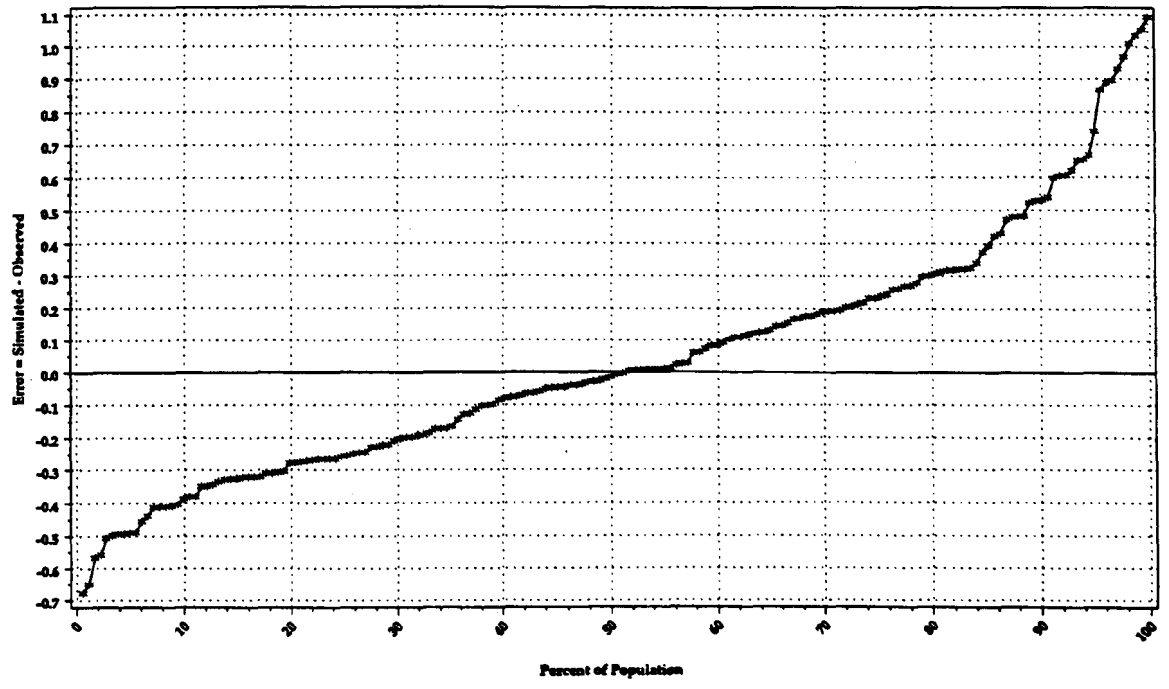
NO3



Rappahannock River at Segement 230
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

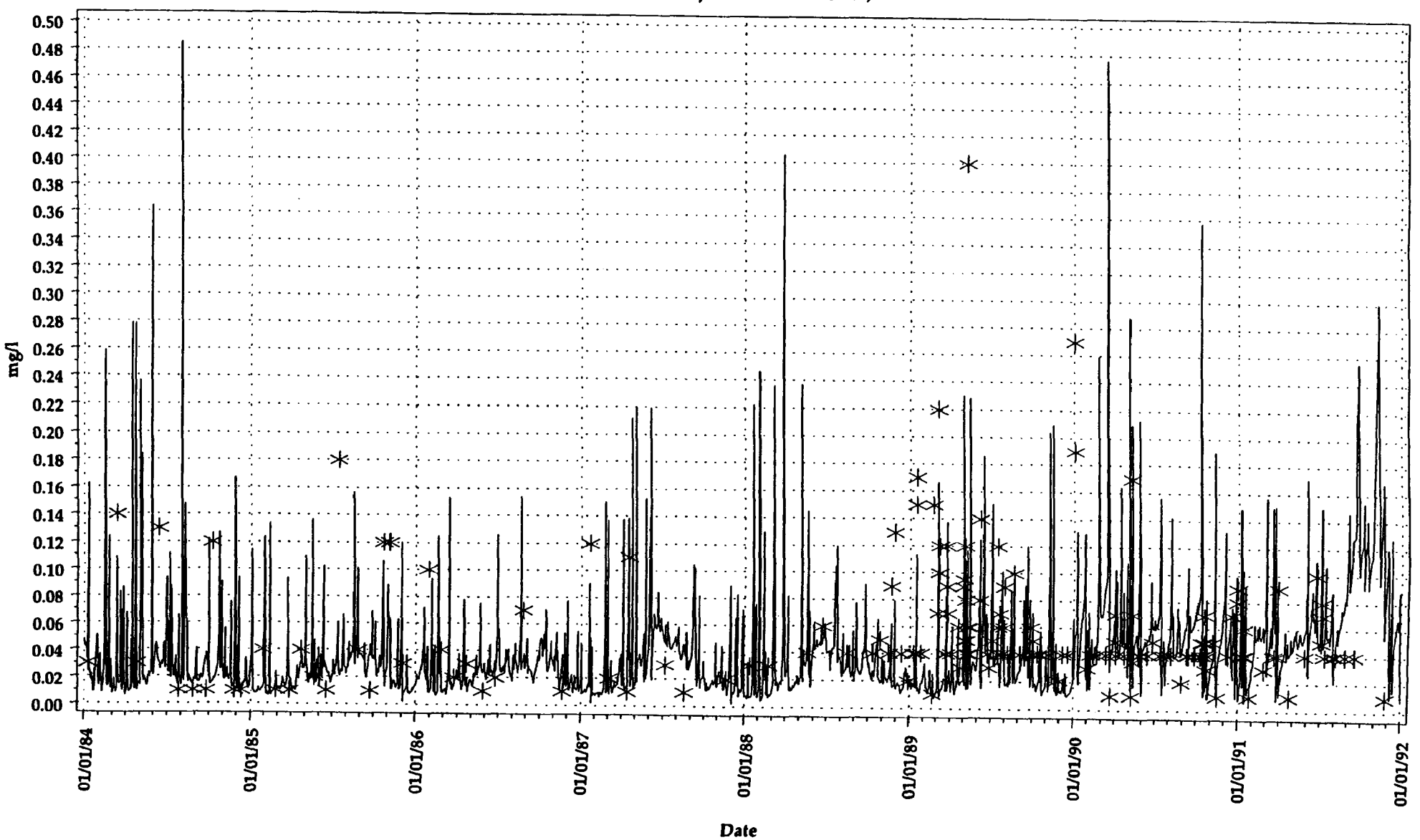


Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data



Rappahannock River at Segment 230
Observed and Simulated versus Time
Total Ammonia

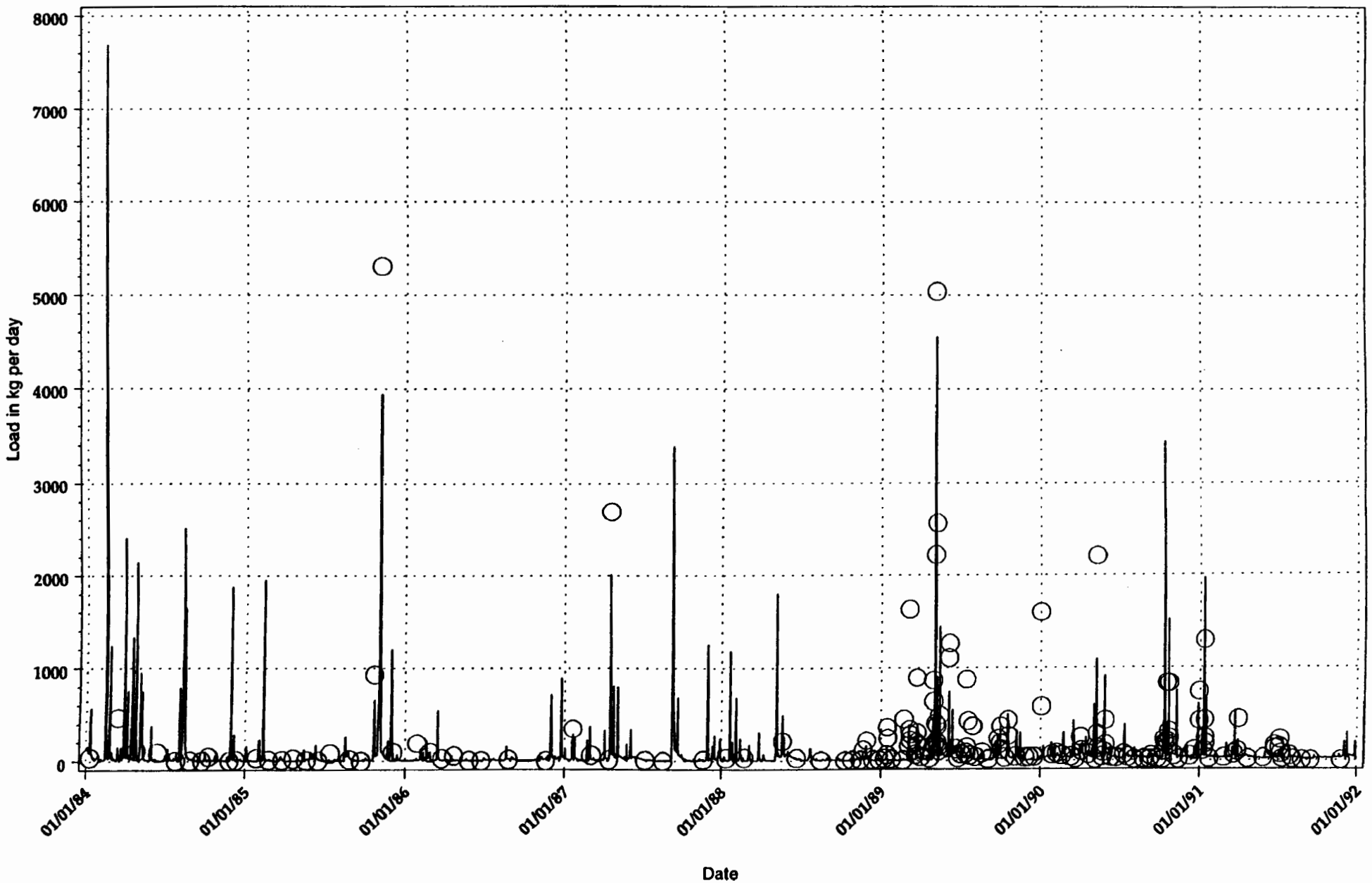
(*=Observed, -=Simulated)



Rappahannock River at Segment 230

Total Ammonia Observed and Simulated Load vs Time

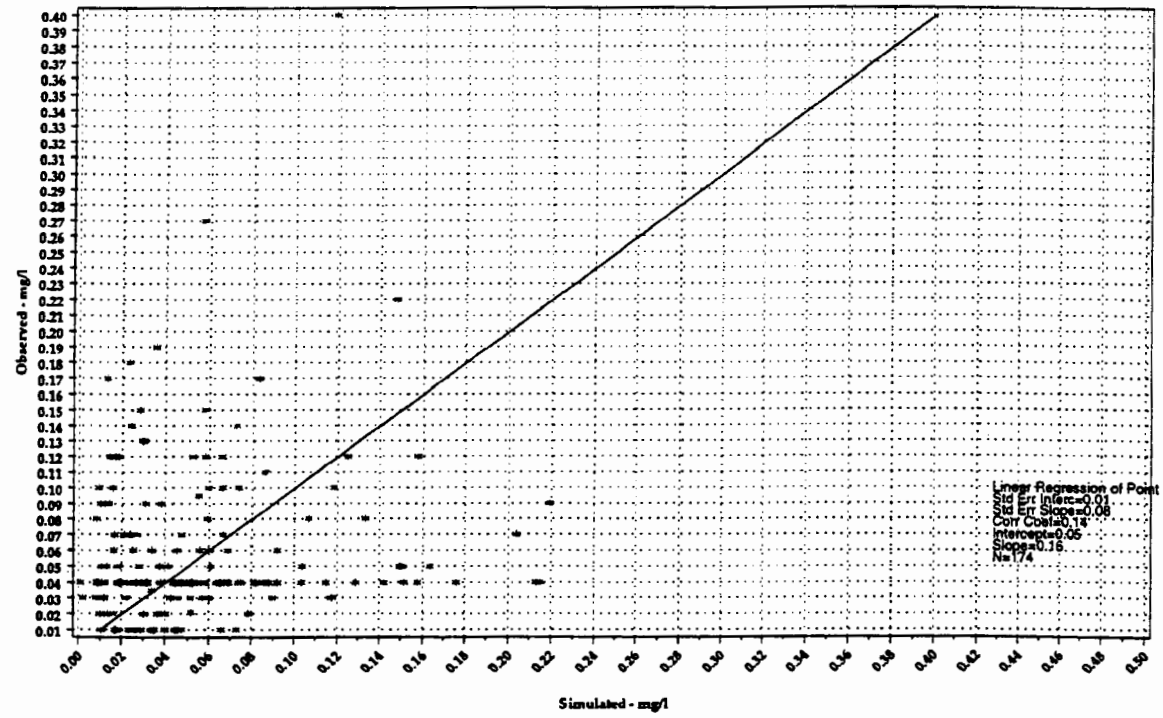
(line = simulated, O = observed)



Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

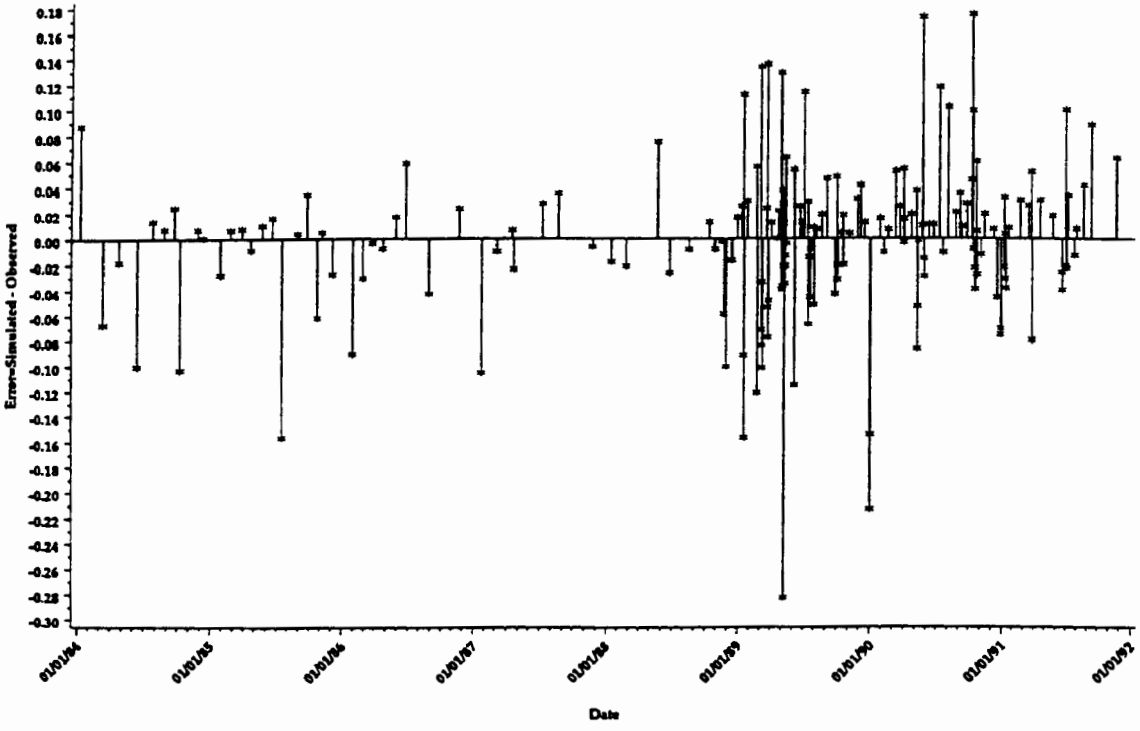
Total Ammonia: 01JAN84 - 01JAN92



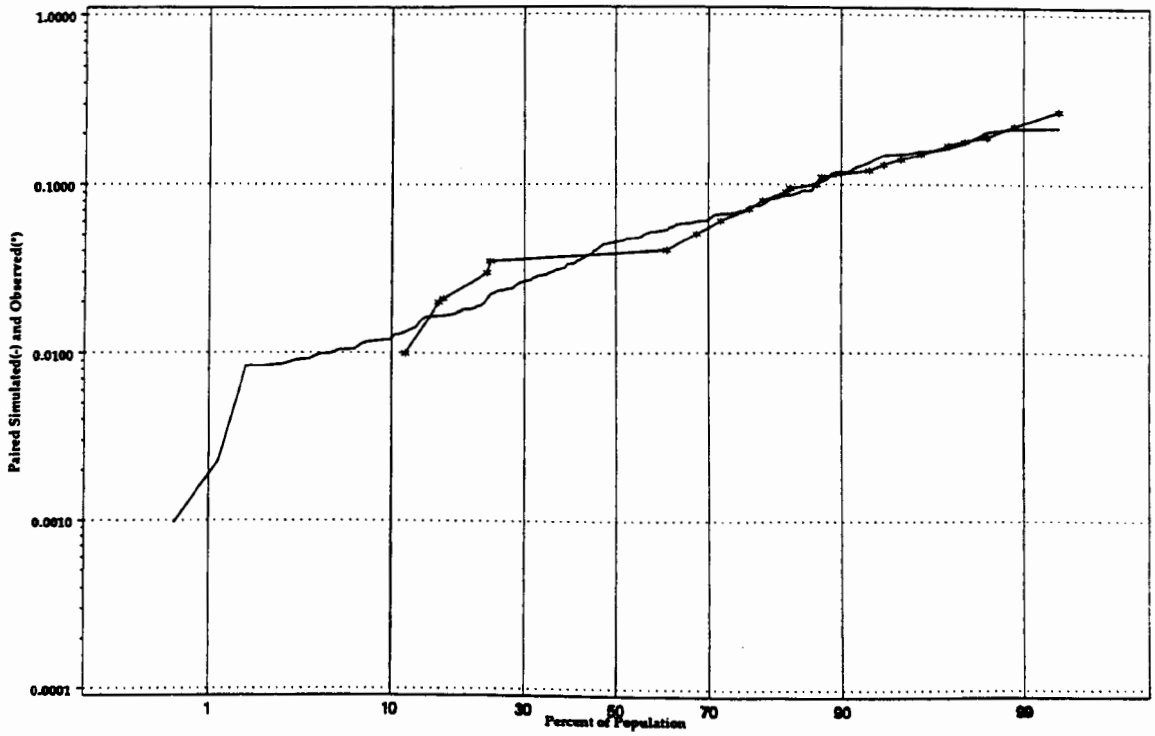
Rappahannock River at Segement 230

Actual Error versus Time

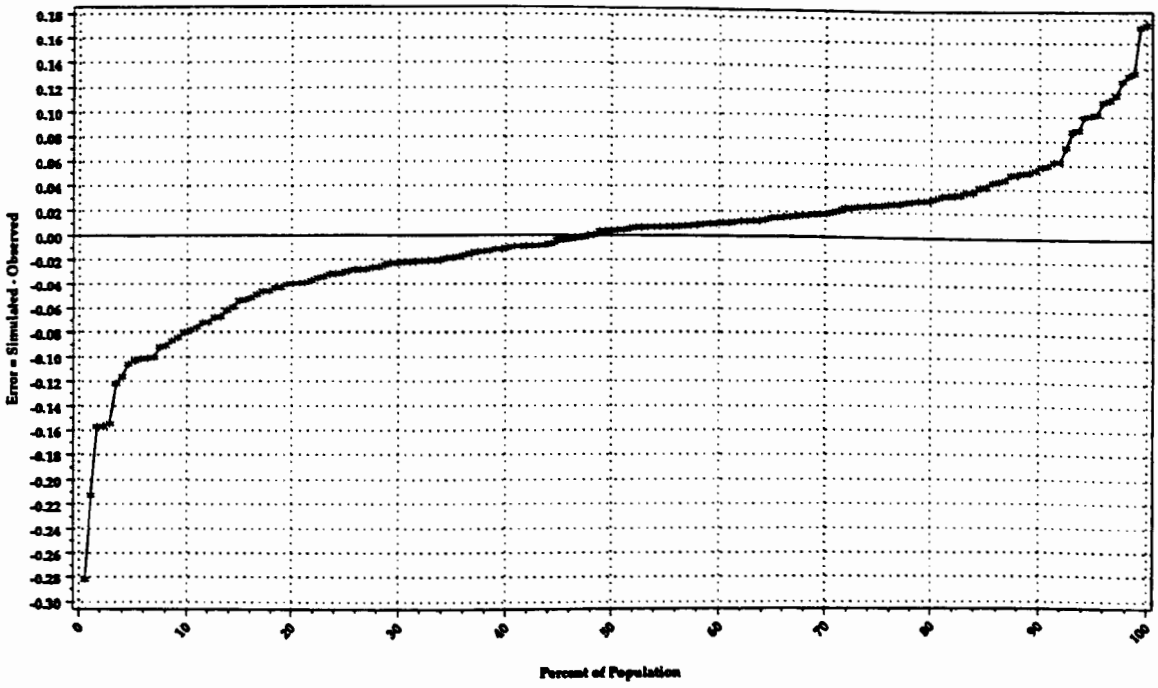
Total Ammonia



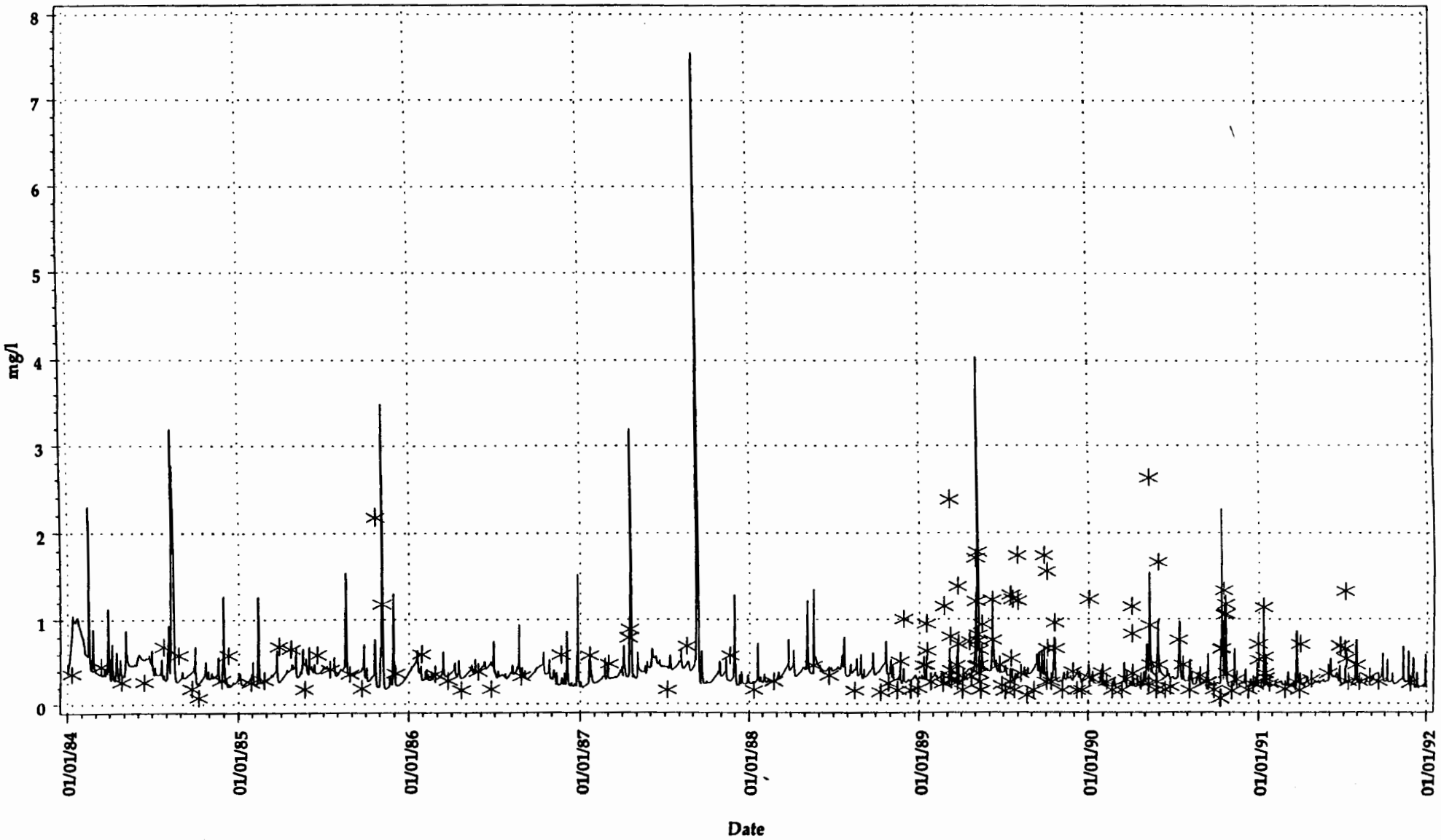
Rappahannock River at Segement 230
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



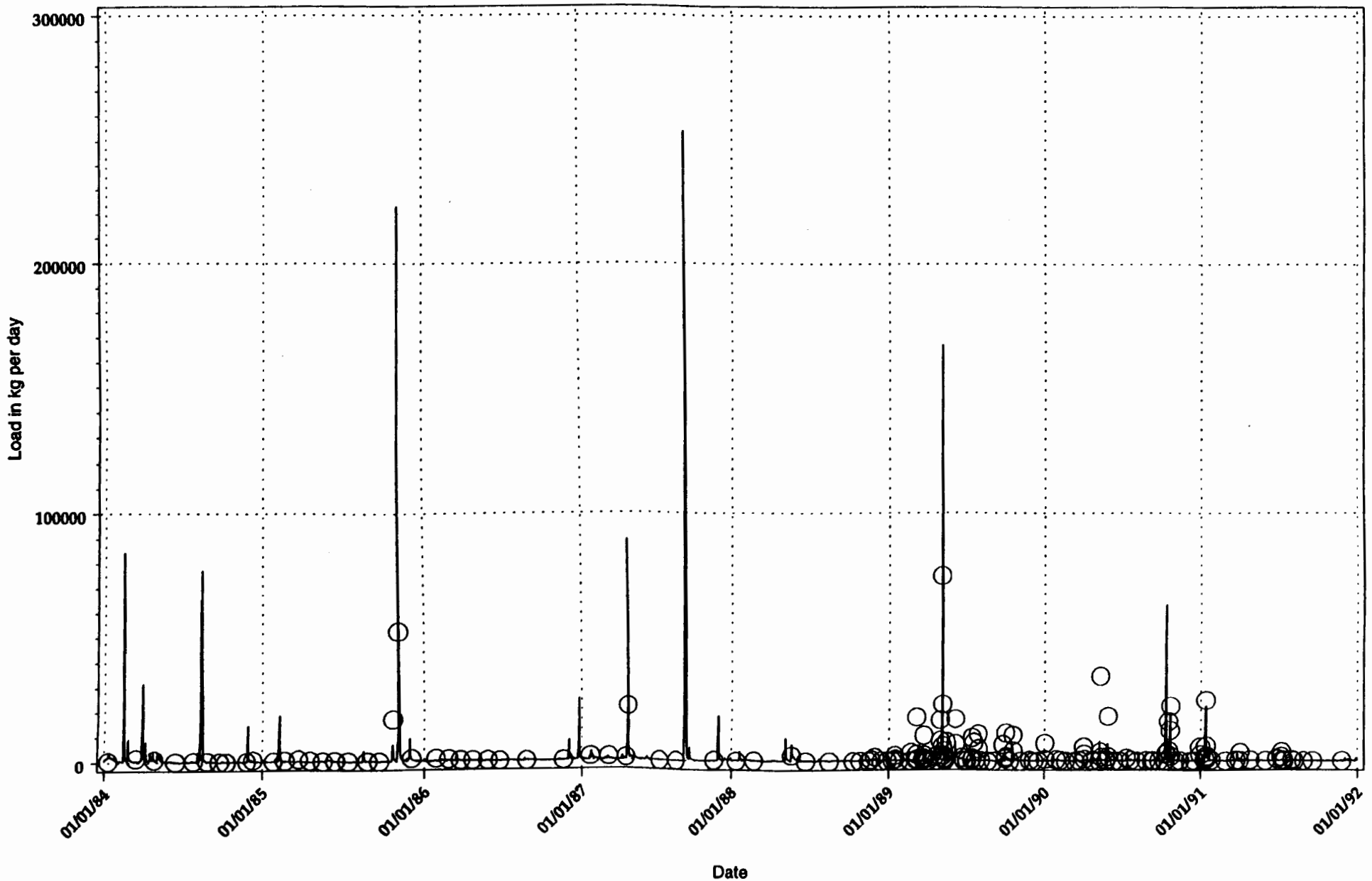
Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



Rappahannock River at Segment 230
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)

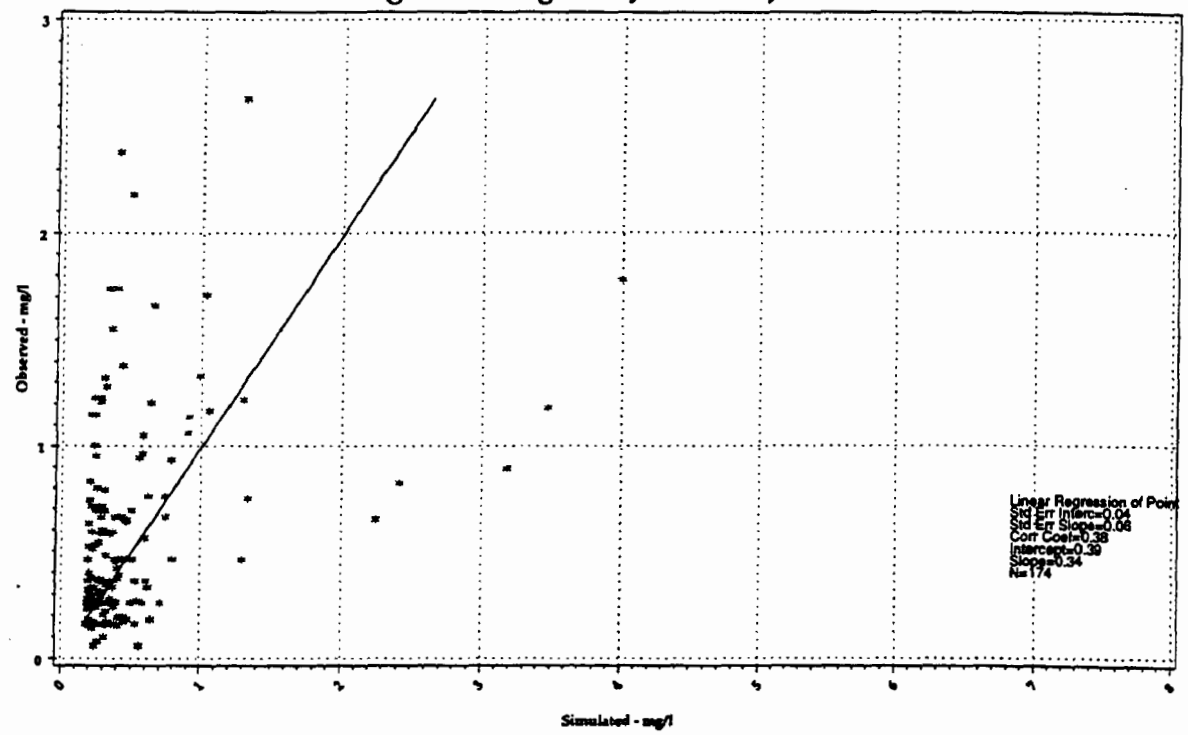


Rappahannock River at Segment 230
Organic Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)



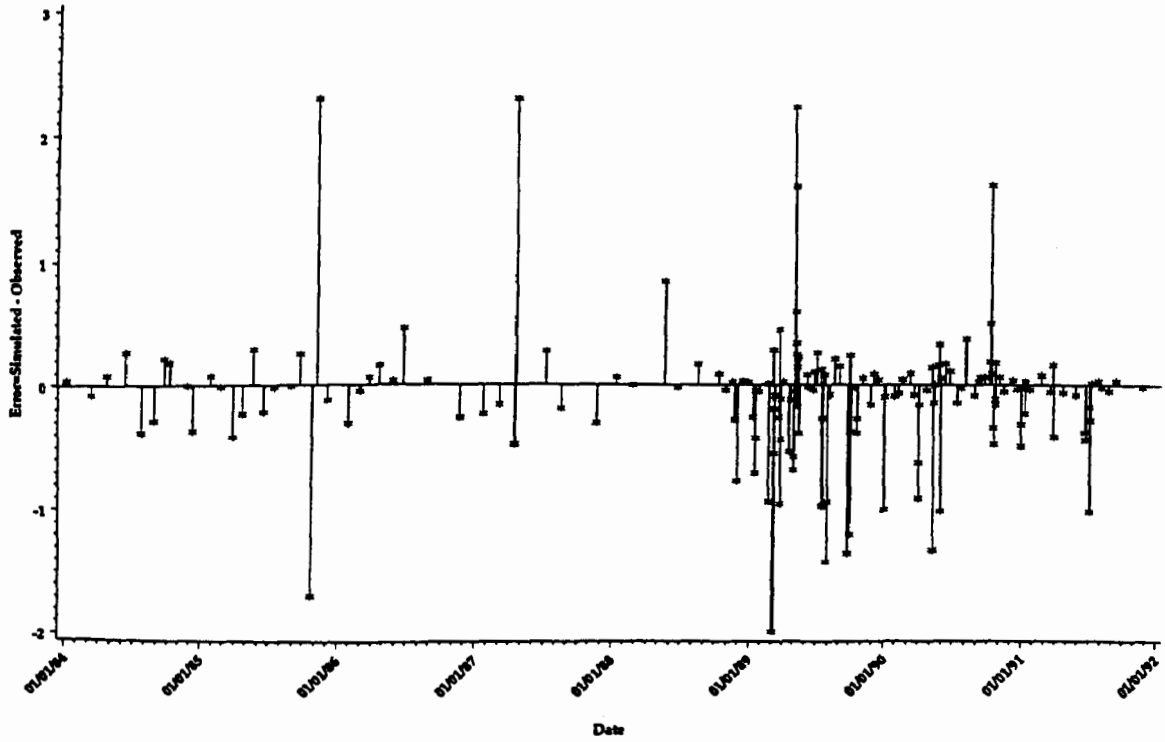
Rappahannock River at Segement 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Organic Nitrogen: 01JAN84 - 01JAN92

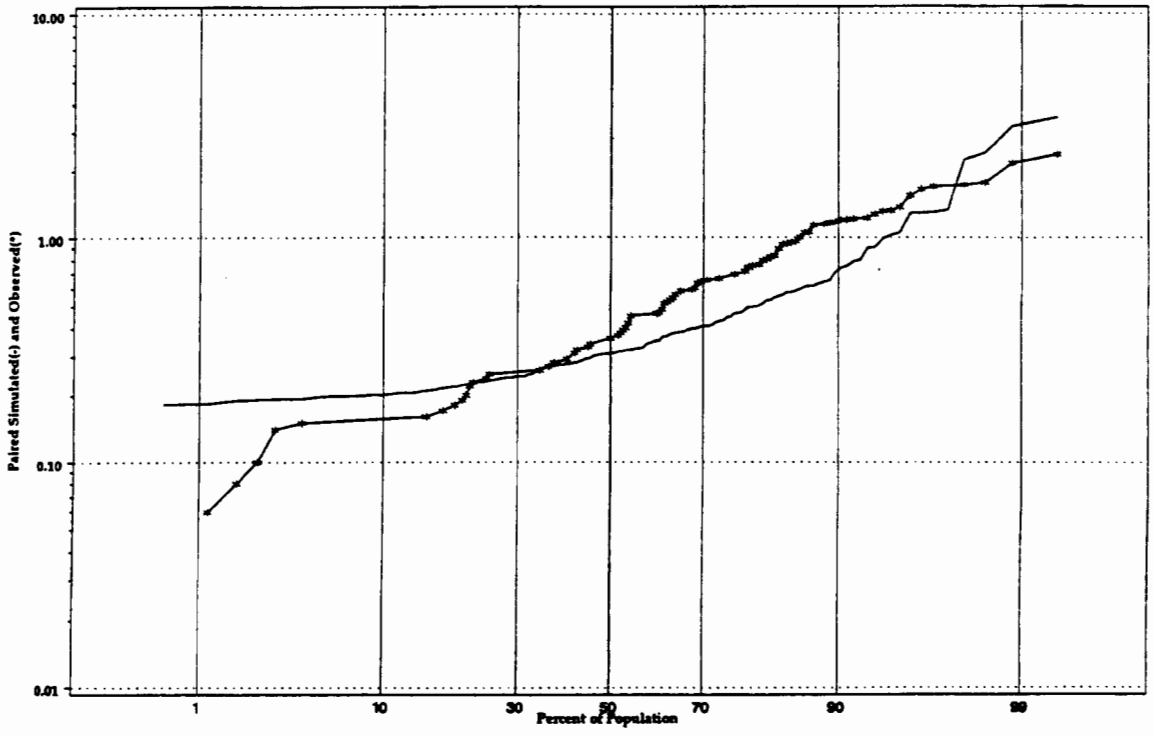


Rappahannock River at Segement 230

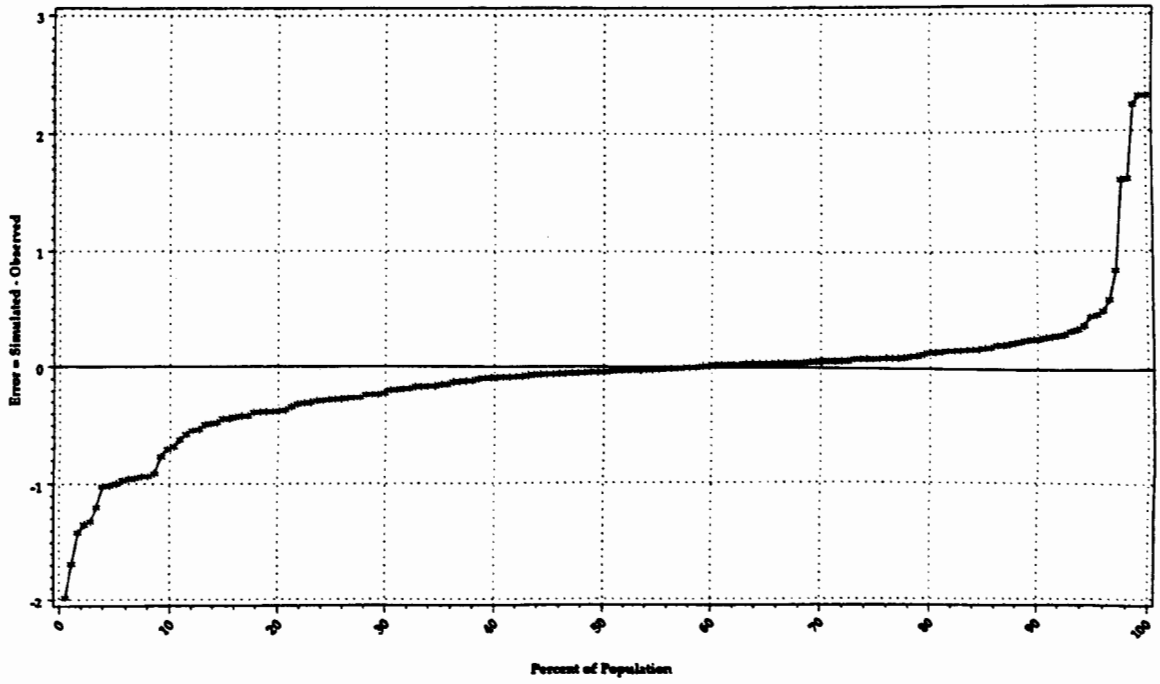
Actual Error versus Time
Organic Nitrogen



Rappahannock River at Segement 230
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Rappahannock River at Segement 230
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.5.0 York River Basin

Basin Segments:

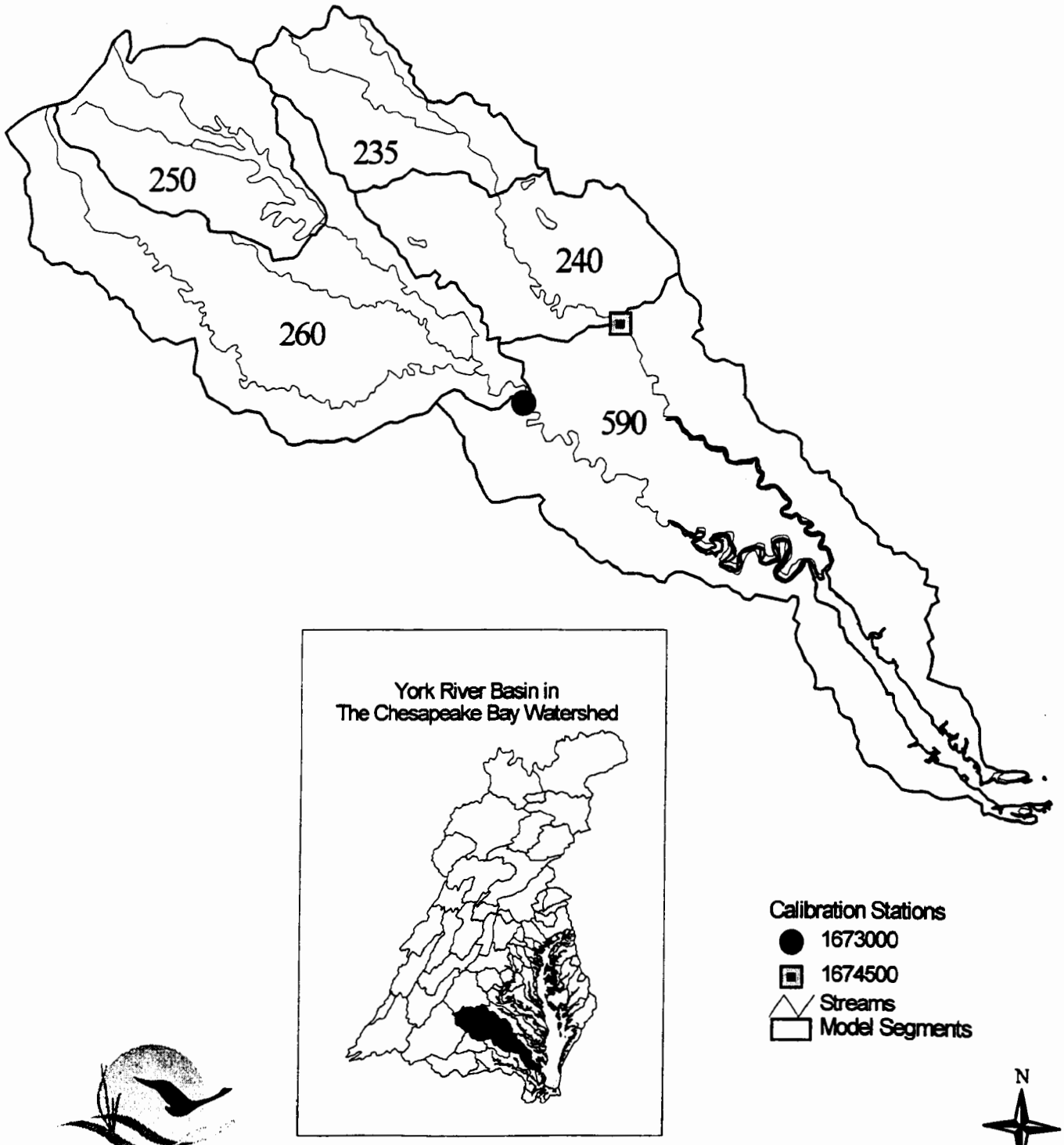
Above Fall Line Basin Segments: 235, 240, 250, and 260
Below Fall Line Basin Segments: 590

Section Contents:

B.5.0 Monitoring Stations in the York River Basin (Figure B.5.0)
B.5.1 Mattaponi River (Monitoring Station: 1674500)
B.5.2 Pamunkey River (Monitoring Station: 1673000)

Figure B.5

Monitoring Stations in the York River Basin



Chesapeake Bay Program

Map Date: April 1998

Source: USGS and USEPA Chesapeake Bay Program

B.5.1 Mattaponi River near Beulahville, VA at Segment 240 (Monitoring Station: 1674500) (Above Fall Line Basin Segments: 235 and 240)

Section Summary:

The Mattaponi basin together with the Pamunkey form the above fall line portion of the York River. The Mattaponi is similar to the Rappahannock in its rural character dominated by agricultural loads. Concentrations of total nitrogen, total phosphorus, and total suspended sediment are generally low at the Mattaponi gage station. Water quality observations increased and were oriented toward storm weighted sampling after 1989. Model calibration focused primarily on the refined, storm-weighted sampling after 1989.

The Mattaponi basin above the gaged site covers an area of 594 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 72% forest land, 11% cropland, 8% other agricultural areas, 7% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage increased from 0.64 million pounds in 1985 to 0.67 million pounds in 1996. Total phosphorus loads over the same time period decreased from 58 thousand pounds to 49 thousand pounds. In general, point source loads above the gage site decreased. Estimated septic system total nitrogen loads increased 39%, from 41 thousand pounds in 1985 to 58 thousand pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 2%, and other agricultural loads (primarily pasture and manure loads) by 28%. Total phosphorus decreased for these land uses by 22% and 54% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 32% for total nitrogen and 29% for total phosphorus due to increases in population and urban land use area

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

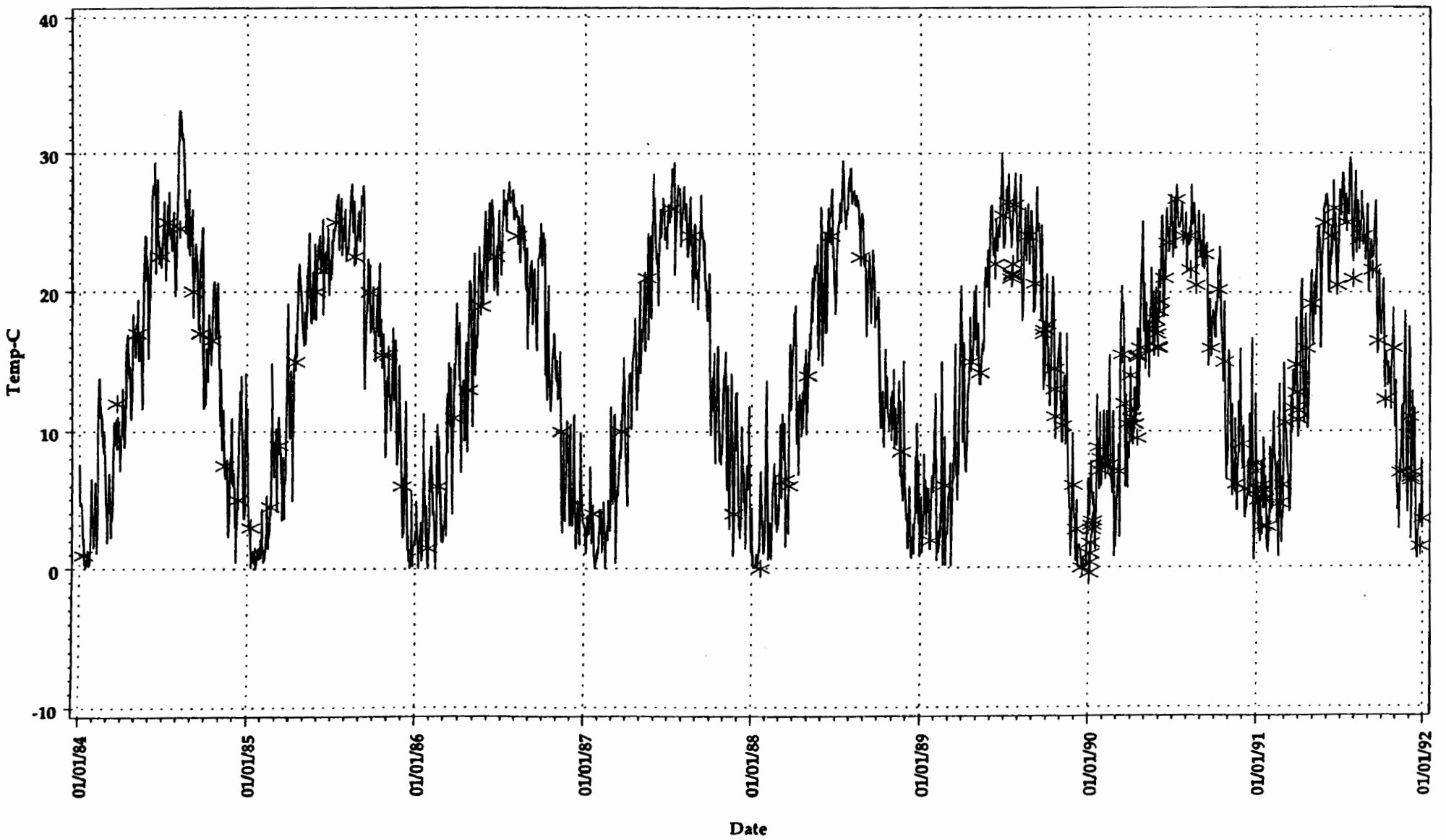
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

Mattaponi River at Segment 240
Observed and Simulated versus Time
Temperature-C

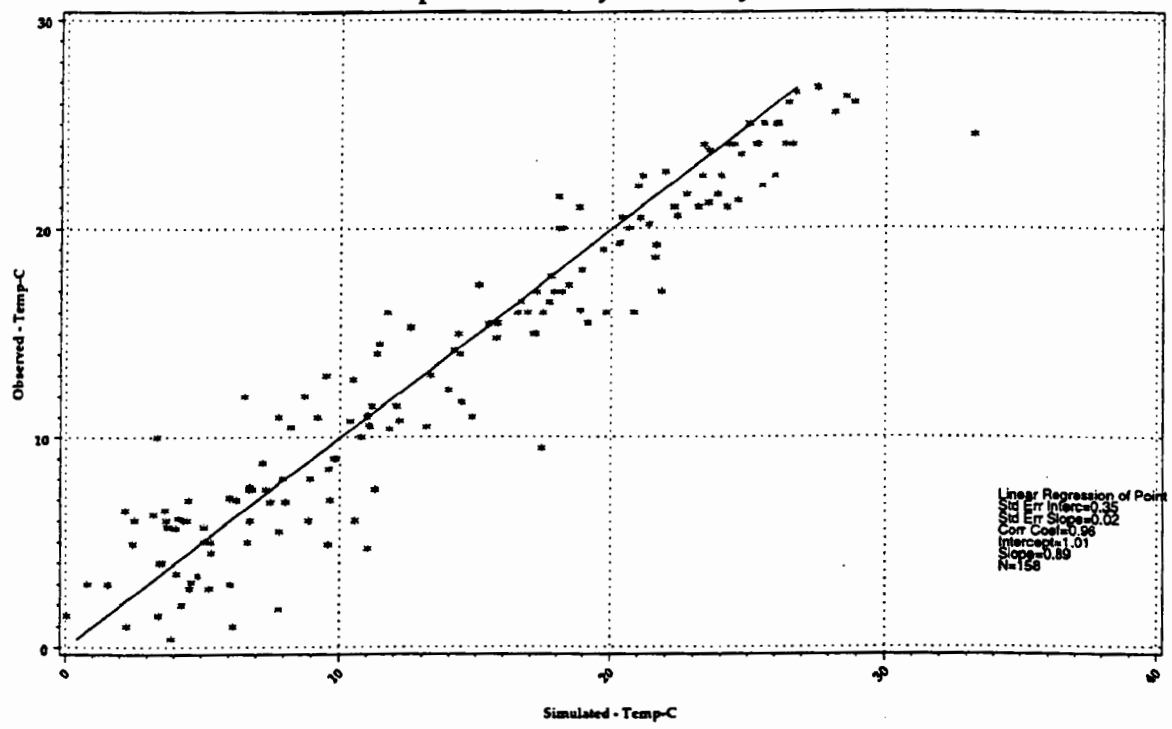
(*=Observed, -=Simulated)



(y21_plot1.sas dataslave2 (pgm.p3 jamco.sas) plotsmt - ontime)
(graph_a.dev 26AUG97 17:26)

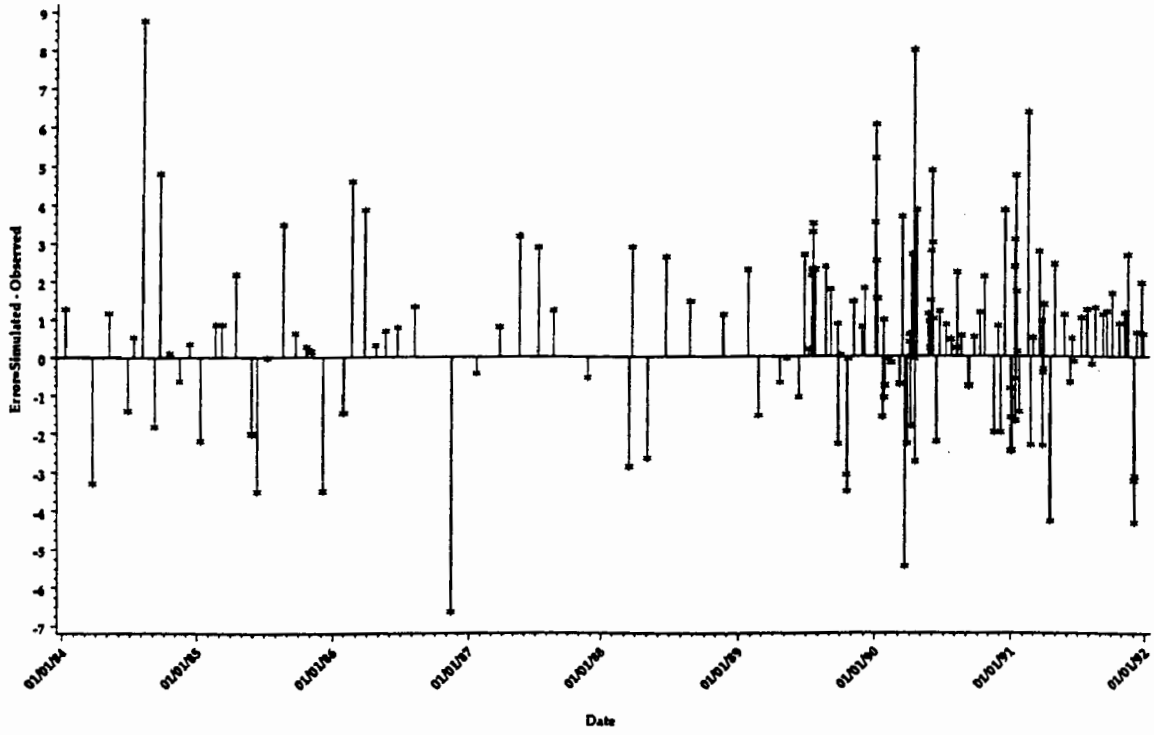
Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Temperature-C: 01JAN84 - 01JAN92

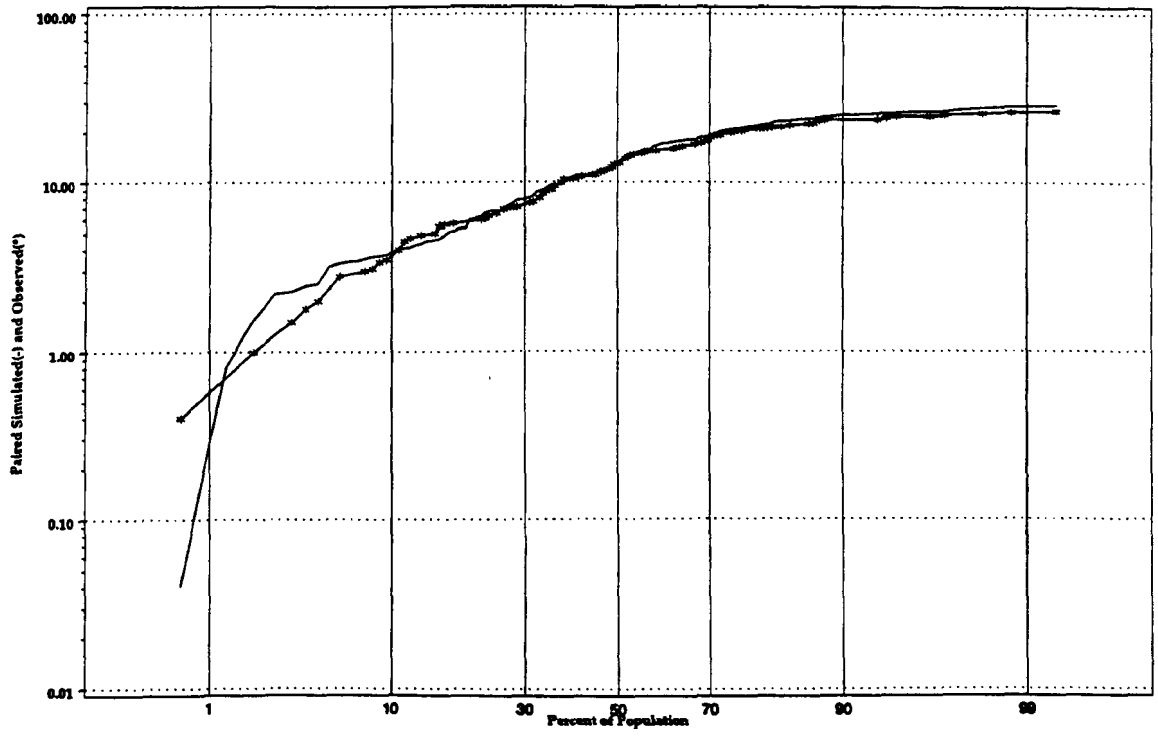


Mattaponi River at Segment 240

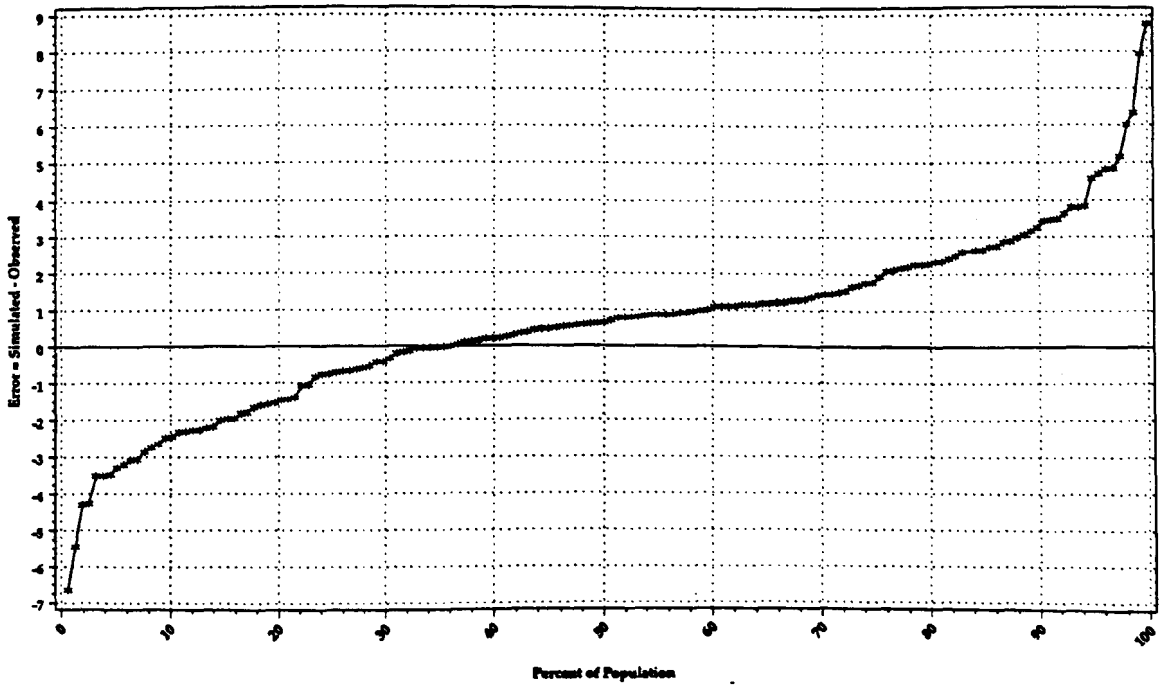
Actual Error versus Time
Temperature-C



Mattaponi River at Segment 240
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

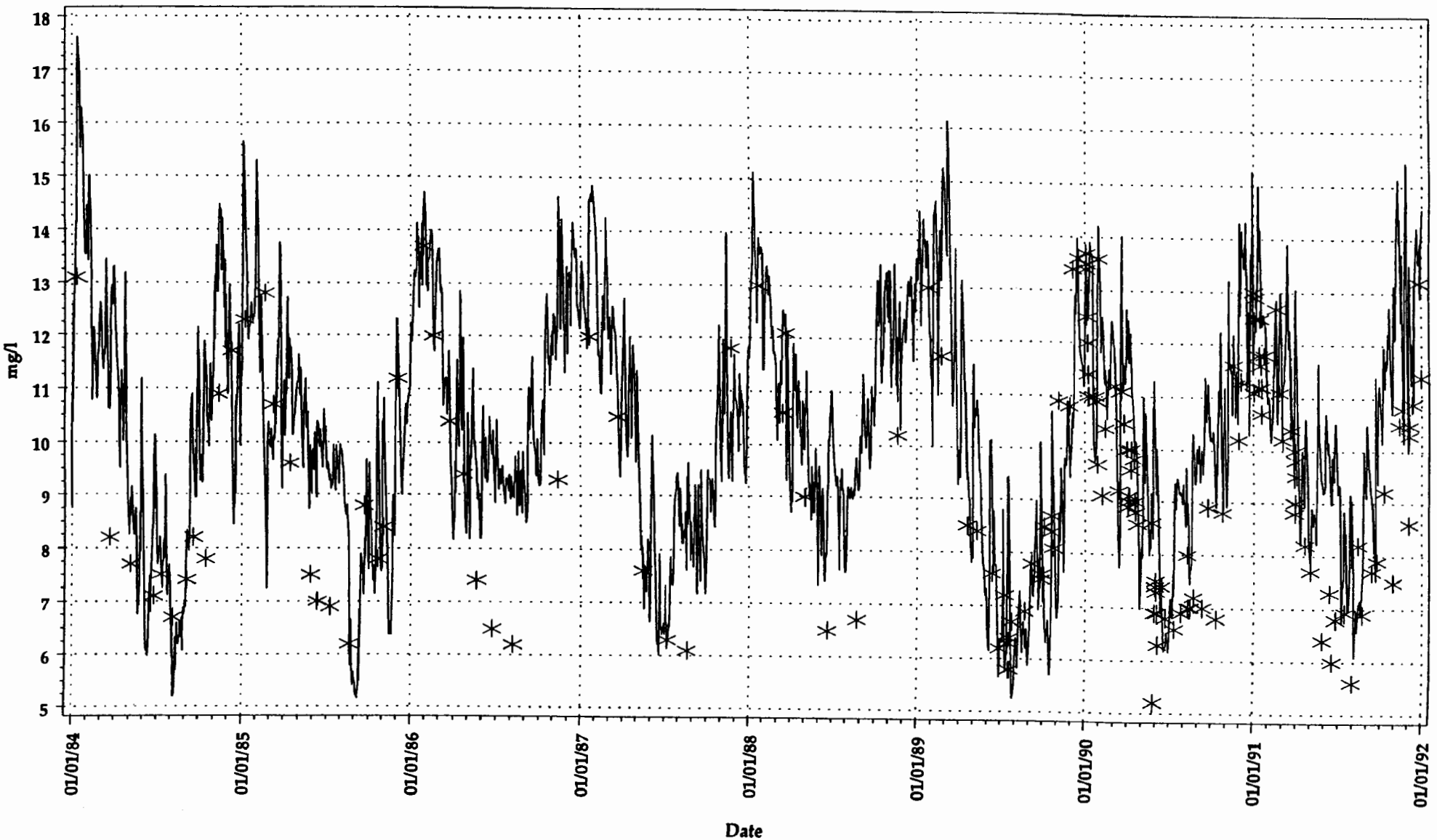


Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data



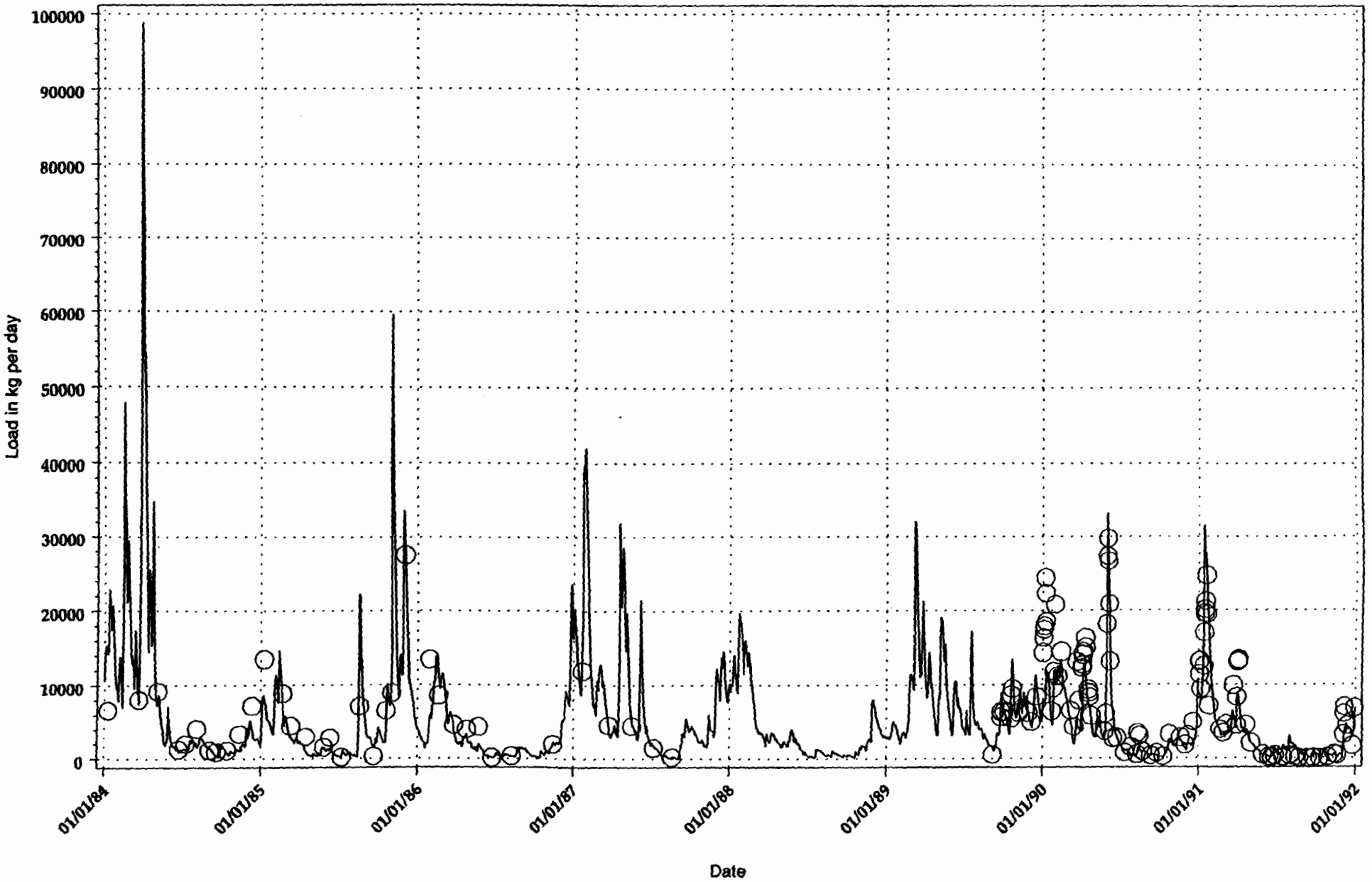
Mattaponi River at Segment 240
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2 jrps p3 james.sas) plotcmt - ontime)
(graph_a.drv 25AUG97 17:25)

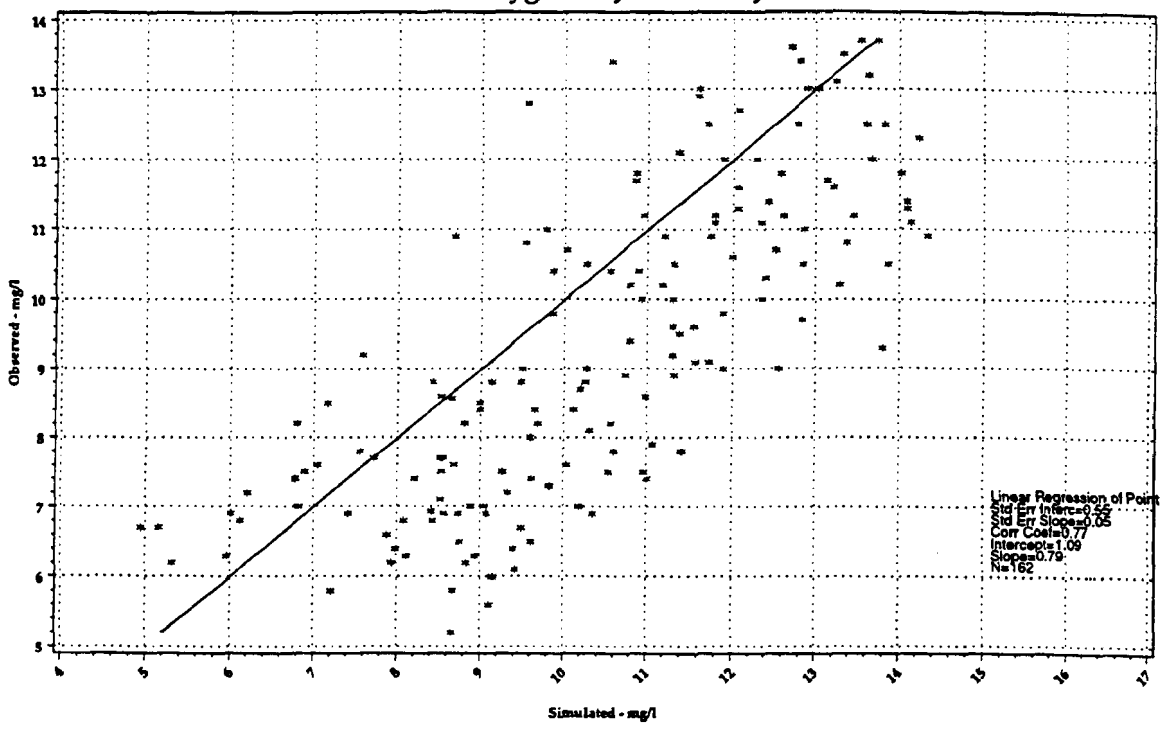
Mattaponi River at Segment 240
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)



Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

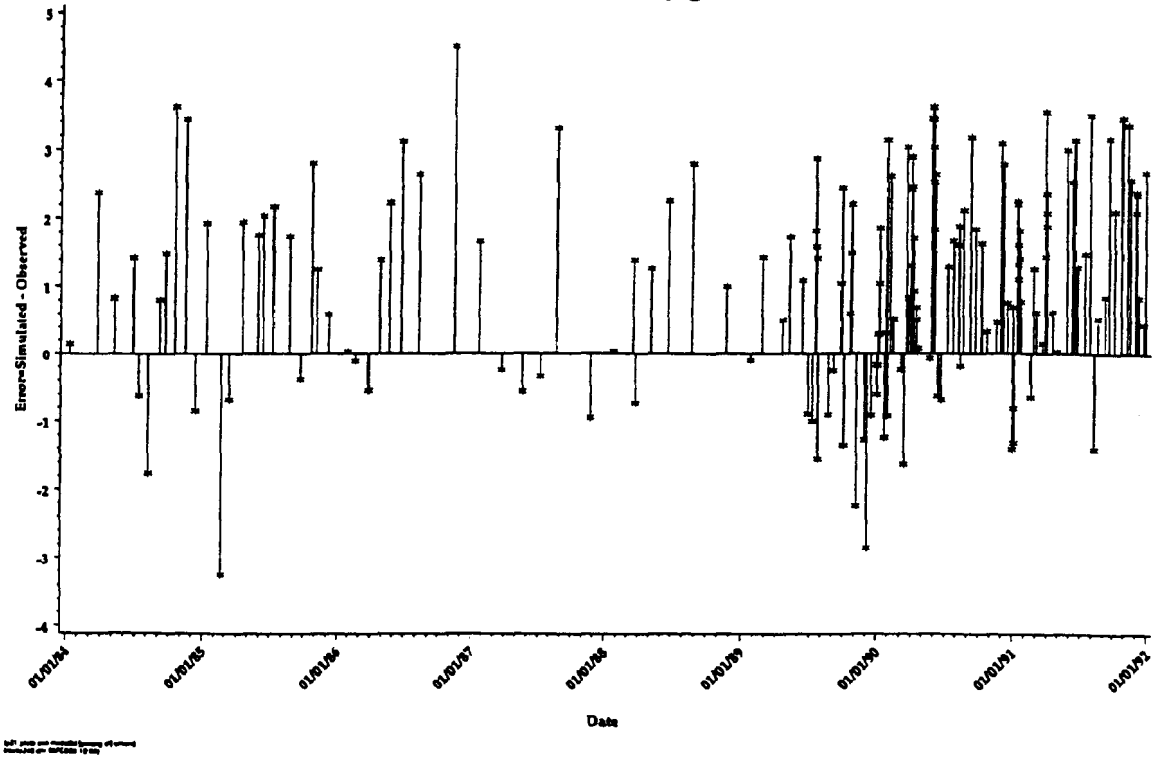
Dissolved Oxygen: 01JAN84 - 01JAN92



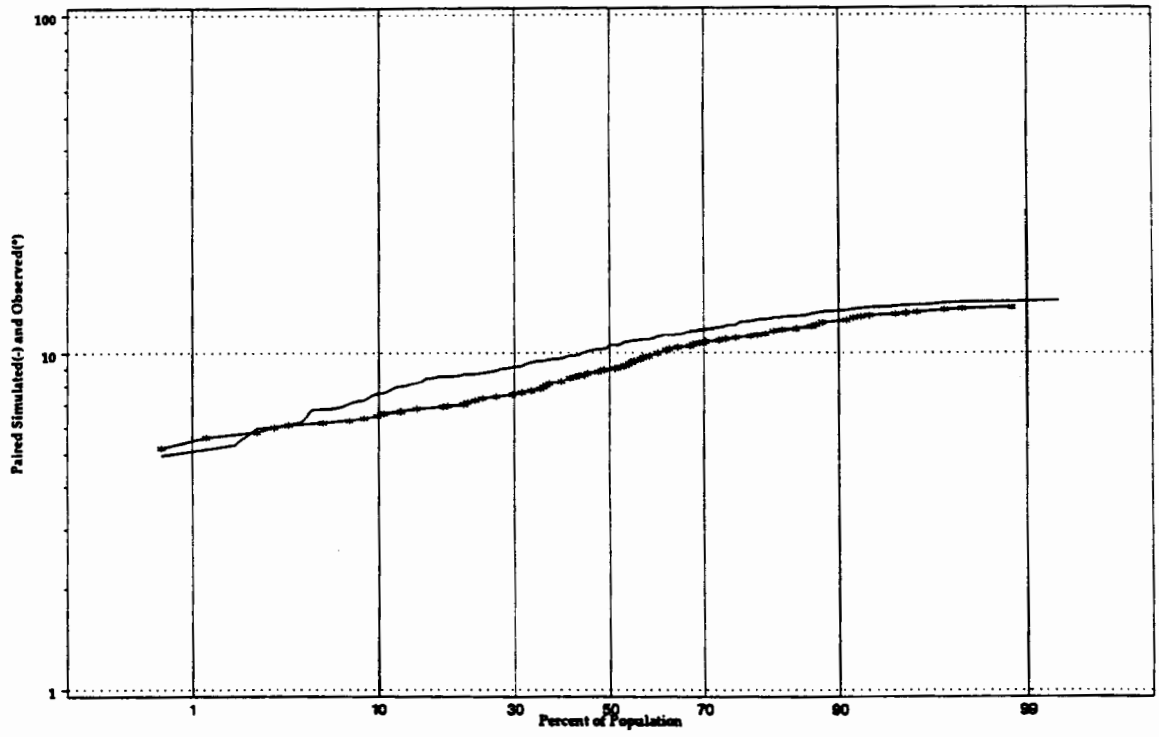
Mattaponi River at Segment 240

Actual Error versus Time

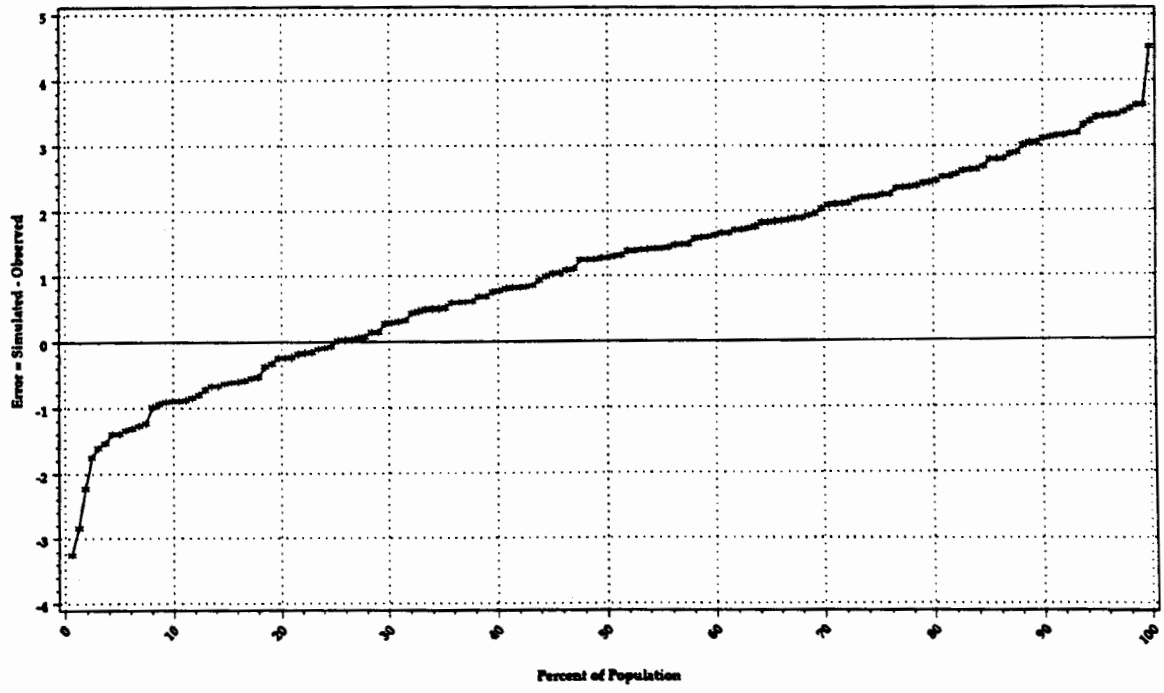
Dissolved Oxygen



Mattaponi River at Segment 240
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

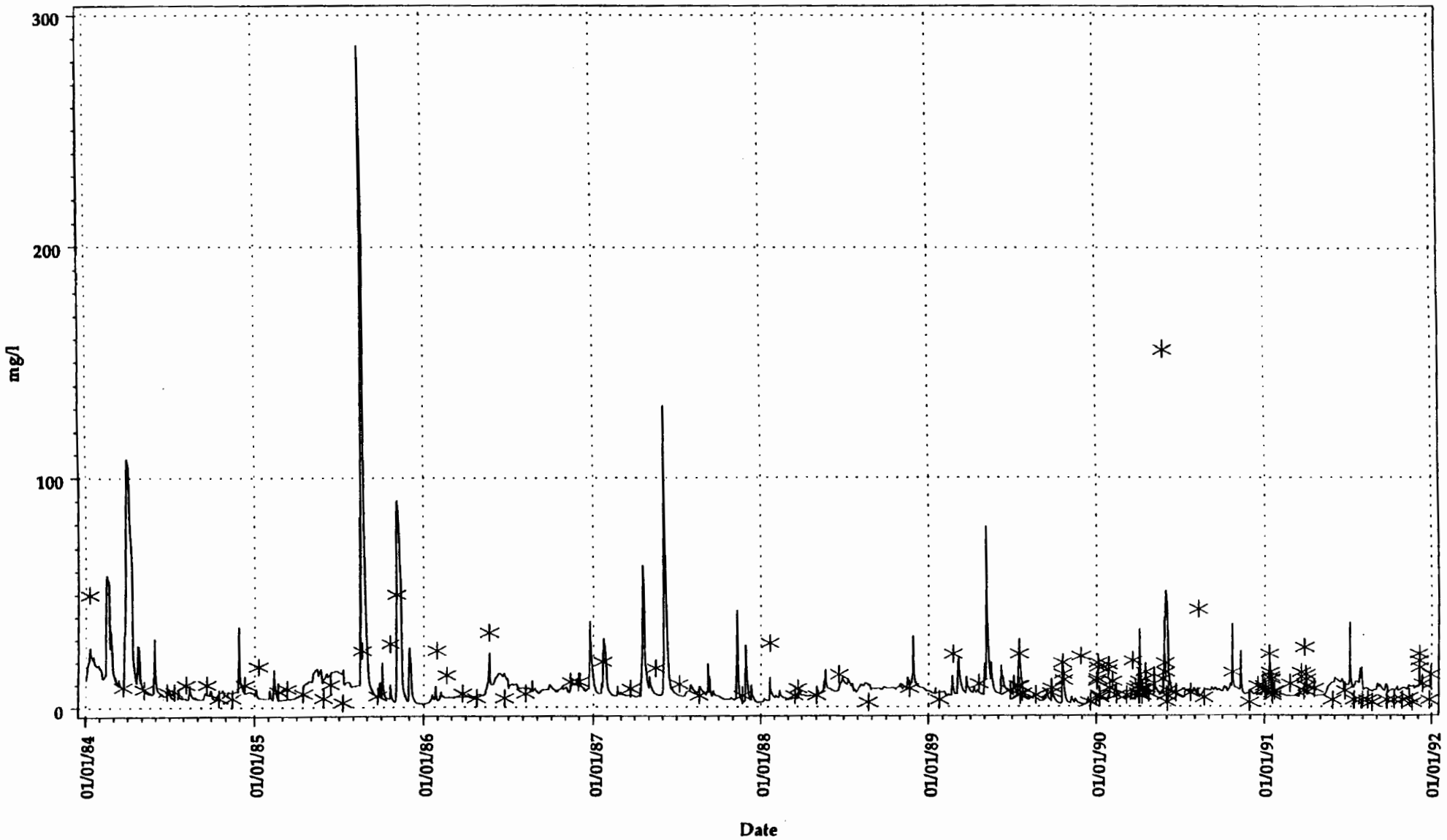


Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Mattaponi River at Segment 240
Observed and Simulated versus Time
Total Suspended Sediment

(*=Observed, -=Simulated)

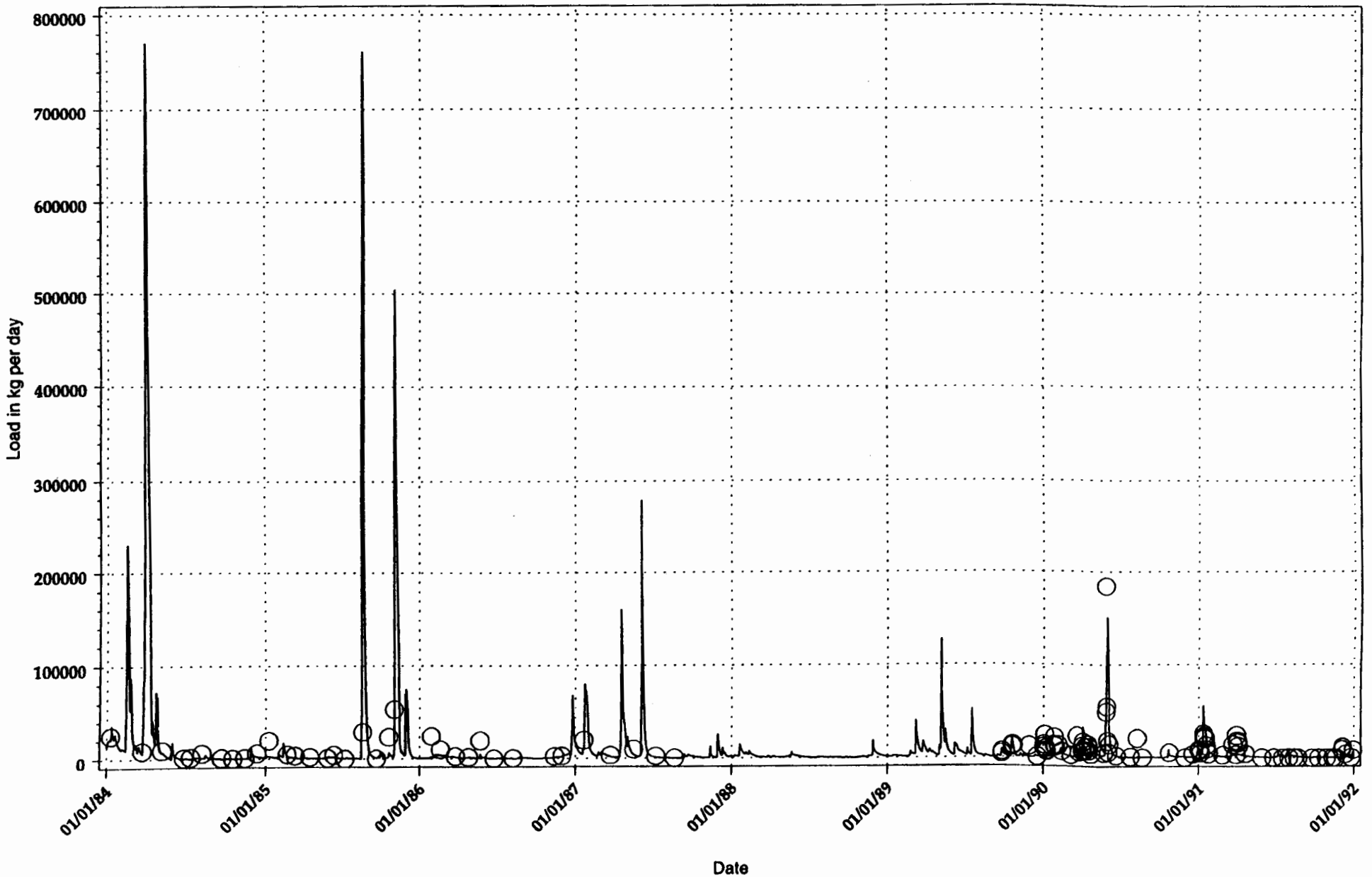


(y21_plot1.sas datastore2 jrpe p3 james.sas| plotomf - omtime)
(graph_a.drv 25AUG97 17:25)

Mattaponi River at Segment 240

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

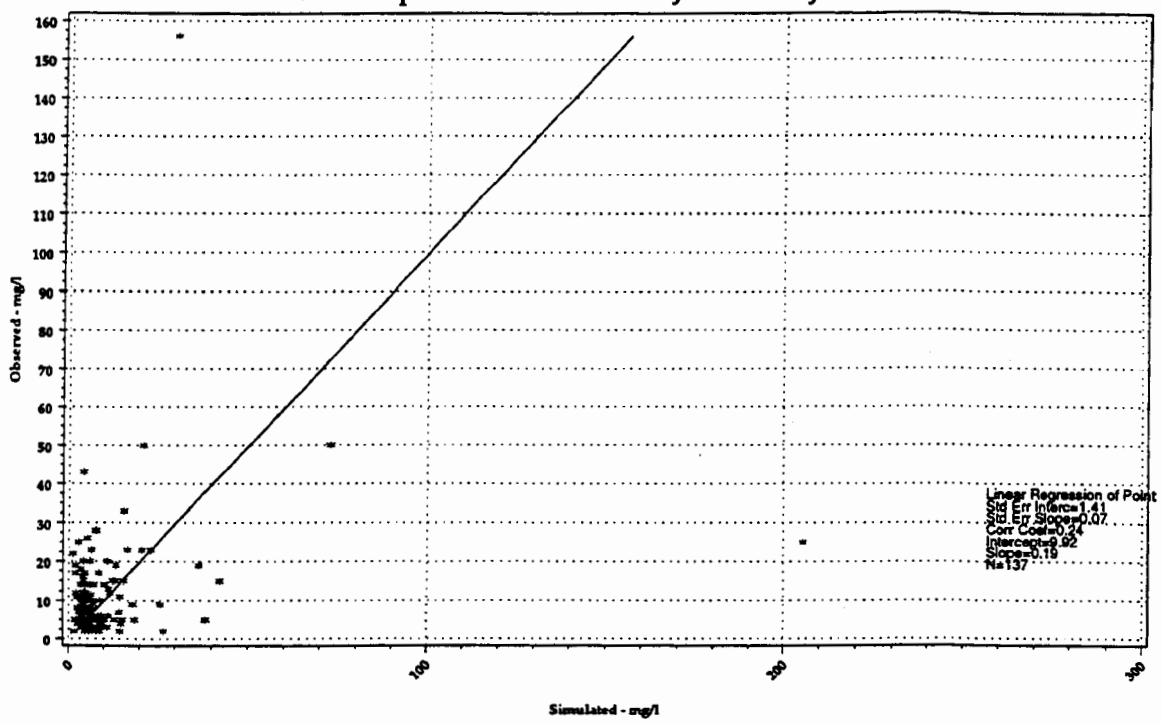


(y21_plot1 sas datastore2 (nps.p3 (amos.sas) fldfloe)
(graph_a drv 28AUG97 17.25 proc reg model y=t)

Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

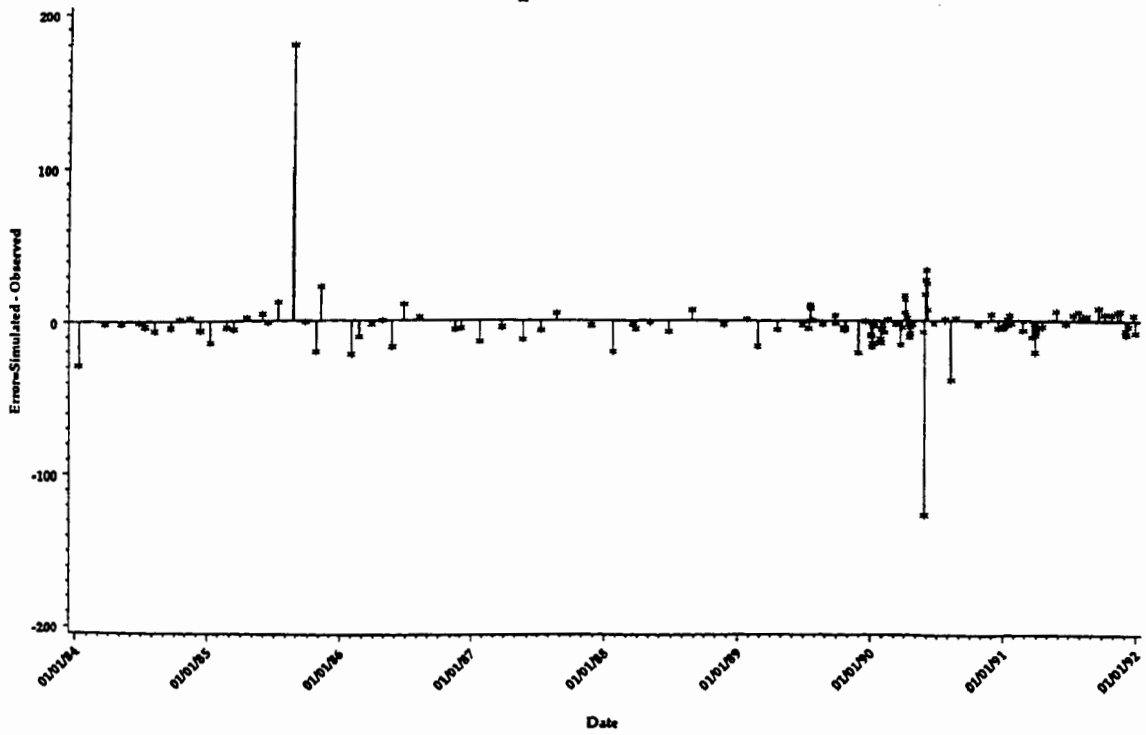
Total Suspended Sediment: 01JAN84 - 01JAN92



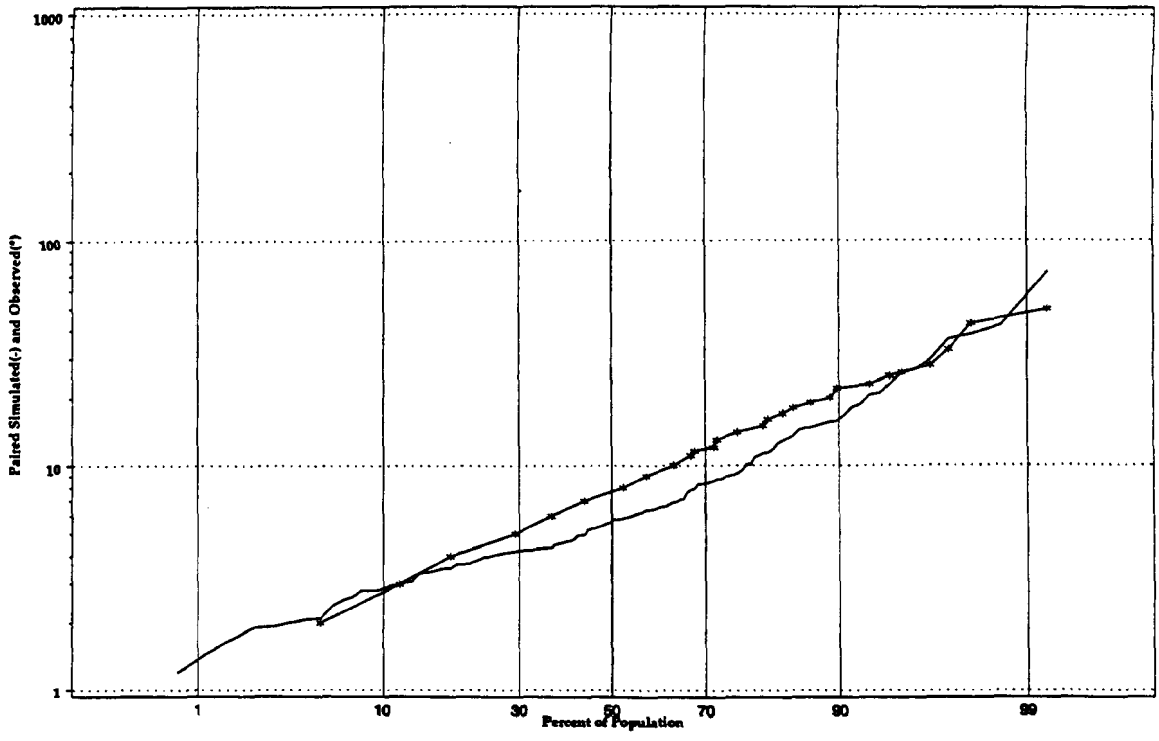
Mattaponi River at Segment 240

Actual Error versus Time

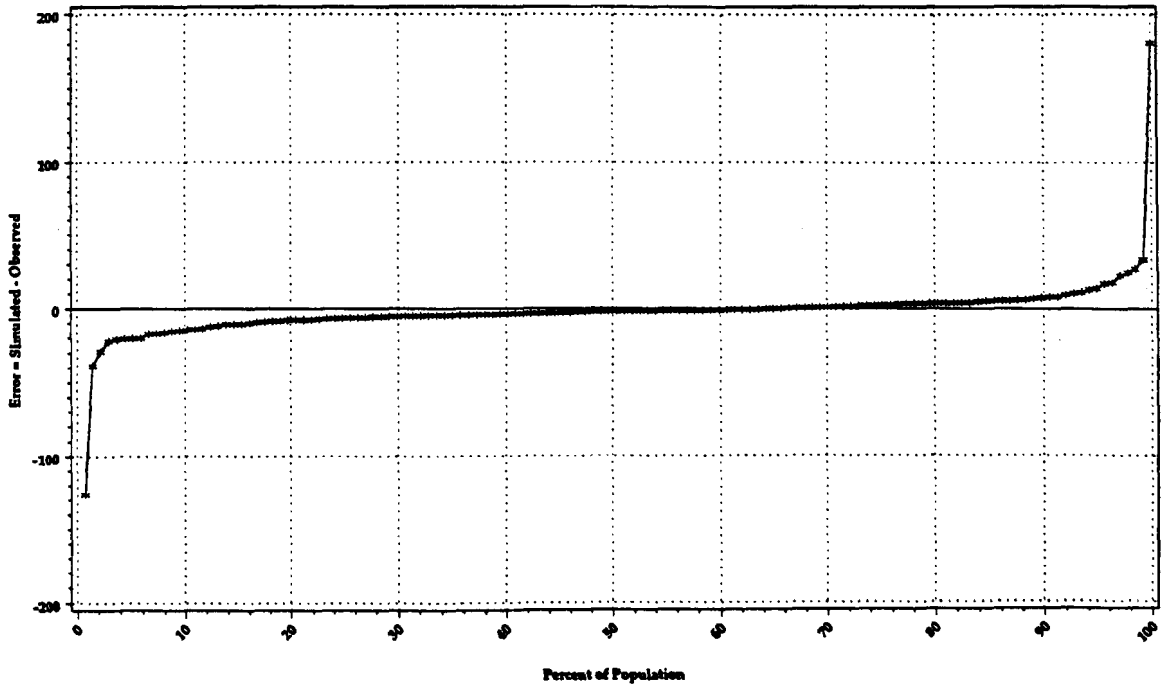
Total Suspended Sediment



Mattaponi River at Segment 240
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

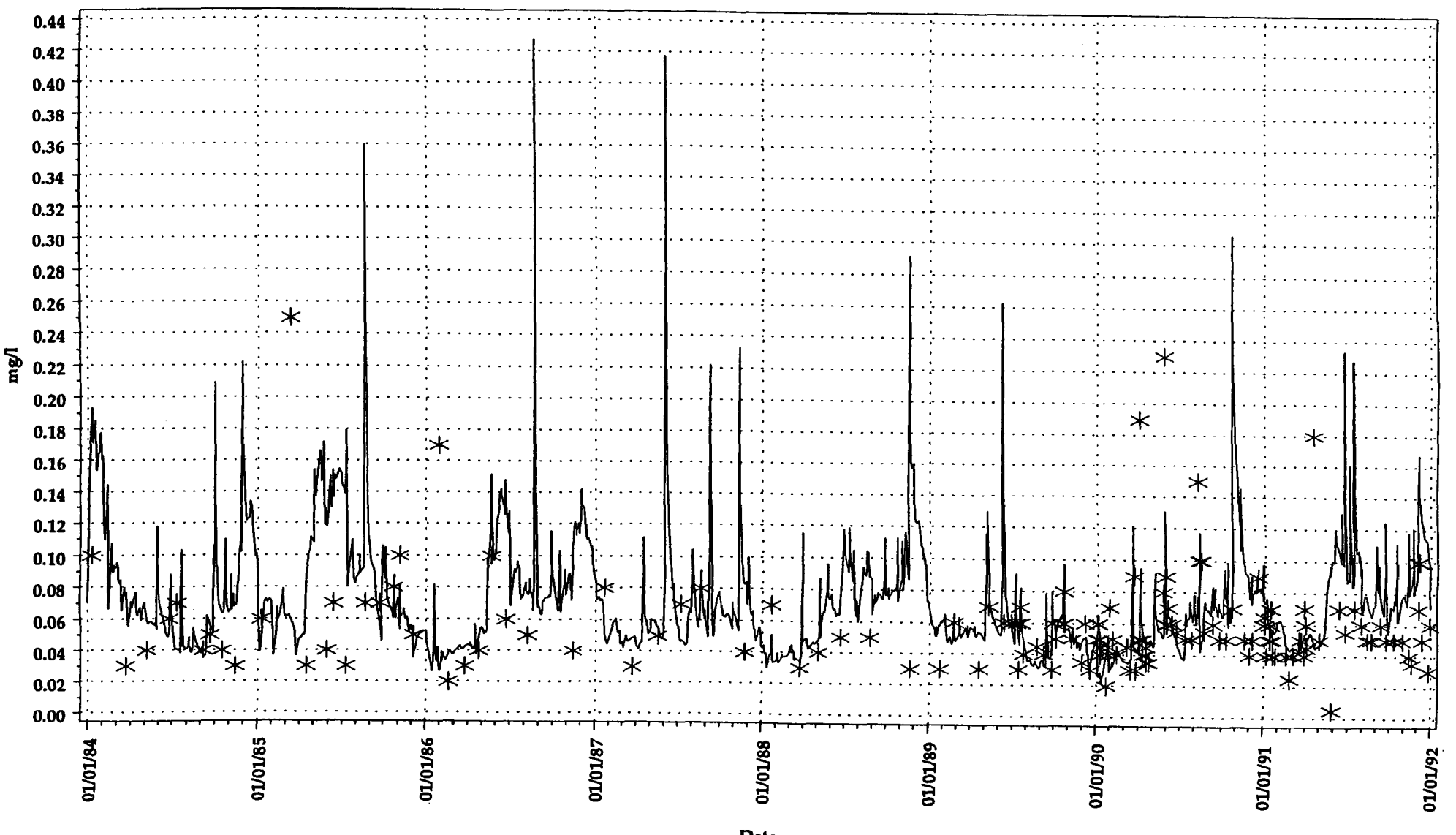


Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



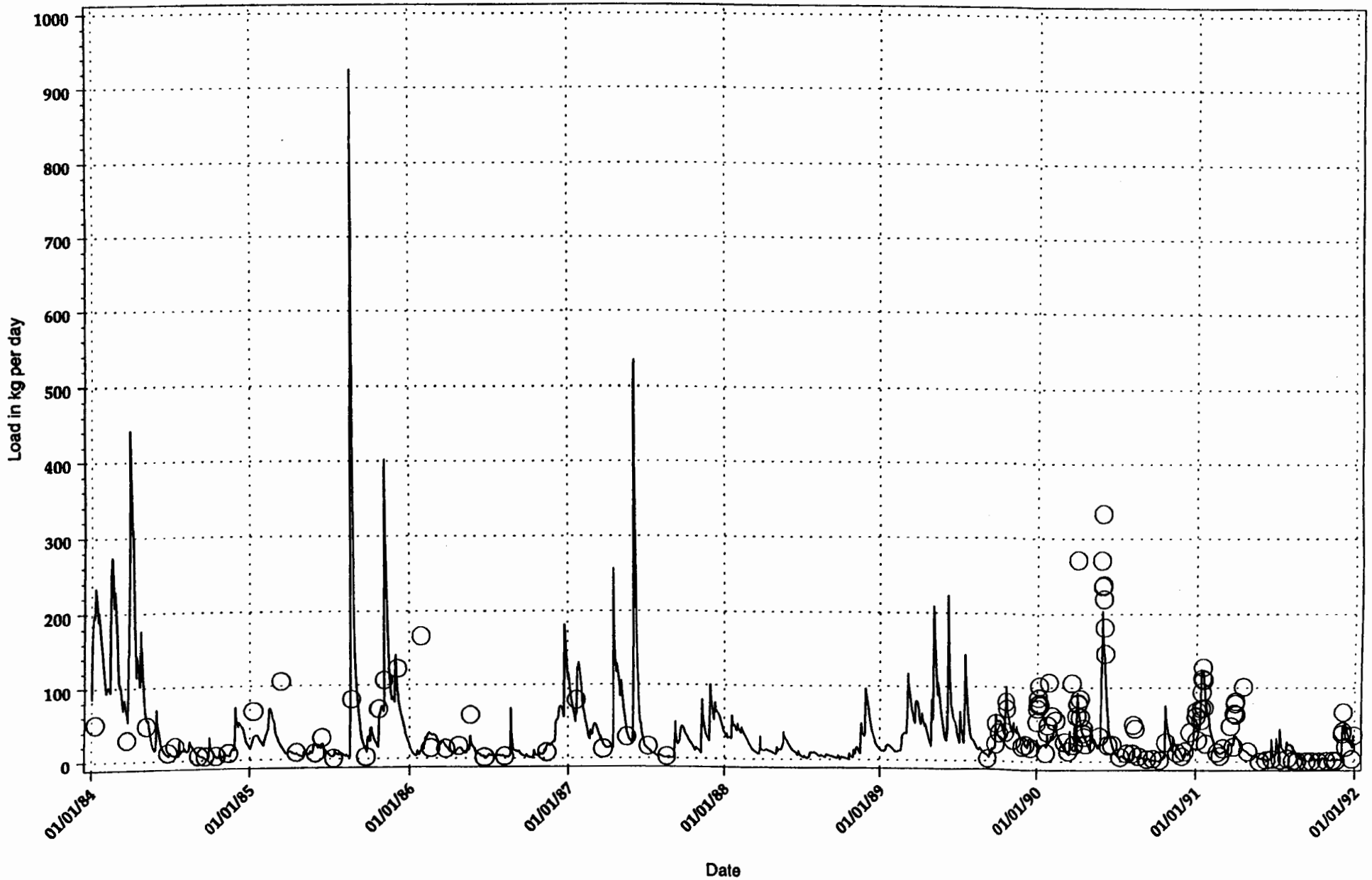
Mattaponi River at Segment 240
Observed and Simulated versus Time
Total Phosphorus

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2 jrps p3 james.sas| plotcmt - omdme)
(graph_a.div 25AUG97 17:25)

Mattaponi River at Segment 240
Total Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

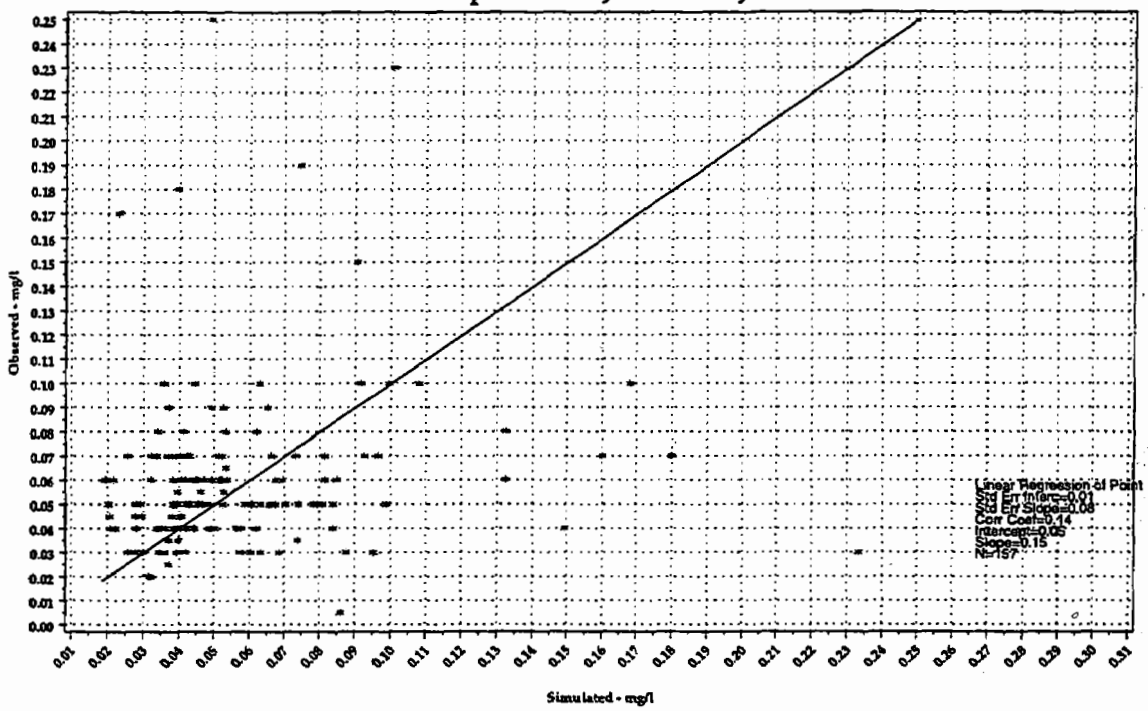


(y21_plot1.sas dataotave2 (rpe.p3 jemes.sas) 8dfiet)
(graph_a div 25AUG97 17:25 proc reg model y=x)

Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

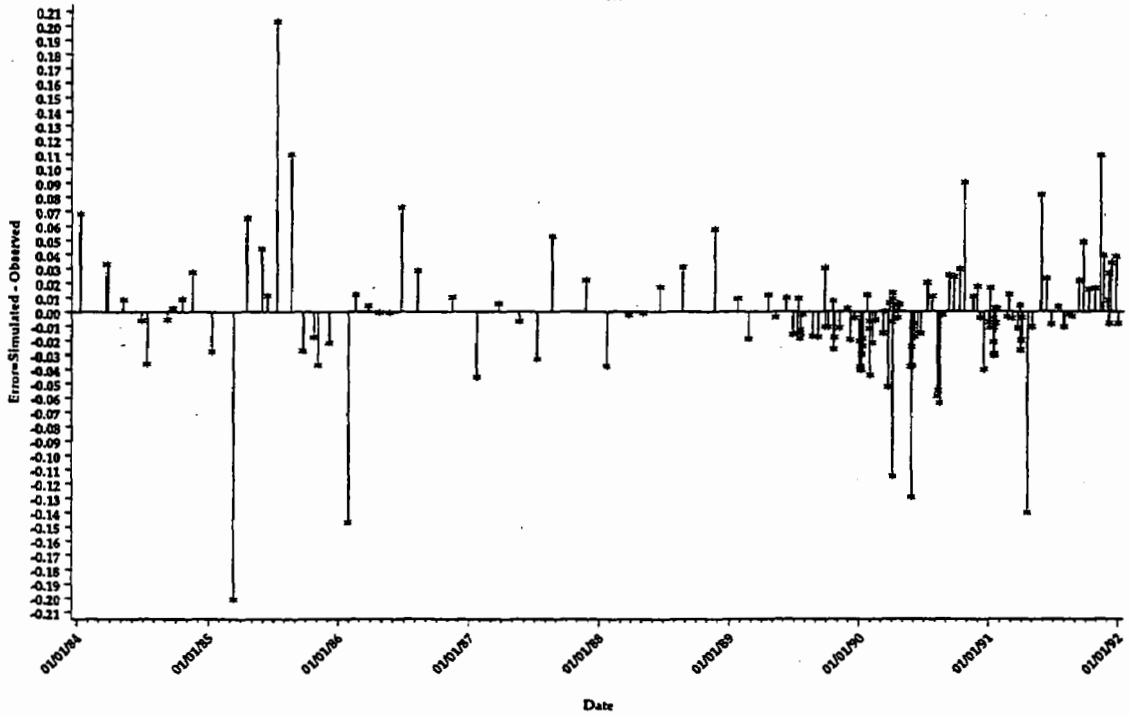
Total Phosphorus: 01JAN84 - 01JAN92



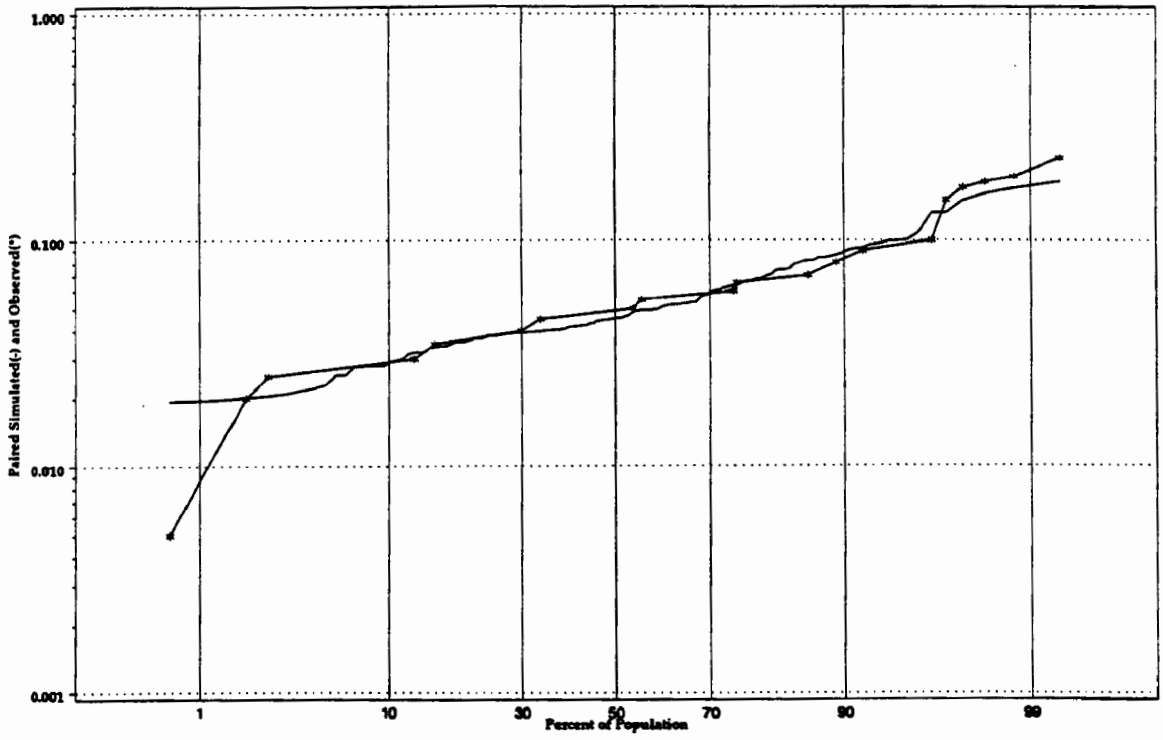
Mattaponi River at Segment 240

Actual Error versus Time

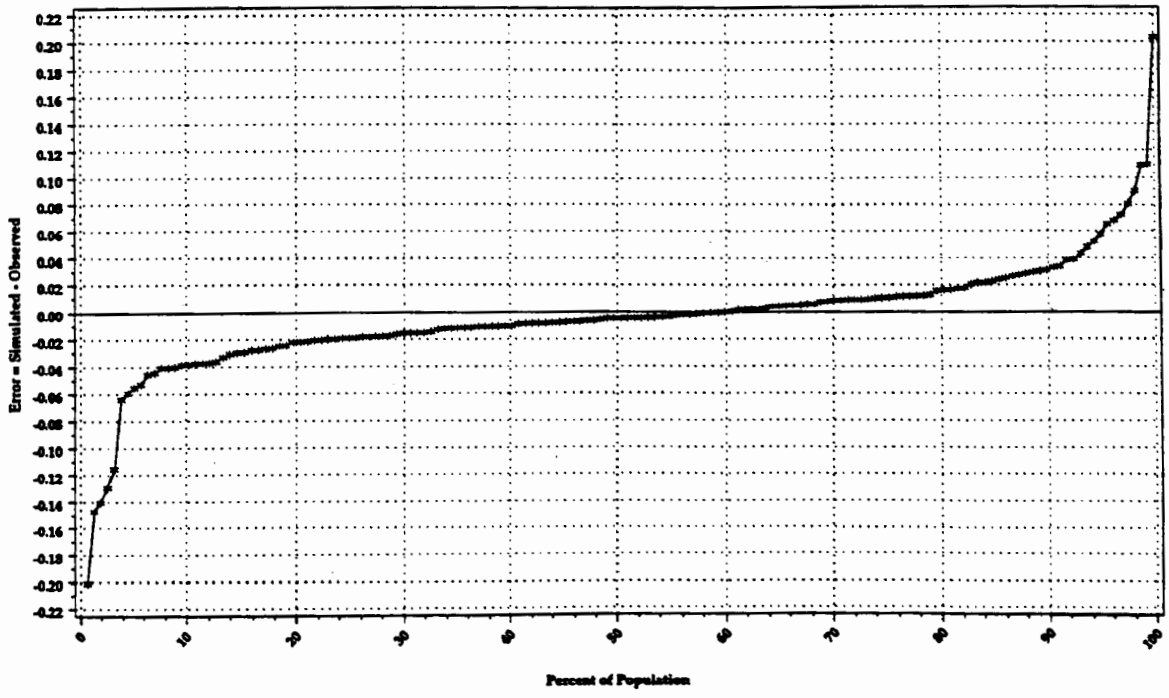
Total Phosphorus



Mattaponi River at Segment 240
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

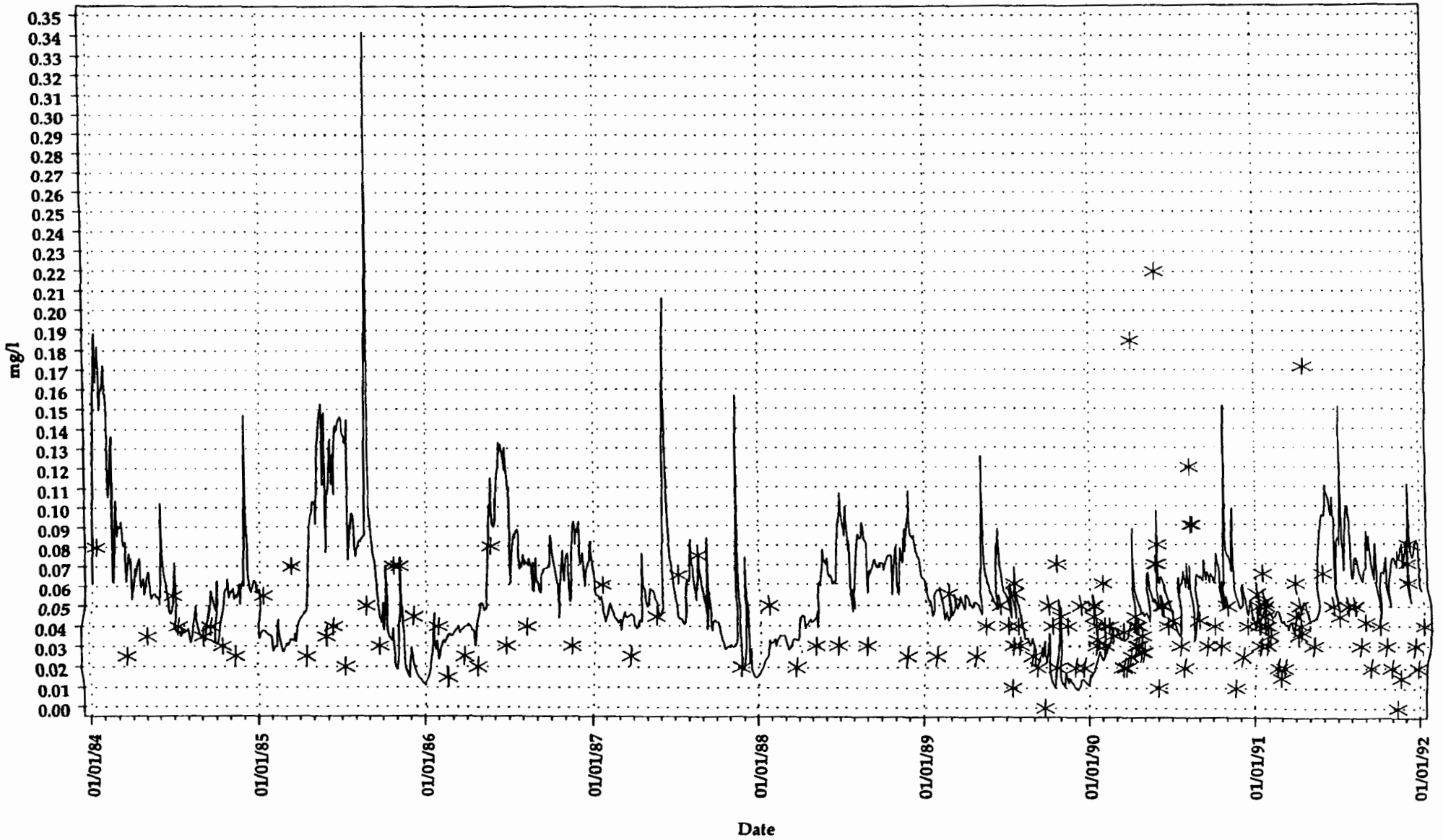


Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Mattaponi River at Segment 240
Observed and Simulated versus Time
Organic and Particulate Phosphorus

(*=Observed, -=Simulated)

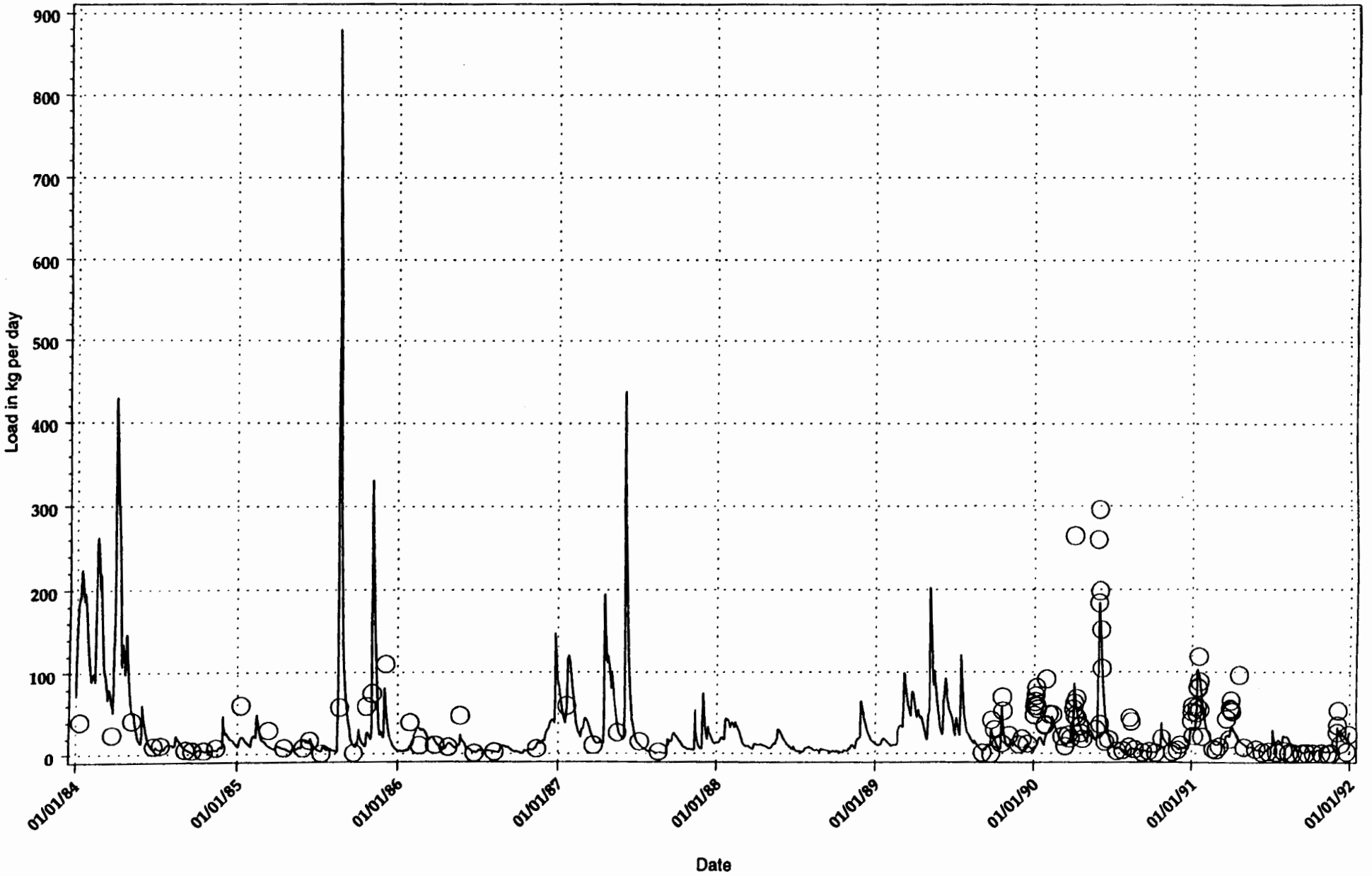


(y21_plot1.sas datastore2 [rpo p3 james sas] plotomi - ontime)
(graph_a drv 25AUG97 17:25)

Mattaponi River at Segment 240

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

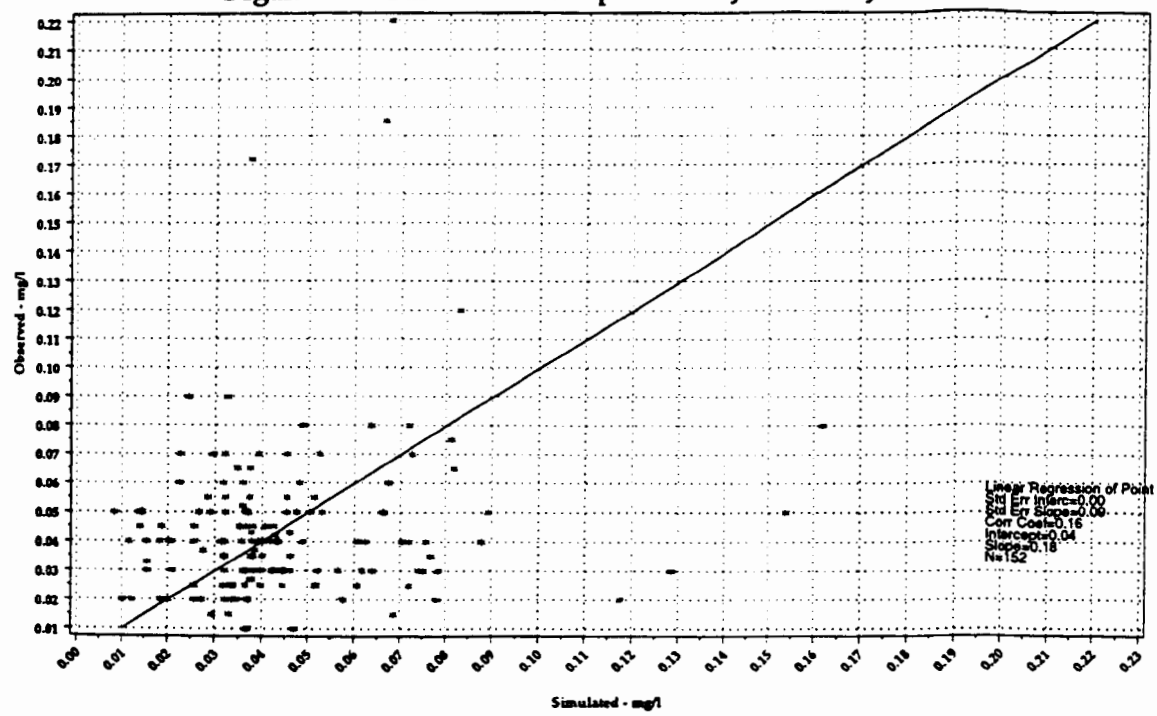
(line = simulated, O = observed)



Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

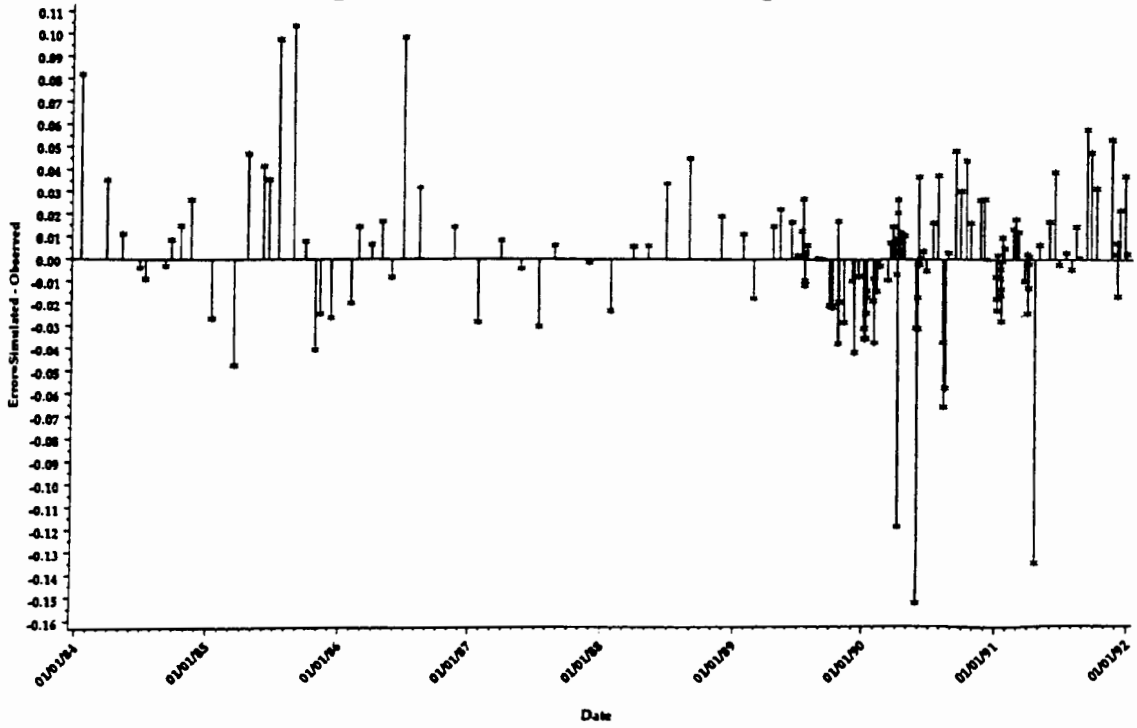
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



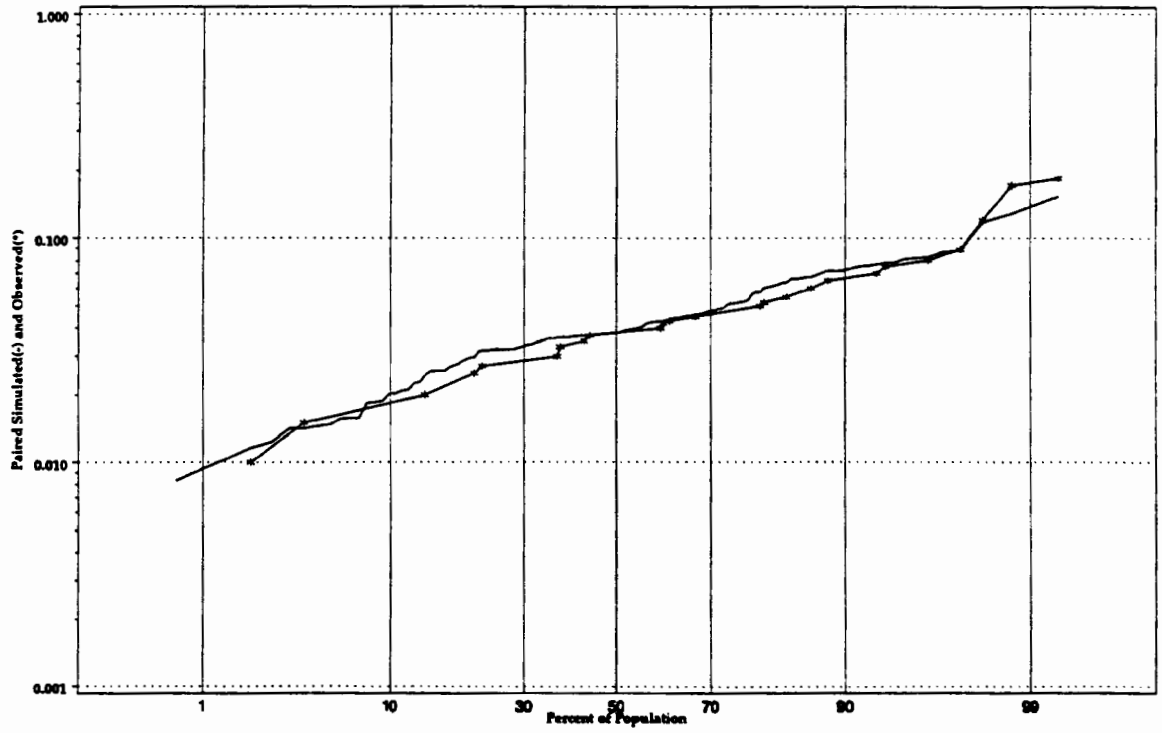
Mattaponi River at Segment 240

Actual Error versus Time

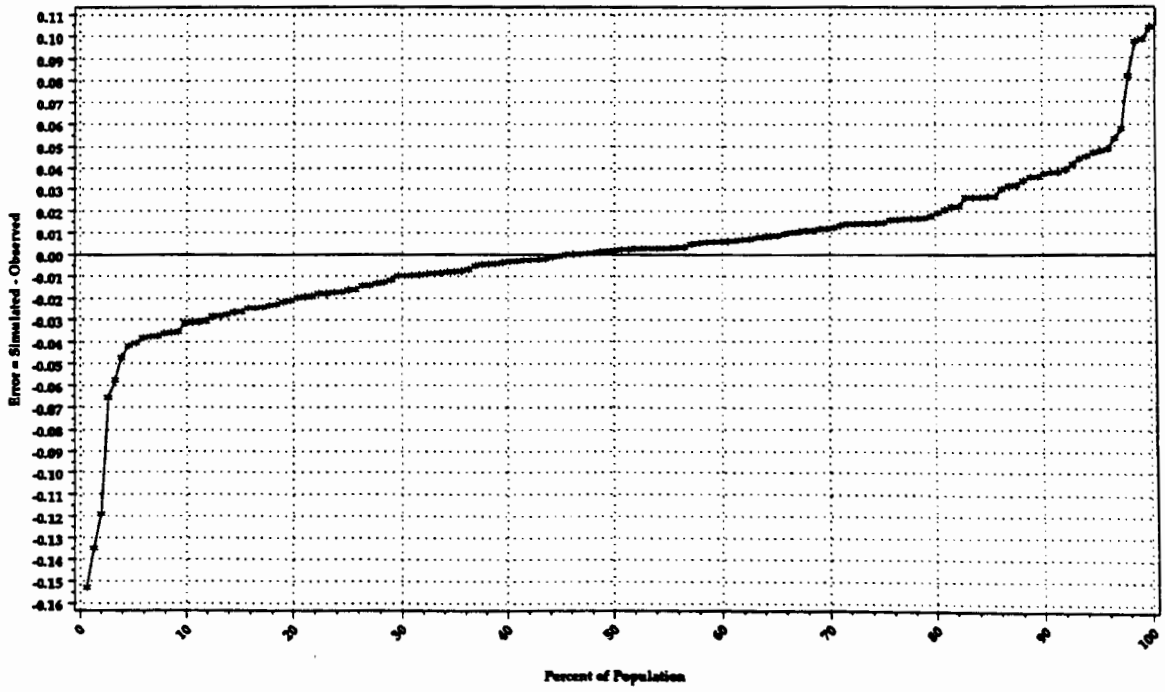
Organic and Particulate Phosphorus



Mattaponi River at Segment 240
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

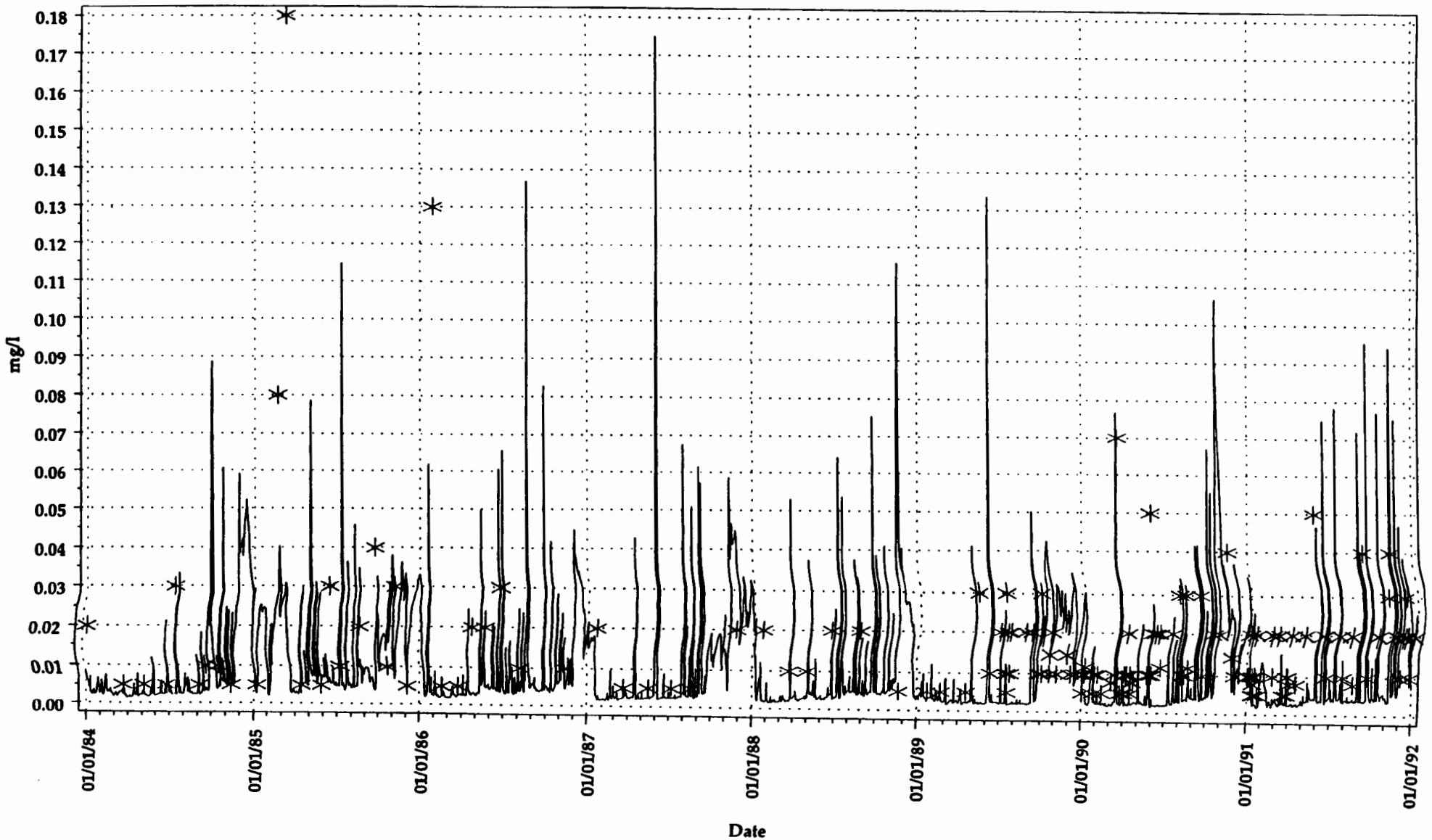


Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data



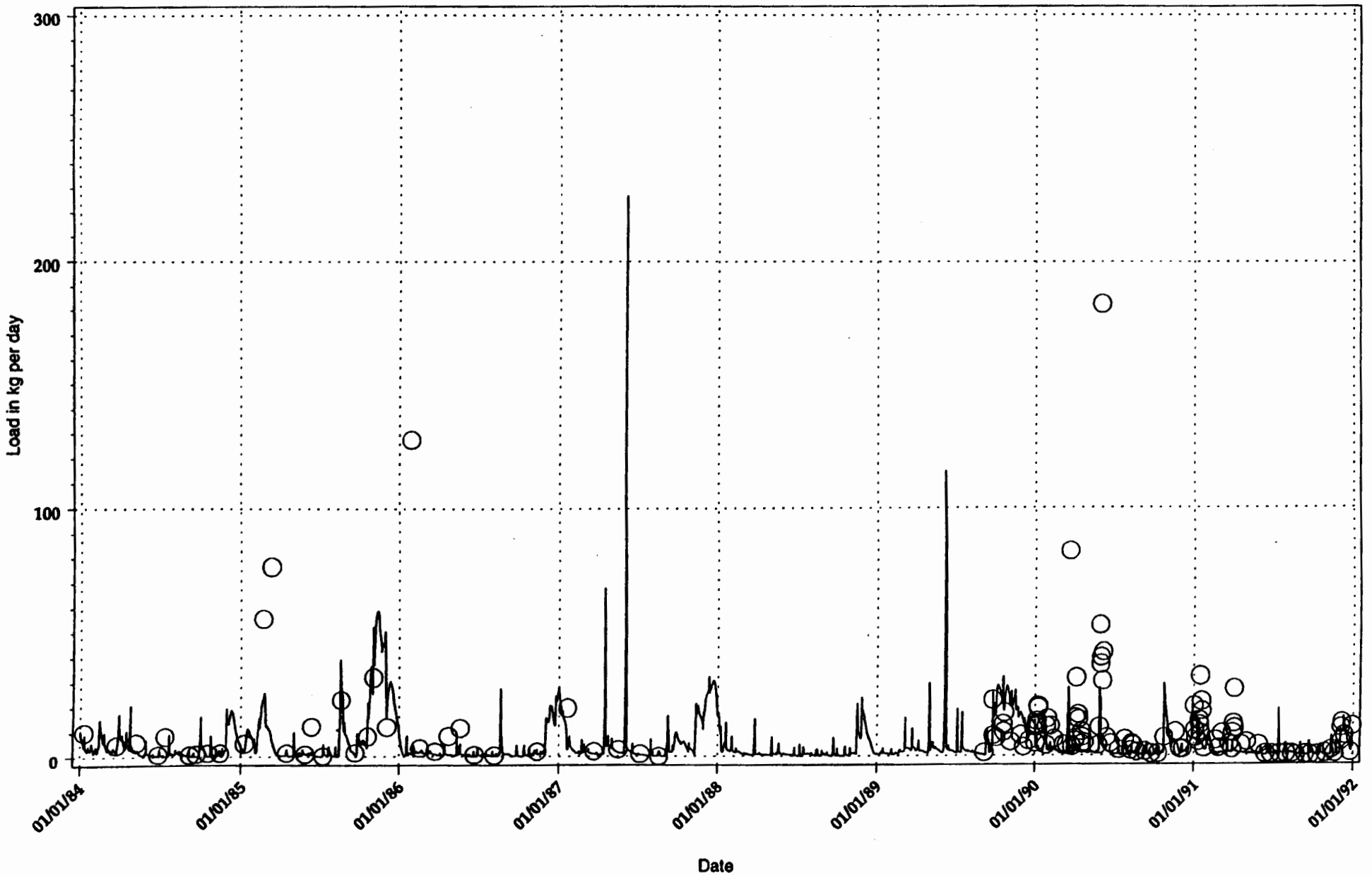
Mattaponi River at Segment 240
Observed and Simulated versus Time
Dissolved Phosphorus

(*=Observed, -=Simulated)



(y21_plot1 sas dataset:c2jmps p3 james sas) plotomt - omtime)
(mata240.dev 03FEB99 11:27)

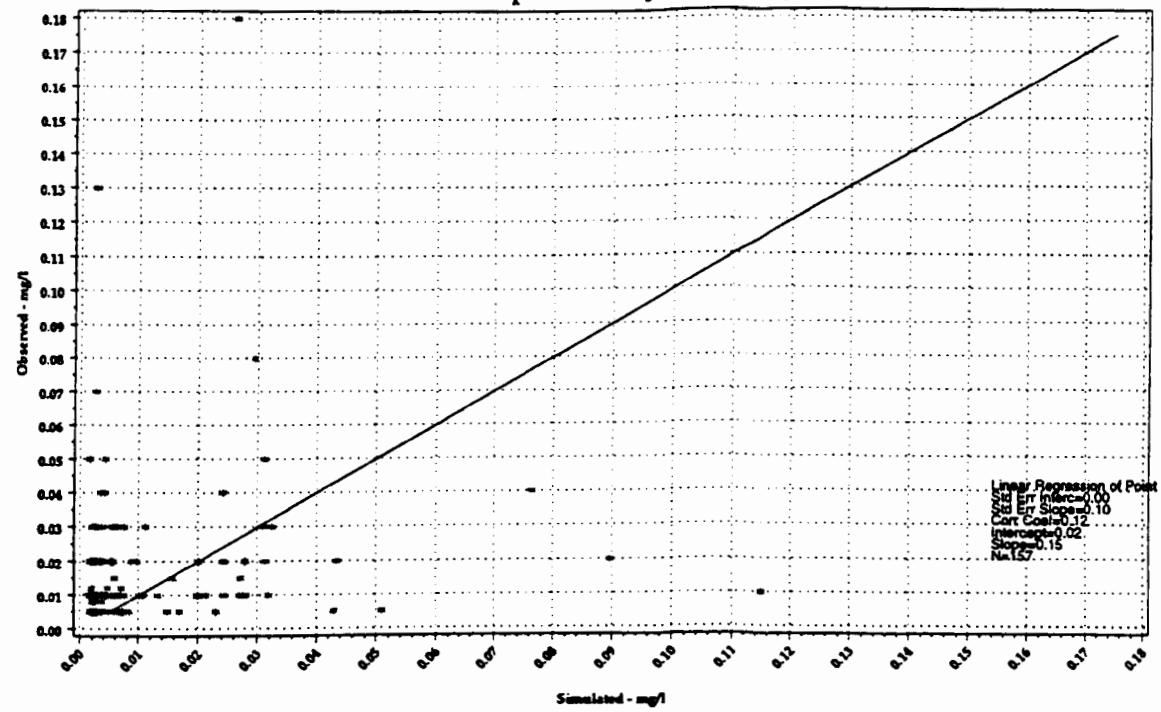
Mattaponi River at Segment 240
Dissolved Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)



Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

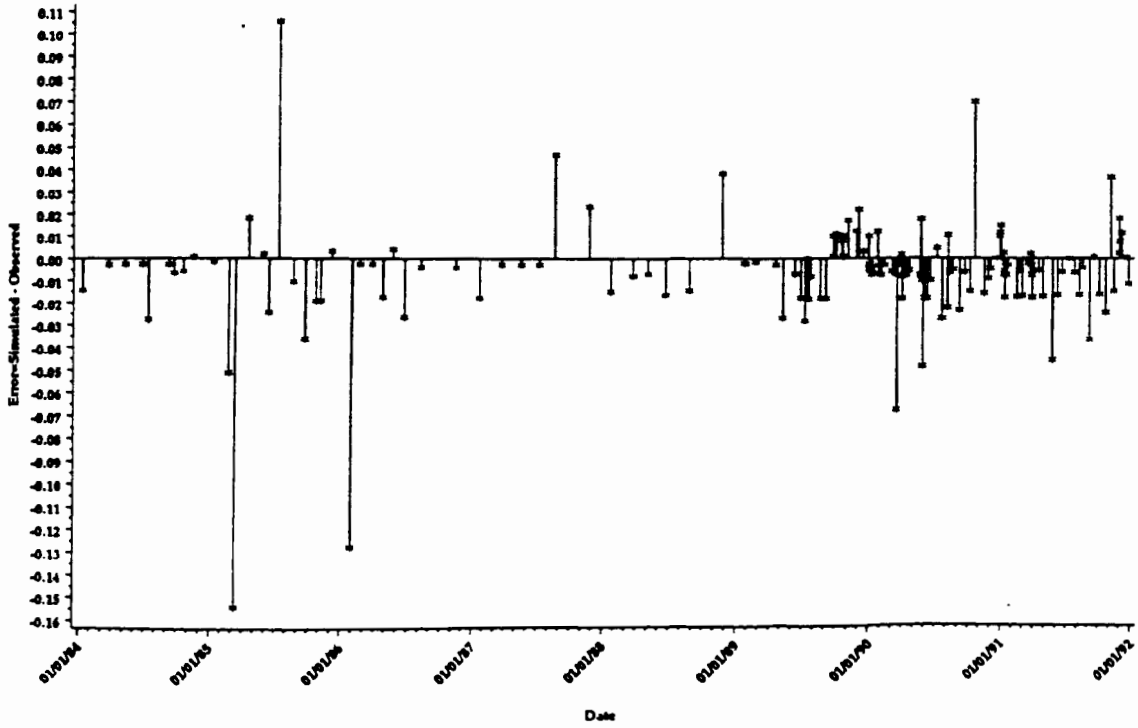
Dissolved Phosphorus: 01JAN84 - 01JAN92



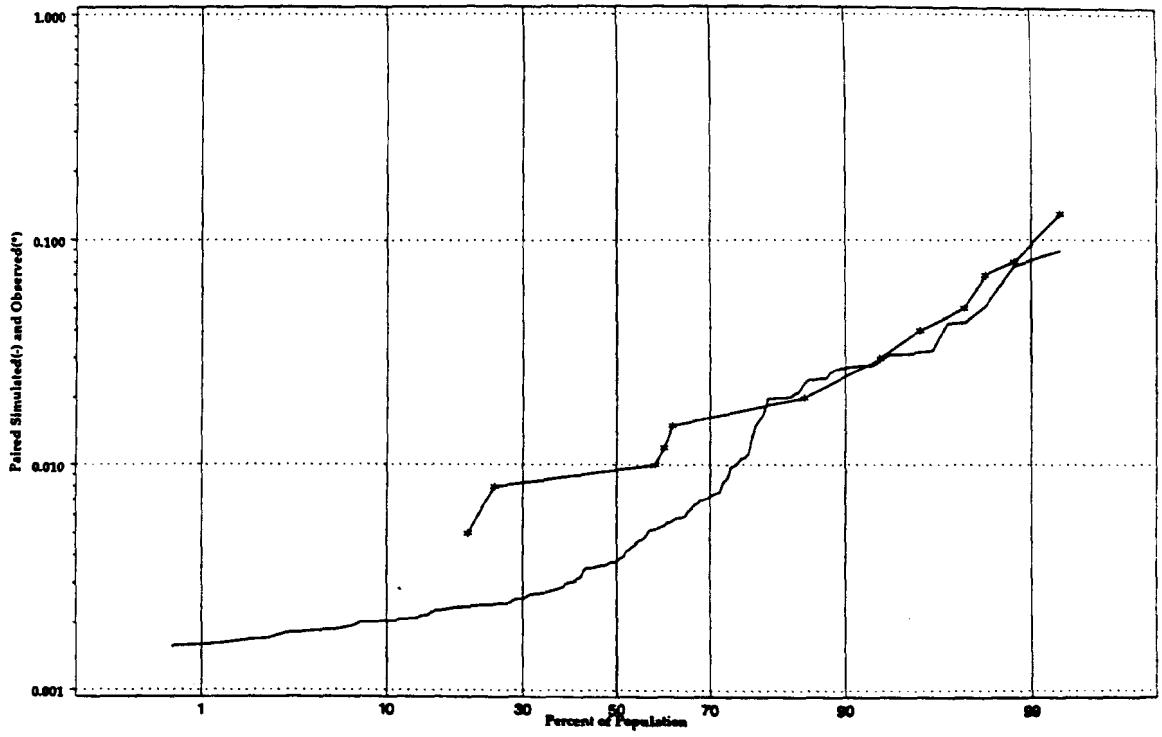
Mattaponi River at Segment 240

Actual Error versus Time

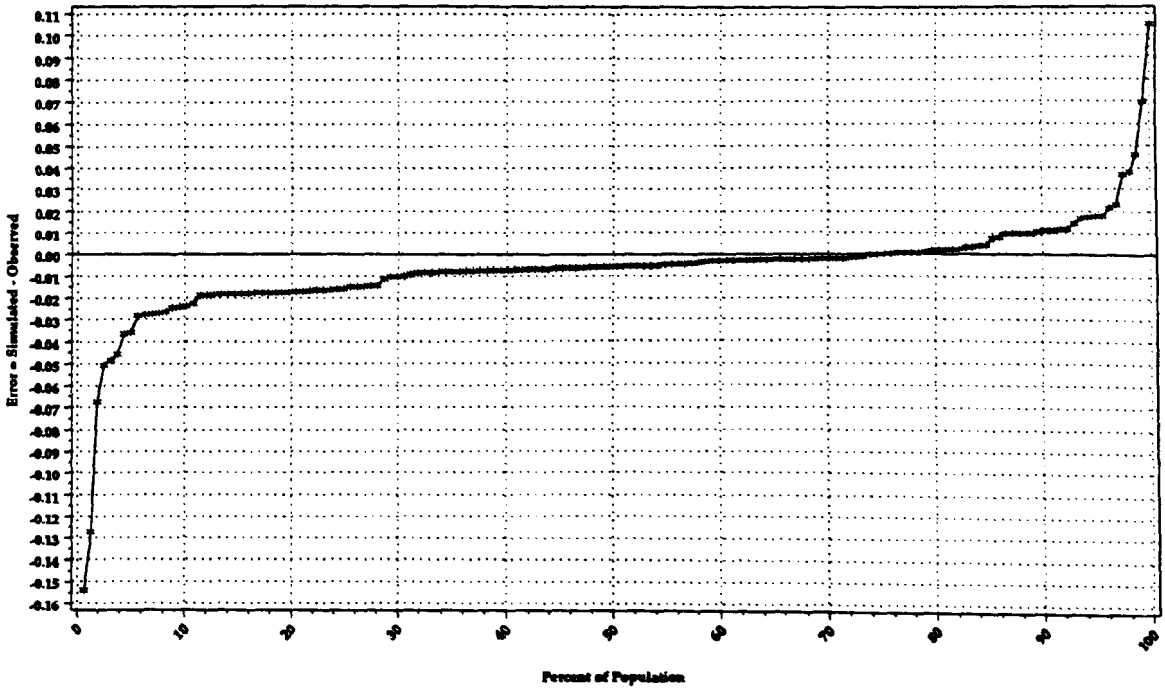
Dissolved Phosphorus



Mattaponi River at Segment 240
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

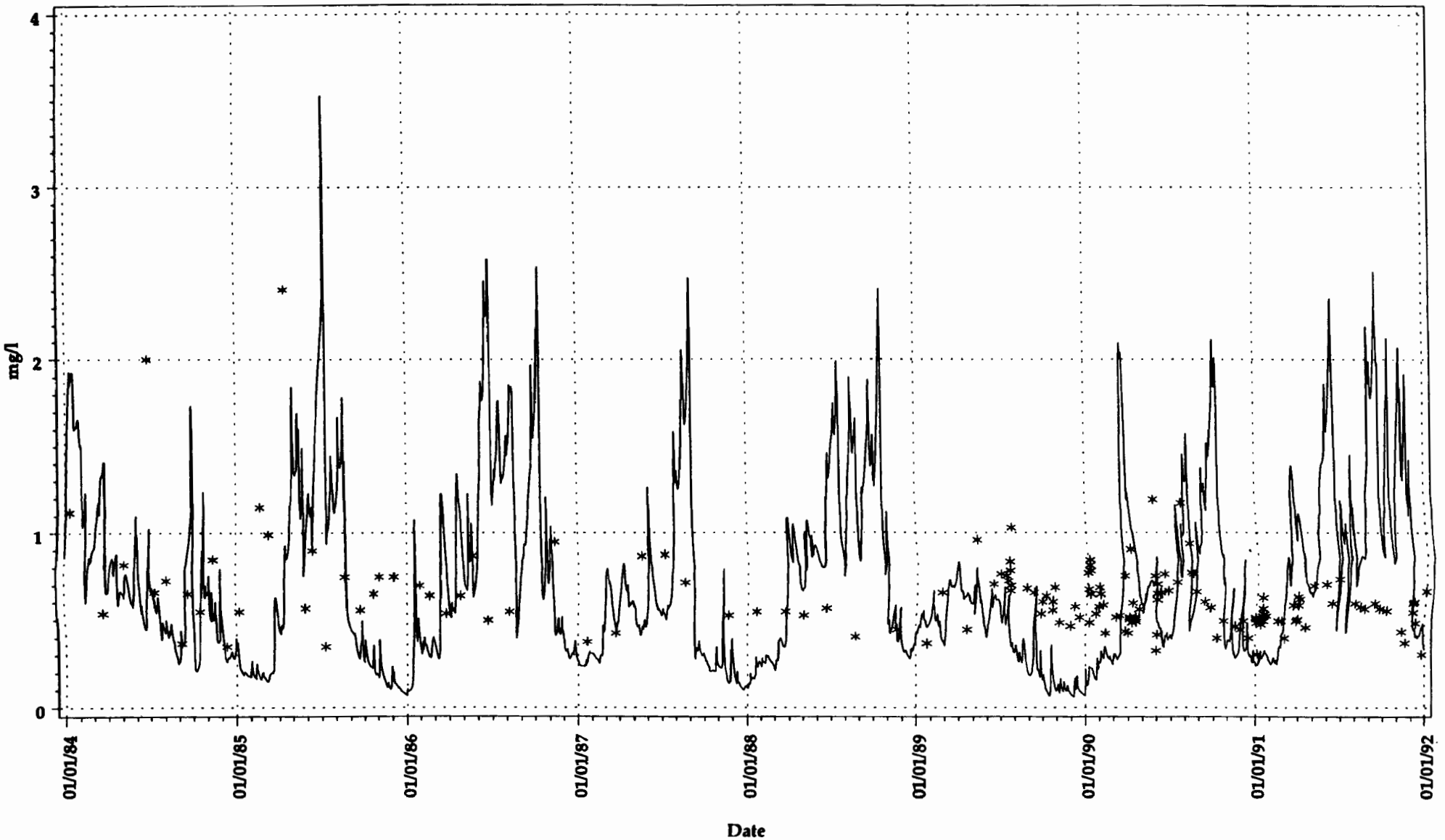


Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



Mattaponi River at Segment 240
Observed and Simulated versus Time
Total Nitrogen

(*=Observed, -=Simulated)

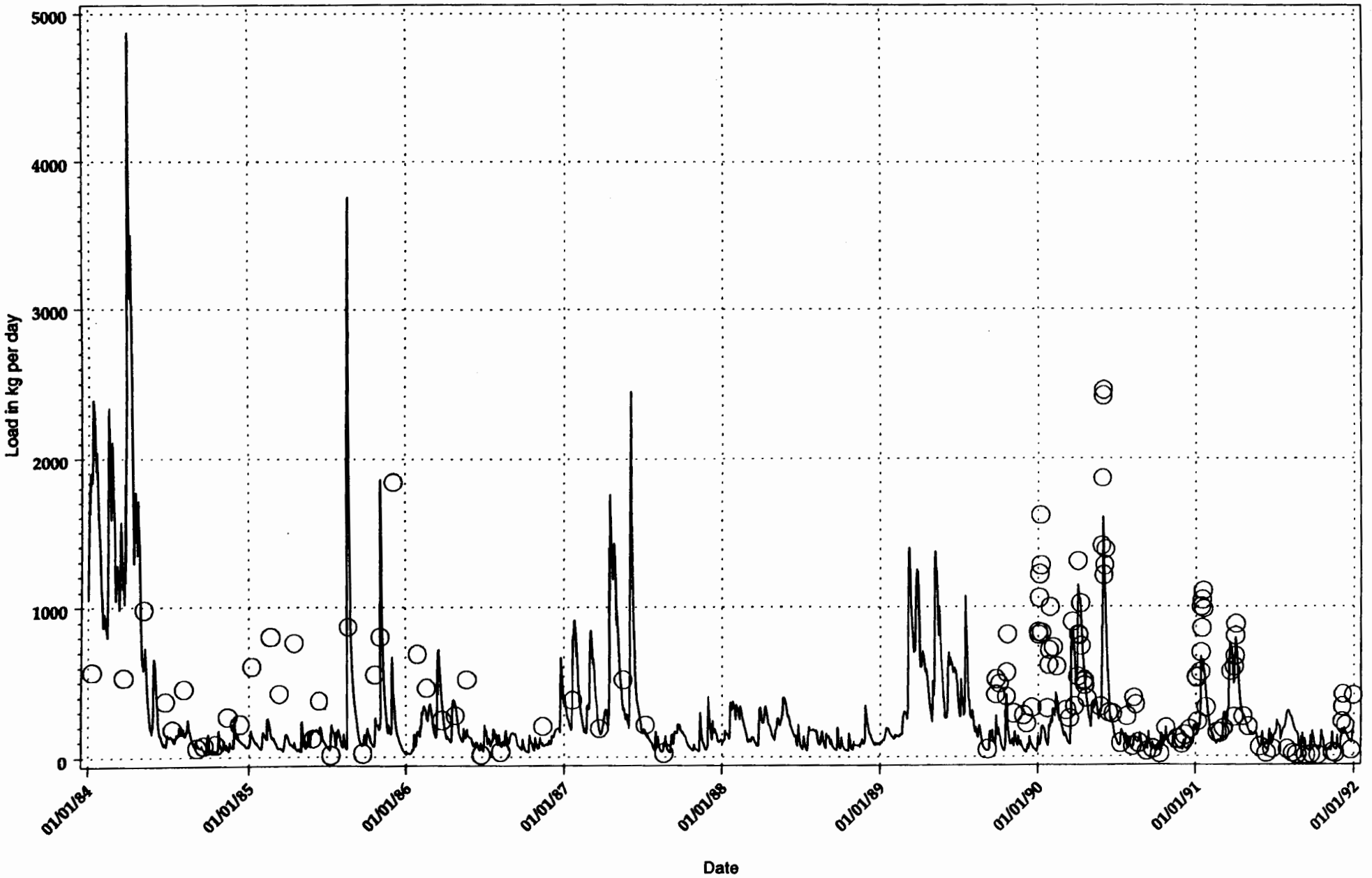


(y21_plots.sas model3d [pwang.dt] plotomi - ontime)
(metta240.dtr 23FEB98 09:27)

Mattaponi River at Segment 240

Total Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)

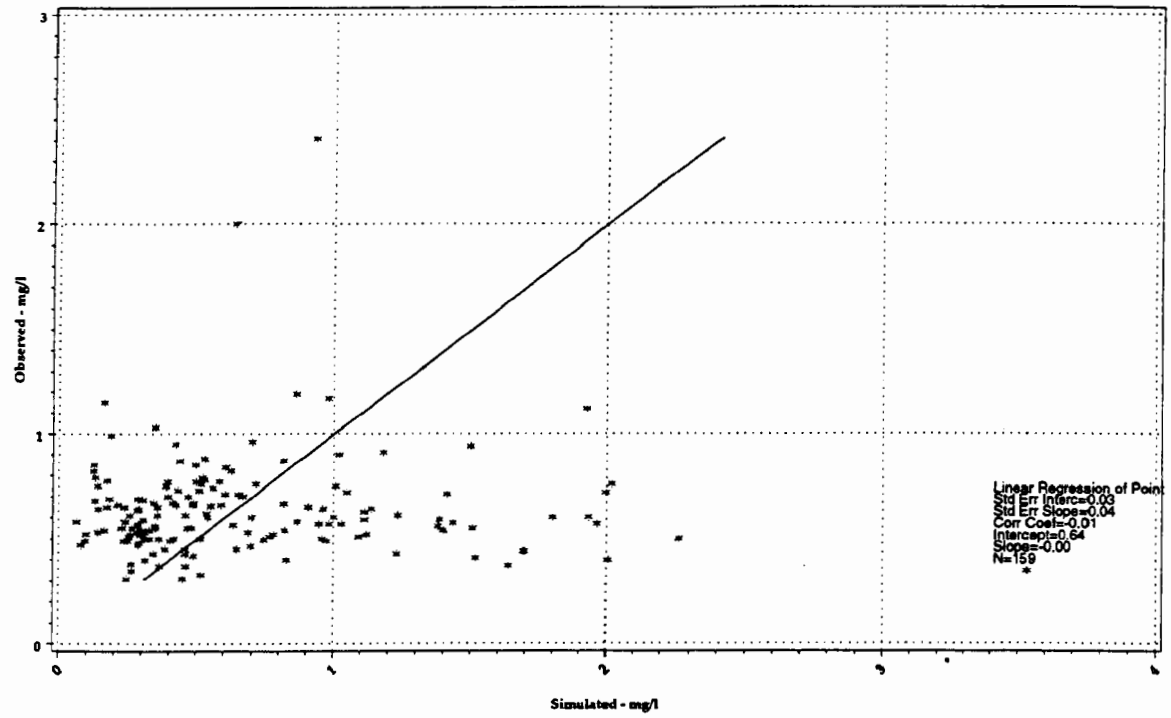


(y21_plots.sas model3d (pwang.dj lidlas)
(matta240.drv 23FEB96 09:27,proc reg,model y=t)

Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

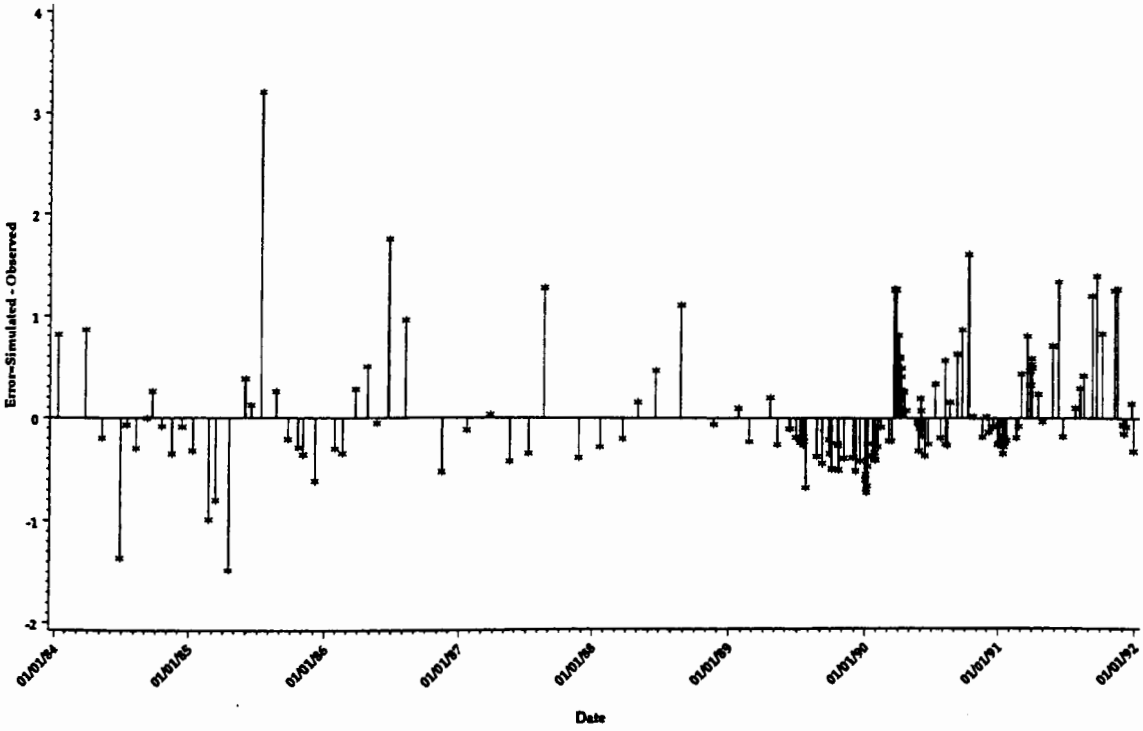
Total Nitrogen: 01JAN84 - 01JAN92



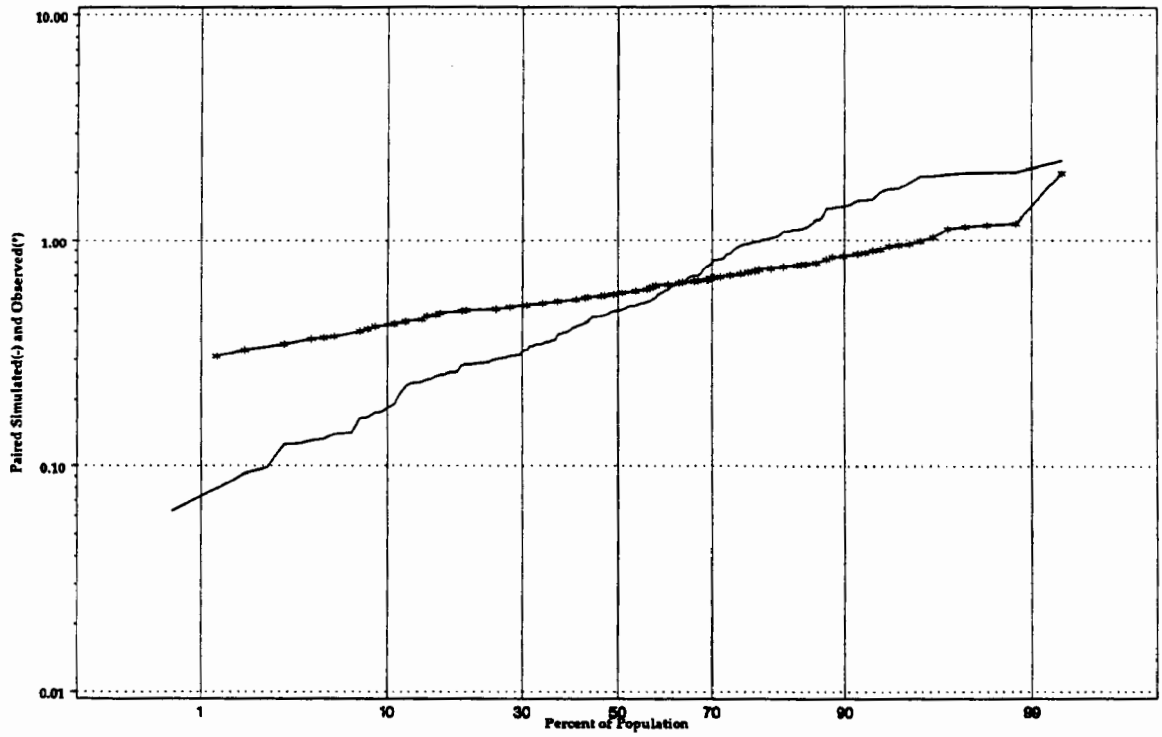
Mattaponi River at Segment 240

Actual Error versus Time

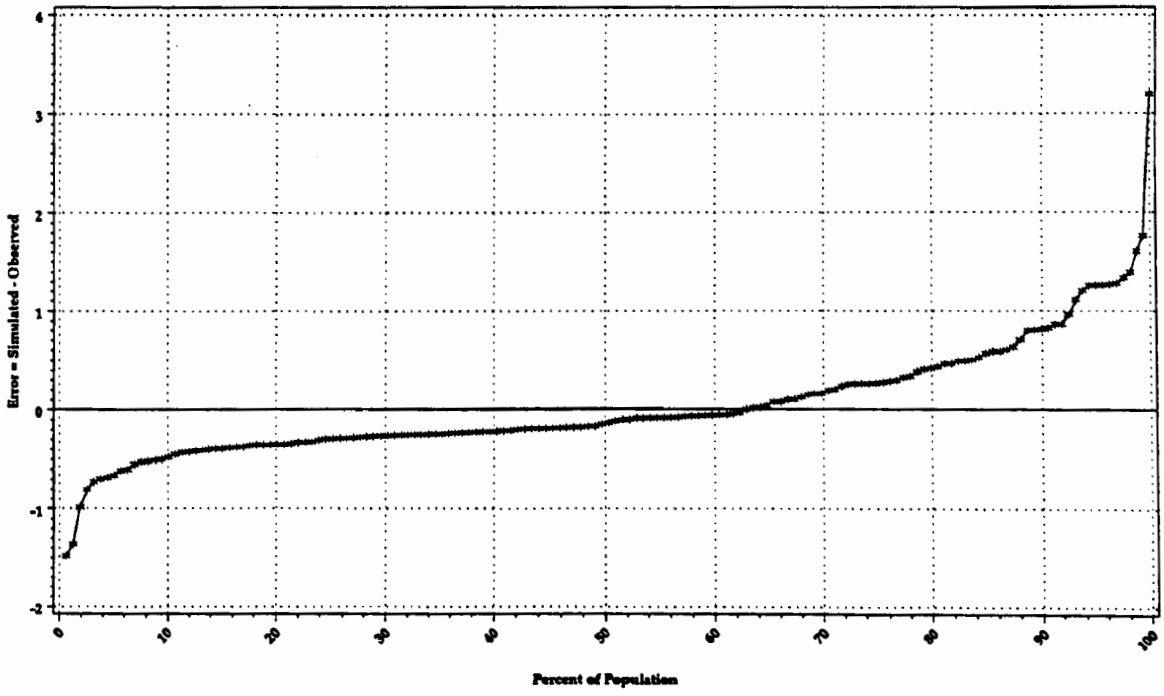
Total Nitrogen



Mattaponi River at Segment 240
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

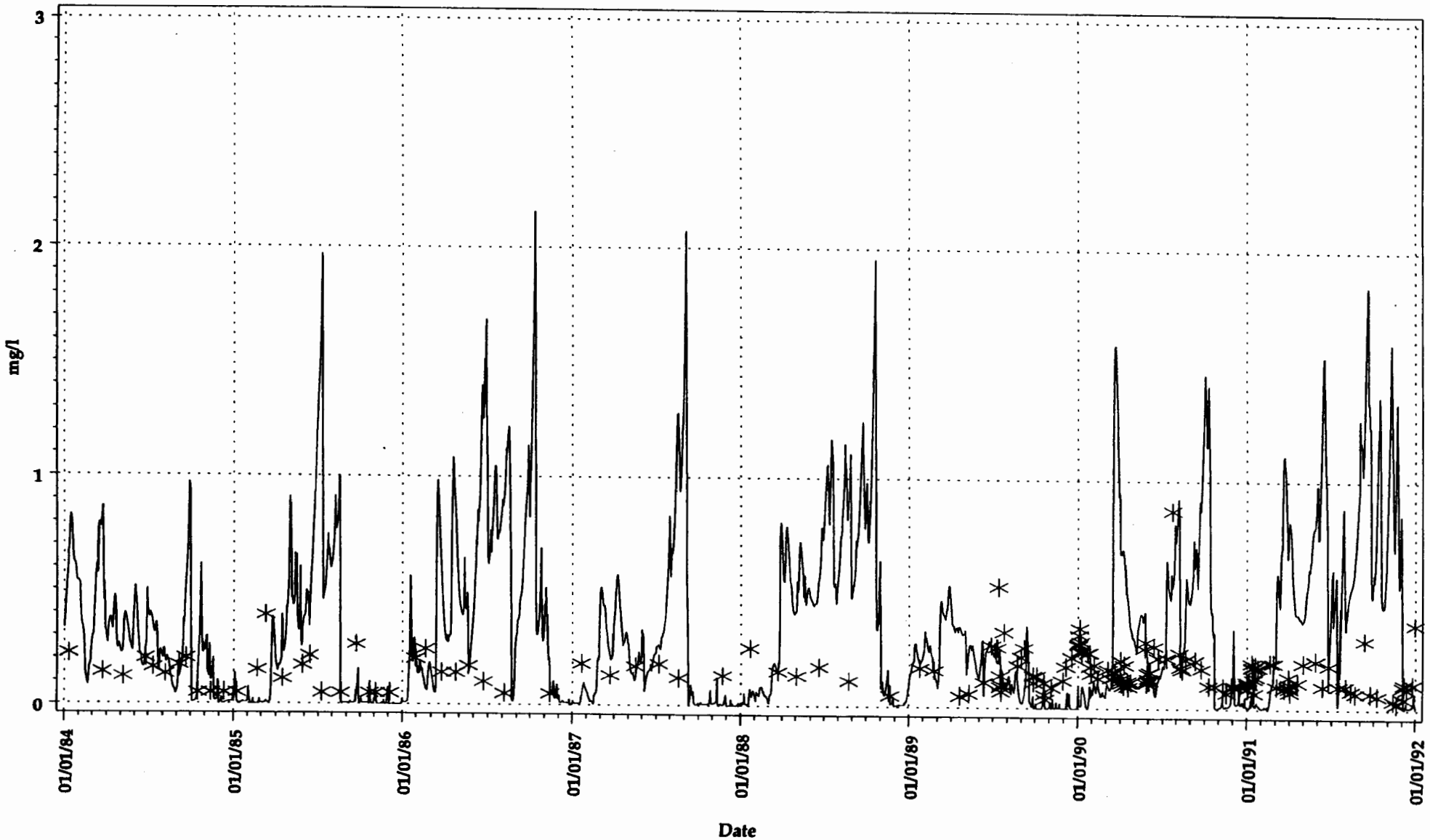


Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data



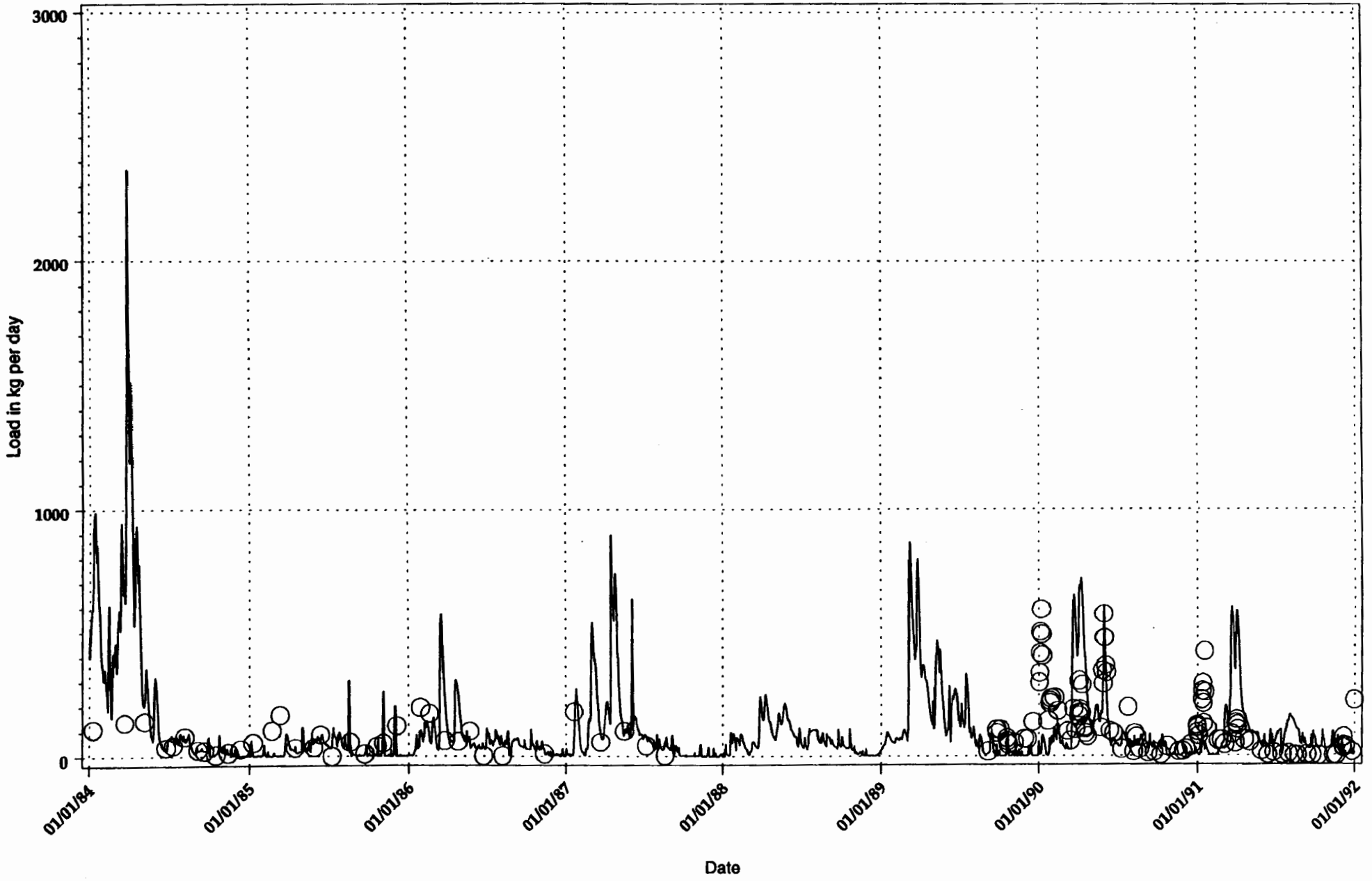
Mattaponi River at Segment 240
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



(y21_plot.aas model3d(gwang.dl) plotomi - online)
(matta240.drv 23FEB88 09:27)

Mattaponi River at Segment 240
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

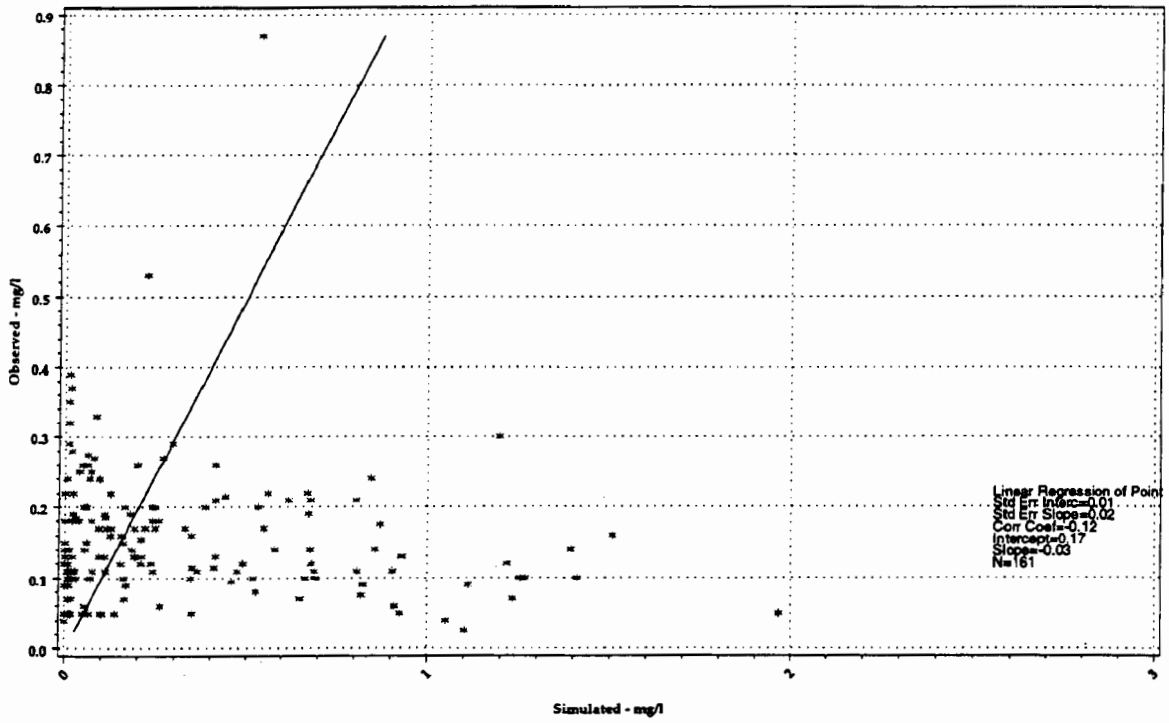


(y21_plotb.sas model3d:[pwang.dt] lidline)
(matta240.div 23FEB98 09:27,proc reg,model y=x)

Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

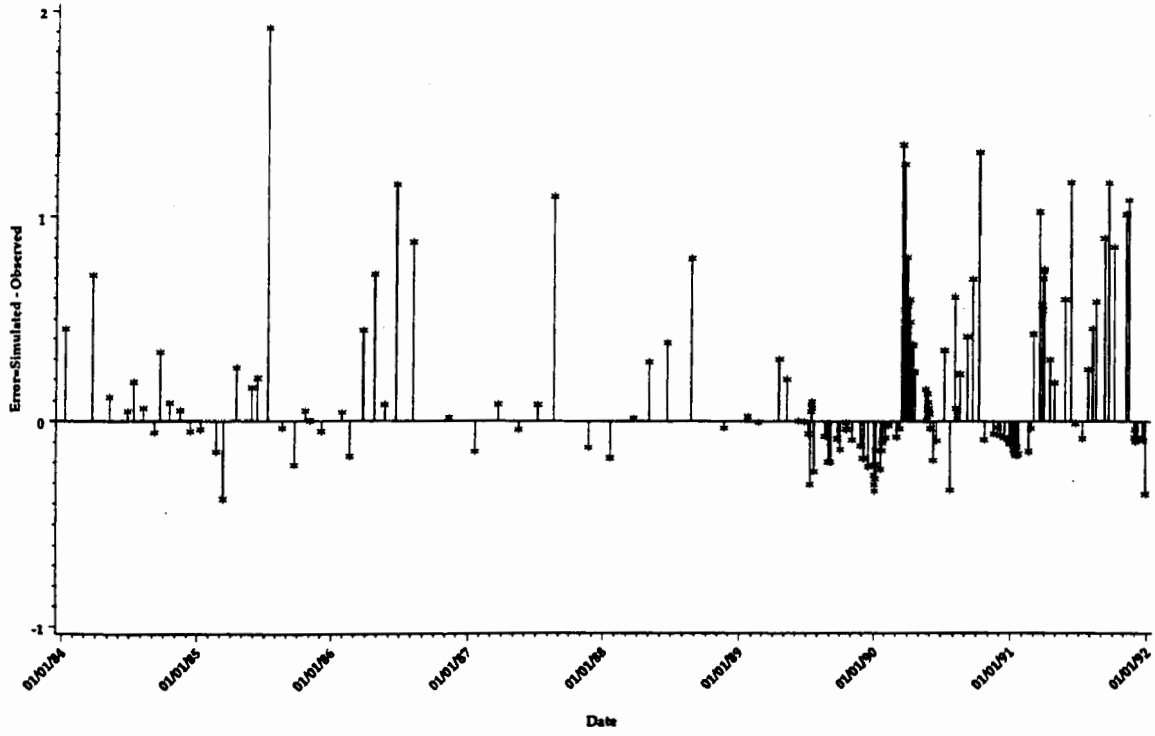
NO3: 01JAN84 - 01JAN92



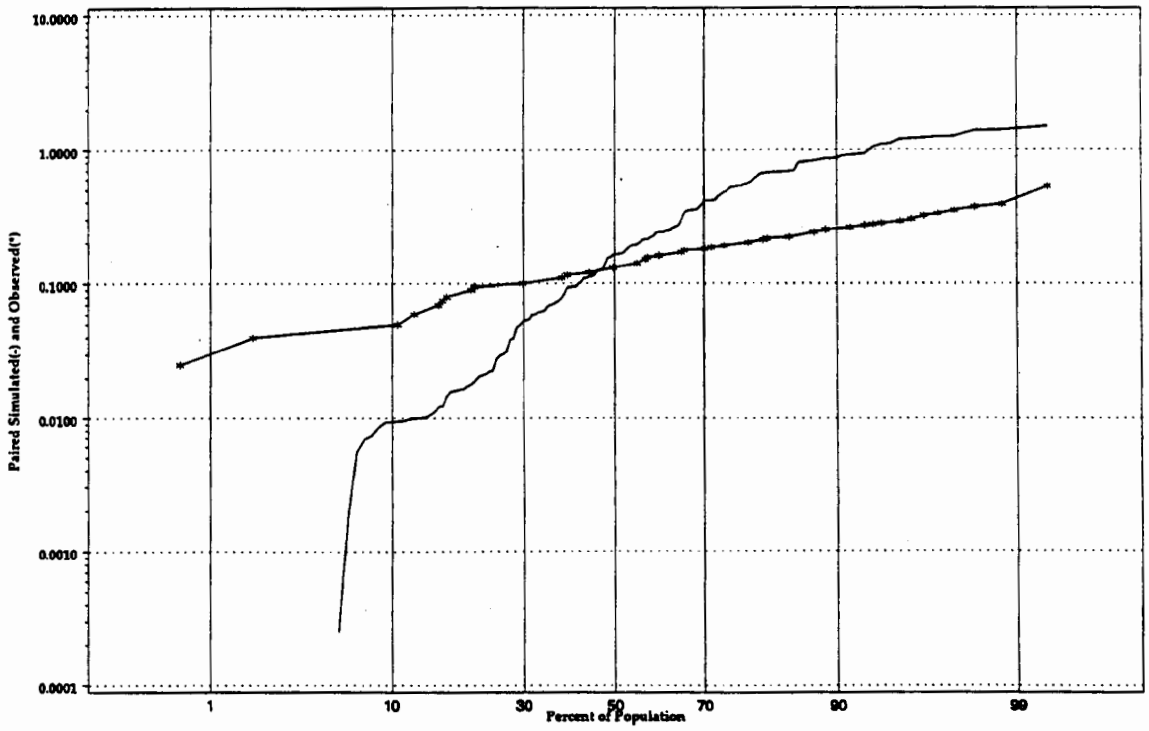
Mattaponi River at Segment 240

Actual Error versus Time

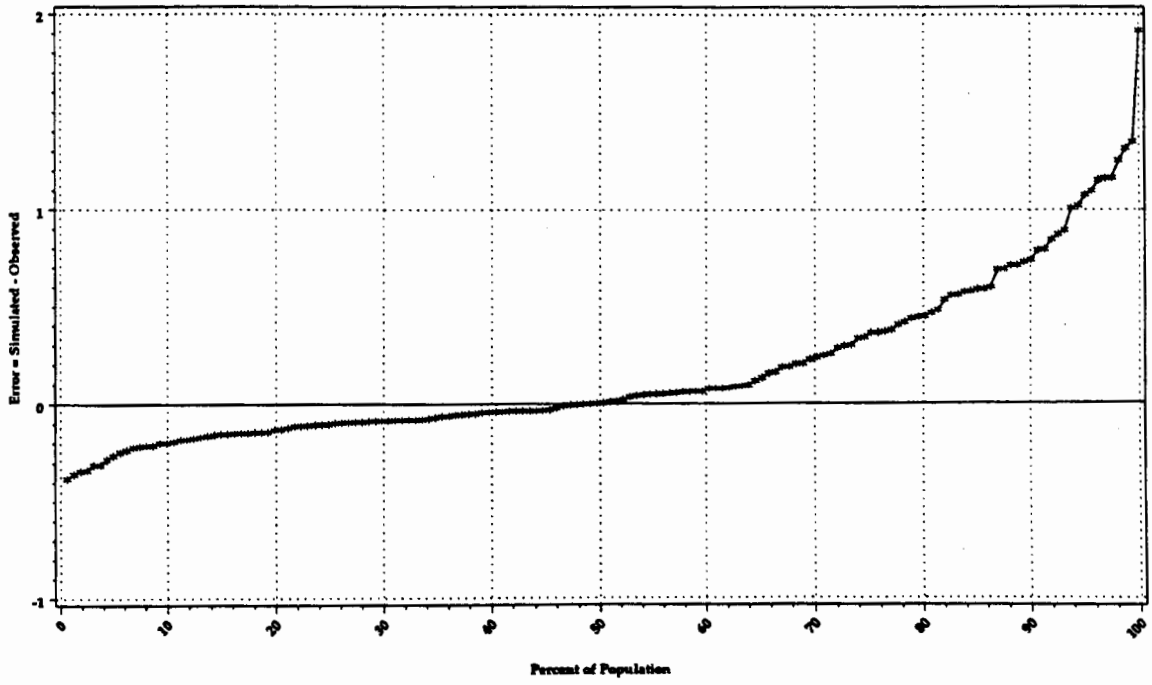
NO3



Mattaponi River at Segment 240
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

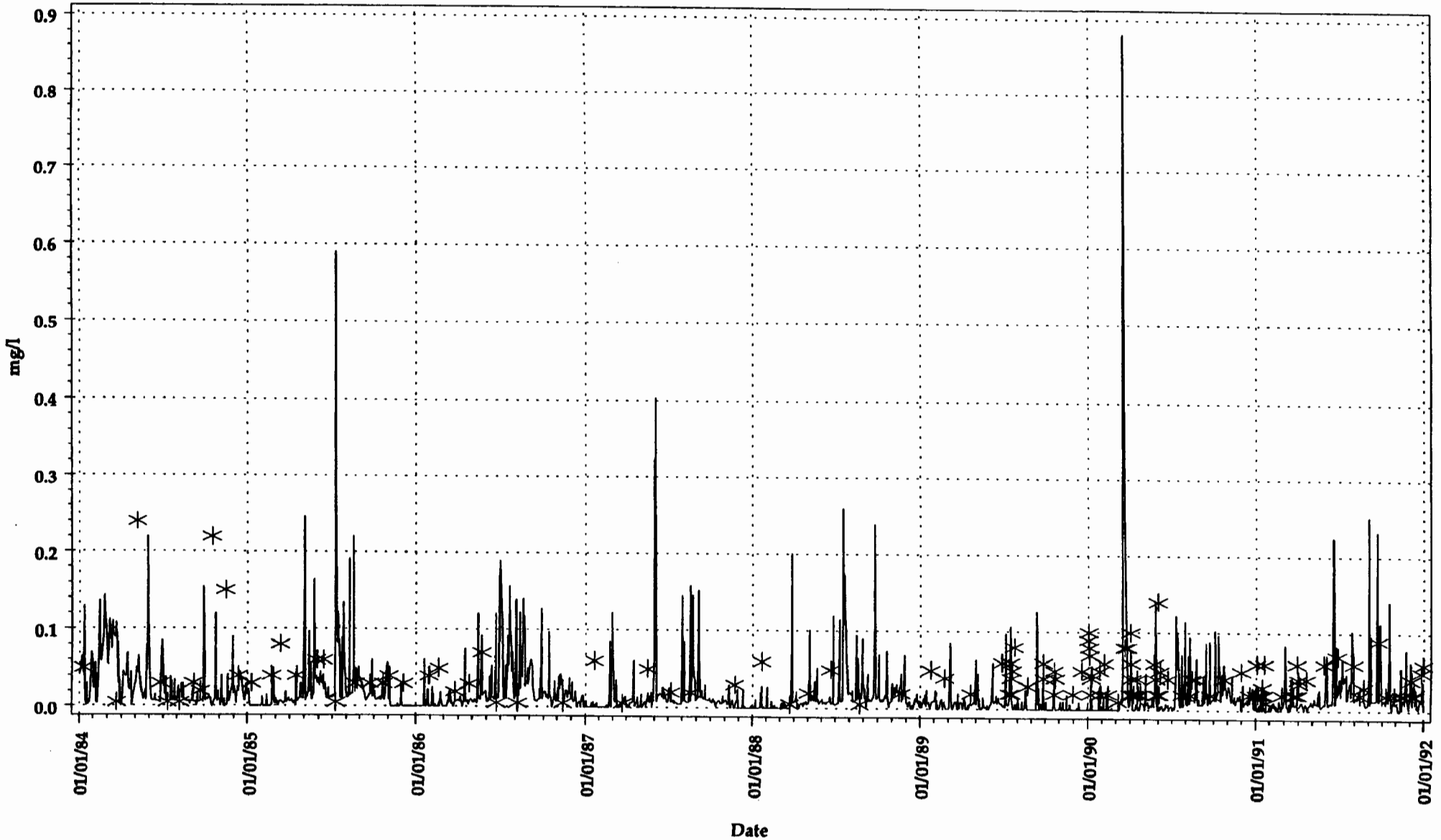


Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data



Mattaponi River at Segment 240
Observed and Simulated versus Time
Total Ammonia

(*=Observed, -=Simulated)

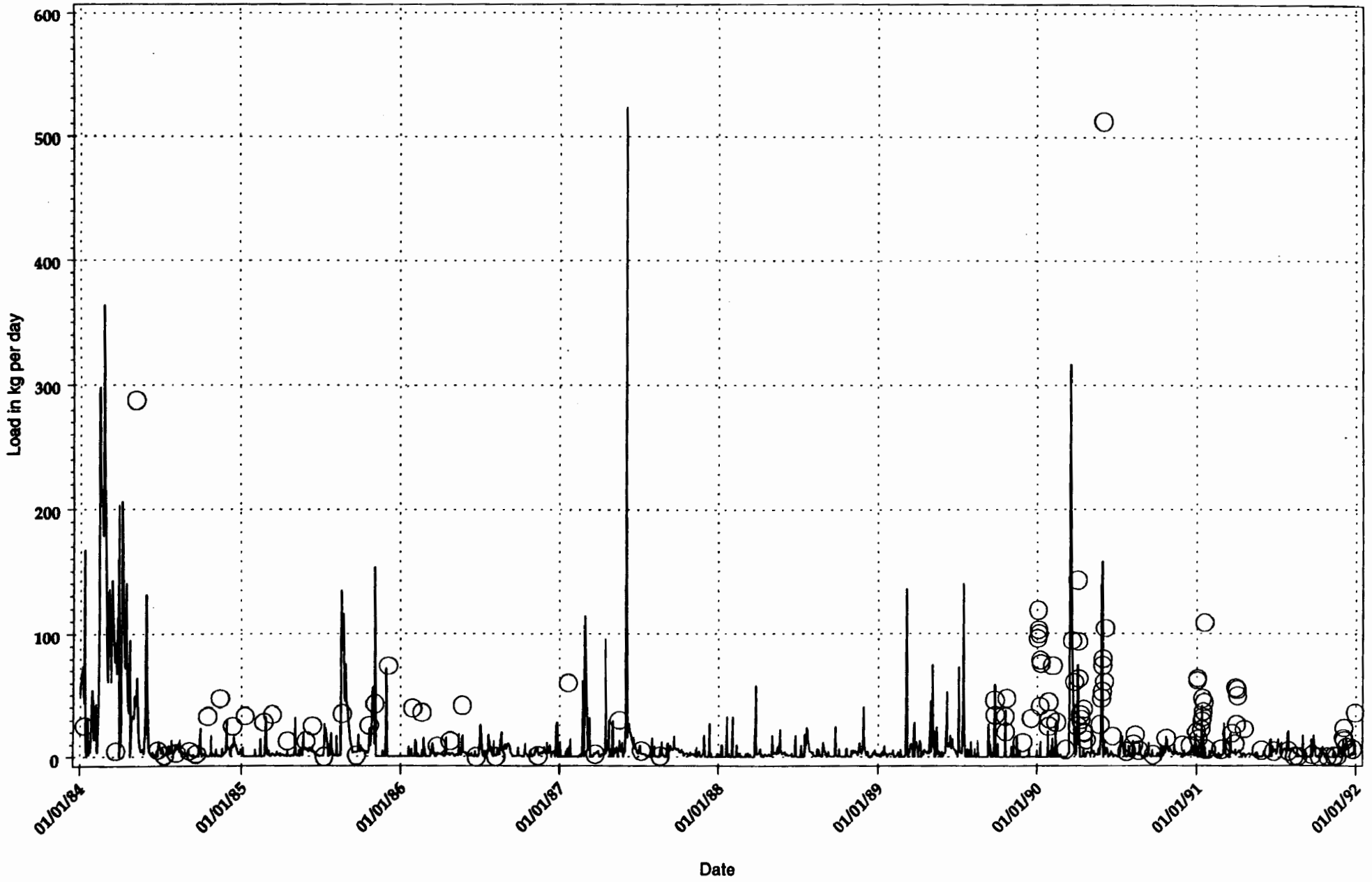


(y21_plotb.aos model3d(pwarg.dl) plotcmt - ontime)
(matta240.dsv 22FEB99 09:27)

Mattaponi River at Segment 240

Total Ammonia Observed and Simulated Load vs Time

(line = simulated, O = observed)

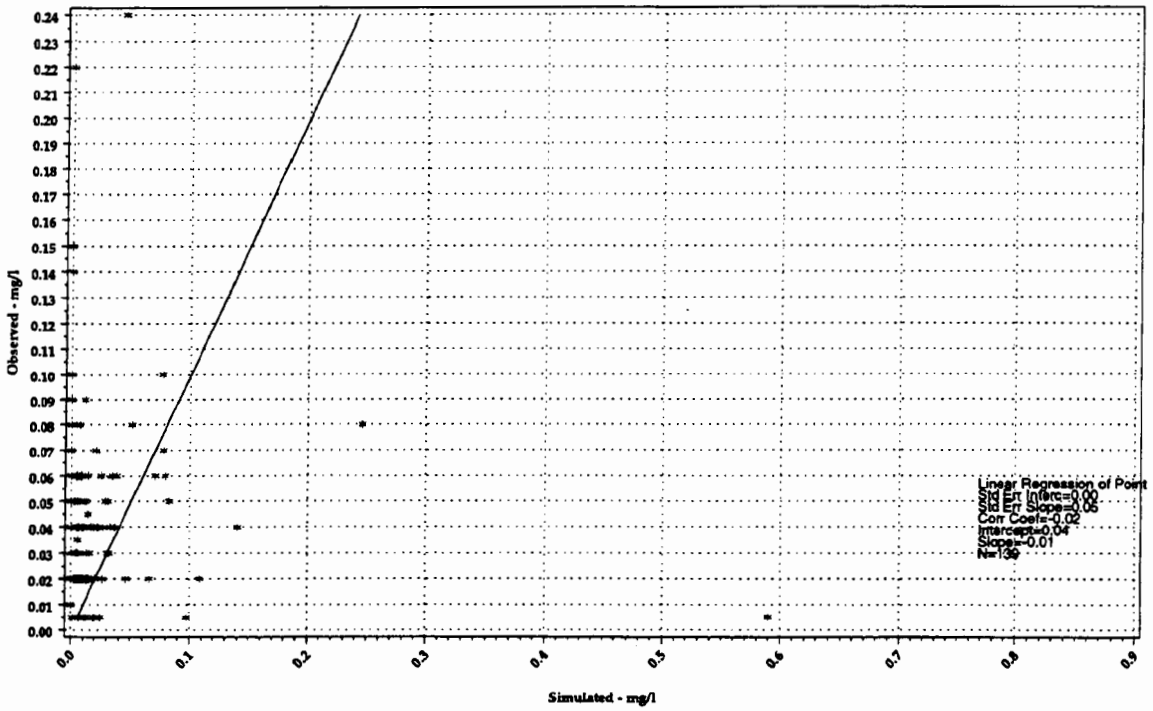


(y21_plotb.sas model3d.jgwang.dll fdlfee)
(matta240.dev 23FEB98 09:27,proc reg,model y=x)

Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

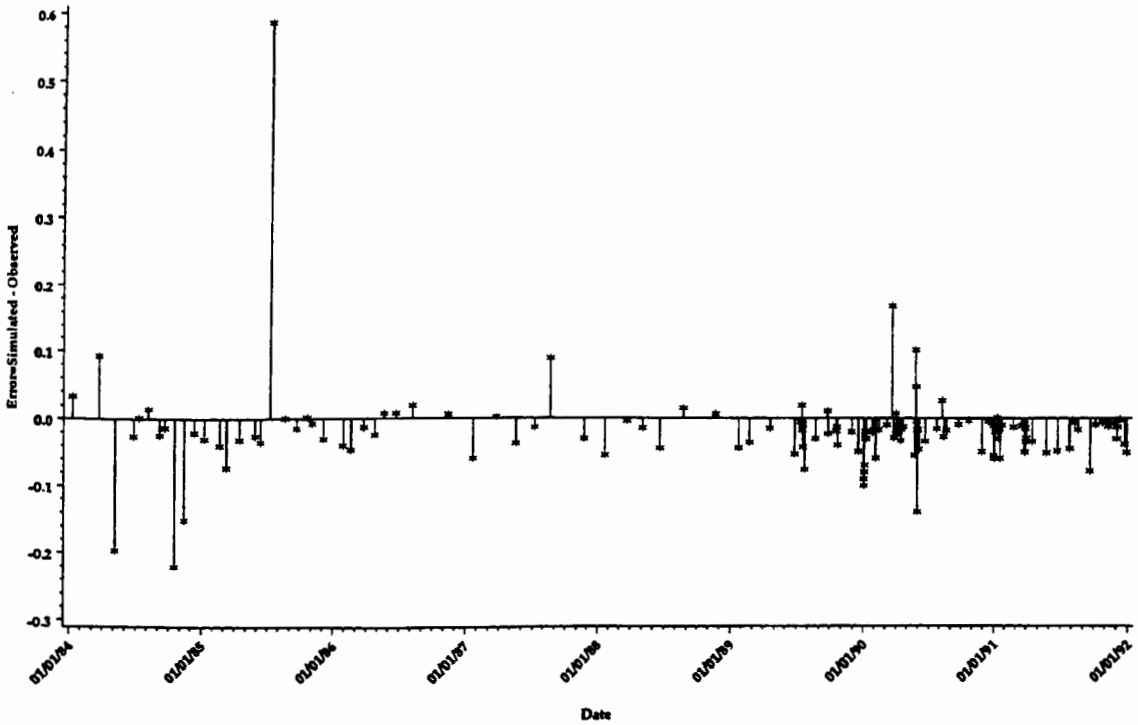
Total Ammonia: 01JAN84 - 01JAN92



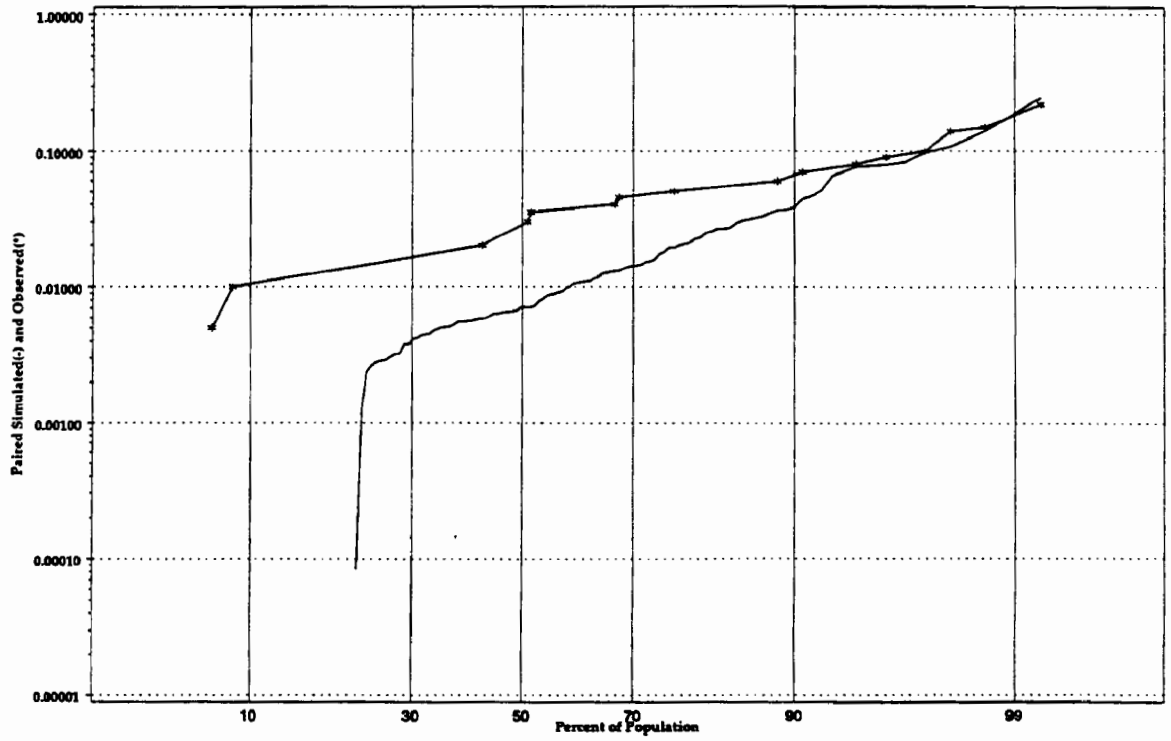
Mattaponi River at Segment 240

Actual Error versus Time

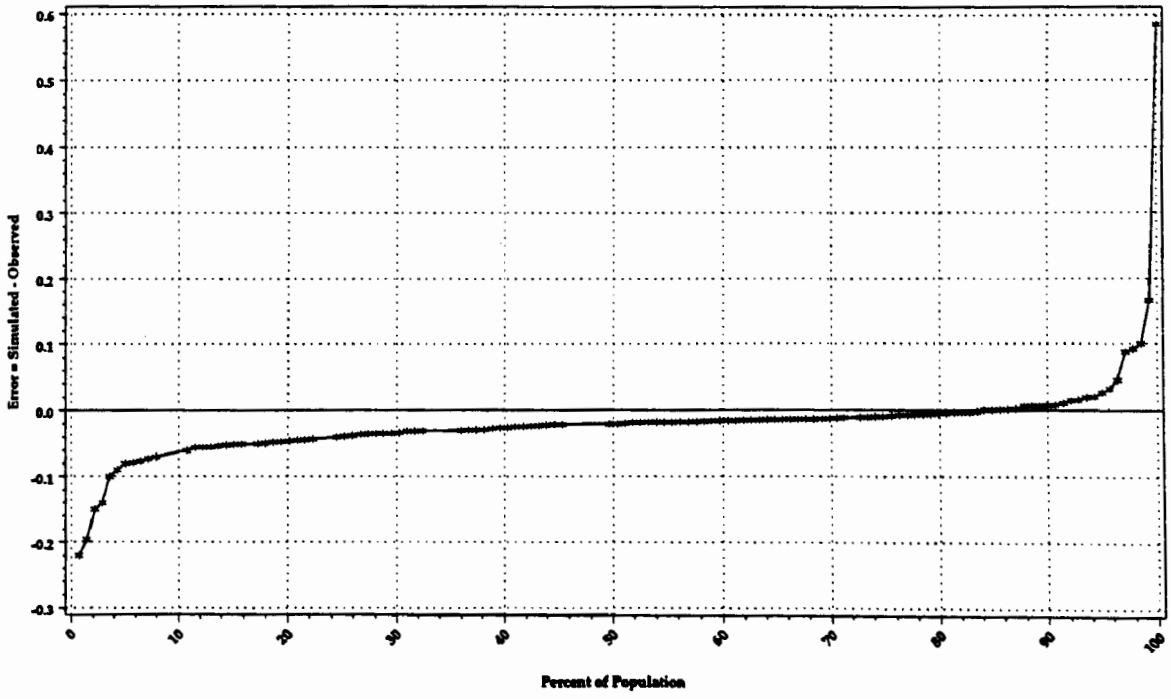
Total Ammonia



Mattaponi River at Segment 240
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data

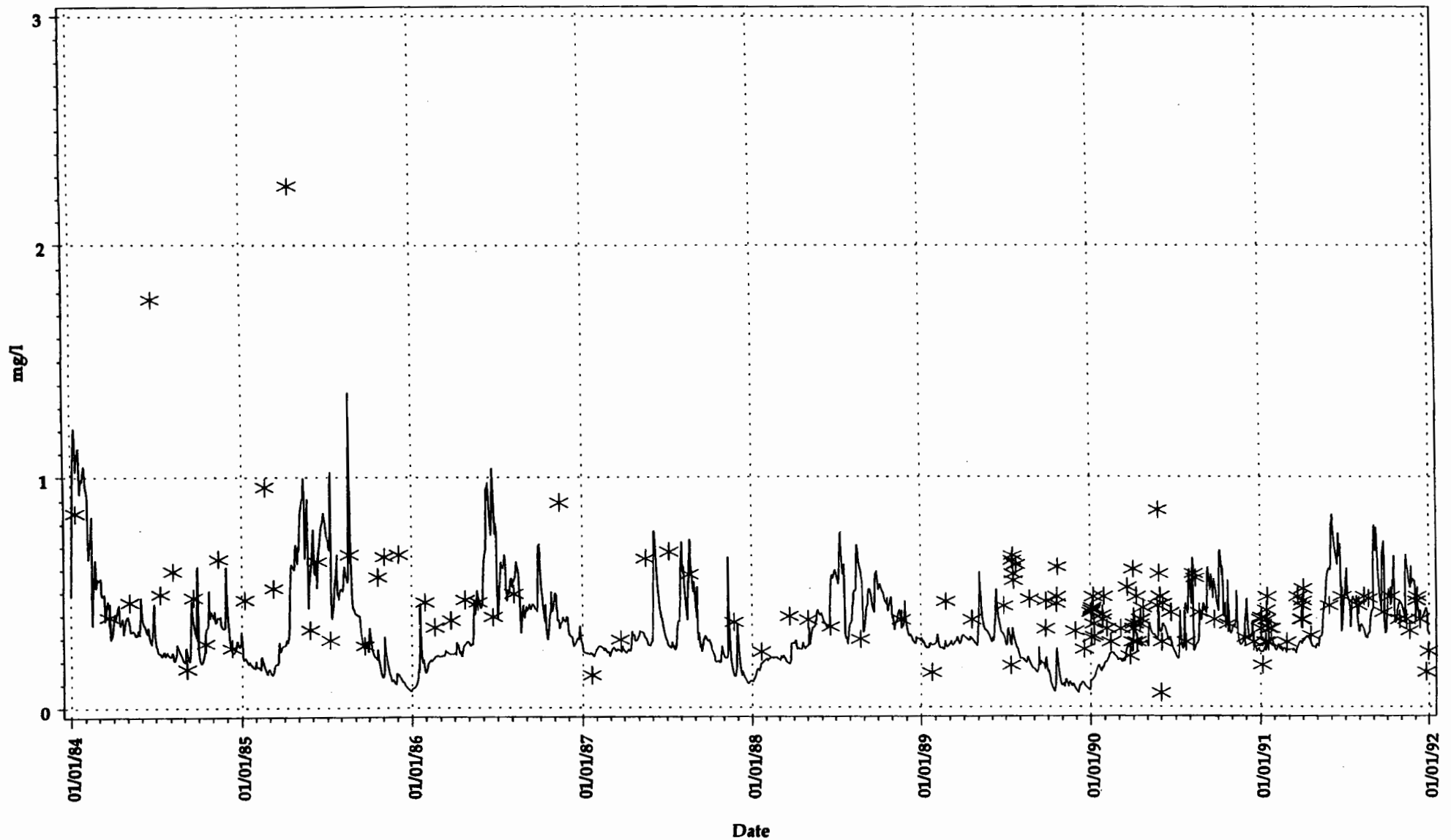


Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



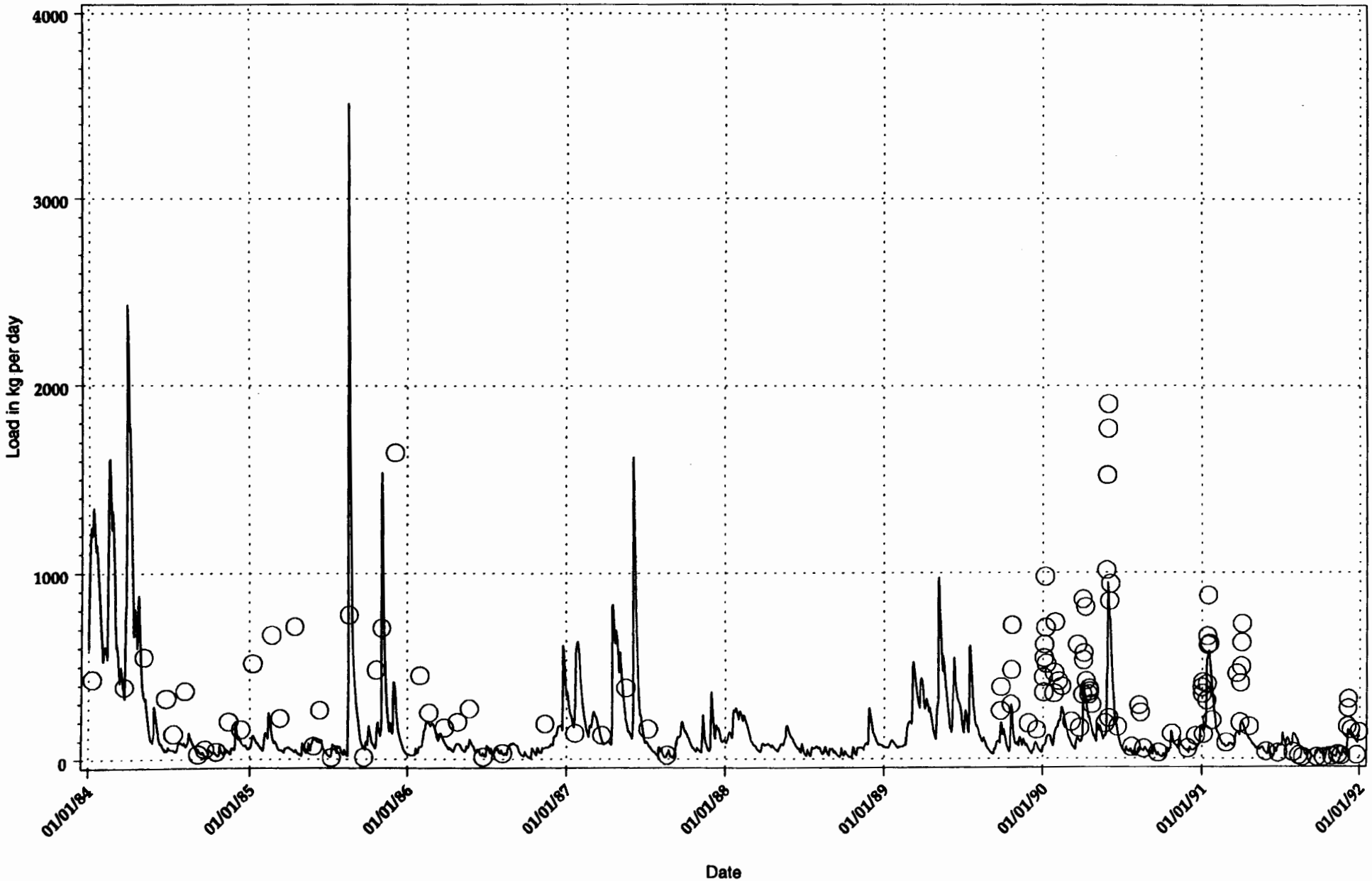
Mattaponi River at Segment 240
Observed and Simulated versus Time
Organic Nitrogen

(*=Observed, -=Simulated)



(y21_plotb.sas model2d1gwang.dl[plotoml - ontime)
(matta240.dev 23FEB98 09:27)

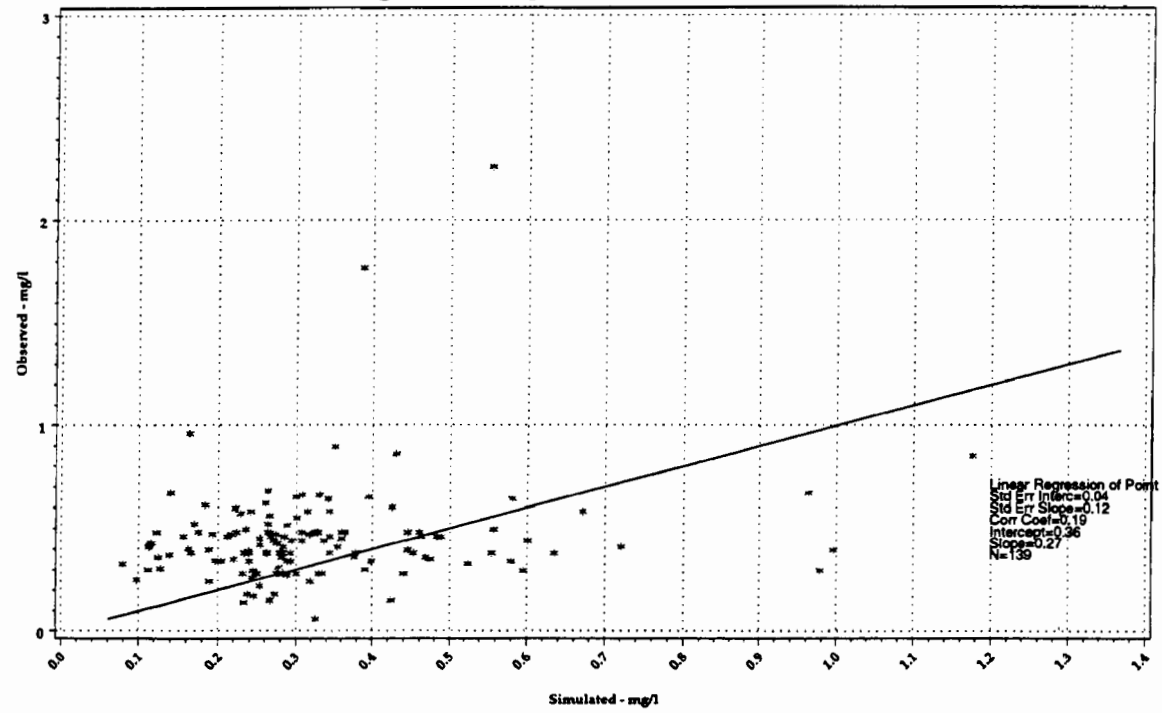
Mattaponi River at Segment 240
Organic Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plotb.sas model2d [pwang dl] lidlbo)
(matta240.dir 23FEB96 09:27,proc reg,model y=x)

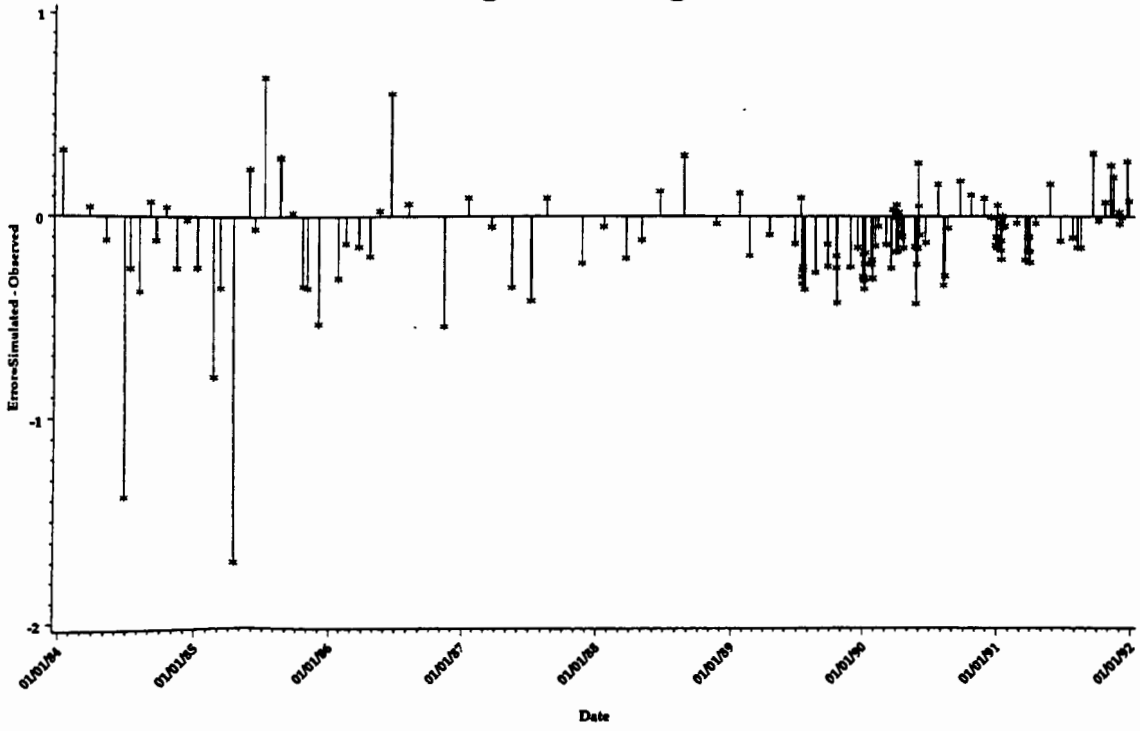
Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Organic Nitrogen: 01JAN84 - 01JAN92

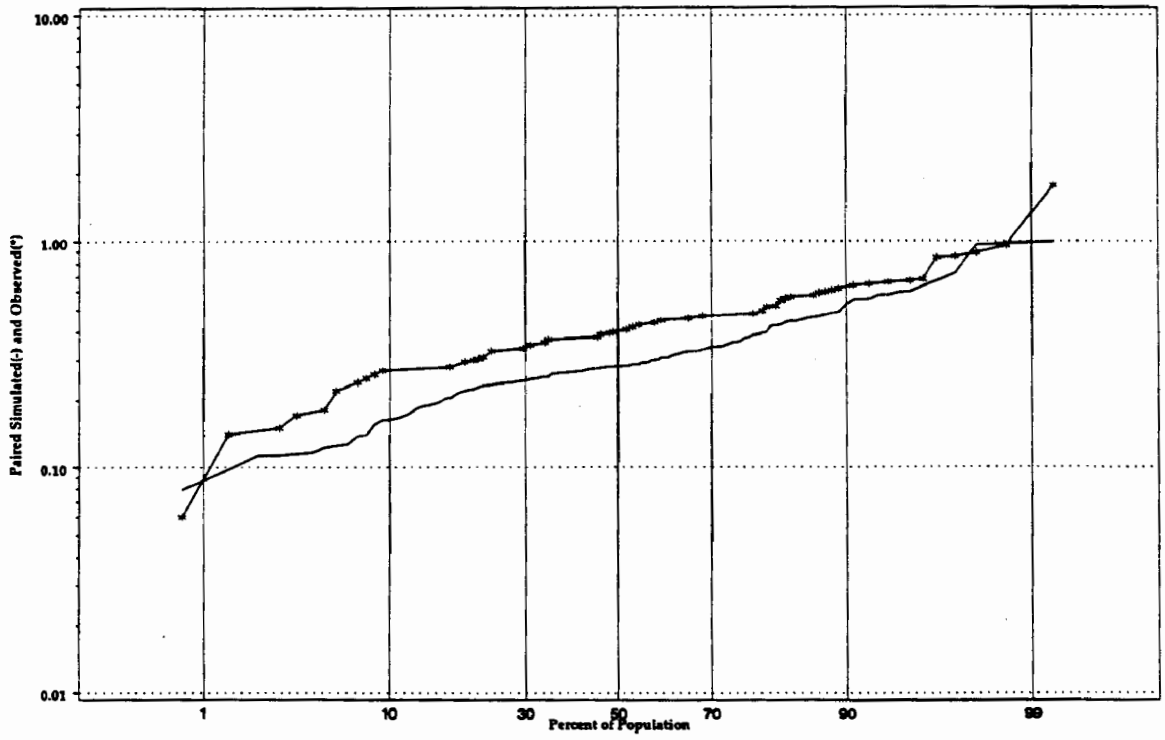


Mattaponi River at Segment 240

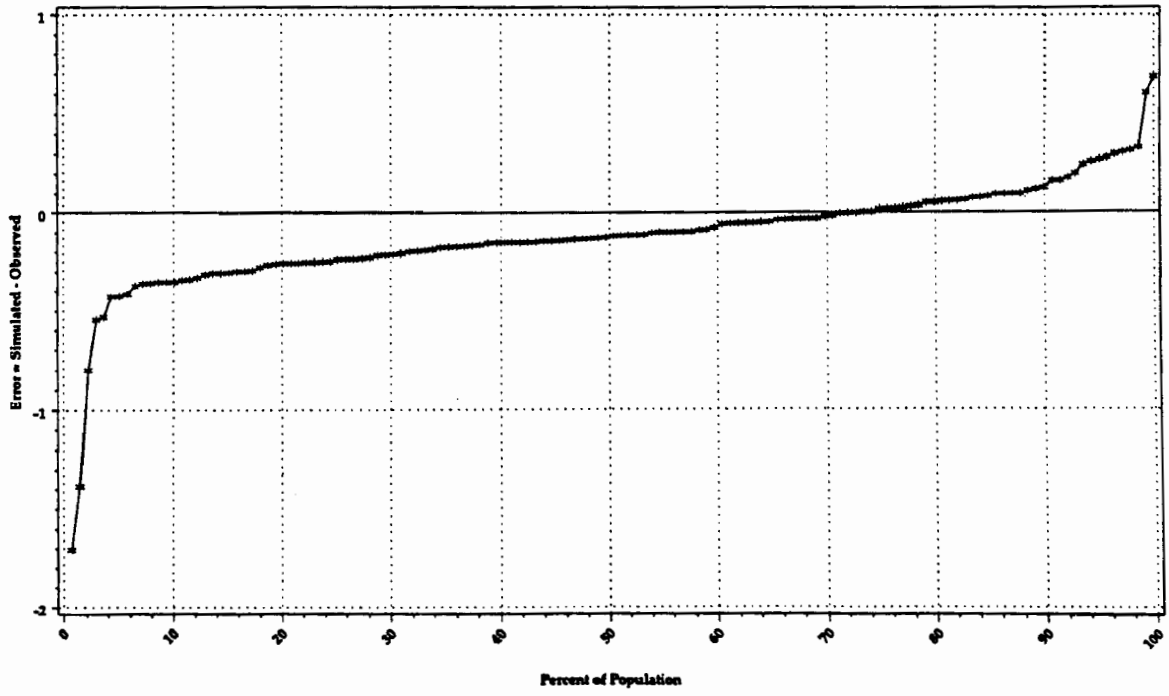
Actual Error versus Time
Organic Nitrogen



Mattaponi River at Segment 240
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.5.2 Pamunkey River near Hanover, VA at Segment 260 (Monitoring Station: 1673000) (Above Fall Line Basin Segments: 250 and 260)

Section Summary:

The Pamunkey basin together with the Mattaponi form the above fall line portion of the York River. The Pamunkey basin is largely rural. The Lake Anna Reservoir influences water quality in this basin contributing to the low concentrations of total nitrogen, total phosphorus, and total suspended sediment at the Pamunkey gage station. Water quality observations increased and were oriented toward storm weighted sampling after 1989. Model calibration focused primarily on the refined, storm-weighted sampling after 1989.

The Pamunkey basin above the gaged site covers an area of 1,070 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 67% forest land, 8% cropland, 17% other agricultural areas, 6% urban areas, and 3% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage increased from 1.7 million pounds in 1985 to 1.9 million pounds in 1996. Total phosphorus loads over the same time period did not change at 0.15 million pounds. In general, point source loads above the gage site decreased. In 1996, the total nitrogen point source load was 9% of the total load and the total phosphorus point source load was 11% of the total load. Estimated septic system total nitrogen loads increased 36%, from 61 thousand pounds in 1985 to 83 thousand pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation resulted in no change in the estimated cropland total nitrogen loads, and decreased other agricultural loads (primarily pasture and manure loads) by 6%. Total phosphorus decreased for cropland by 10% and increased for other agriculture by 2%. Urban loads were estimated to have increased over the 1985 to 1996 period by 36% for total nitrogen and 44% for total phosphorus due to increases in population and urban land use area

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

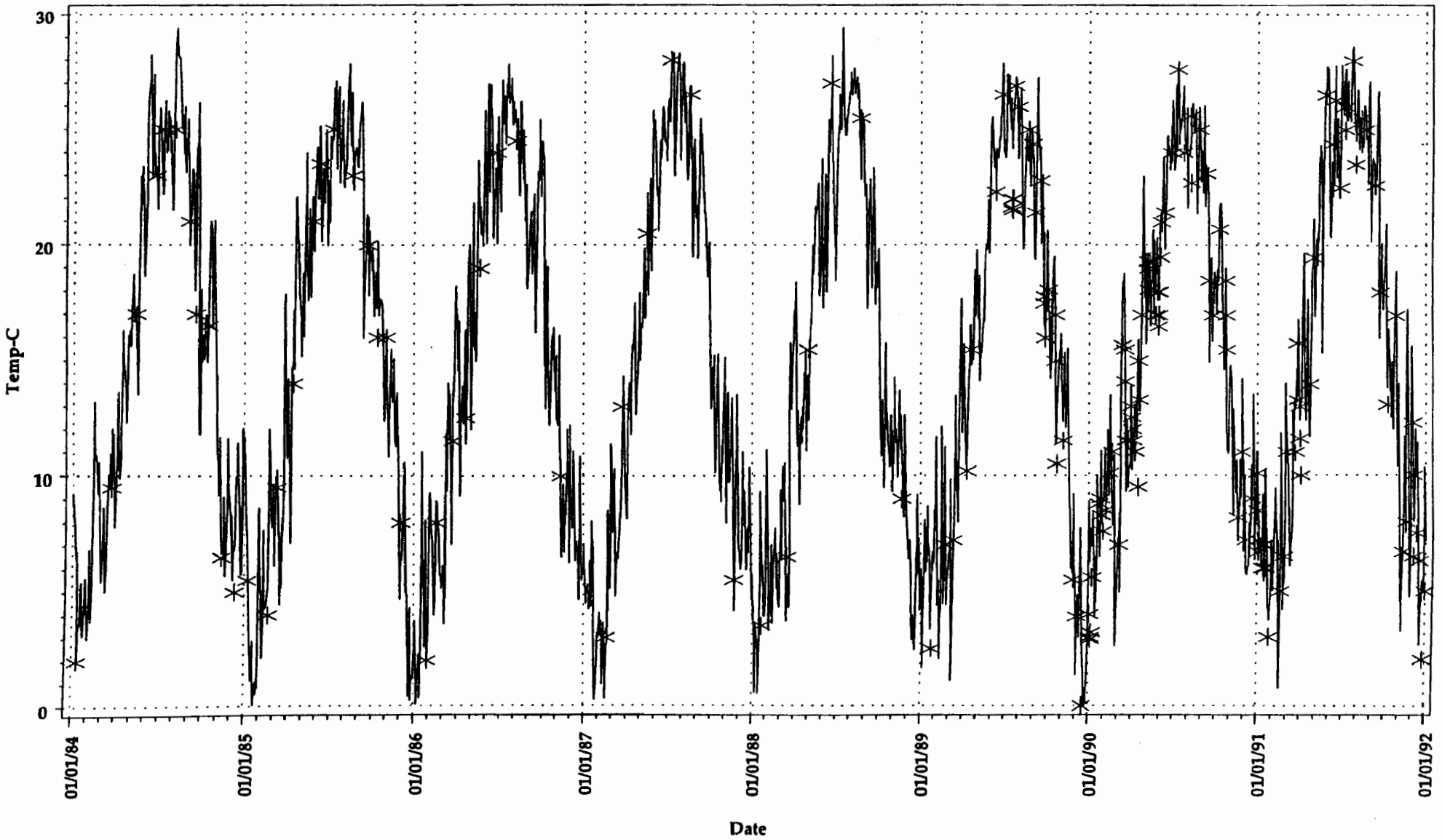
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

Pamunkey River at Segment 260
Observed and Simulated versus Time
Temperature-C

(*=Observed, -=Simulated)

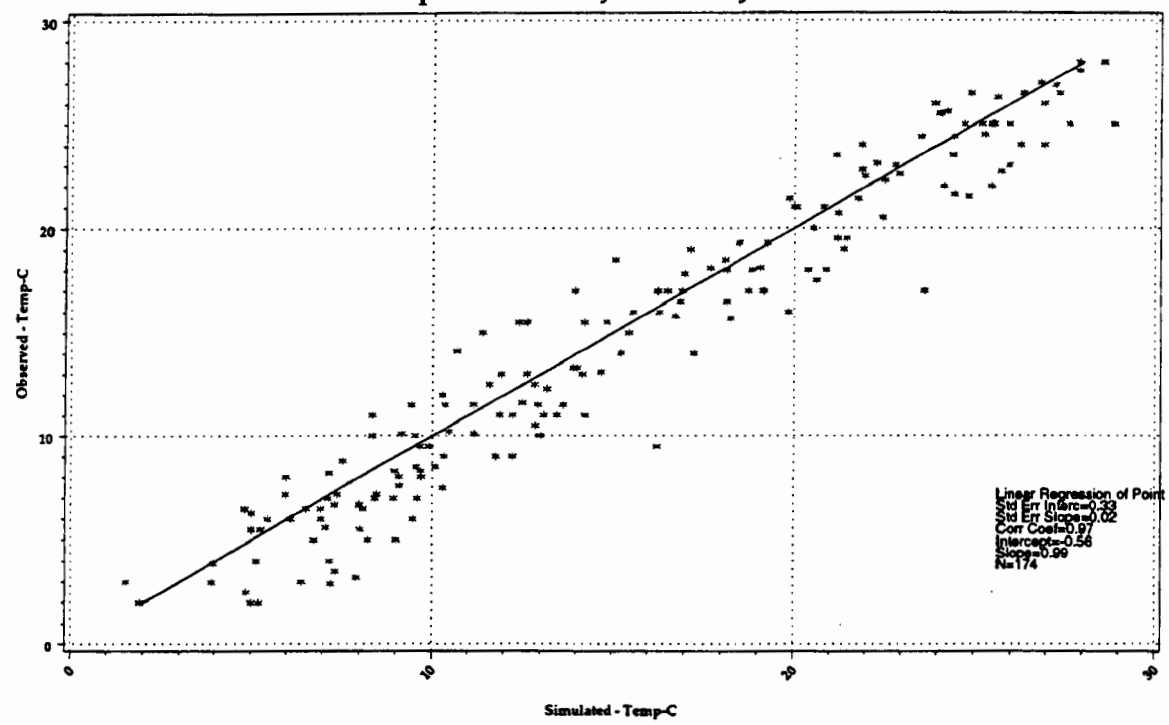


[y21_plot1.sas datastore2:rpo p3 james.and plotnmt - nmtime]
(graph_a.dnr 27AUG97 16:10)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

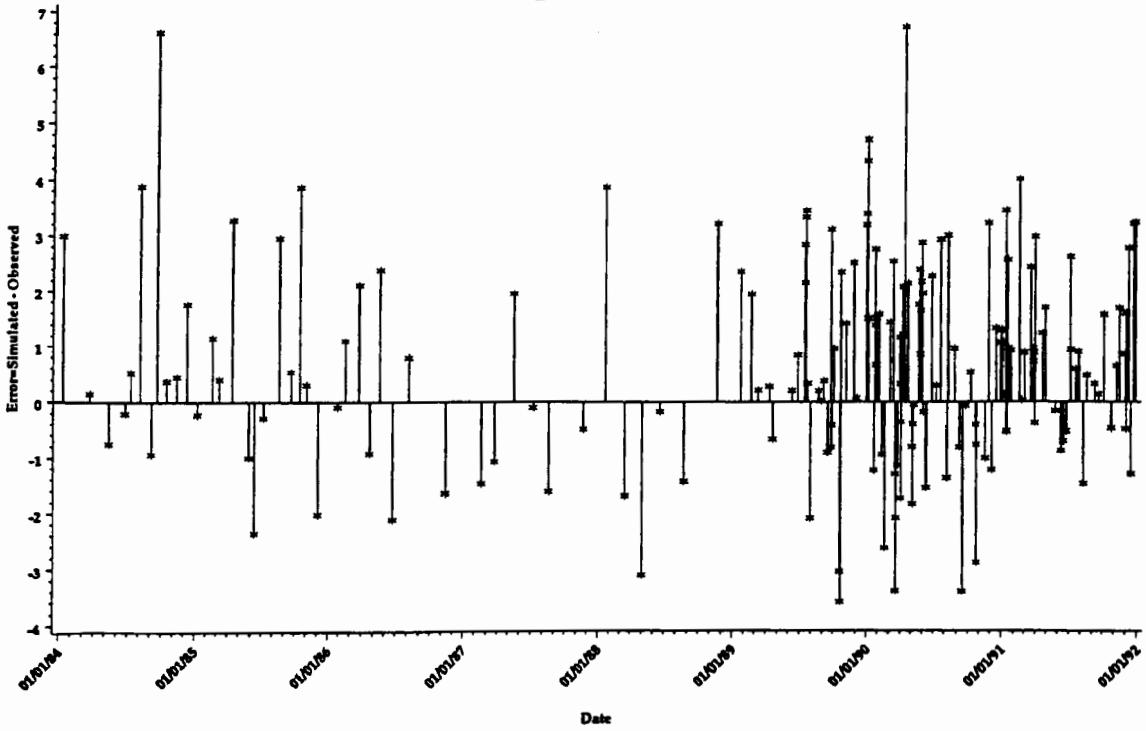
Temperature-C: 01JAN84 - 01JAN92



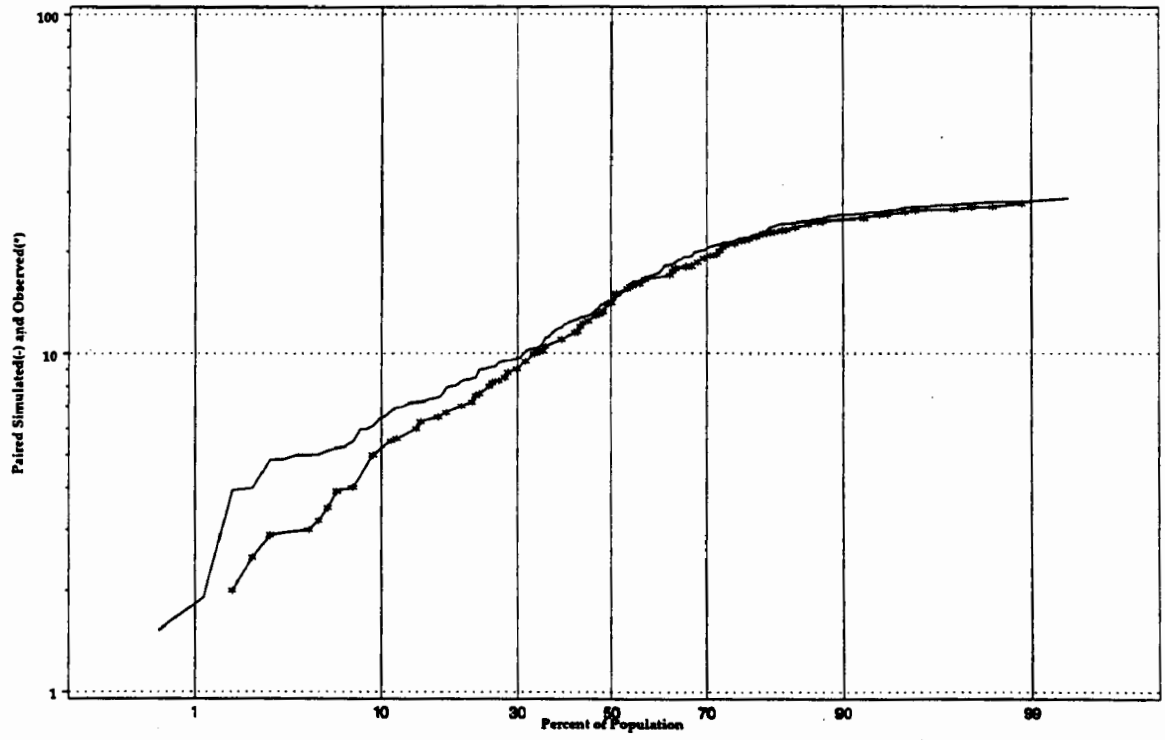
Pamunkey River at Segment 260

Actual Error versus Time

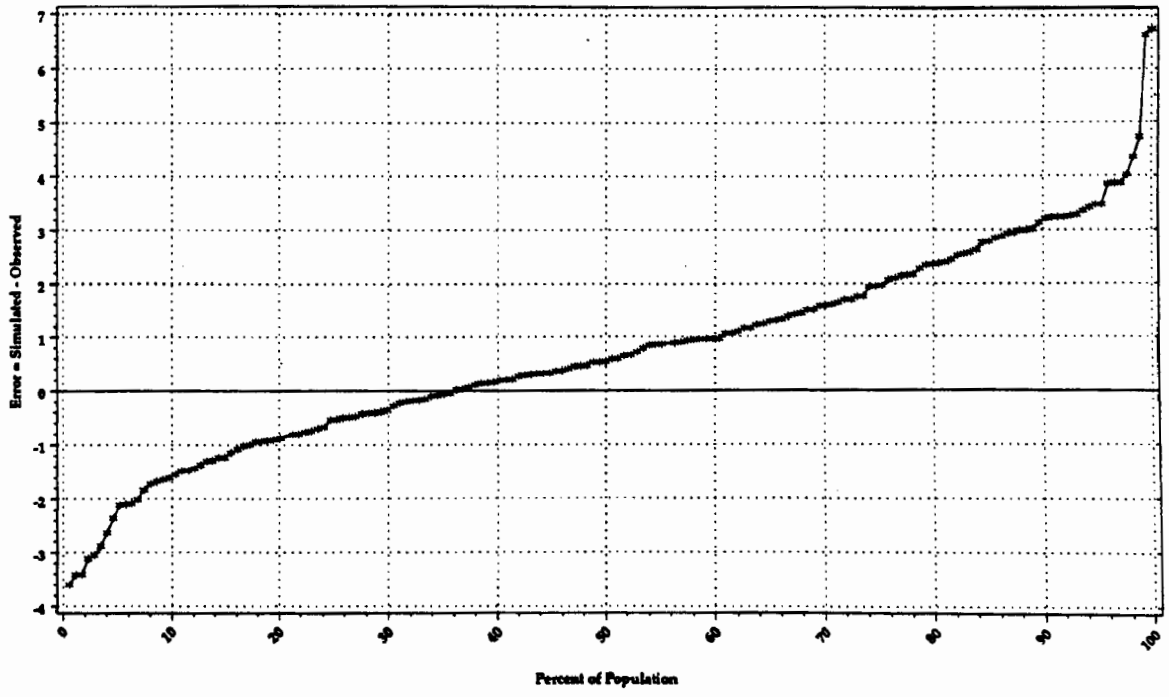
Temperature-C



Pamunkey River at Segment 260
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

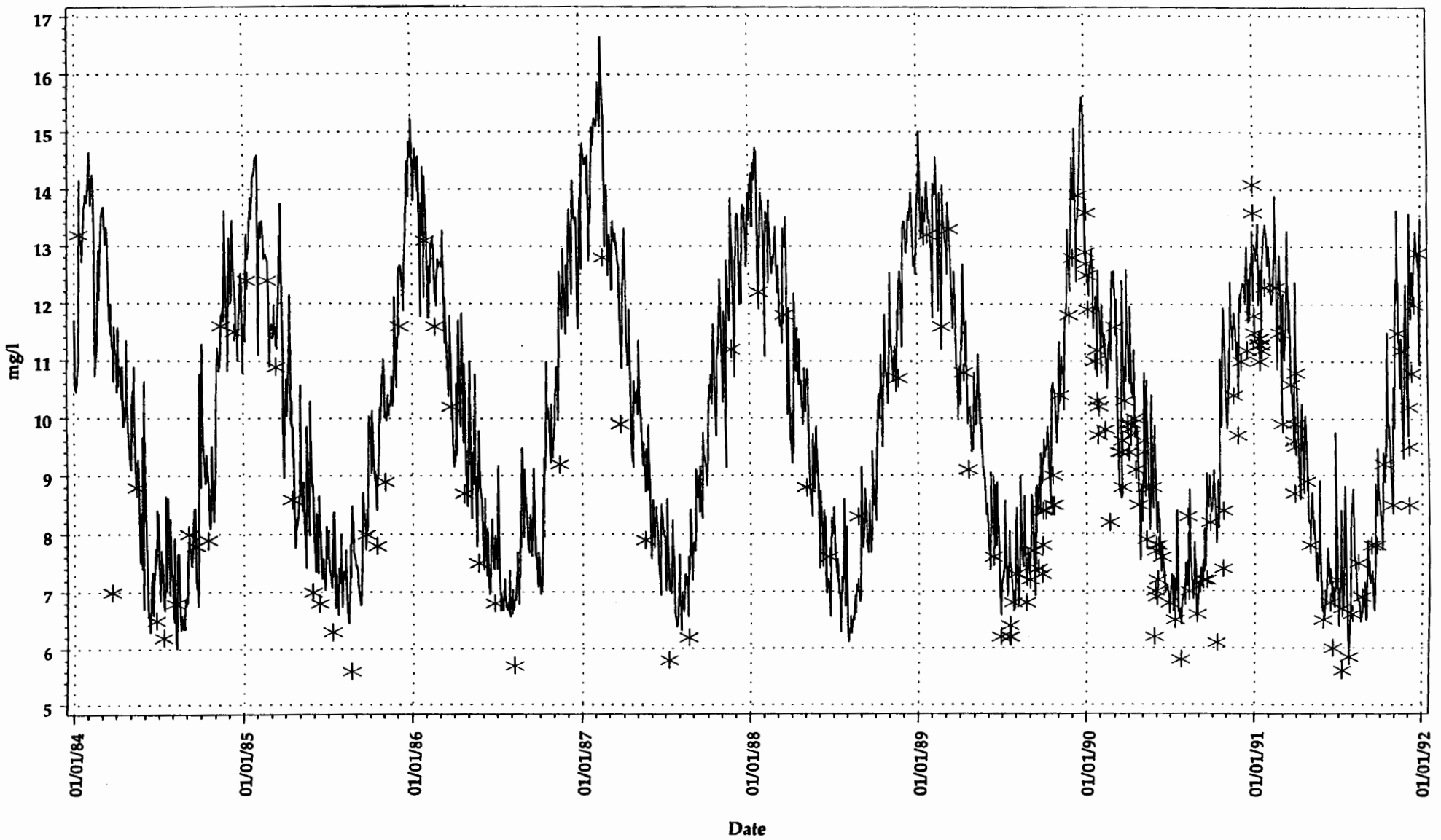


Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data



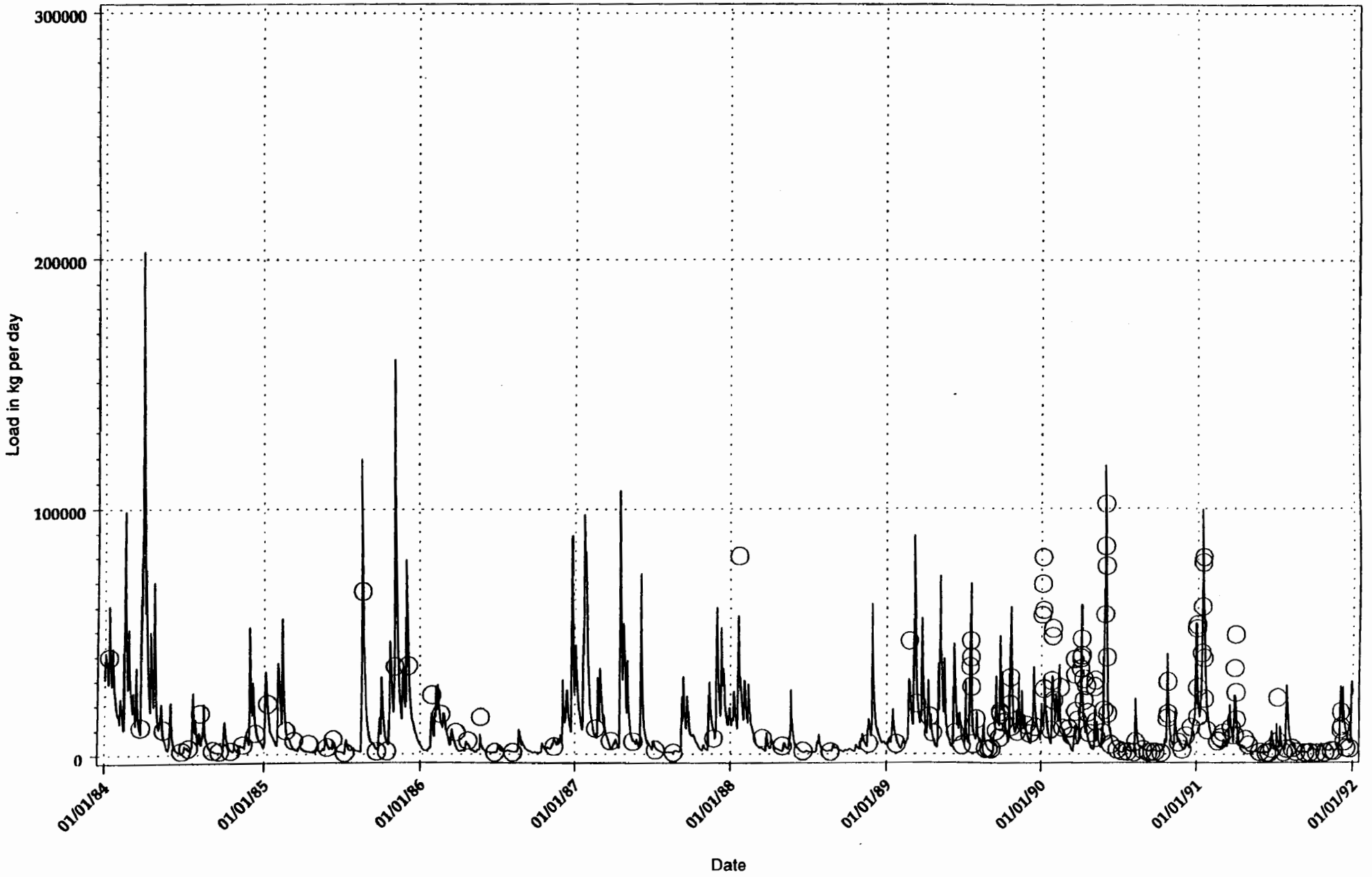
Pamunkey River at Segment 260
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



(y21_plot1.sas dataslave2:jrgs.p3.james.sas|plotomt - ondine)
(gsaph_a.dev 27AUG97 16:54)

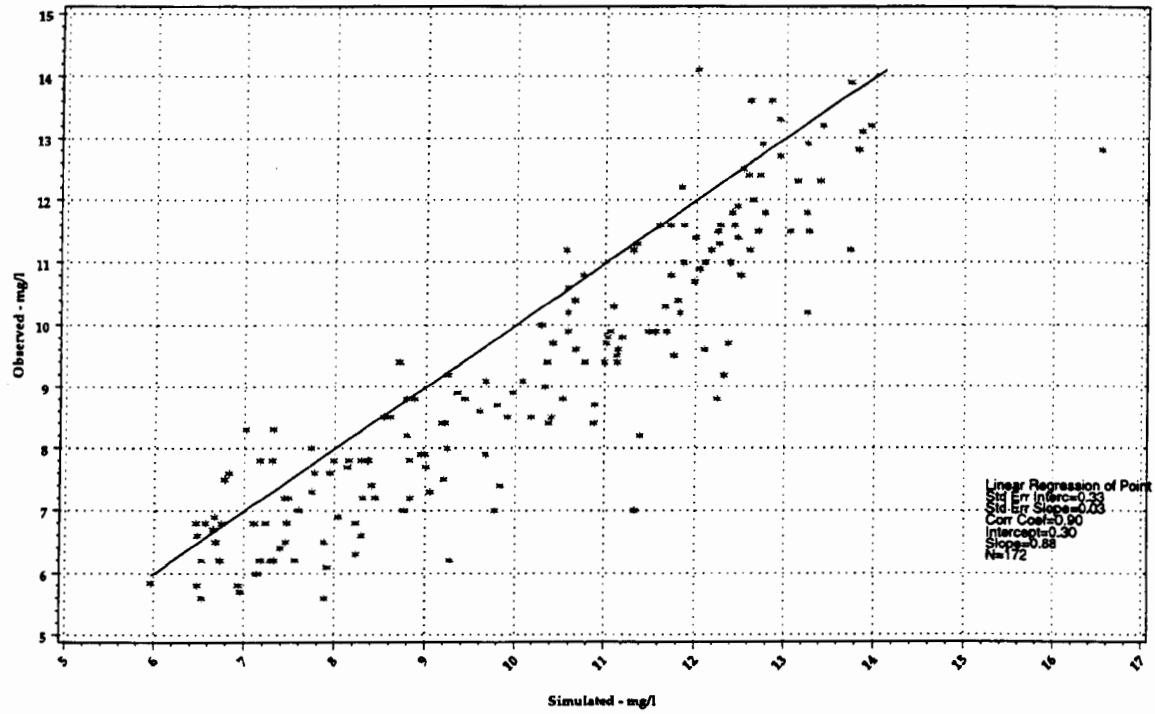
Pamunkey River at Segment 260
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plot1.sas datastore2:[nps.p3.james.sas] fdflas)
(graph_a.drv 27AUG97 16:50,proc reg,model y=x)

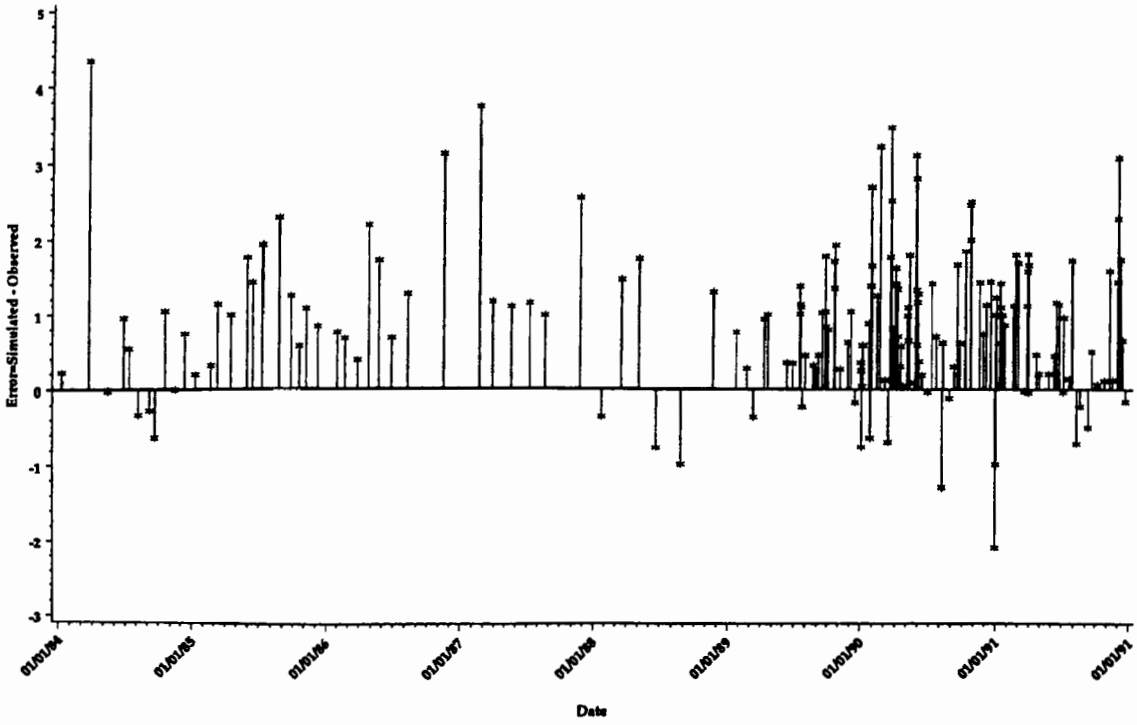
Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line Dissolved Oxygen: 01JAN84 - 01JAN92

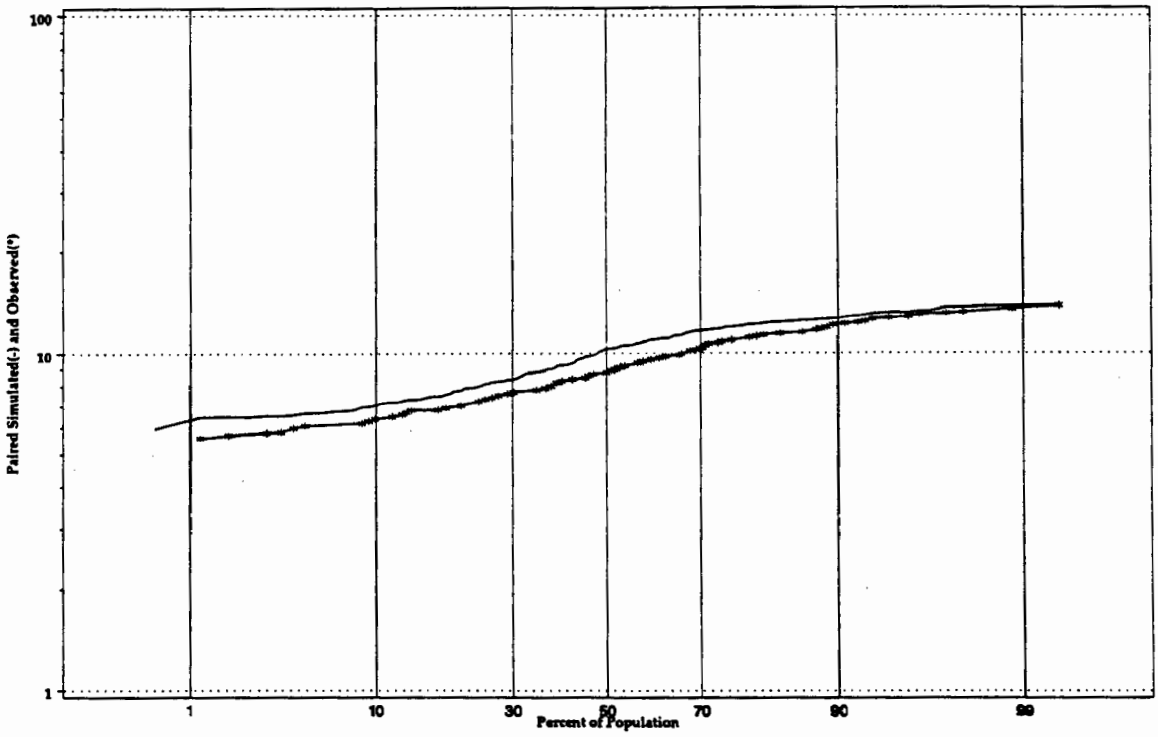


Pamunkey River at Segment 260

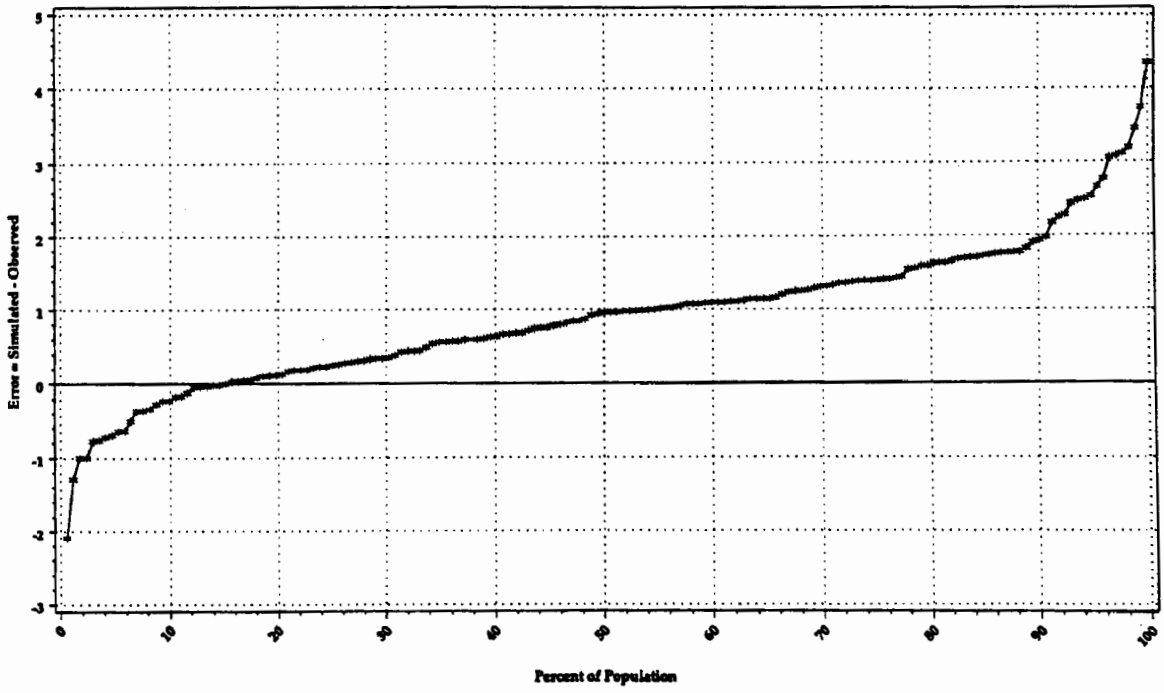
Actual Error versus Time Dissolved Oxygen



Pamunkey River at Segment 260
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

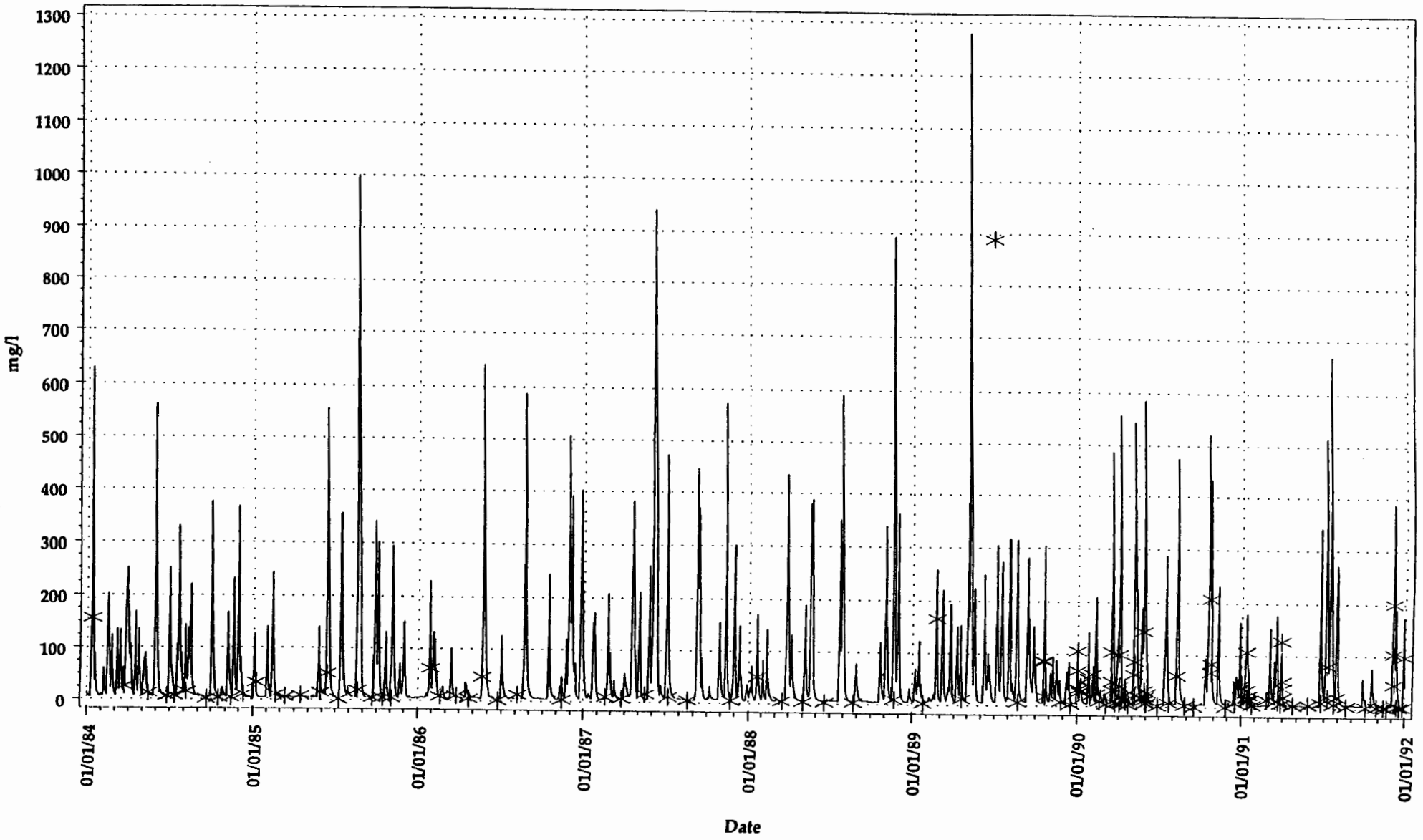


Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Pamunkey River at Segment 260
Observed and Simulated versus Time
Total Suspended Sediment

(*=Observed, -=Simulated)

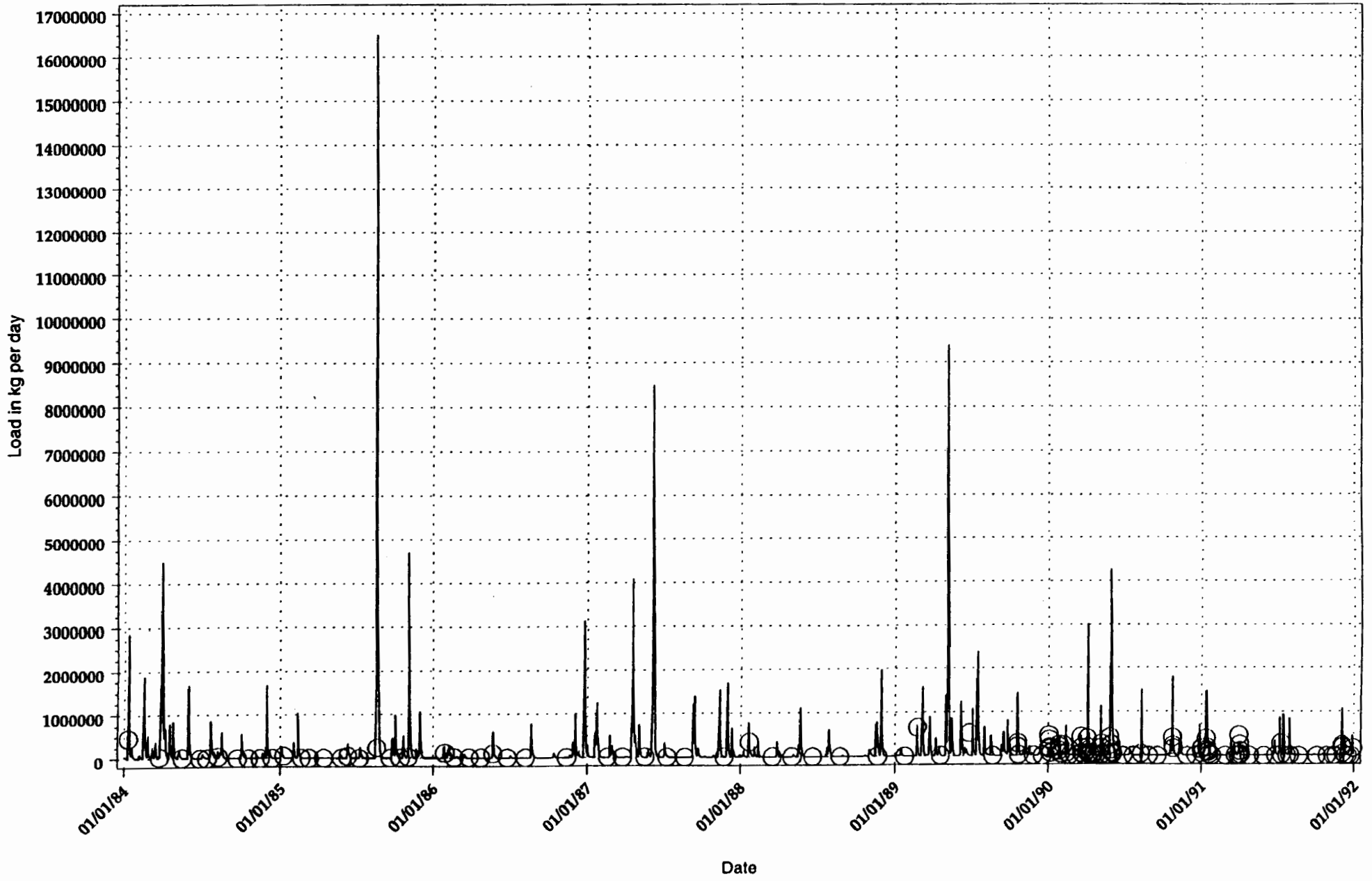


(y21_plot1.sas dataslave2 (rqs.p2.james.sas) plotcmt - online)
(graph_a drv 27AUG97 16:59)

Pamunkey River at Segment 260

Total Suspended Sediment Observed and Simulated Load vs Time

(line = simulated, O = observed)

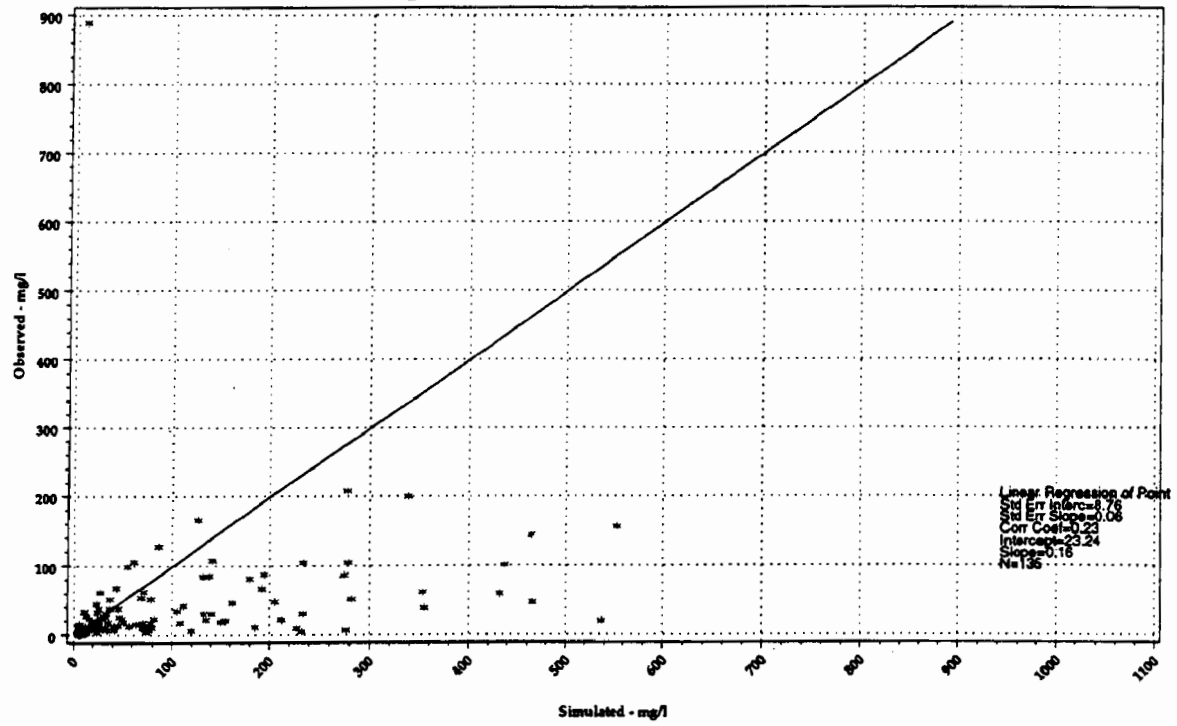


(y21_plot1 sas dataslore2 (nps p3 james.sas) 8dlles)
(graph_s drv 27AUG97 18:50.proc reg.model y=ll)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

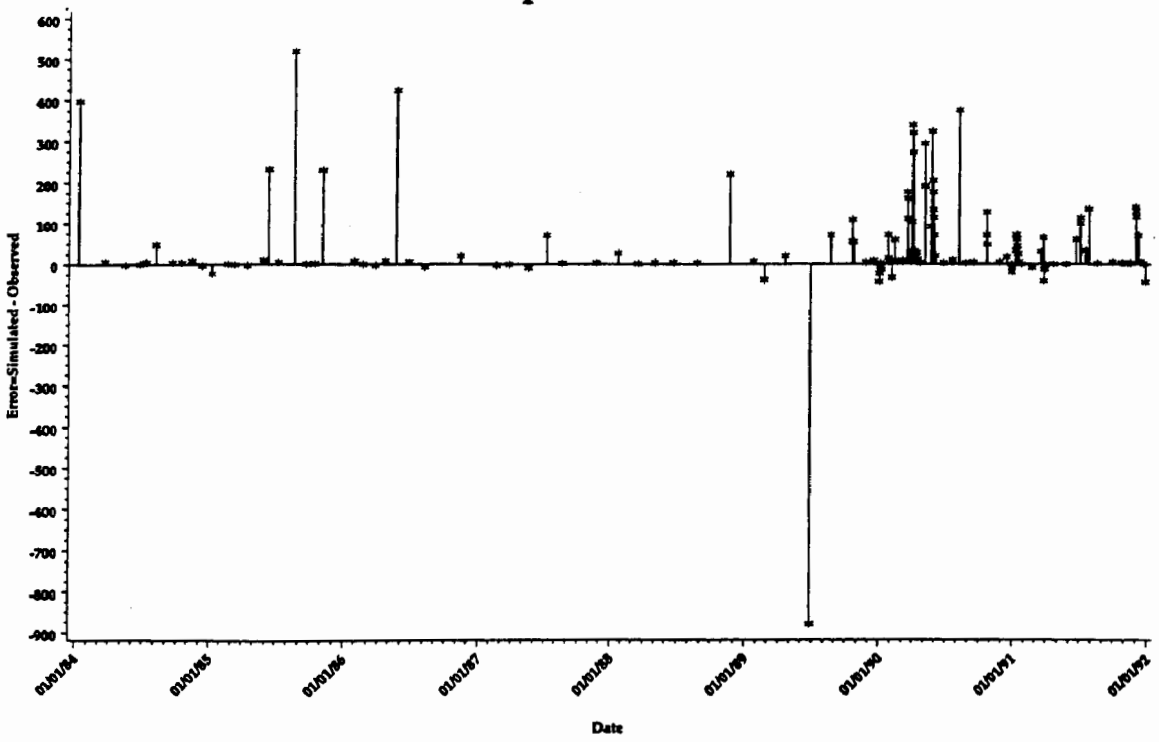
Total Suspended Sediment: 01JAN84 - 01JAN92



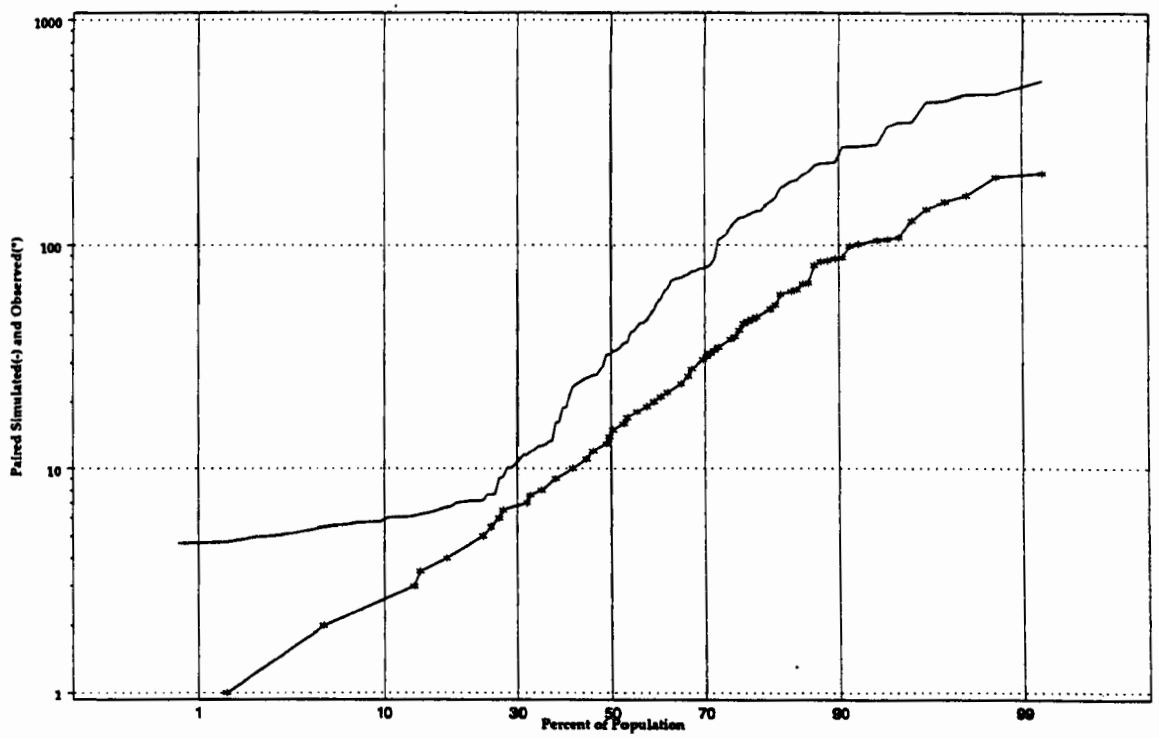
Pamunkey River at Segment 260

Actual Error versus Time

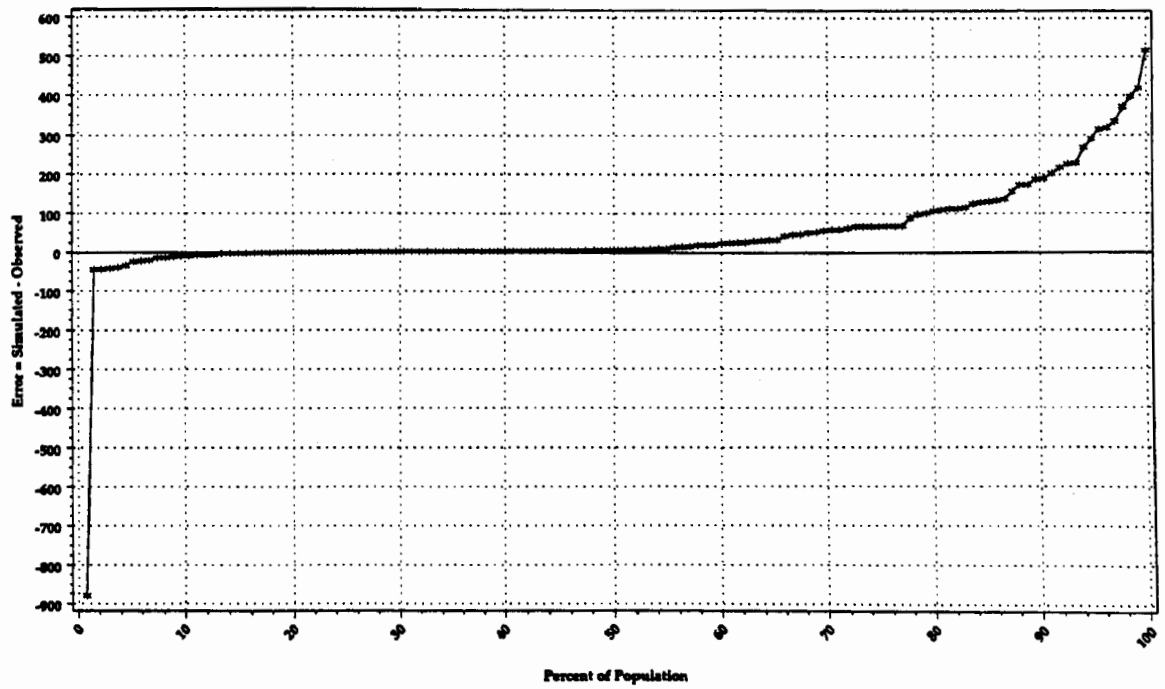
Total Suspended Sediment



Pamunkey River at Segment 260
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

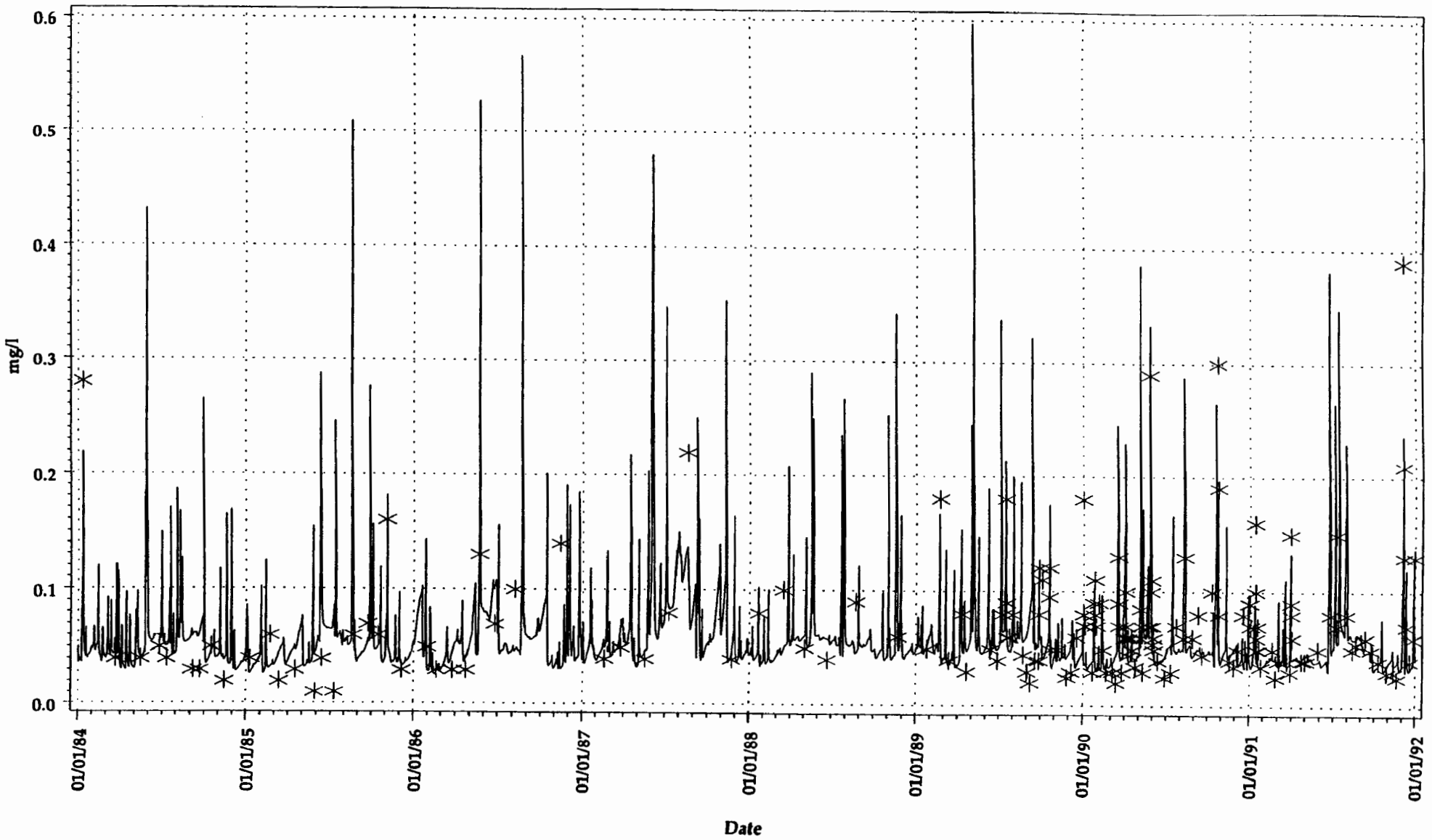


Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



Pamunkey River at Segment 260
Observed and Simulated versus Time
Total Phosphorus

(*=Observed, -=Simulated)

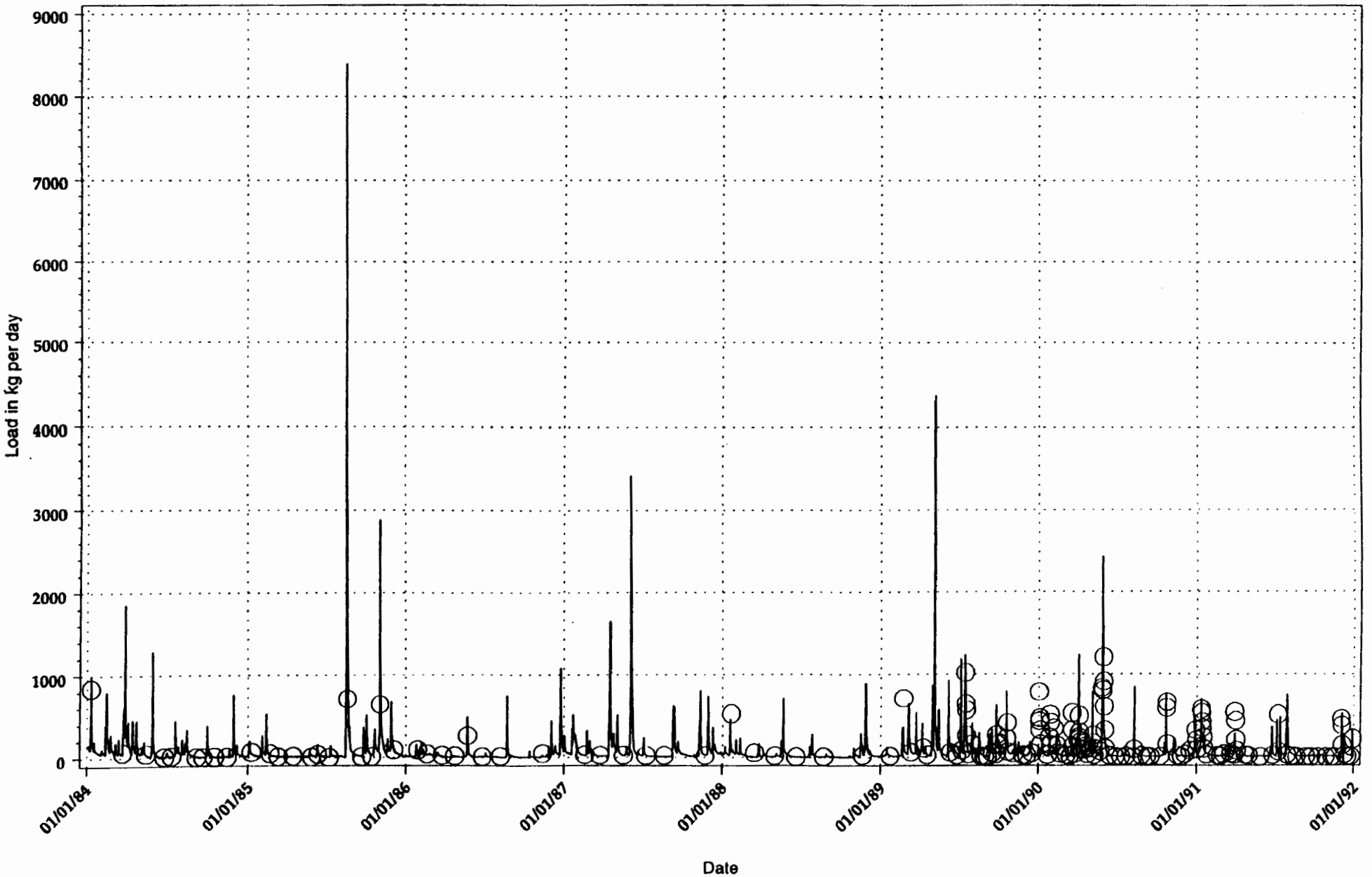


(y21_plot1.sas dataclove2 jrgs.p3 james.sas) plotsmi - ontime)
(graph_a.drv 27AUG97 14:56)

Pamunkey River at Segment 260

Total Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

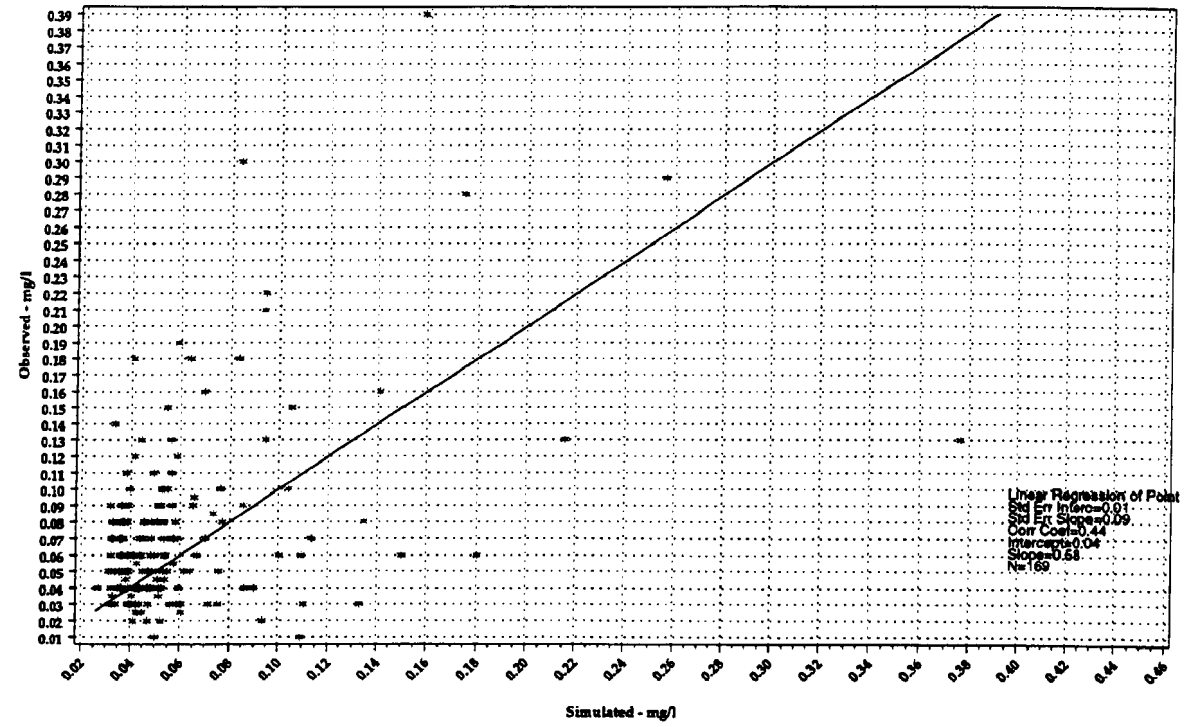


(y21 plot1 sas datastore2 (pgs p2 james sas) 8dflos)
(graph a div 27AUG97 18 50 proc reg model y=t)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

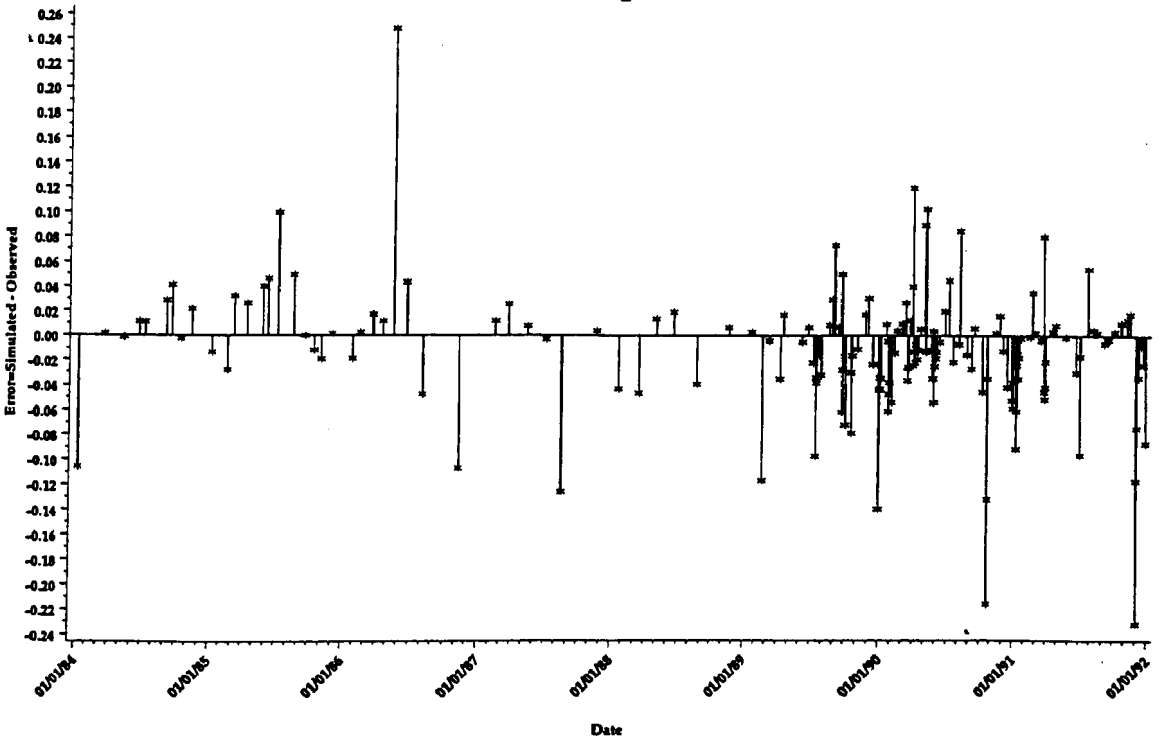
Total Phosphorus: 01JAN84 - 01JAN92



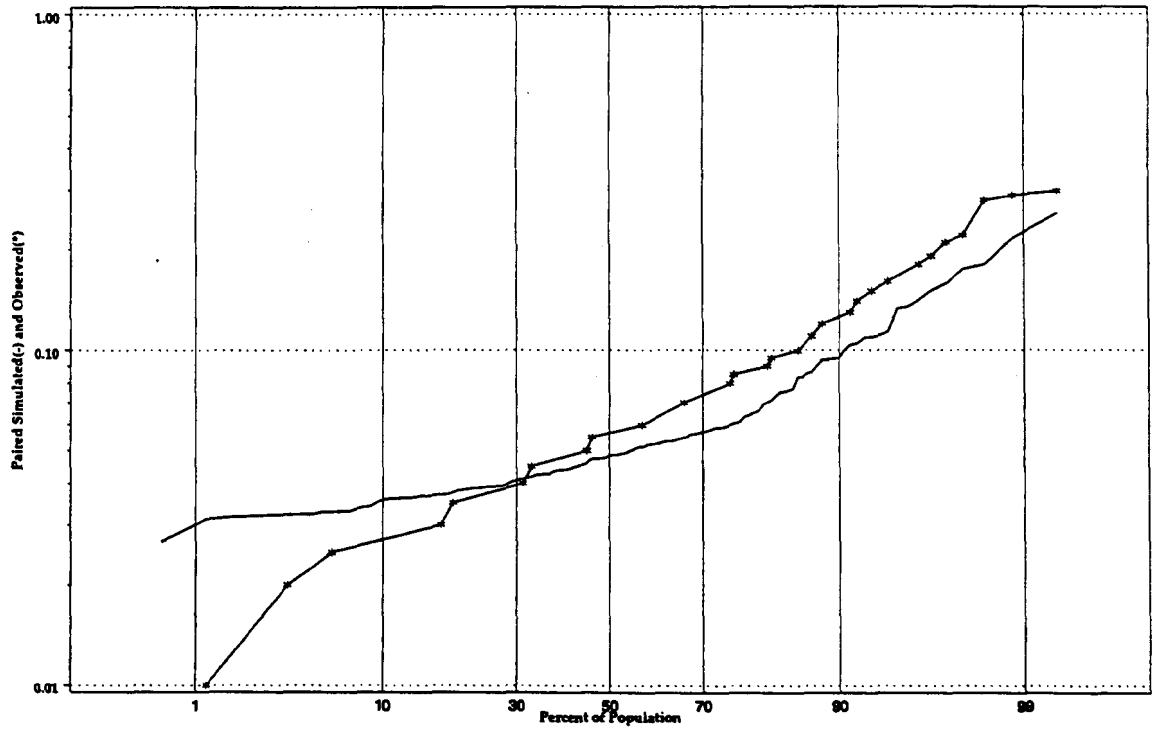
Pamunkey River at Segment 260

Actual Error versus Time

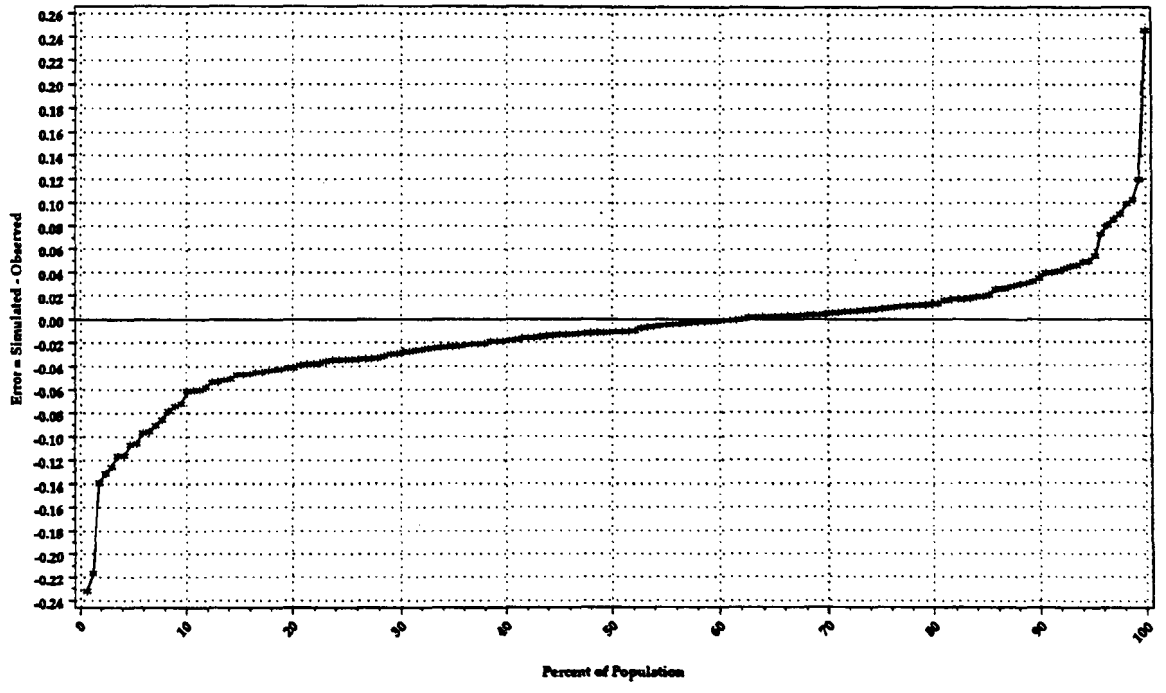
Total Phosphorus



Pamunkey River at Segment 260
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

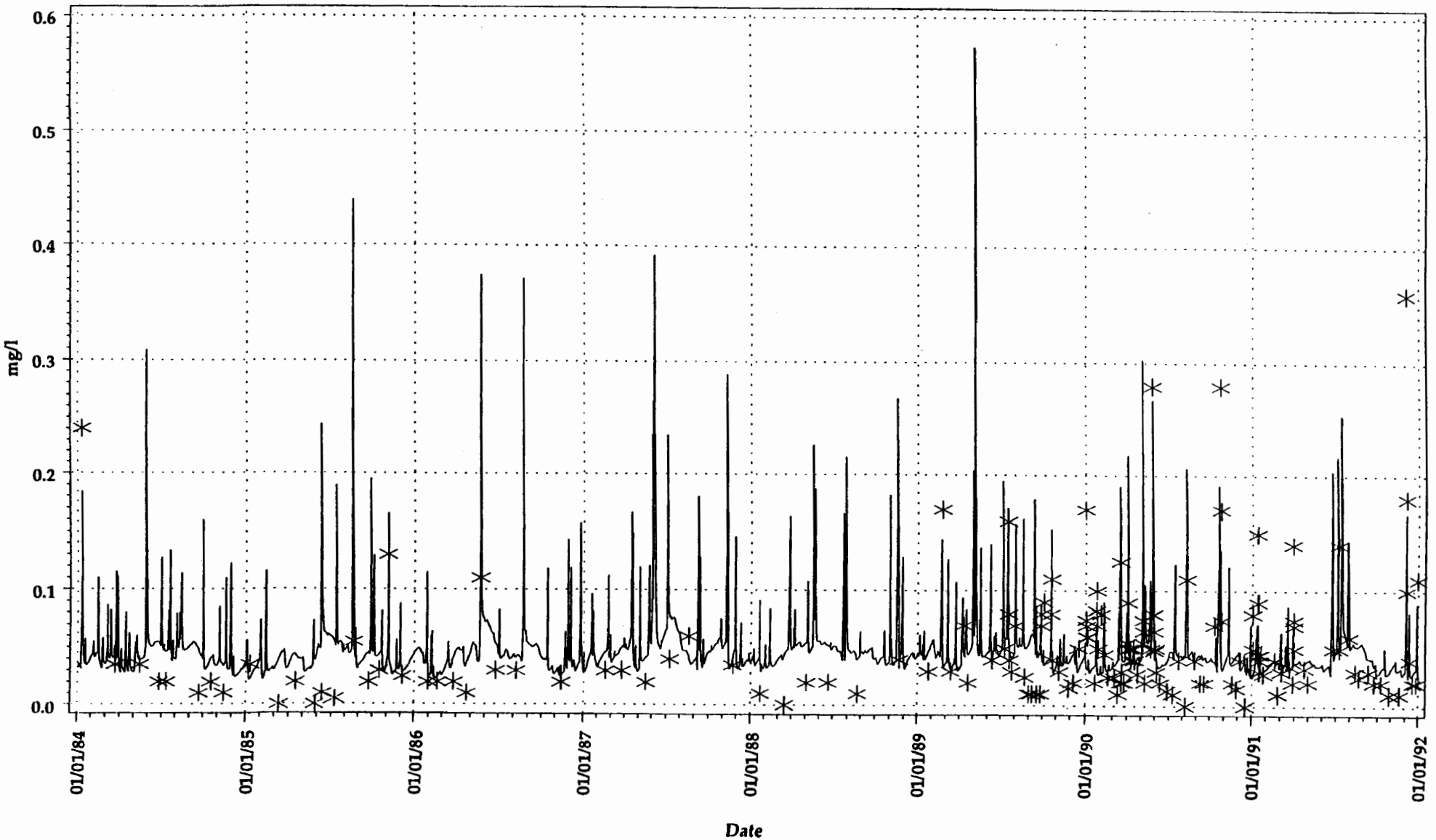


Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Pamunkey River at Segment 260
Observed and Simulated versus Time
Organic and Particulate Phosphorus

(*=Observed, -=Simulated)

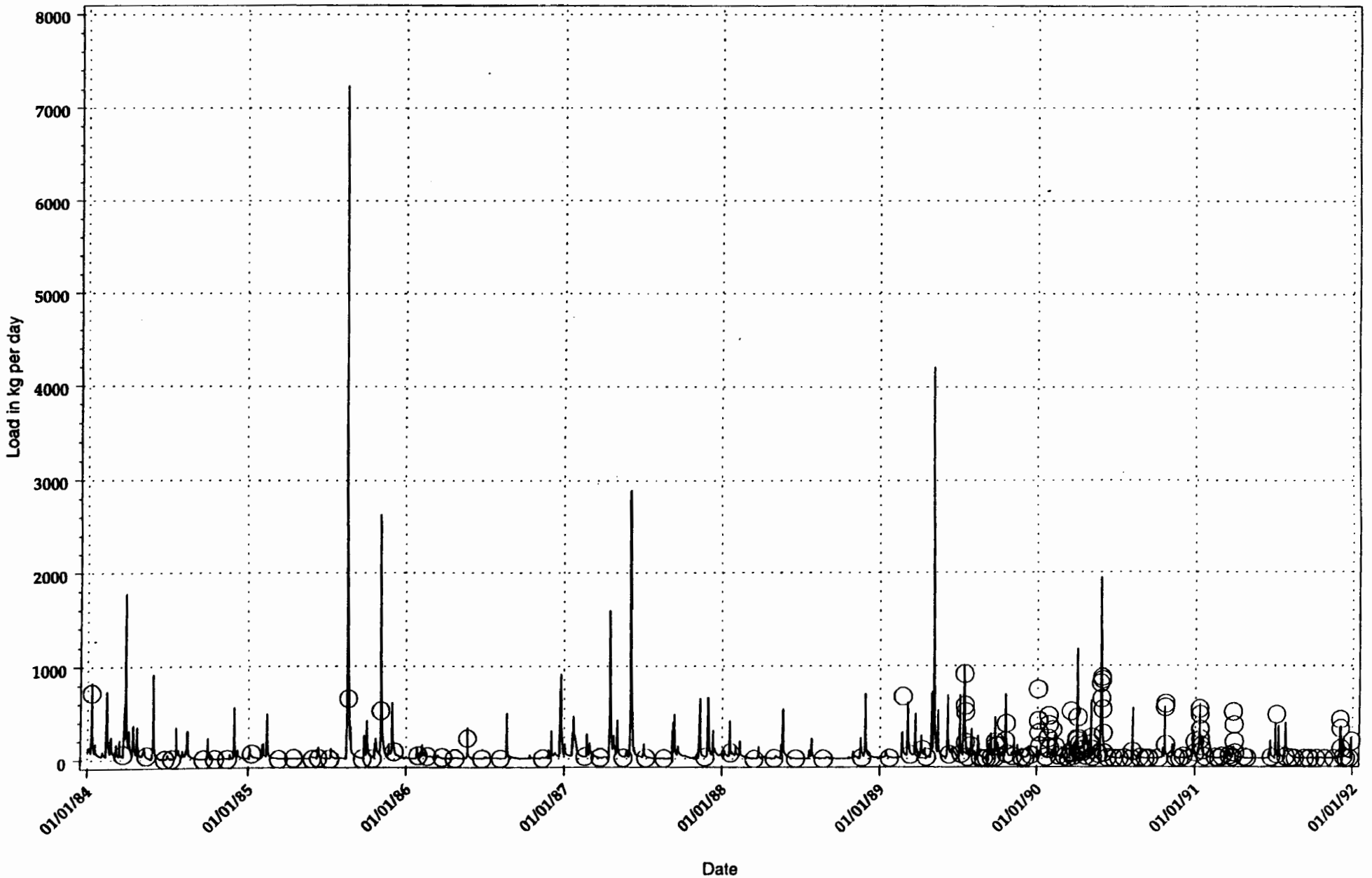


(gr21_plot1.sas datastore2 jrps p3 james.sas| plotsmt - ondmo)
(graph_p.dir 27/AUG/97 14:34)

Pamunkey River at Segment 260

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

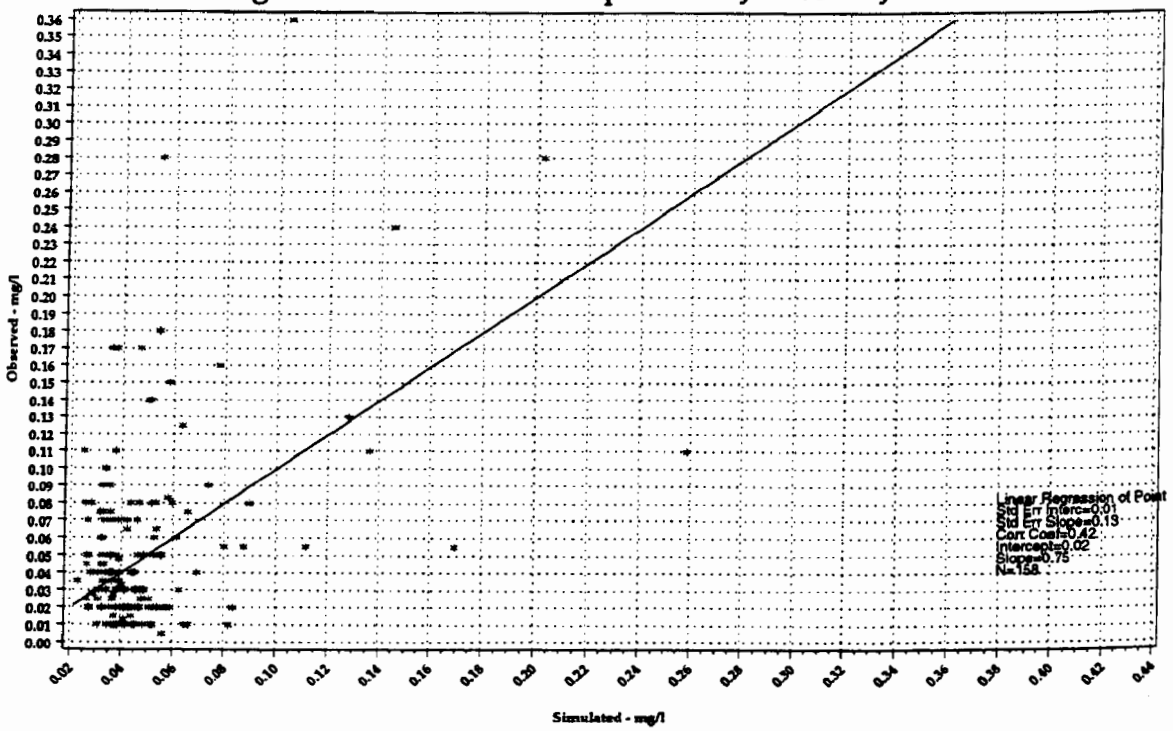


(y21_plot1 sas datasetore2 (nps p3 james sas) 9dflag)
(graph_a drv 27AUG97 16:50.proc reg.model y==)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

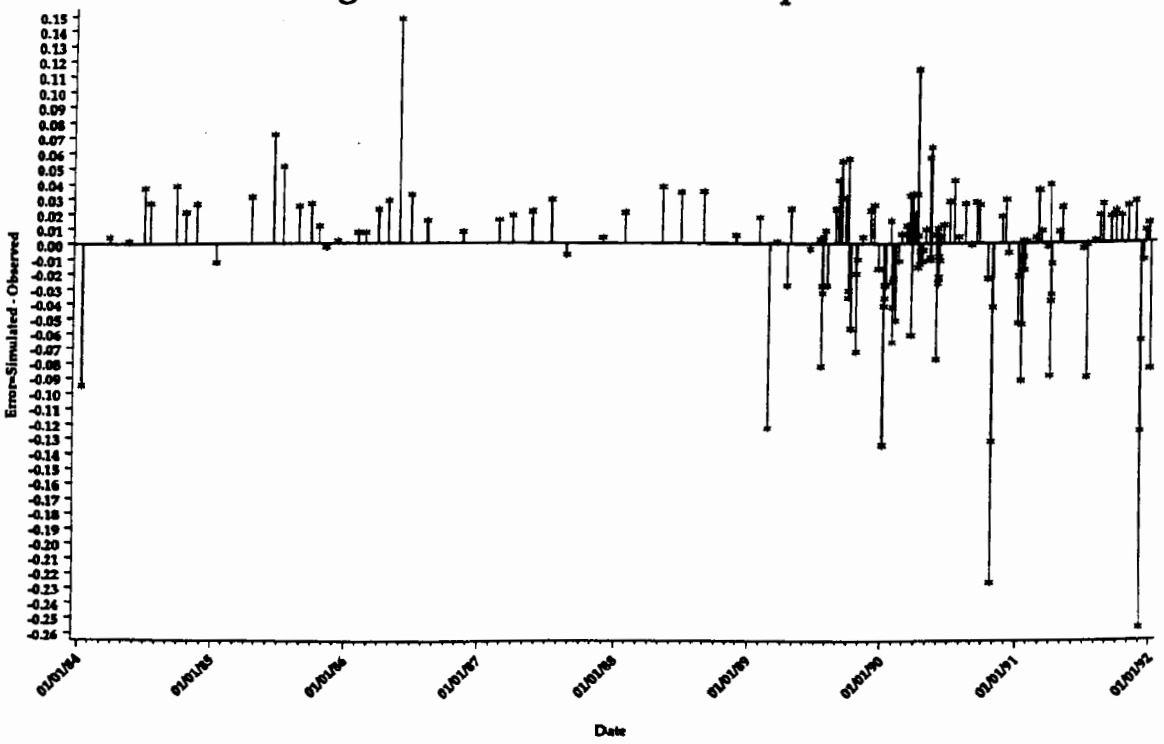
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



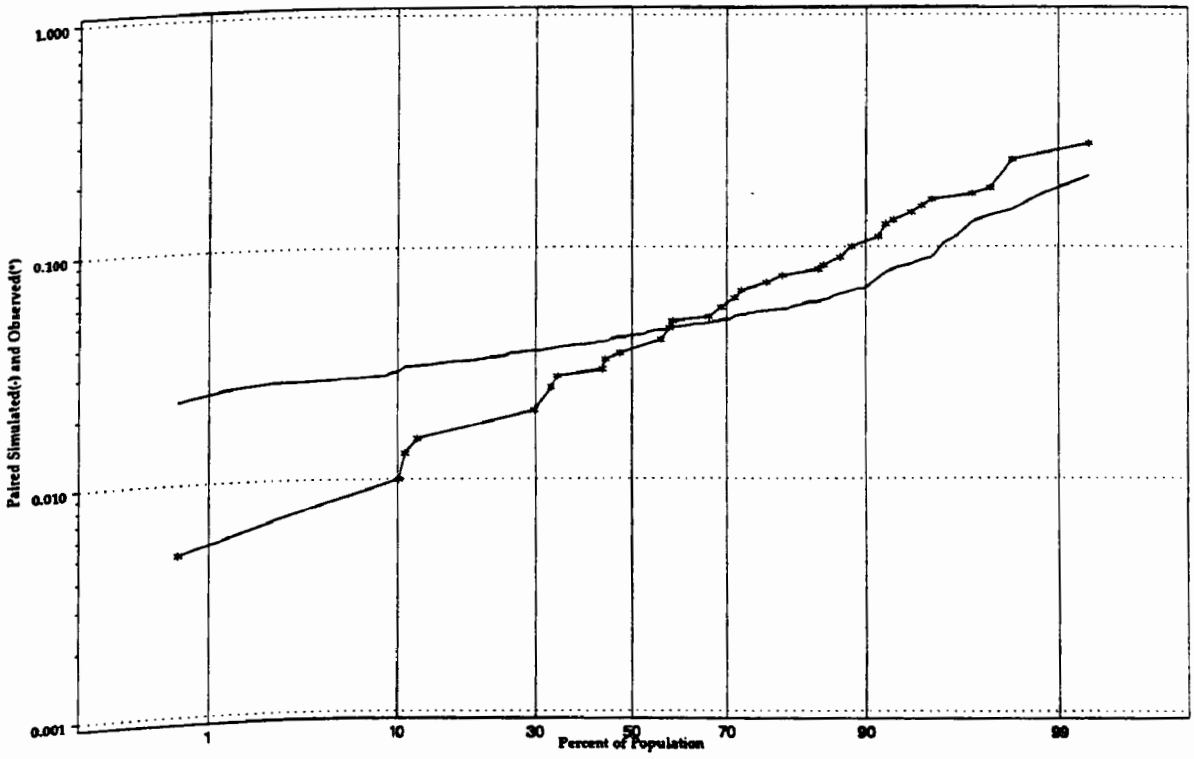
Pamunkey River at Segment 260

Actual Error versus Time

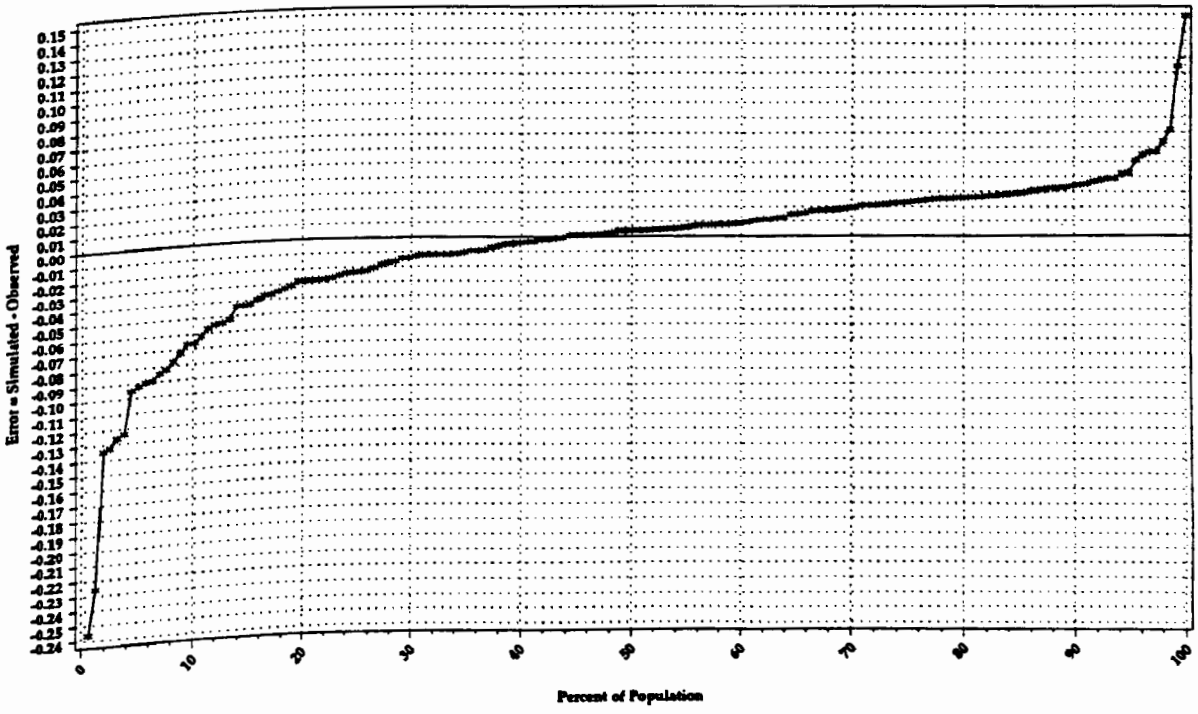
Organic and Particulate Phosphorus



Pamunkey River at Segment 260
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

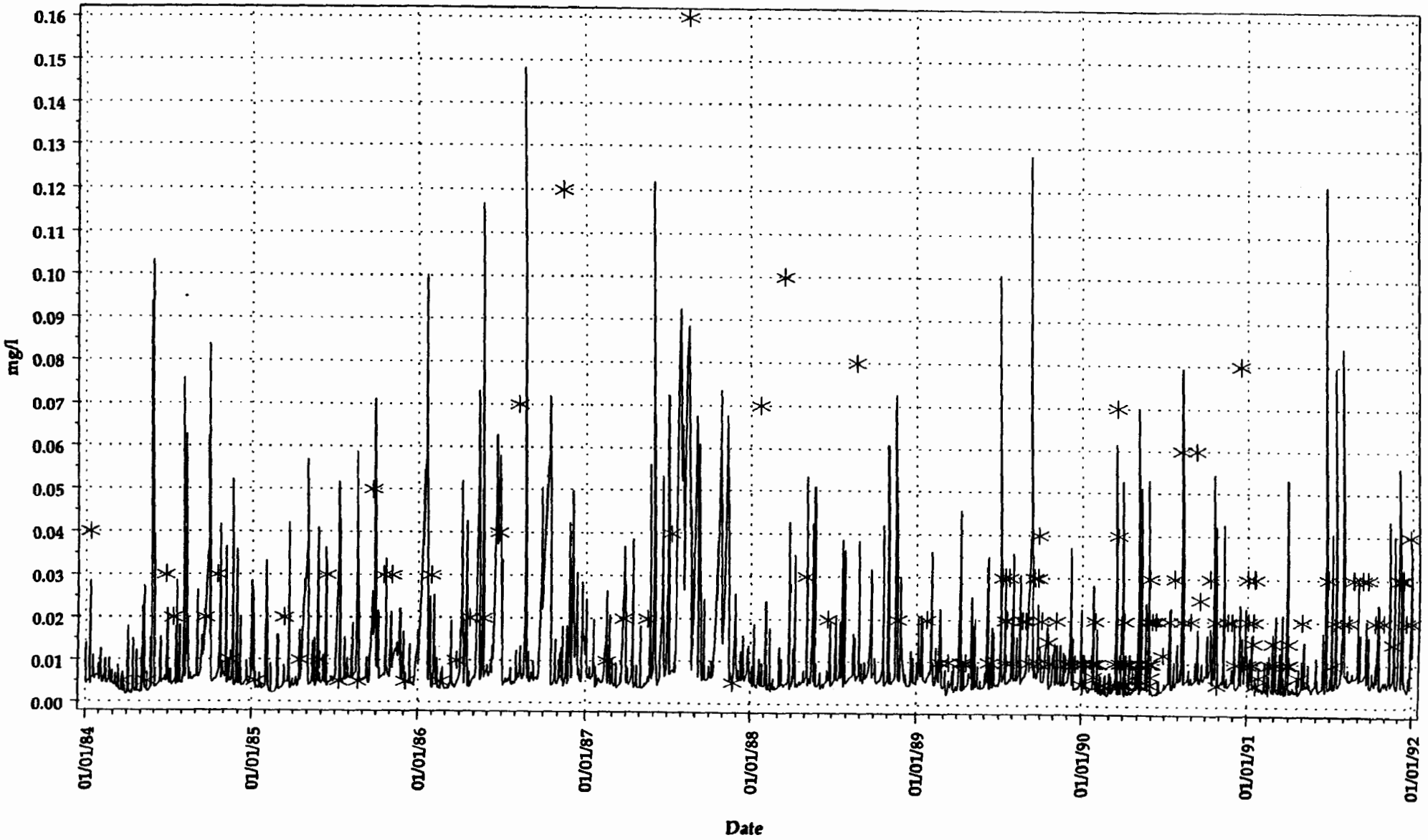


Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data

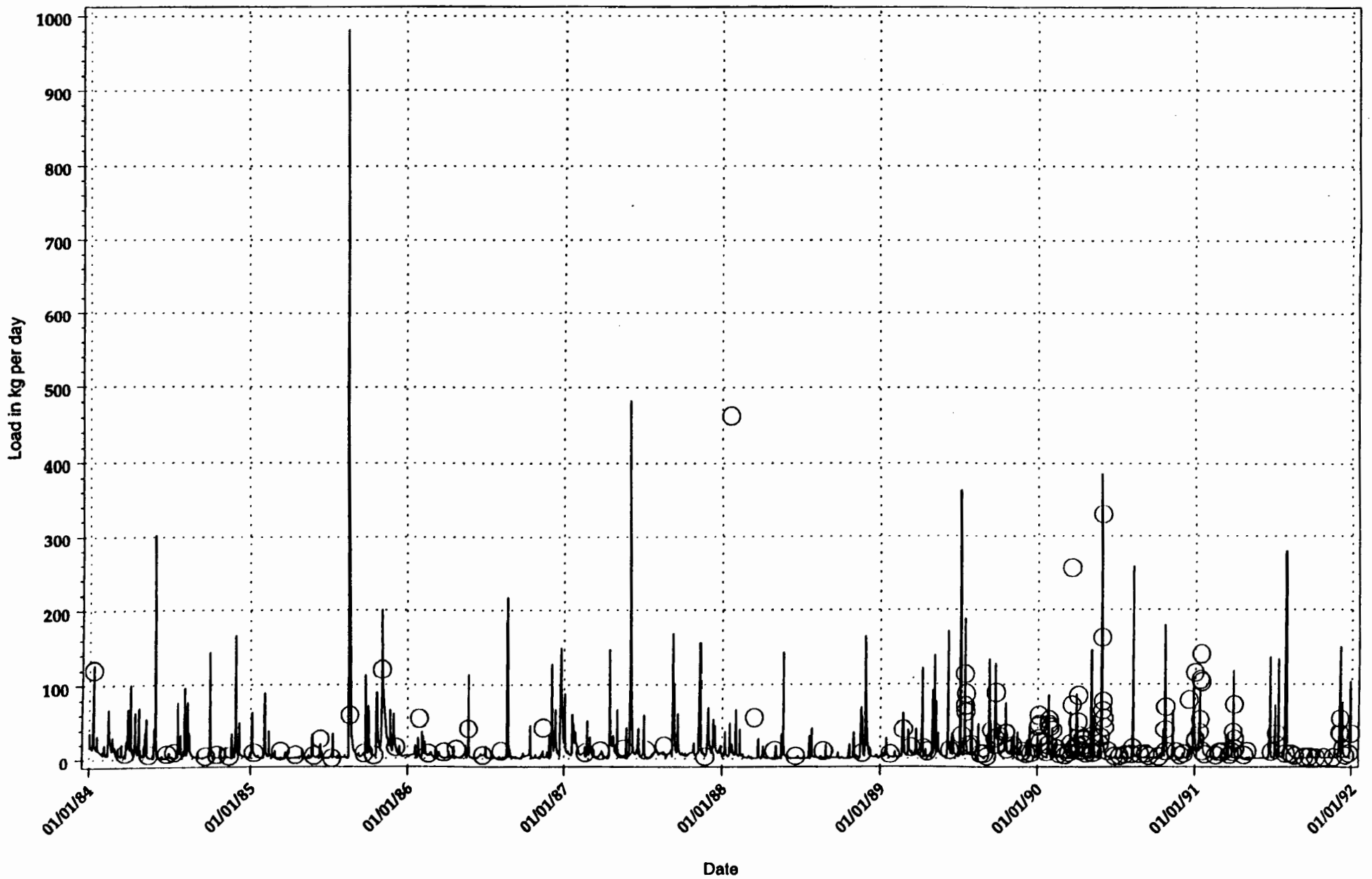


Pamunkey River at Segment 260
Observed and Simulated versus Time
Dissolved Phosphorus

(*=Observed, -=Simulated)



Pamunkey River at Segment 260
Dissolved Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)

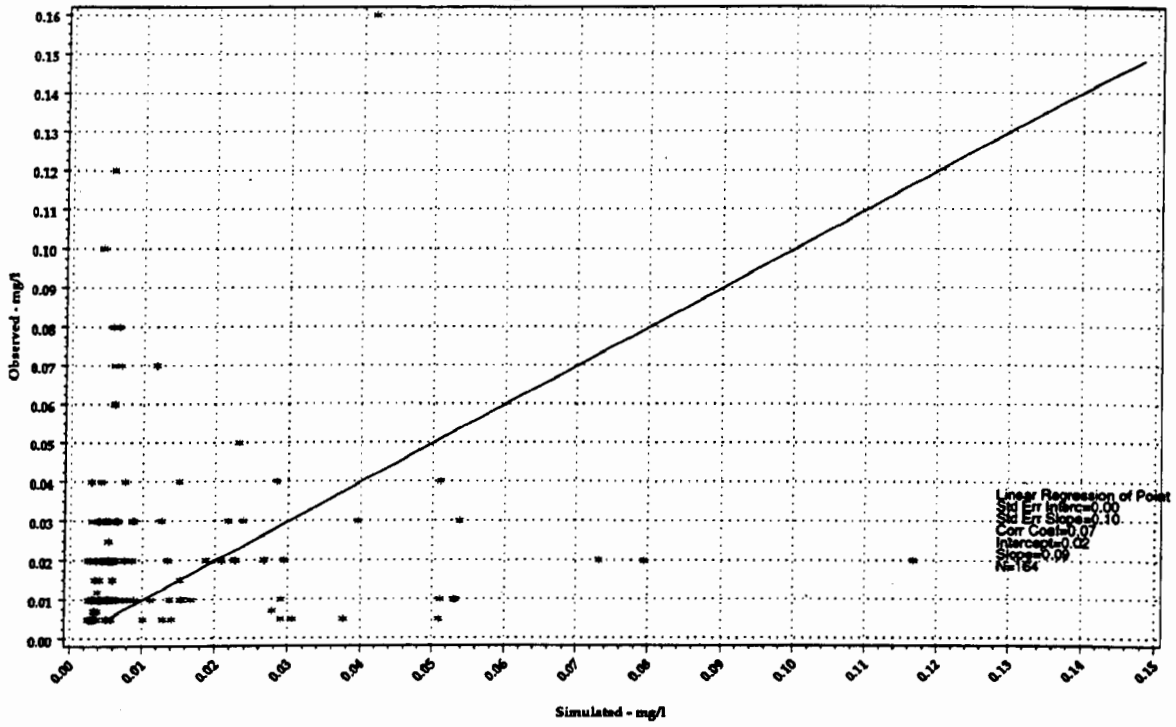


(y21_plot1 sas datastore2 (rps p3 james sas) 5dflod)
(pamun260 dev 03FEB98 14 44,proc reg,model y=x)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

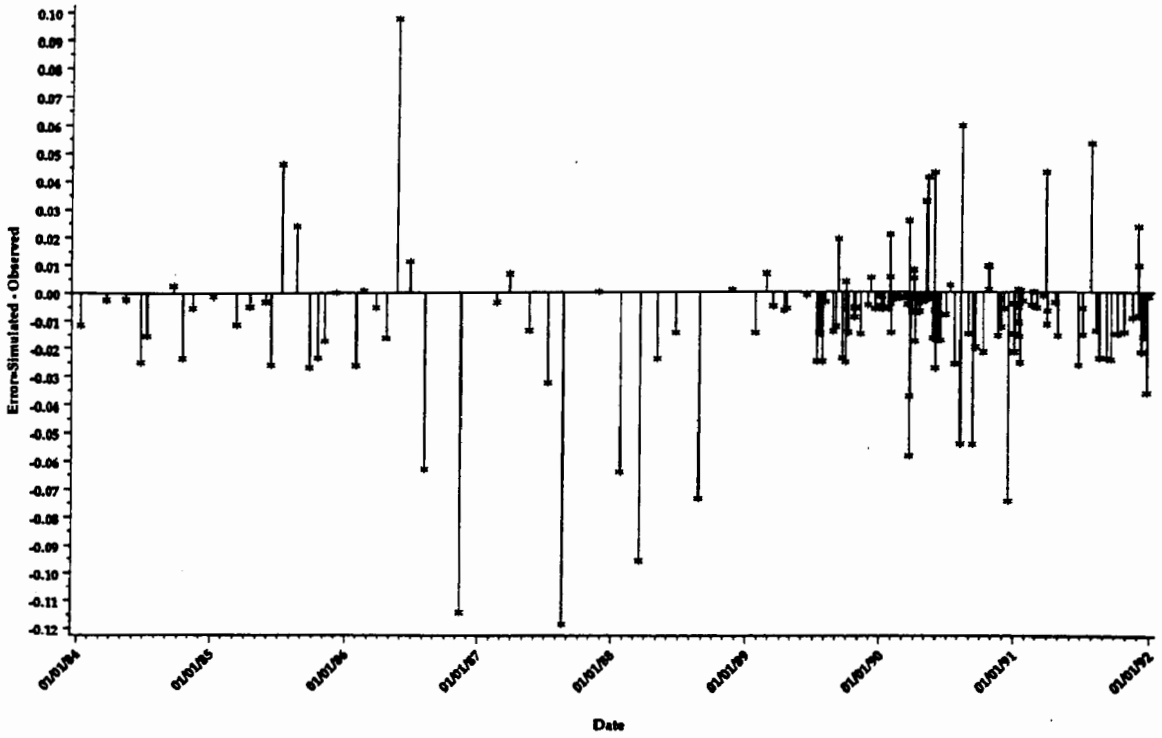
Dissolved Phosphorus: 01JAN84 - 01JAN92



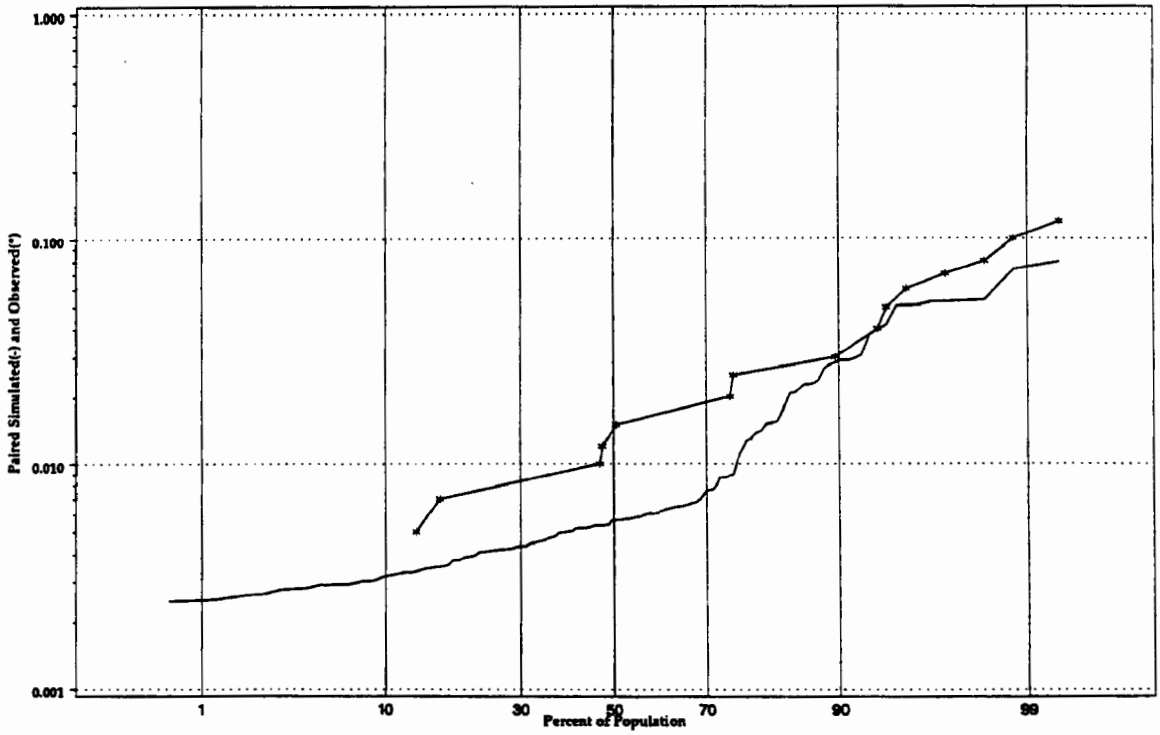
Pamunkey River at Segment 260

Actual Error versus Time

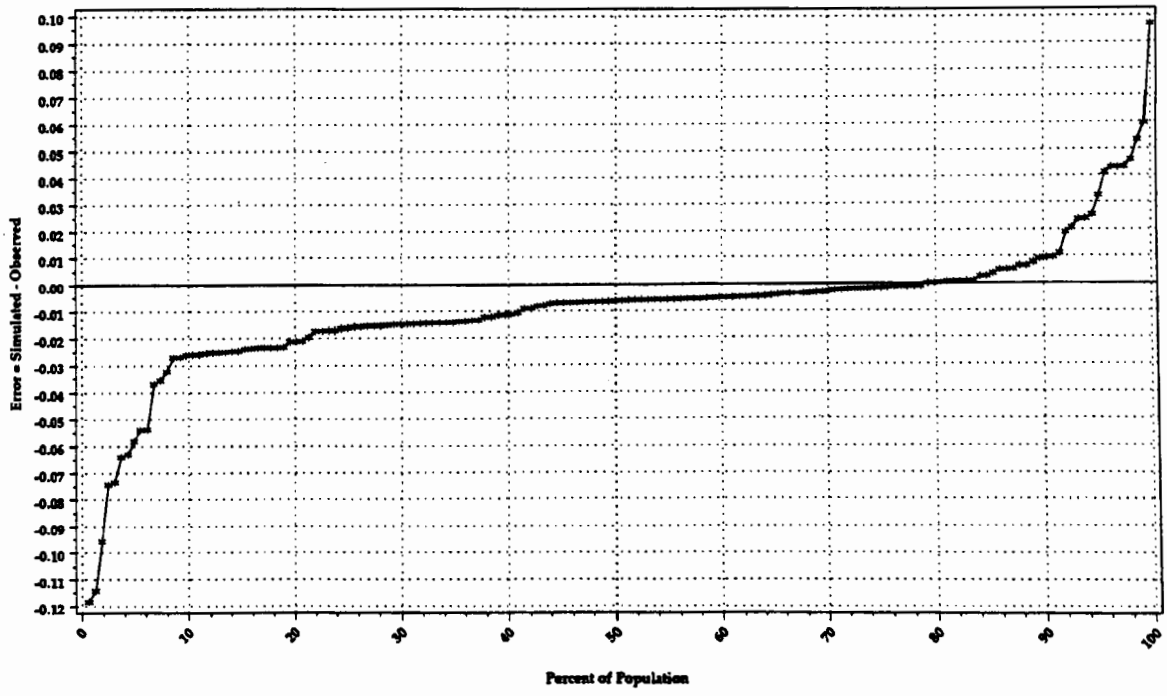
Dissolved Phosphorus



Pamunkey River at Segment 260
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

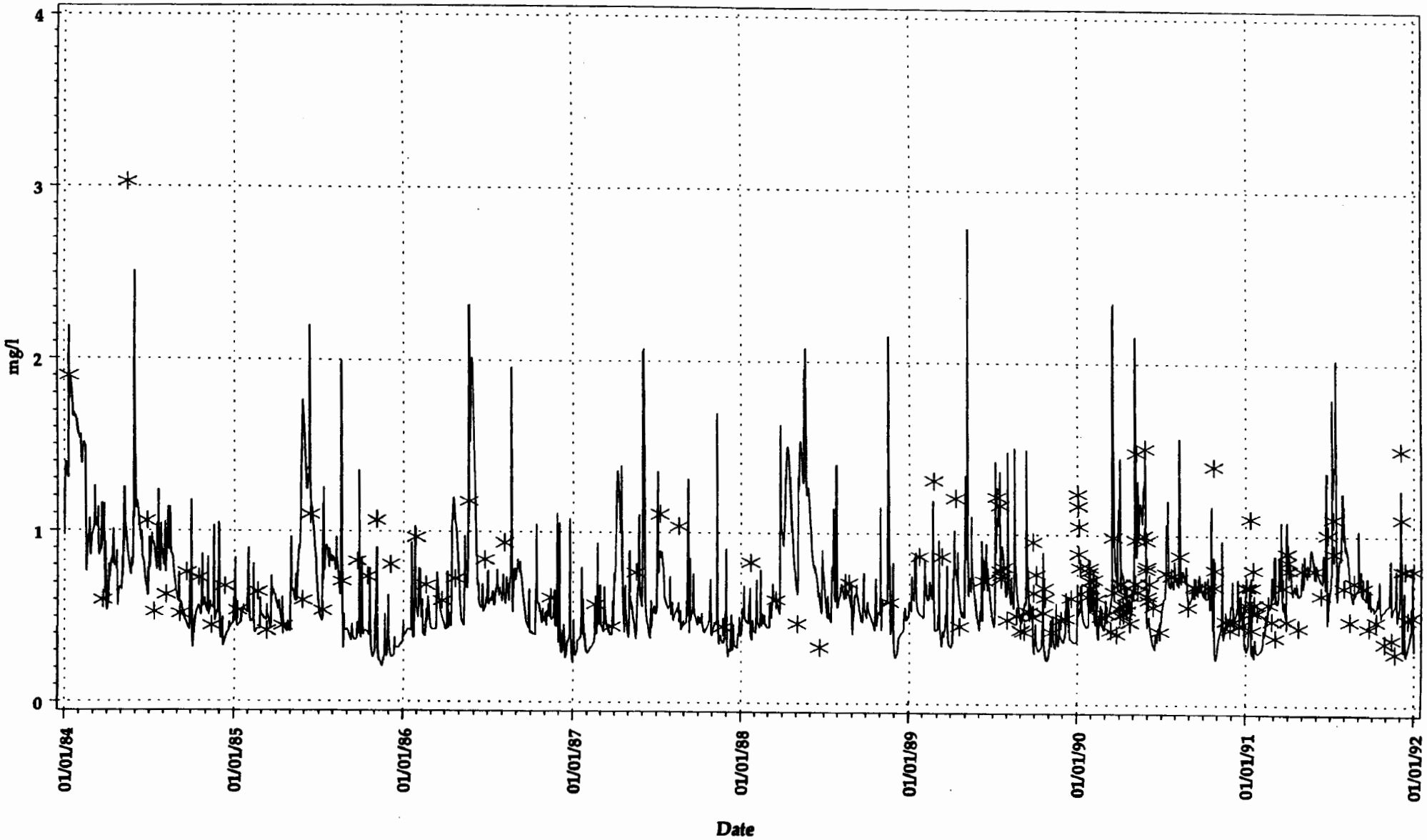


Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data

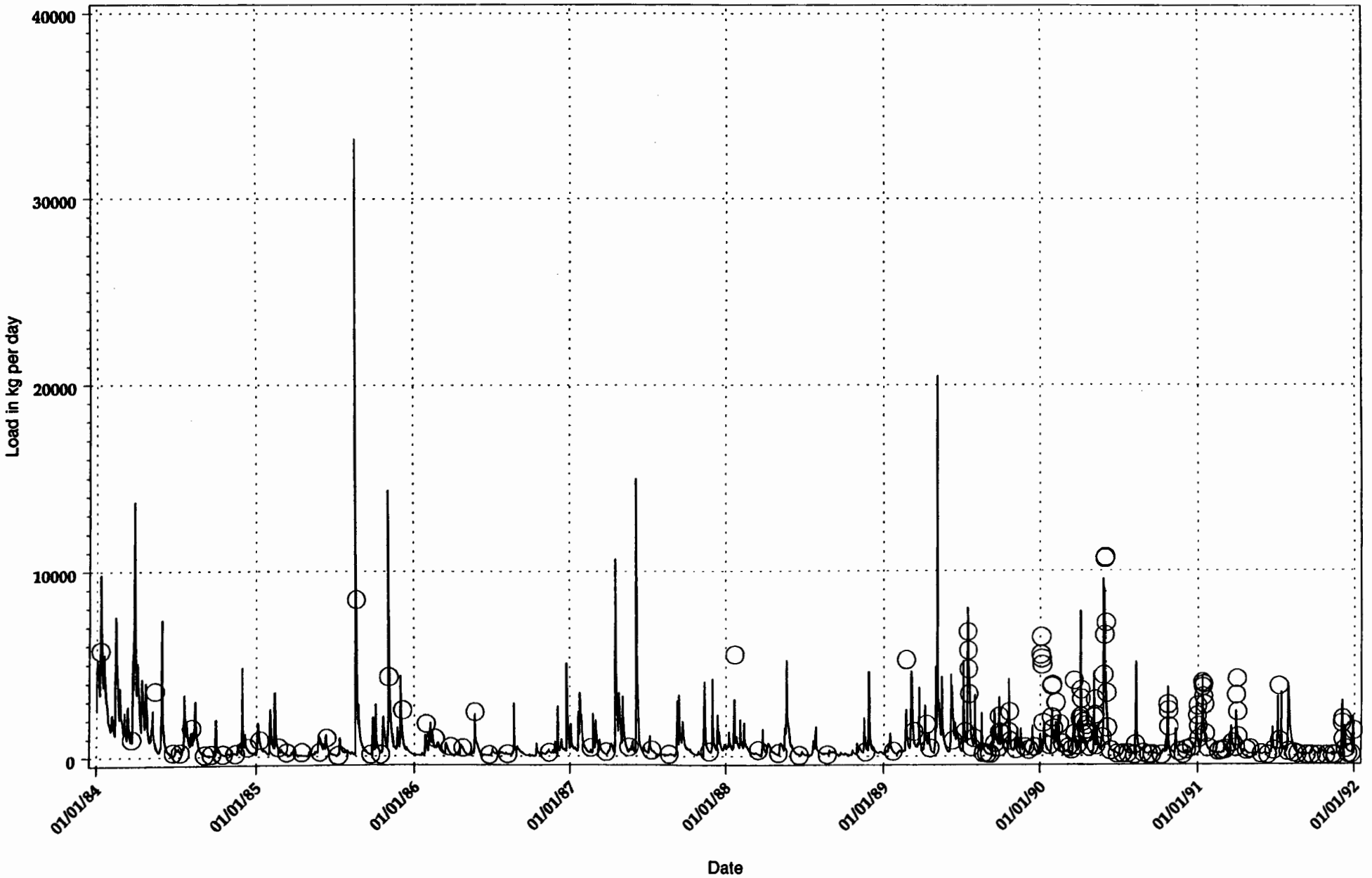


Pamunkey River at Segment 260
Observed and Simulated versus Time
Total Nitrogen

(*=Observed, -=Simulated)



Pamunkey River at Segment 260
Total Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)

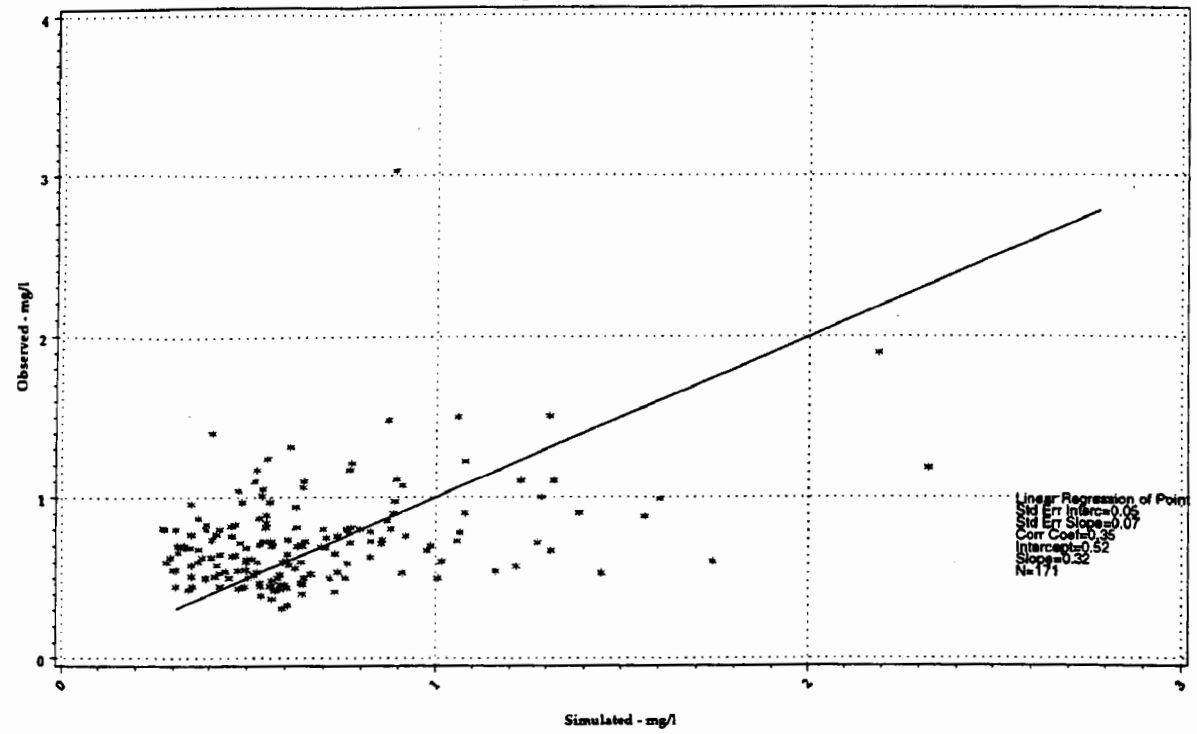


(y21_plotb.sas model3d:[pwang.dl] ldlias)
(pamun260.drv 23FEB96 07:45,proc reg,model y=x)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

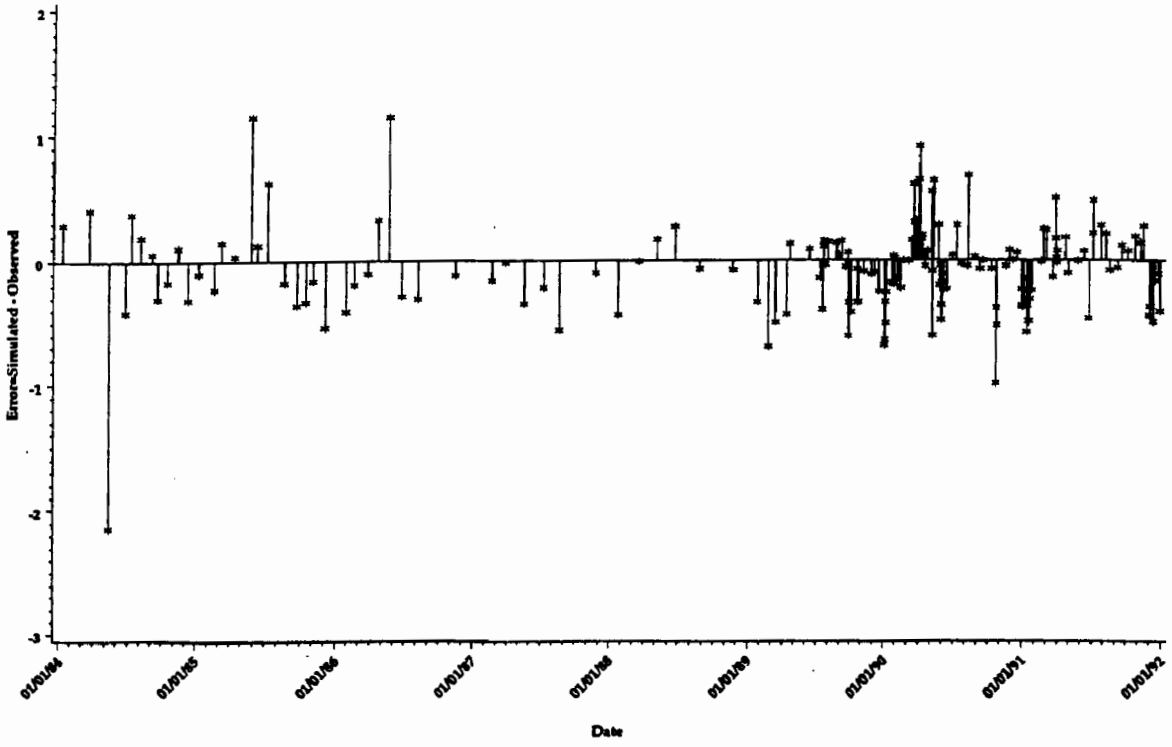
Total Nitrogen: 01JAN84 - 01JAN92



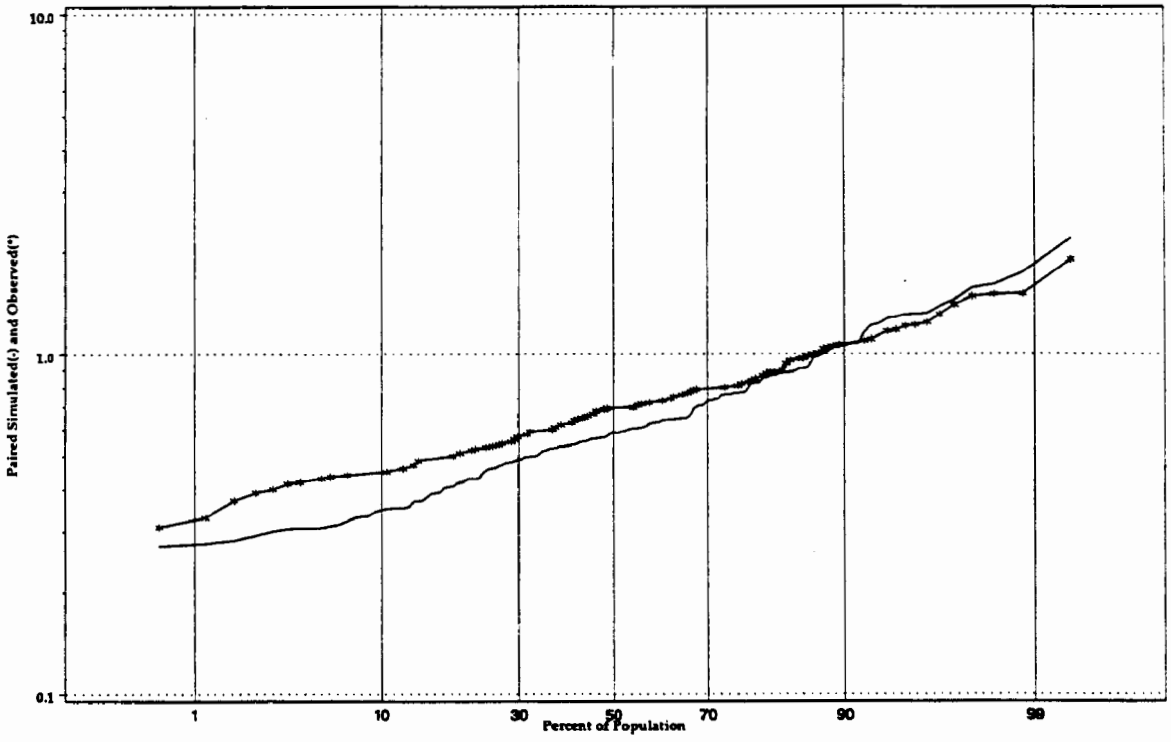
Pamunkey River at Segment 260

Actual Error versus Time

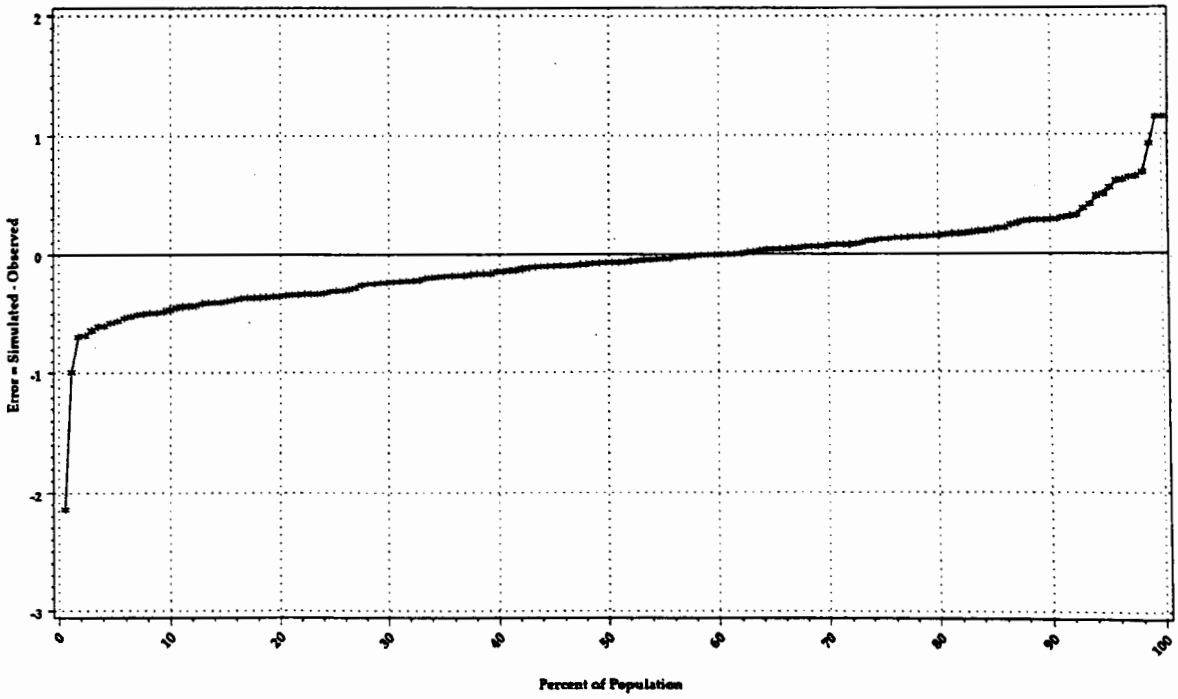
Total Nitrogen



Pamunkey River at Segment 260
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

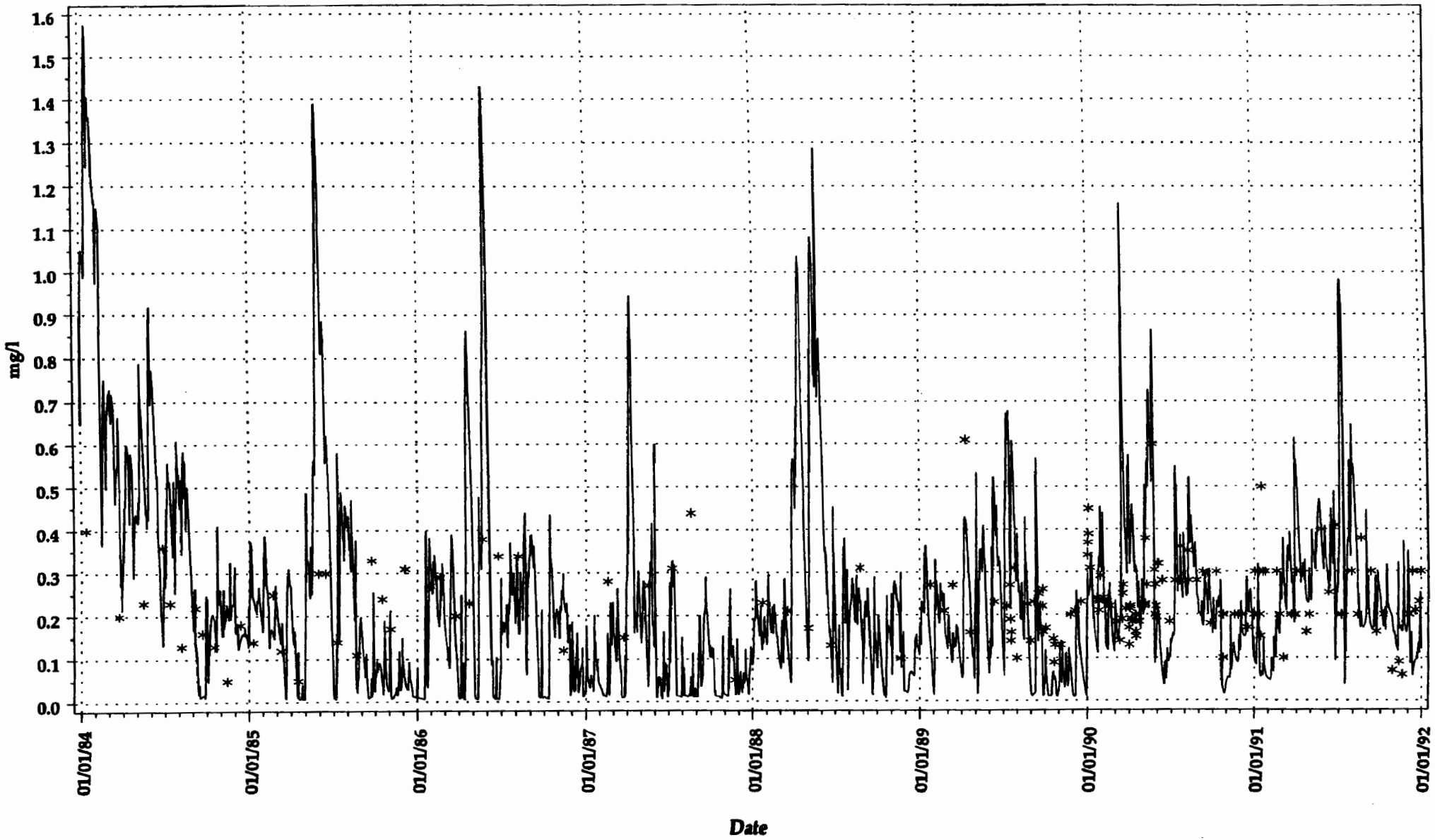


Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data

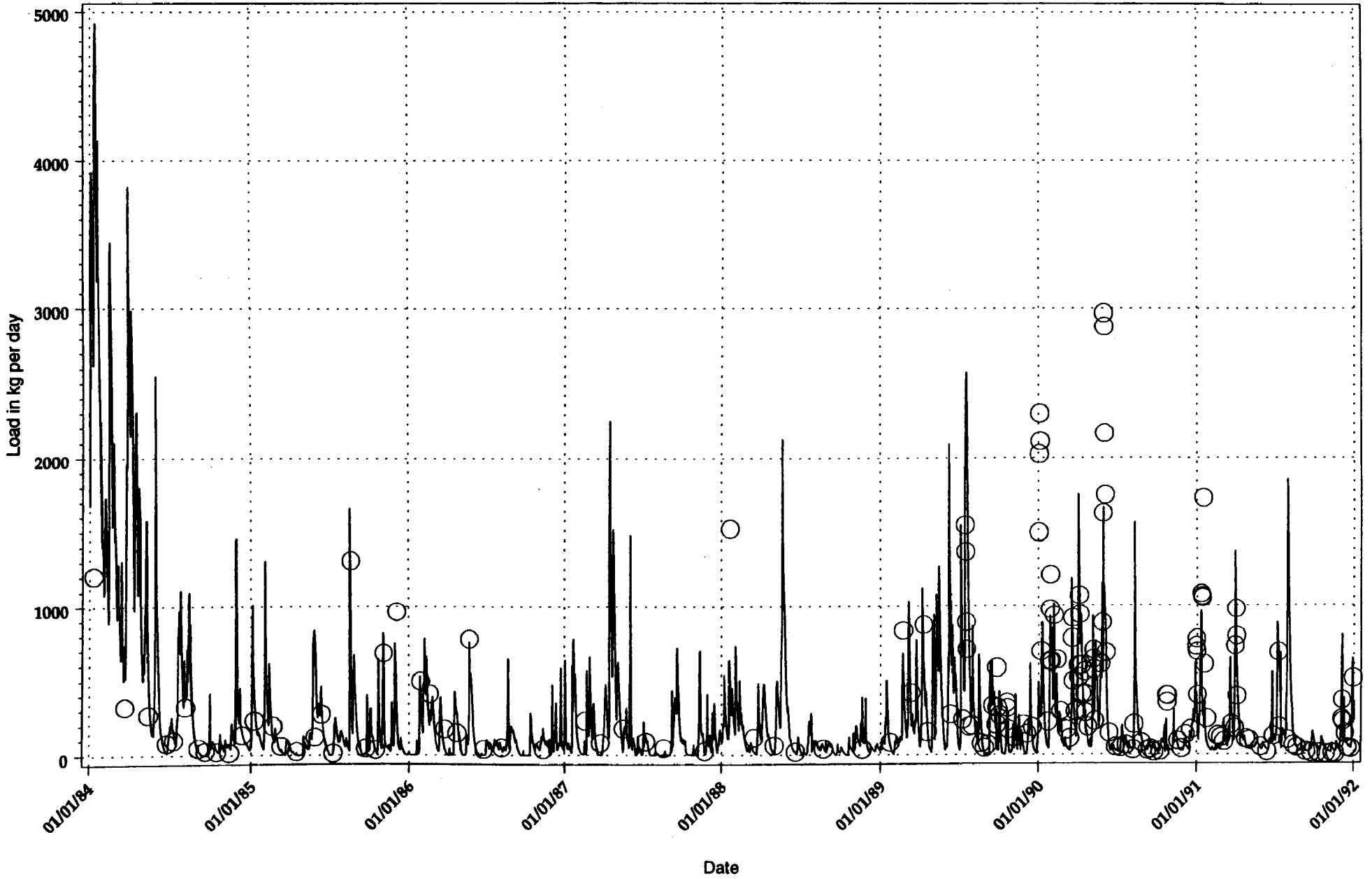


Pamunkey River at Segment 260
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



Pamunkey River at Segment 260
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

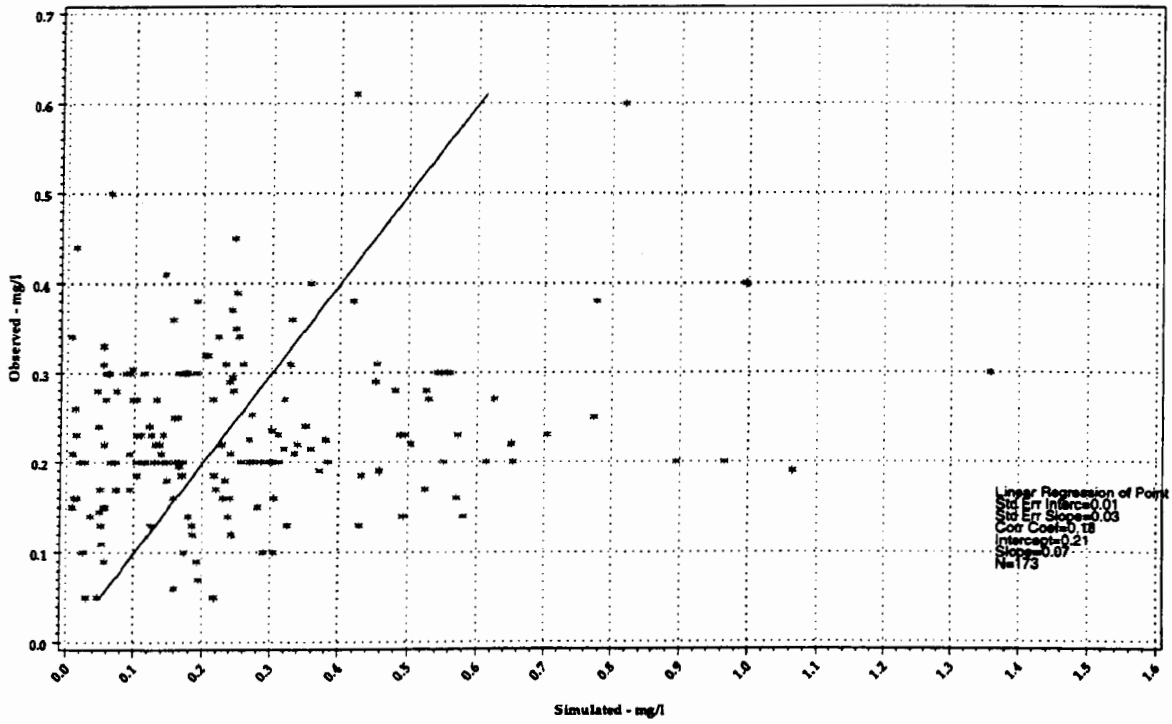


(y21_plotb sas model3d (pwang dl| ldfiles)
(pamun260.drv 23FEB96 07:45,proc reg,model y=x)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

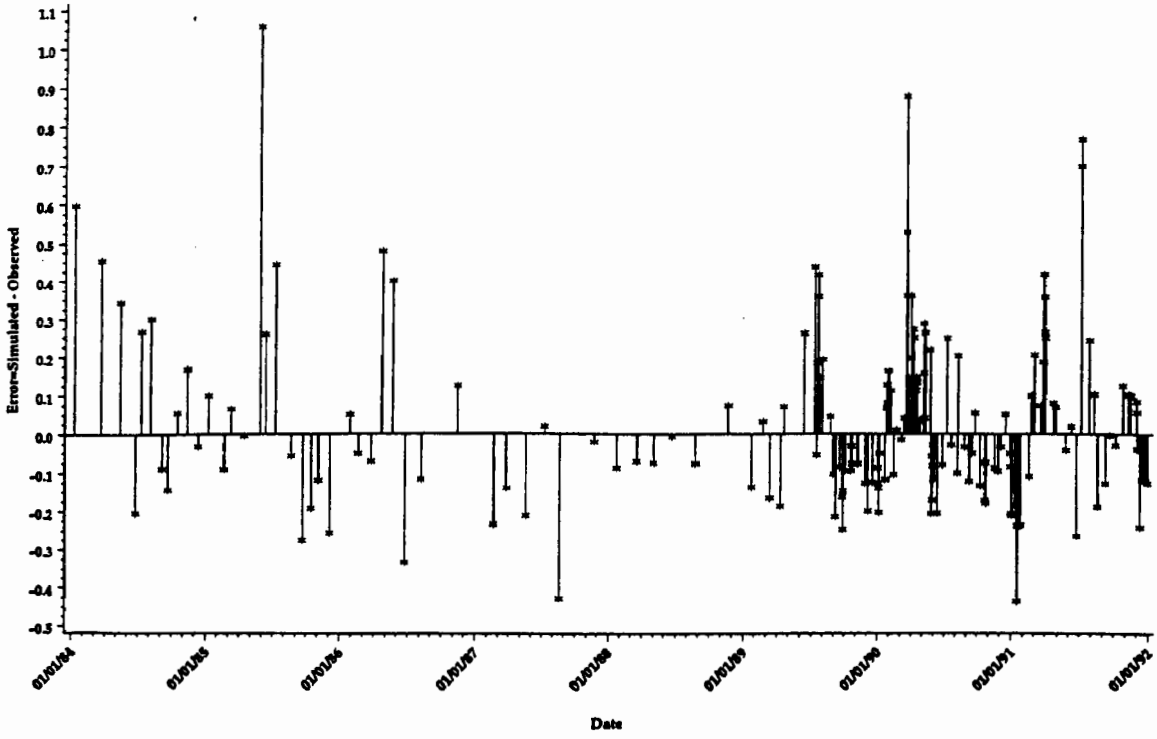
NO3: 01JAN84 - 01JAN92



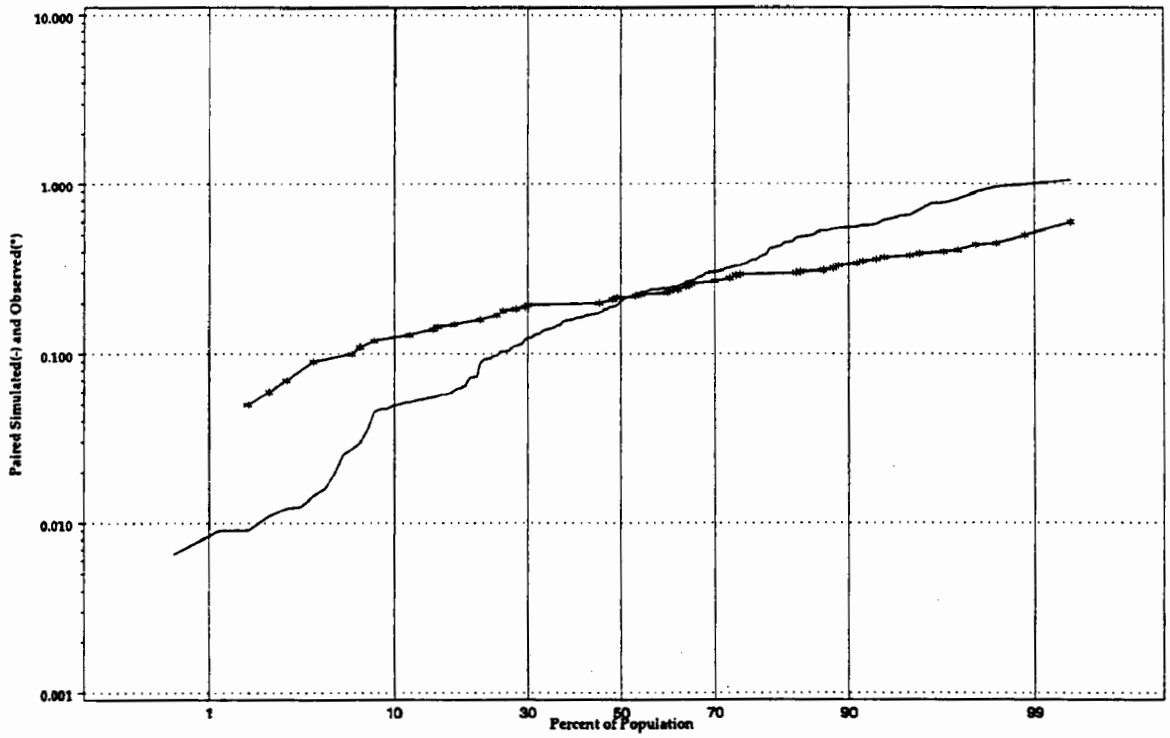
Pamunkey River at Segment 260

Actual Error versus Time

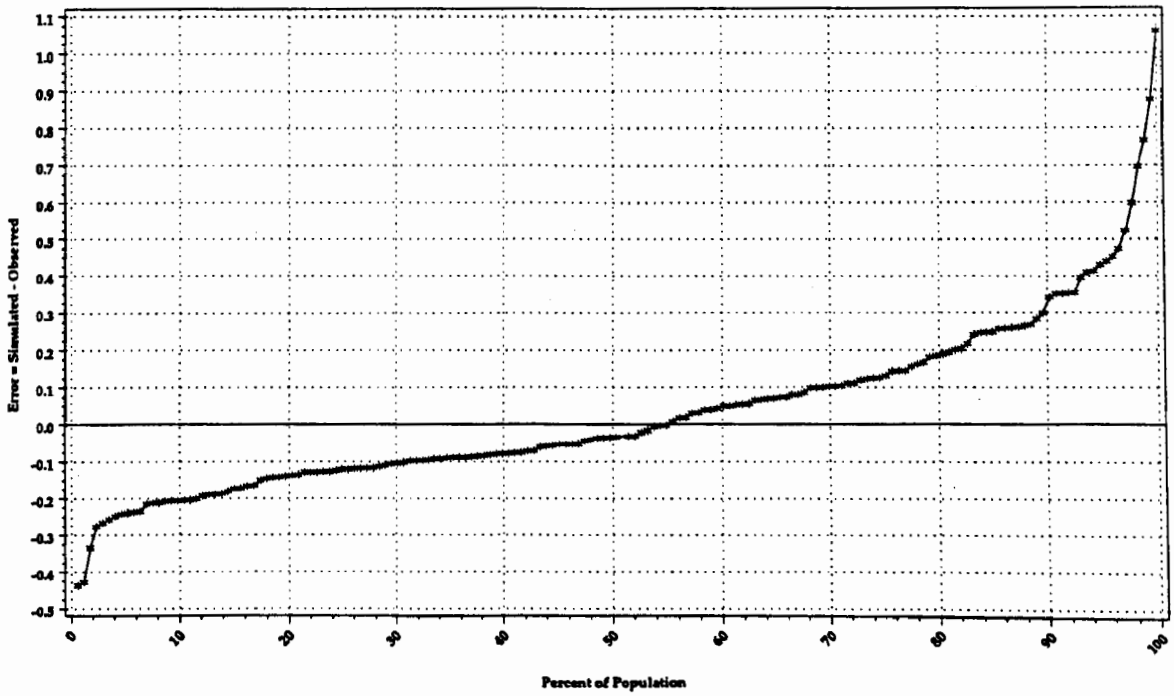
NO3



Pamunkey River at Segment 260
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

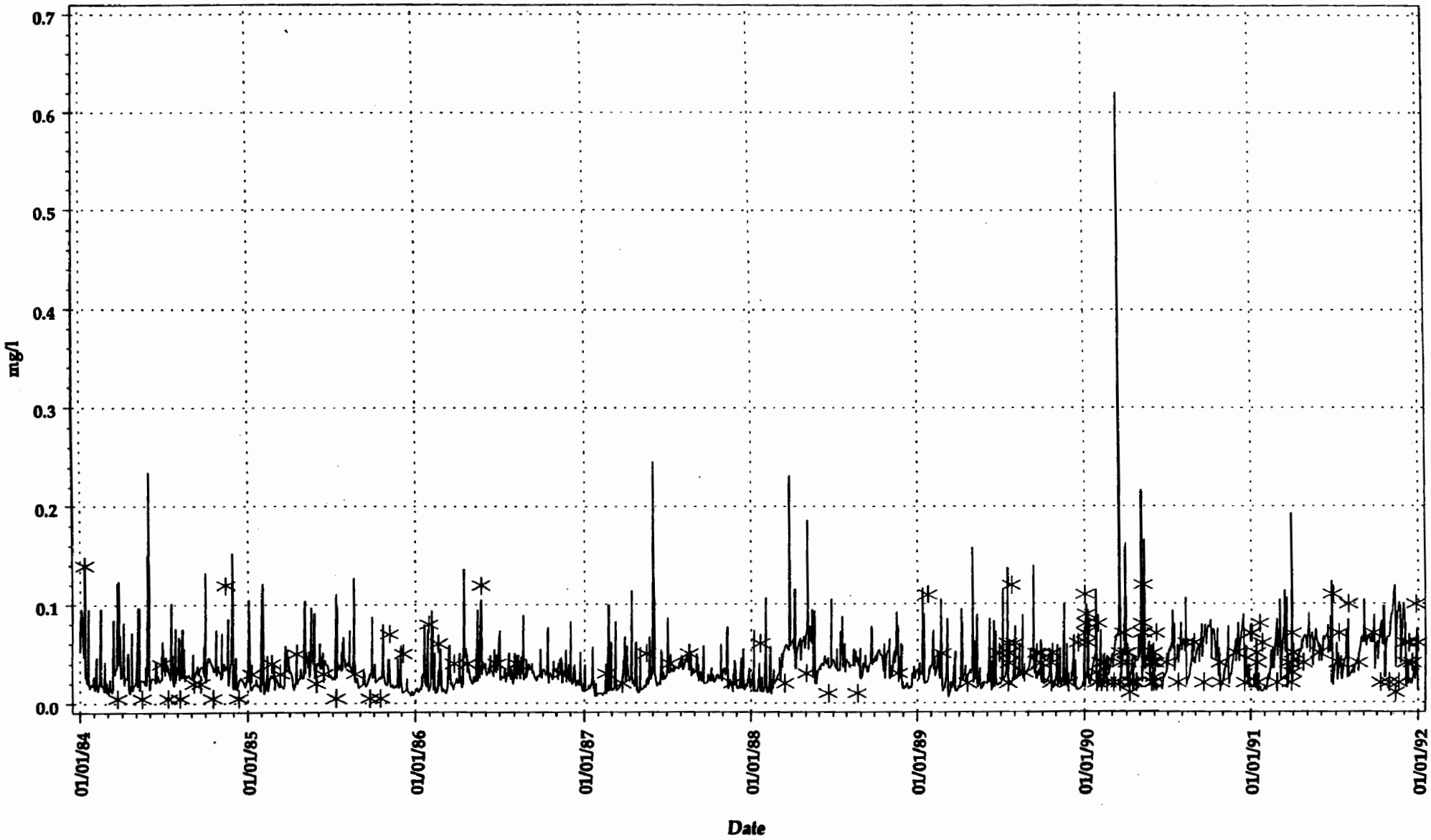


Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data



Pamunkey River at Segment 260
Observed and Simulated versus Time
Total Ammonia

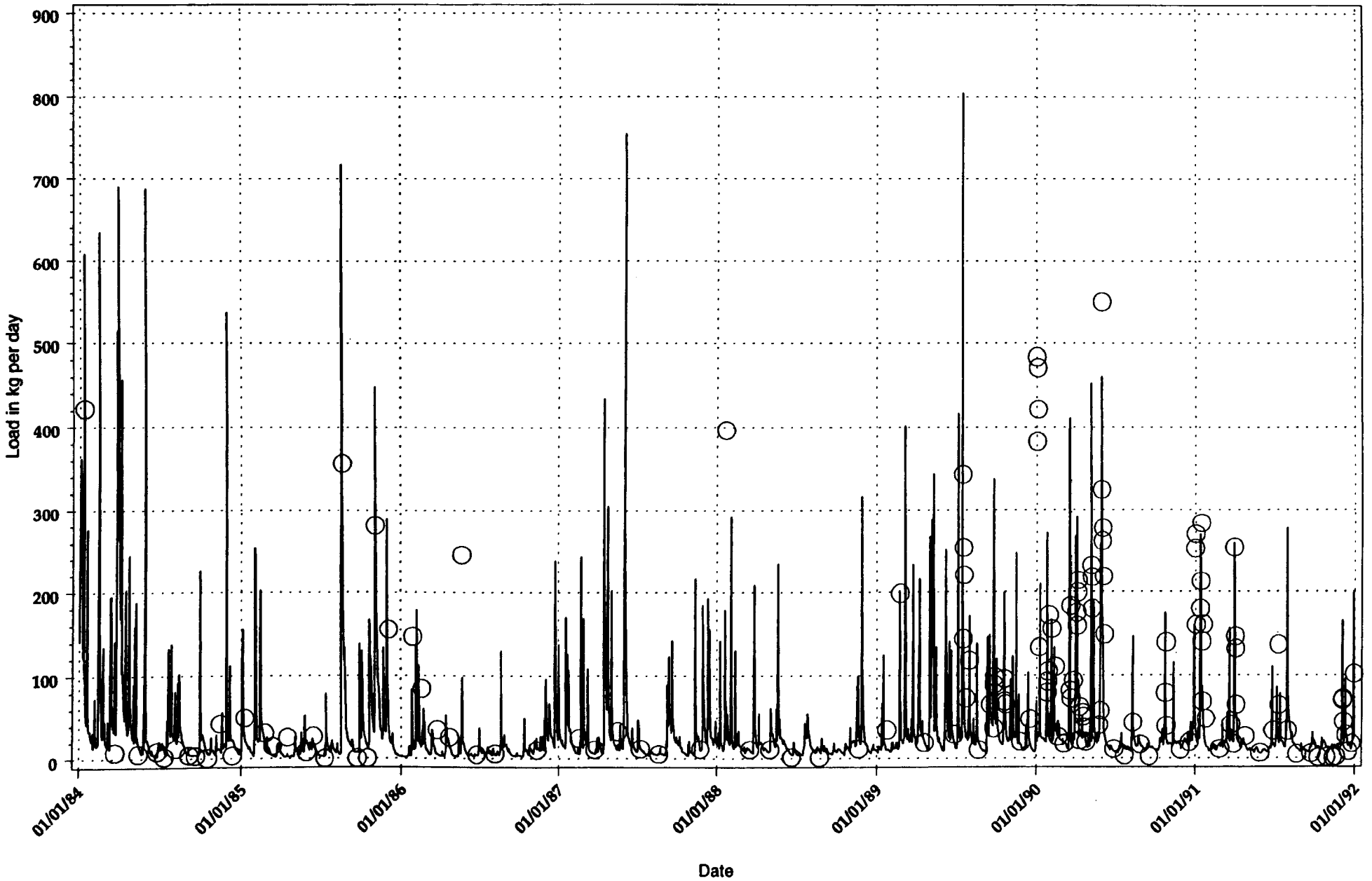
(*=Observed, -=Simulated)



Pamunkey River at Segment 260

Total Ammonia Observed and Simulated Load vs Time

(line = simulated, O = observed)

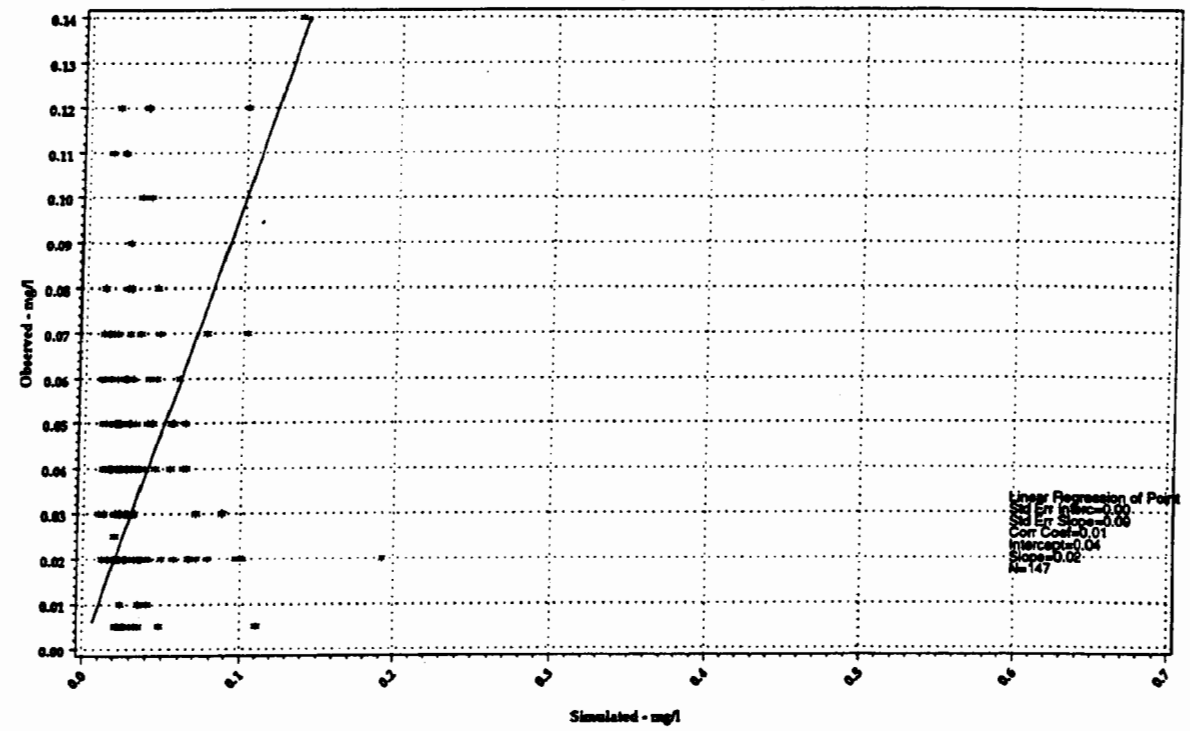


(y21_plotb.sas model3d (pwang.dl) lidlee)
(pamur260.drv 23FEB96 07:48 proc reg model y=x)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

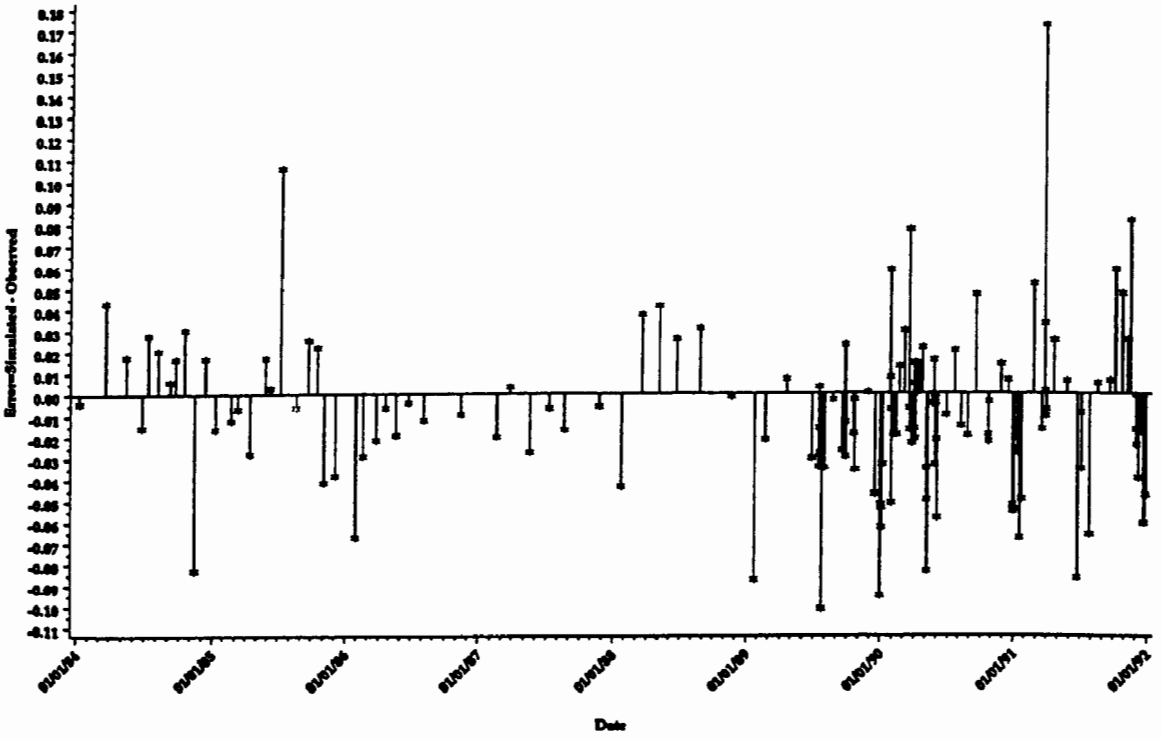
Total Ammonia: 01JAN84 - 01JAN92



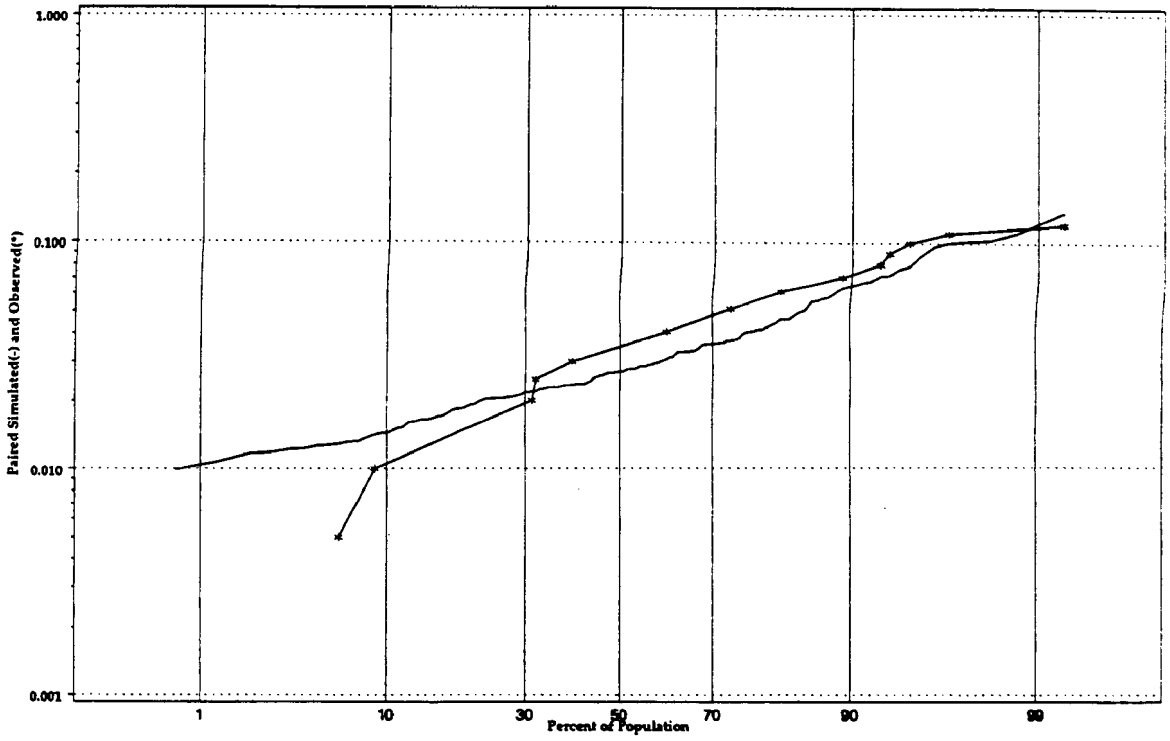
Pamunkey River at Segment 260

Actual Error versus Time

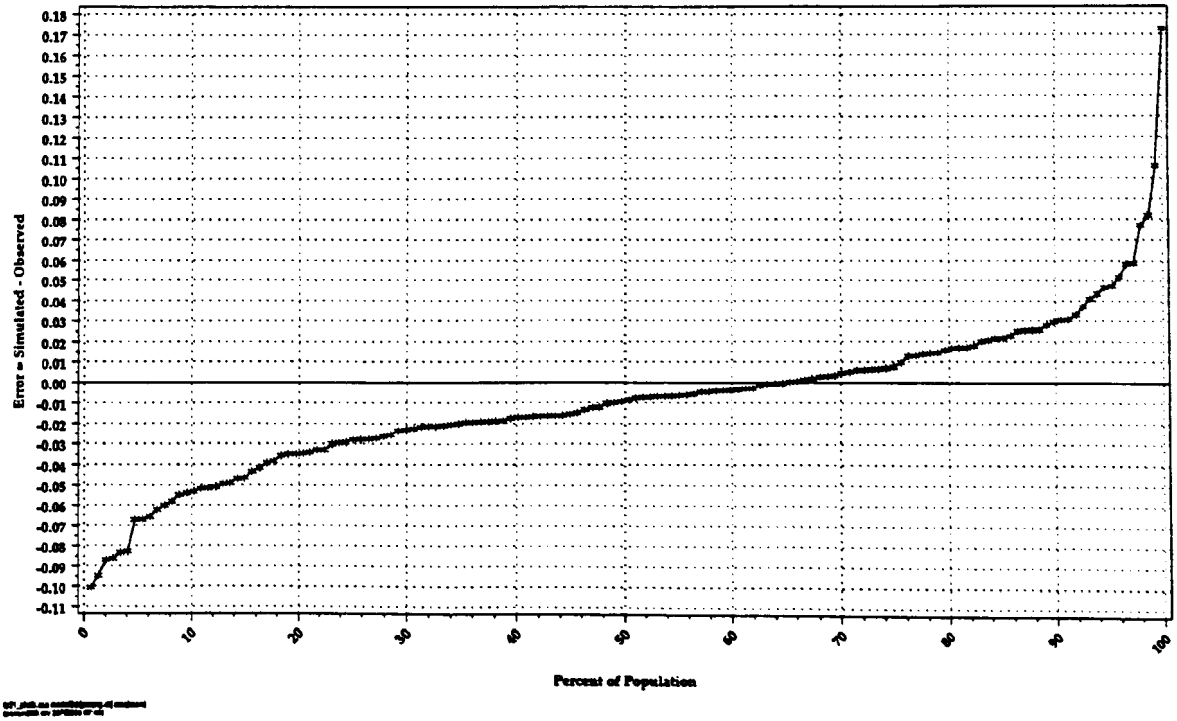
Total Ammonia



Pamunkey River at Segment 260
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data

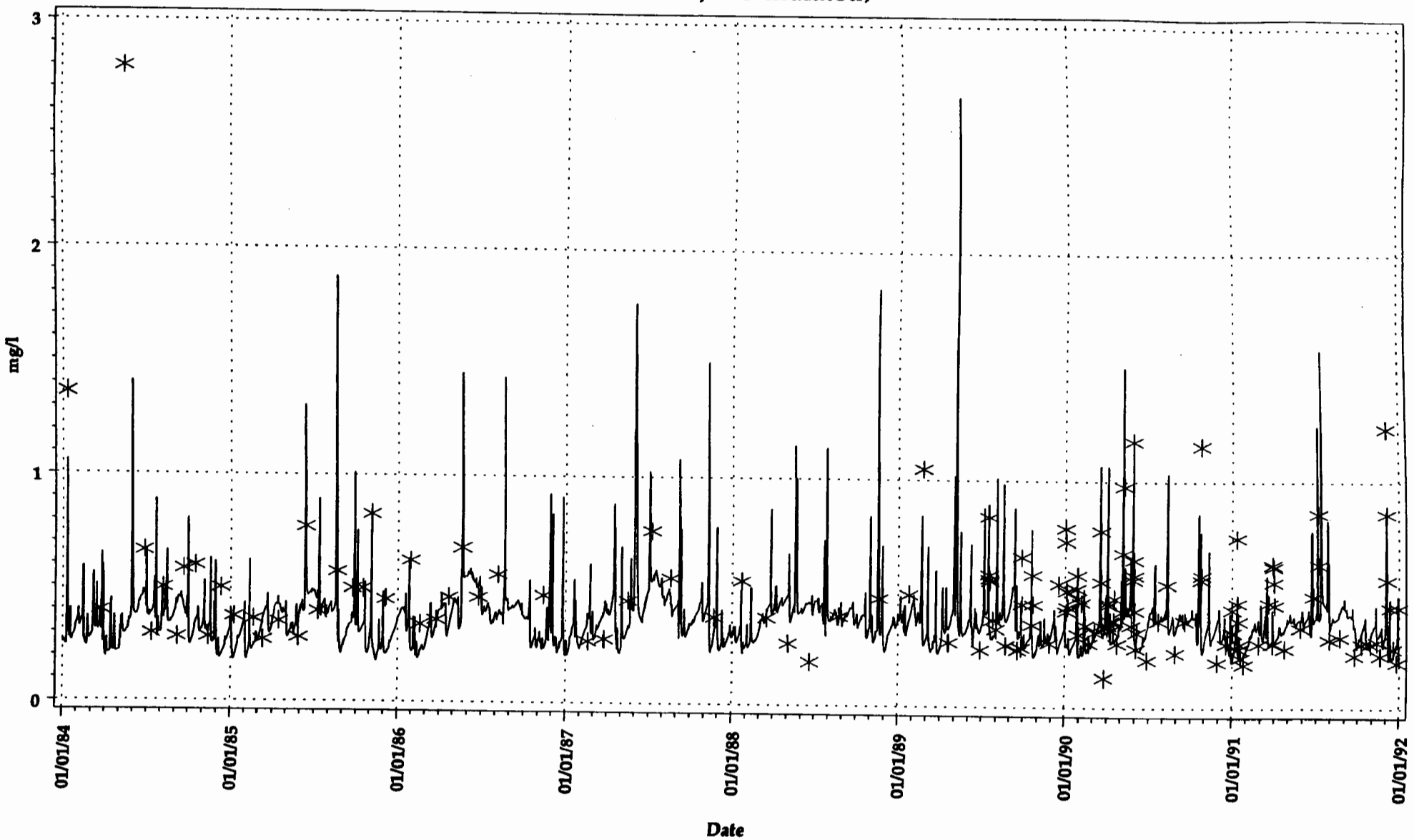


Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



Pamunkey River at Segment 260
Observed and Simulated versus Time
Organic Nitrogen

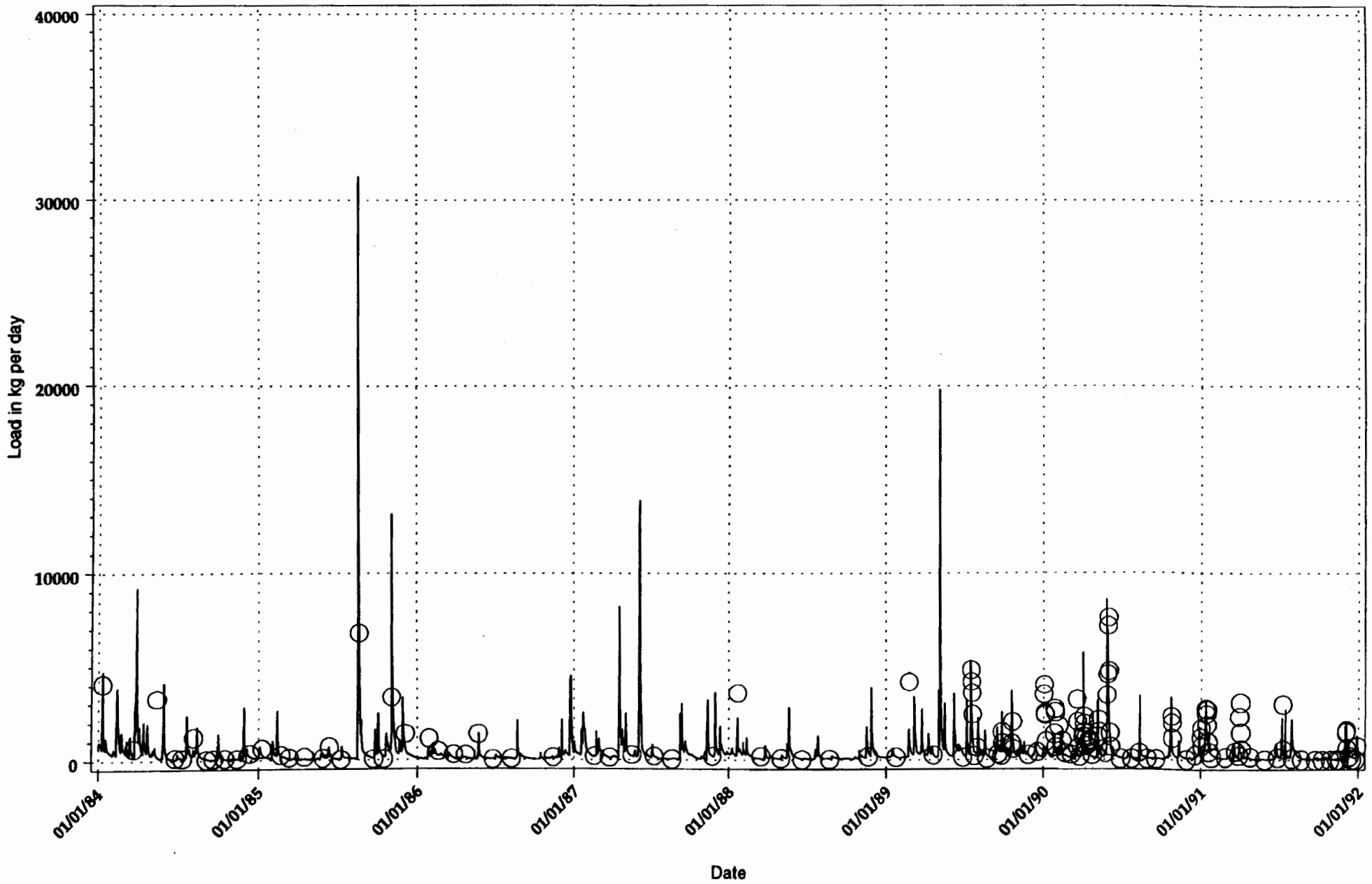
(*=Observed, -=Simulated)



Pamunkey River at Segment 260

Organic Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)

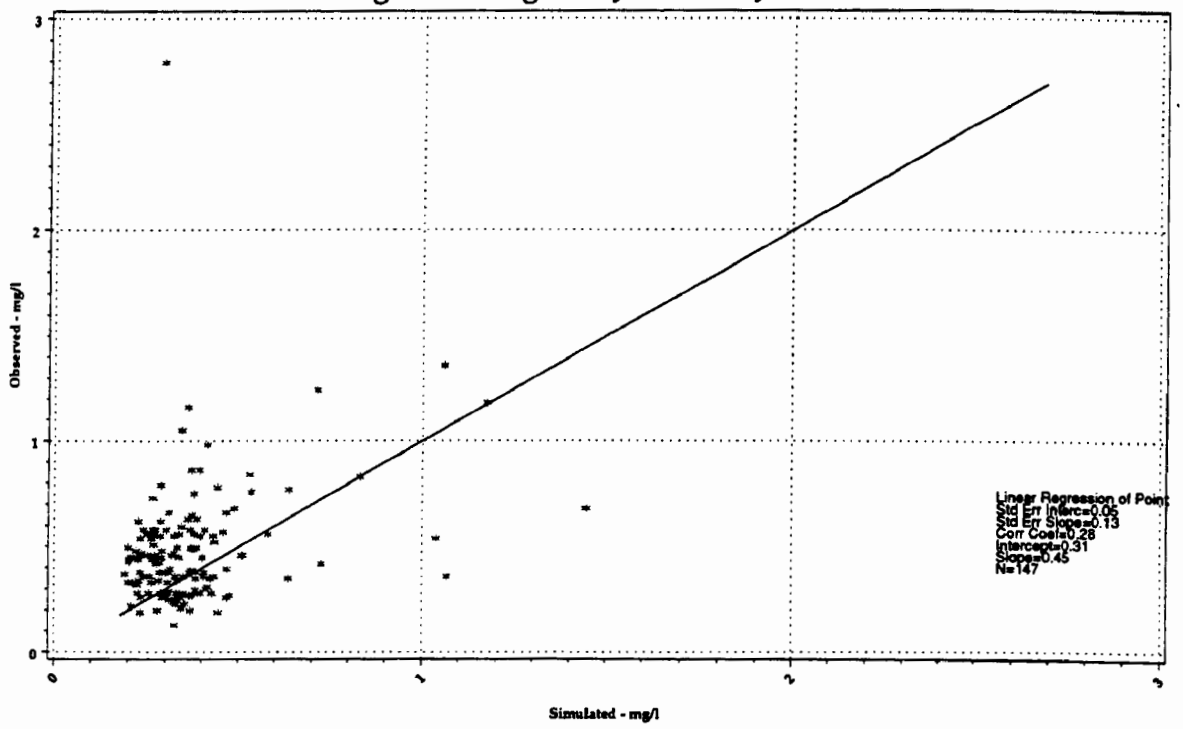


(y21_plotb.sas model3d[pwang.dt] lidlles)
(pamun260.drv 23FEB96 07:46 proc reg model y=x)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

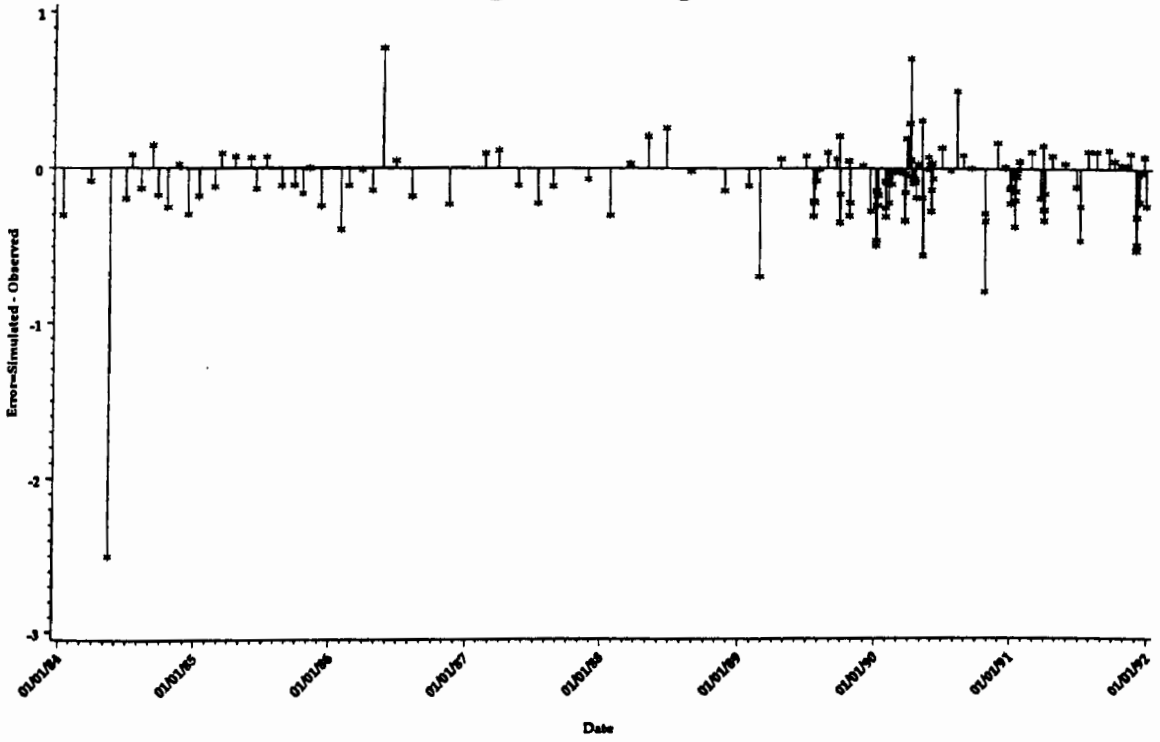
Organic Nitrogen: 01JAN84 - 01JAN92



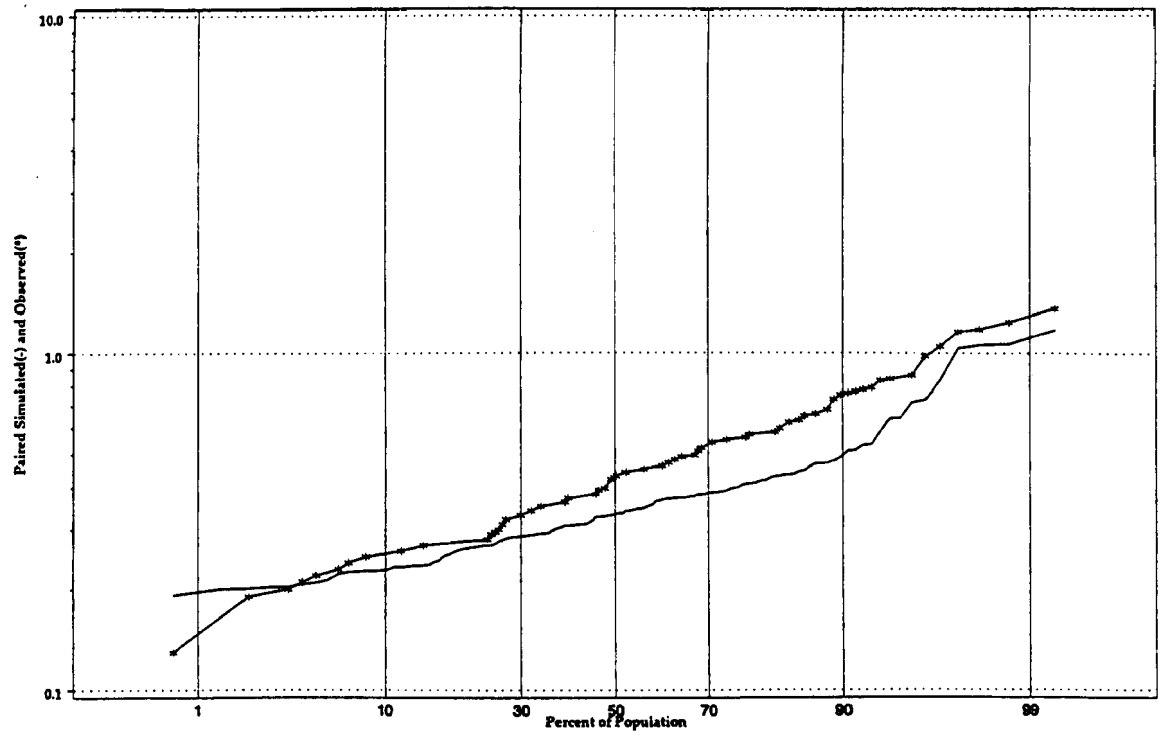
Pamunkey River at Segment 260

Actual Error versus Time

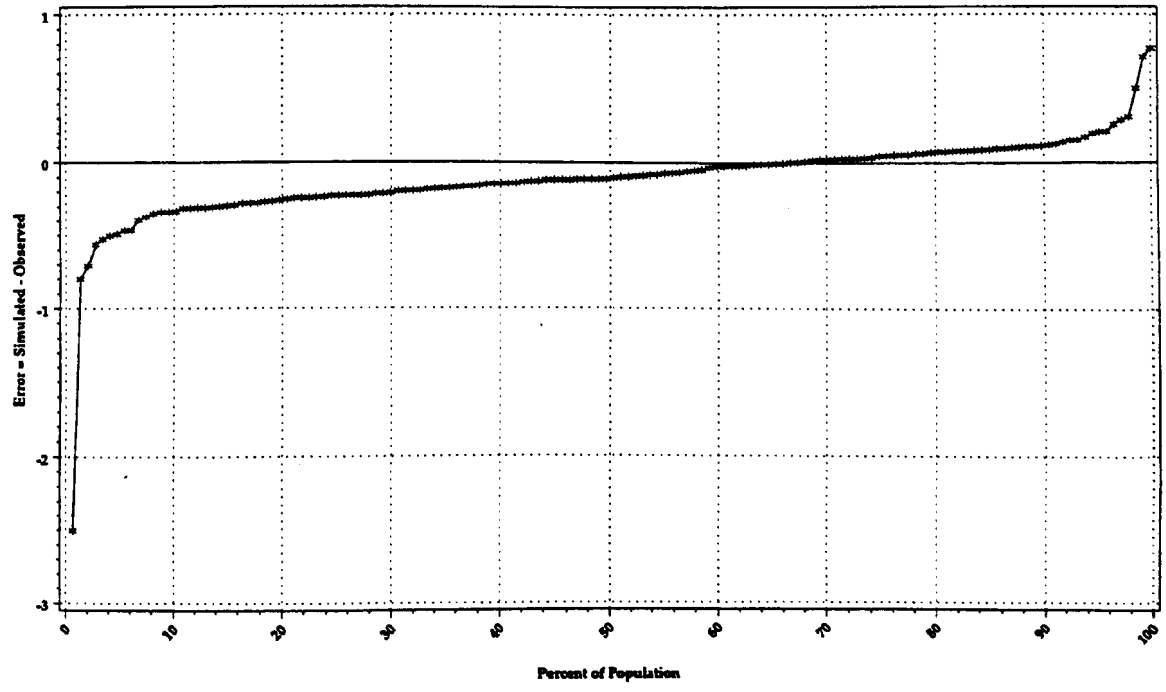
Organic Nitrogen



Pamunkey River at Segment 260
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.6.0 James River Basin

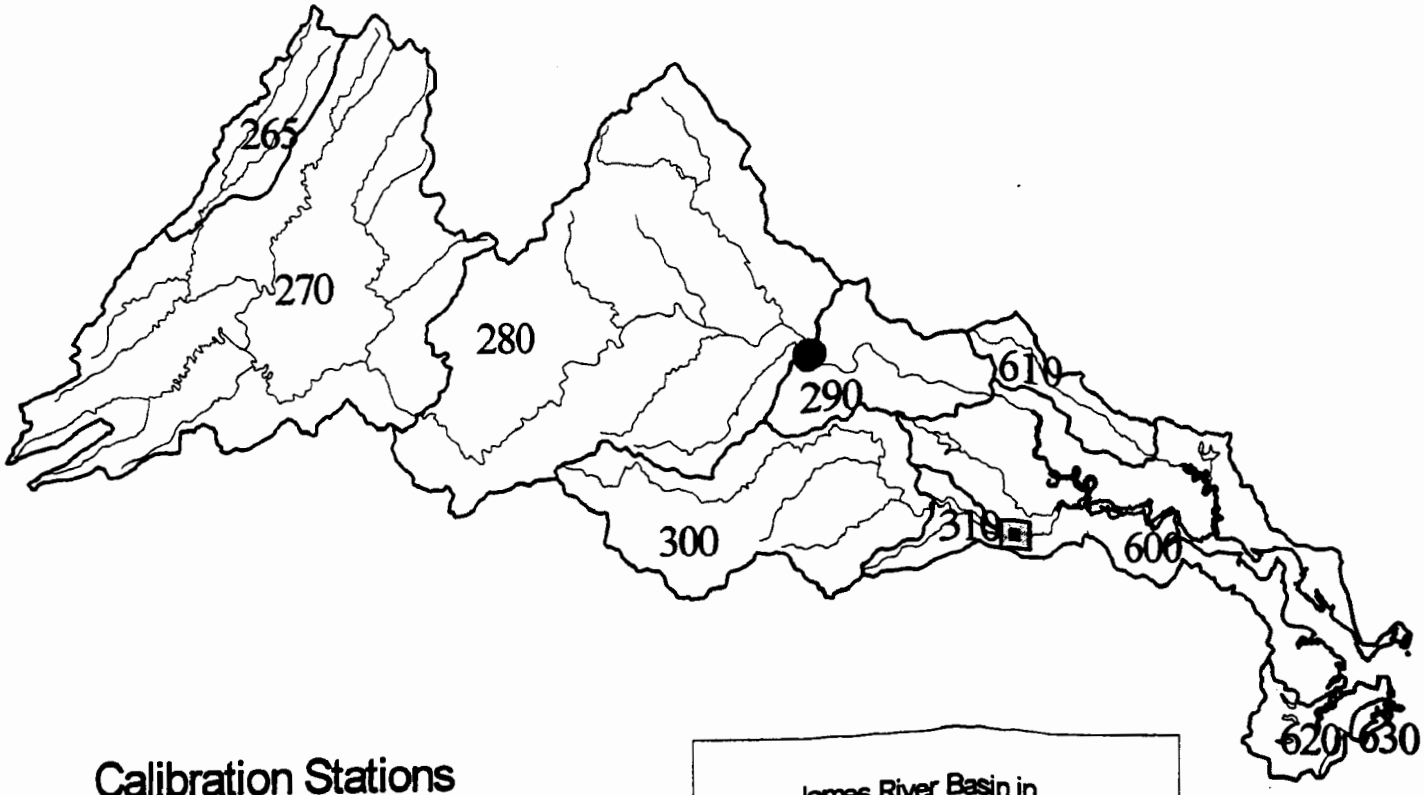
Basin Segments:

Above Fall Line Basin Segments: 265, 270, 280, 290, 300, and 310
Below Fall Line Basin Segments: 600, 610, 620, and 630

Section Contents:

B.6.0 Monitoring Stations in the James River Basin (Figure B.6.0)
B.6.1 James River (Monitoring Station: 2035000)
B.6.2 Appomattox River (Monitoring Station: 2041650)

Monitoring Stations in the James River Basin



Calibration Stations
- 2035000
- 2041650
- Streams
- Model Segments

Chesapeake Bay Program

Map Date: April 1998

Source: USGS and USEPA Chesapeake Bay Program

N

KJH

B.6.1 James River at Cartersville, VA at Segment 280 (Monitoring Station: 2035000) (Above Fall Line Basin Segments: 265, 270, 280, and 290)

Section Summary:

The James basin water quality gage is at Cartersville, VA, about 40 miles above the fall line at Richmond, VA. Above the gage at Cartersville, the James basin is largely rural and forested. Water quality observations increased and were oriented toward storm weighted sampling after 1989. Model calibration focused primarily on the refined, storm weighted sampling after 1989.

The James basin above the gaged site covers an area of 6,810 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 75% forest land, 2% cropland, 16% other agricultural areas, 6% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 8.2 million pounds in 1985 to 7.9 million pounds in 1996. Total phosphorus loads over the same time period decreased from 2.4 million pounds to 2.3 million pounds. In general, point source loads above the gage site decreased. In 1996, the total nitrogen point source load was 14% of the total load and the total phosphorus point source load was 20% of the total load. Estimated septic system total nitrogen loads increased 13%, from 0.41 million pounds in 1985 to 0.46 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 13%, and other agricultural loads (primarily pasture and manure loads) by 12%. Total phosphorus decreased for these land uses by 10% and 7% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 14% for total nitrogen and 11% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen

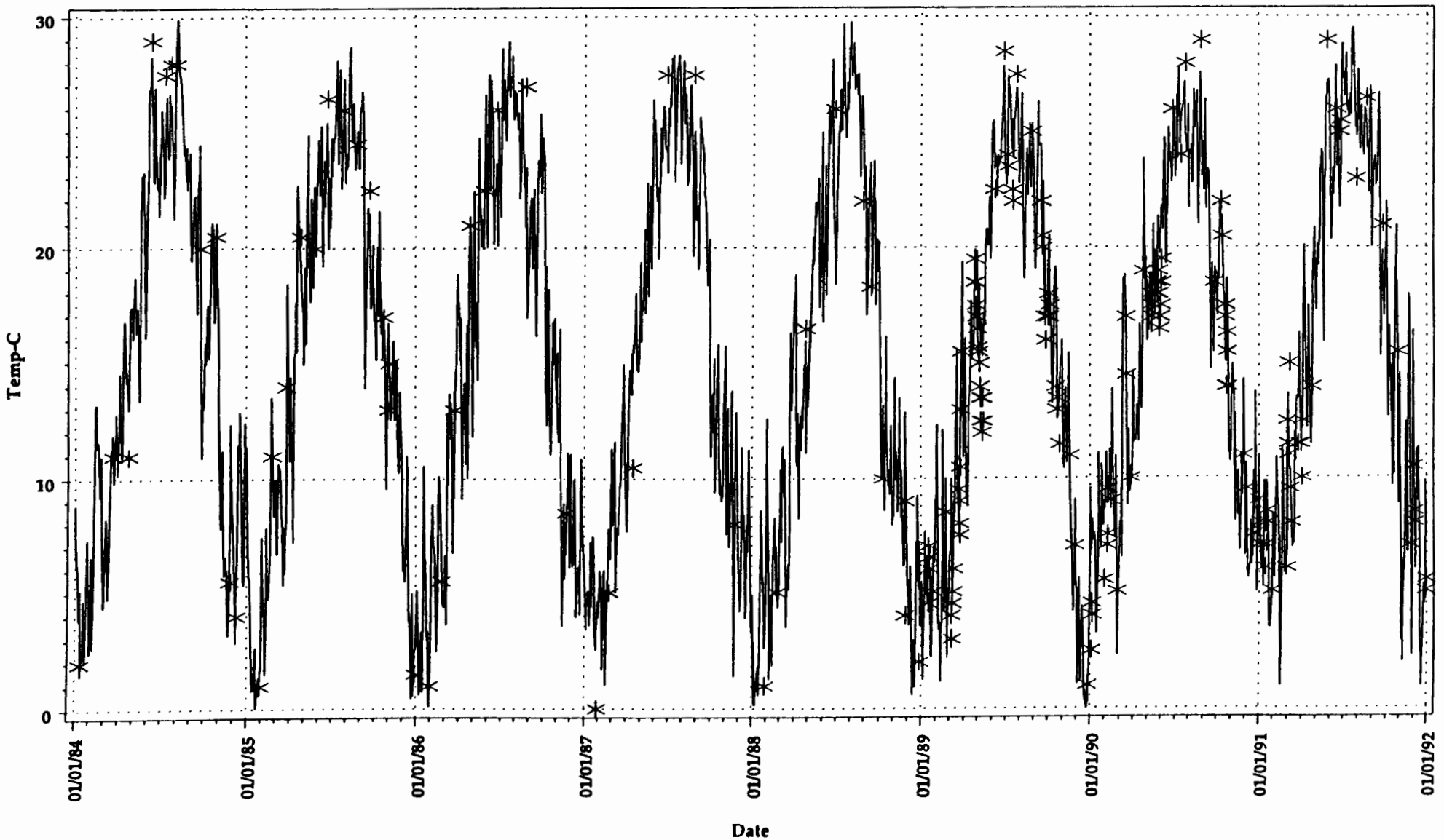
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

James River at Segment 280
Observed and Simulated versus Time
Temperature-C

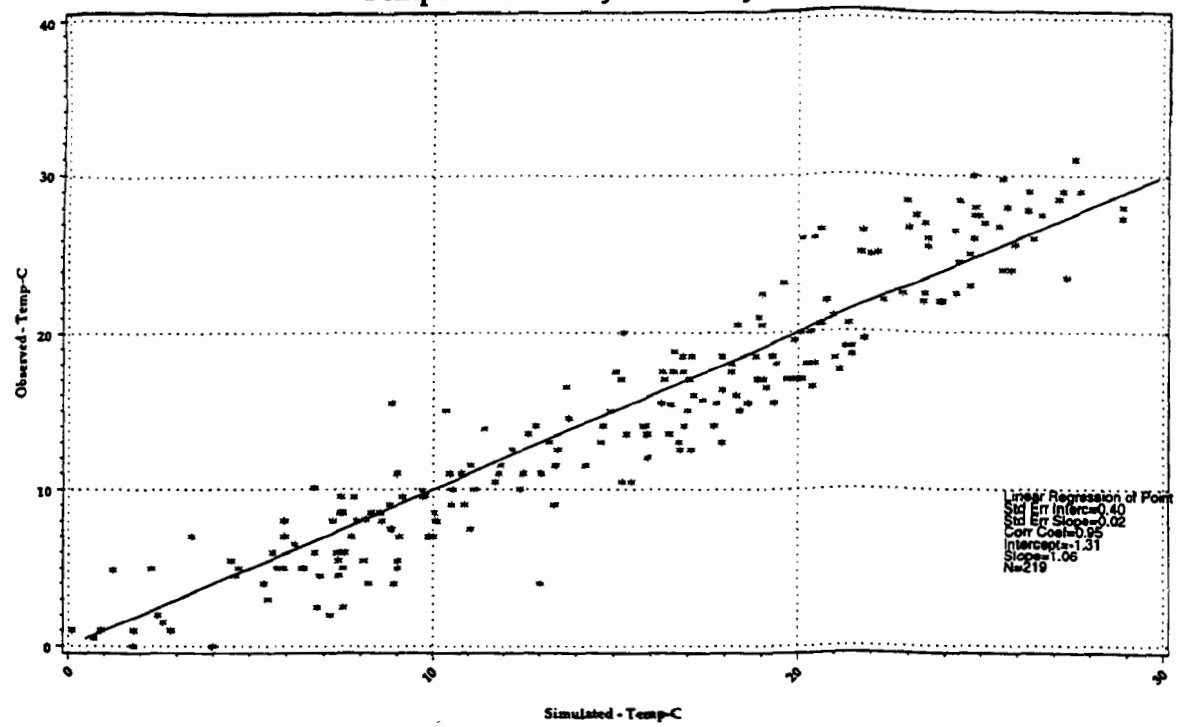
(*=Observed, -=Simulated)



James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

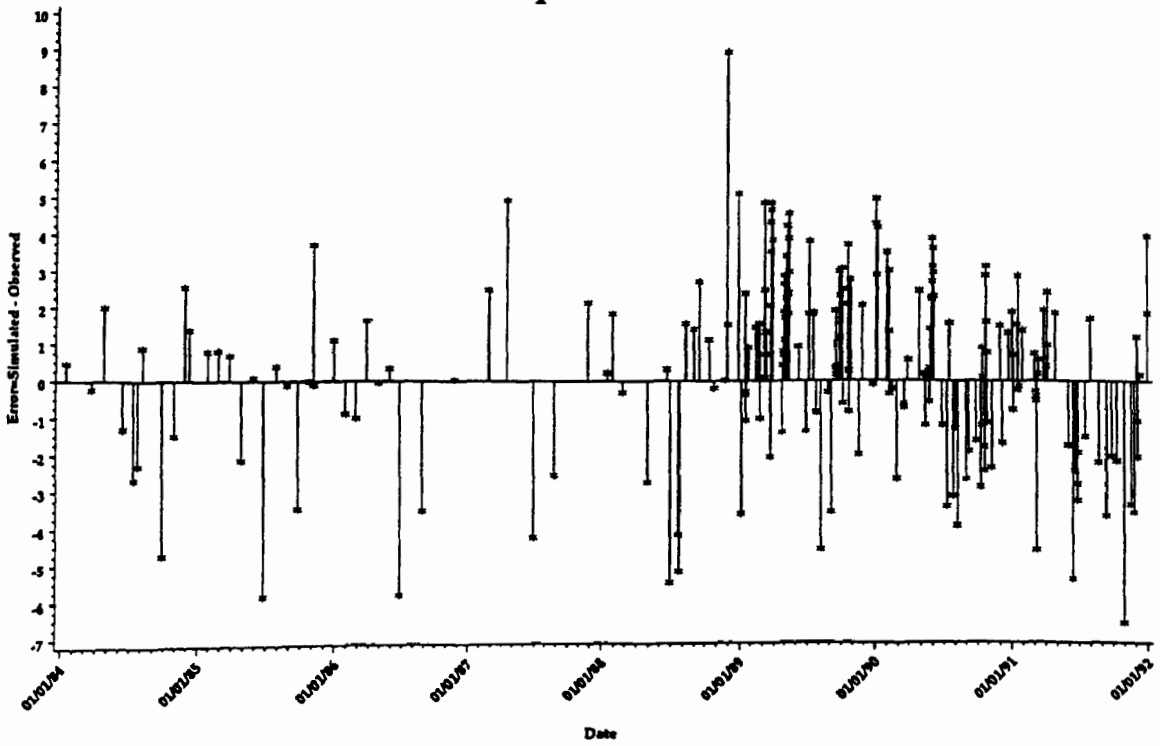
Temperature-C: 01JAN84 - 01JAN92



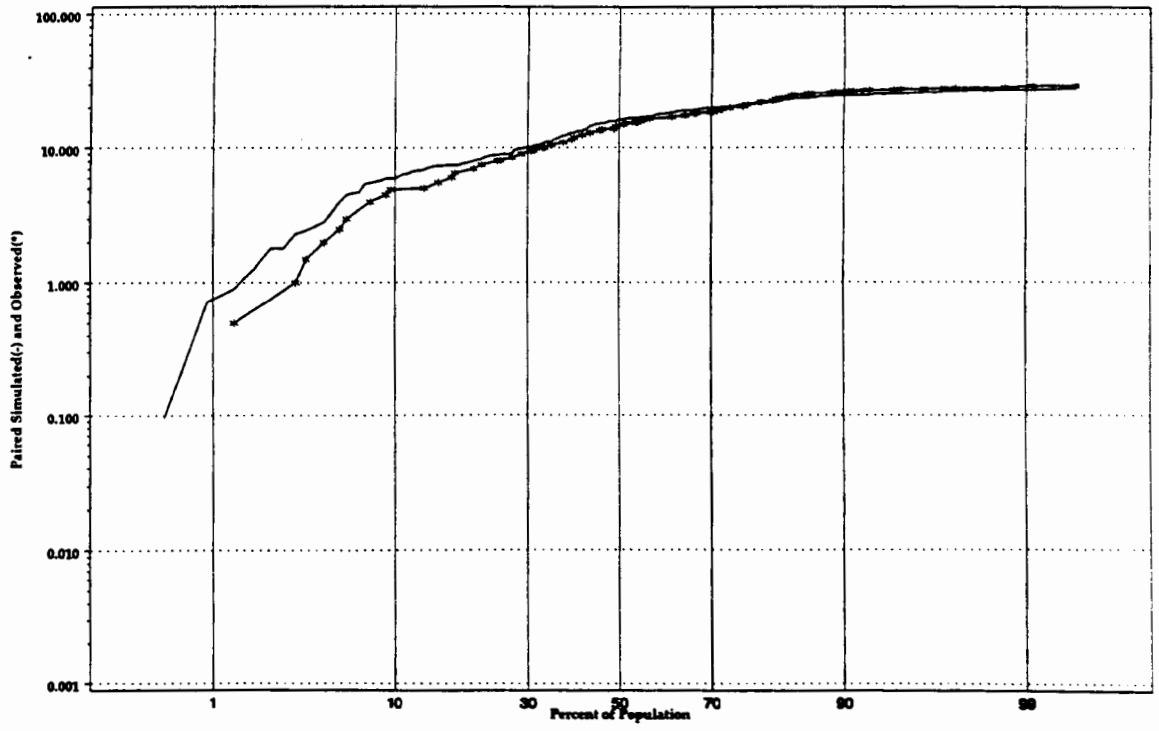
James River at Segment 280

Actual Error versus Time

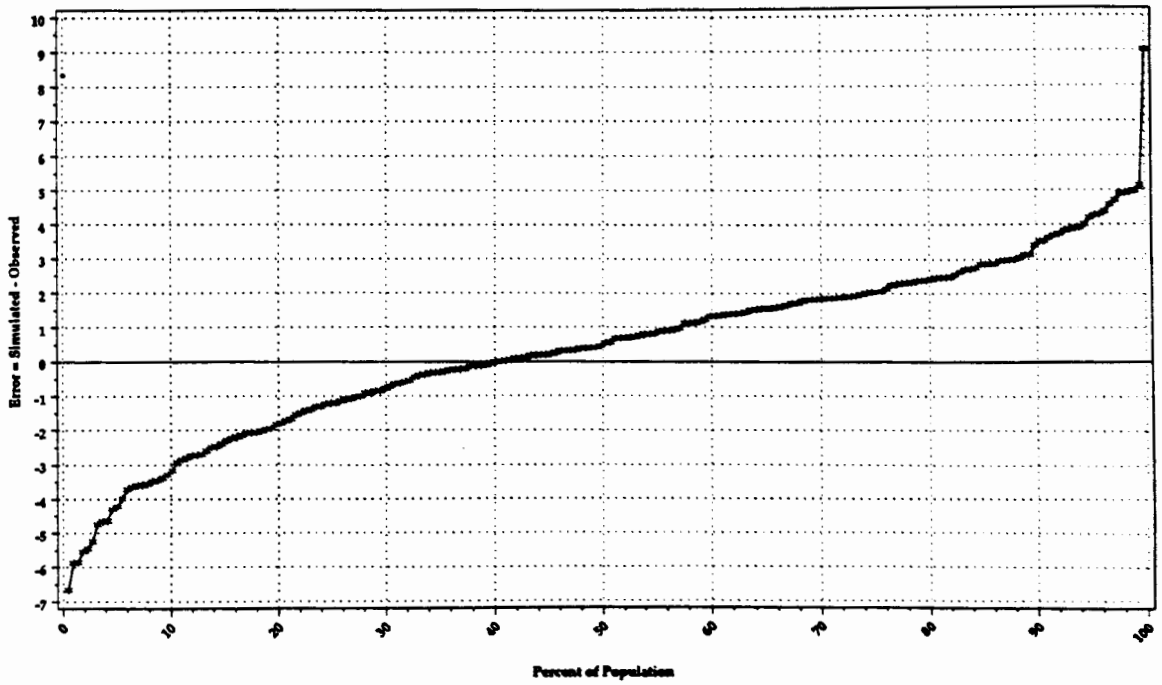
Temperature-C



James River at Segment 280
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

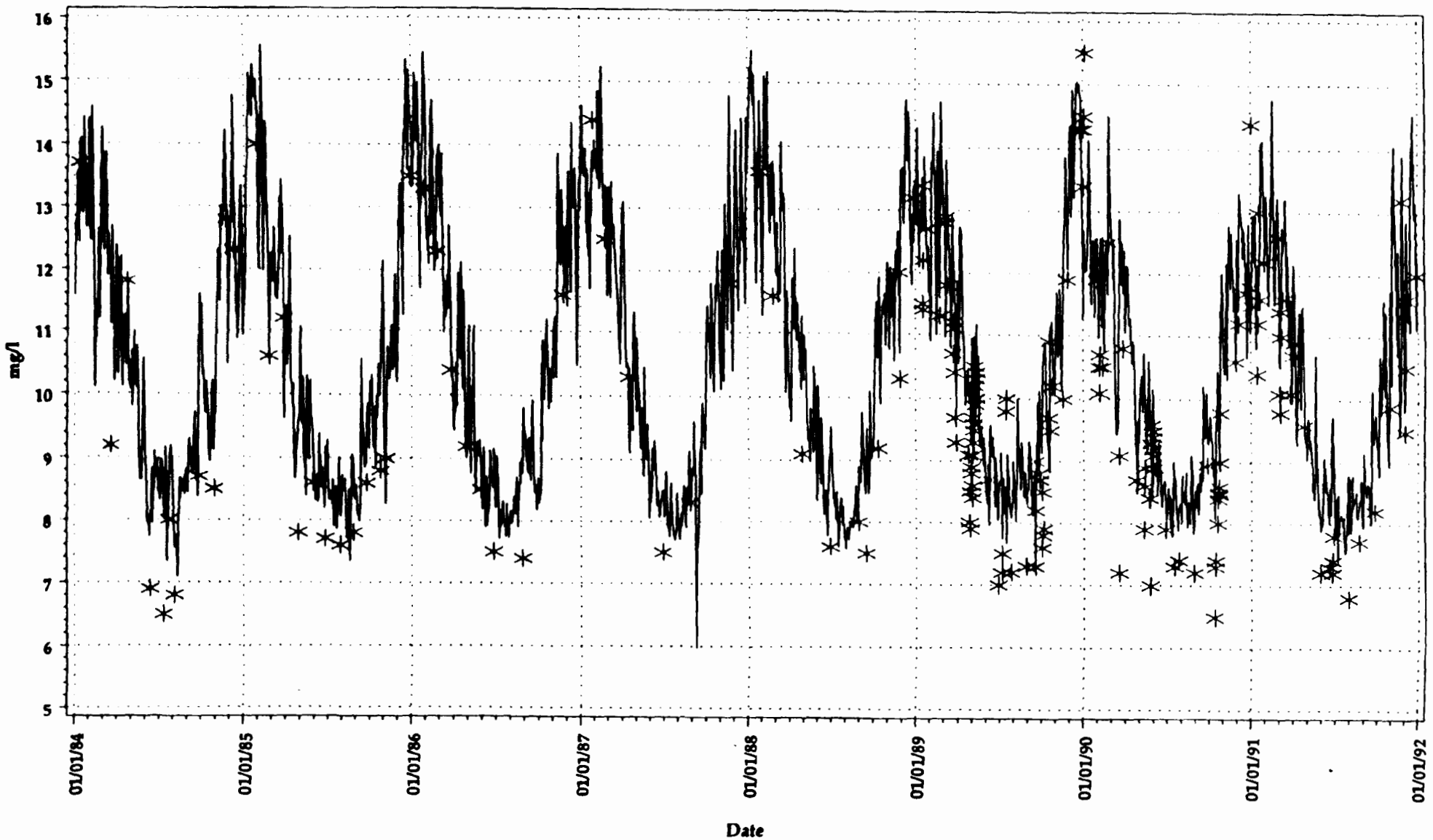


James River at Segment 280
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data

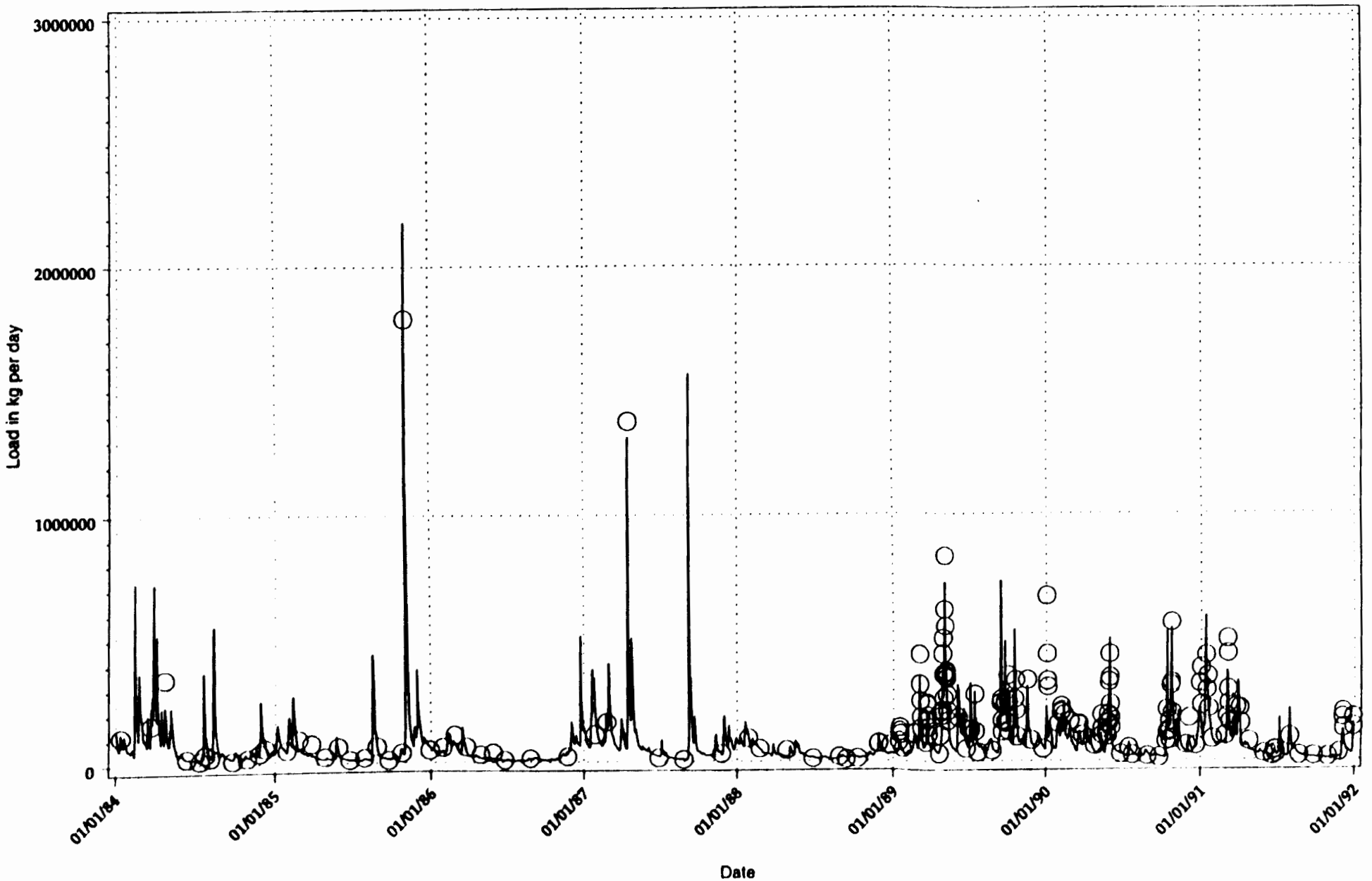


James River at Segment 280
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)

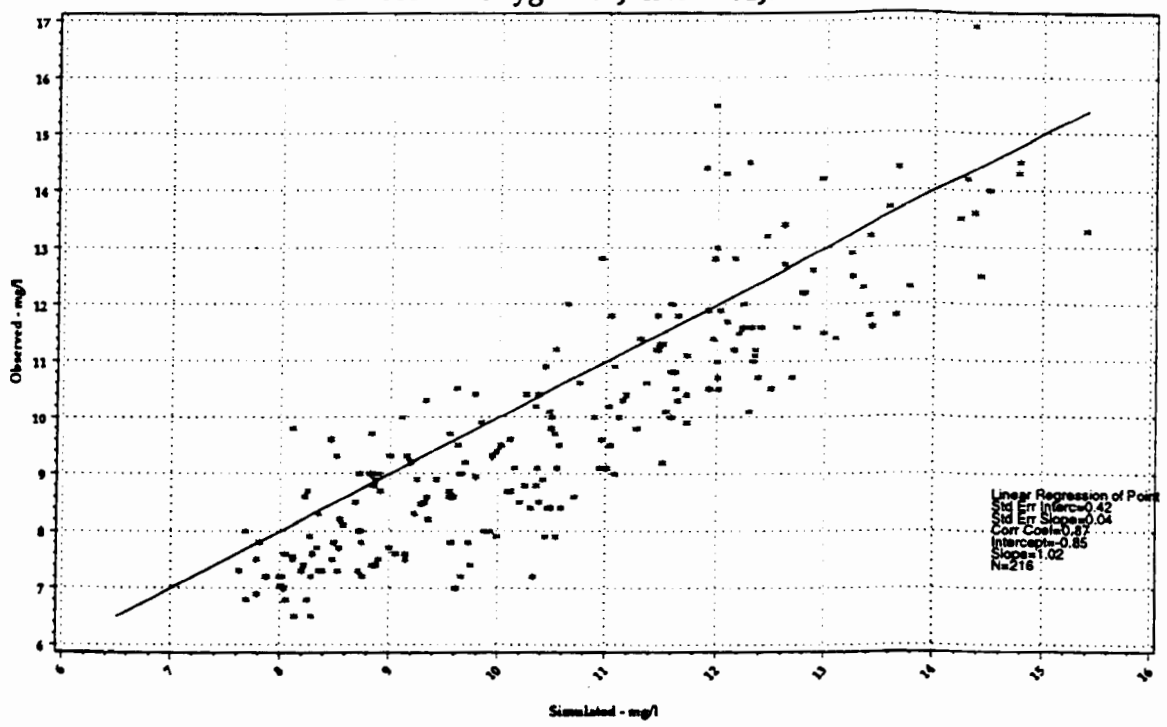


James River at Segment 280
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)



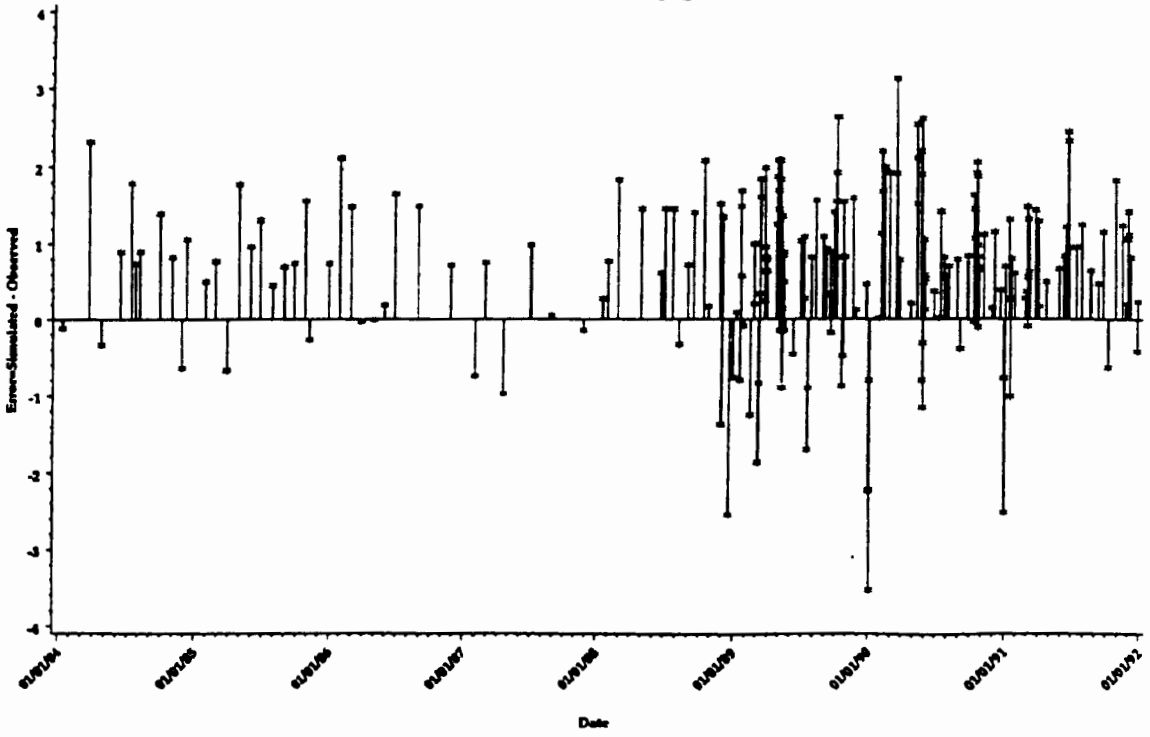
James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Dissolved Oxygen: 01JAN84 - 01JAN92

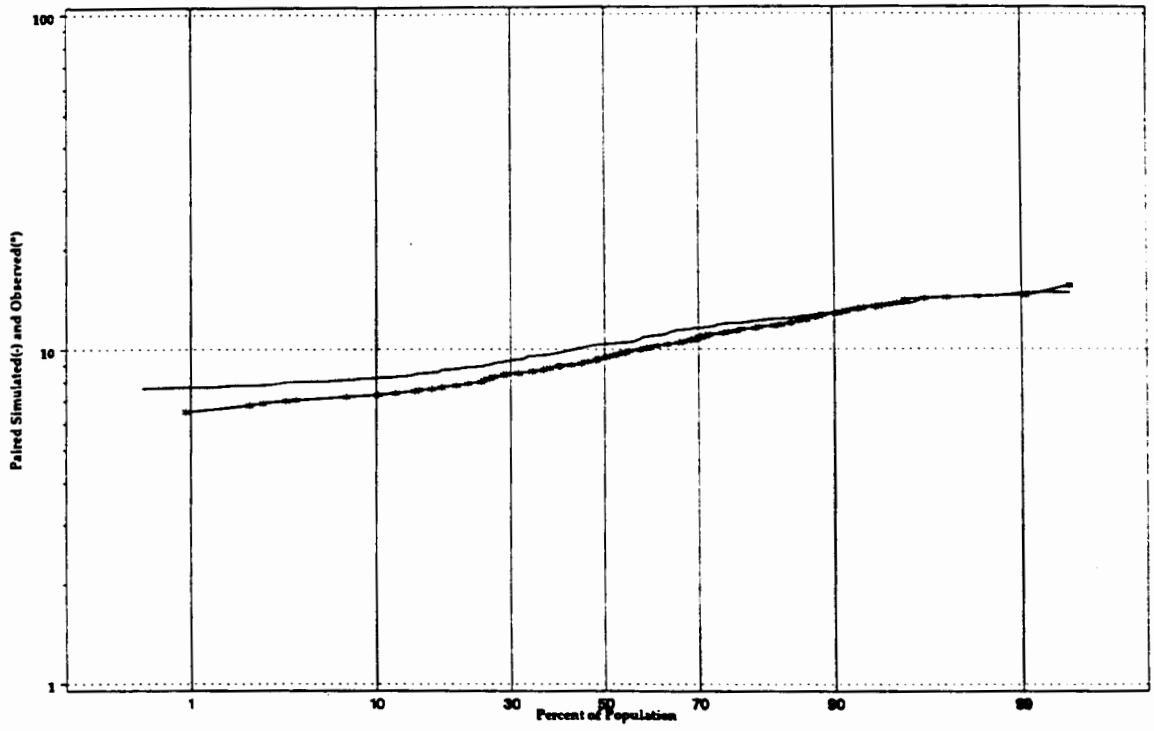


James River at Segment 280

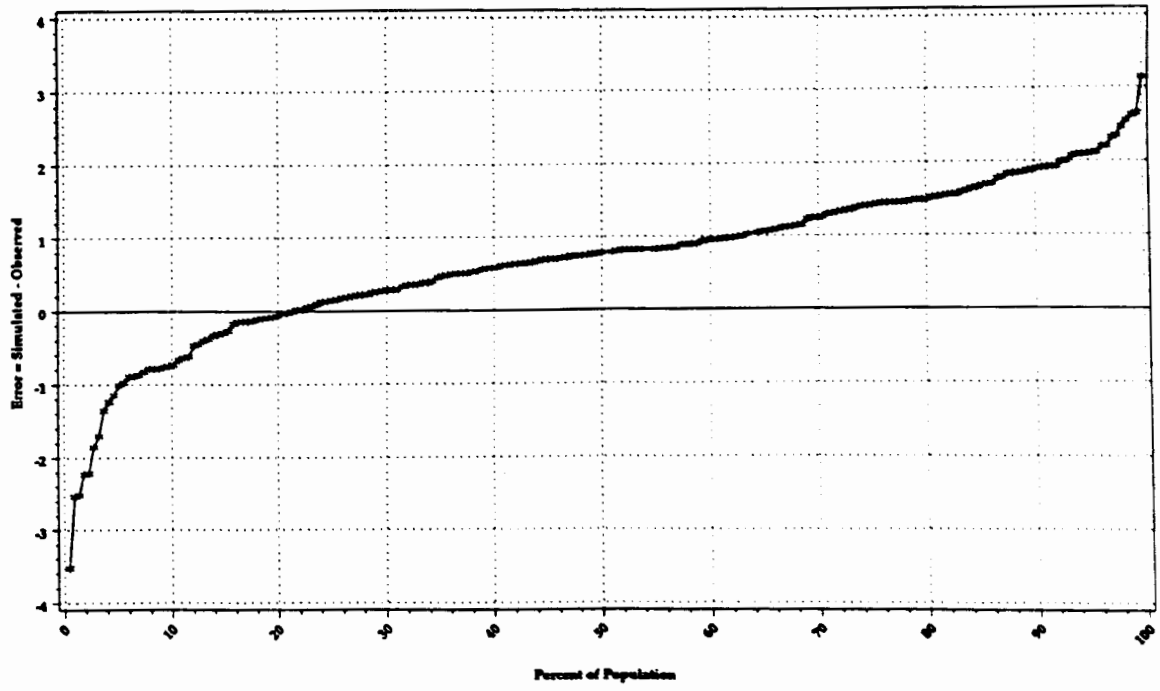
Actual Error versus Time
Dissolved Oxygen



James River at Segment 280
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

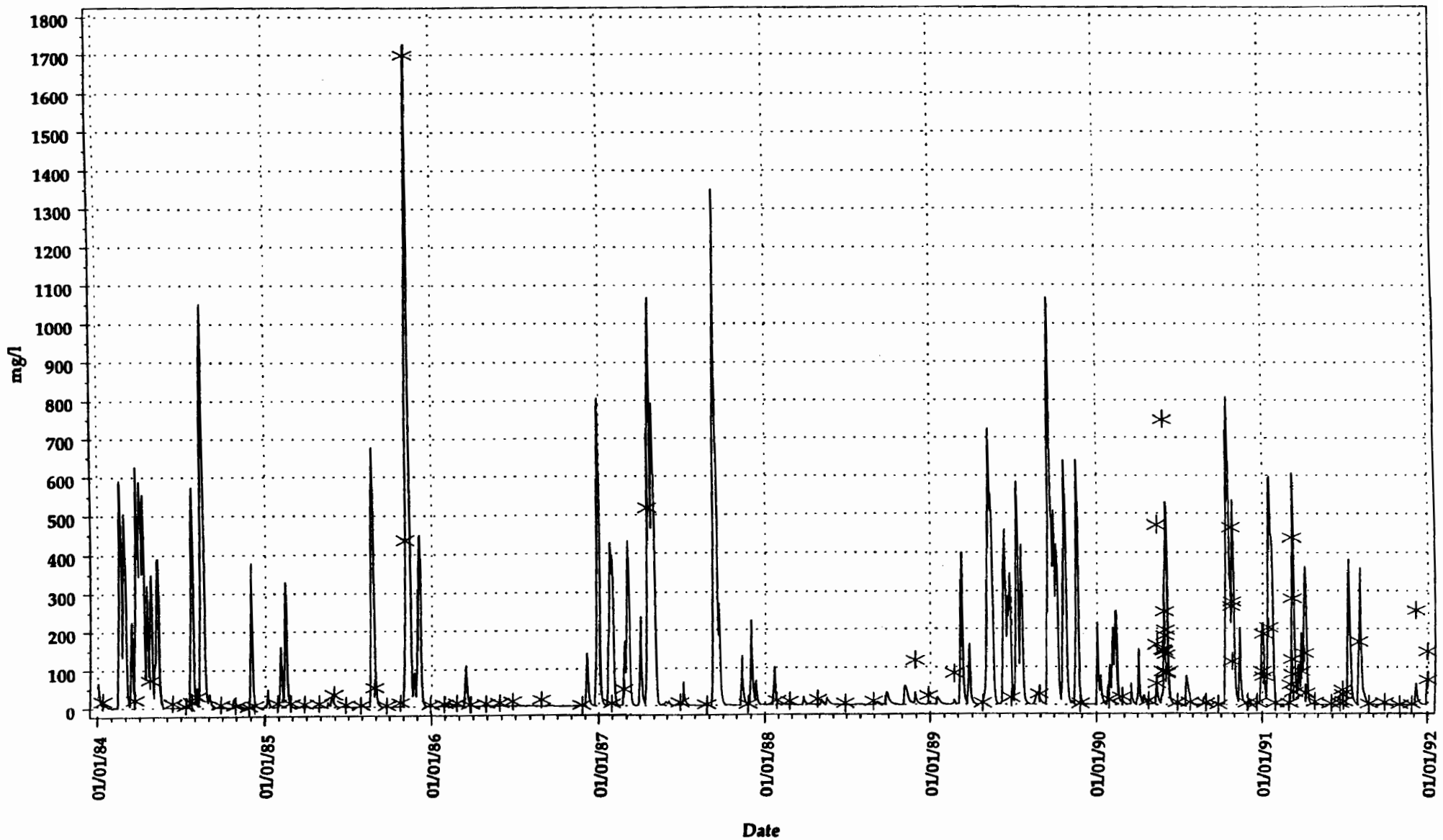


James River at Segment 280
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



James River at Segment 280
Observed and Simulated versus Time
Total Suspended Sediment

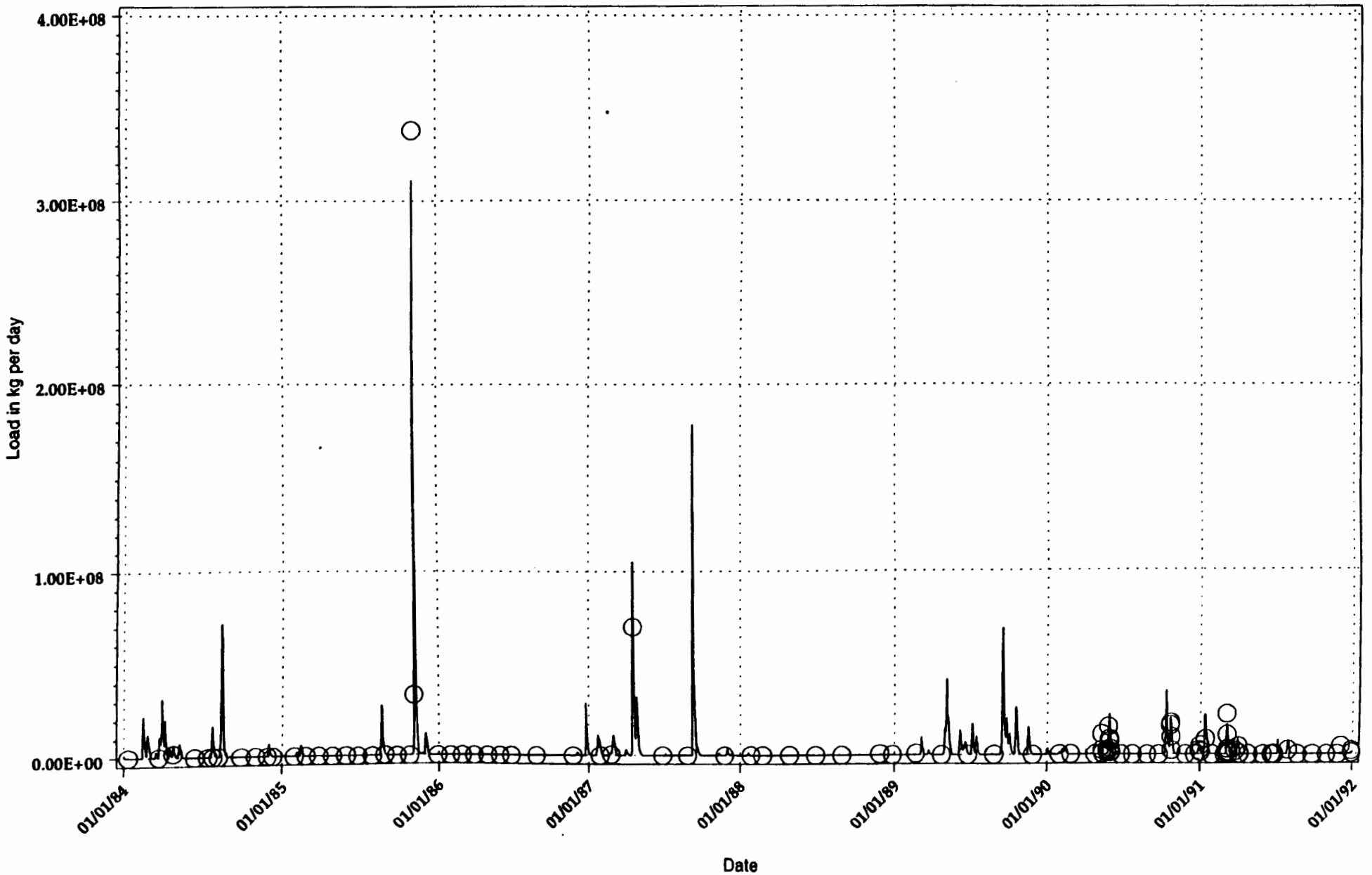
(*=Observed, -=Simulated)



James River at Segment 280

Total Suspended Sediment Observed and Simulated Load vs Time

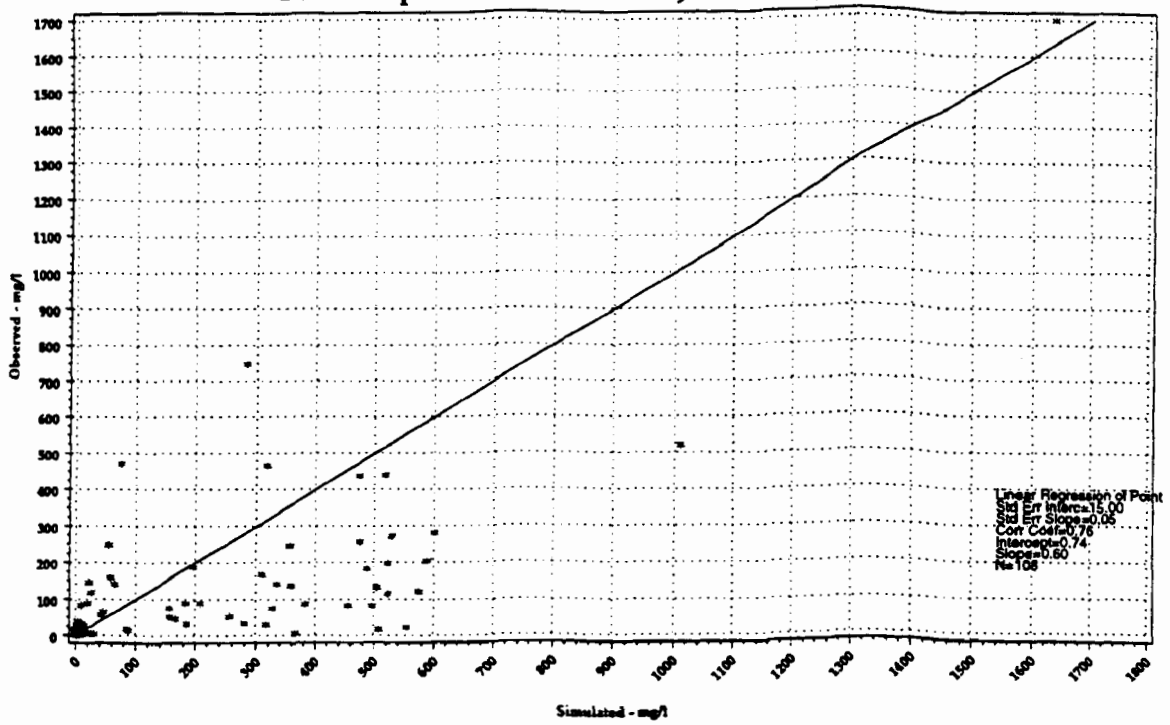
(line = simulated, O = observed)



James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

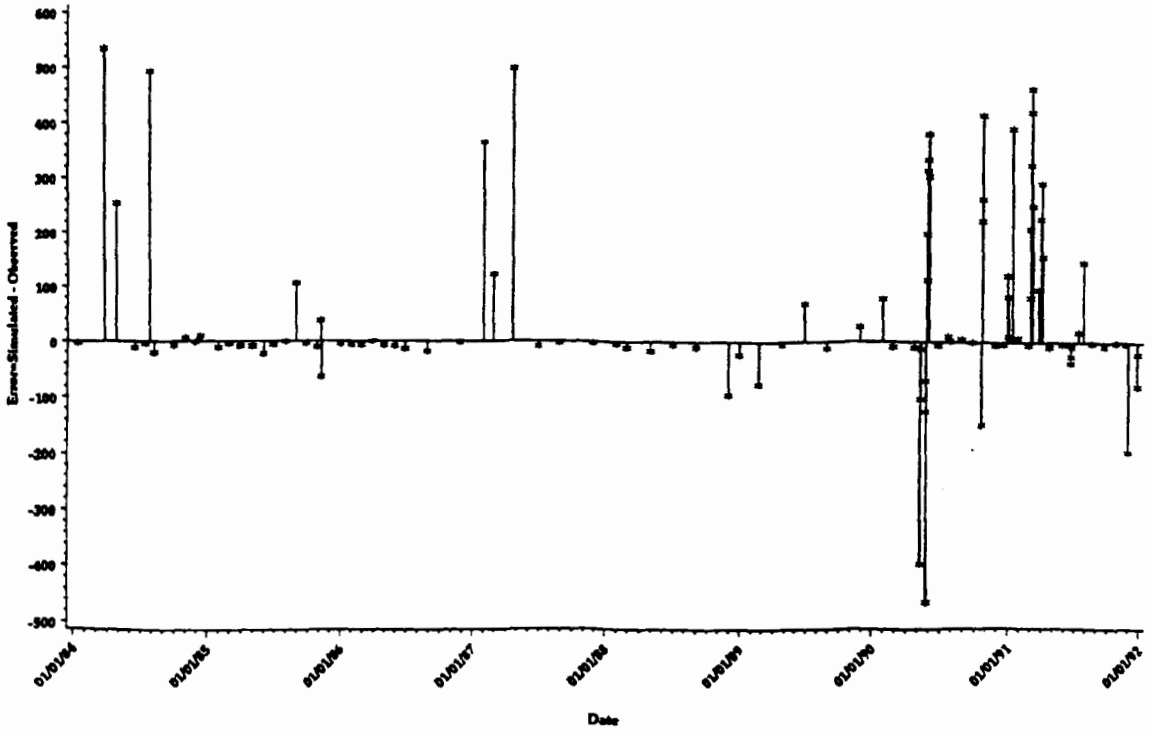
Total Suspended Sediment: 01JAN84 - 01JAN92



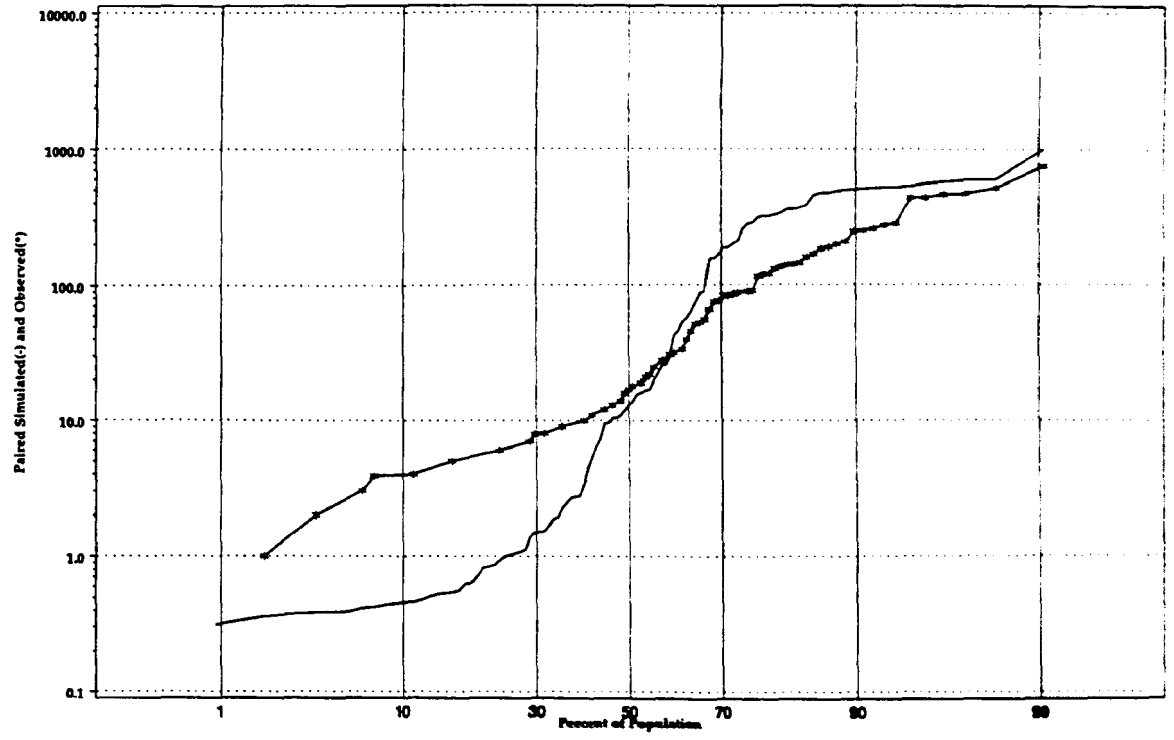
James River at Segment 280

Actual Error versus Time

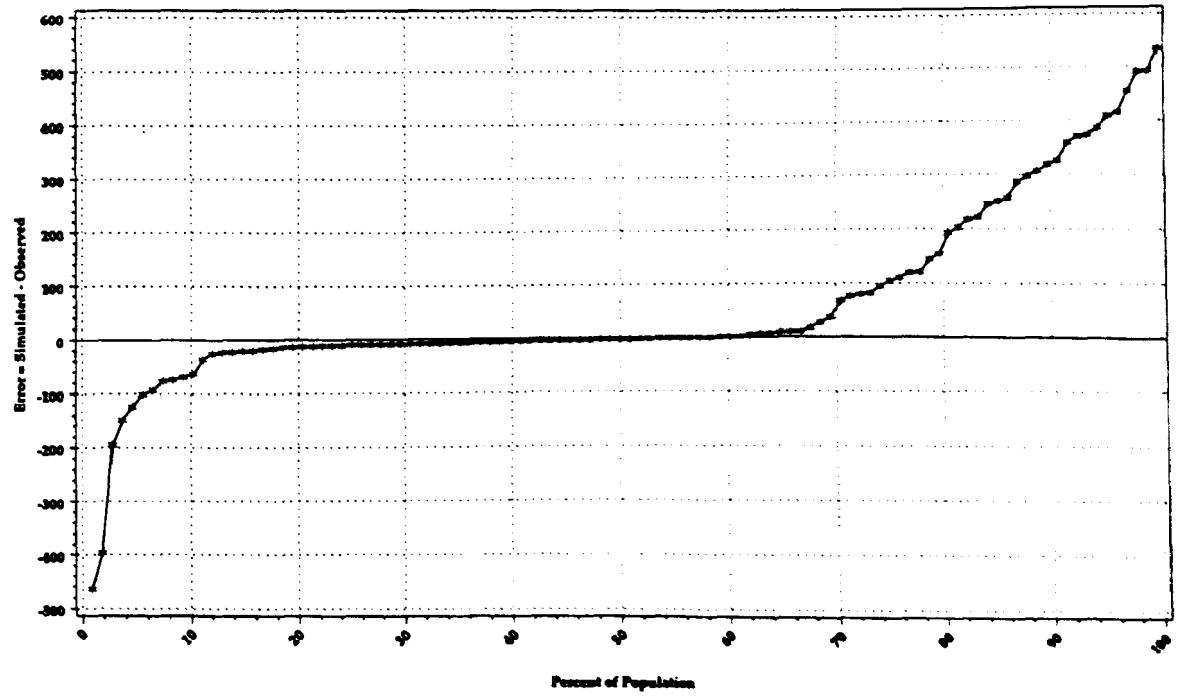
Total Suspended Sediment



James River at Segment 280
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

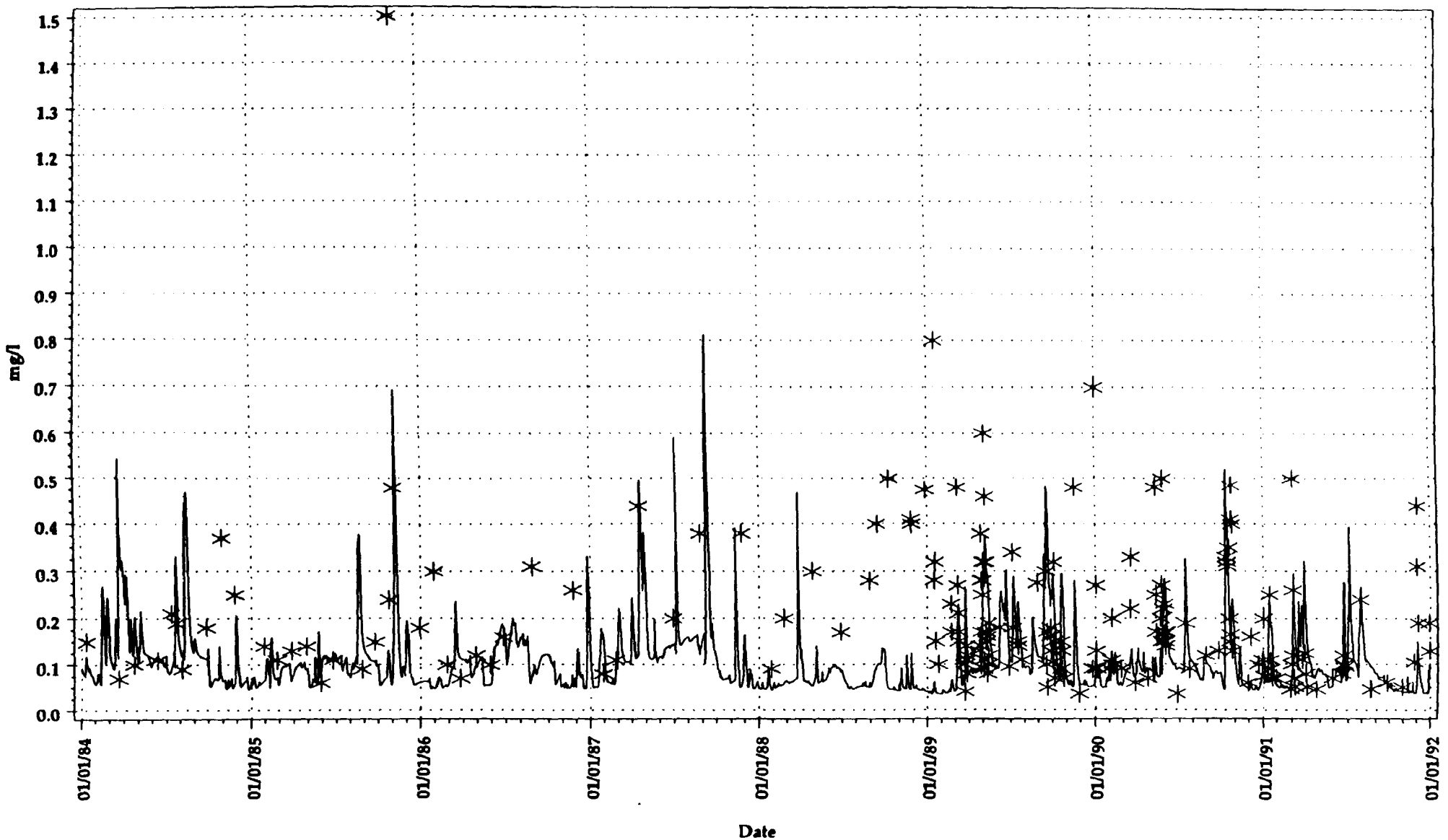


James River at Segment 280
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



James River at Segment 280
Observed and Simulated versus Time
Total Phosphorus

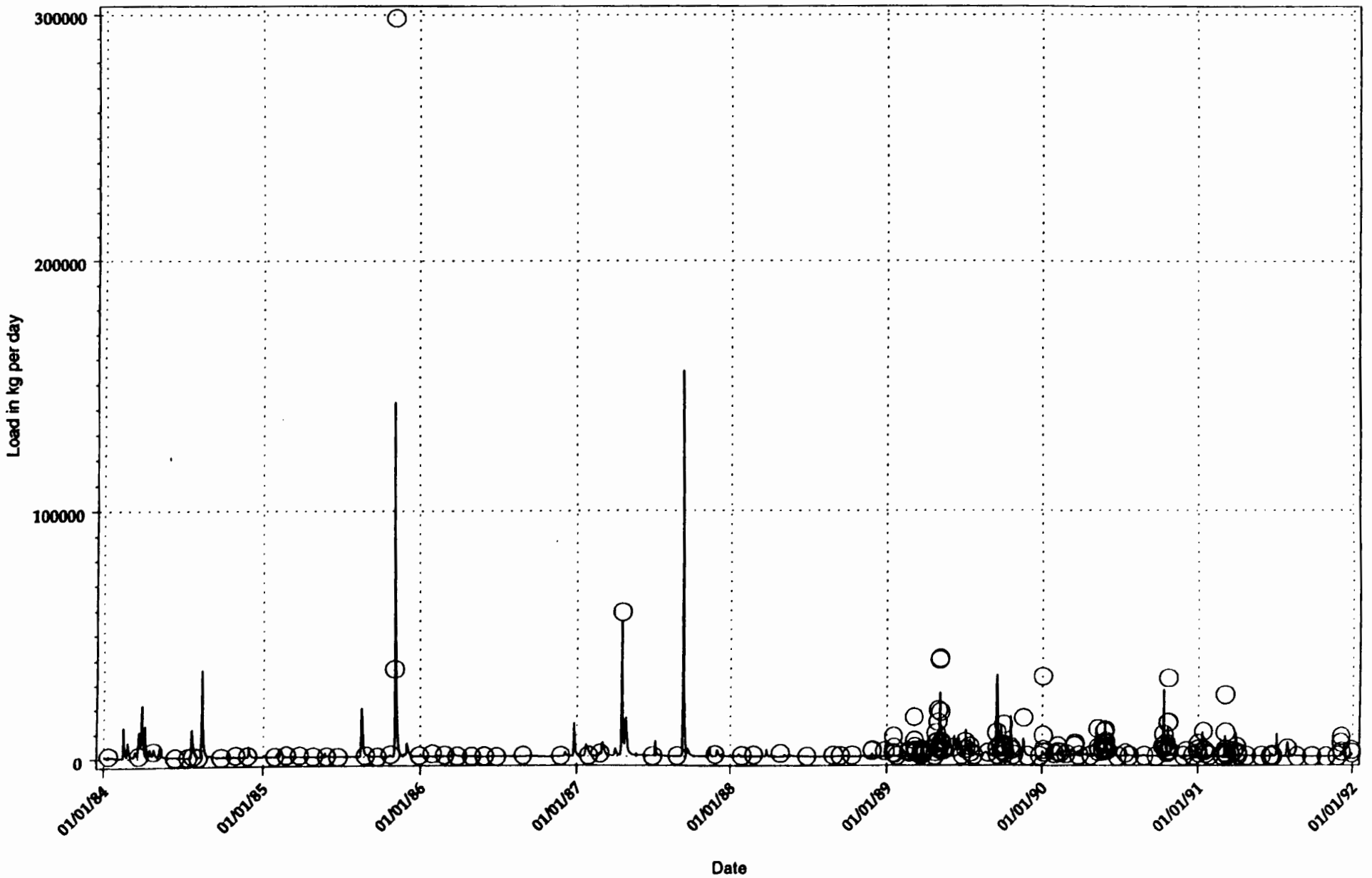
(*=Observed, -=Simulated)



James River at Segment 280

Total Phosphorus Observed and Simulated Load vs Time

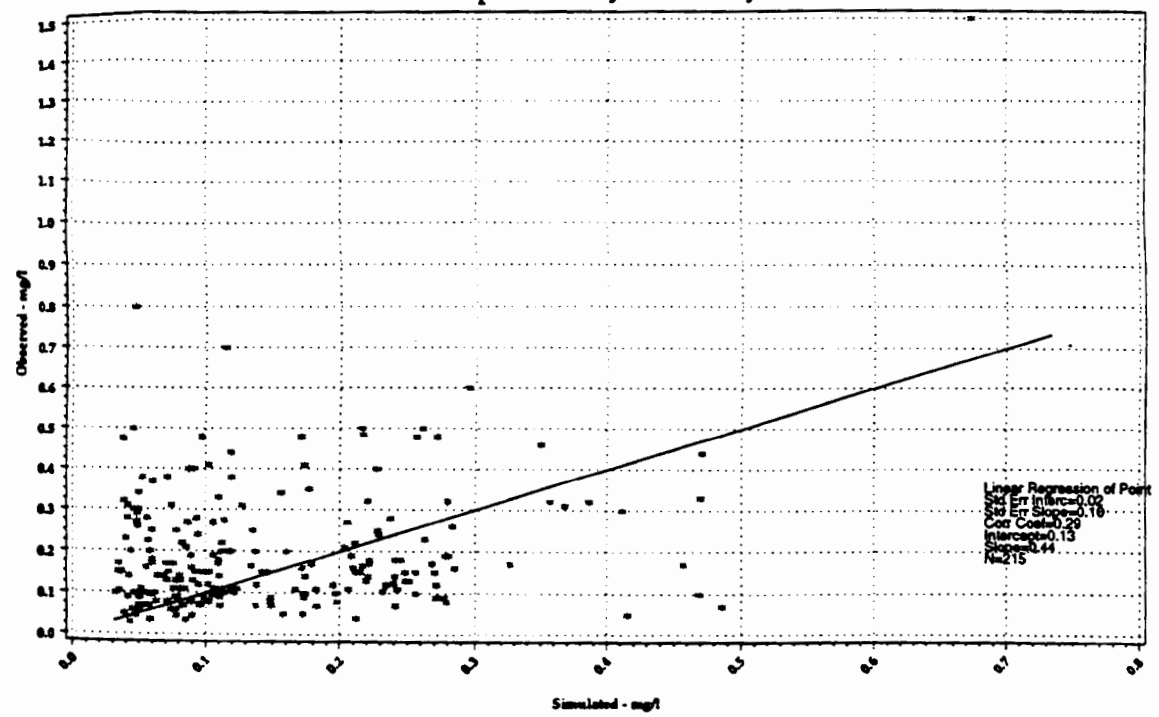
(line = simulated, O = observed)



James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

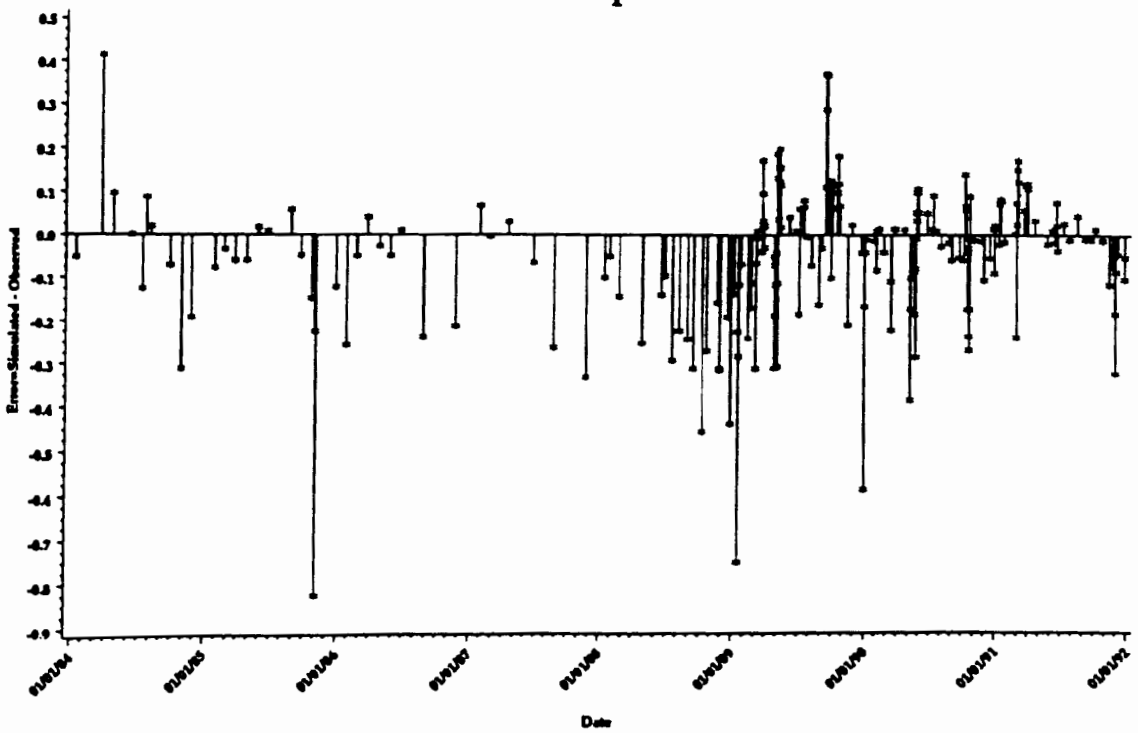
Total Phosphorus: 01JAN84 - 01JAN92



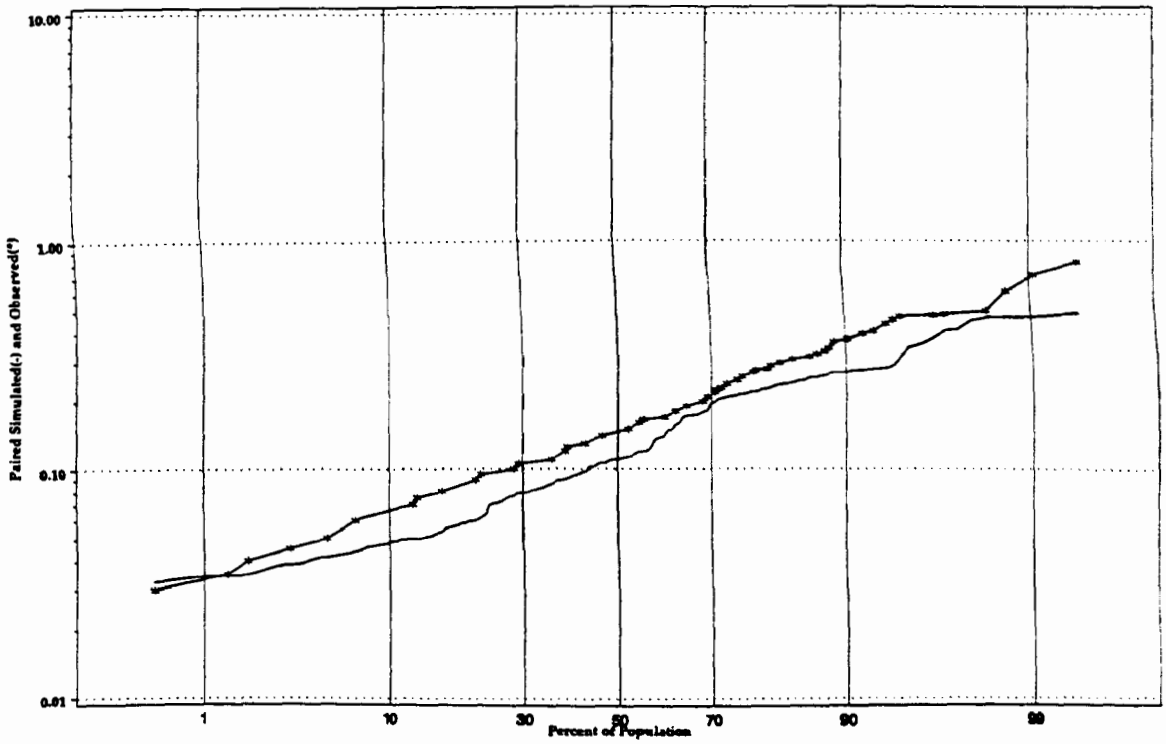
James River at Segment 280

Actual Error versus Time

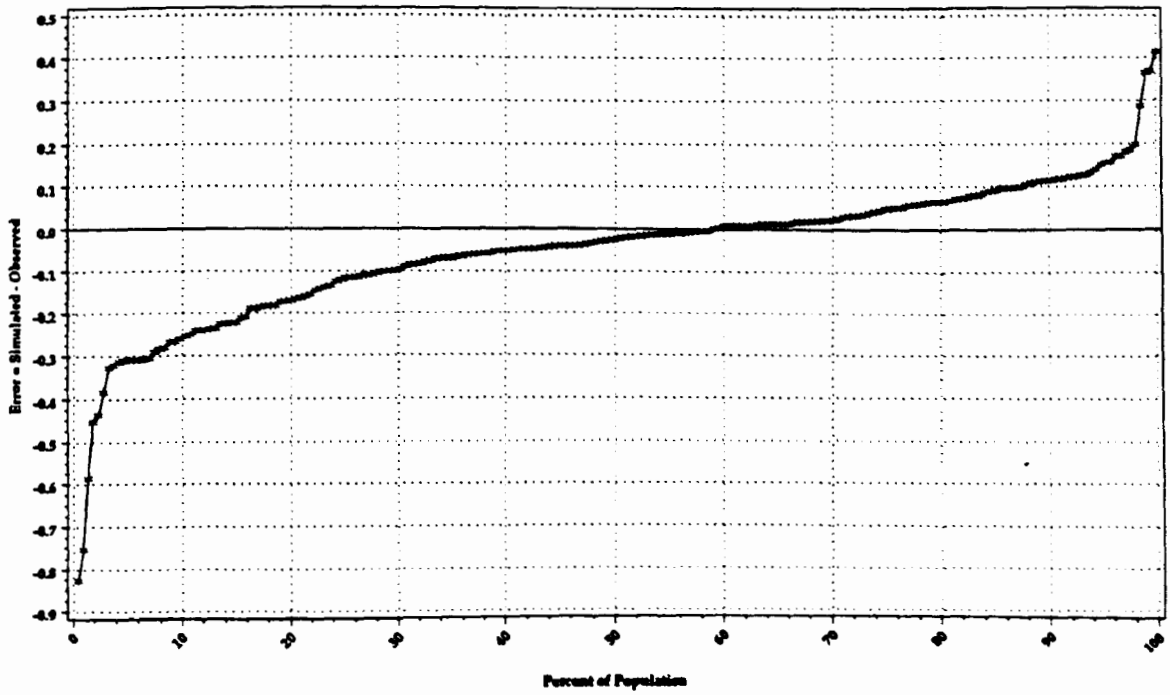
Total Phosphorus



James River at Segment 280
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

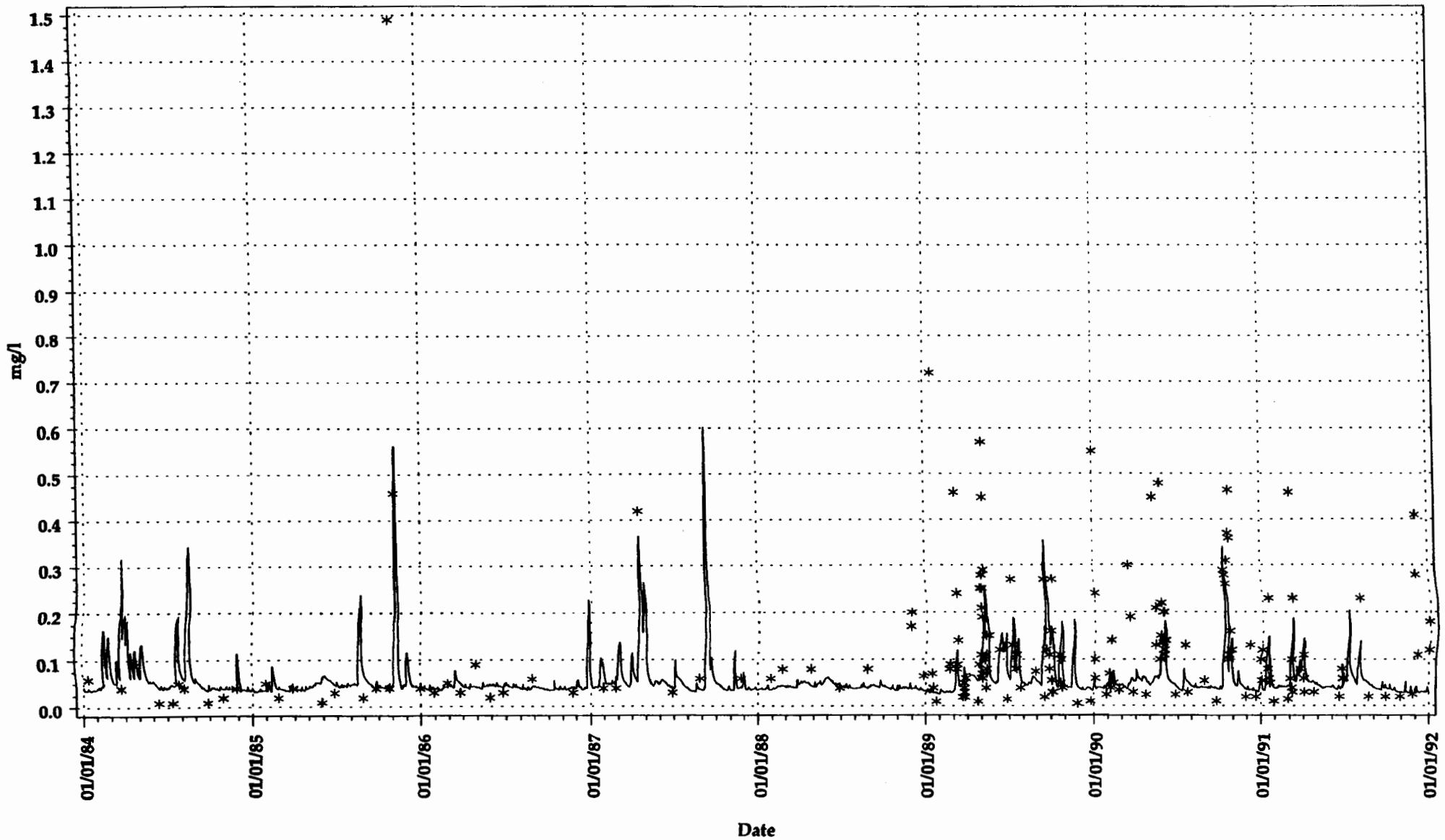


James River at Segment 280
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



James River at Segment 280
Observed and Simulated versus Time
Organic and Particulate Phosphorus

(*=Observed, -=Simulated)

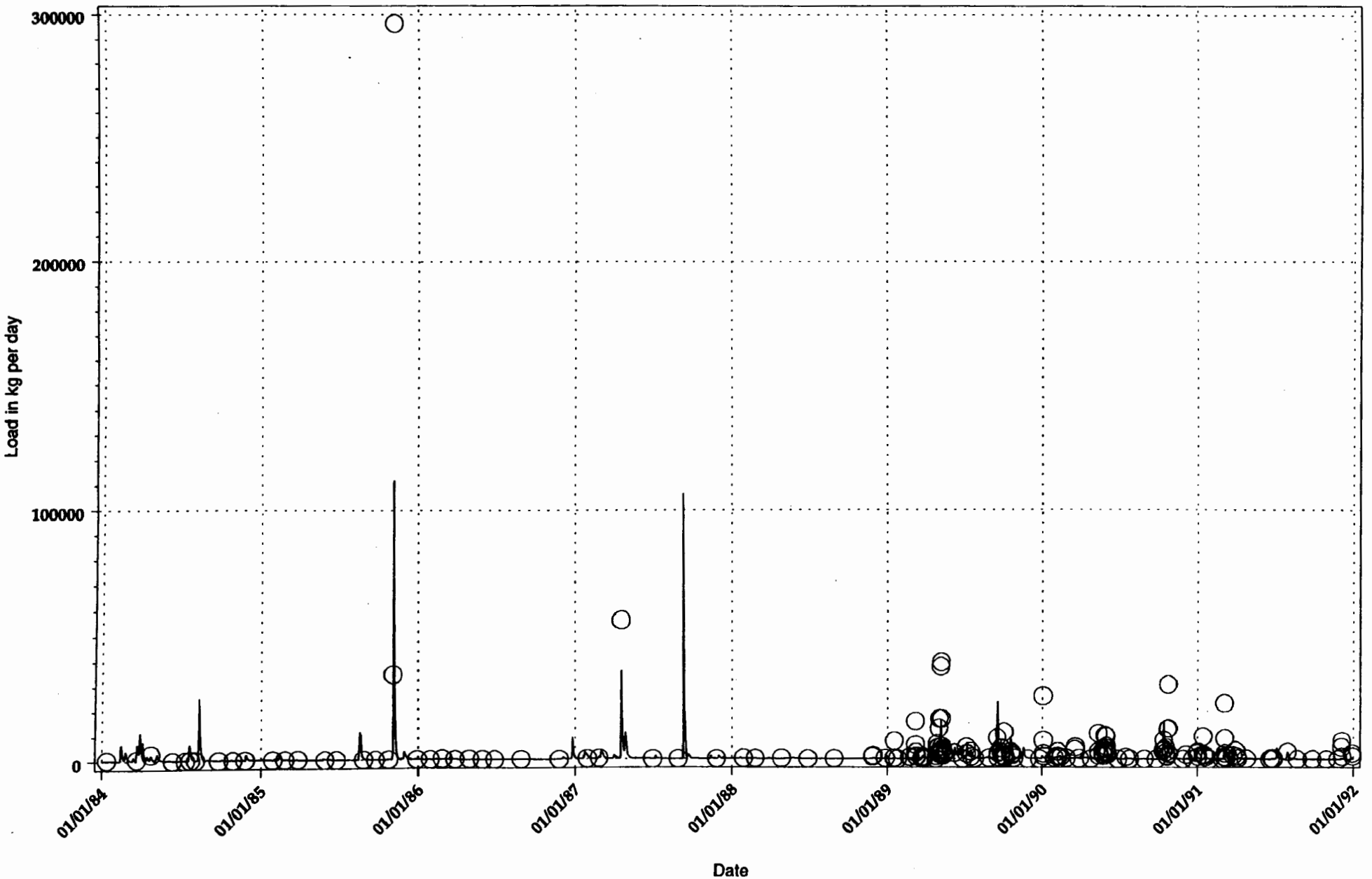


(y21_plotb.sas model3d:jpwang.dl plotcmt - online)
(2.dir 23FEB98 11:33)

James River at Segment 280

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)

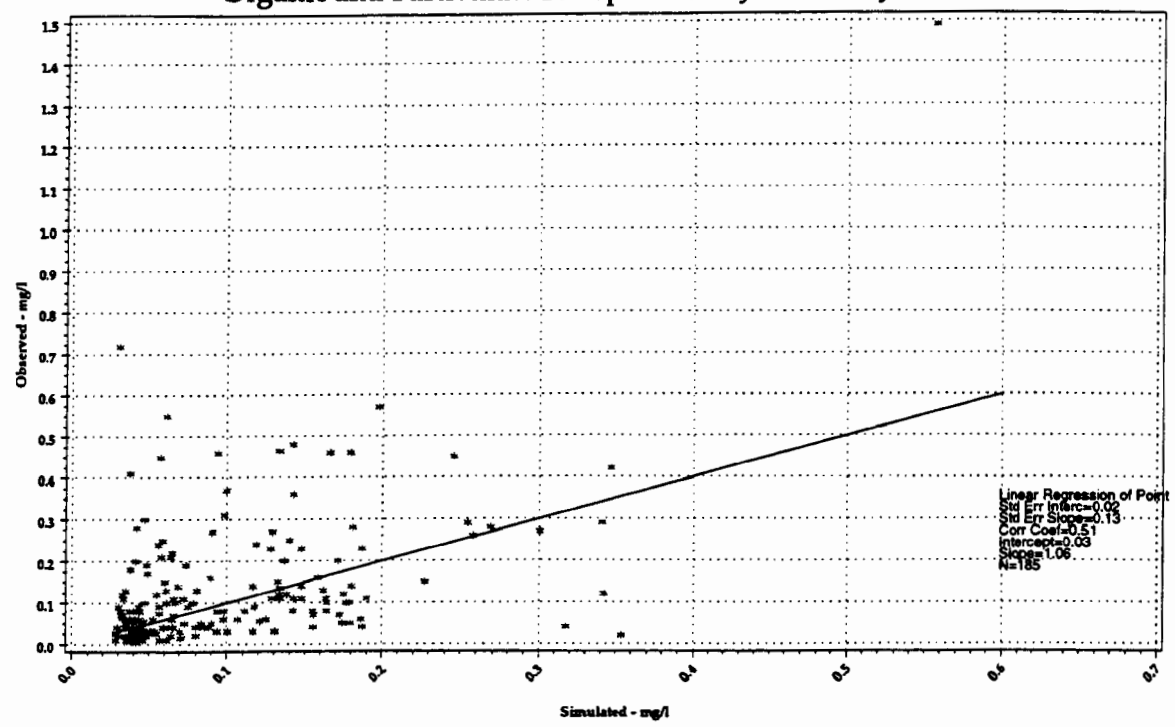


(y21_plotb.sas model3d:[pwang.dl] lldflas)
(g2.drv 23FEB98 11:33,proc reg,model y=x)

James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

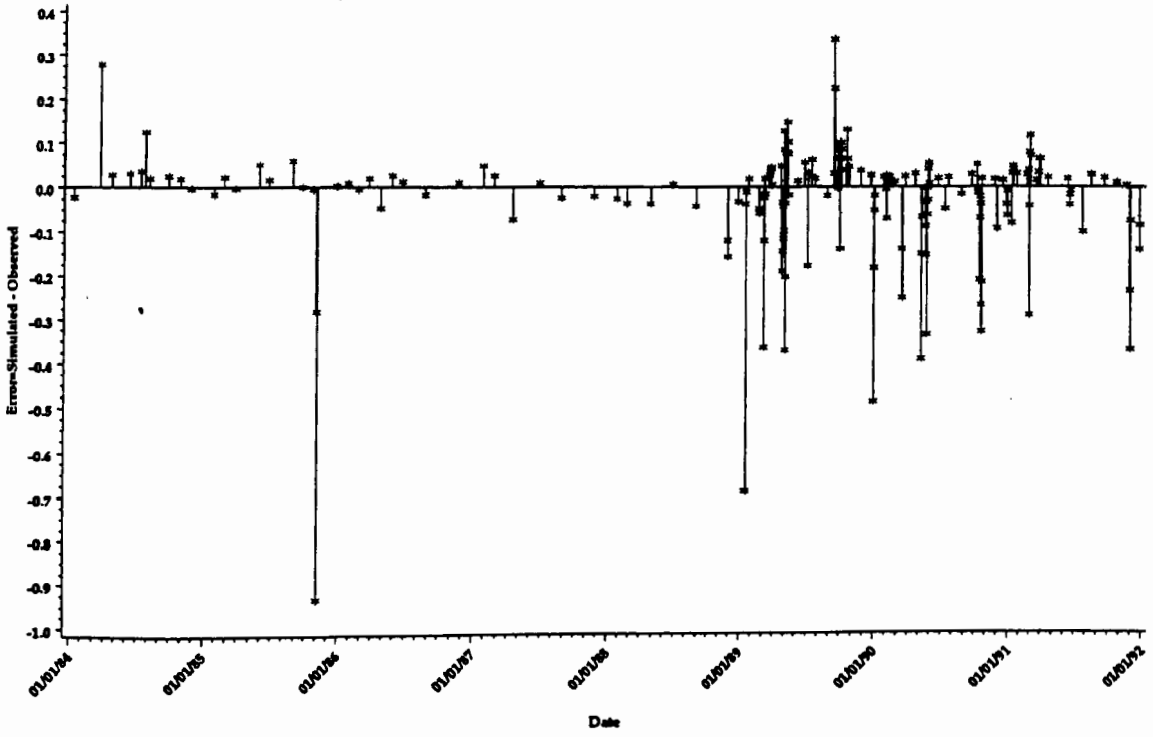
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



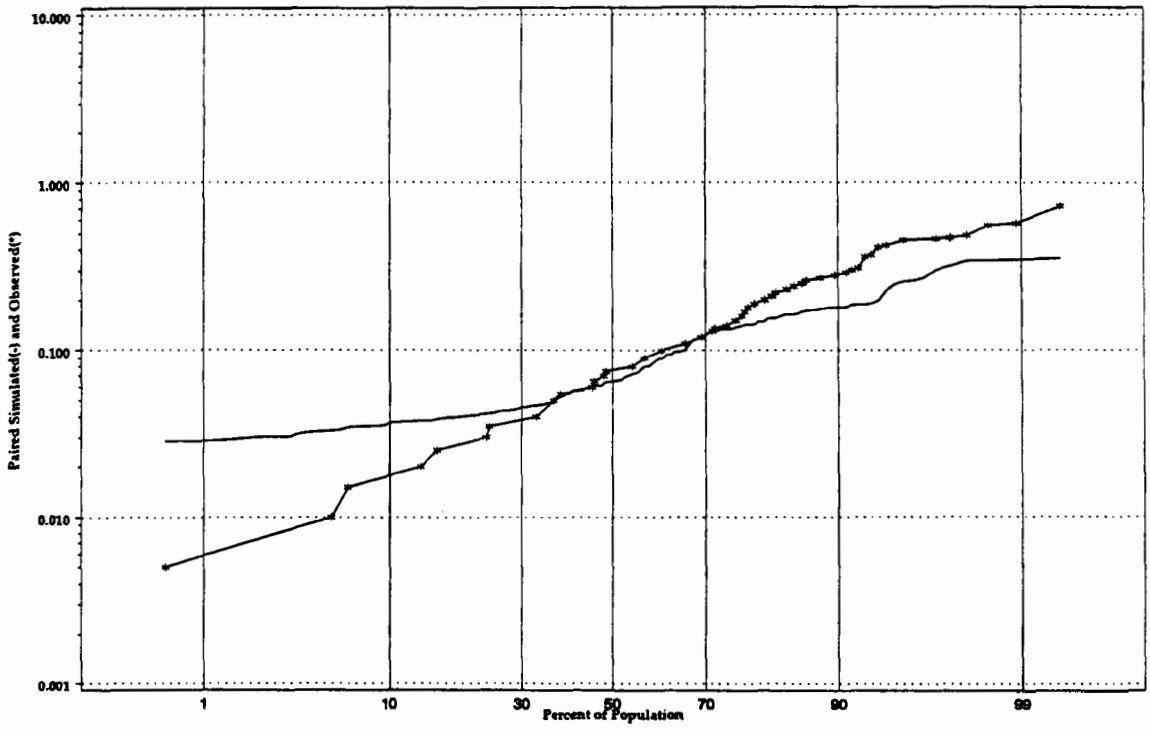
James River at Segment 280

Actual Error versus Time

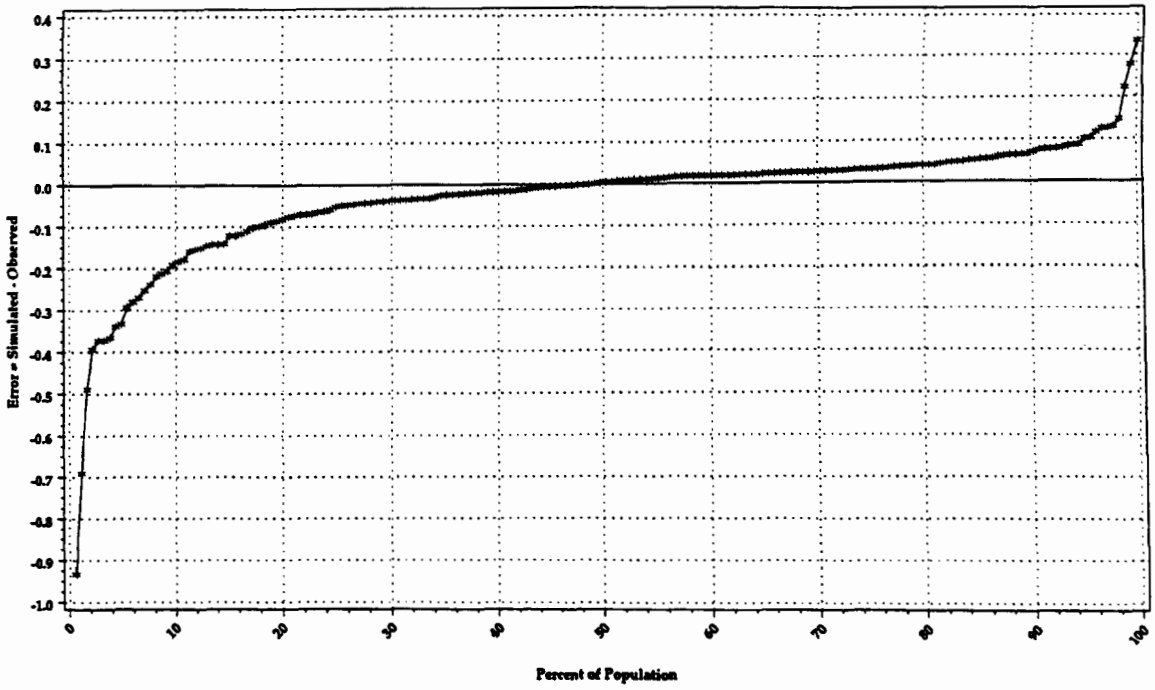
Organic and Particulate Phosphorus



James River at Segment 280
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

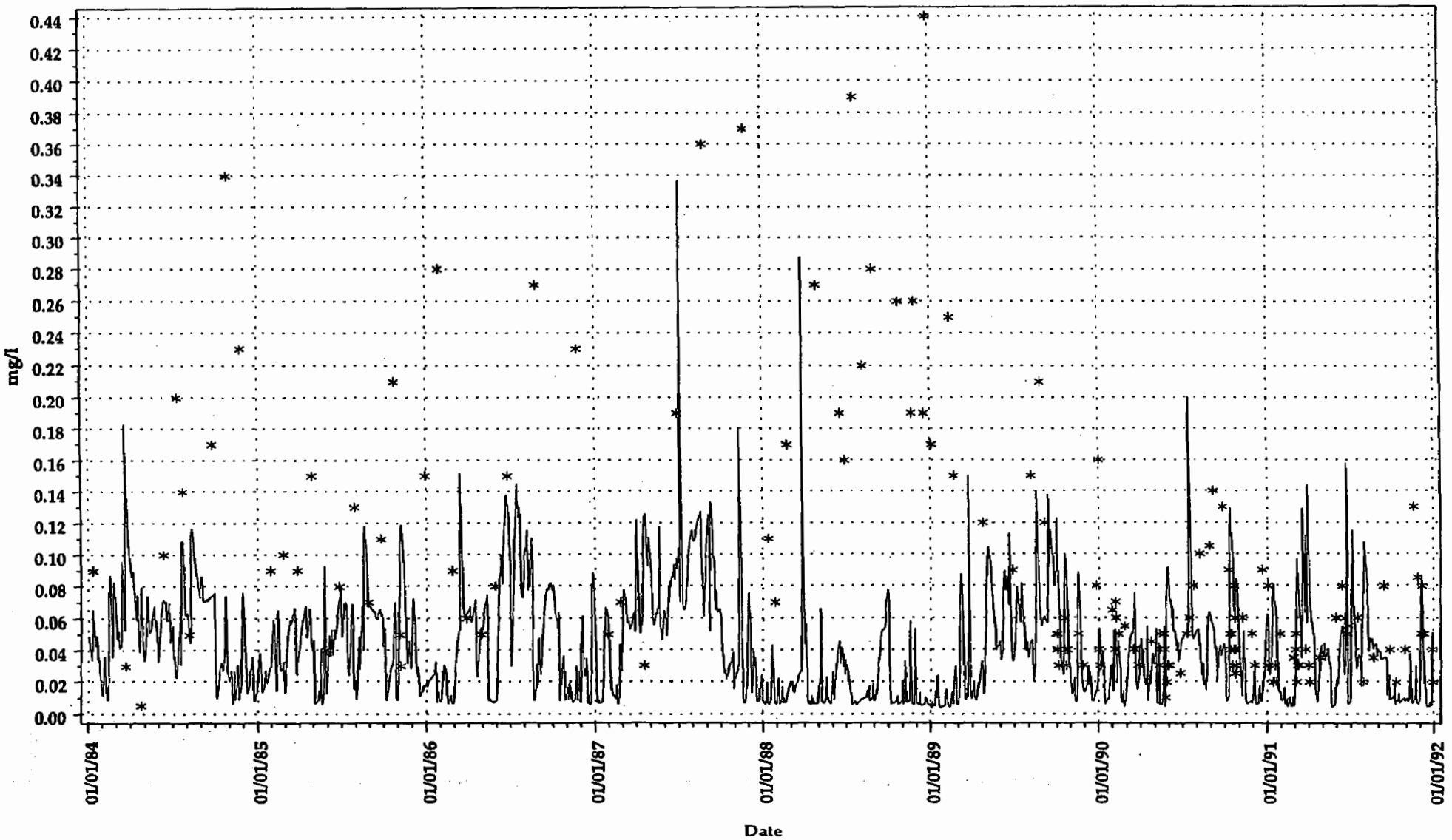


James River at Segment 280
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data



James River at Segment 280
Observed and Simulated versus Time
Dissolved Phosphorus

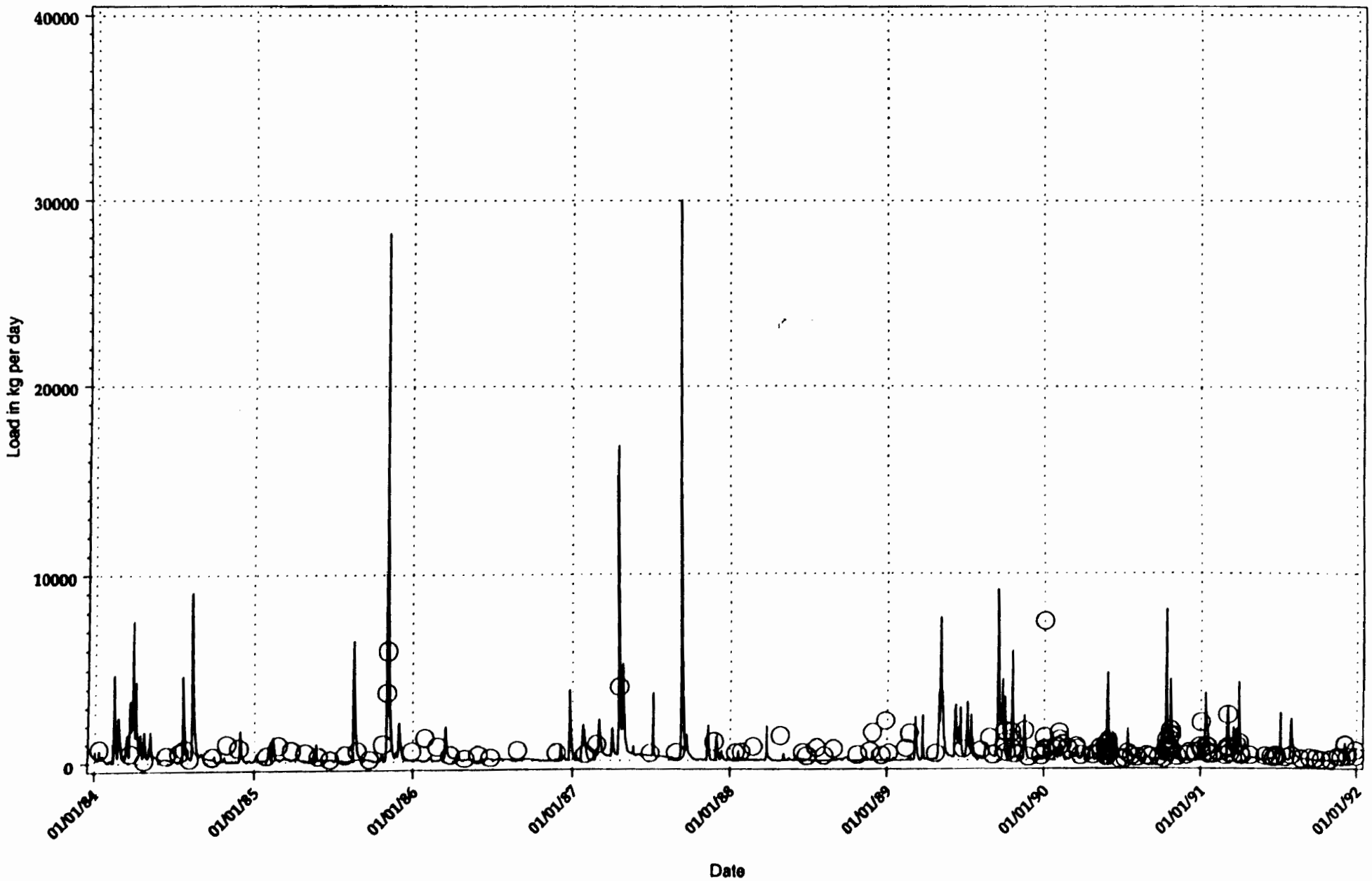
(*=Observed, -=Simulated)



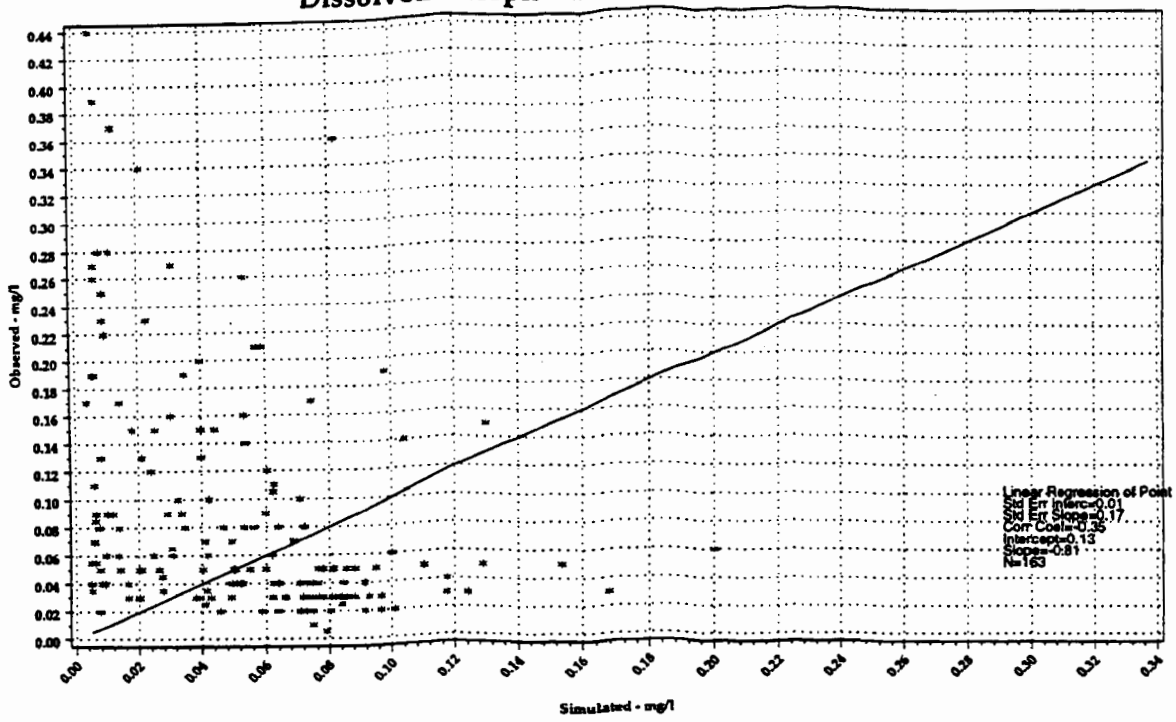
James River at Segment 280

Dissolved Phosphorus Observed and Simulated Load vs Time

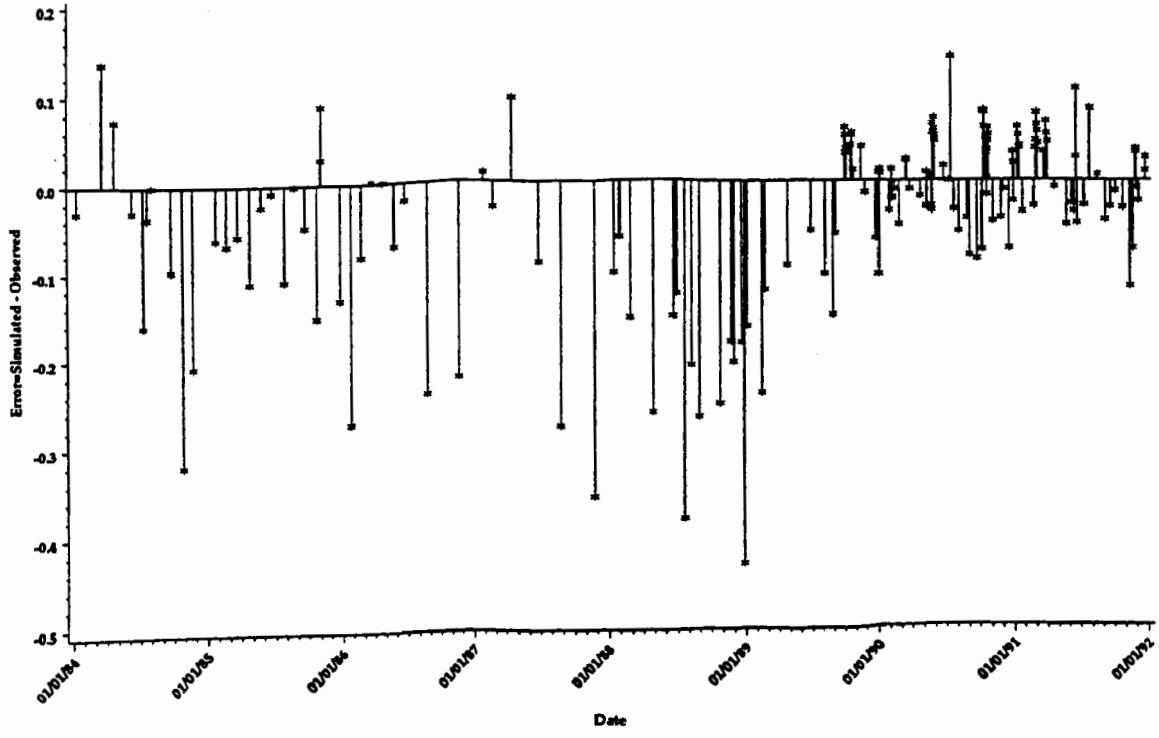
(line = simulated, O = observed)



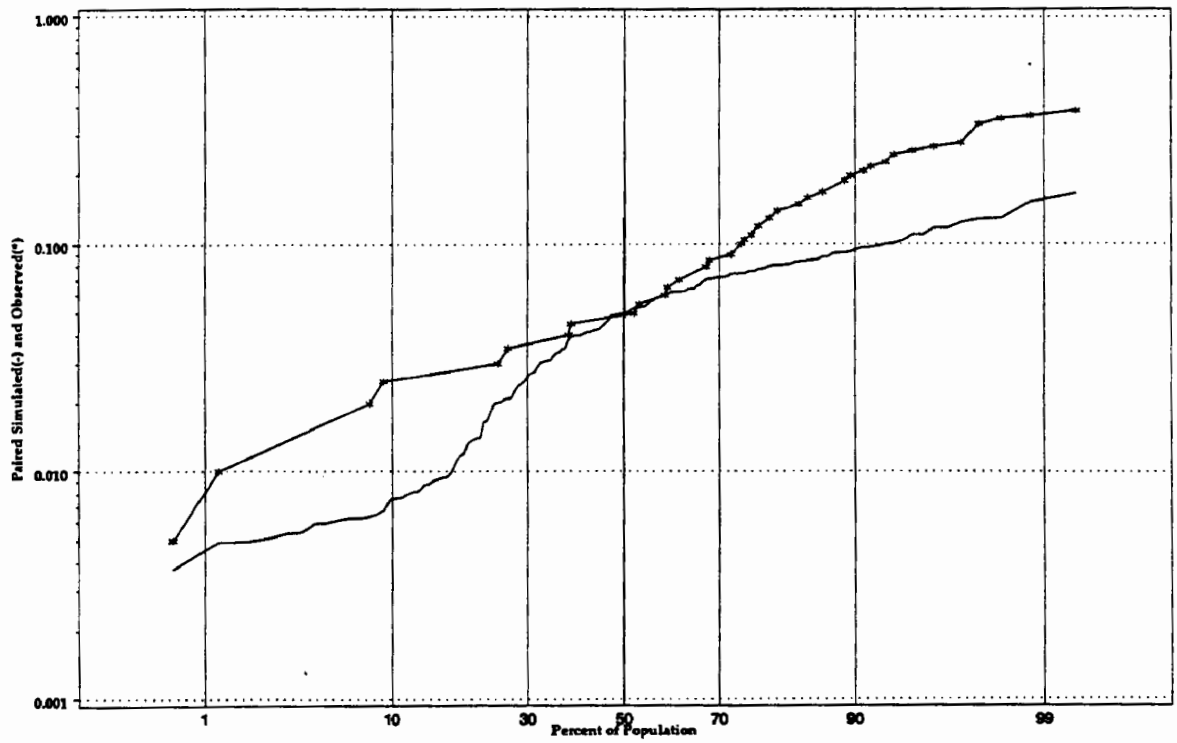
James River at Segment 280
Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Dissolved Phosphorus: 01JAN84 - 01JAN92



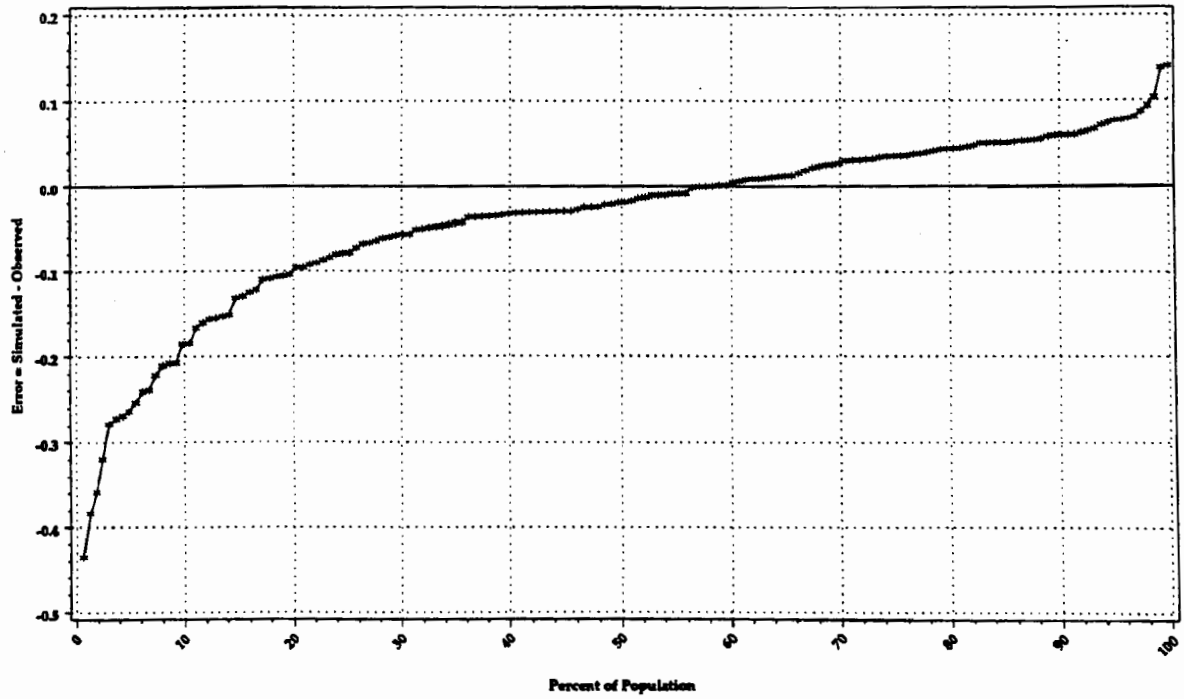
James River at Segment 280
Actual Error versus Time
Dissolved Phosphorus



James River at Segment 280
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

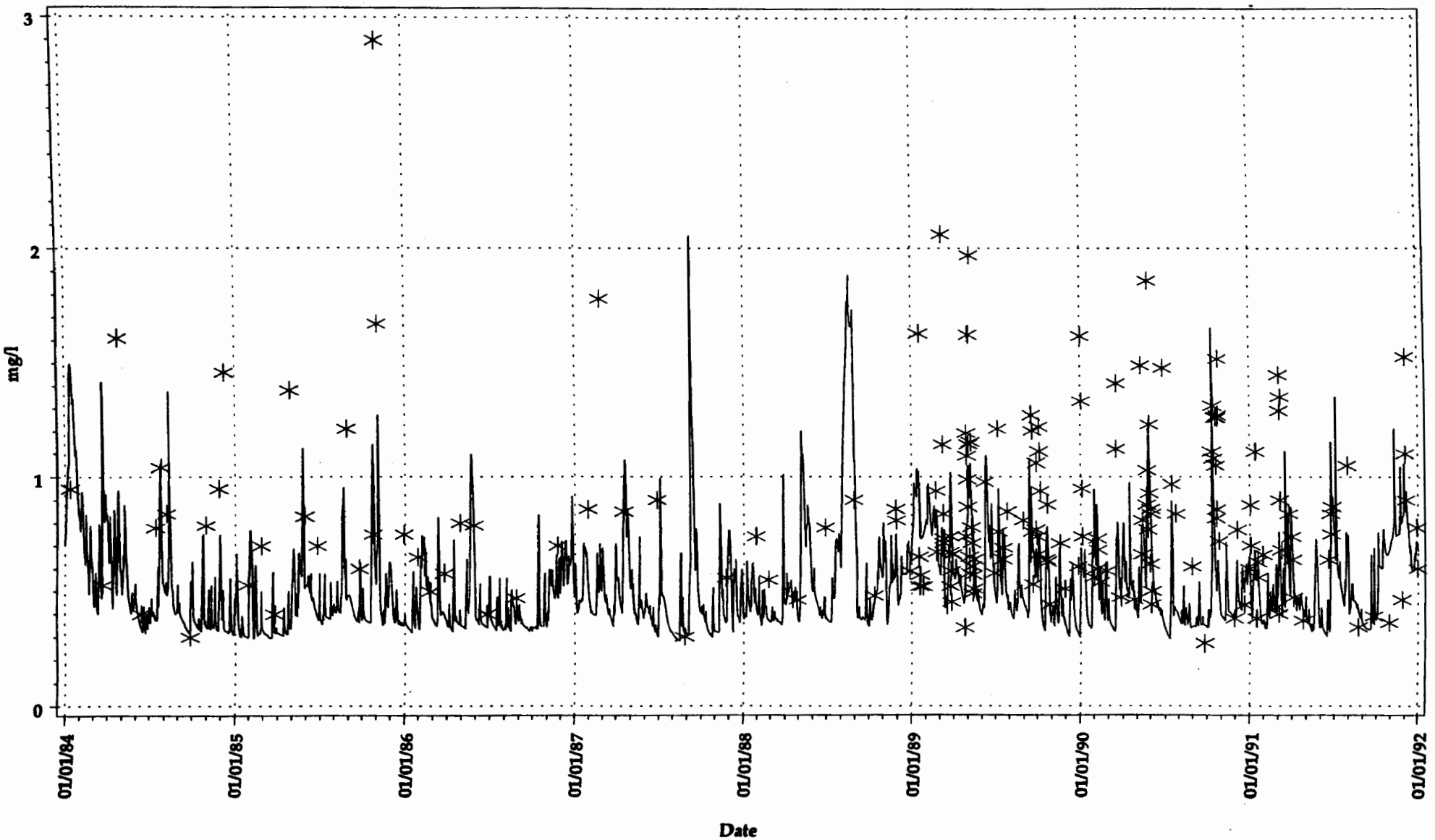


James River at Segment 280
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data

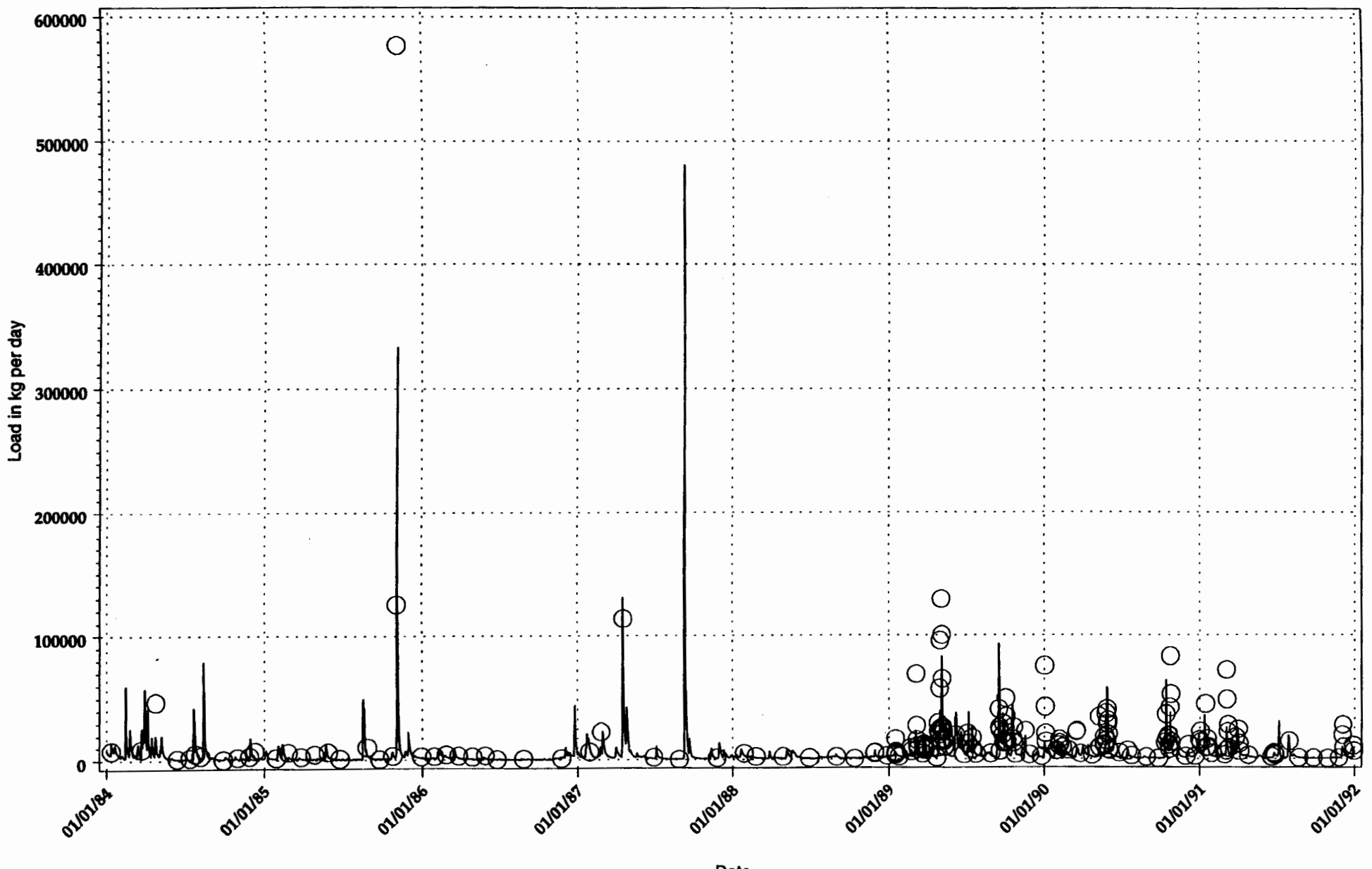


James River at Segment 280
Observed and Simulated versus Time
Total Nitrogen

(*=Observed, -=Simulated)



James River at Segment 280
Total Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)

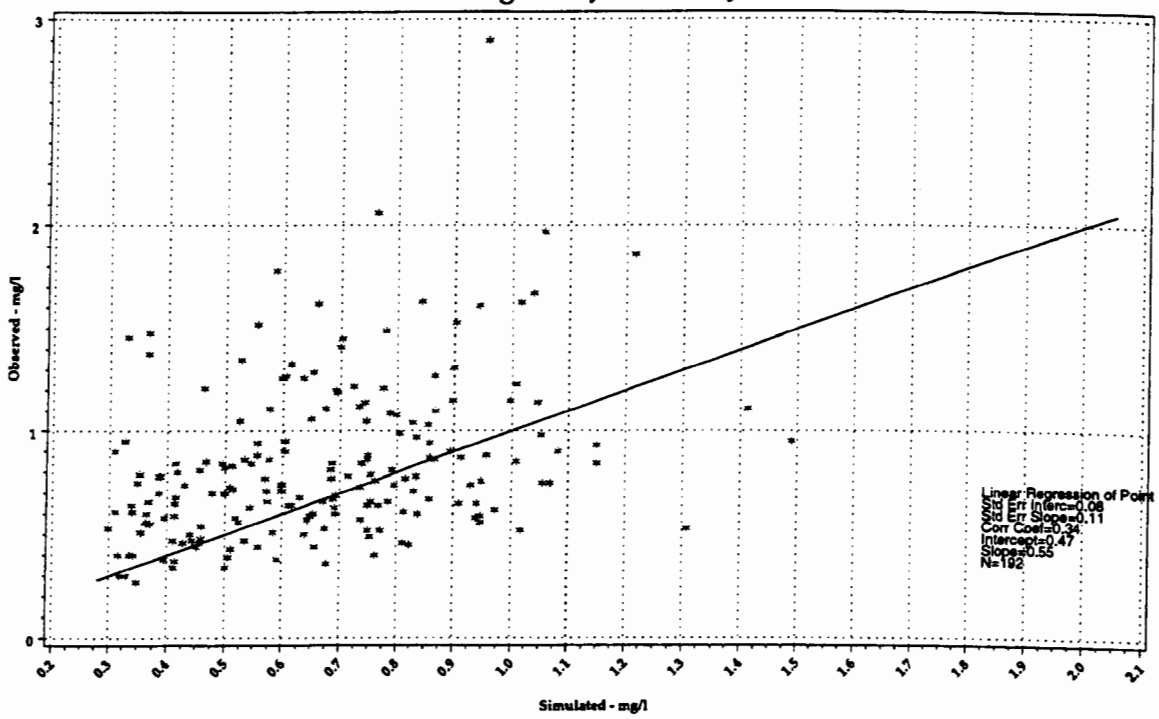


(y21_plotb.sas model3d [pwang.dt] tidfiss)
(2.div 23FEB98 11:33,proc reg,model y=x)

James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

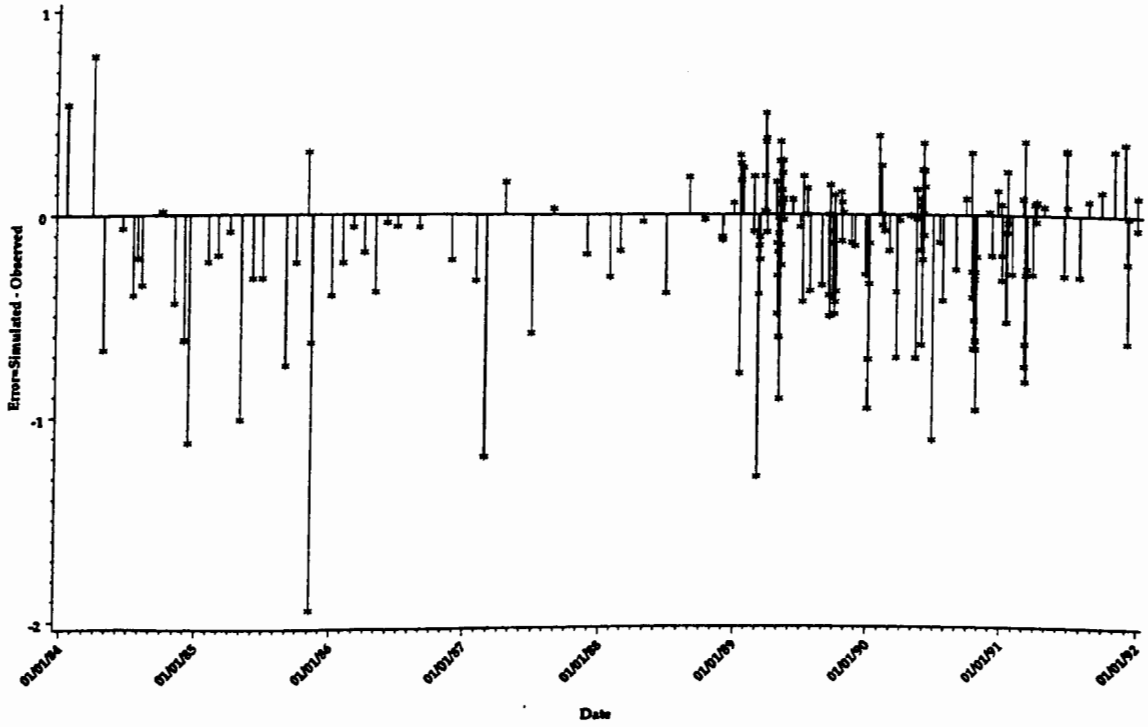
Total Nitrogen: 01JAN84 - 01JAN92



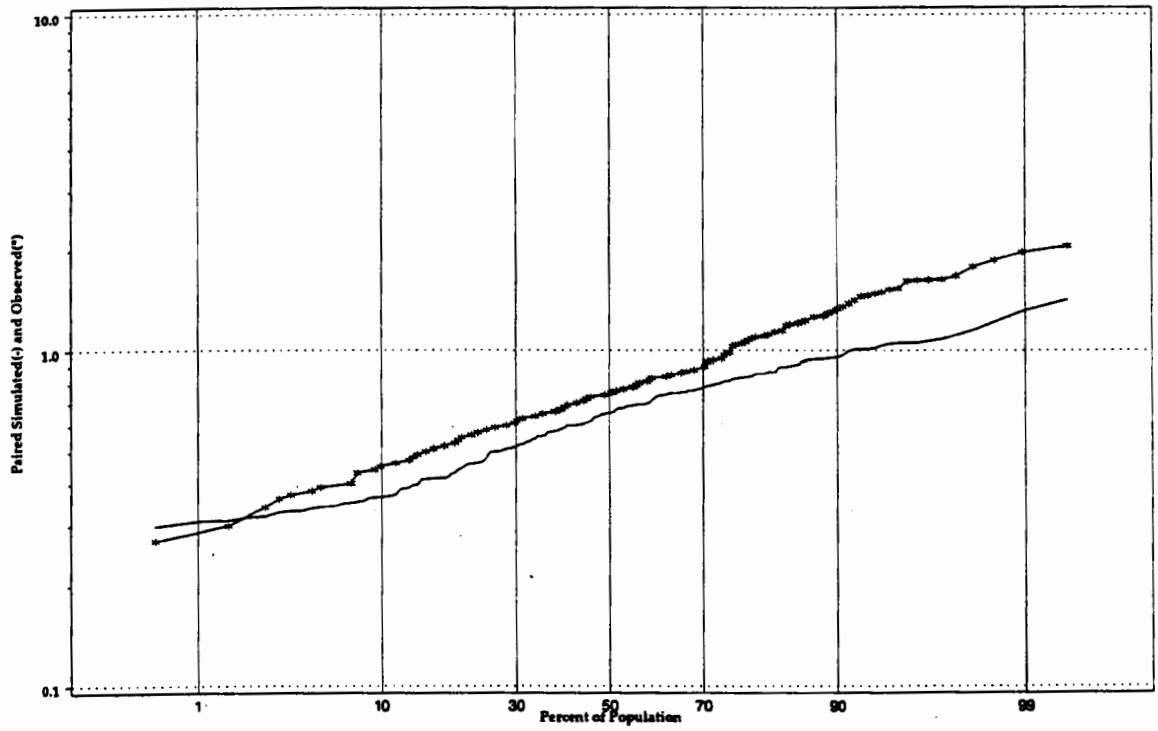
James River at Segment 280

Actual Error versus Time

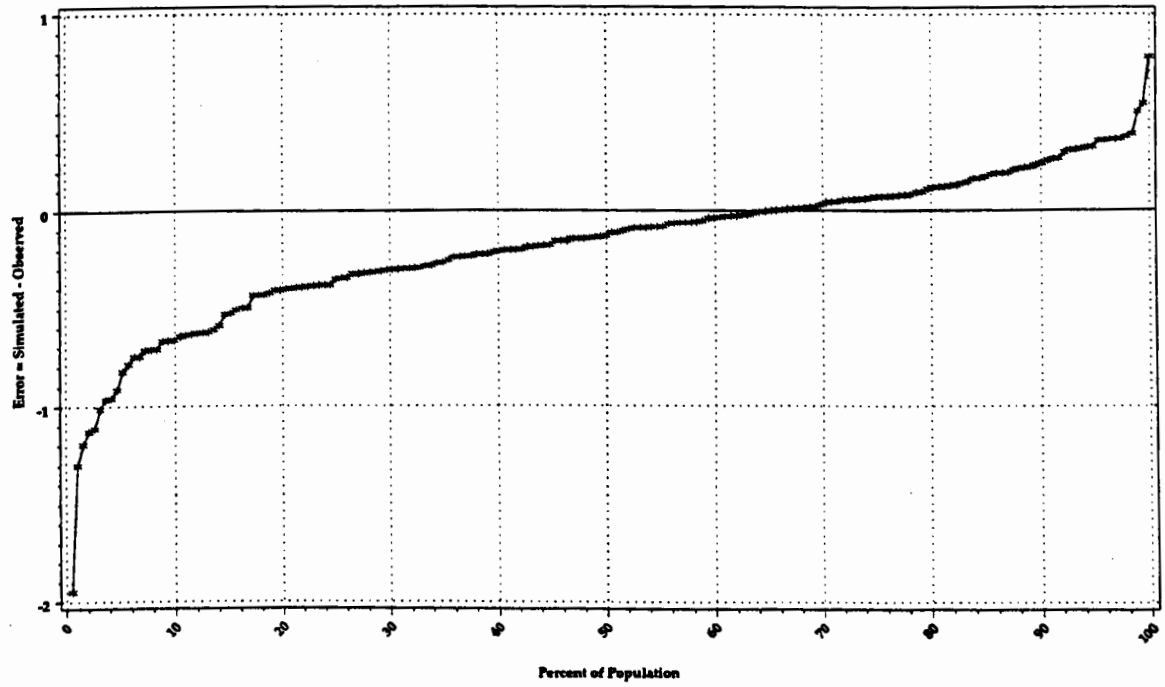
Total Nitrogen



James River at Segment 280
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

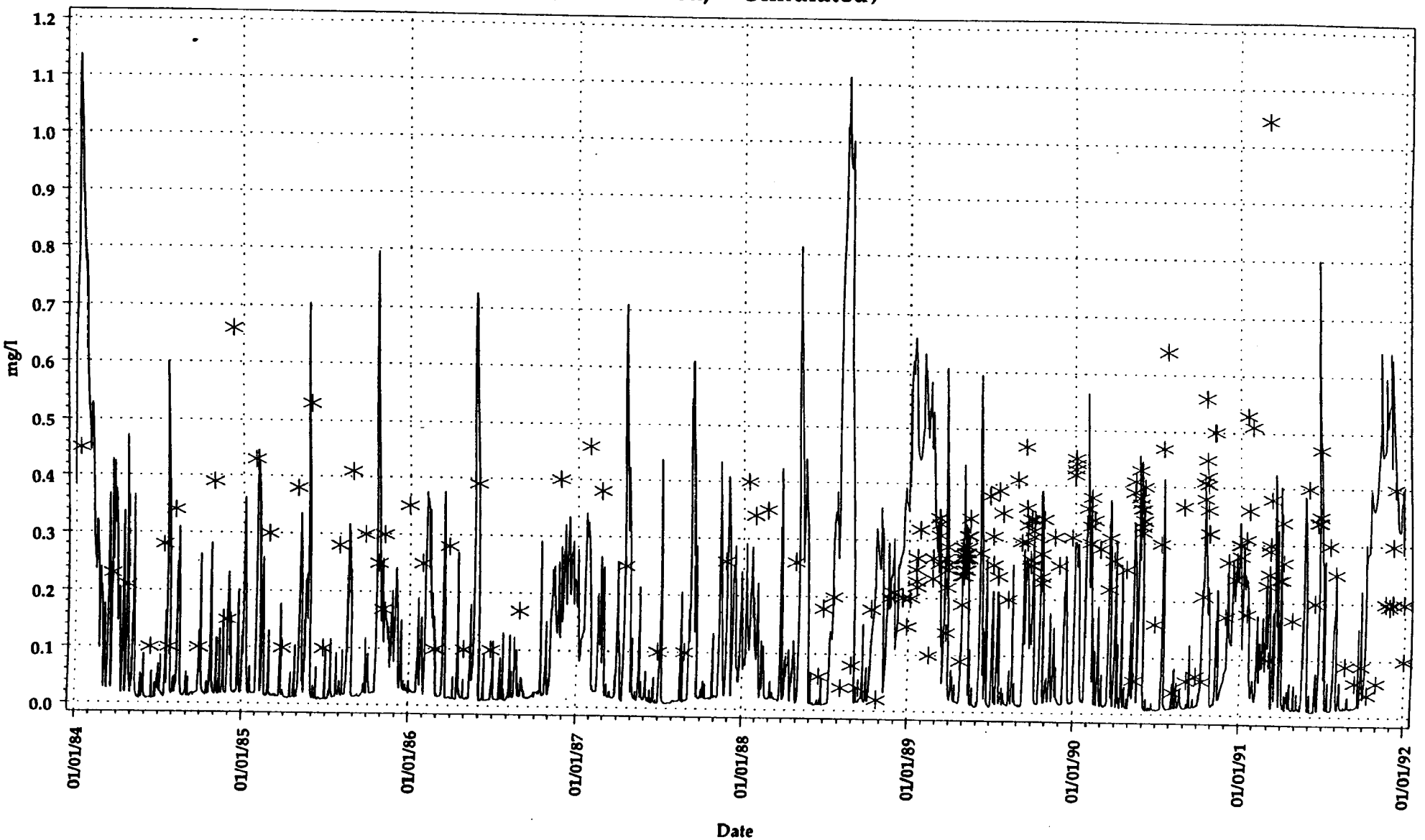


James River at Segment 280
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data

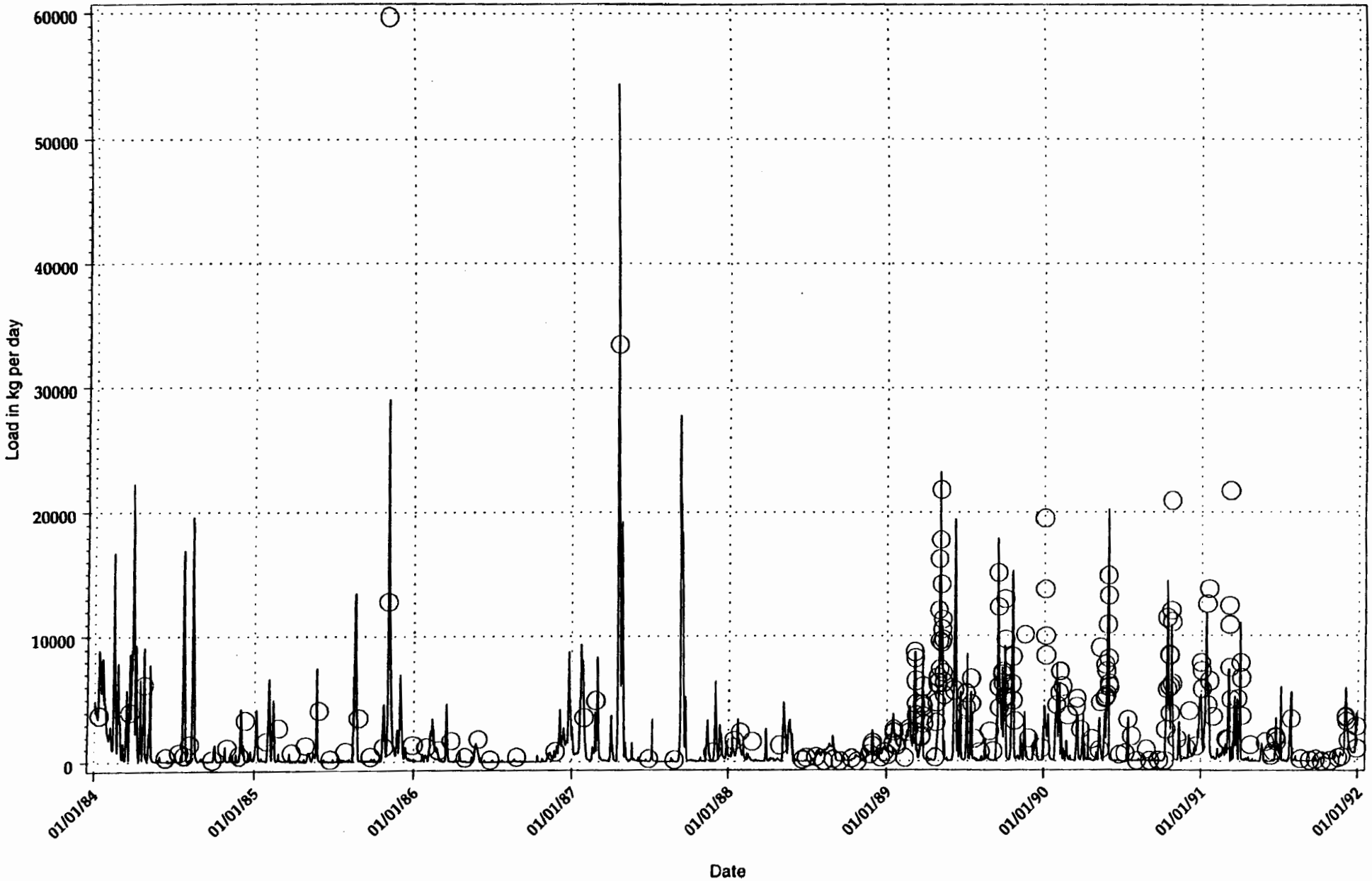


James River at Segment 280
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



James River at Segment 280
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

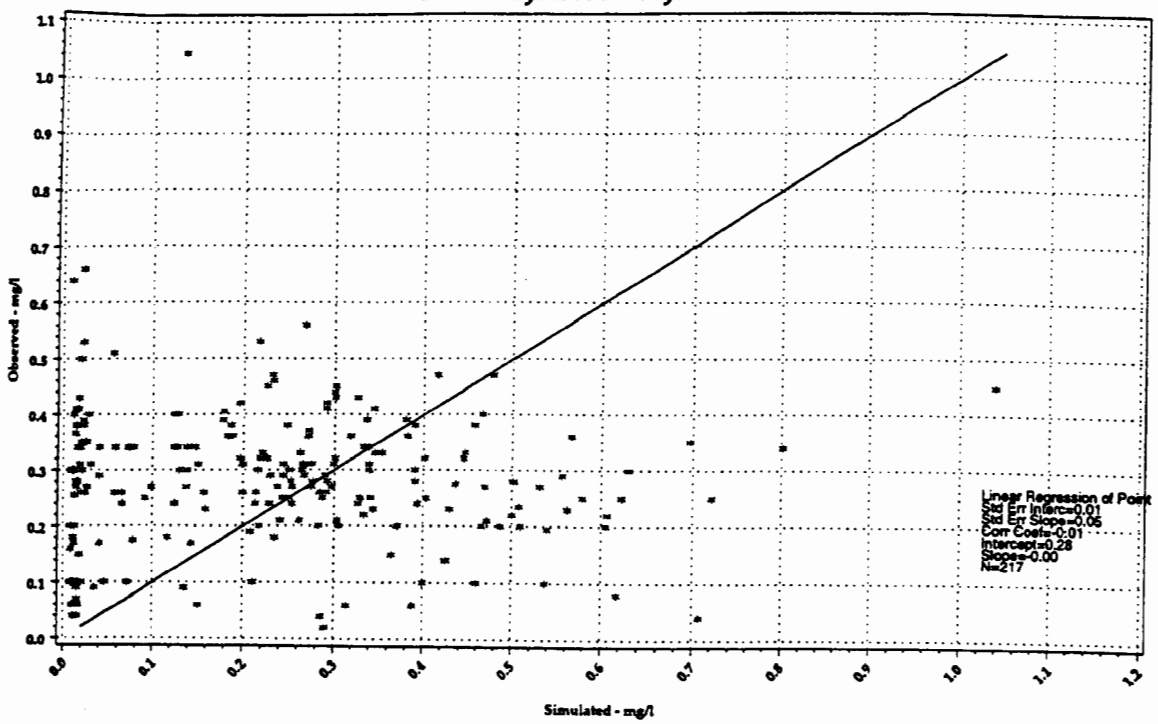


(y21_plot1.sas datastore2 [rps p3 james sas] lldilas)
(g2.drv 04FEB98 17:01 proc reg model y=x)

James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

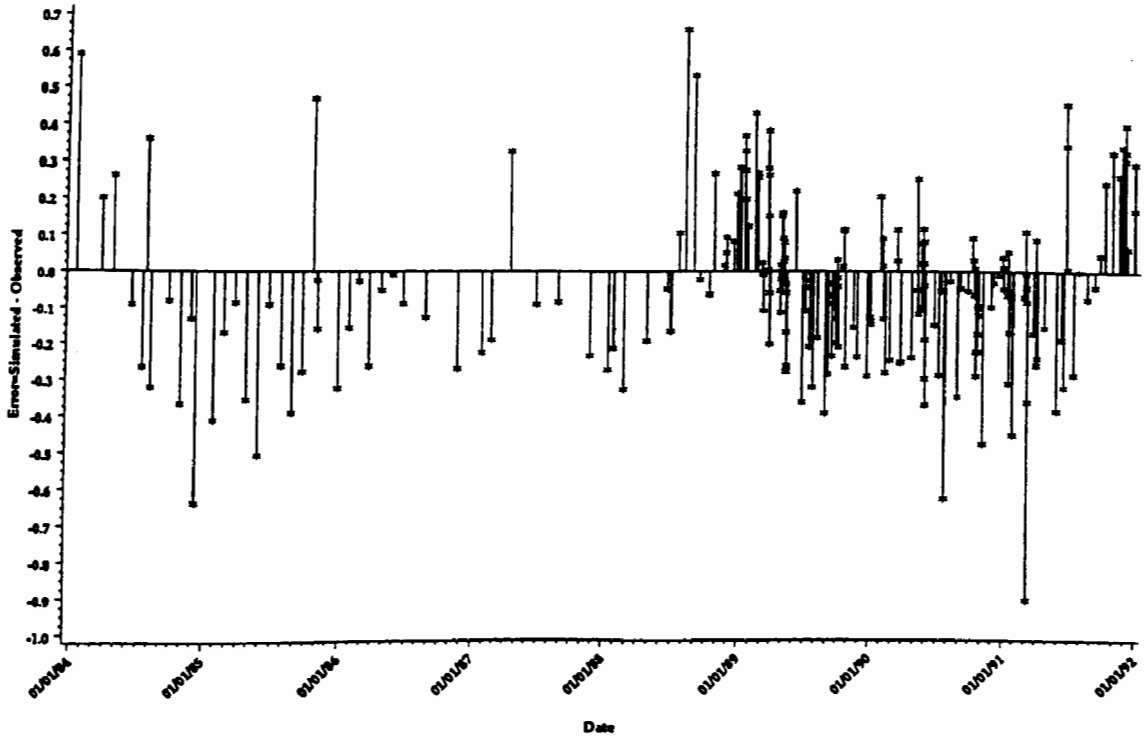
NO3: 01JAN84 - 01JAN92



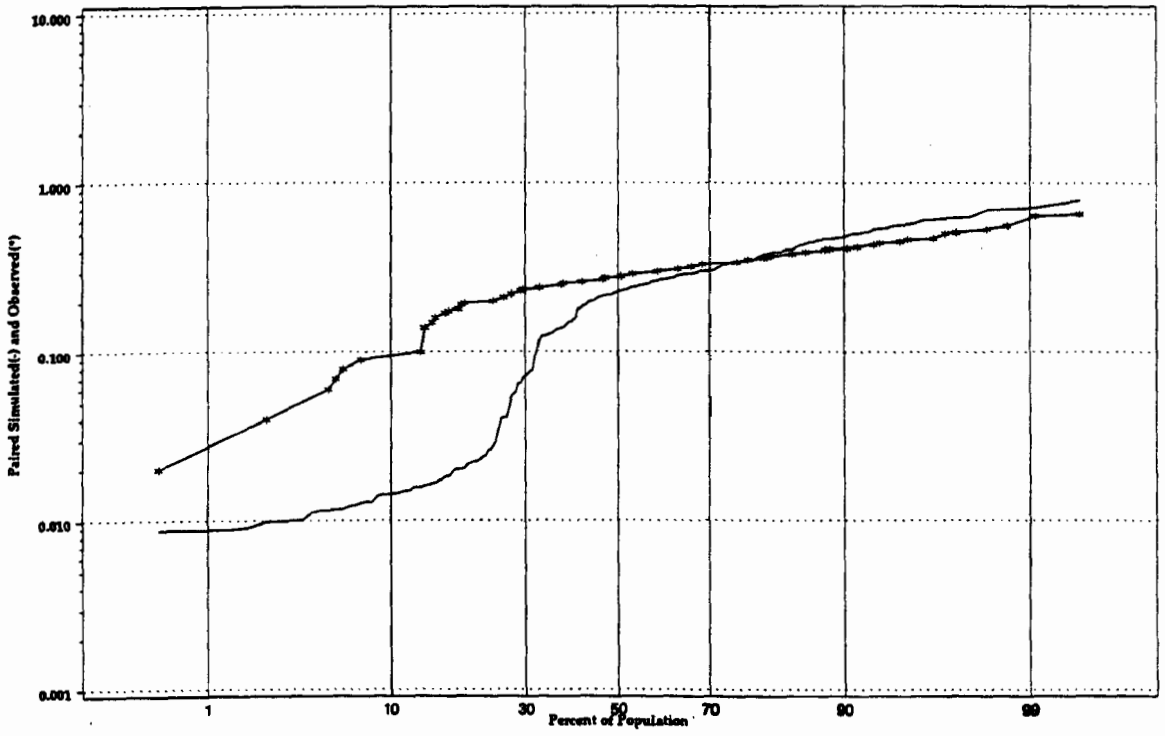
James River at Segment 280

Actual Error versus Time

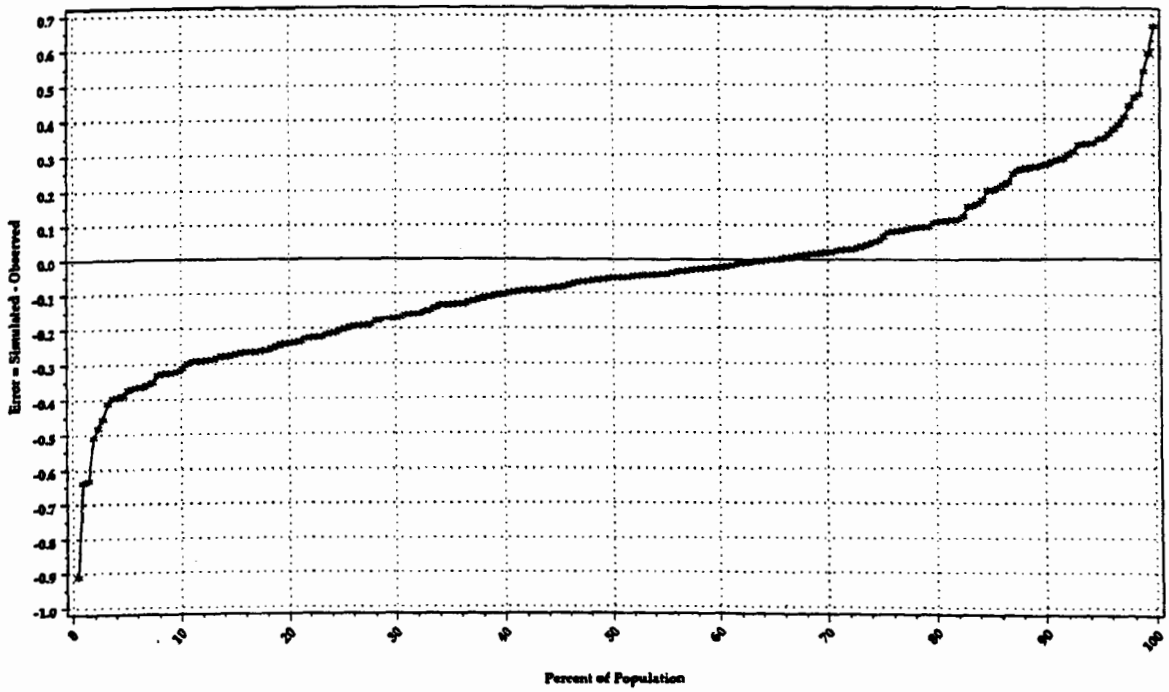
NO3



James River at Segment 280
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

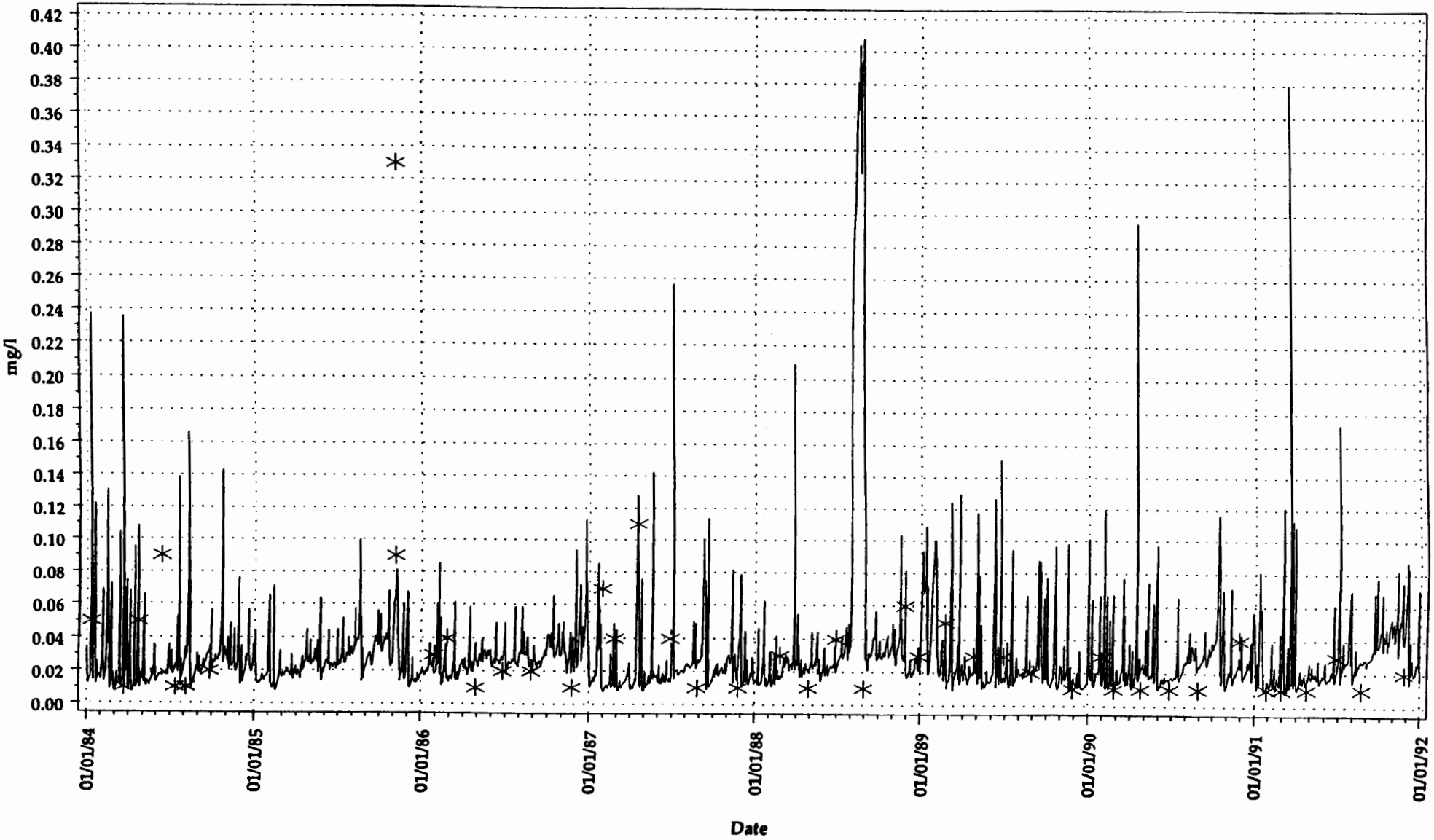


James River at Segment 280
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data



James River at Segment 280
Observed and Simulated versus Time
Total Ammonia

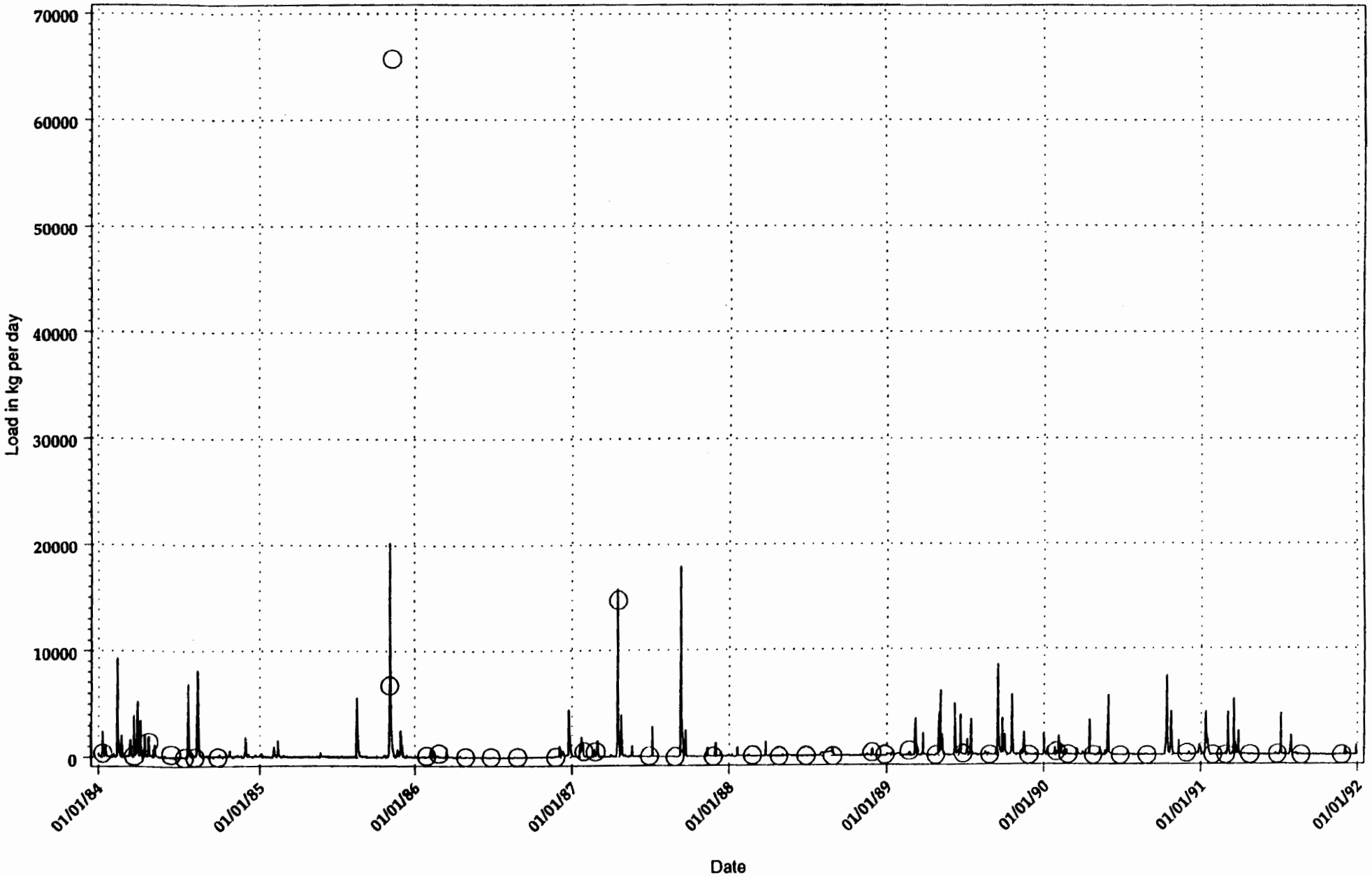
(*=Observed, -=Simulated)



James River at Segment 280

Total Ammonia Observed and Simulated Load vs Time

(line = simulated, O = observed)

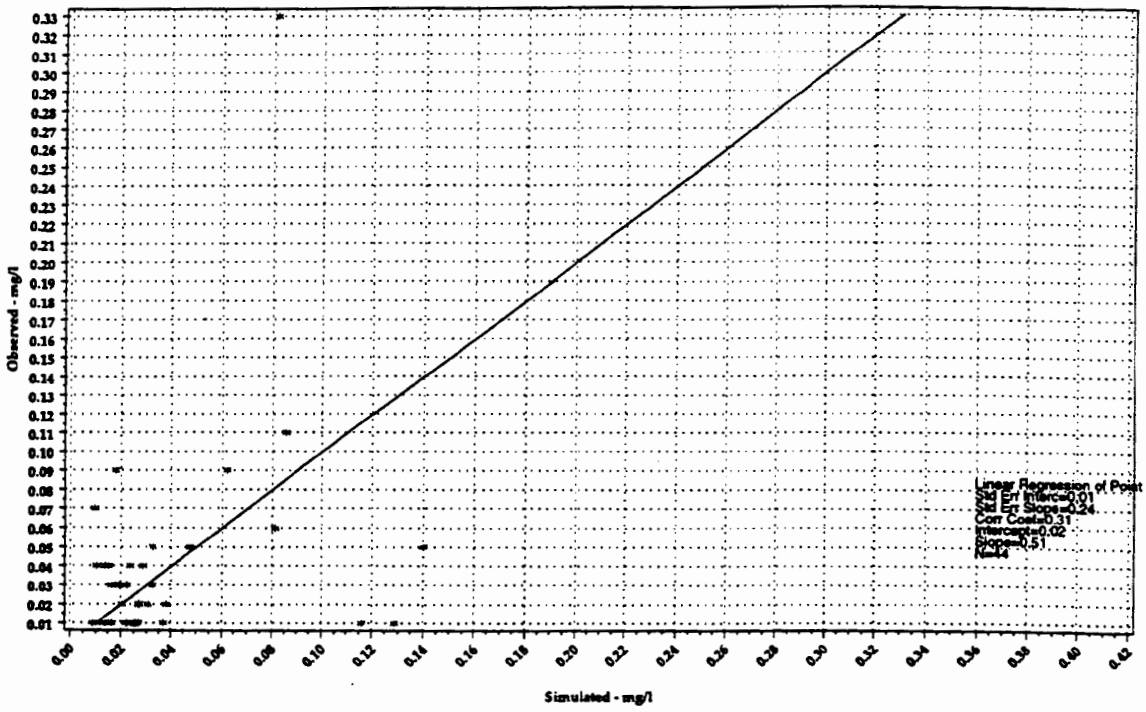


(y21_plot1 sas dataslore2 jrqs p3 james sas) lidlas)
(jz drv 04FEB98 17 01 proc reg model y=x)

James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

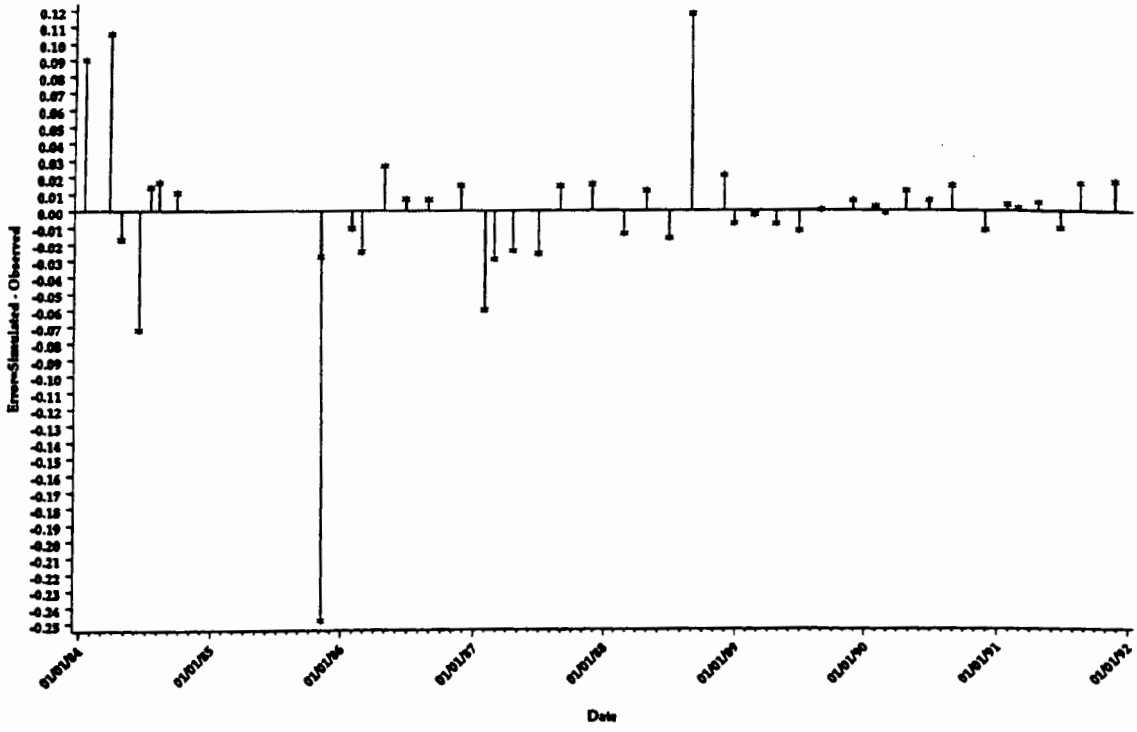
Total Ammonia: 01JAN84 - 01JAN92



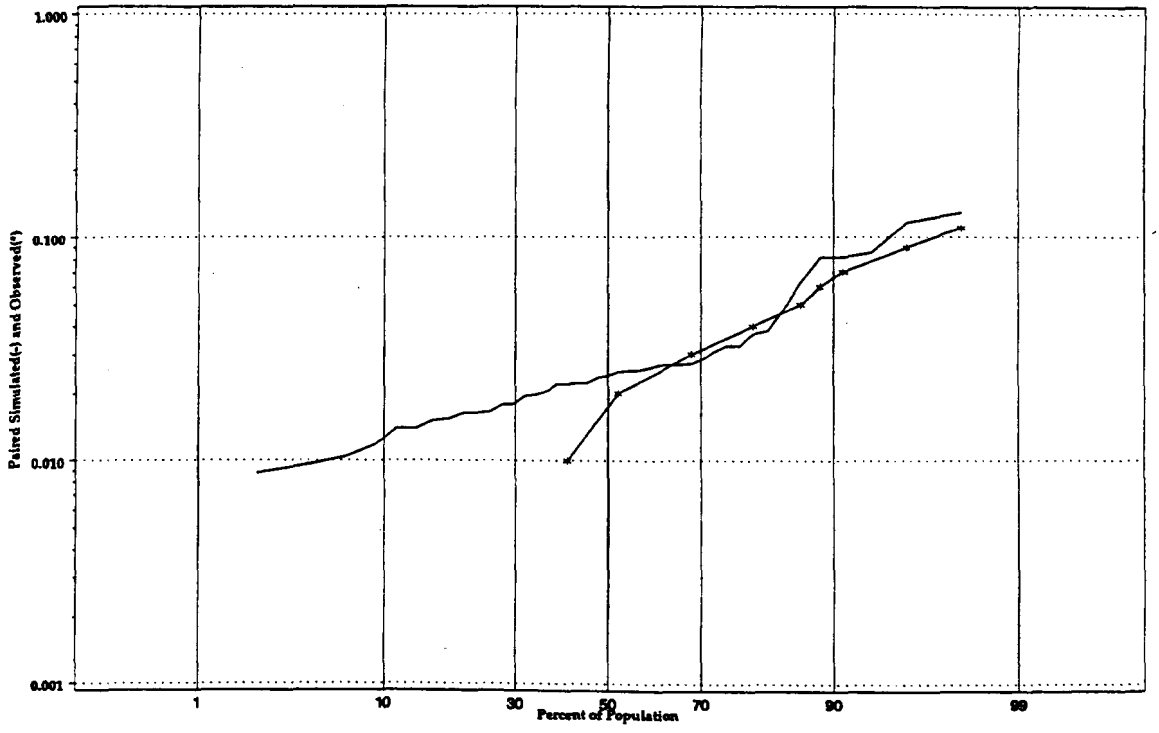
James River at Segment 280

Actual Error versus Time

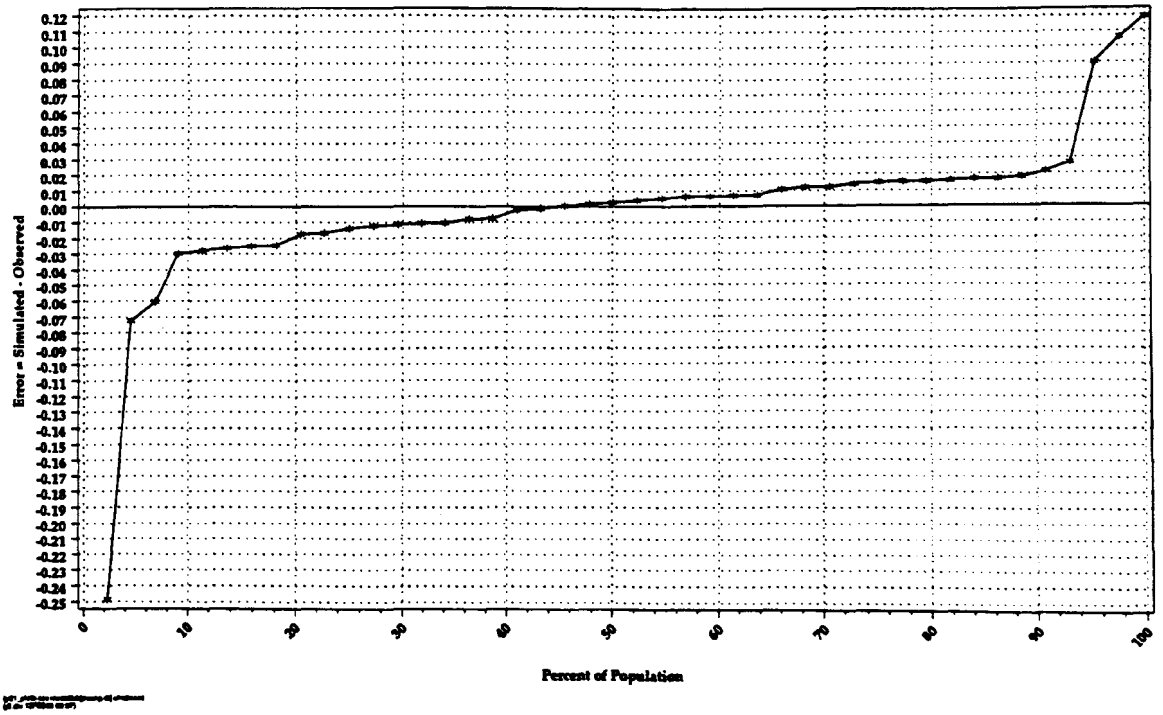
Total Ammonia



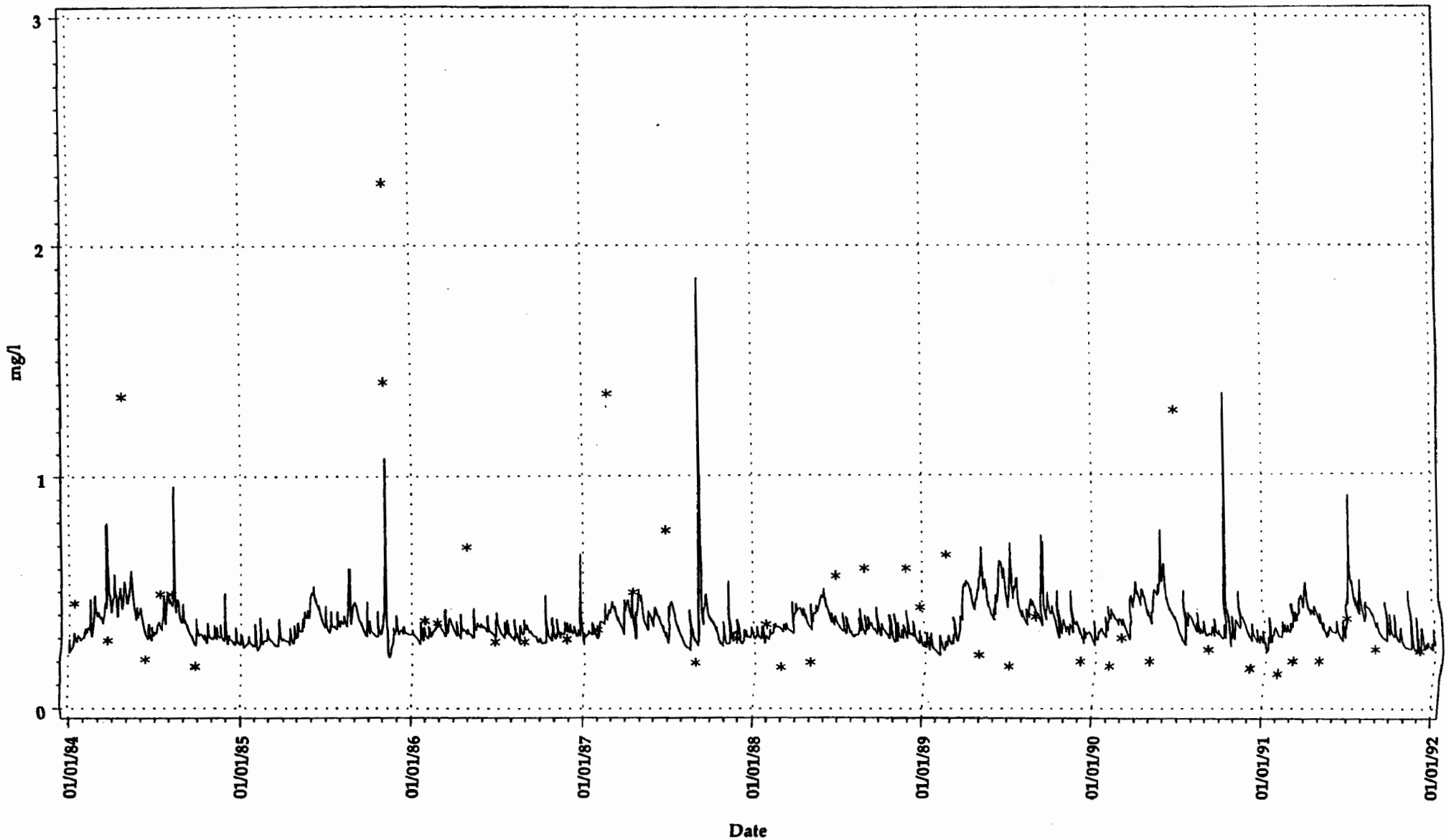
James River at Segment 280
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



James River at Segment 280
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



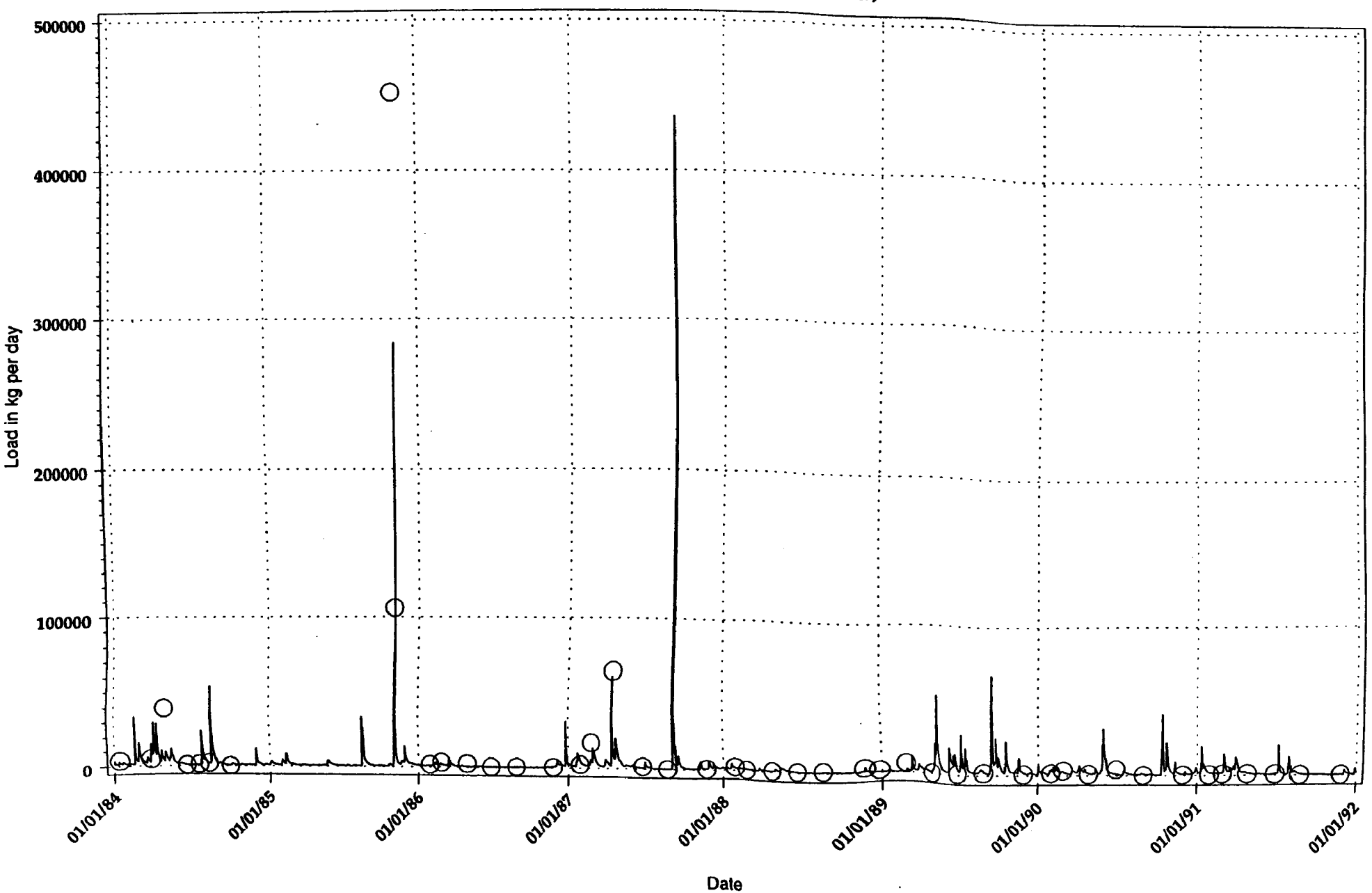
James River at Segment 280
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)



James River at Segment 280

Organic Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)

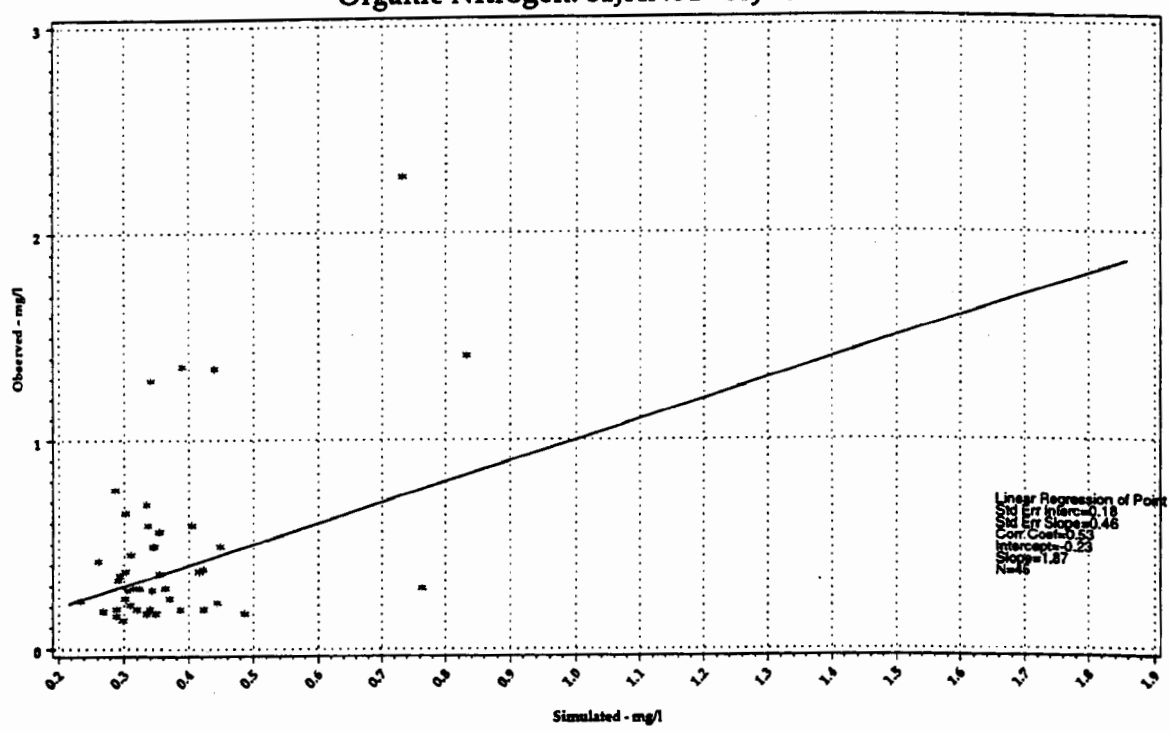


(y21_plot1.sas datastore2.[nps.p3 james.sas] lidfile)
(g2.dev 04FEB98 17.01,proc reg,model y=x)

James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

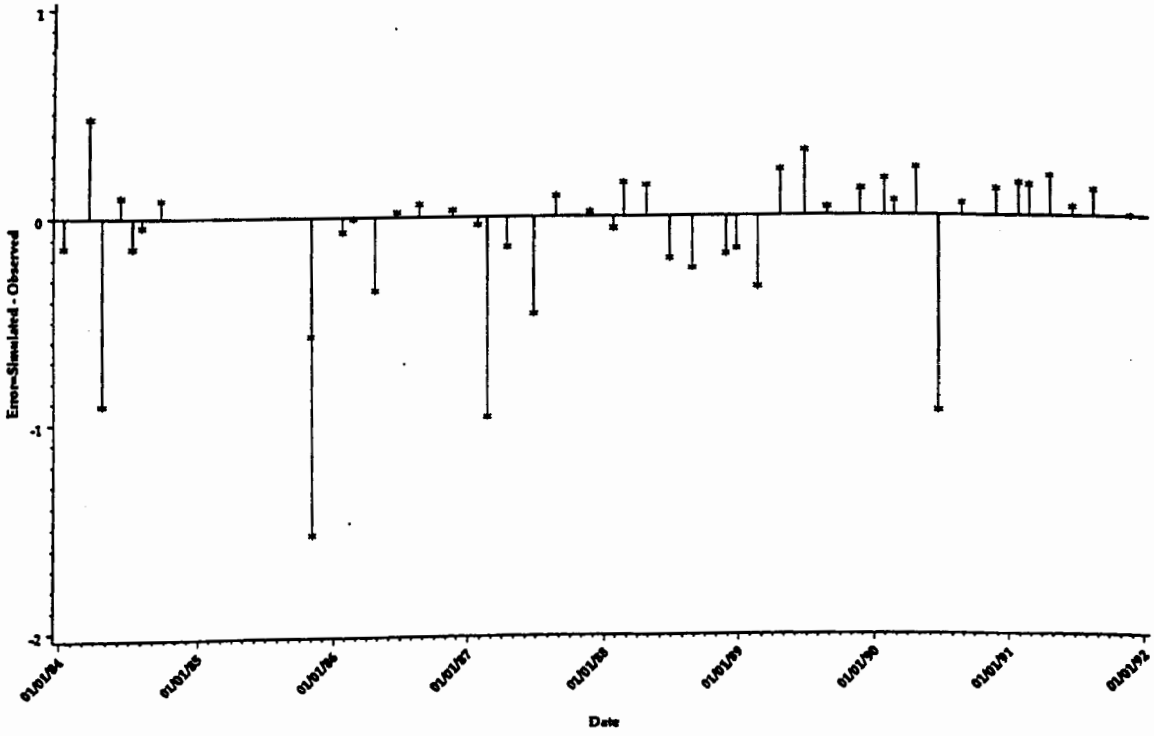
Organic Nitrogen: 01JAN84 - 01JAN92



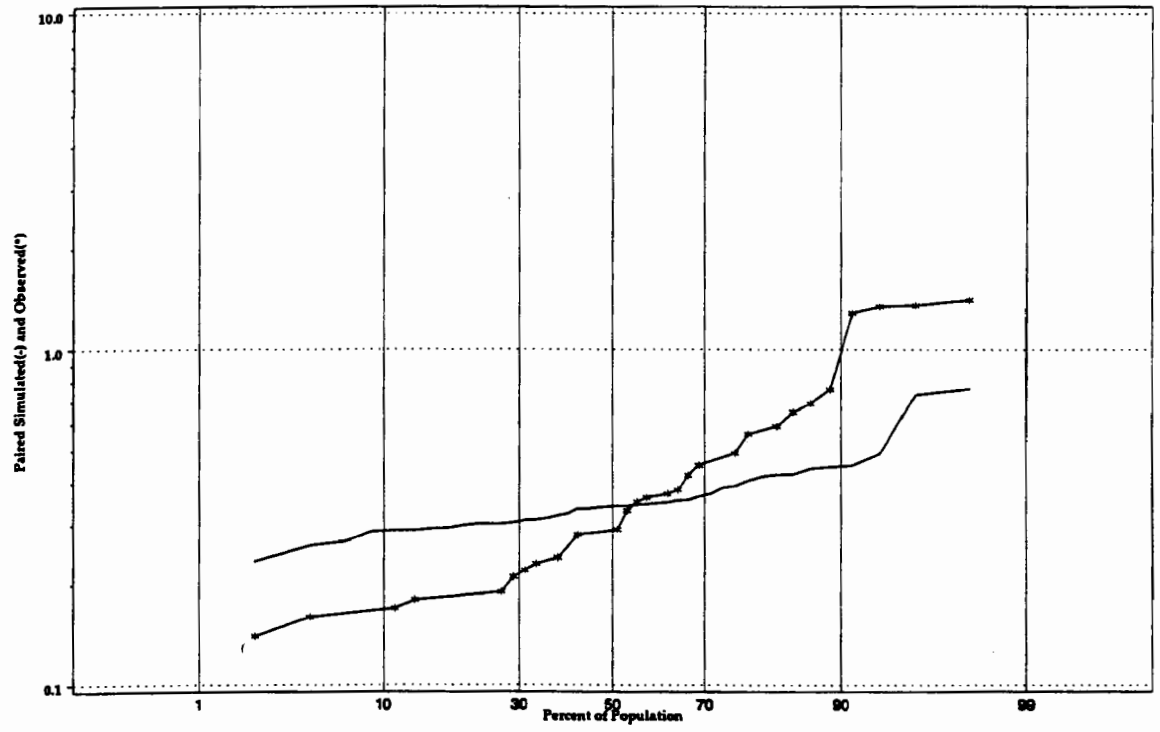
James River at Segment 280

Actual Error versus Time

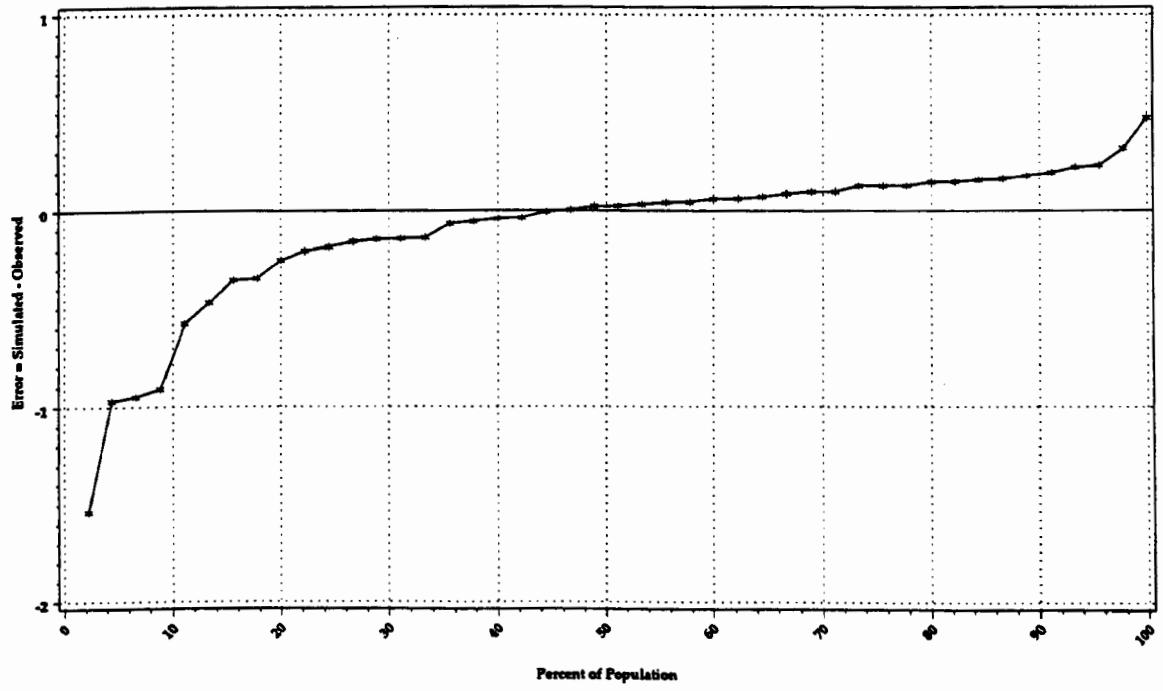
Organic Nitrogen



James River at Segment 280
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



James River at Segment 280
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.6.2 Appomattox River at Matoaca, VA at Segment 310 (Monitoring Station: 2041650) (Above Fall Line Basin Segments: 300 and 310)

Section Summary:

The Appomattox basin water quality gage is below a series of reservoirs, which influence water quality at the gage. As with other Virginia tributaries, water quality observations increased and were oriented toward storm weighted sampling after 1989. Model calibration focused primarily on the refined, storm weighted sampling after 1989.

The Appomattox basin above the gaged site covers an area of 1,352 square miles. At the midpoint of the simulation, 1990, the land use for the basin was composed of 70% forest land, 8% cropland, 16% other agricultural areas, 6% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 2.3 million pounds in 1985 to 2.1 million pounds in 1996. Total phosphorus loads over the same time period decreased from 0.20 million pounds to 0.18 million pounds. In general, point source loads above the gage site decreased. In 1996, the total nitrogen point source load was 2% of the total load and the total phosphorus point source load was 4% of the total load. Estimated septic system total nitrogen loads increased 11%, from 0.10 million pounds in 1985 to 0.11 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 16%, and other agricultural loads (primarily pasture and manure loads) by 11%. Total phosphorus decreased for these land uses by 26% and 12% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 12% for total nitrogen and 14% for total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

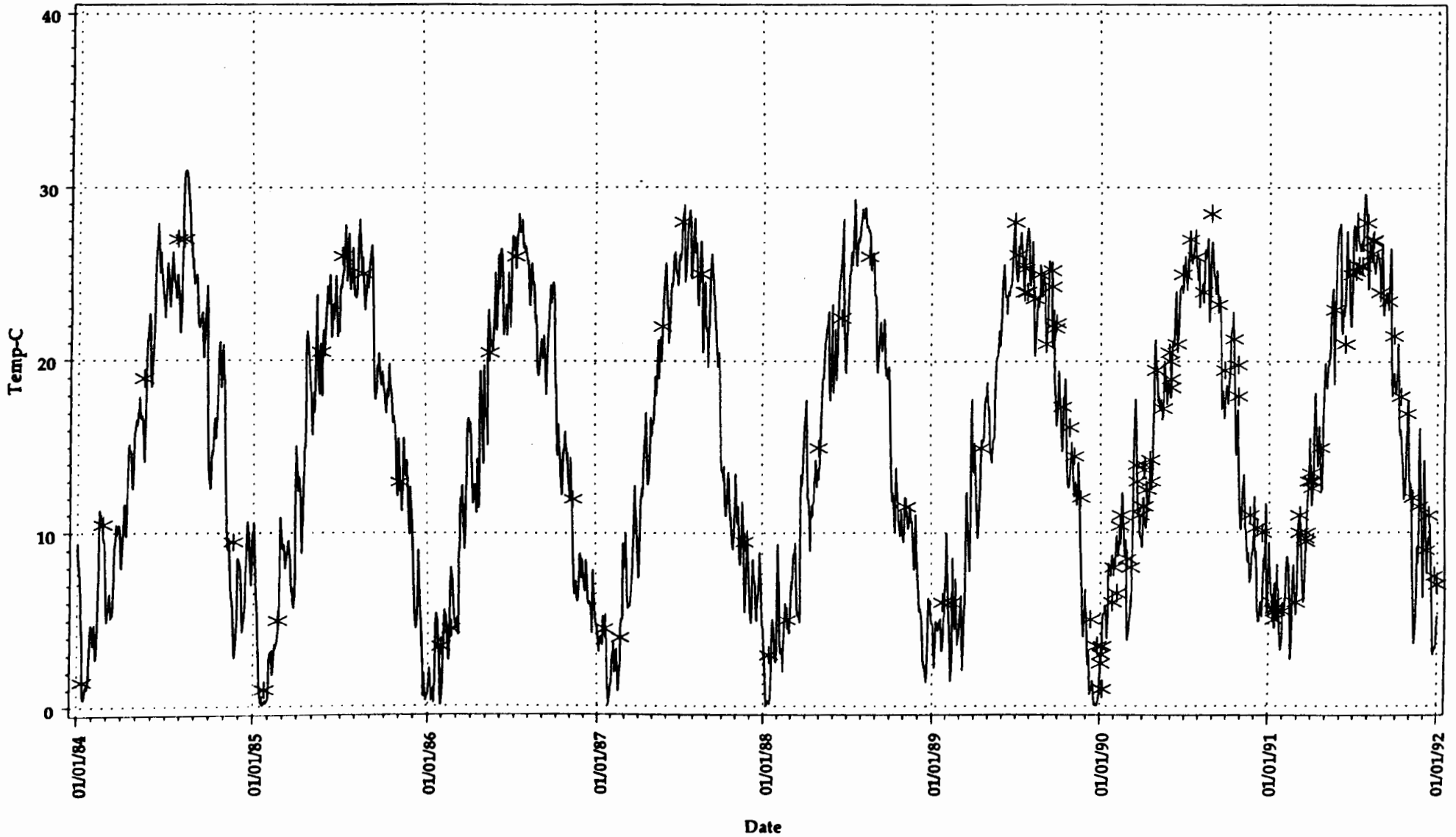
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

Appomattox River at Segment 310
Observed and Simulated versus Time
Temperature-C

(*=Observed, -=Simulated)

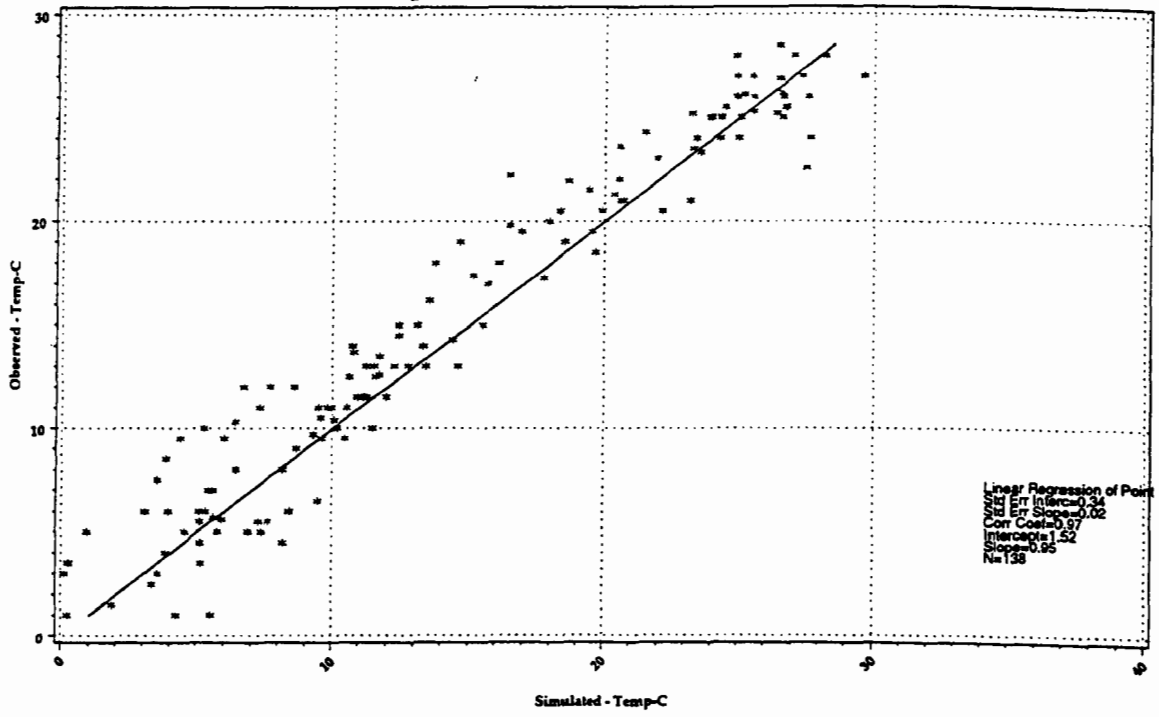


(y21_plot1.sas datastore2:[ppp p3.james.sas] plotomi - omdime)
(graph_a div 26AUG97 15:22)

Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

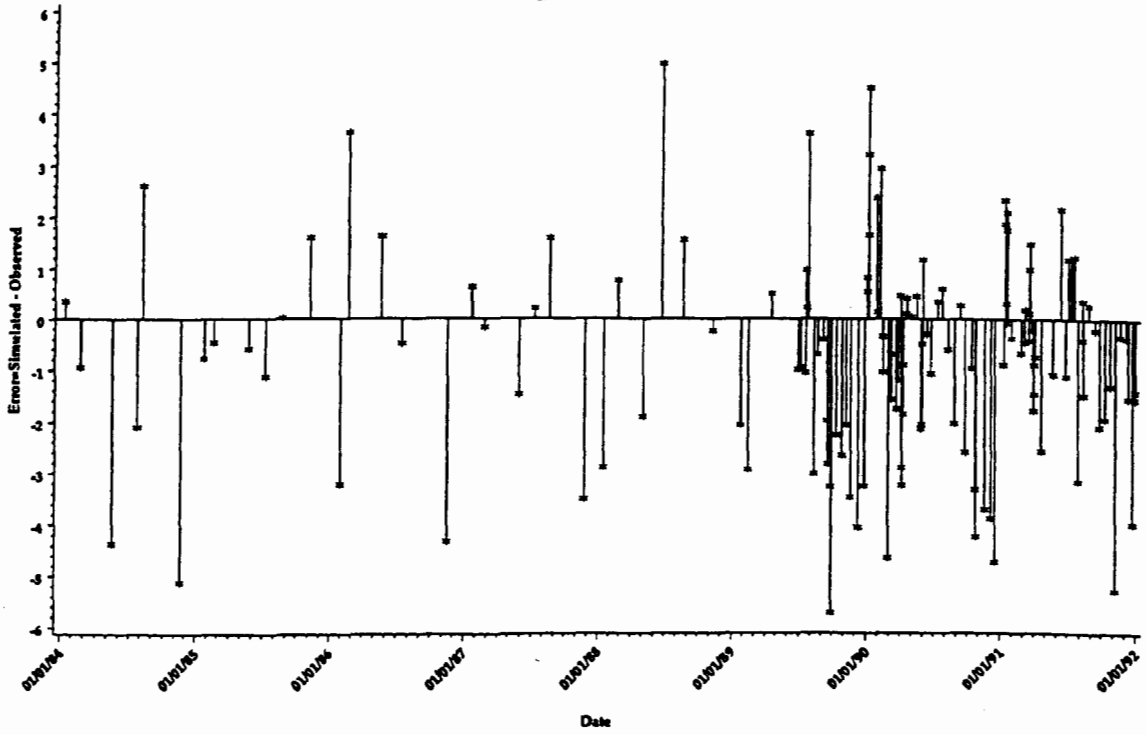
Temperature-C: 01JAN84 - 01JAN92



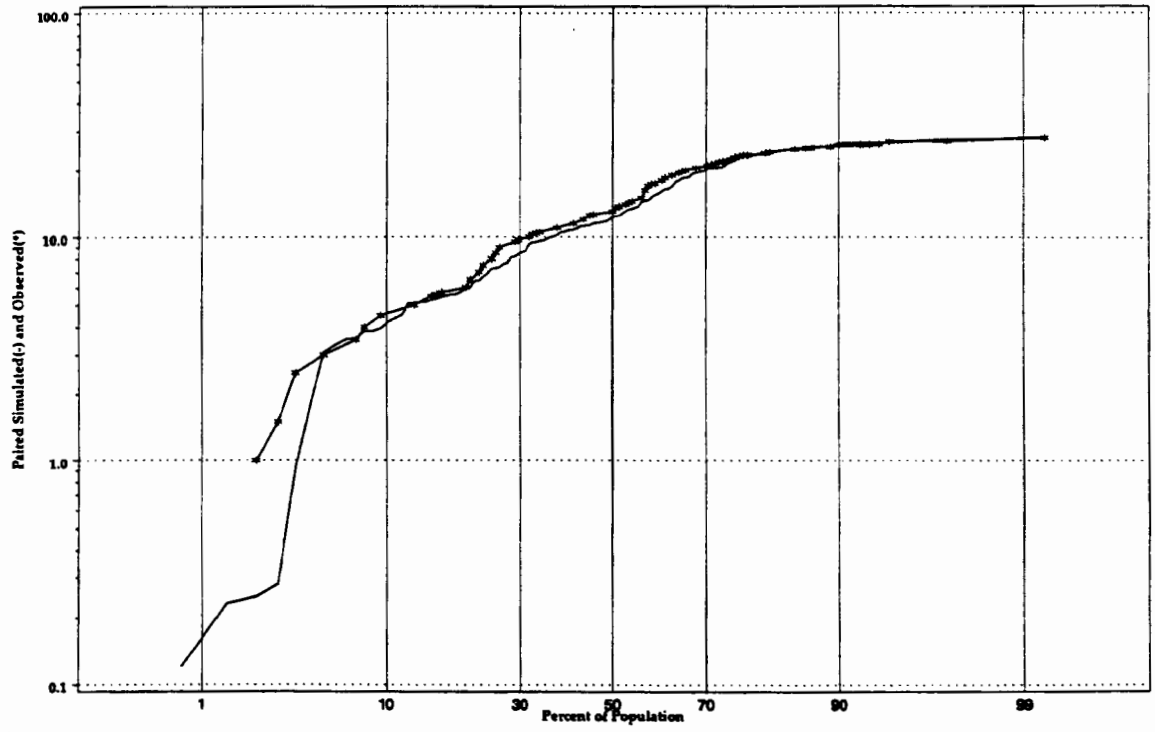
Appomattox River at Segment 310

Actual Error versus Time

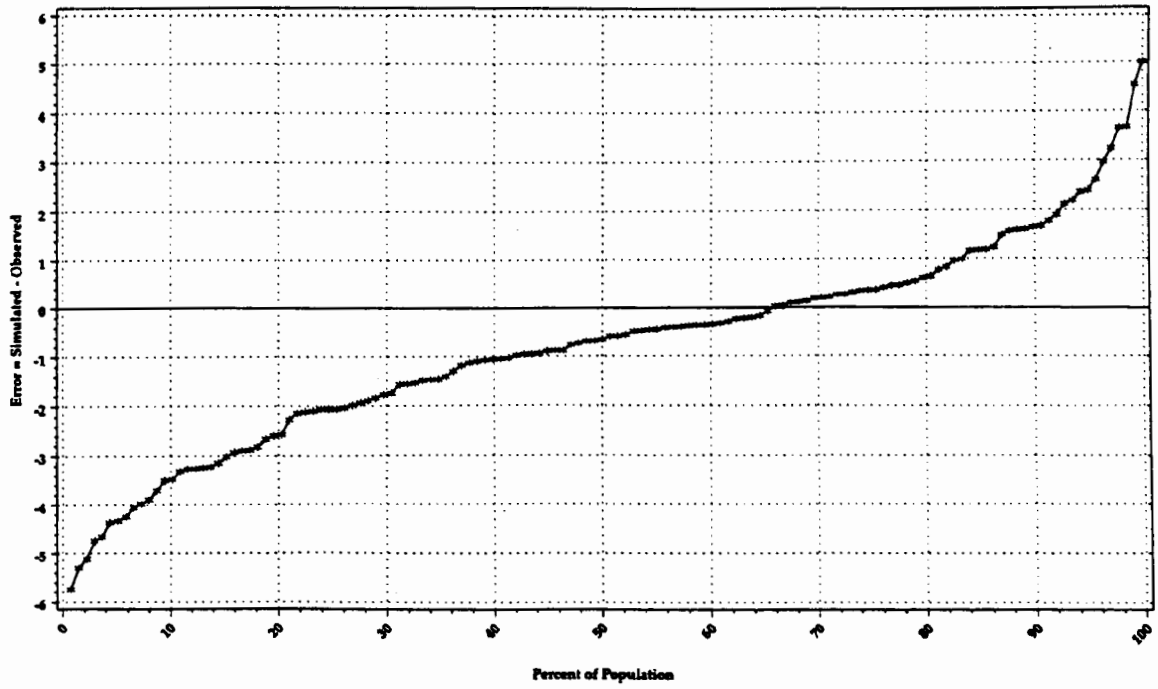
Temperature-C



Appomattox River at Segment 310
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

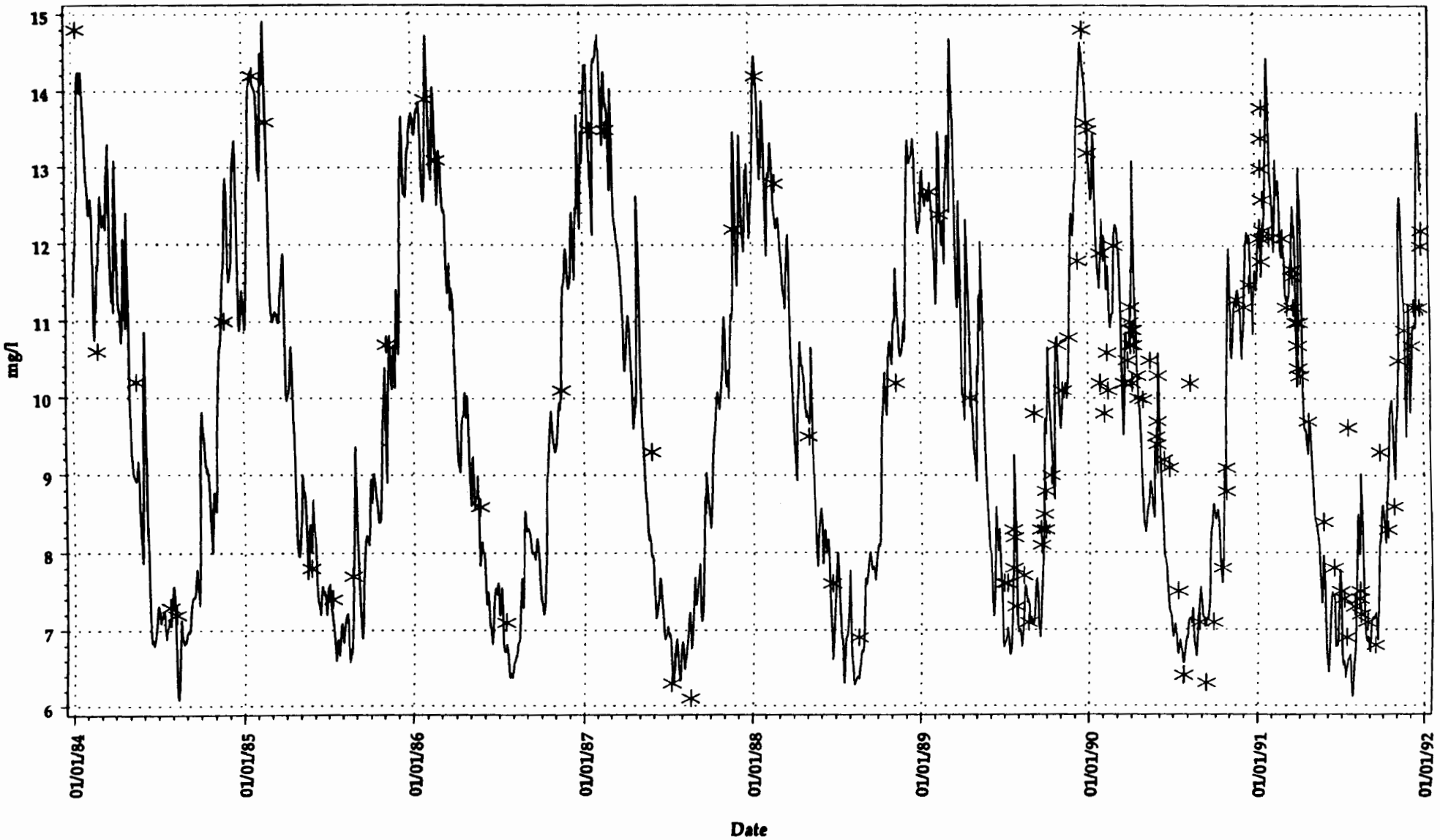


Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data

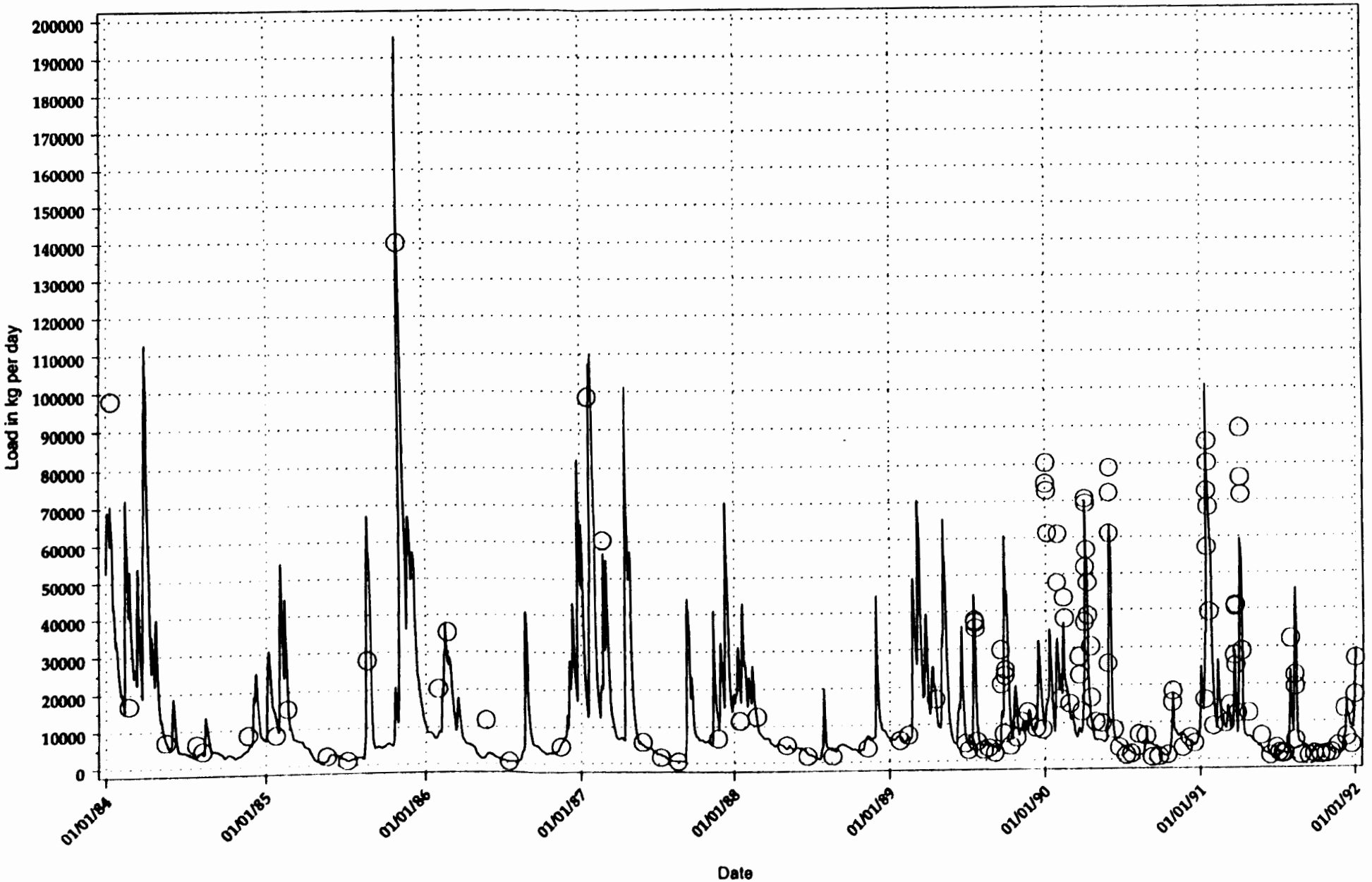


Appomattox River at Segment 310
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



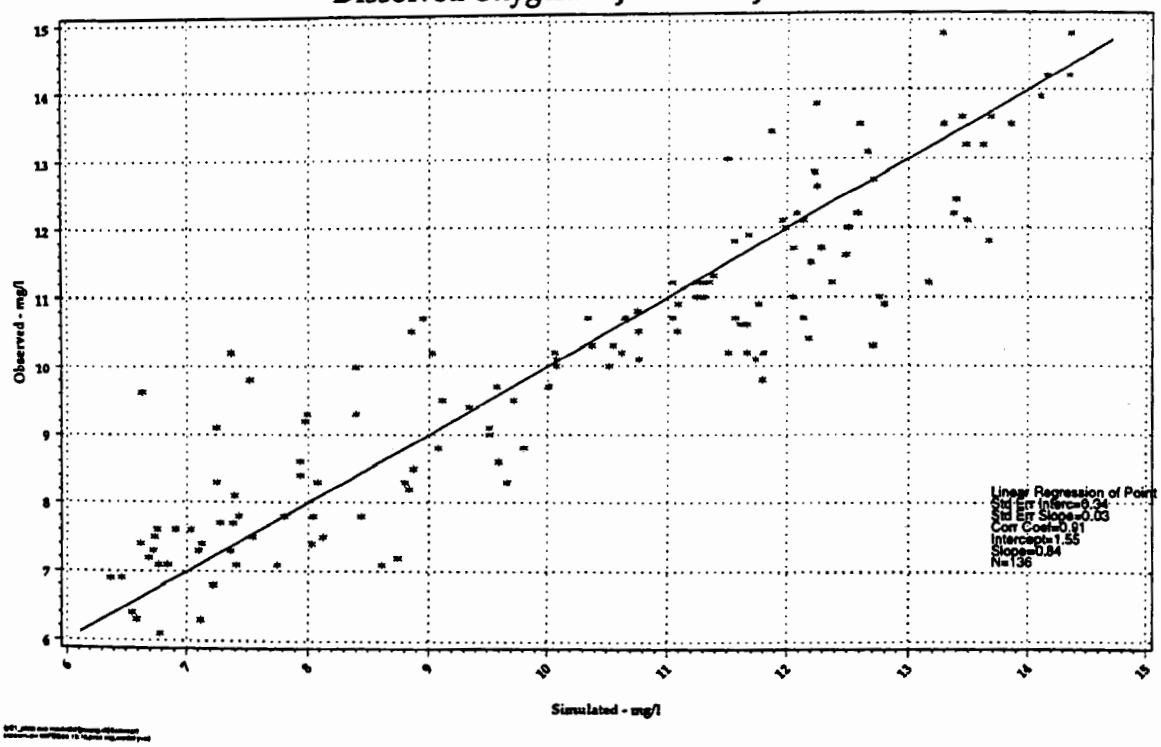
Appomattox River at Segment 310
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)



Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

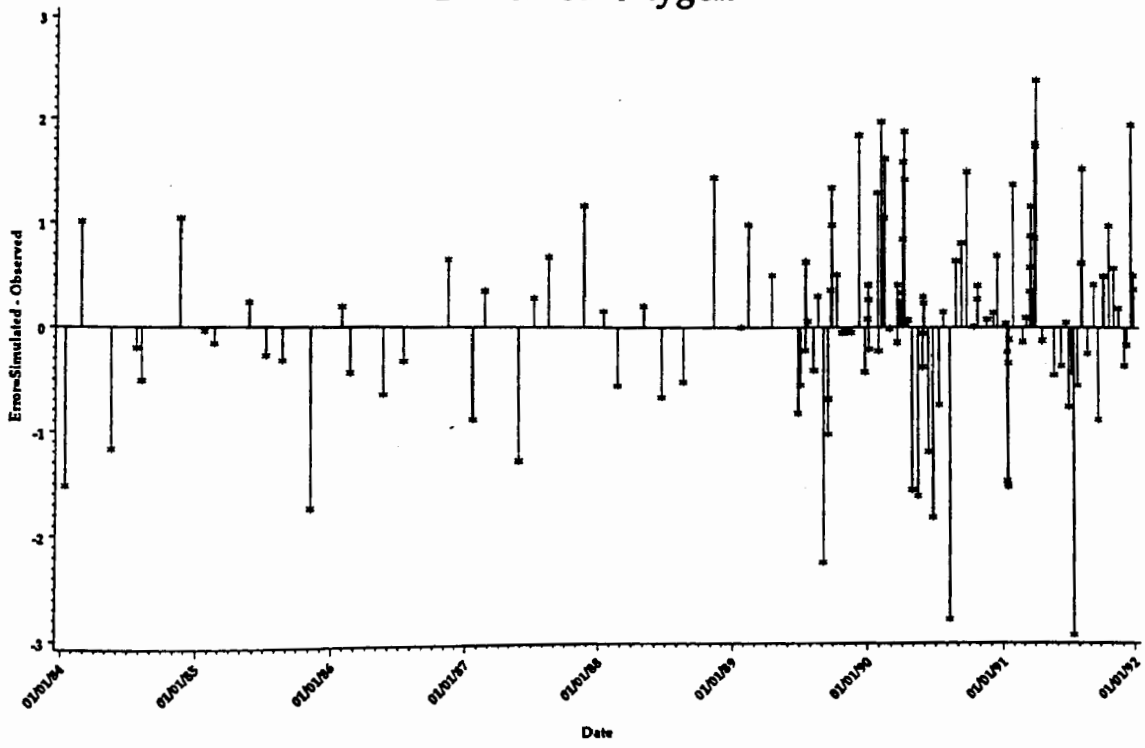
Dissolved Oxygen: 01JAN84 - 01JAN92



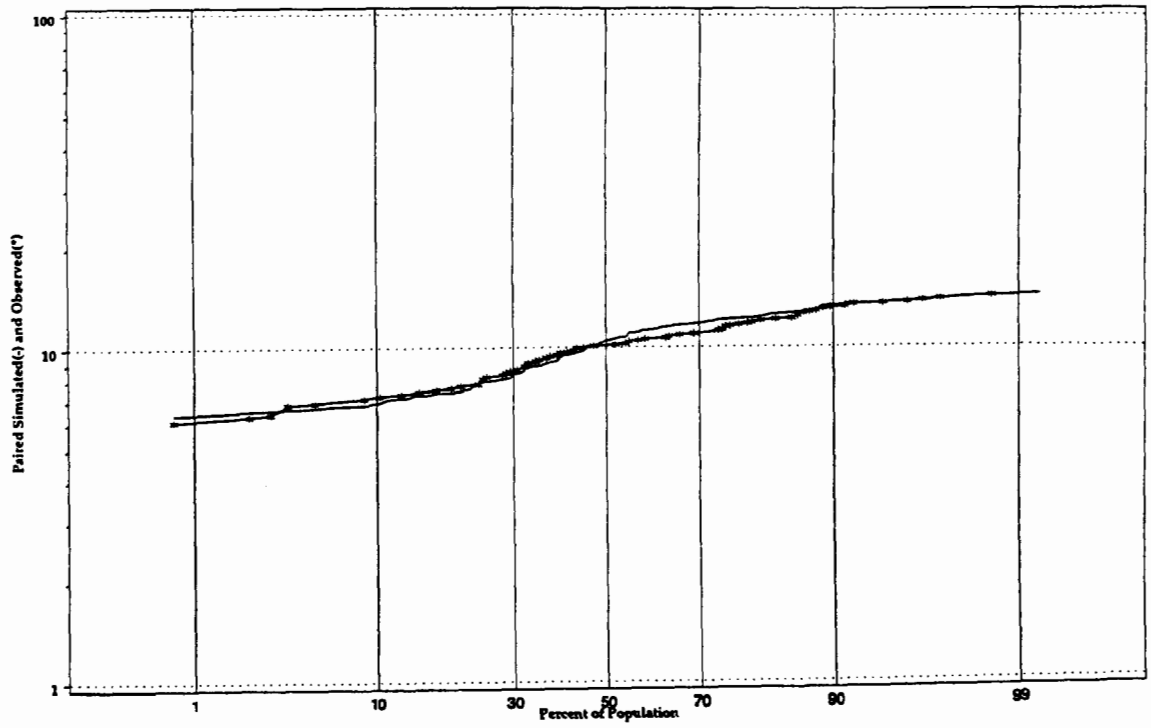
Appomattox River at Segment 310

Actual Error versus Time

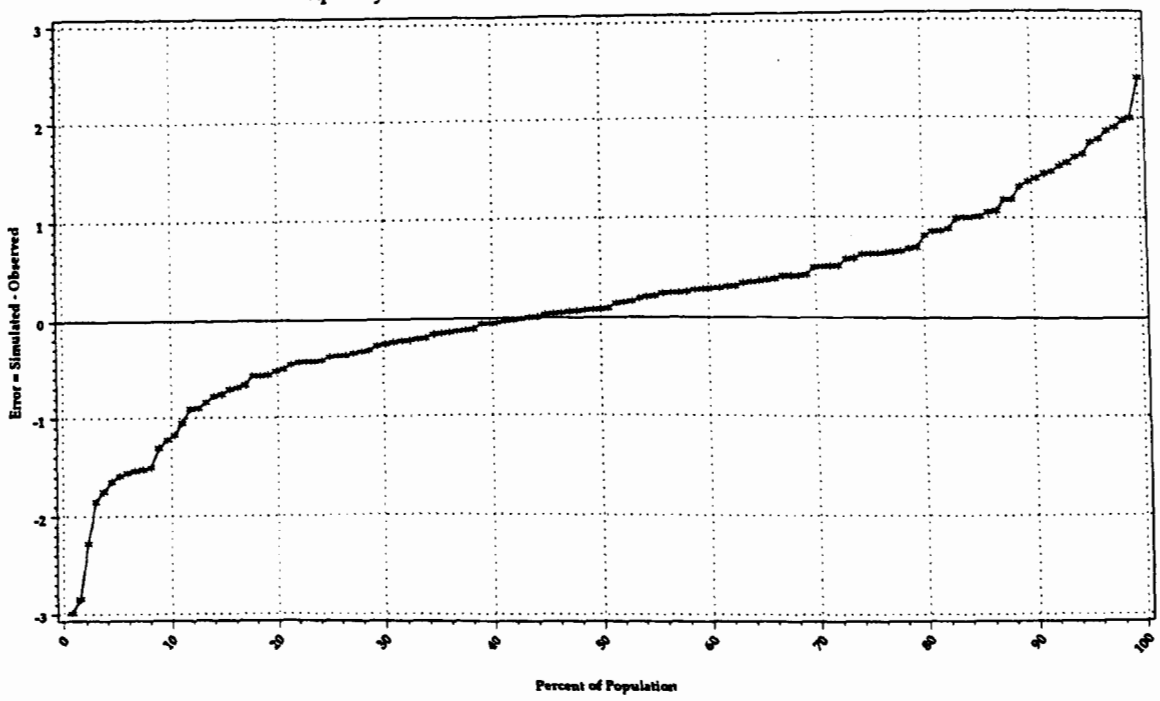
Dissolved Oxygen



Appomattox River at Segment 310
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

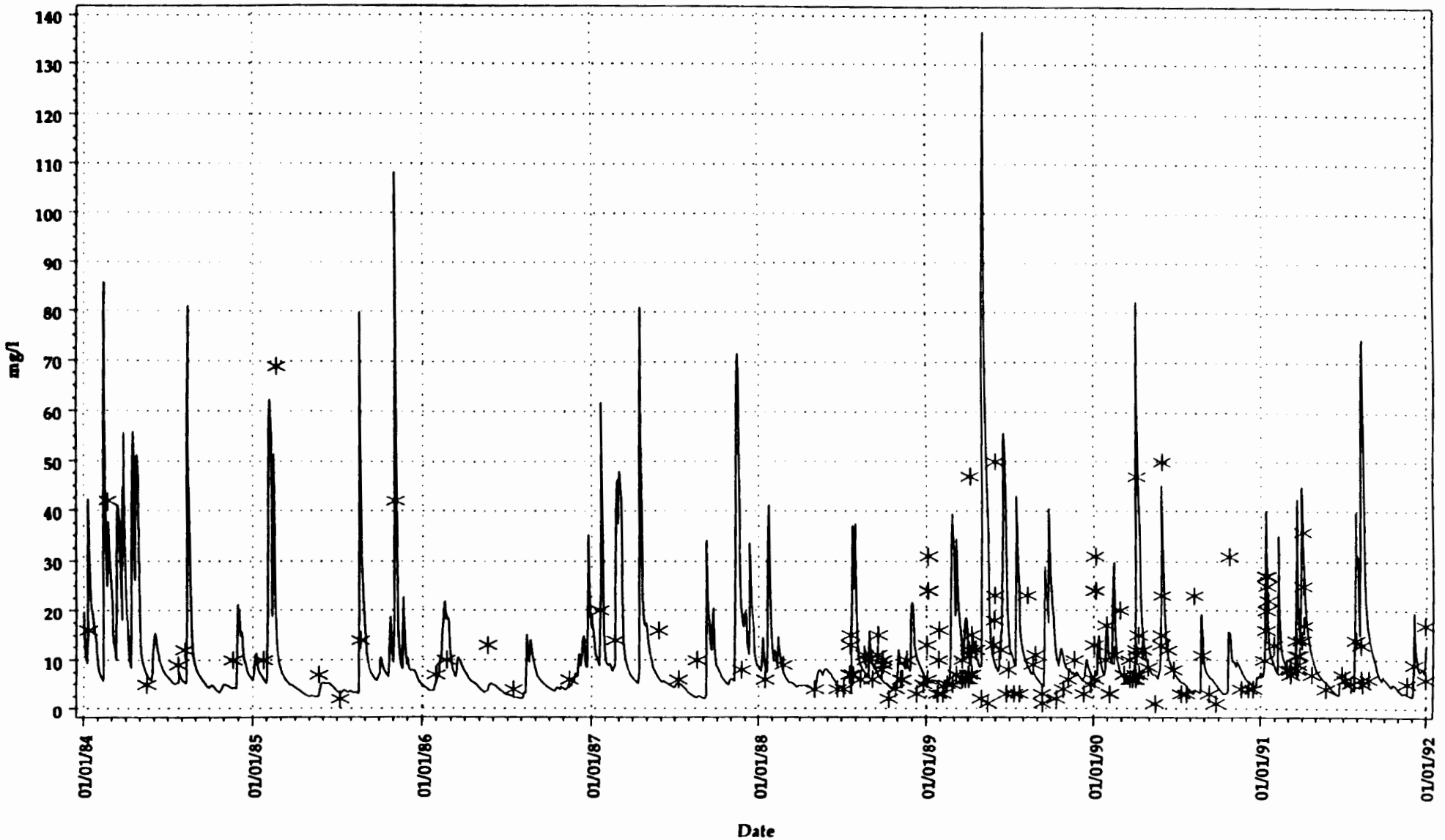


Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Appomattox River at Segment 310
Observed and Simulated versus Time
Total Suspended Sediment

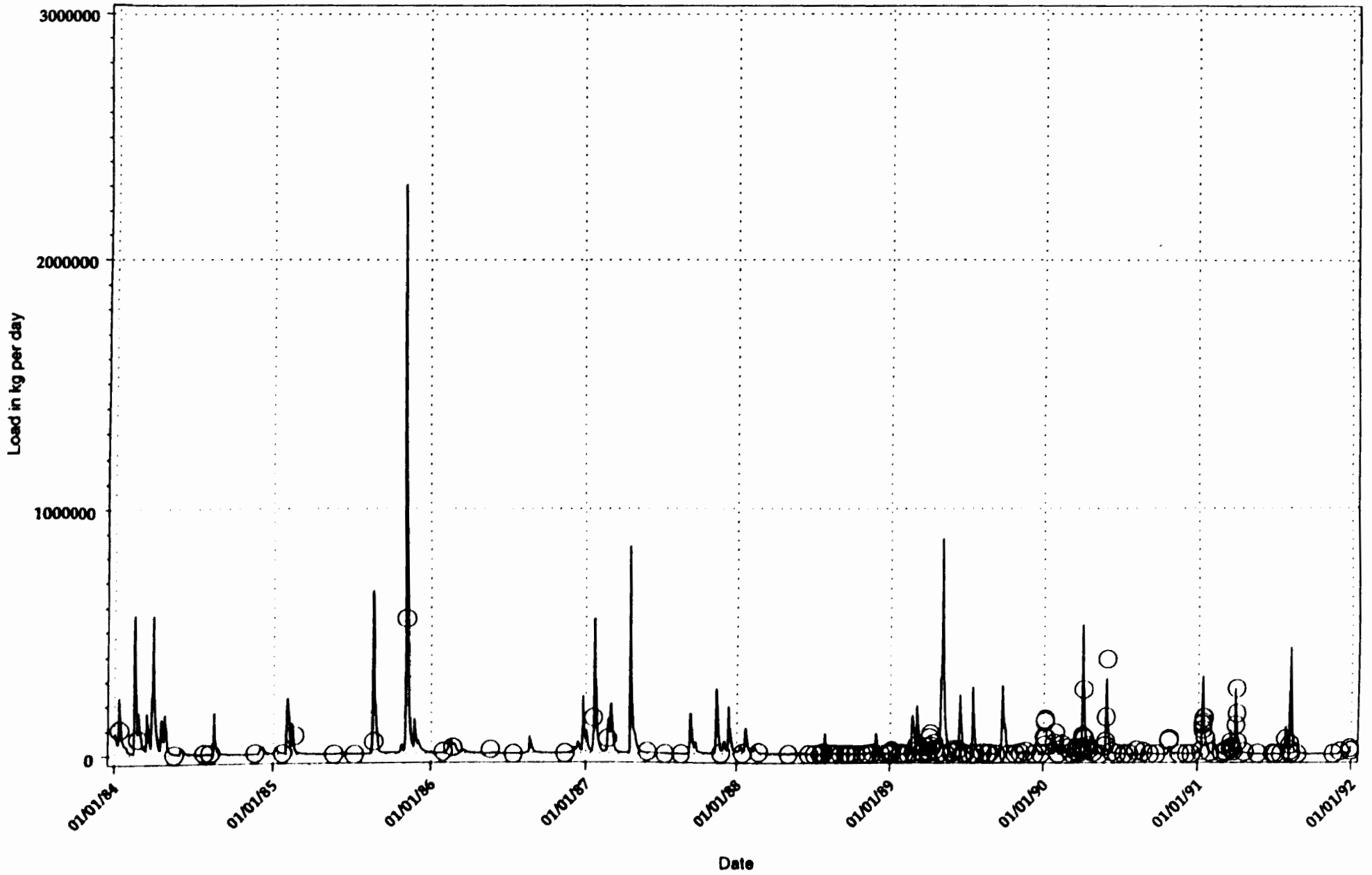
(*=Observed, -=Simulated)



Appomattox River at Segment 310

Total Suspended Sediment Observed and Simulated Load vs Time

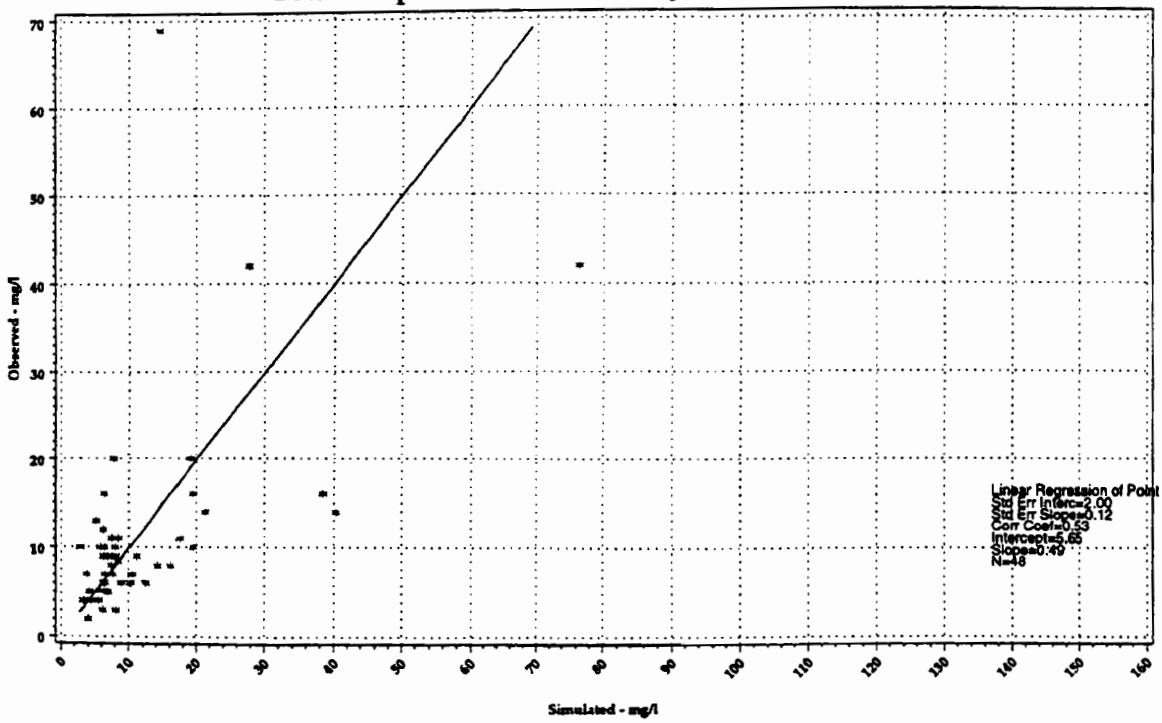
(line = simulated, O = observed)



Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

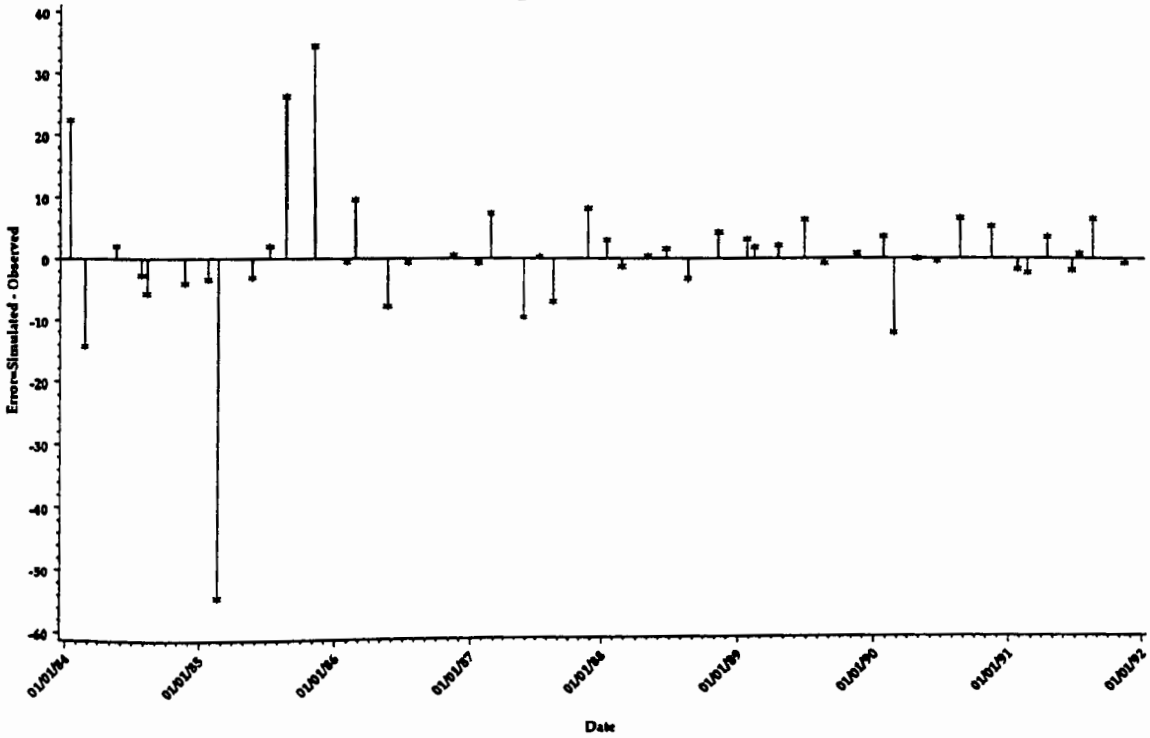
Total Suspended Sediment: 01JAN84 - 01JAN92



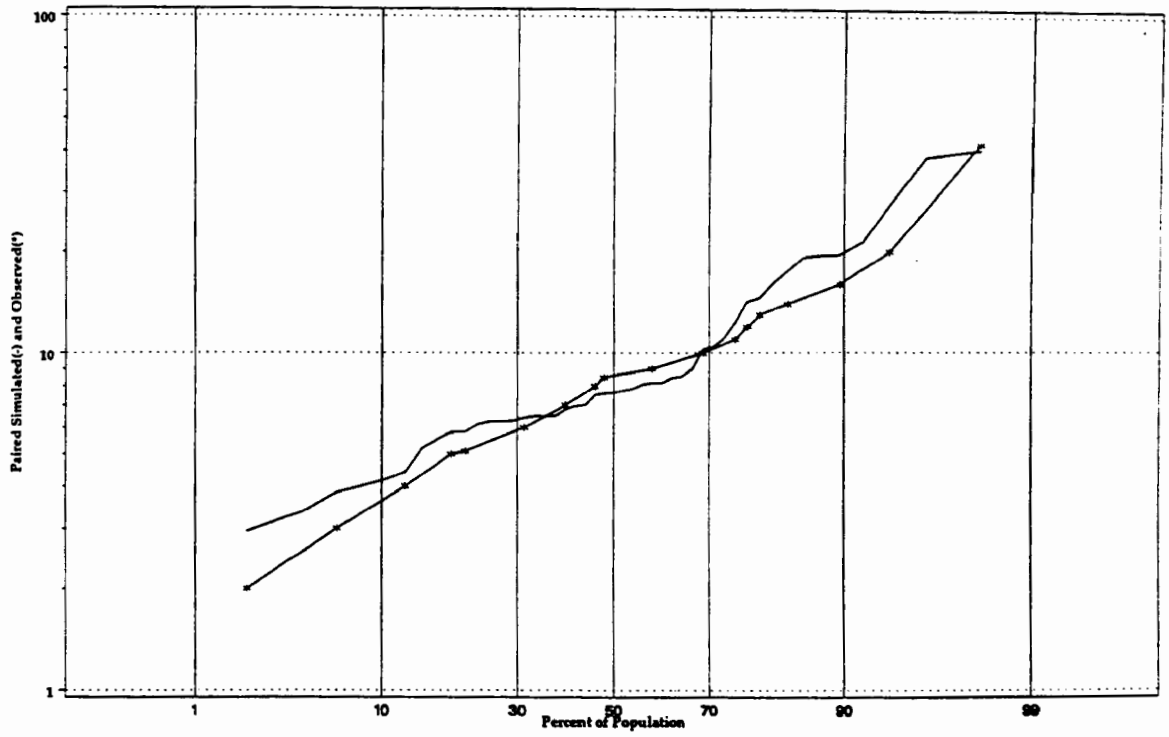
Appomattox River at Segment 310

Actual Error versus Time

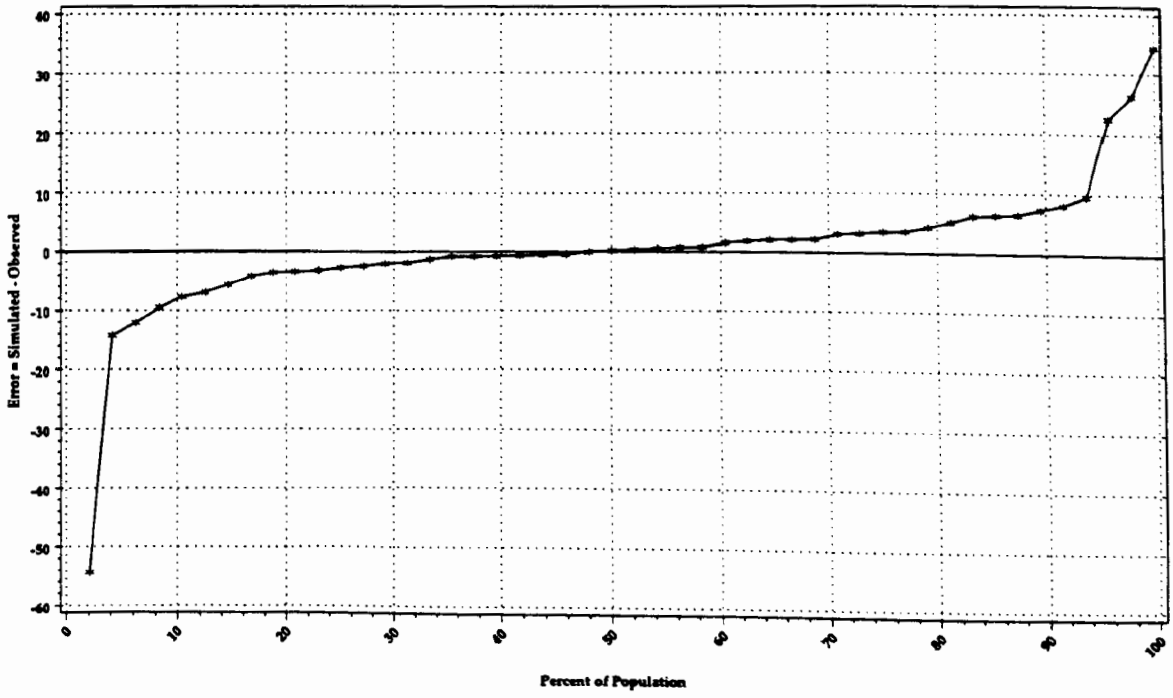
Total Suspended Sediment



Appomattox River at Segment 310
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

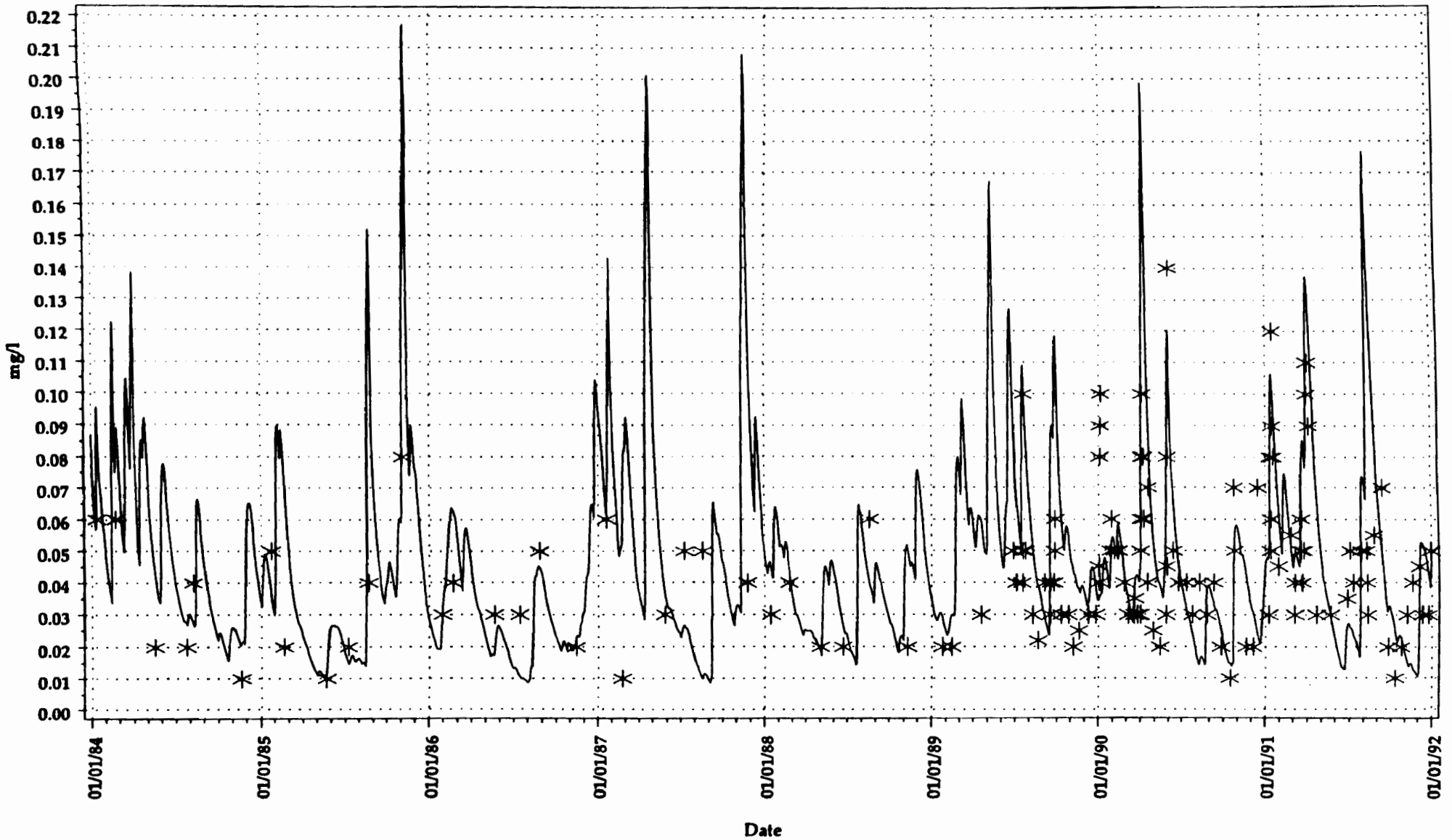


Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



Appomattox River at Segment 310
Observed and Simulated versus Time
Total Phosphorus

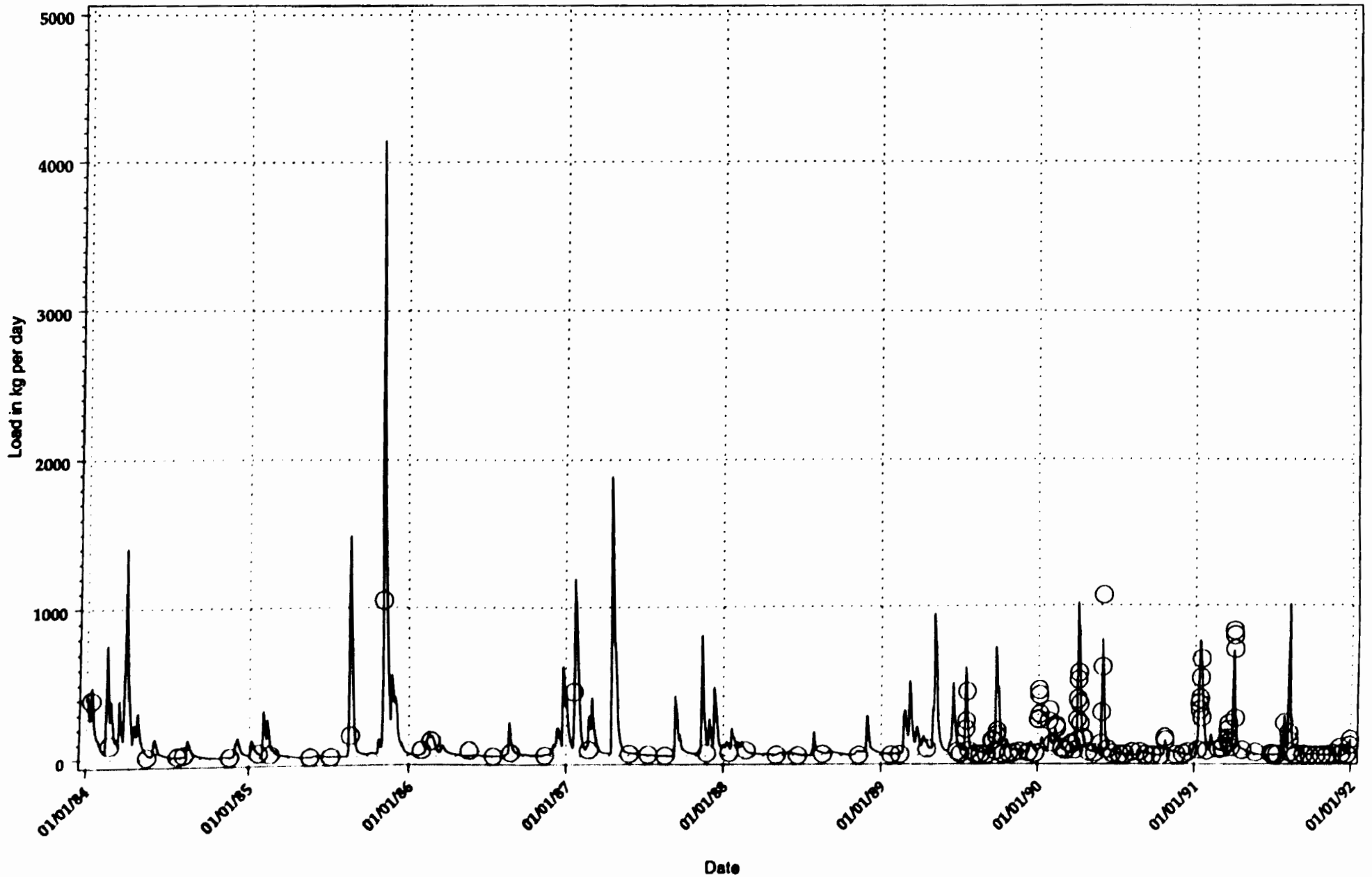
(*=Observed, -=Simulated)



Appomattox River at Segment 310

Total Phosphorus Observed and Simulated Load vs Time

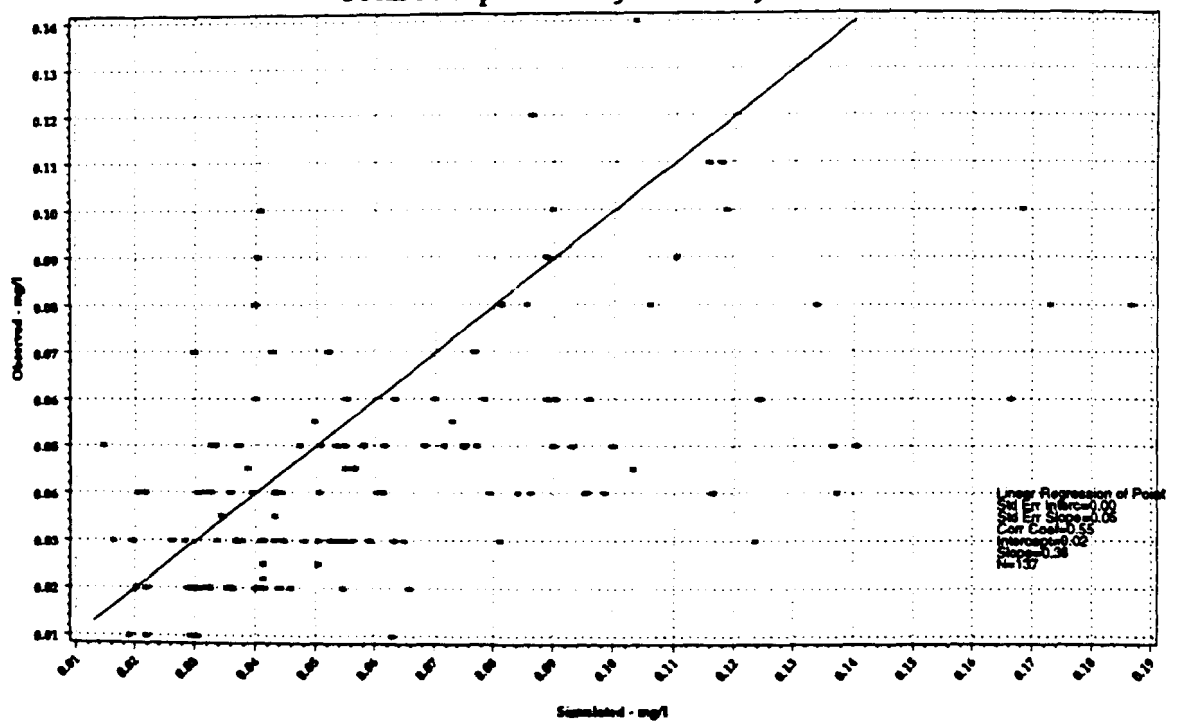
(line = simulated, O = observed)



Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

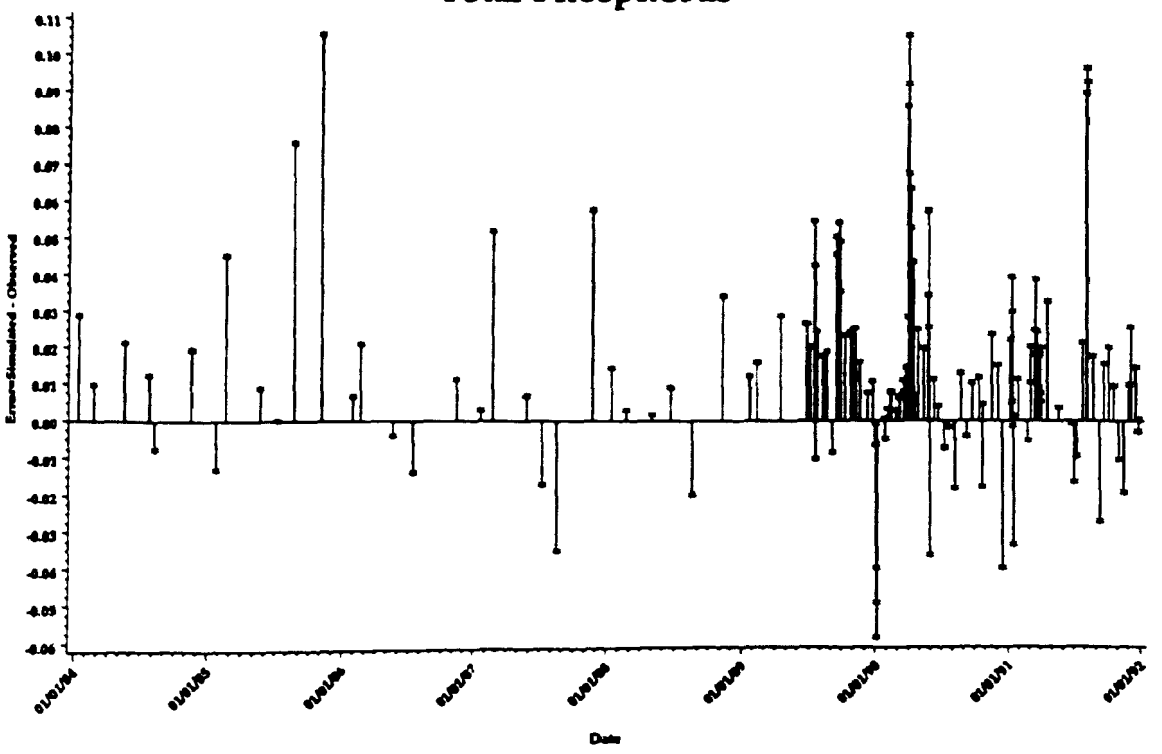
Total Phosphorus: 01JAN84 - 01JAN92



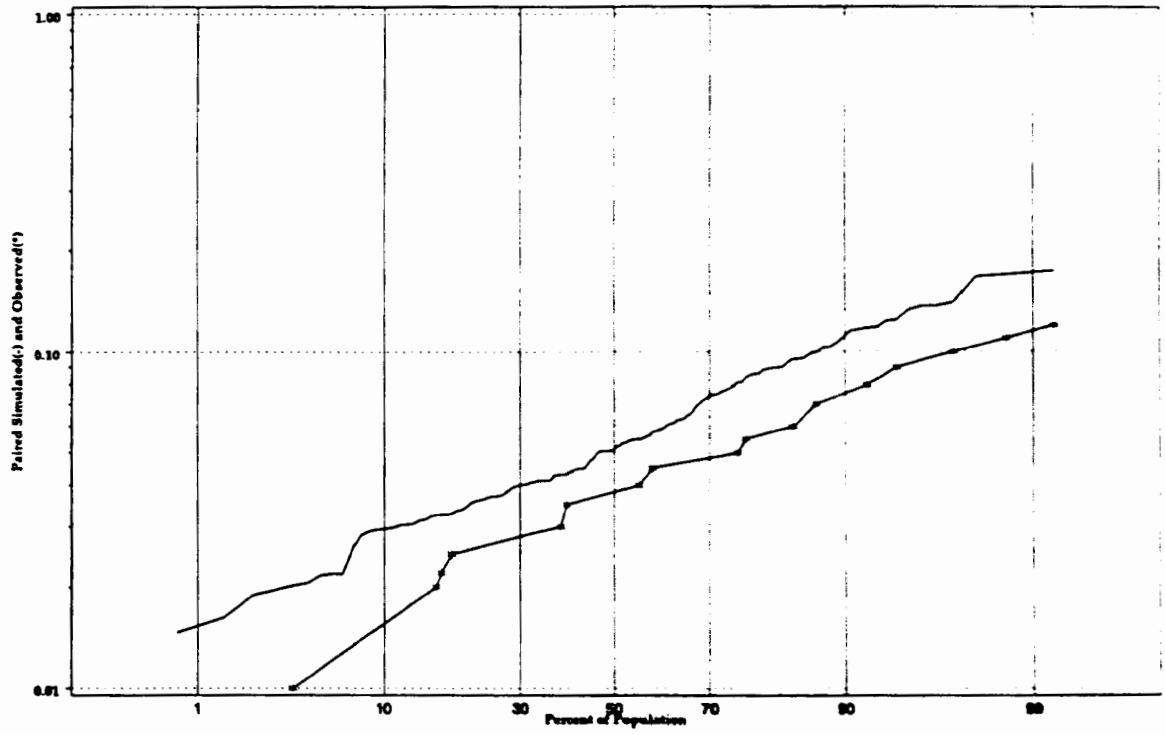
Appomattox River at Segment 310

Actual Error versus Time

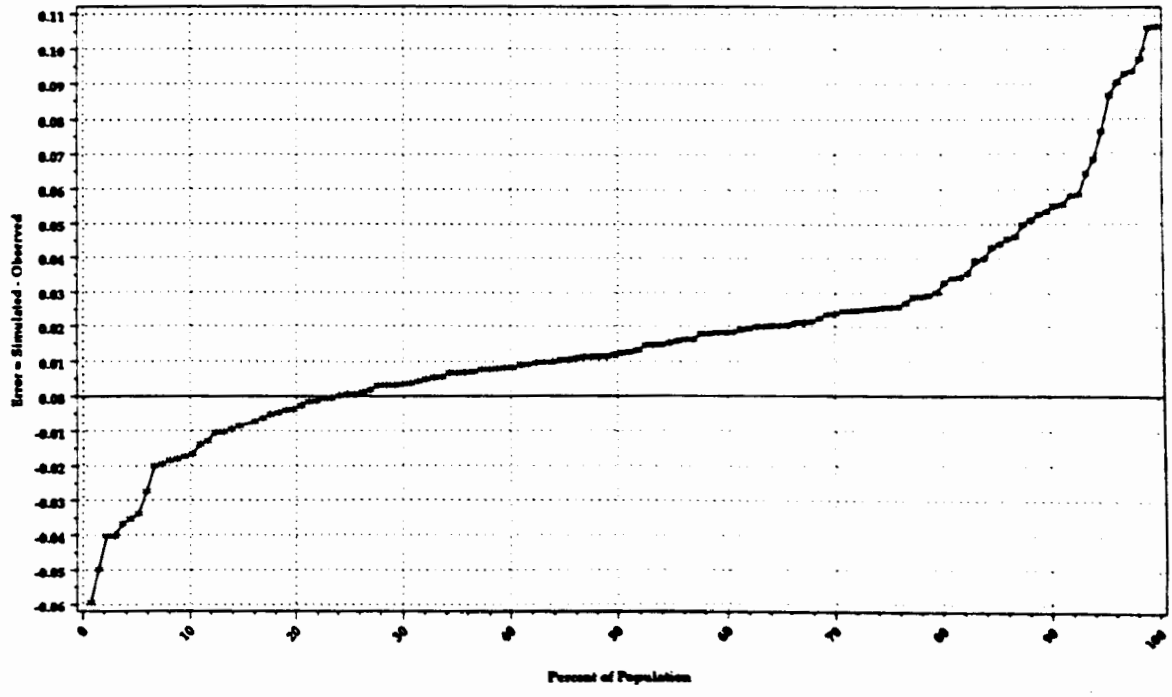
Total Phosphorus



Appomattox River at Segment 310
Total Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

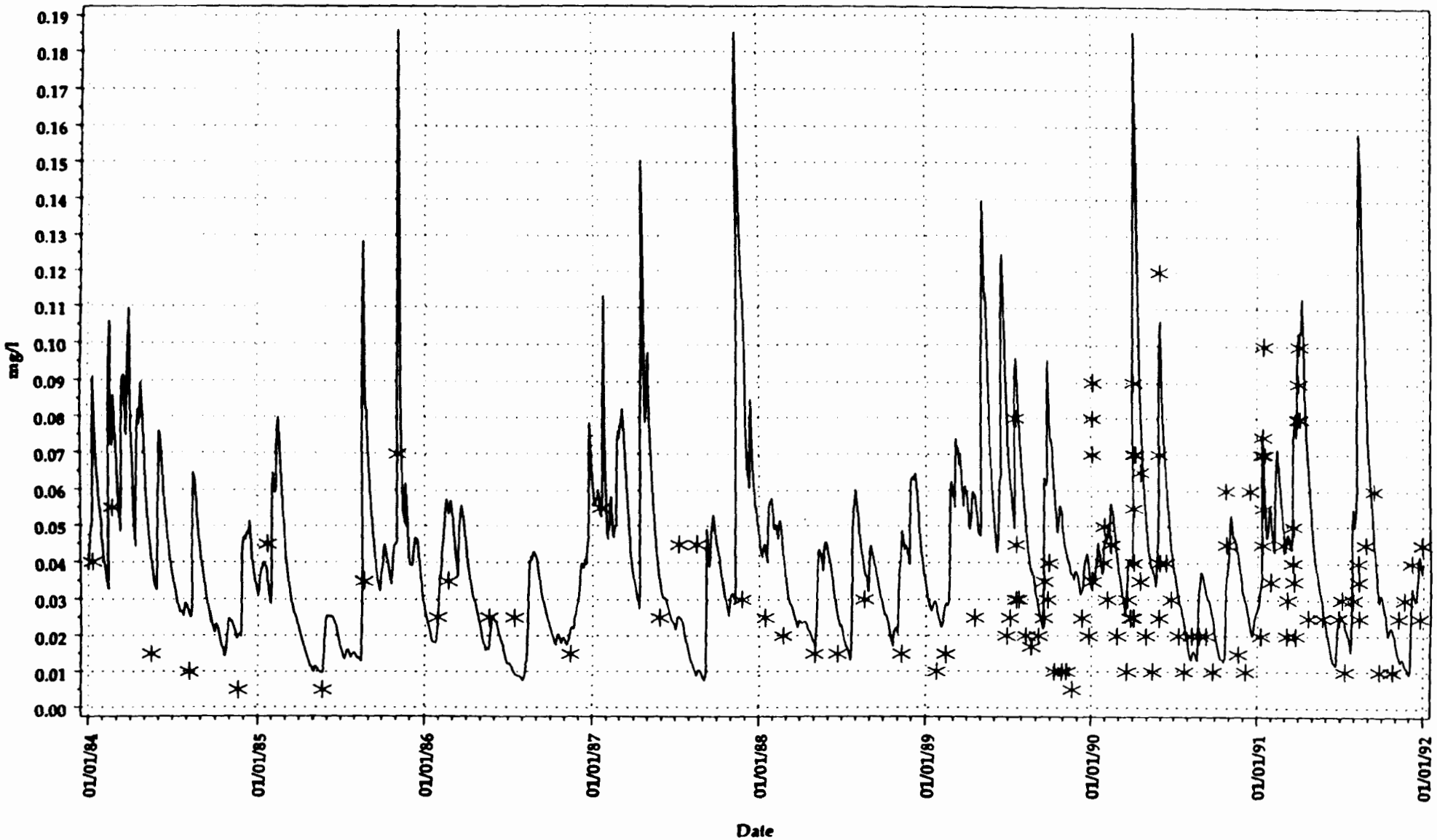


Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Total Phosphorus
Frequency Distribution - All Simulated and Observed Data



Appomattox River at Segment 310
Observed and Simulated versus Time
Organic and Particulate Phosphorus

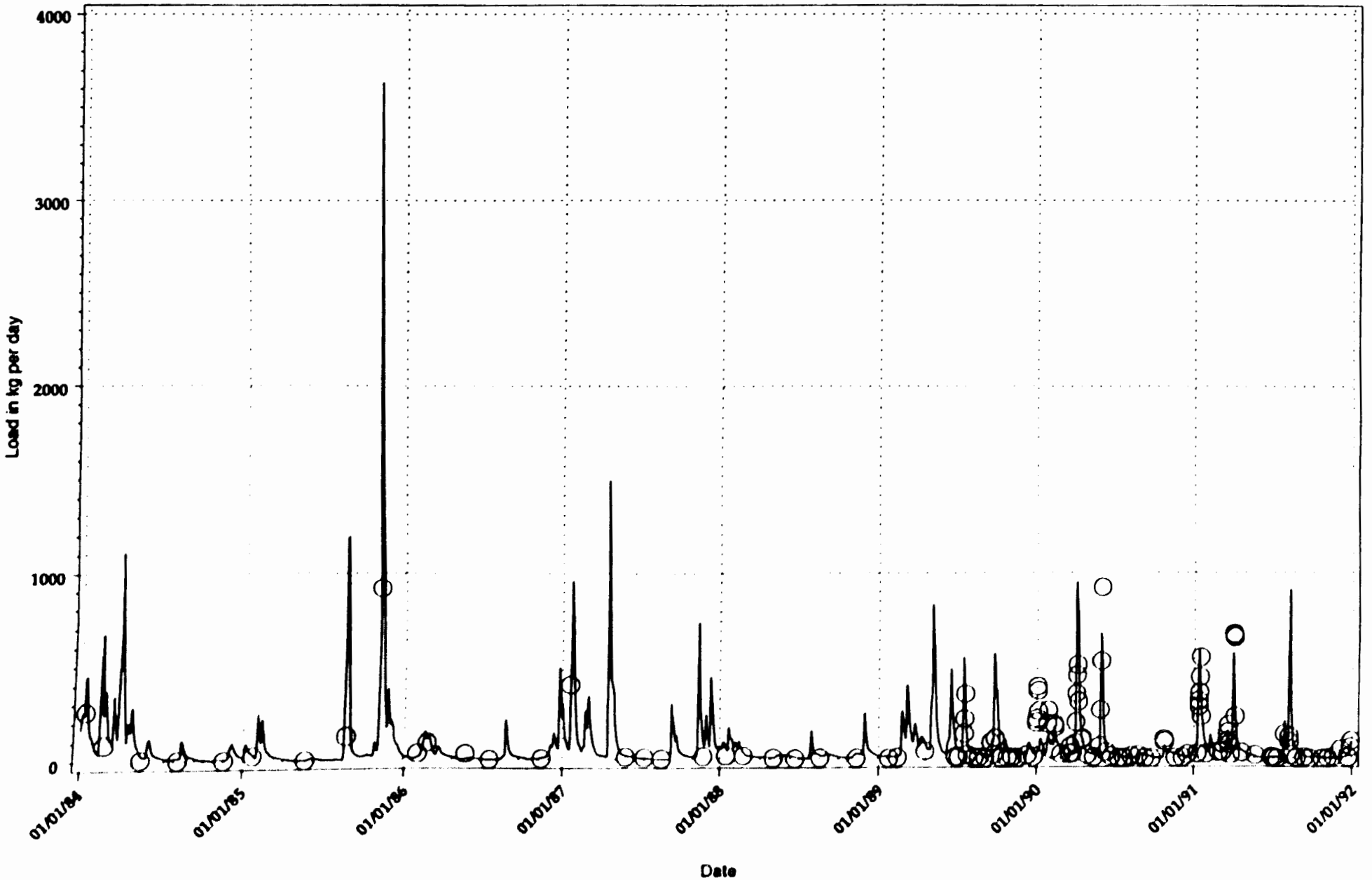
(*=Observed, -=Simulated)



Appomattox River at Segment 310

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

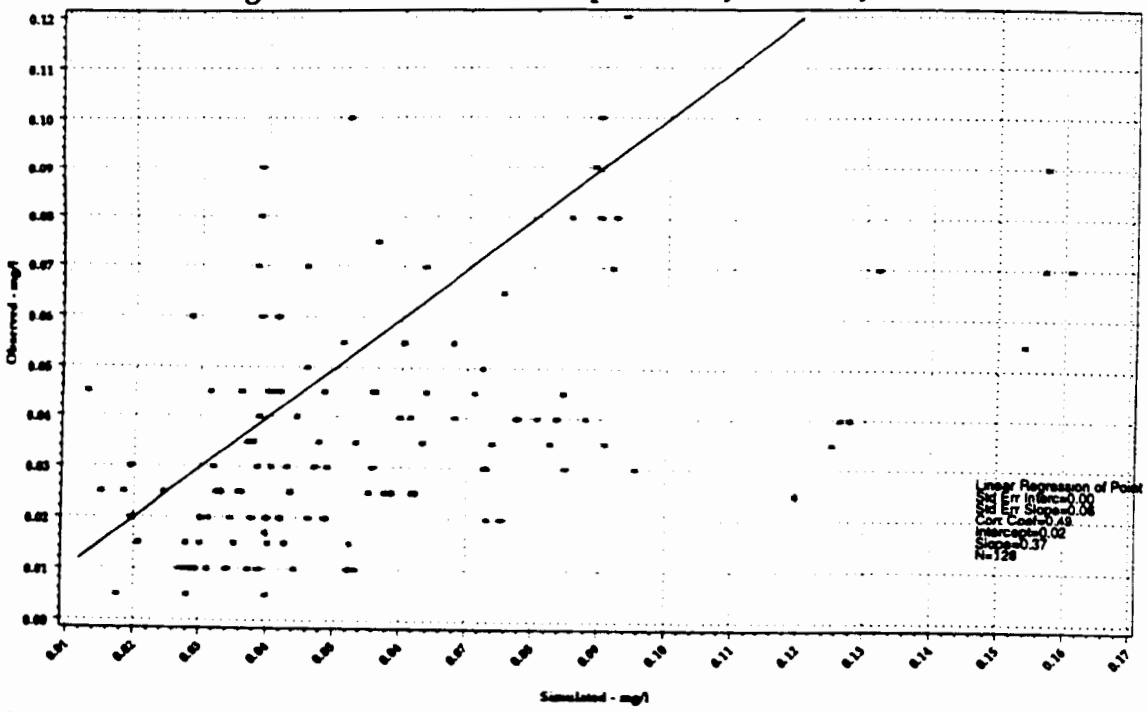
(line = simulated, O = observed)



Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

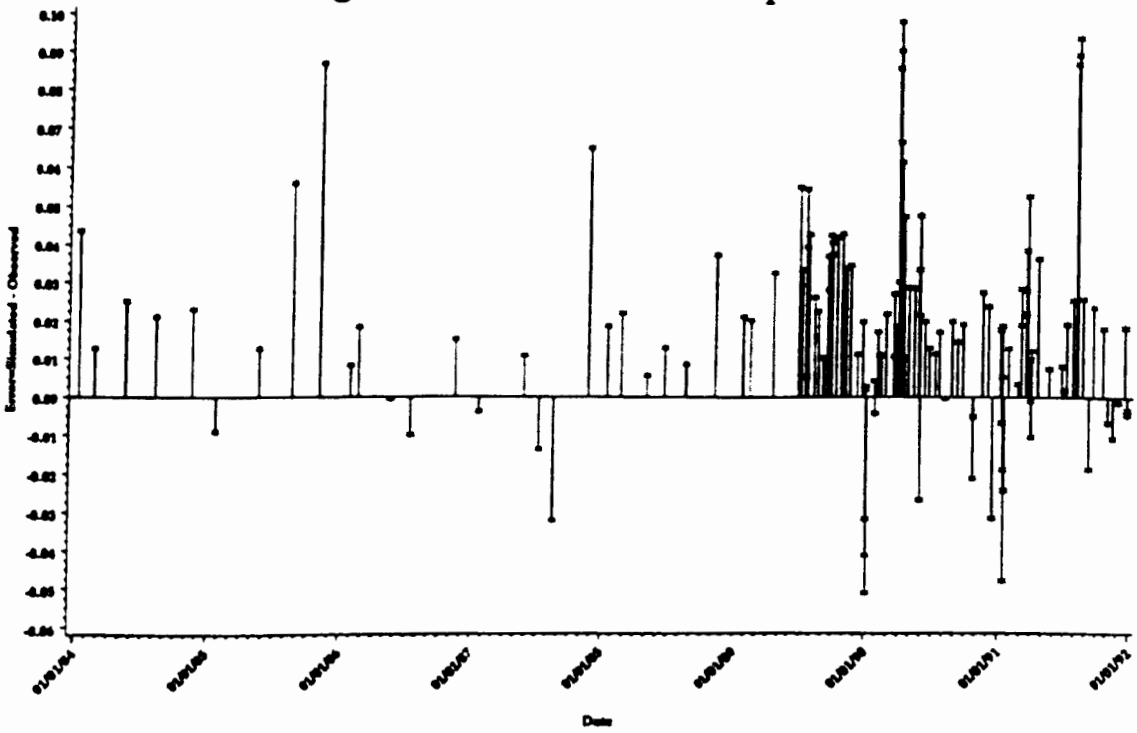
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



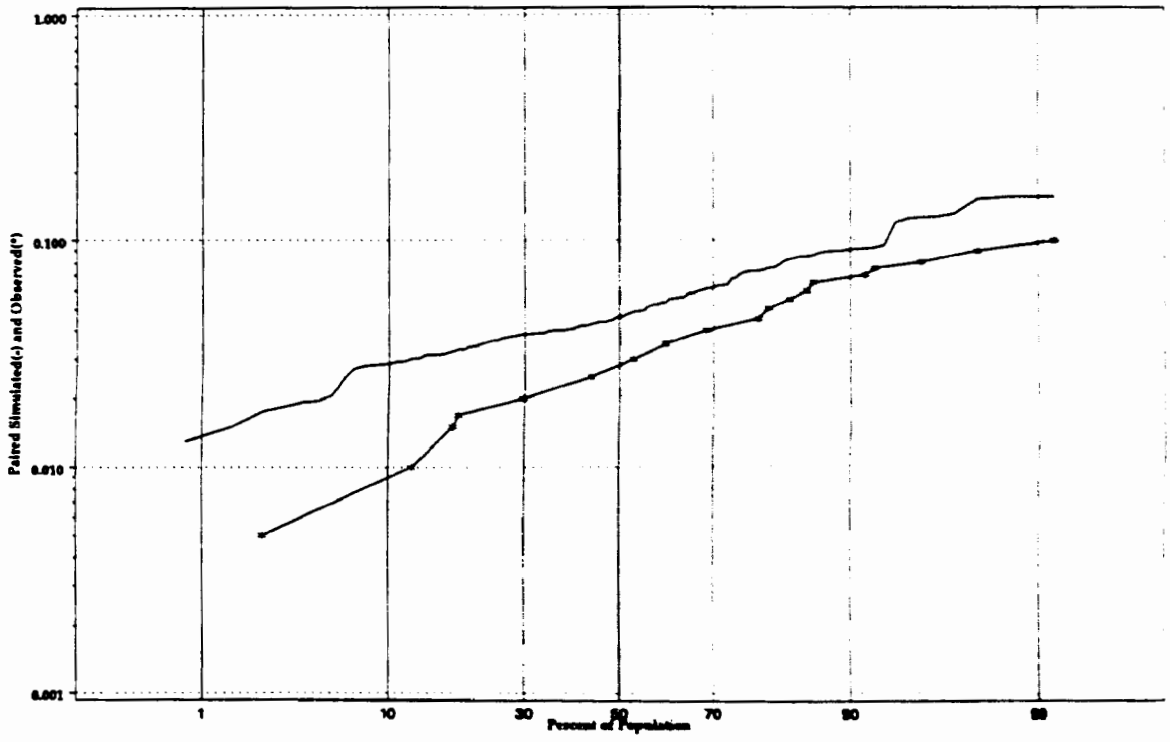
Appomattox River at Segment 310

Actual Error versus Time

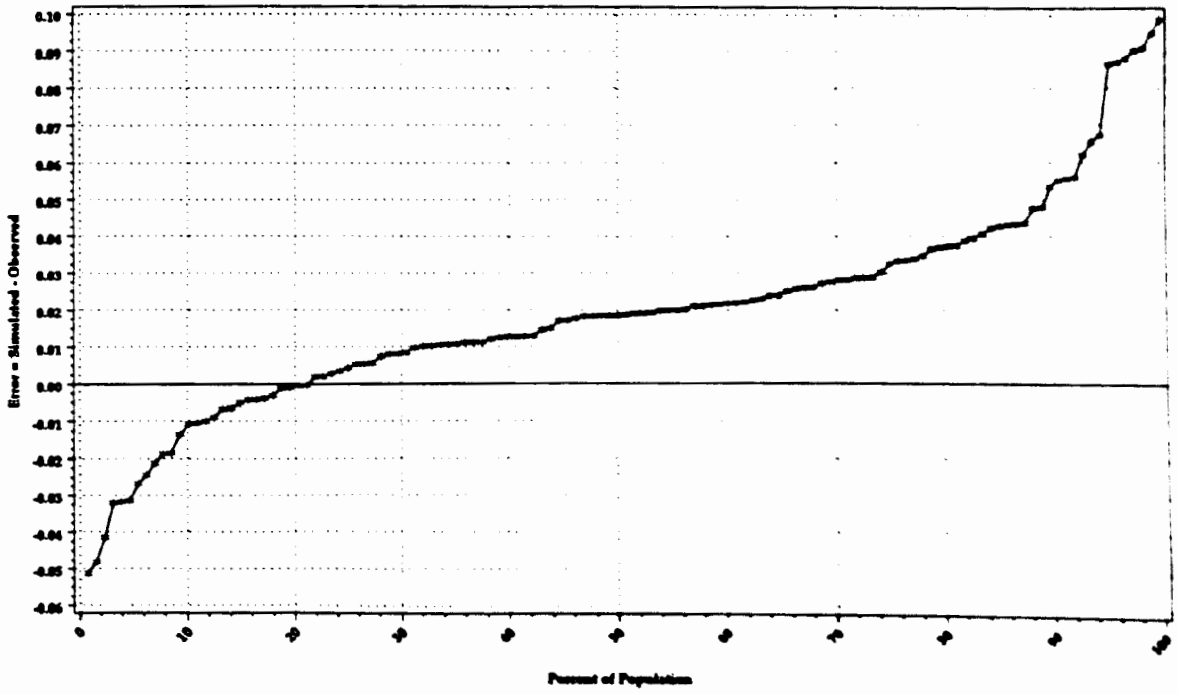
Organic and Particulate Phosphorus



Appomattox River at Segment 310
Organic and Particulate Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

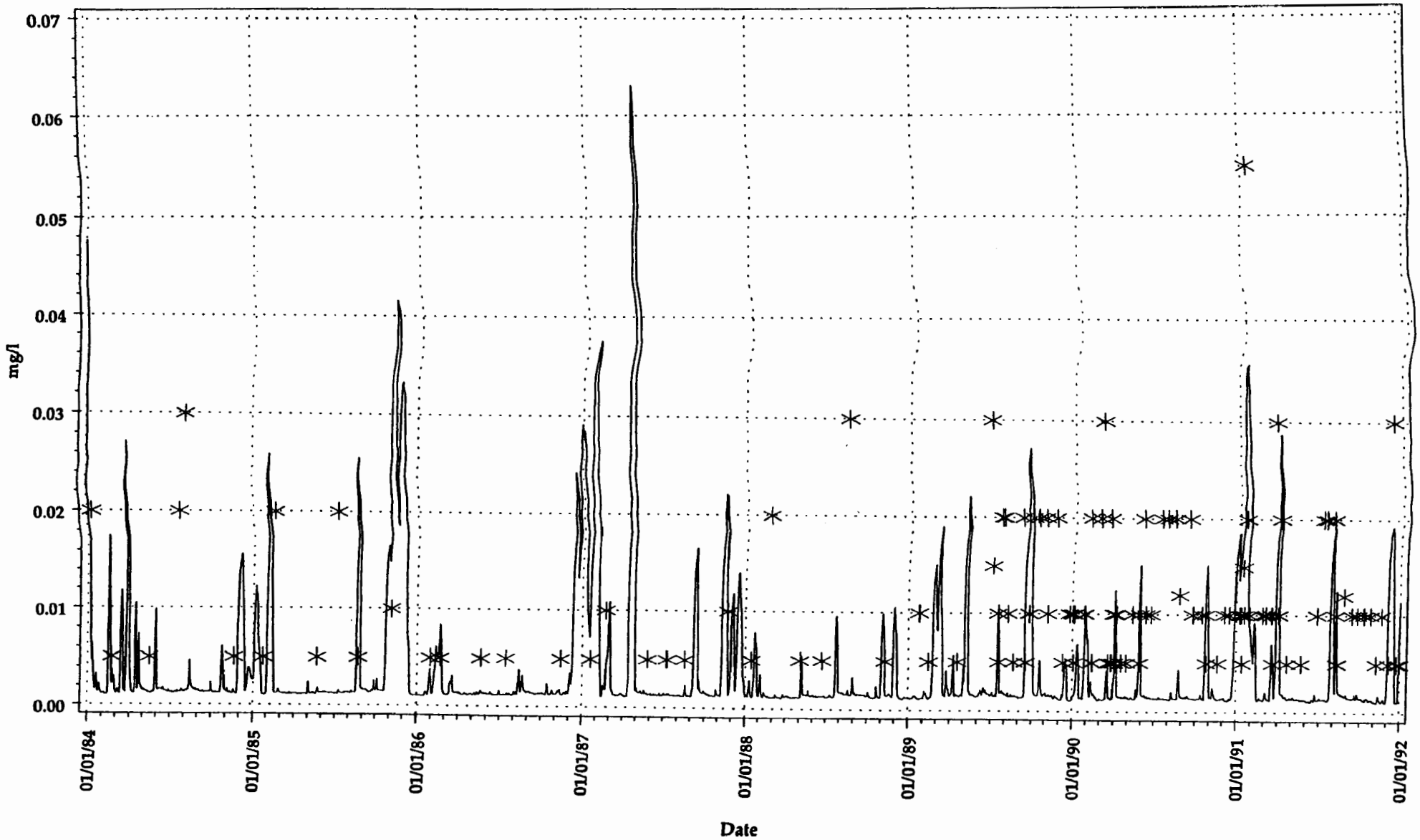


Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus
Frequency Distribution - All Simulated and Observed Data



Appomattox River at Segment 310
Observed and Simulated versus Time
Dissolved Phosphorus

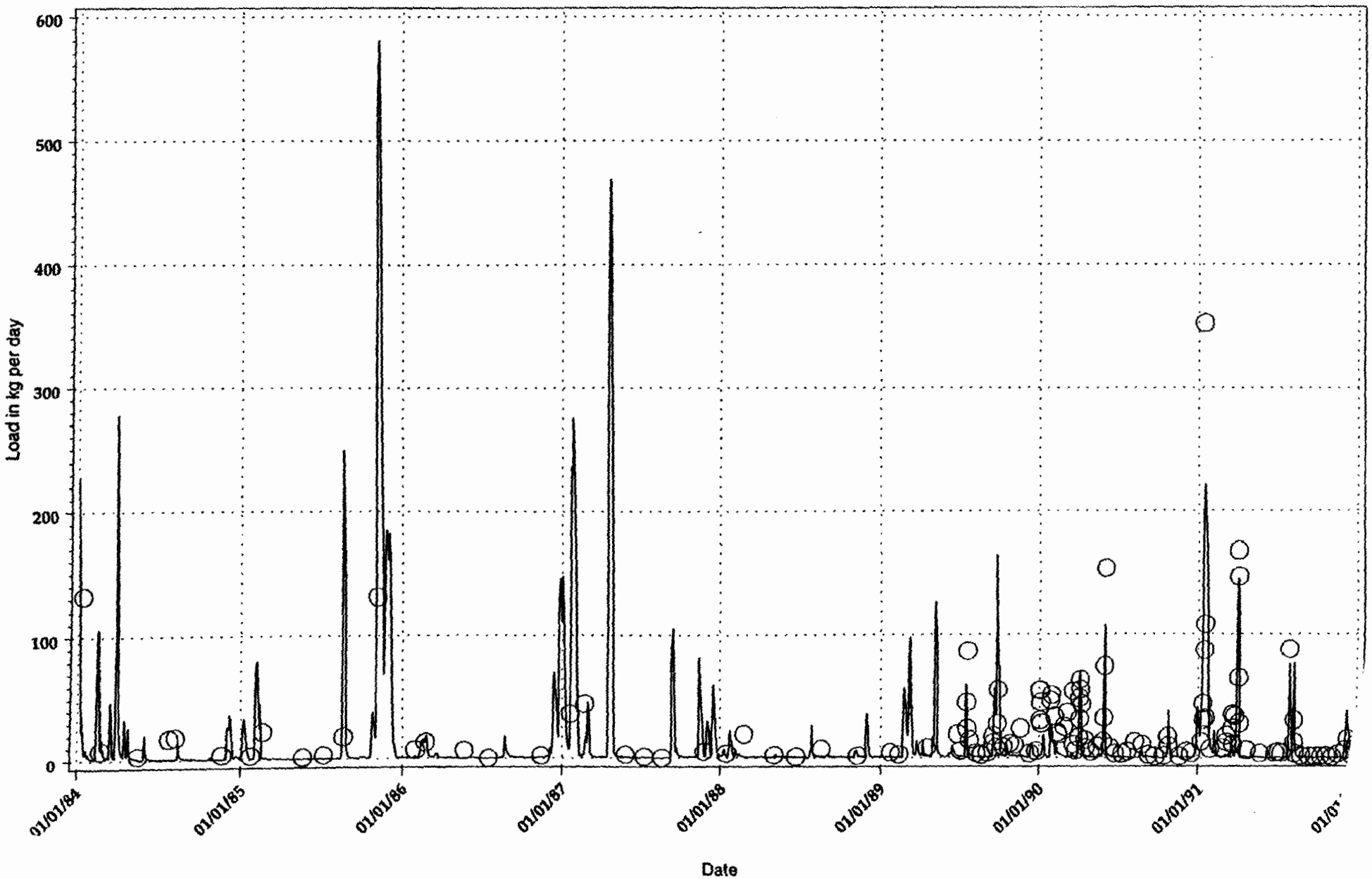
(*=Observed, -=Simulated)



Appomattox River at Segment 310

Dissolved Phosphorus Observed and Simulated Load vs Time

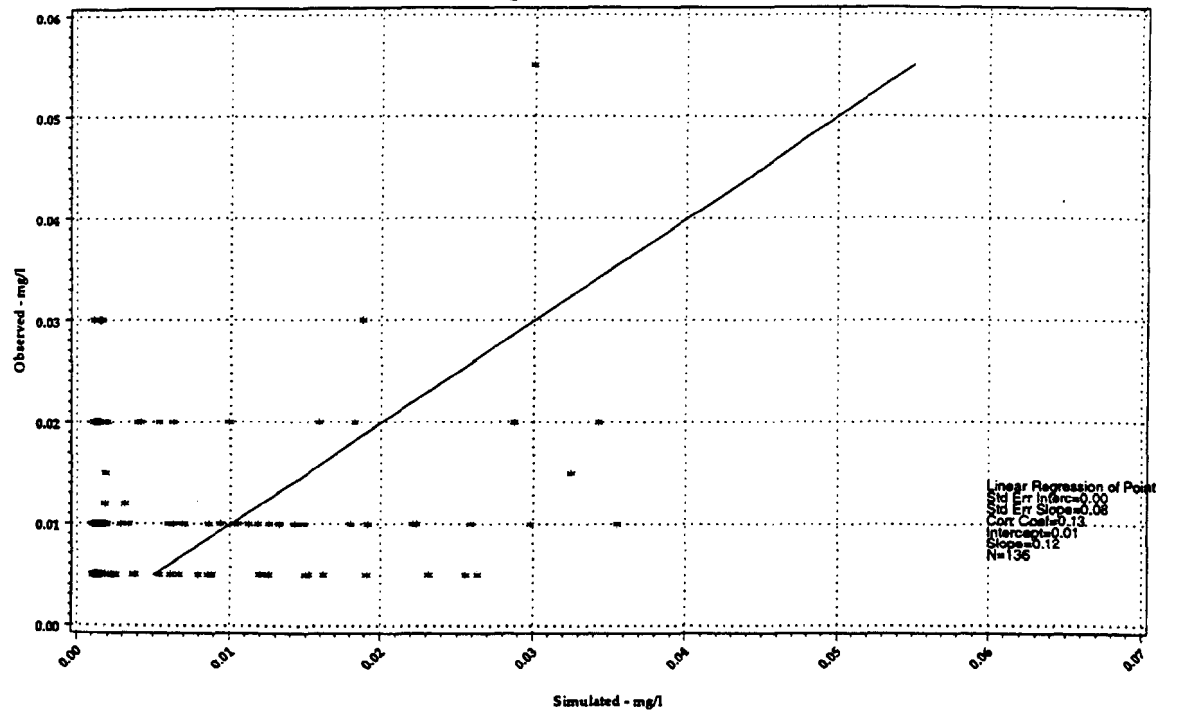
(line = simulated, O = observed)



Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

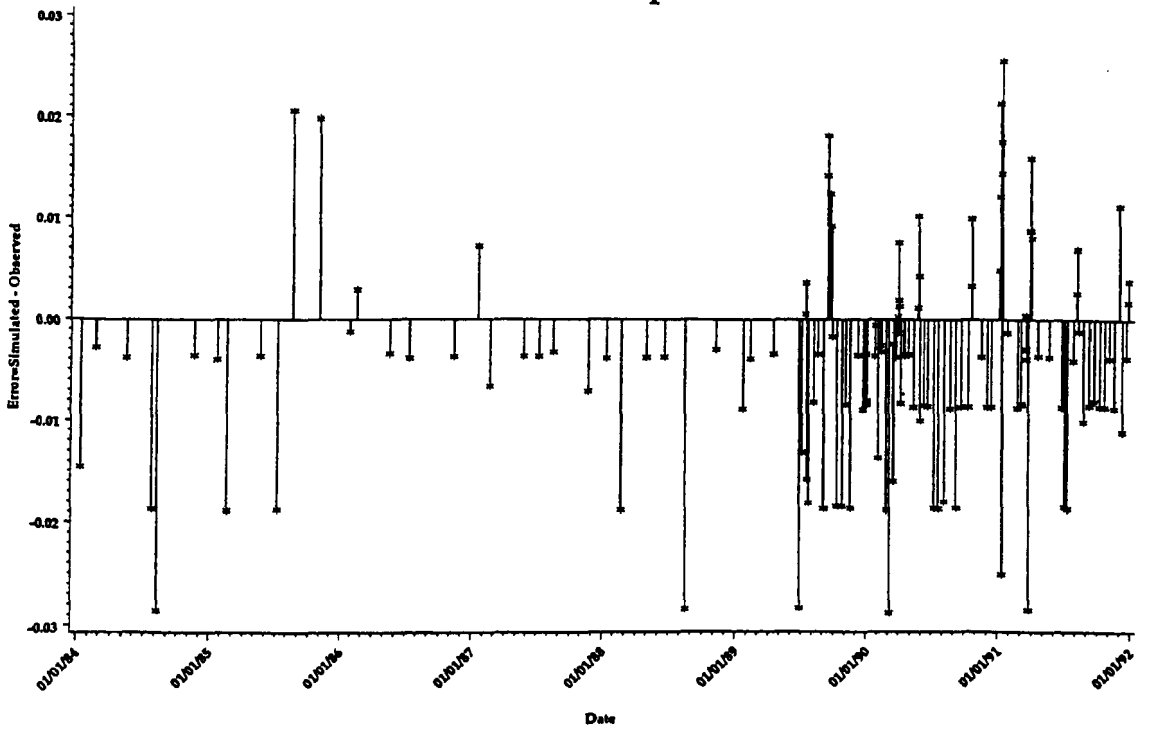
Dissolved Phosphorus: 01JAN84 - 01JAN92



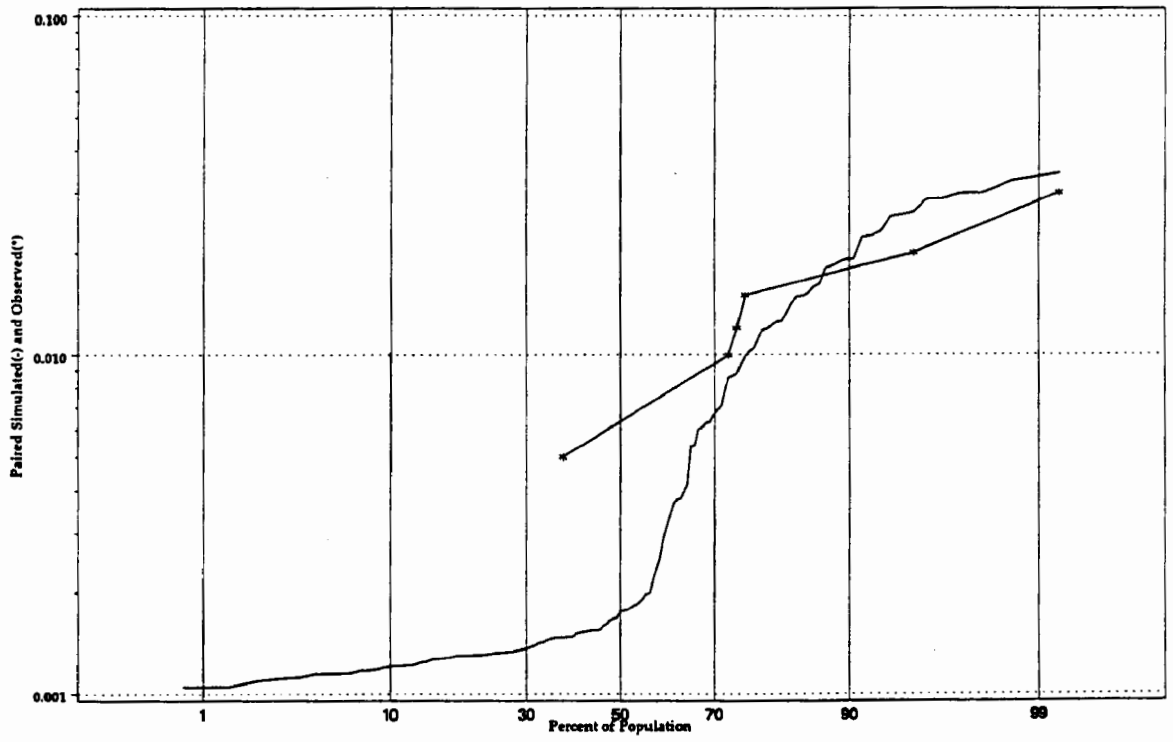
Appomattox River at Segment 310

Actual Error versus Time

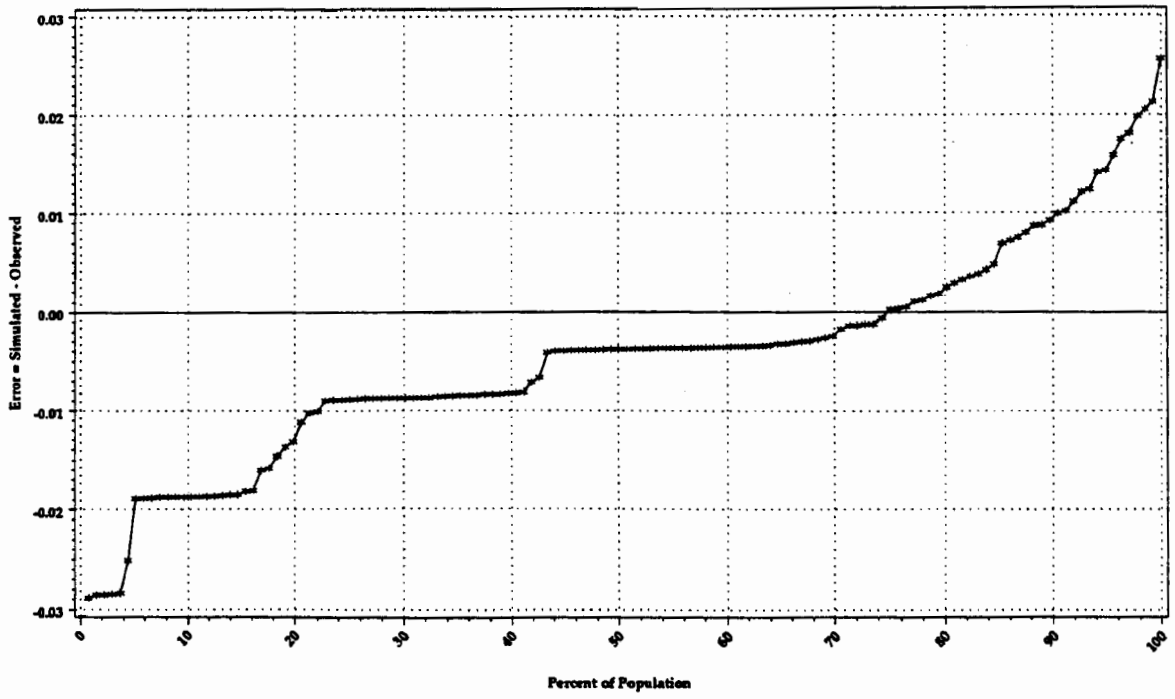
Dissolved Phosphorus



Appomattox River at Segment 310
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

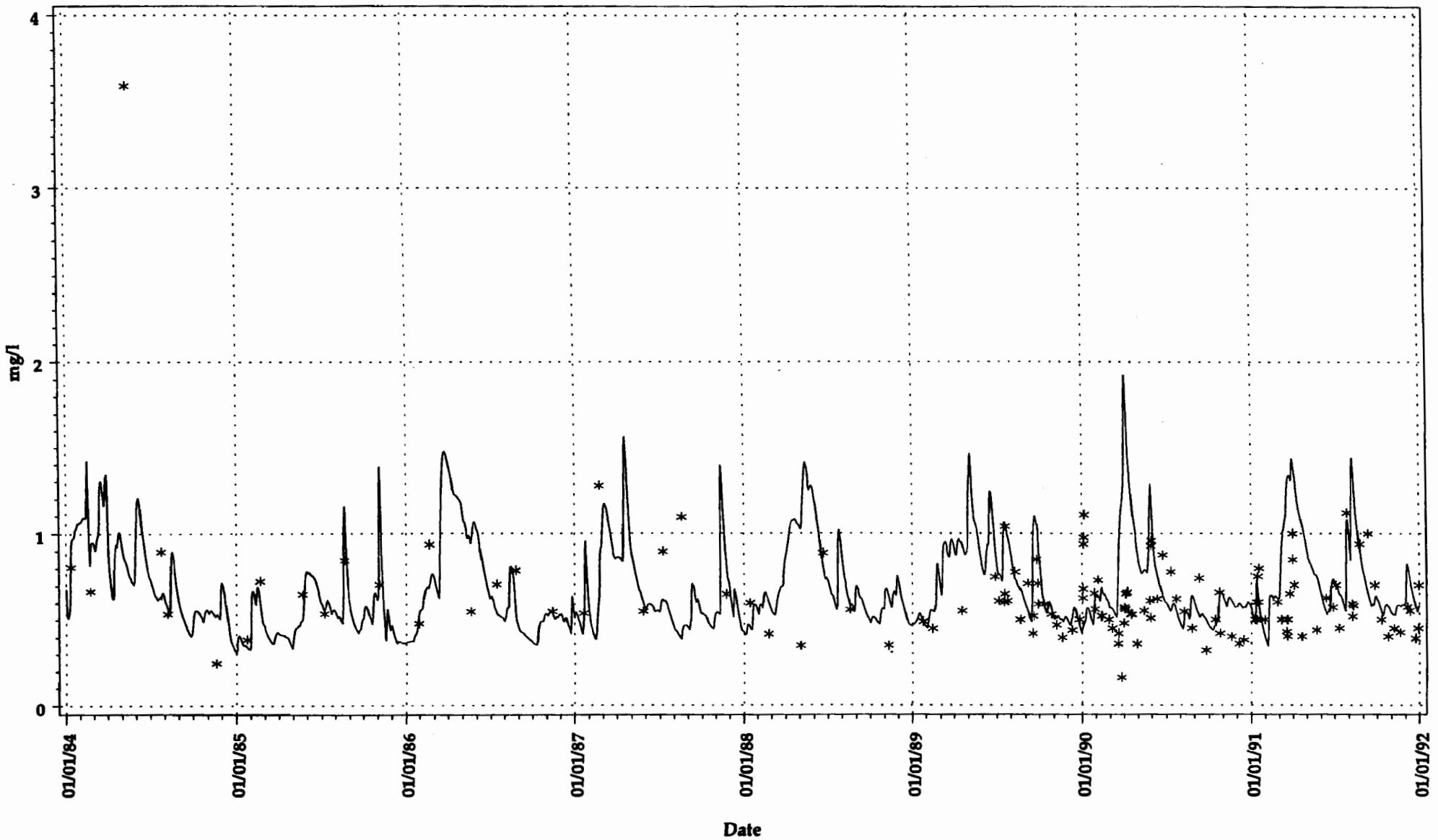


Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



Appomattox River at Segment 310
Observed and Simulated versus Time
Total Nitrogen

(*=Observed, -=Simulated)

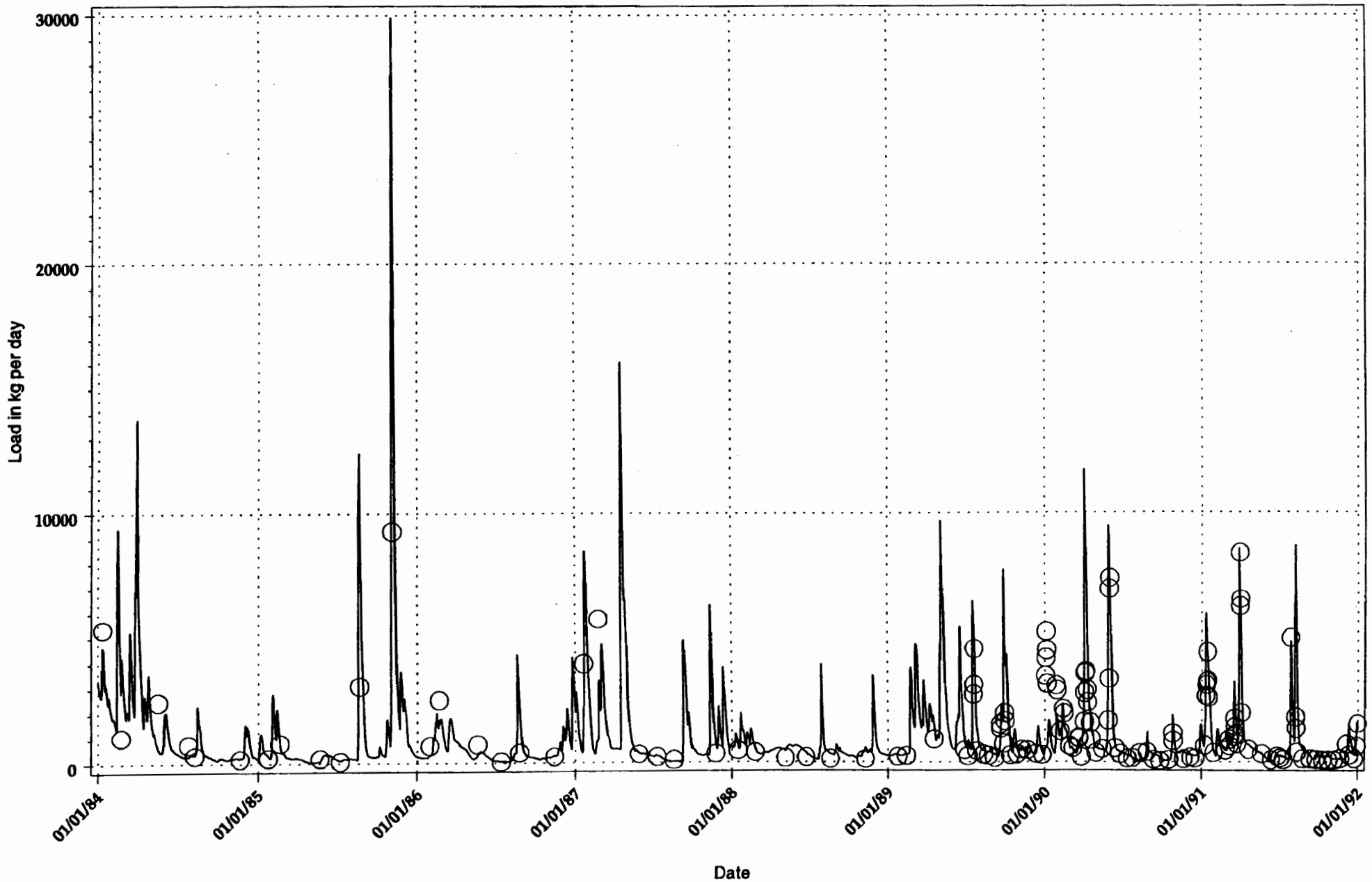


(y21_plotb.sas model3d(gwang.dl) plotant - ontime)
(appom.dev 23FEB99 10:15)

Appomattox River at Segment 310

Total Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)

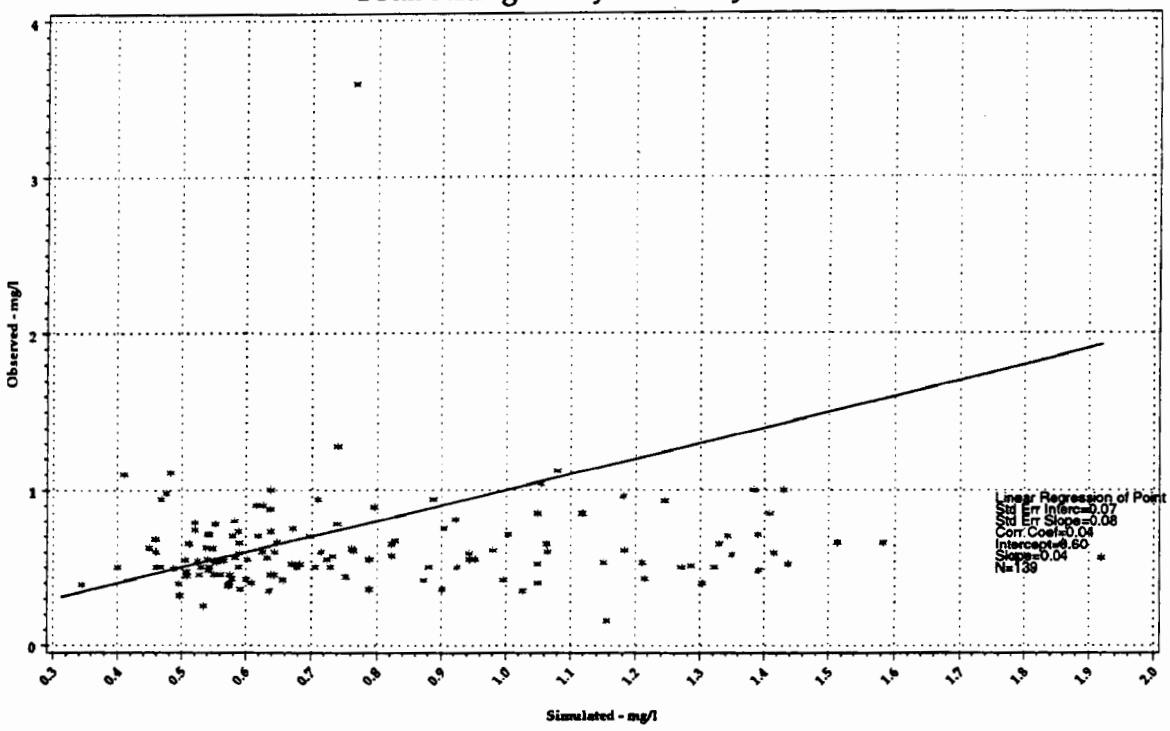


(y21_plotb.sas model3d (pwang.dt) fdflos)
(appom.drv 23FEB98 10:15,proc reg,model y=x)

Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

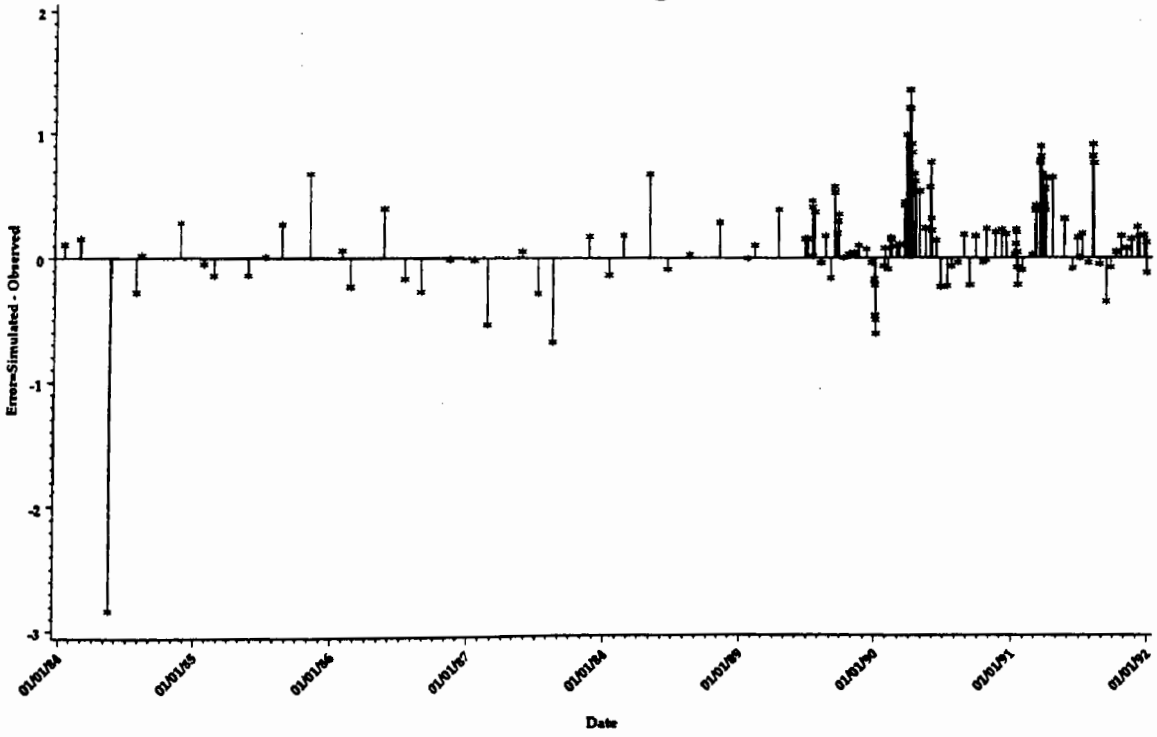
Total Nitrogen: 01JAN84 - 01JAN92



Appomattox River at Segment 310

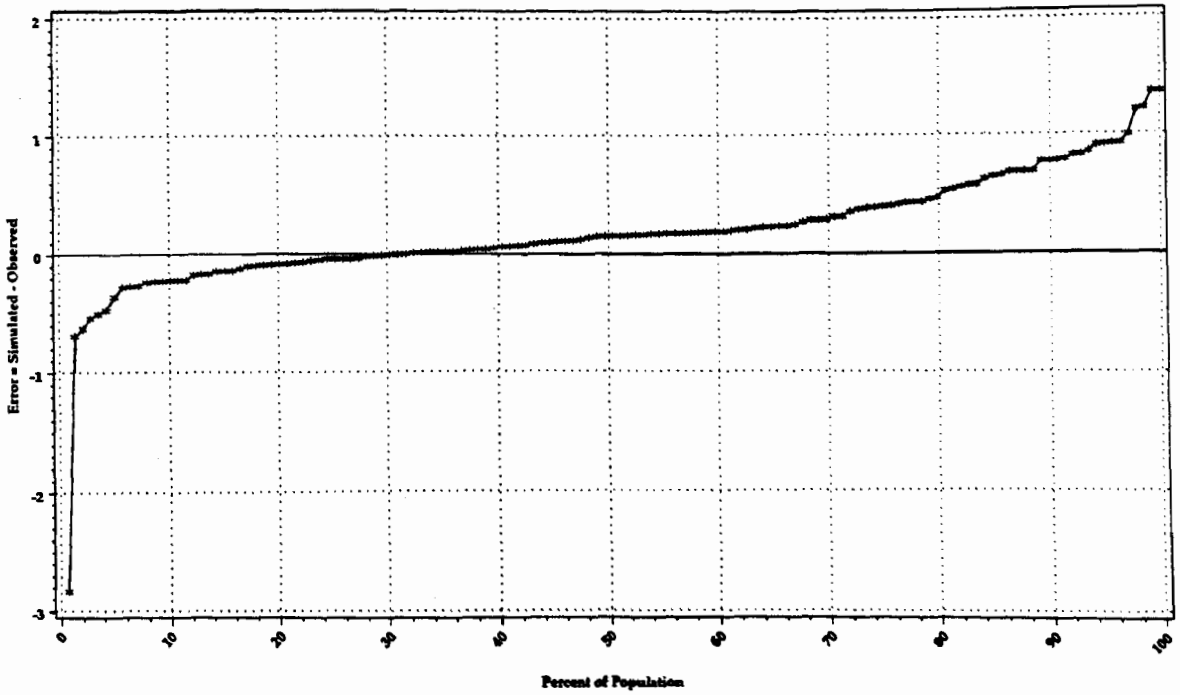
Actual Error versus Time

Total Nitrogen



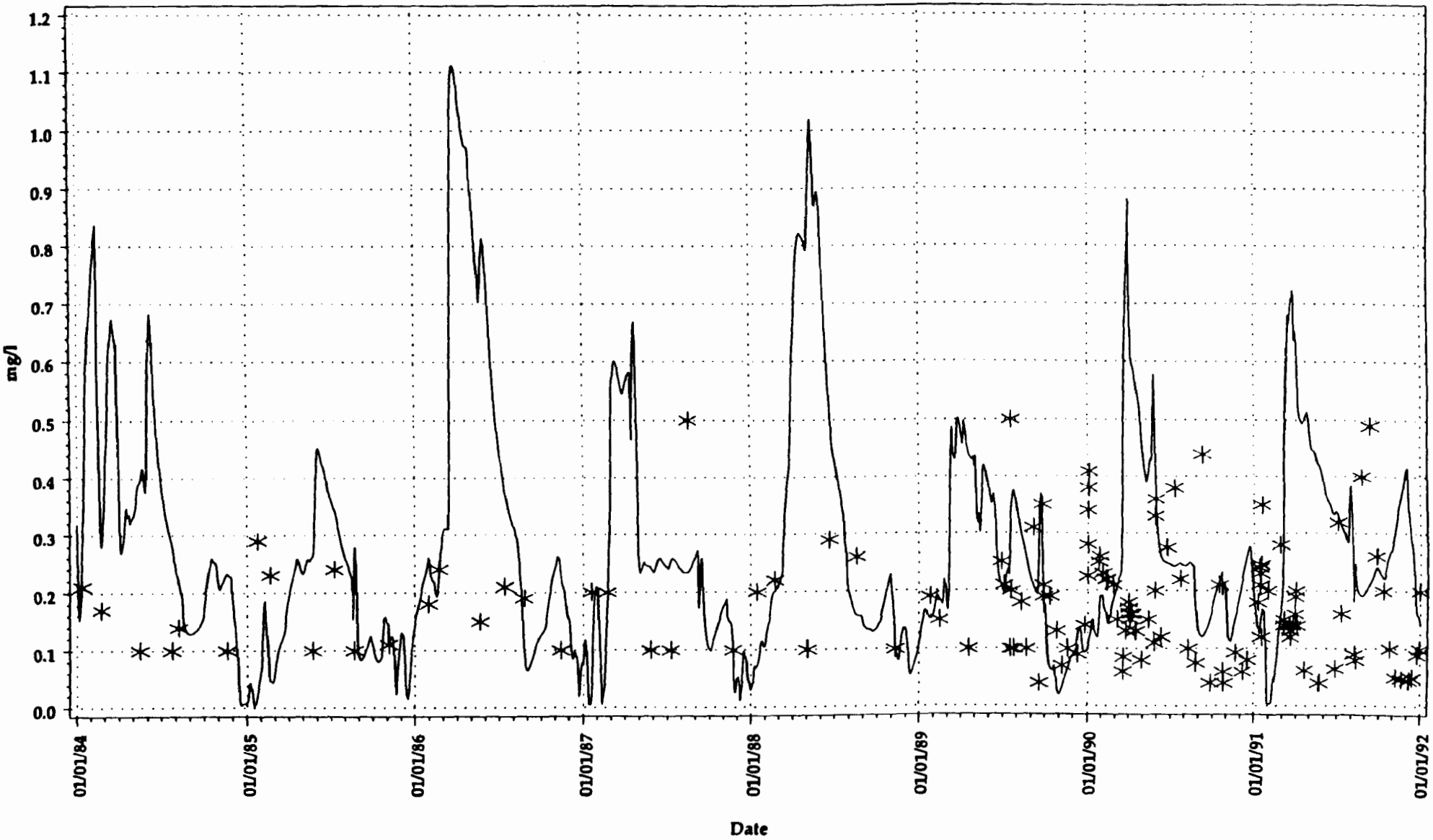
Appomattox River at Segment 310
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data



Appomattox River at Segment 310
Observed and Simulated versus Time
NO3

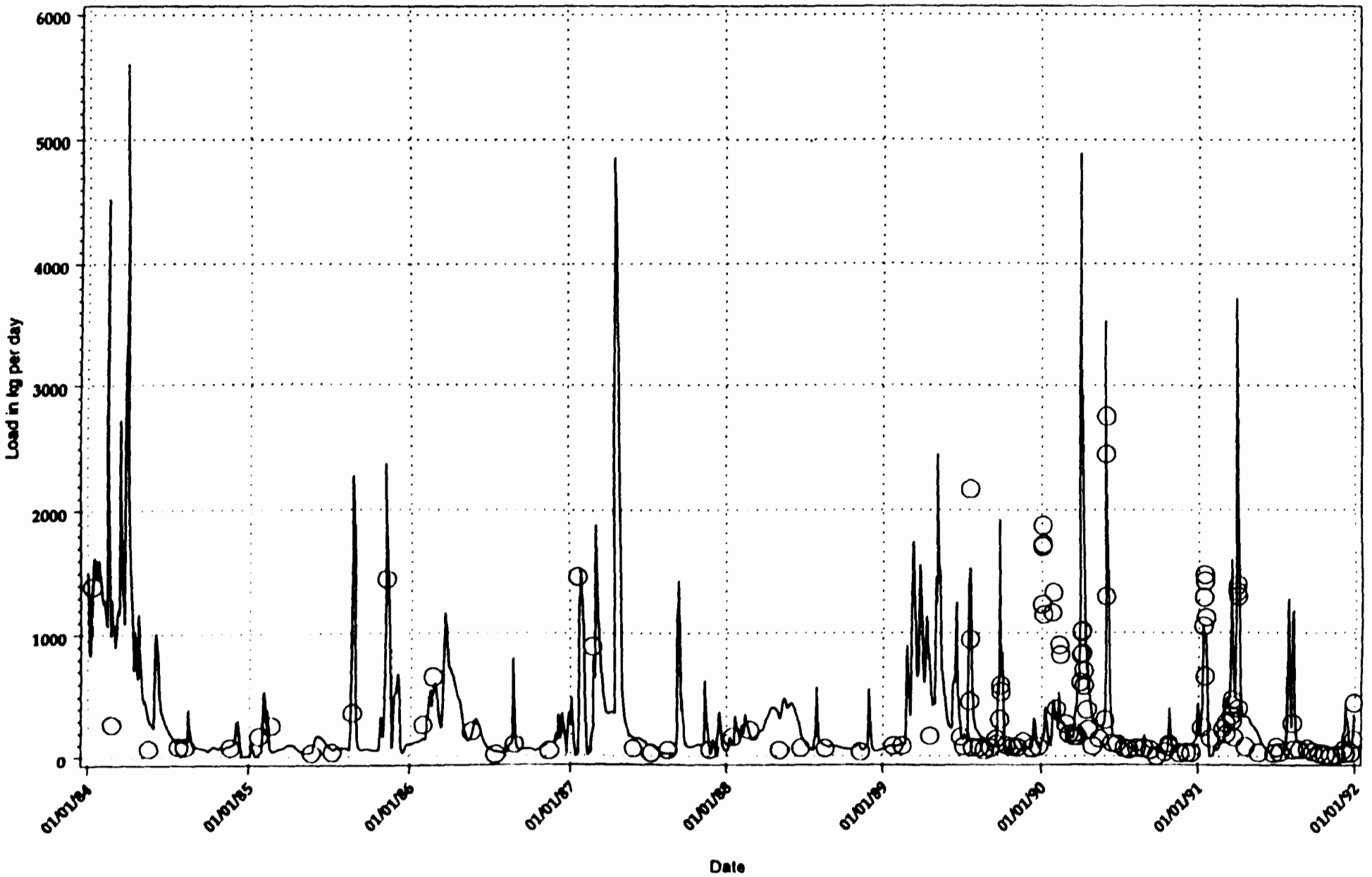
(*=Observed, -=Simulated)



Appomattox River at Segment 310

NO3 Observed and Simulated Load vs Time

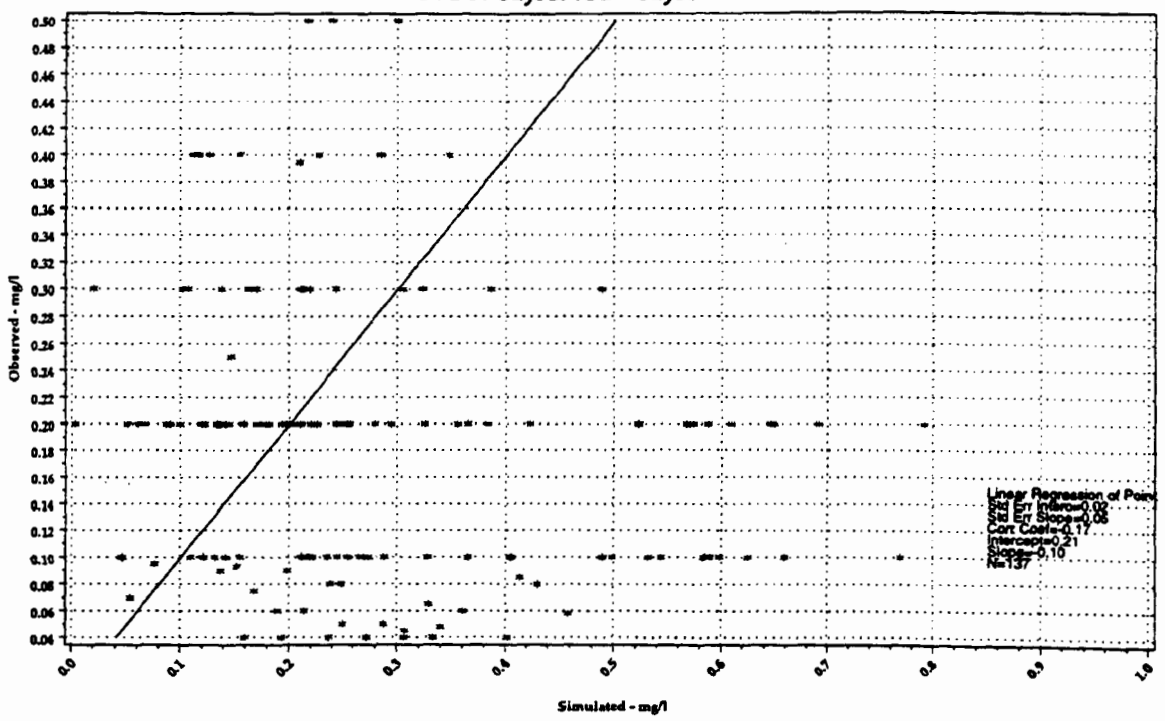
(line = simulated, O = observed)



Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

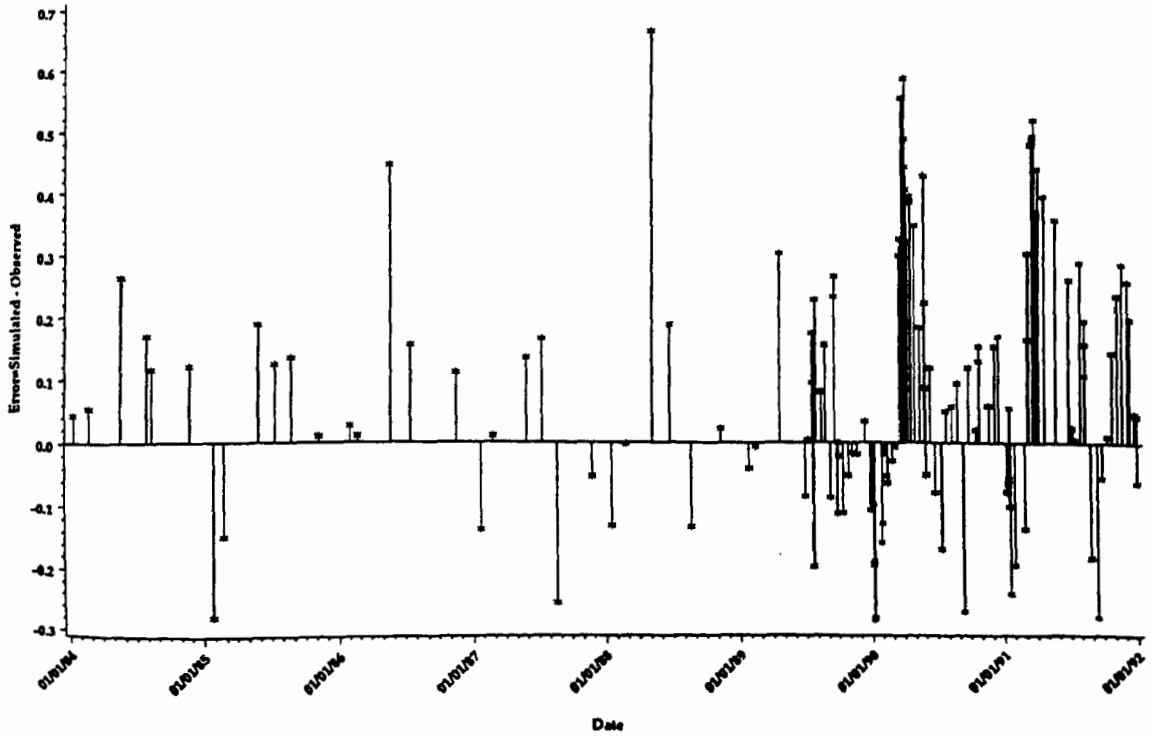
NO3: 01JAN84 - 01JAN92



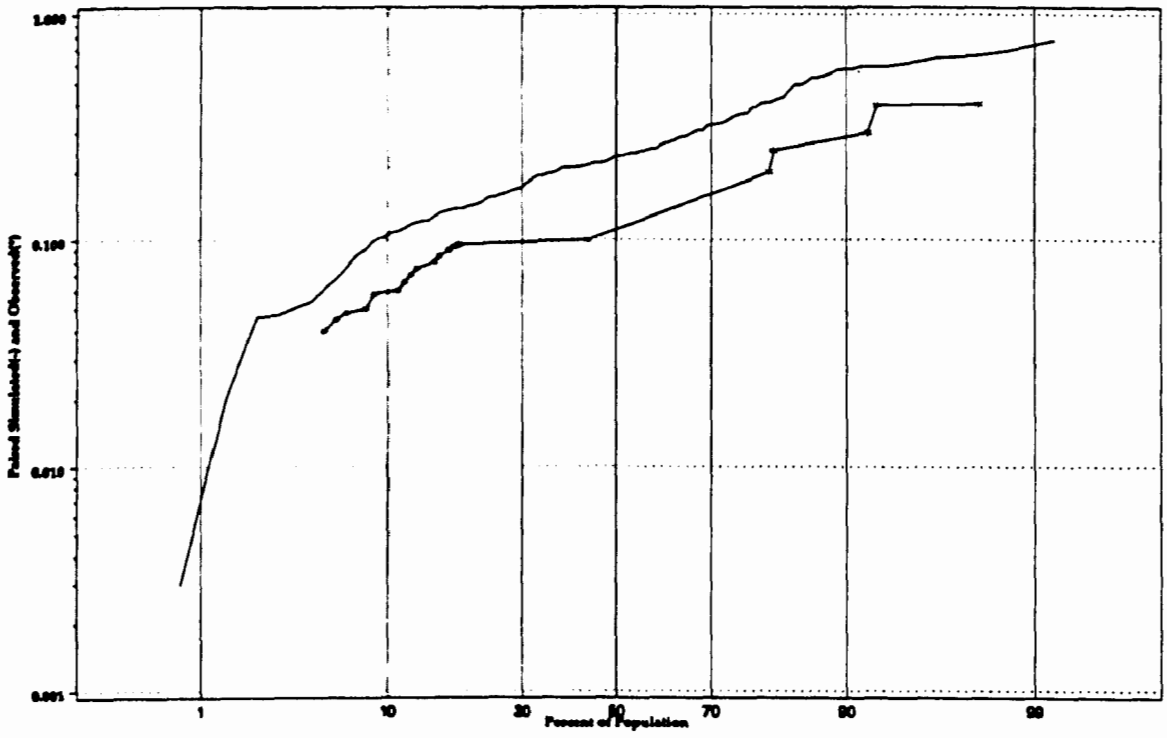
Appomattox River at Segment 310

Actual Error versus Time

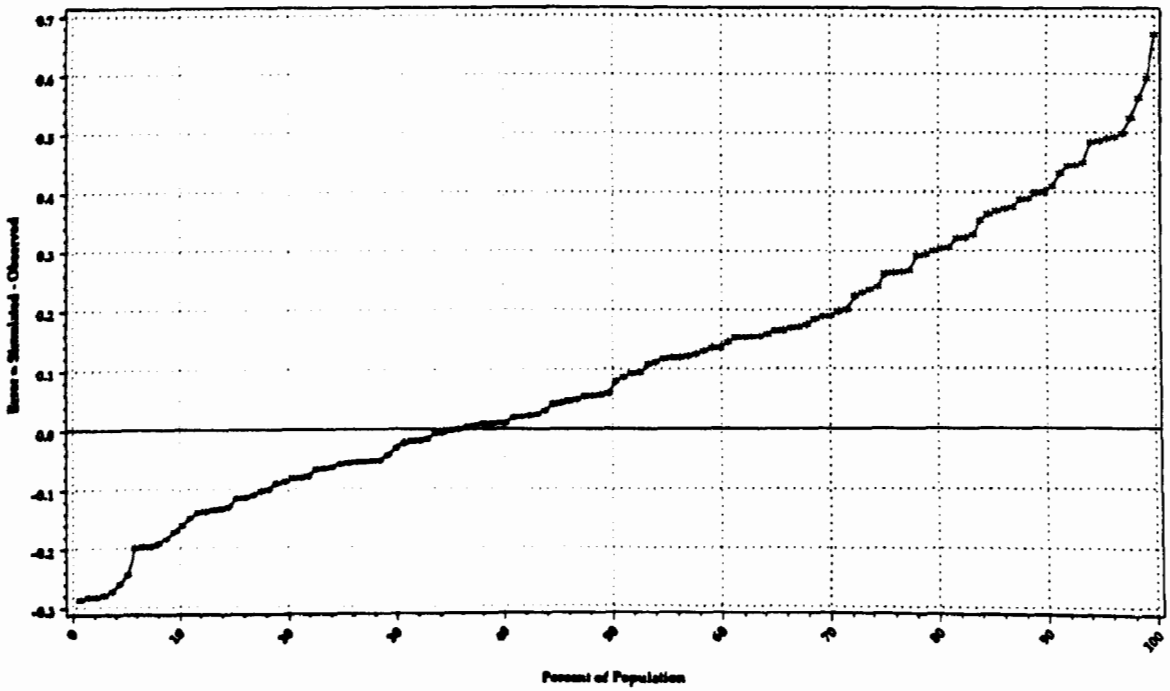
NO3



Appomattox River at Segment 310
NO3
Frequency Distribution - PAIRED Simulated and Observed Data

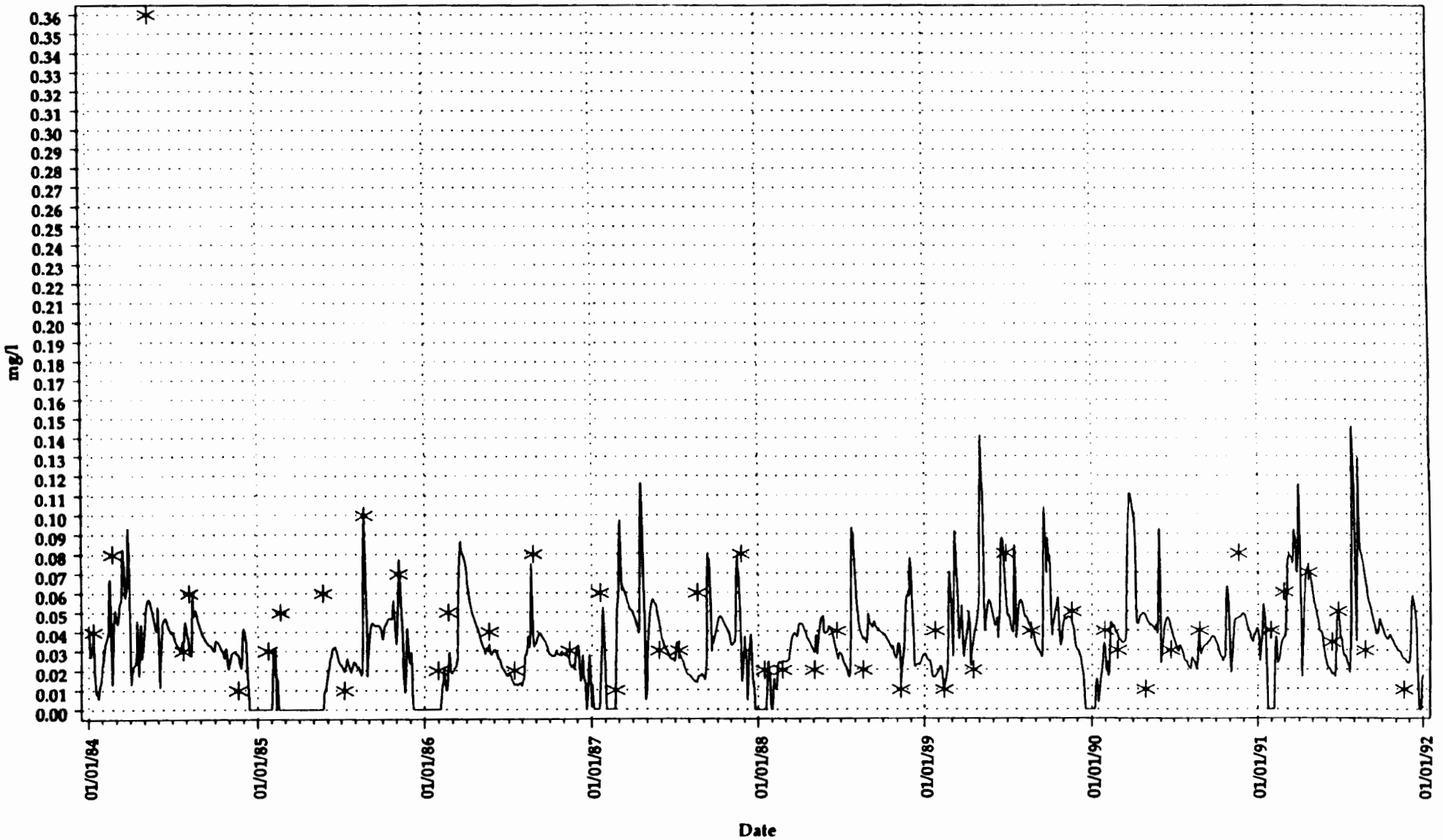


Appomattox River at Segment 310
Actual error versus Percentile Sample Population
NO3
Frequency Distribution - All Simulated and Observed Data

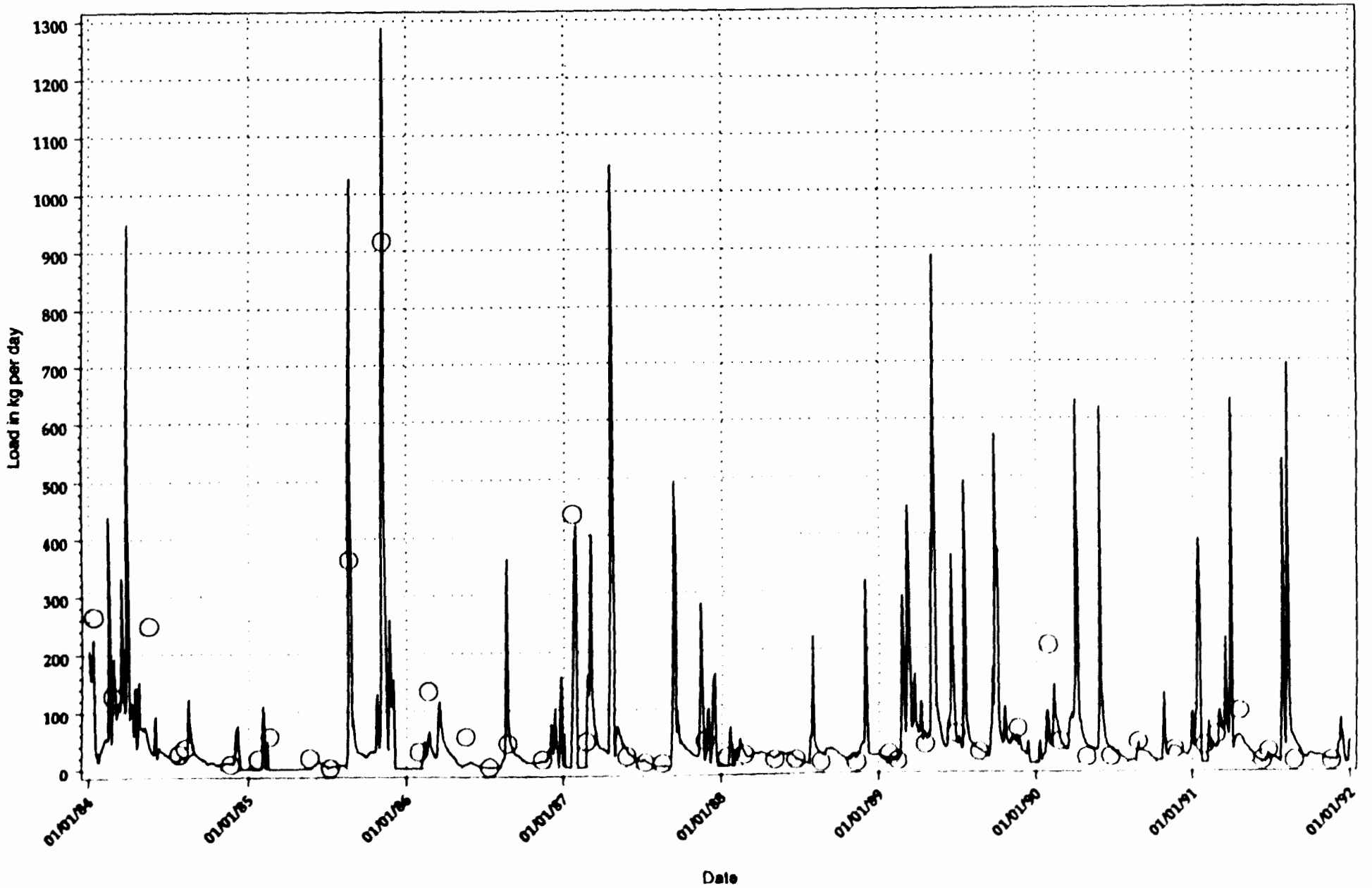


Appomattox River at Segment 310
Observed and Simulated versus Time
Total Ammonia

(*=Observed, -=Simulated)



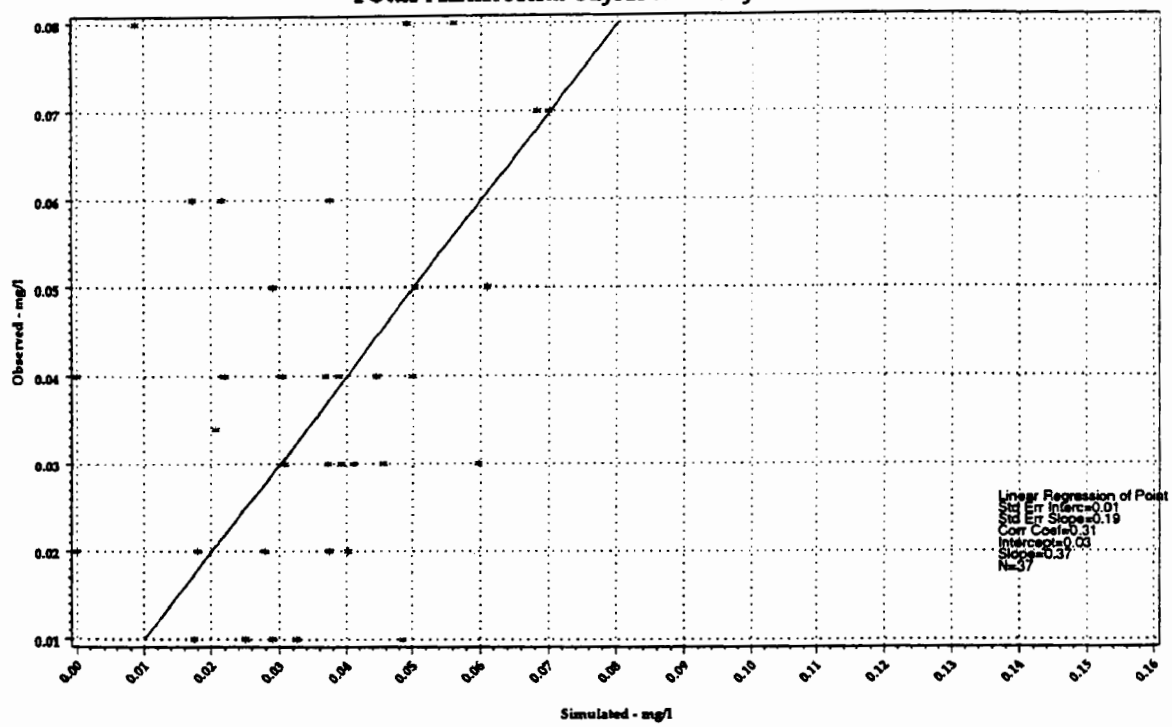
Appomattox River at Segment 310
Total Ammonia Observed and Simulated Load vs Time
(line = simulated, O = observed)



Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

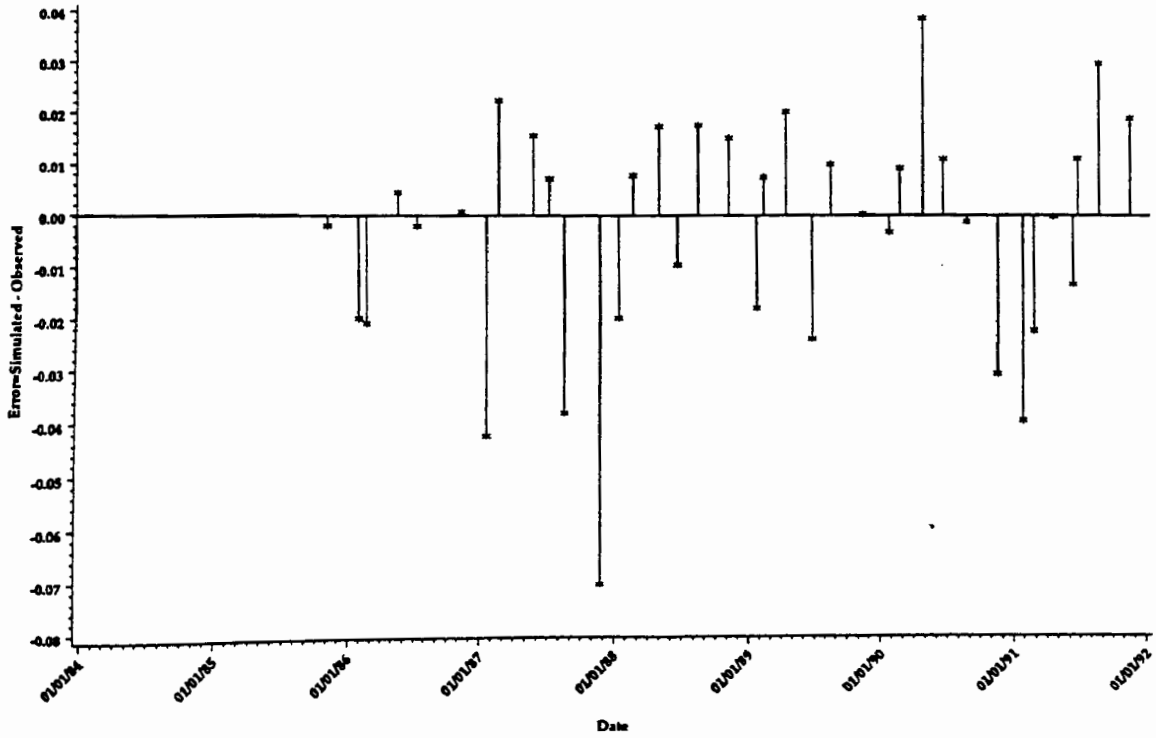
Total Ammonia: 01JAN84 - 01JAN92



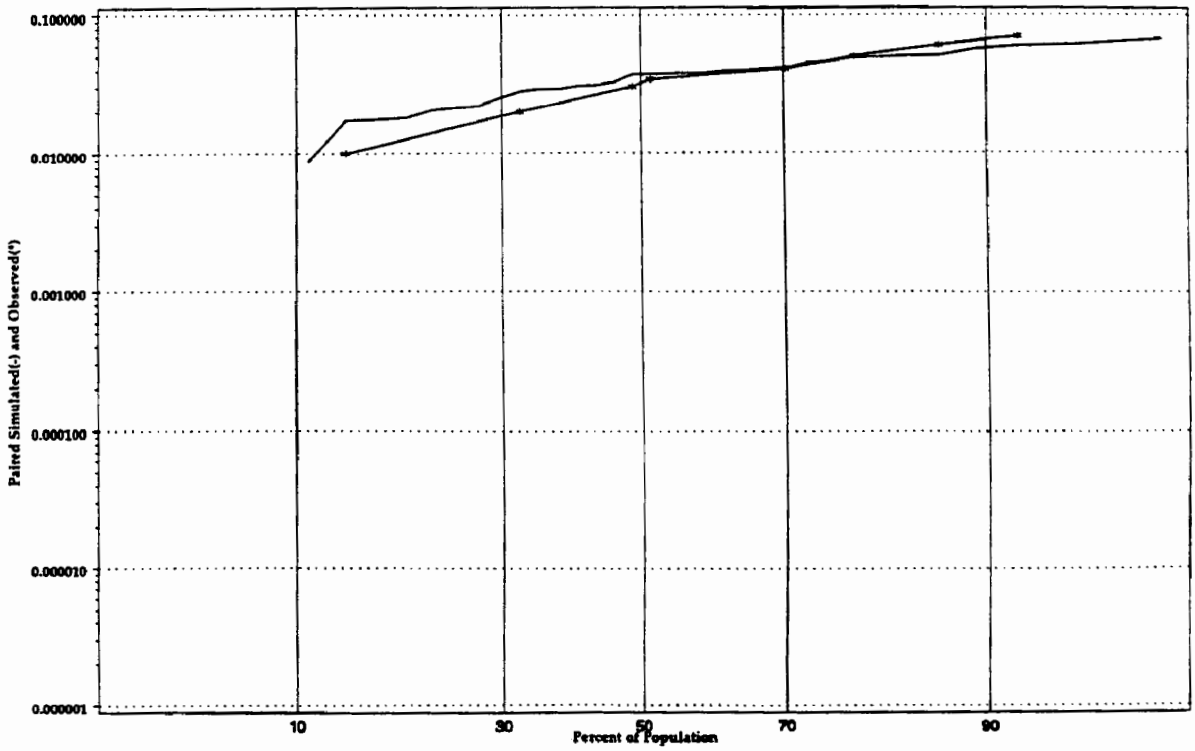
Appomattox River at Segment 310

Actual Error versus Time

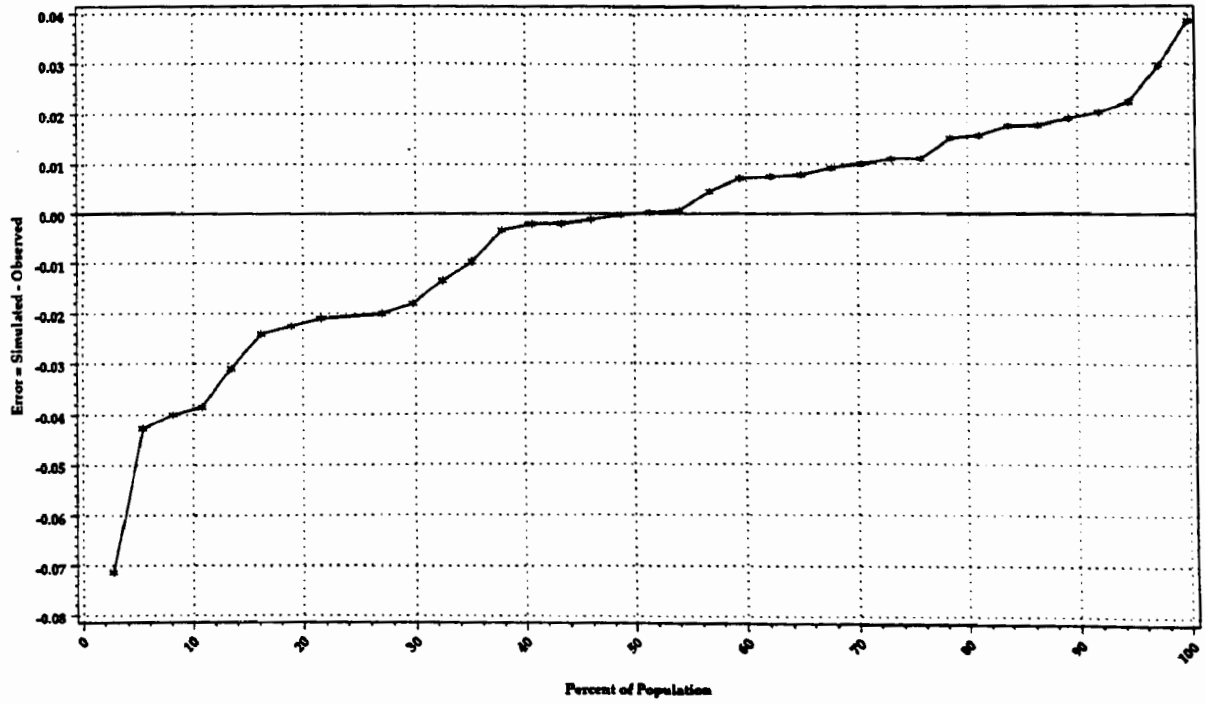
Total Ammonia



Appomattox River at Segment 310
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data

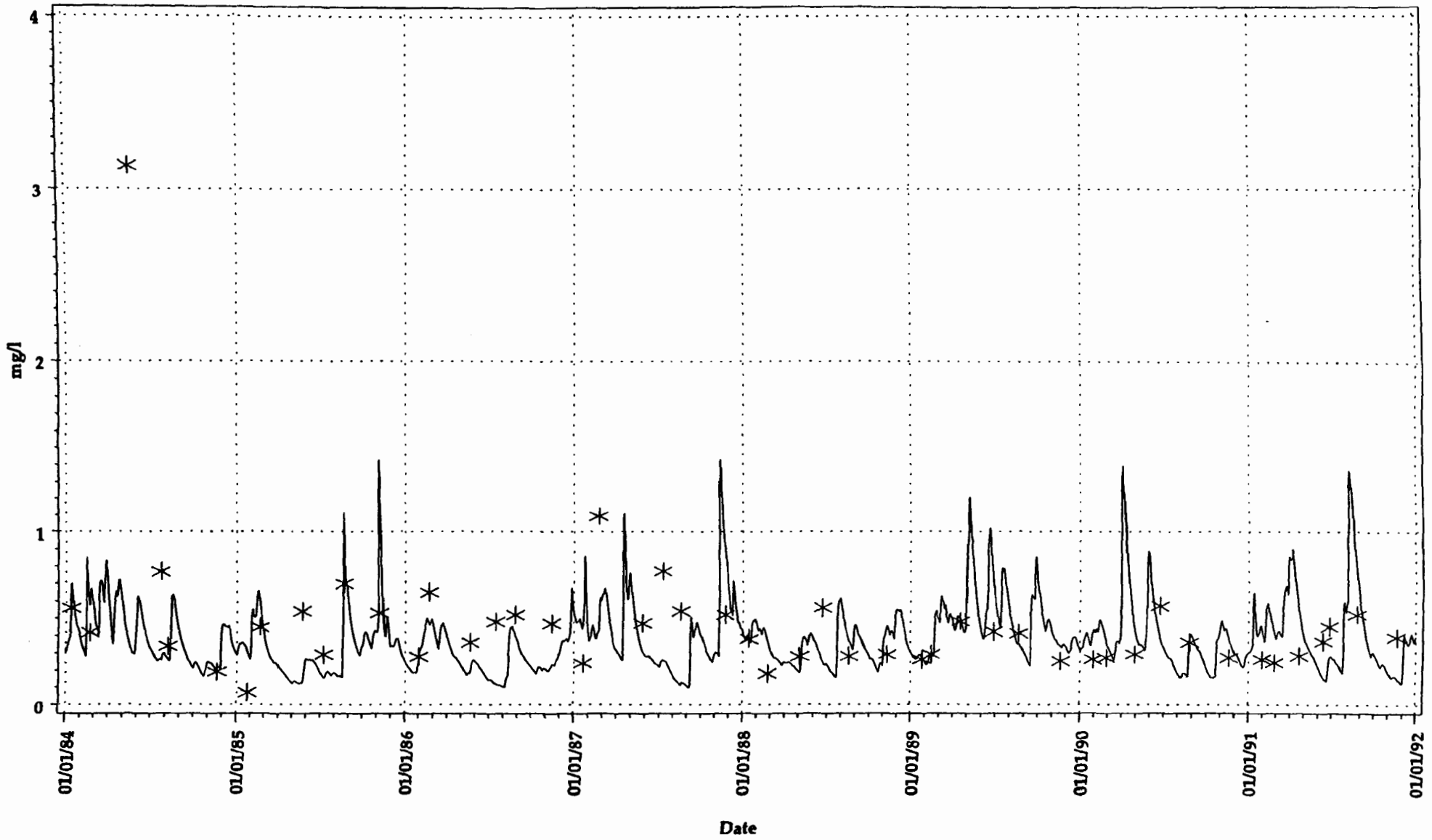


Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data

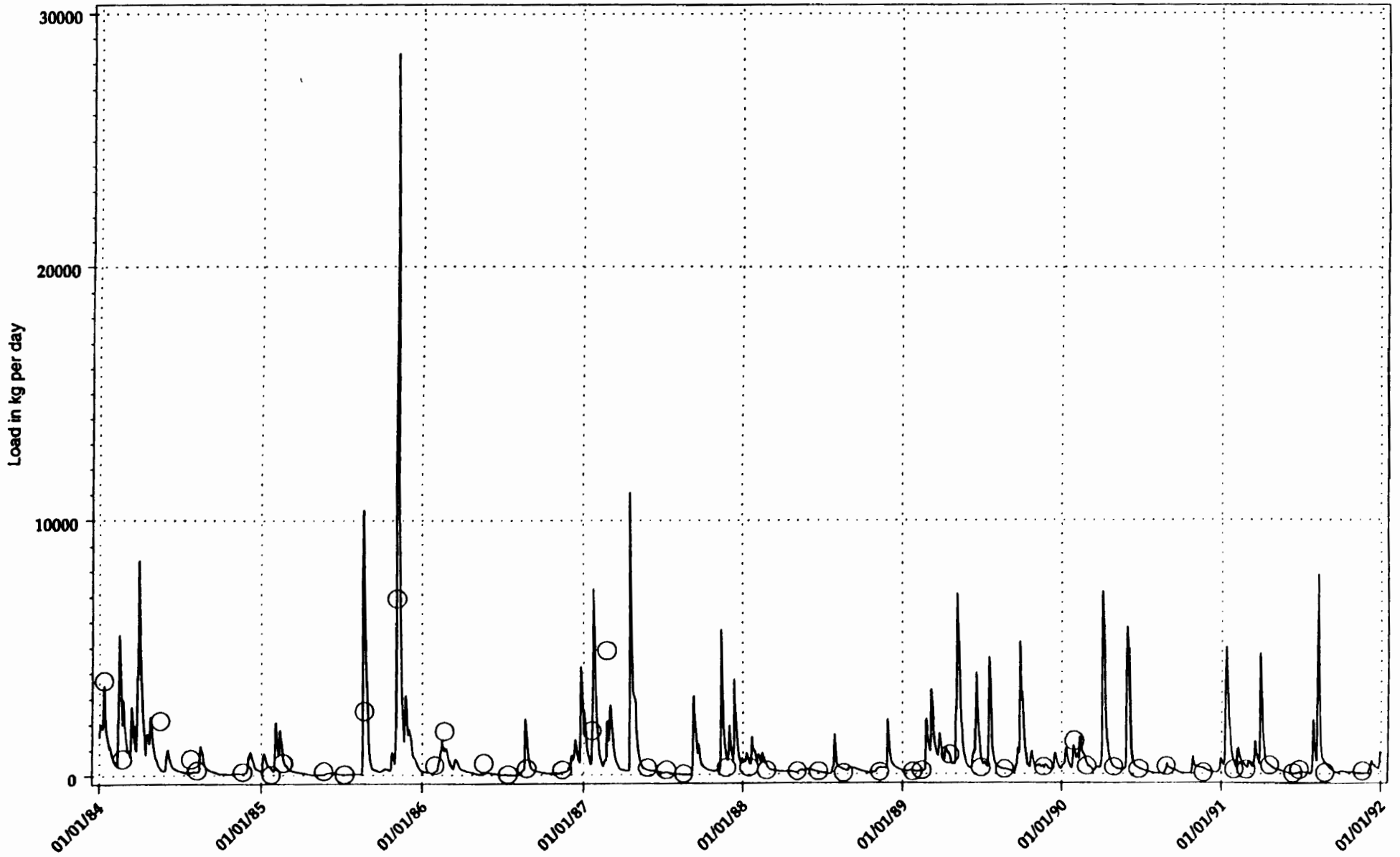


Appomattox River at Segment 310
Observed and Simulated versus Time
Organic Nitrogen

(*=Observed, -=Simulated)



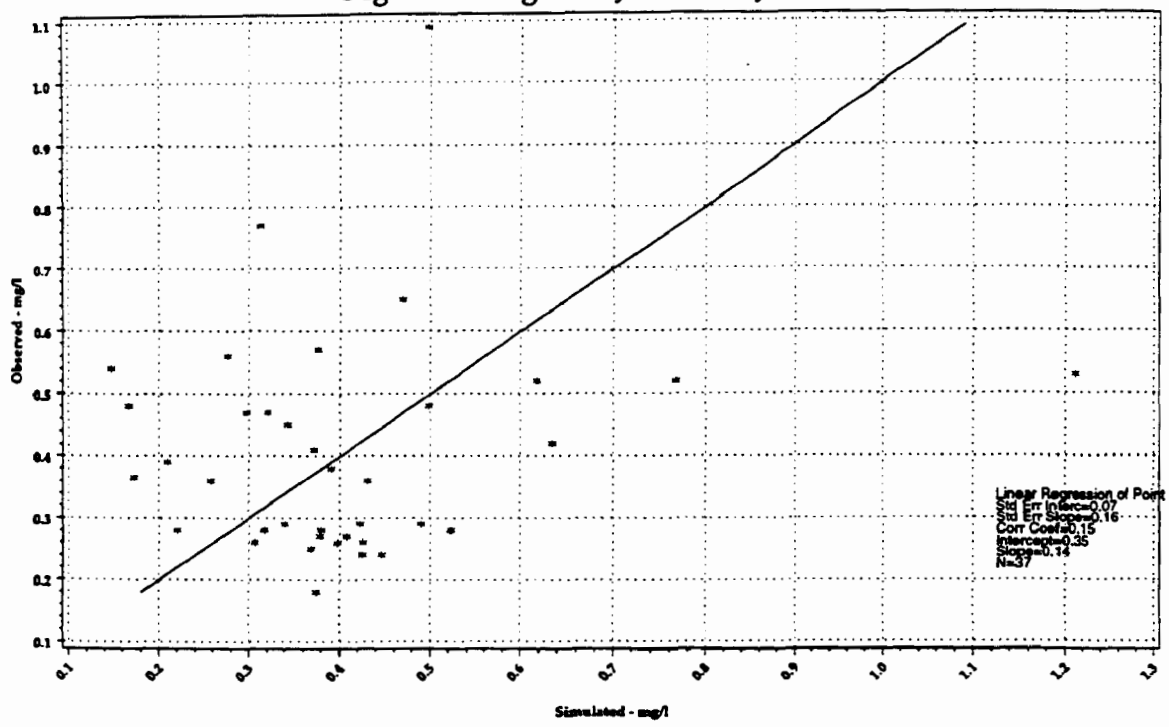
Appomattox River at Segment 310
Organic Nitrogen Observed and Simulated Load vs Time
(line = simulated, O = observed)



Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

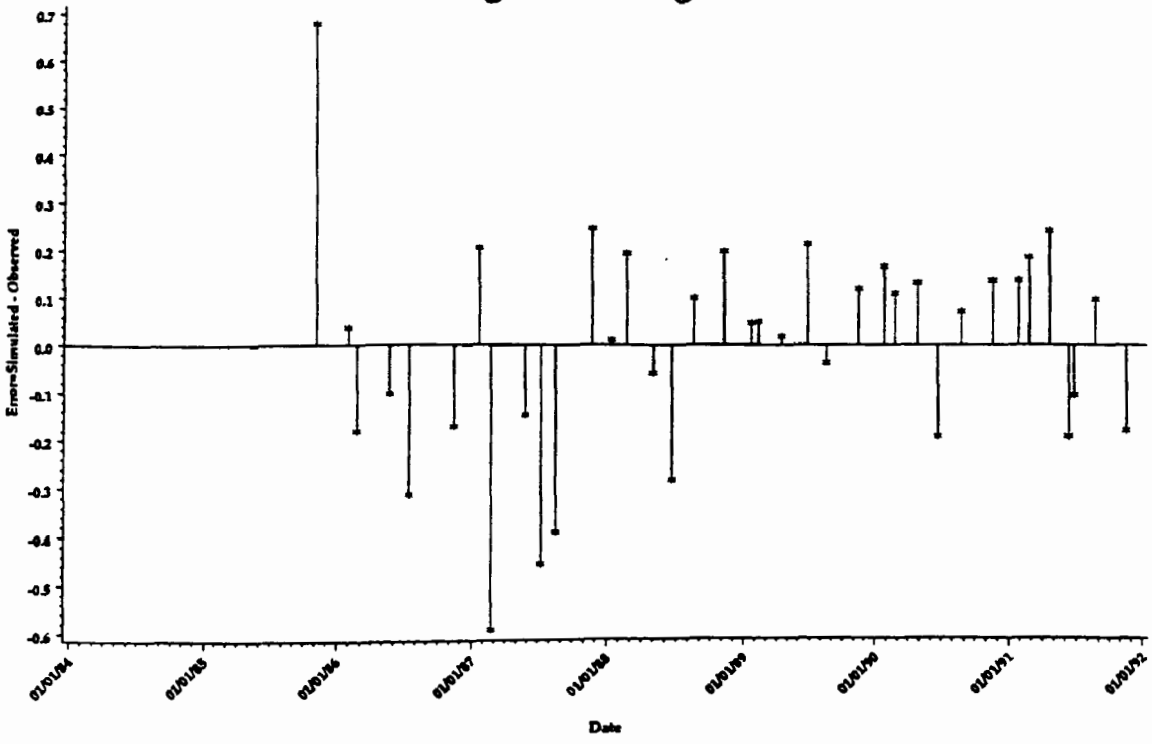
Organic Nitrogen: 01JAN84 - 01JAN92



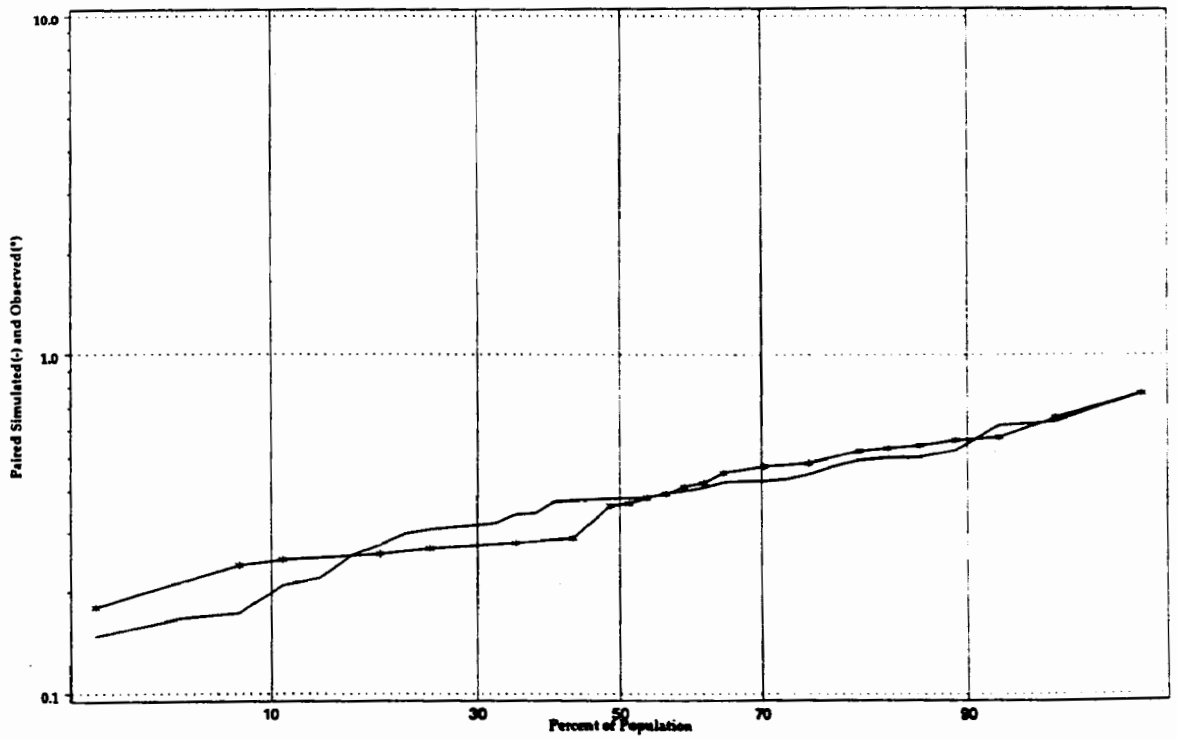
Appomattox River at Segment 310

Actual Error versus Time

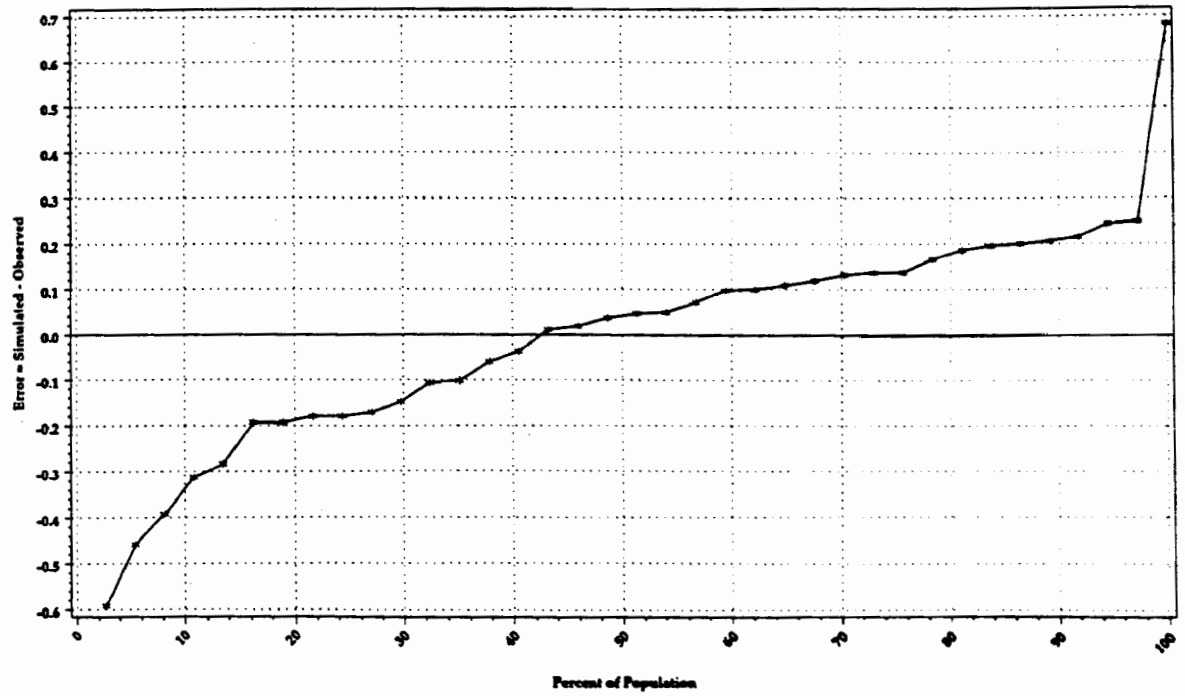
Organic Nitrogen



Appomattox River at Segment 310
Organic Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data



Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Organic Nitrogen
Frequency Distribution - All Simulated and Observed Data



B.7.0 Choptank River Basin

Basin Segments:

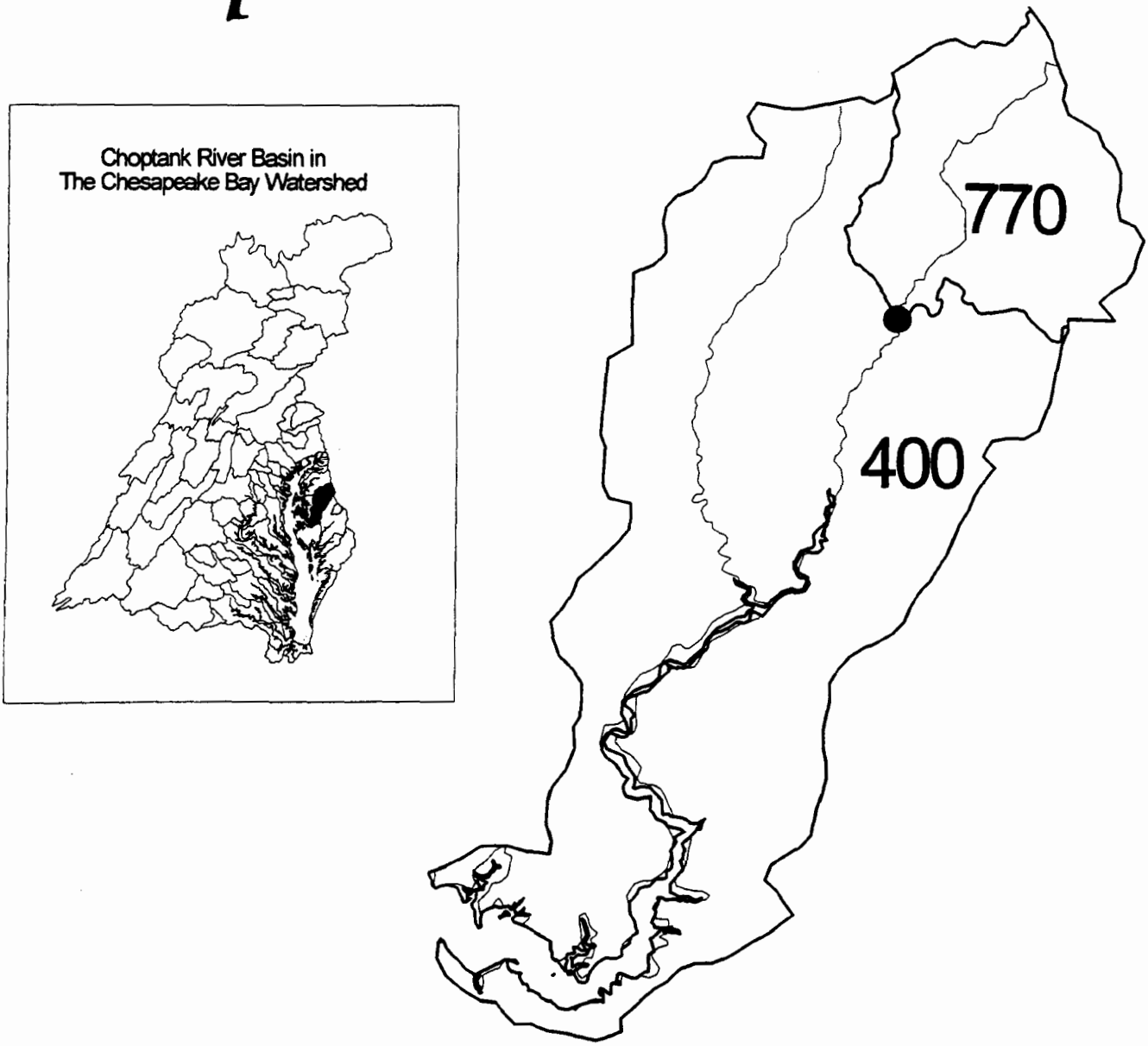
Above Fall Line Basin Segments: 770
Below Fall Line Basin Segments: 400

Section Contents:

B.7.0 Monitoring Stations in the Choptank River Basin (Figure B.7.0)
B.7.1 Choptank River (Monitoring Station: 1491000)

Figure B.7

Monitoring Stations in the Choptank River Basin



Calibration Stations
1491000
Streams
Model Segments

Chesapeake Bay Program
Map Date: April 1998

Source: USGS and USEPA Chesapeake Bay Program

N

KJH

B.7.1 Choptank River near Greensboro, MD at Segment 770 (Monitoring Station: 1491000) (Above Fall Line Basin Segments: 770)

Section Summary:

The Choptank basin water quality gage is in the upper reaches of the Choptank river in land characterized as poorly drained and with less agriculture than in the downstream areas of the Choptank. The Choptank basin above the gaged site covers an area of 582 square miles. At the midpoint of the simulation period, 1990, the land use for the basin was composed of 31% forest land, 54% cropland, 10% other agricultural areas, 4% urban areas, and 1% water (river and lake) surface area.

Based on an average hydrology used in a 1985 Reference scenario and a 1996 Nutrient Reduction Progress scenario estimated total nitrogen delivered to the gage decreased from 4.0 million pounds in 1985 to 3.6 million pounds in 1996. Total phosphorus loads over the same time period decreased from 0.36 million pounds to 0.28 million pounds. In general, point source loads above the gage site decreased. In 1996, the total nitrogen point source load was 5% of the total load and the total phosphorus point source load was 17% of the total load. Estimated septic system total nitrogen loads increased 16%, from 0.11 million pounds in 1985 to 0.12 million pounds in 1996.

Over the 1985 to 1996 period, changes in the land use and BMP simulation decreased estimated cropland total nitrogen loads by 20%, and other agricultural loads (primarily pasture and manure loads) by 32%. Total phosphorus decreased for these land uses by 21% and 43% respectively. Urban loads were estimated to have increased over the 1985 to 1996 period by 10% for both total nitrogen and total phosphorus due to increases in population and urban land use area.

Graphs

Observed and Simulated Concentrations versus Date
Observed and Simulated Loads versus Date
Scatter Plot and Regression of Simulated versus Observed
Actual Error versus Date
Relative Error versus Percentile Sample Population
Actual Error versus Percentile

Parameters

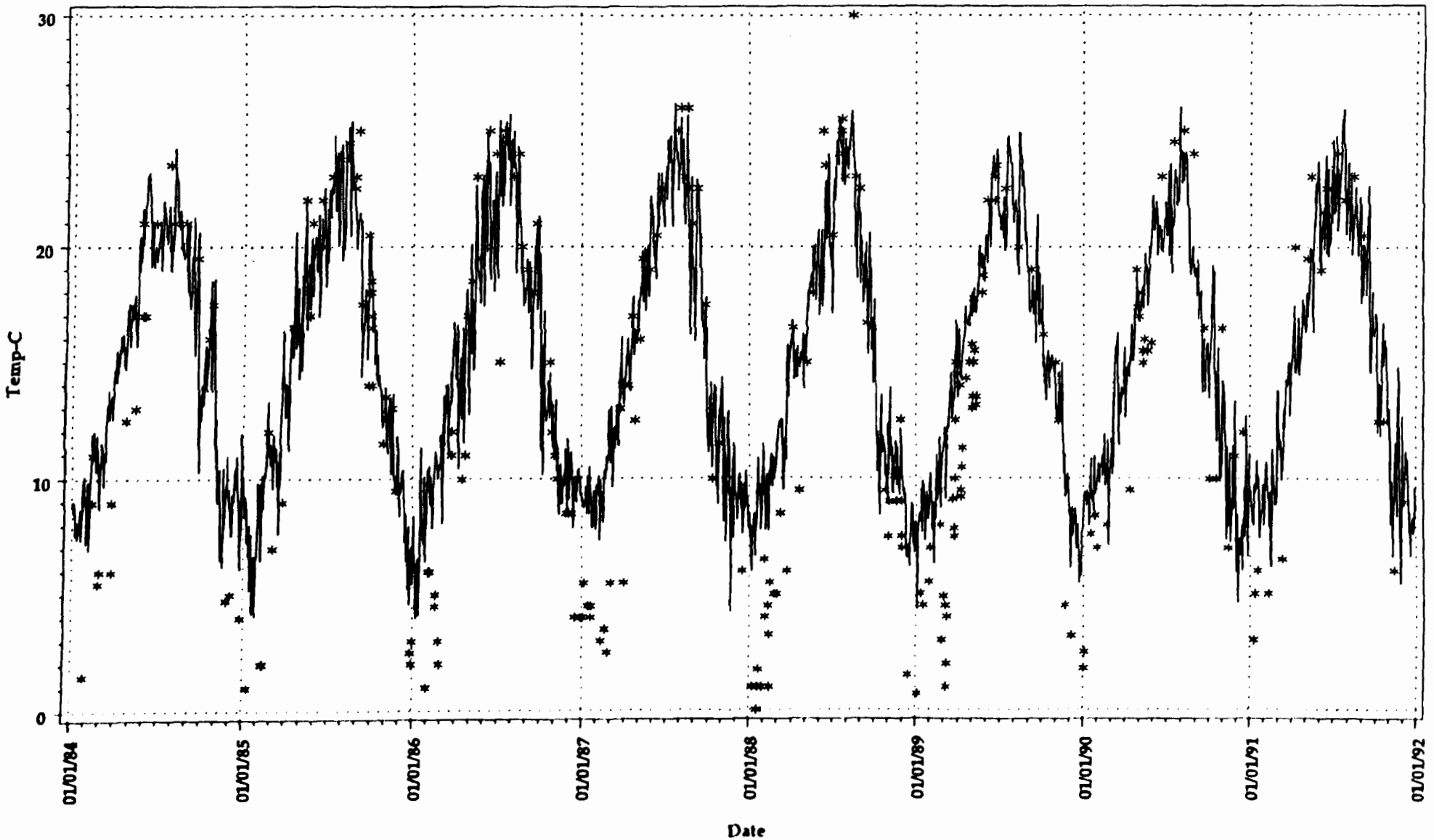
Temperature
Dissolved Oxygen
Total Suspended Sediment
Total Phosphorus
Organic and Particulate Phosphorus
Phosphate
Total Nitrogen
Nitrate
Total Ammonia
Organic Nitrogen

Exceptions

Observed and Simulated Loads versus Date -- Temperature

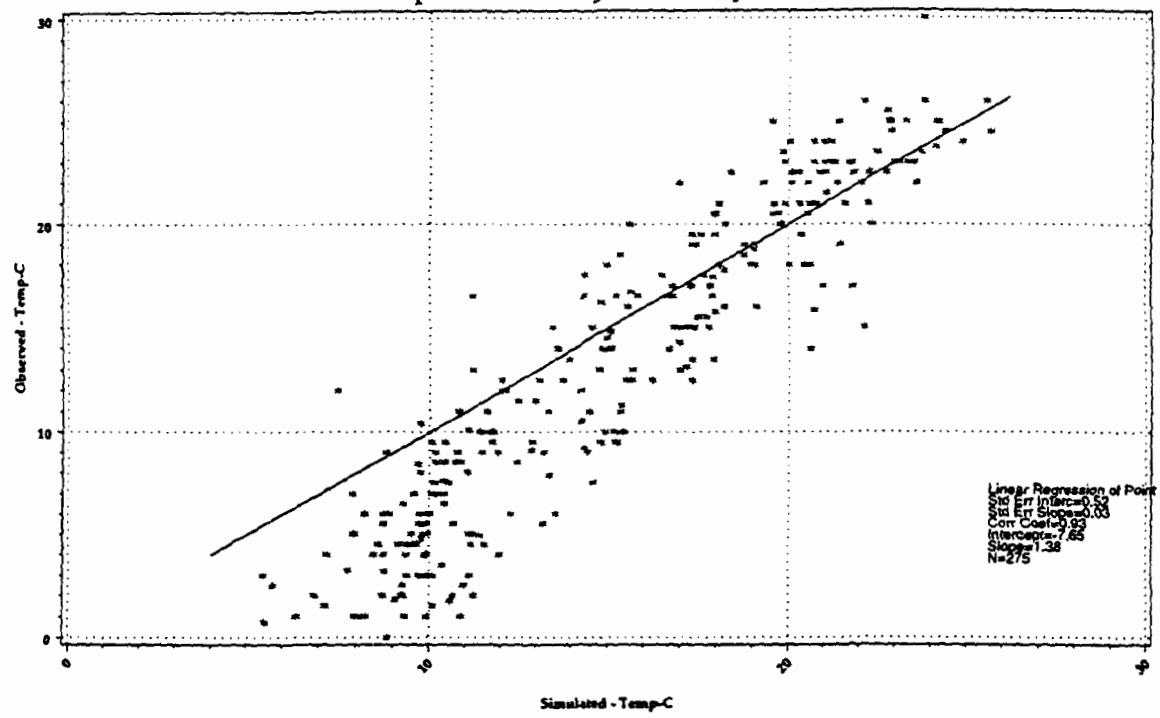
Choptank River at Segment 770
Observed and Simulated versus Time
Temperature-C

(*=Observed, -=Simulated)



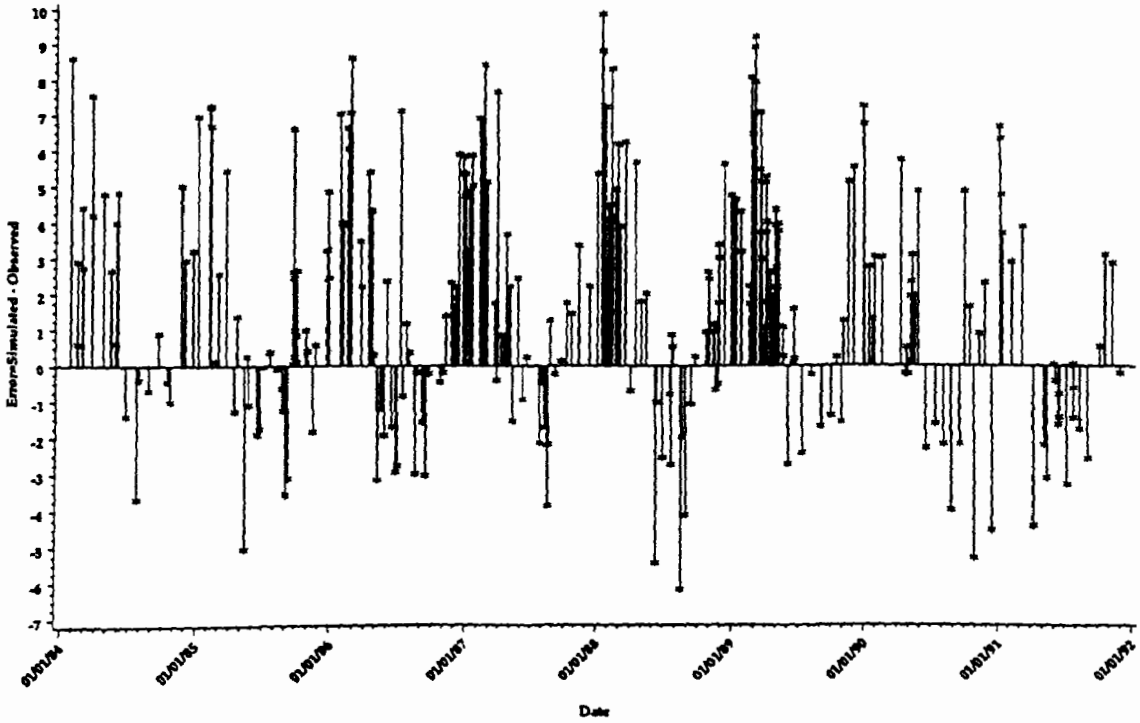
CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Temperature-C: 01JAN84 - 01JAN92

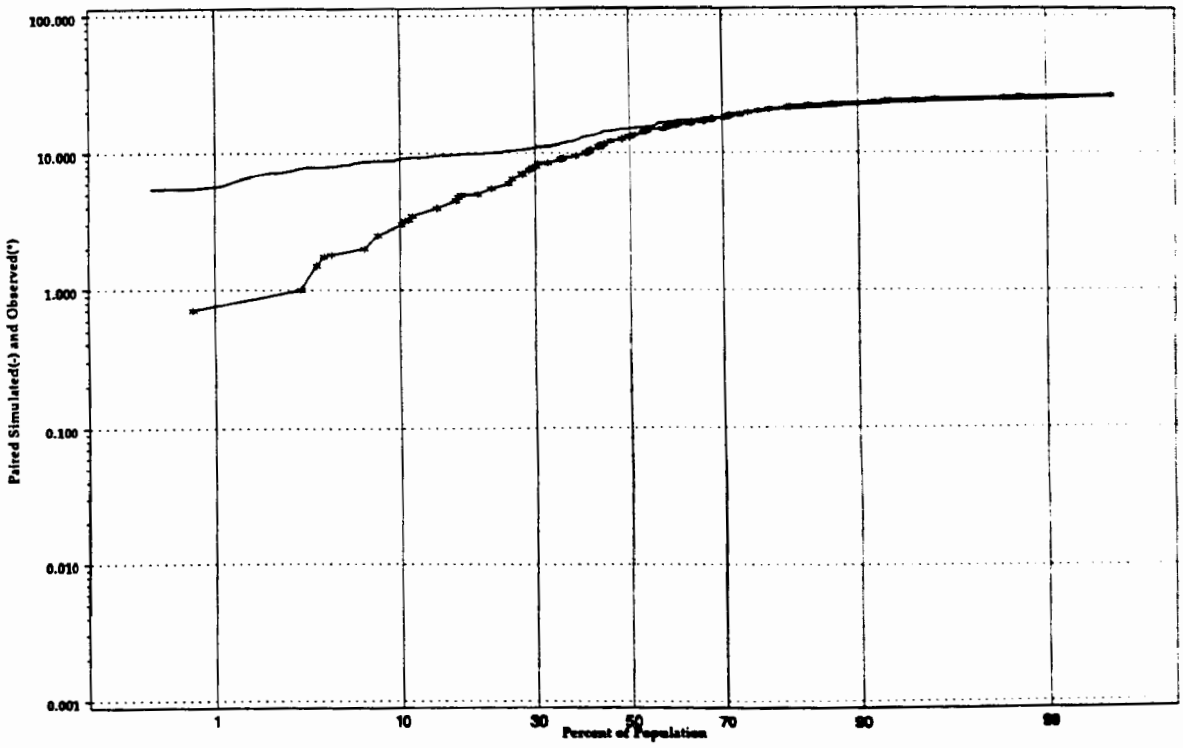


CHOPTANK RIVER at Segment 770

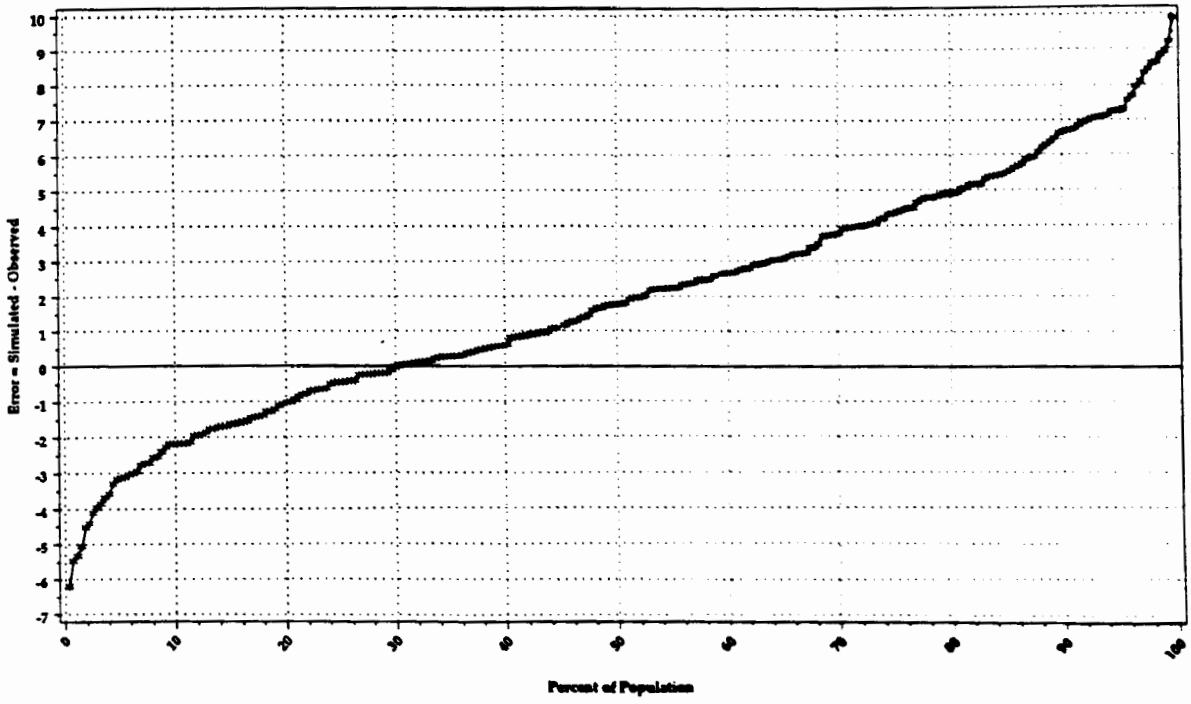
Actual Error versus Time
Temperature-C



CHOPTANK RIVER at Segment 770
Temperature-C
Frequency Distribution - PAIRED Simulated and Observed Data

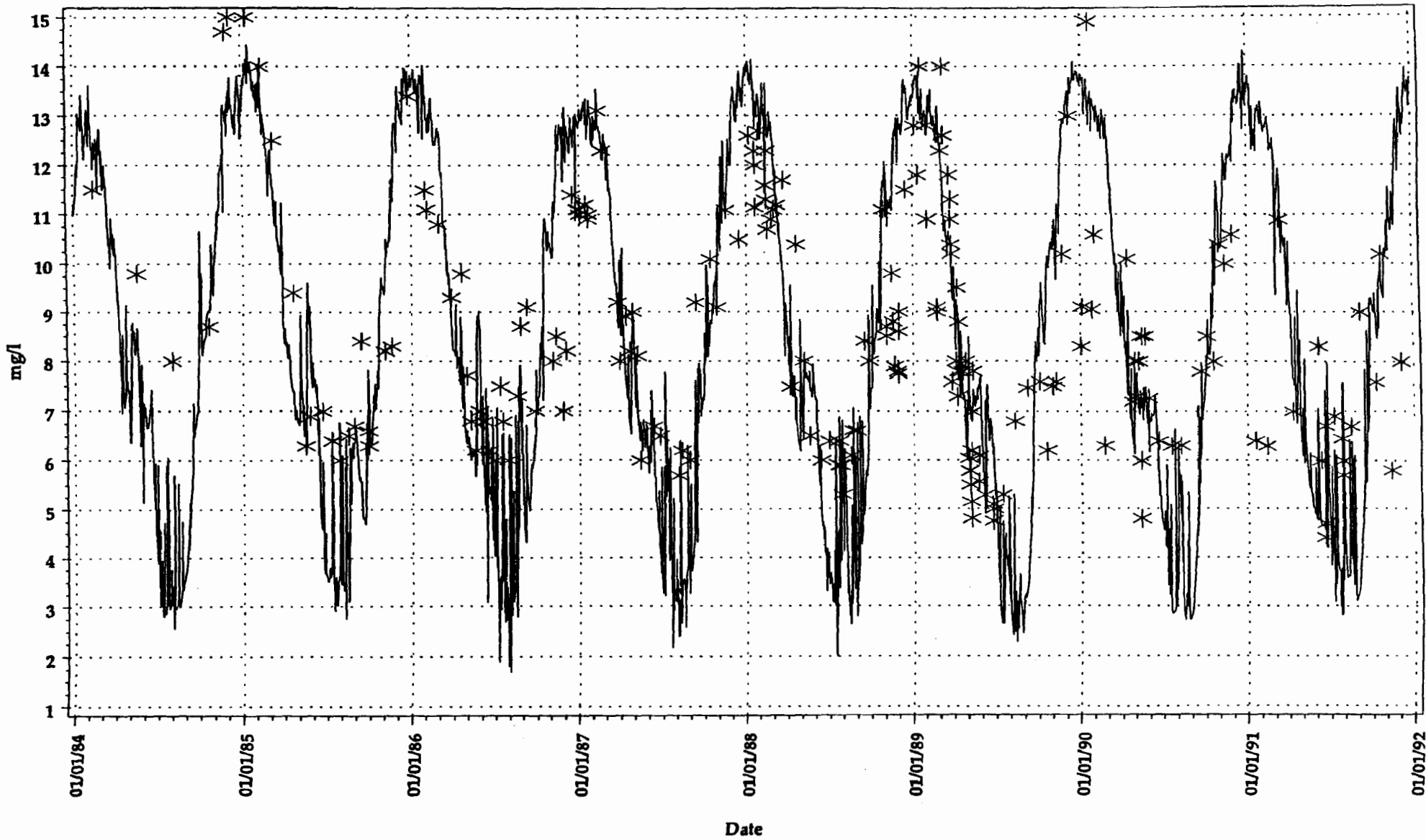


CHOPTANK RIVER at Segment 770
Actual error versus Percentile Sample Population
Temperature-C
Frequency Distribution - All Simulated and Observed Data

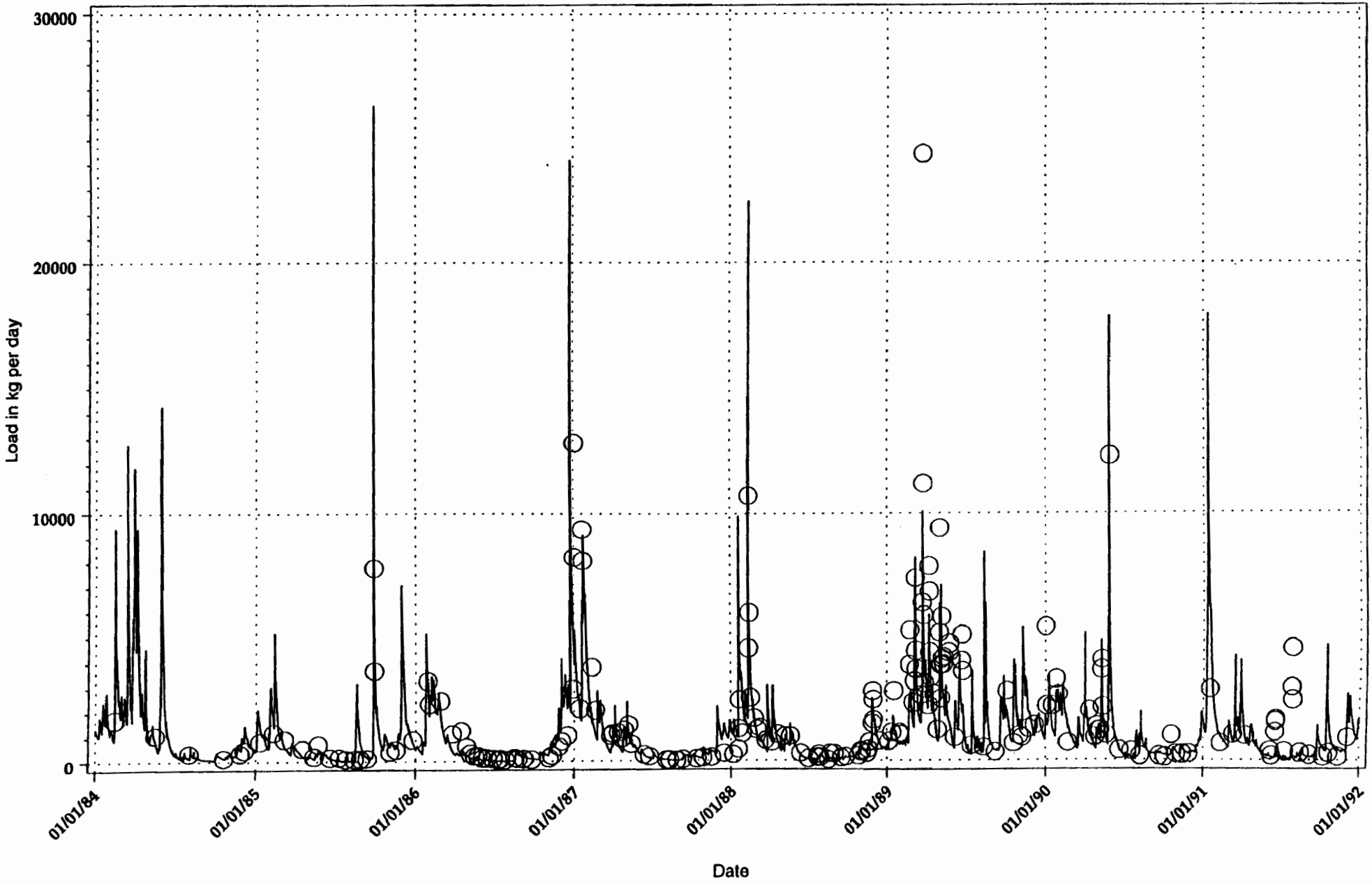


Choptank River at Segment 770
Observed and Simulated versus Time
Dissolved Oxygen

(*=Observed, -=Simulated)



Choptank River at Segment 770
Dissolved Oxygen Observed and Simulated Load vs Time
(line = simulated, O = observed)

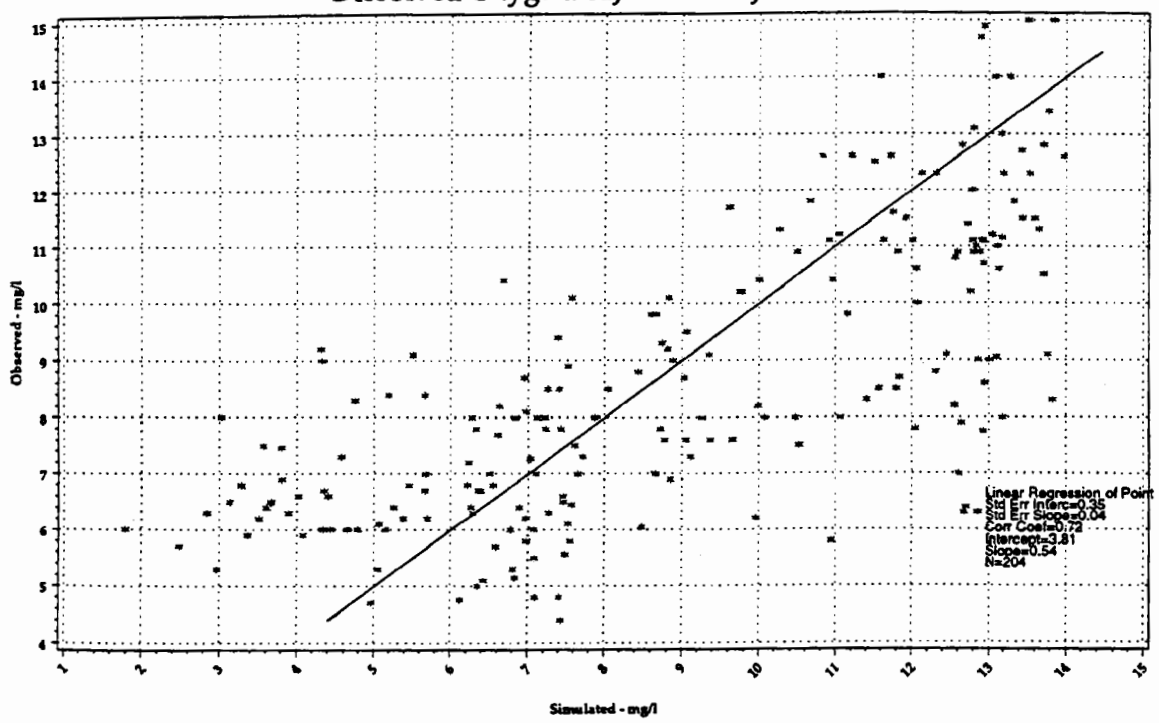


(y21_plot1.sas dataslore2 [nps p3 james.sas] lidlas)
(choptank.drv 04FEB98 11:23,proc reg,model y=x)

CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

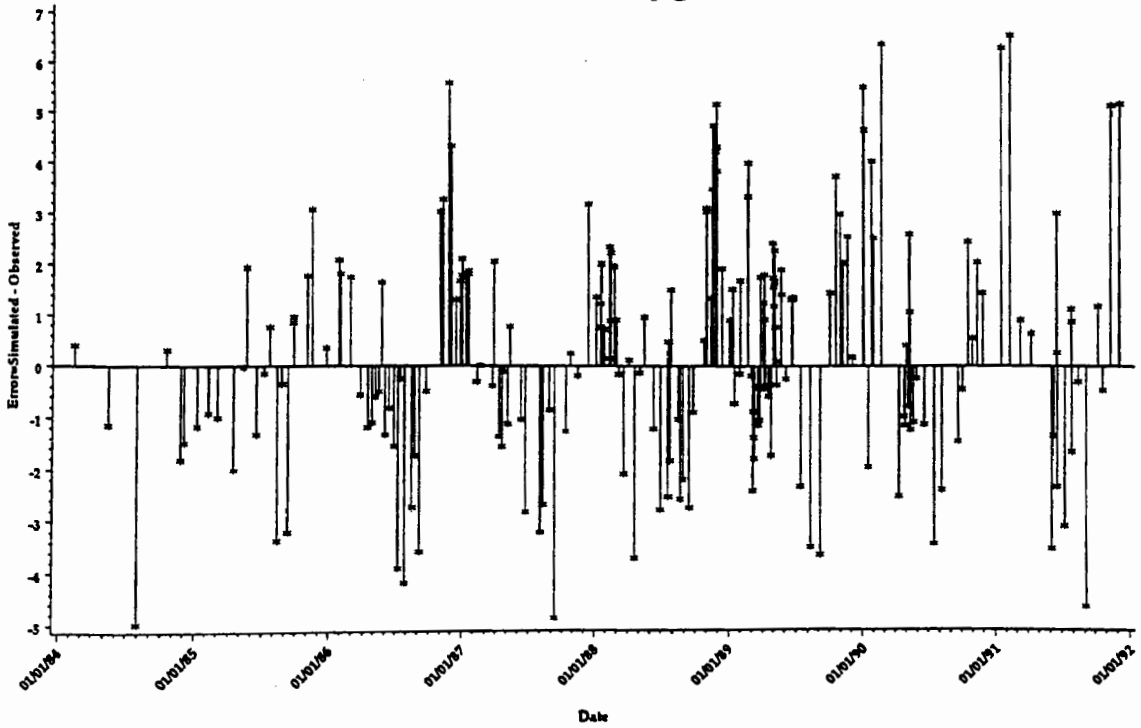
Dissolved Oxygen: 01JAN84 - 01JAN92



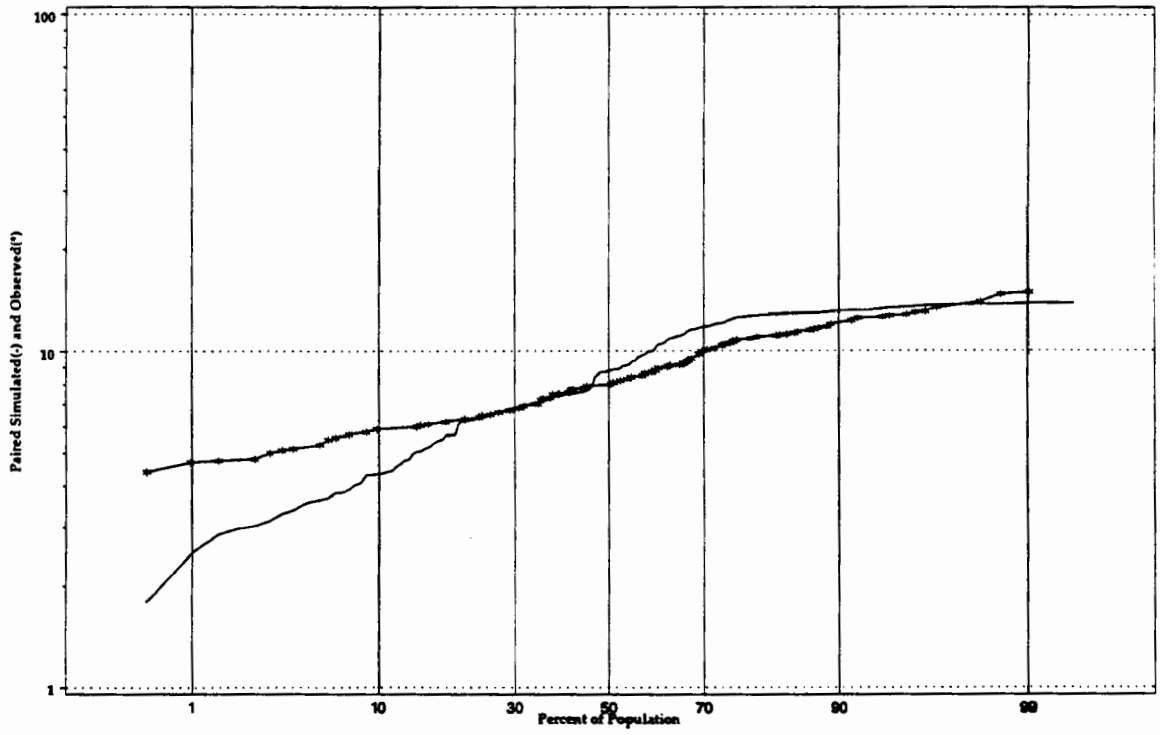
CHOPTANK RIVER at Segment 770

Actual Error versus Time

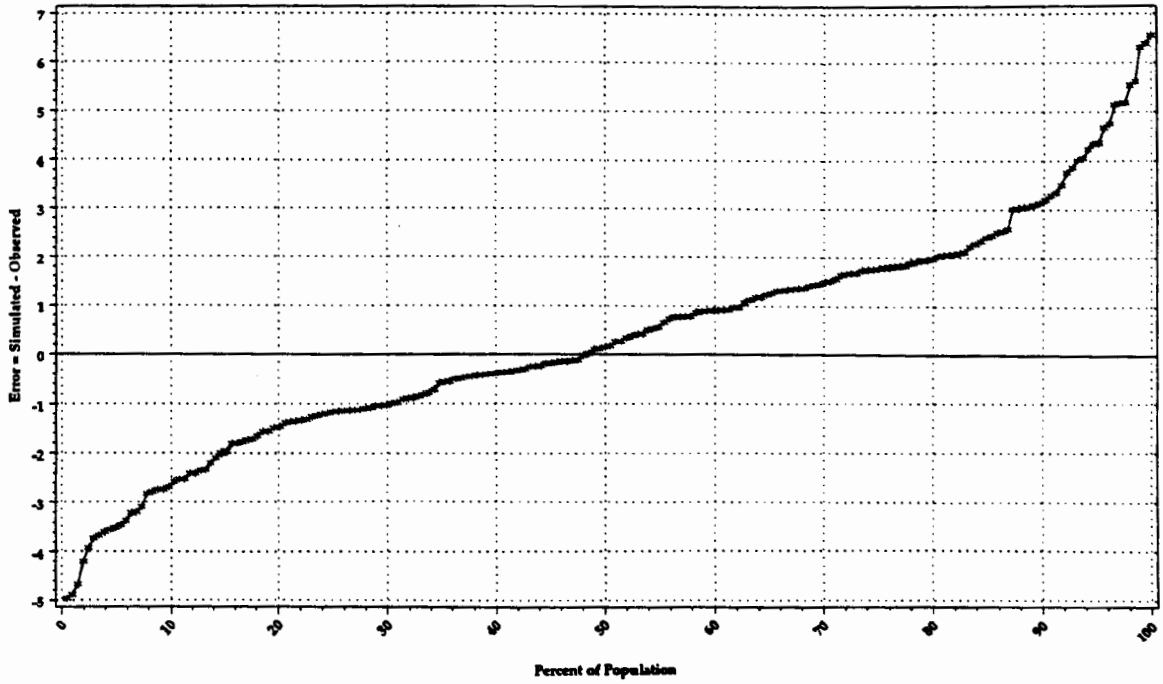
Dissolved Oxygen



CHOPTANK RIVER at Segment 770
Dissolved Oxygen
Frequency Distribution - PAIRED Simulated and Observed Data

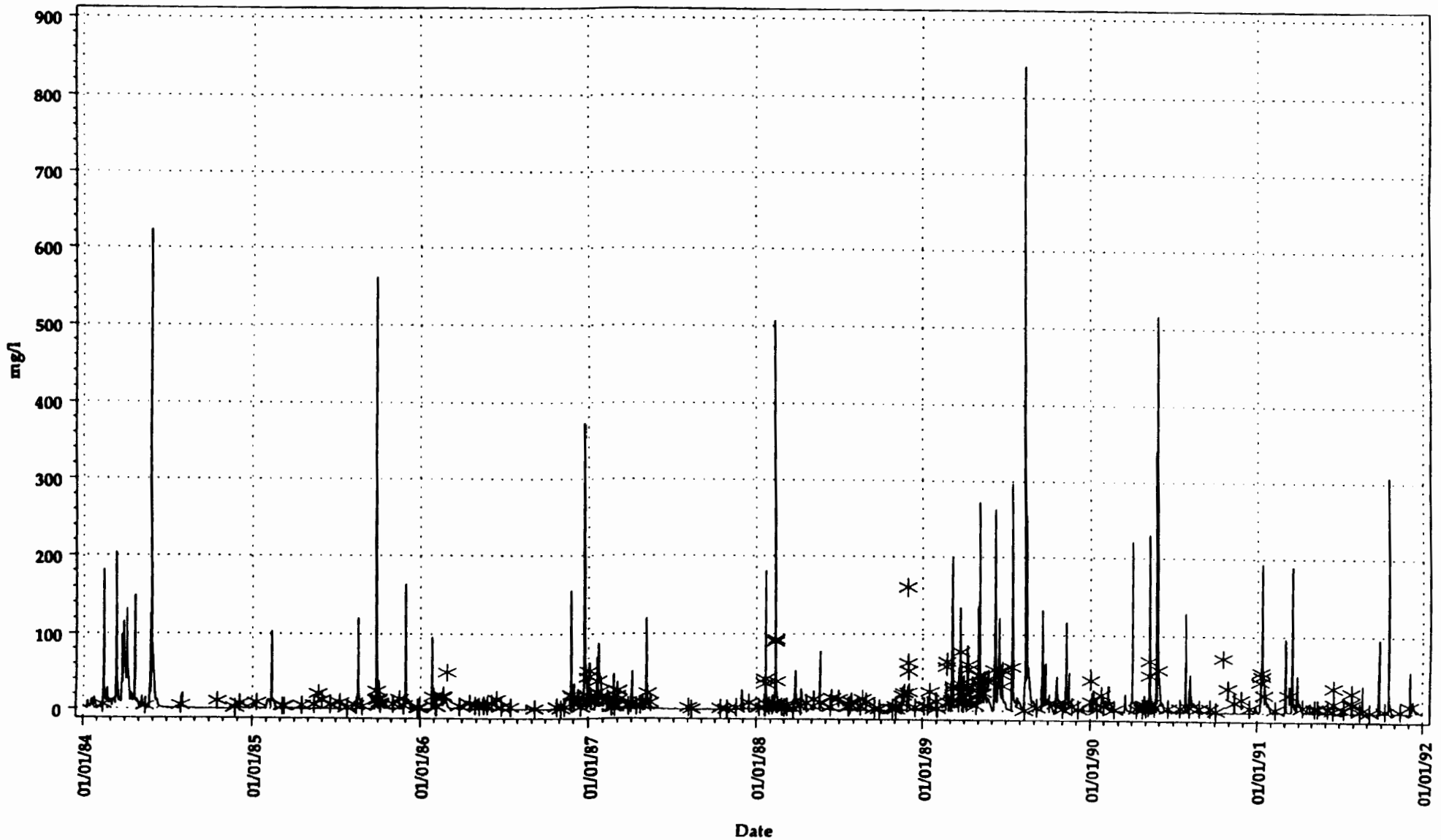


CHOPTANK RIVER at Segment 770
Actual error versus Percentile Sample Population
Dissolved Oxygen
Frequency Distribution - All Simulated and Observed Data



Choptank River at Segment 770
Observed and Simulated versus Time
Total Suspended Sediment

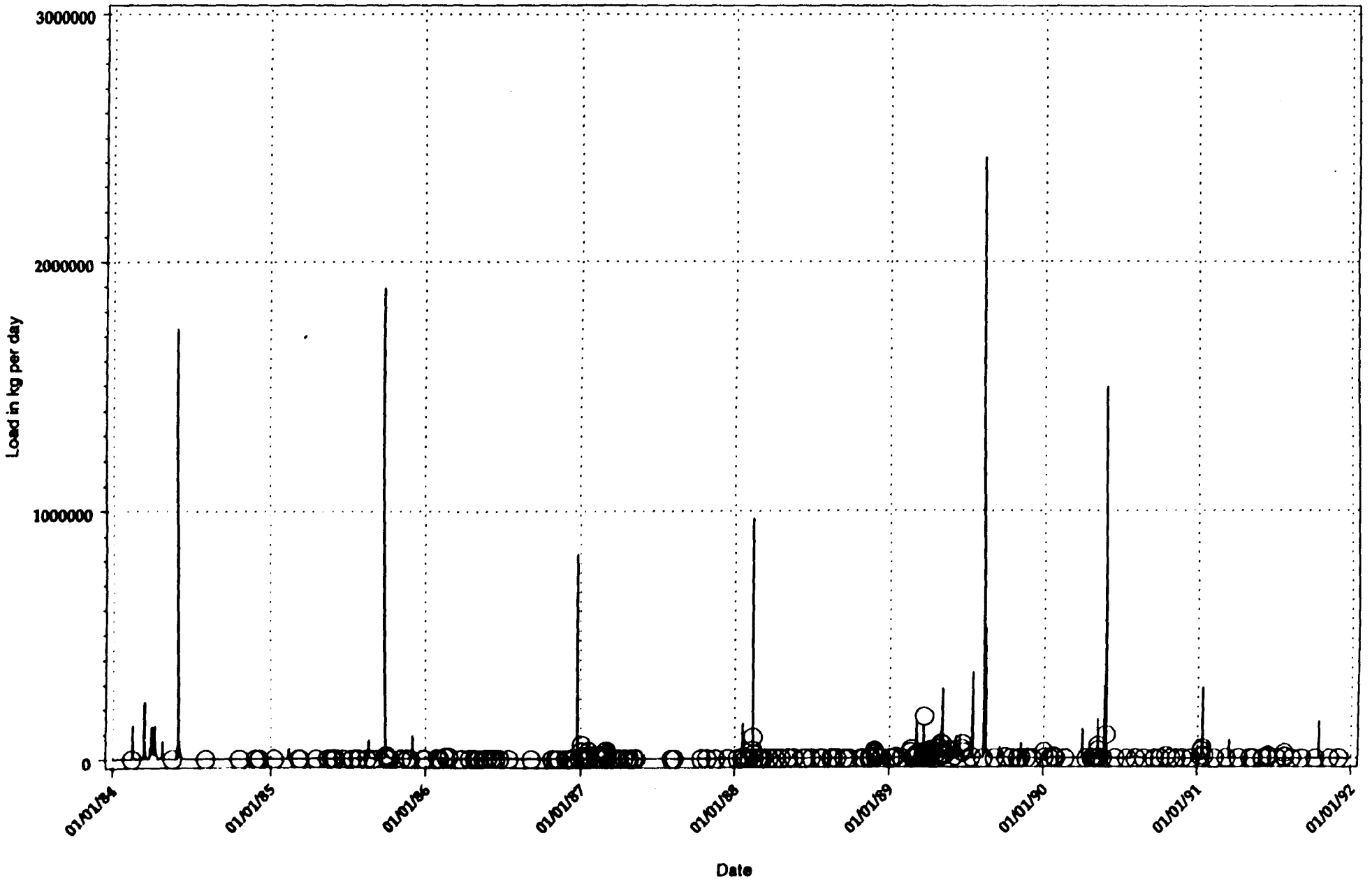
(*=Observed, -=Simulated)



Choptank River at Segment 770

Total Suspended Sediment Observed and Simulated Load vs Time

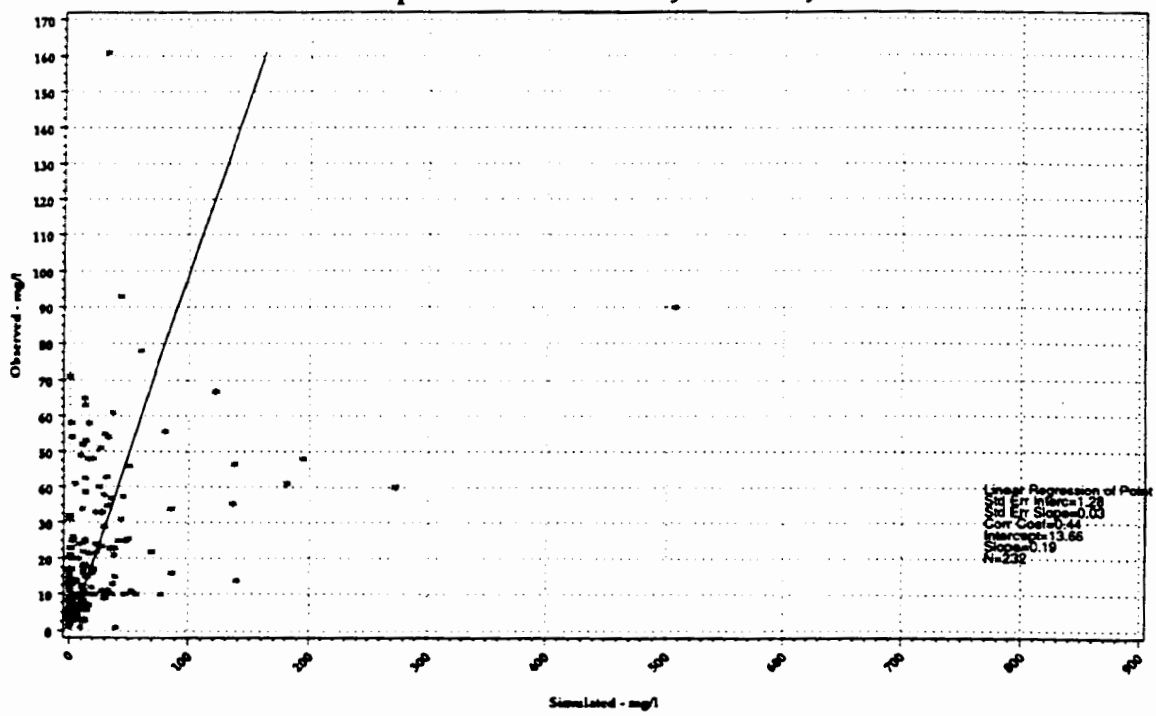
(line = simulated, O = observed)



CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

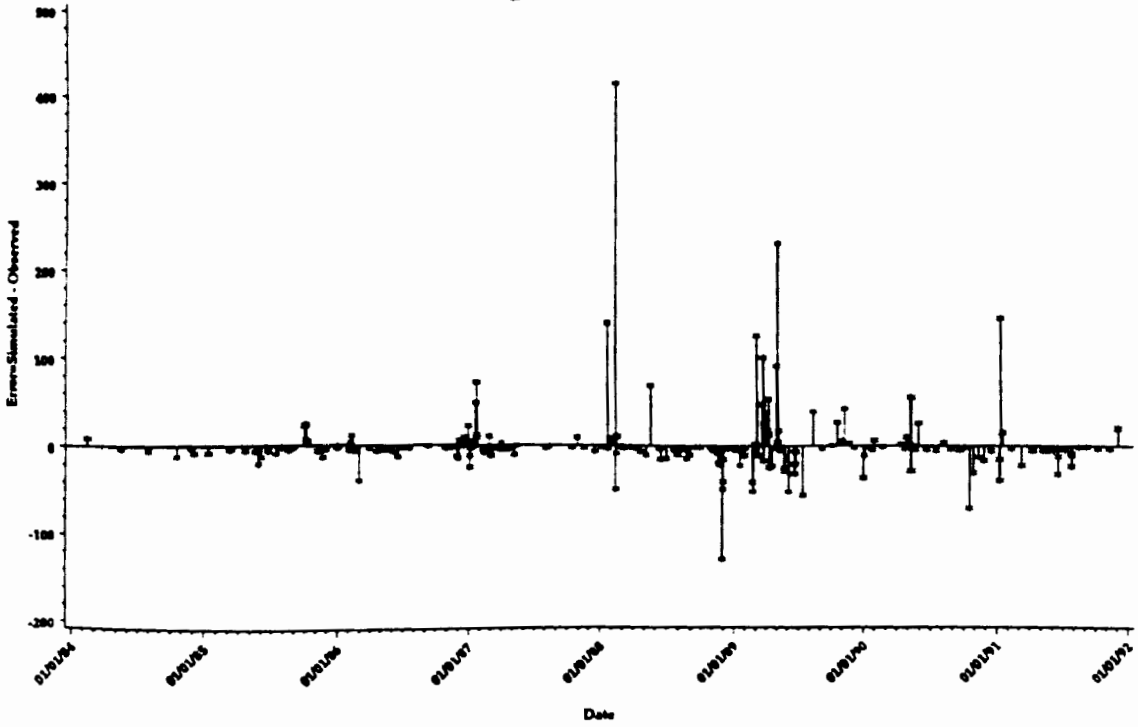
Total Suspended Sediment: 01JAN84 - 01JAN92



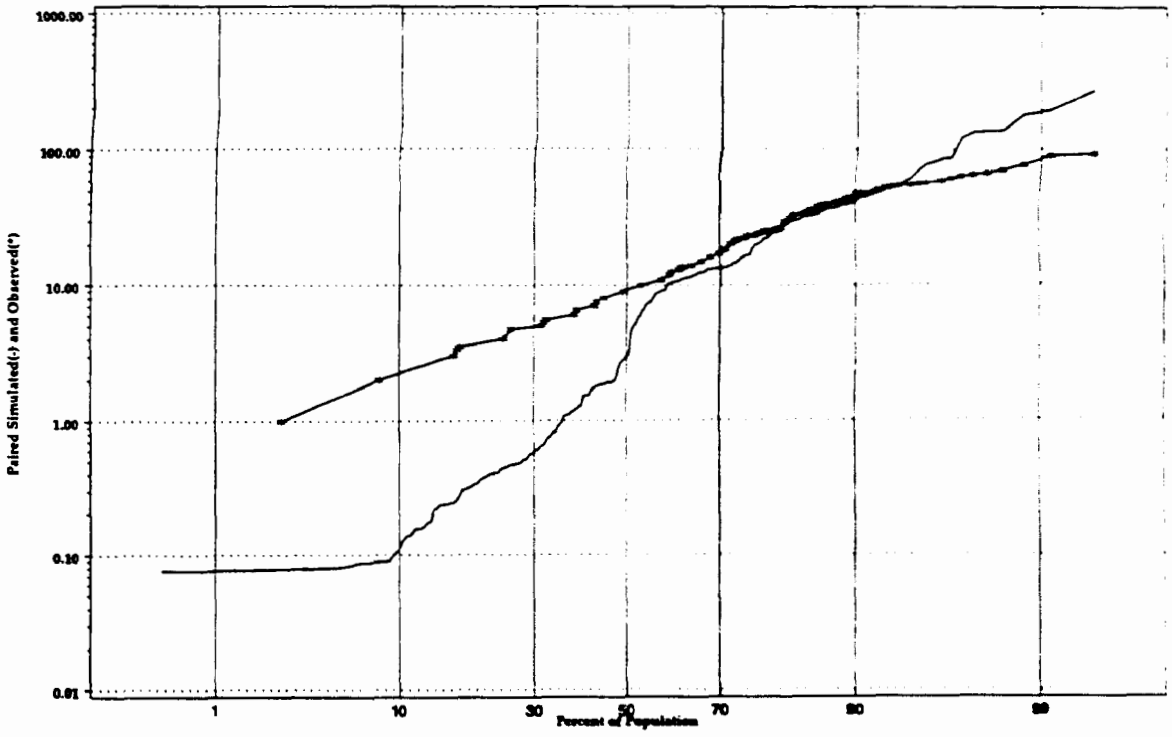
CHOPTANK RIVER at Segment 770

Actual Error versus Time

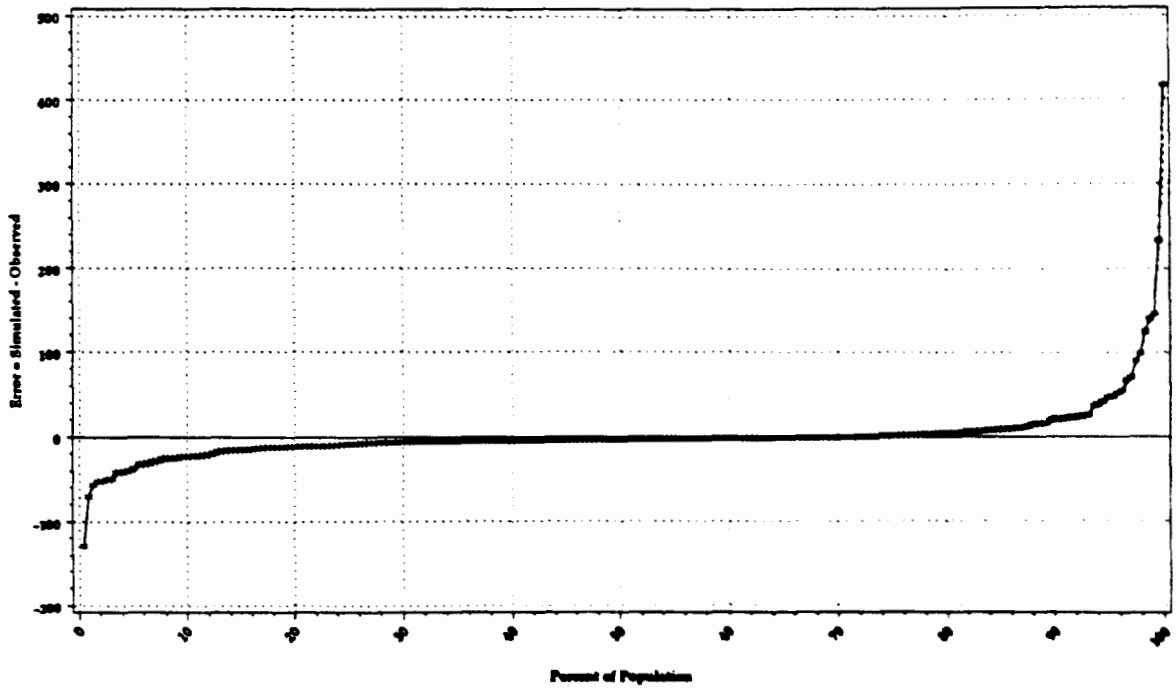
Total Suspended Sediment



CHOPTANK RIVER at Segment 770
Total Suspended Sediment
Frequency Distribution - PAIRED Simulated and Observed Data

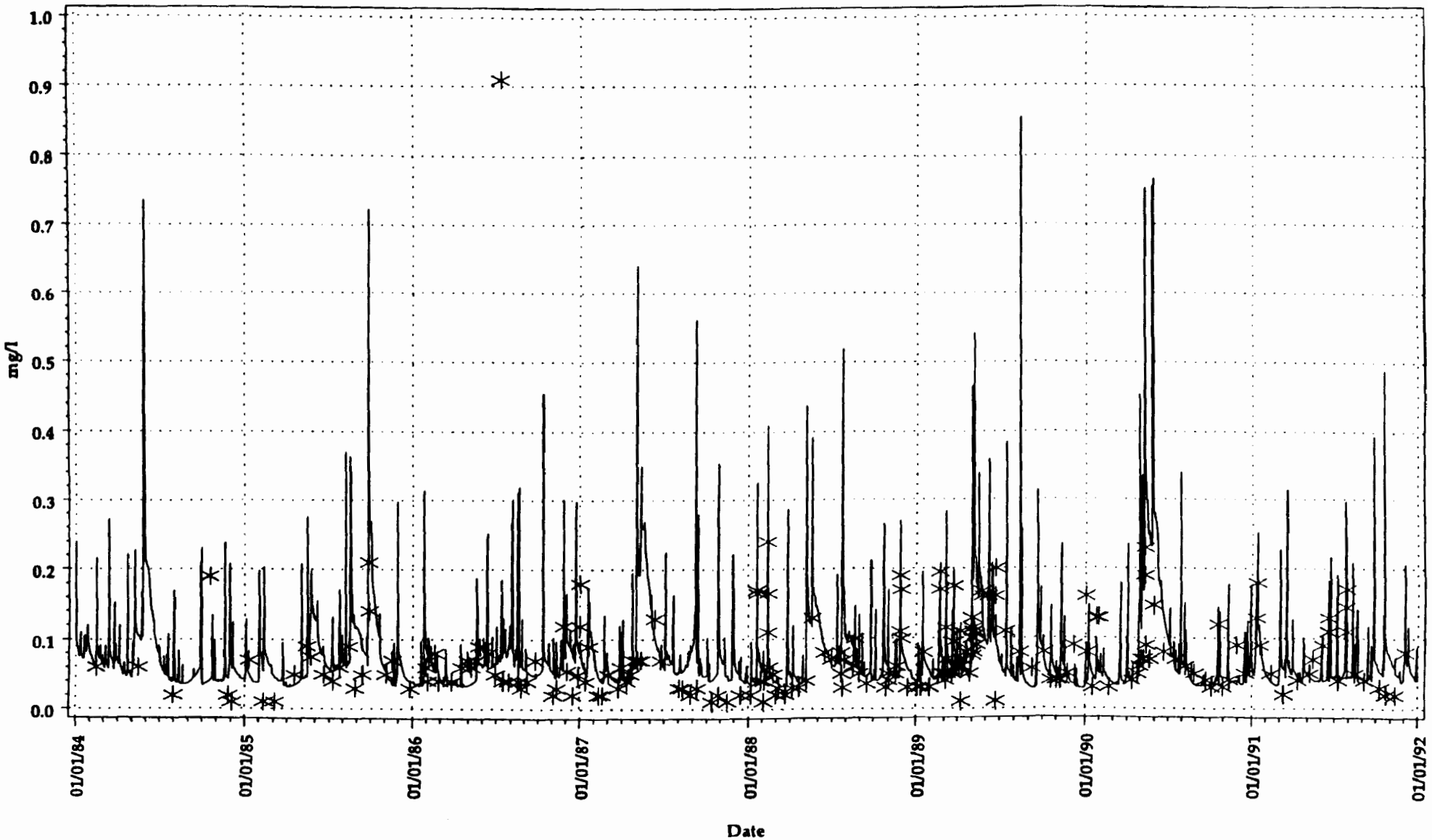


CHOPTANK RIVER at Segment 770
Actual error versus Percentile Sample Population
Total Suspended Sediment
Frequency Distribution - All Simulated and Observed Data



Choptank River at Segment 770
Observed and Simulated versus Time
Total Phosphorus

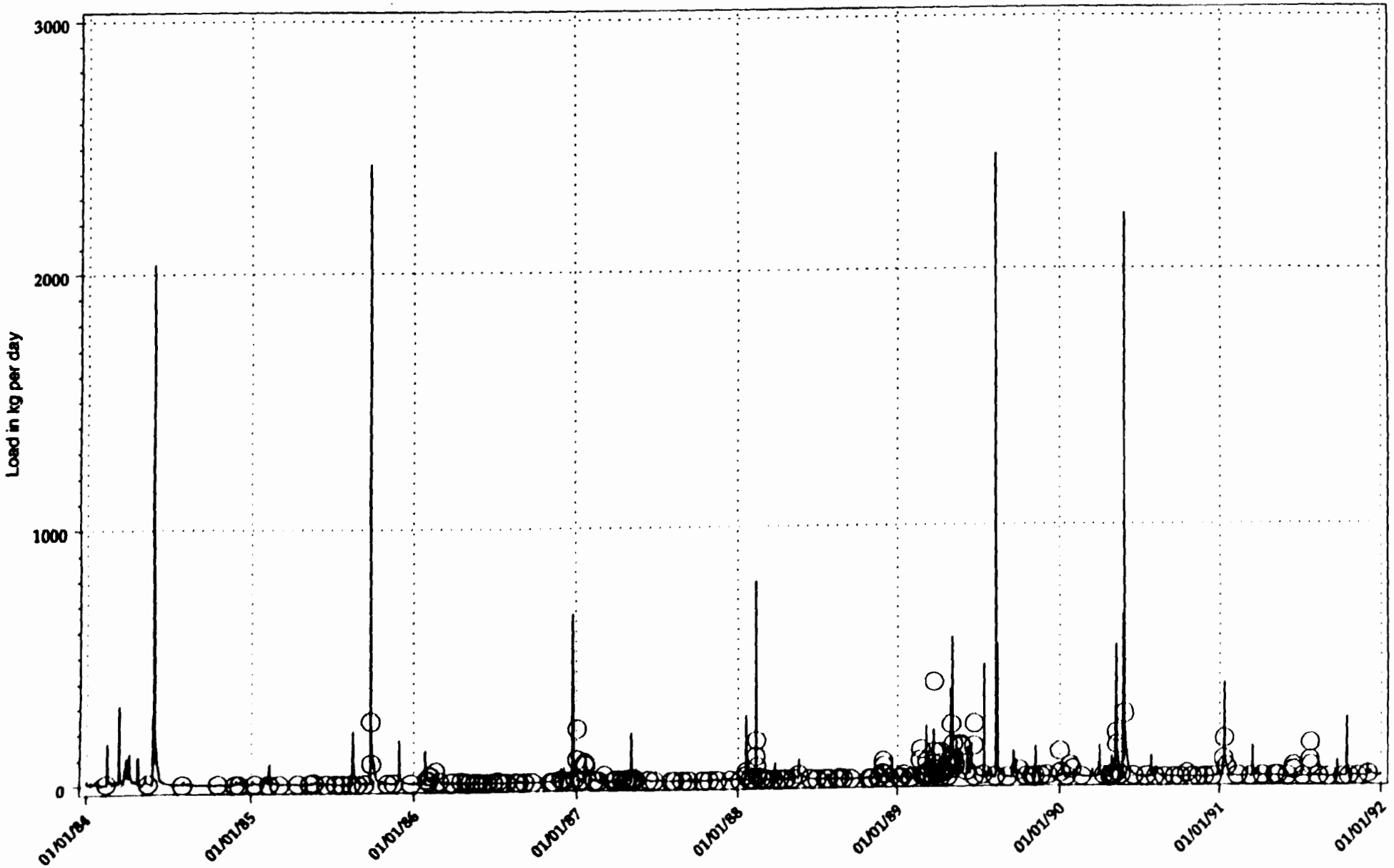
(*=Observed, -=Simulated)



Choptank River at Segment 770

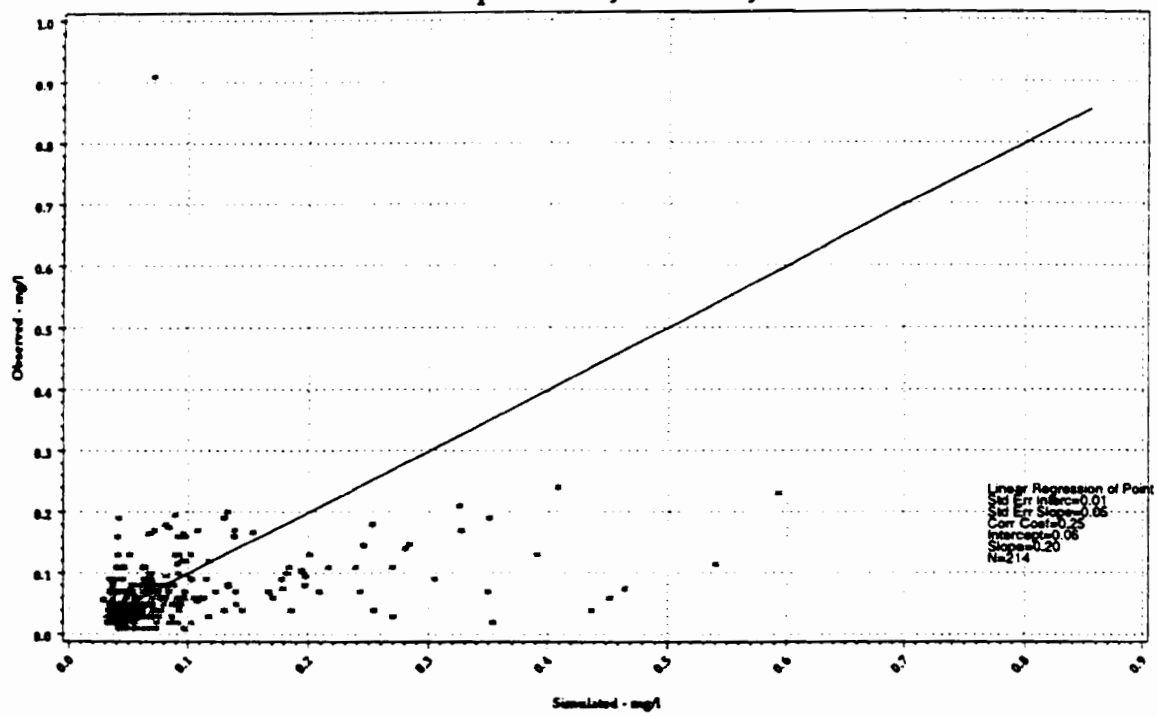
Total Phosphorus Observed and Simulated Load vs Time

(line = simulated, O = observed)



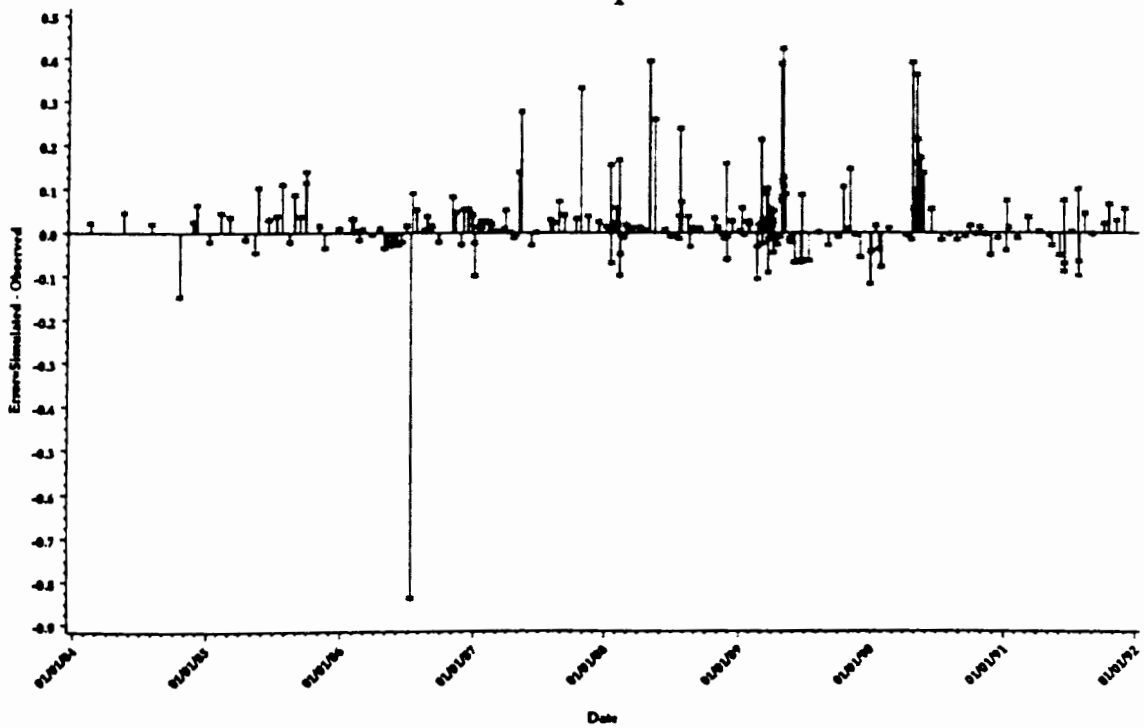
CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Phosphorus: 01JAN84 - 01JAN92



CHOPTANK RIVER at Segment 770

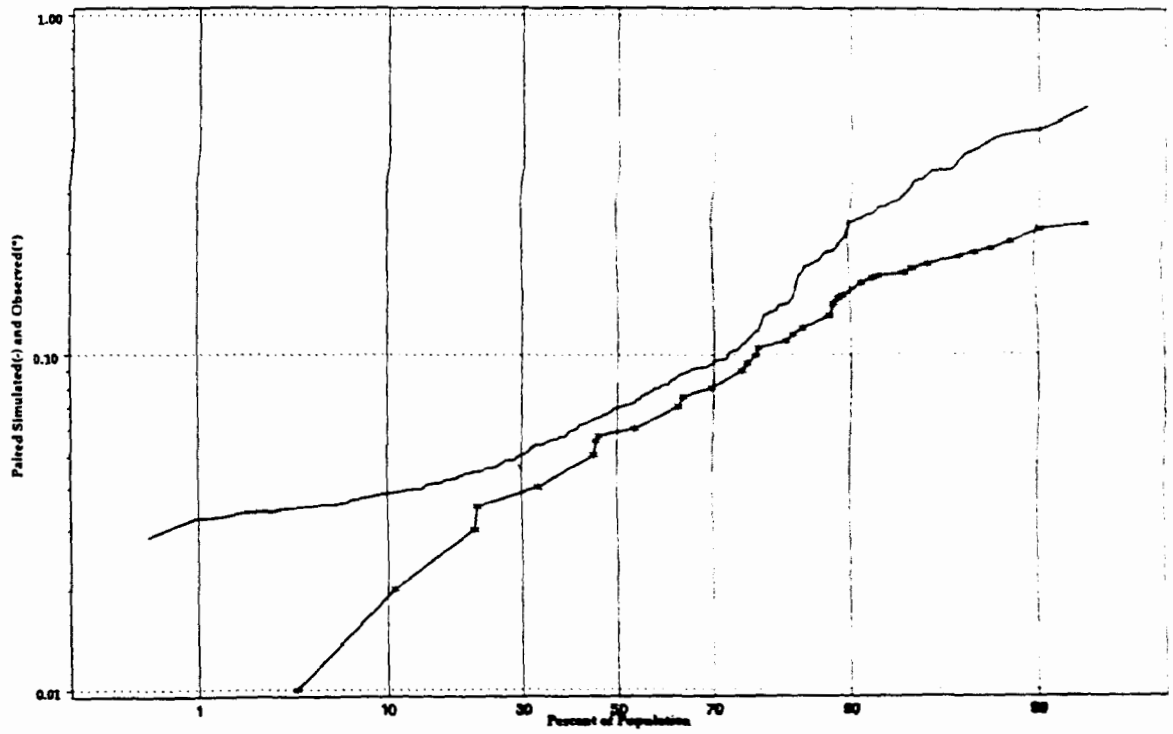
Actual Error versus Time
Total Phosphorus



CHOPTANK RIVER at Segment 770

Total Phosphorus

Frequency Distribution - PAIRED Simulated and Observed Data

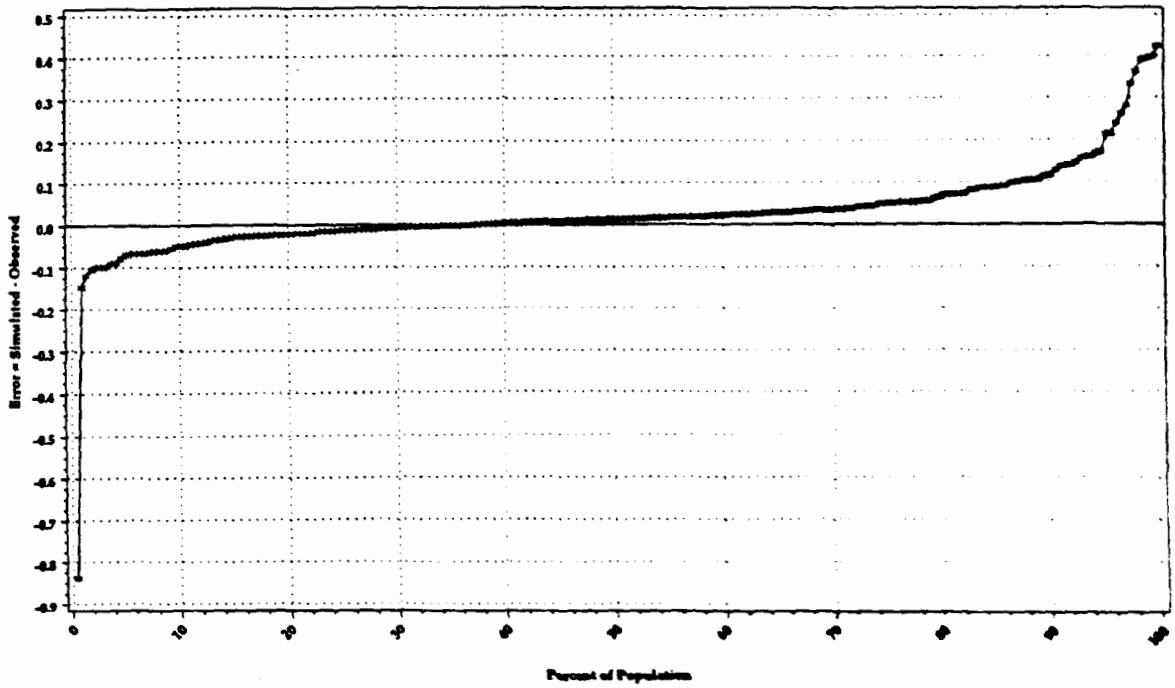


CHOPTANK RIVER at Segment 770

Actual error versus Percentile Sample Population

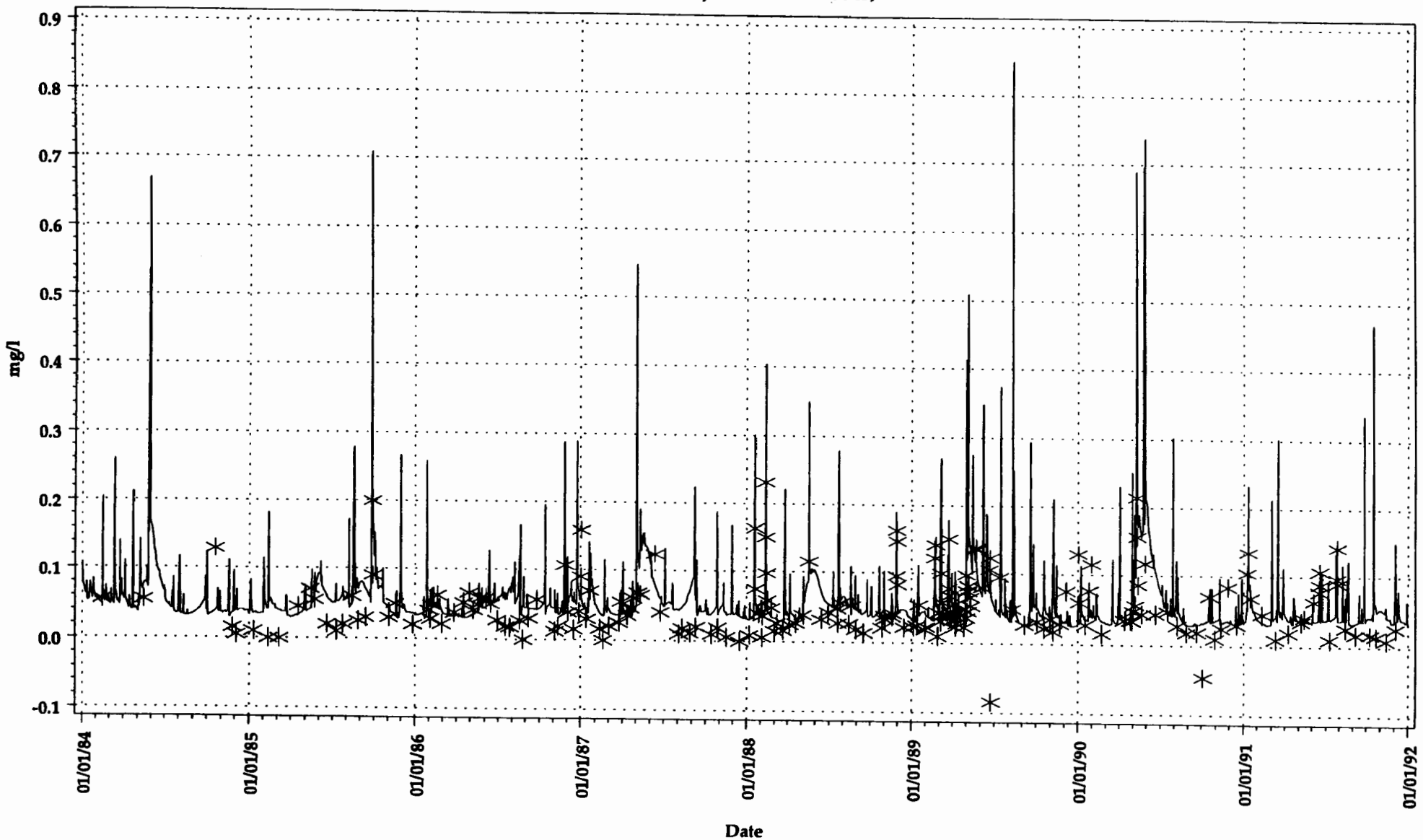
Total Phosphorus

Frequency Distribution - All Simulated and Observed Data



CHOPTANK RIVER at Segment 770
Observed and Simulated versus Time
Organic and Particulate Phosphorus

(*=Observed, -=Simulated)

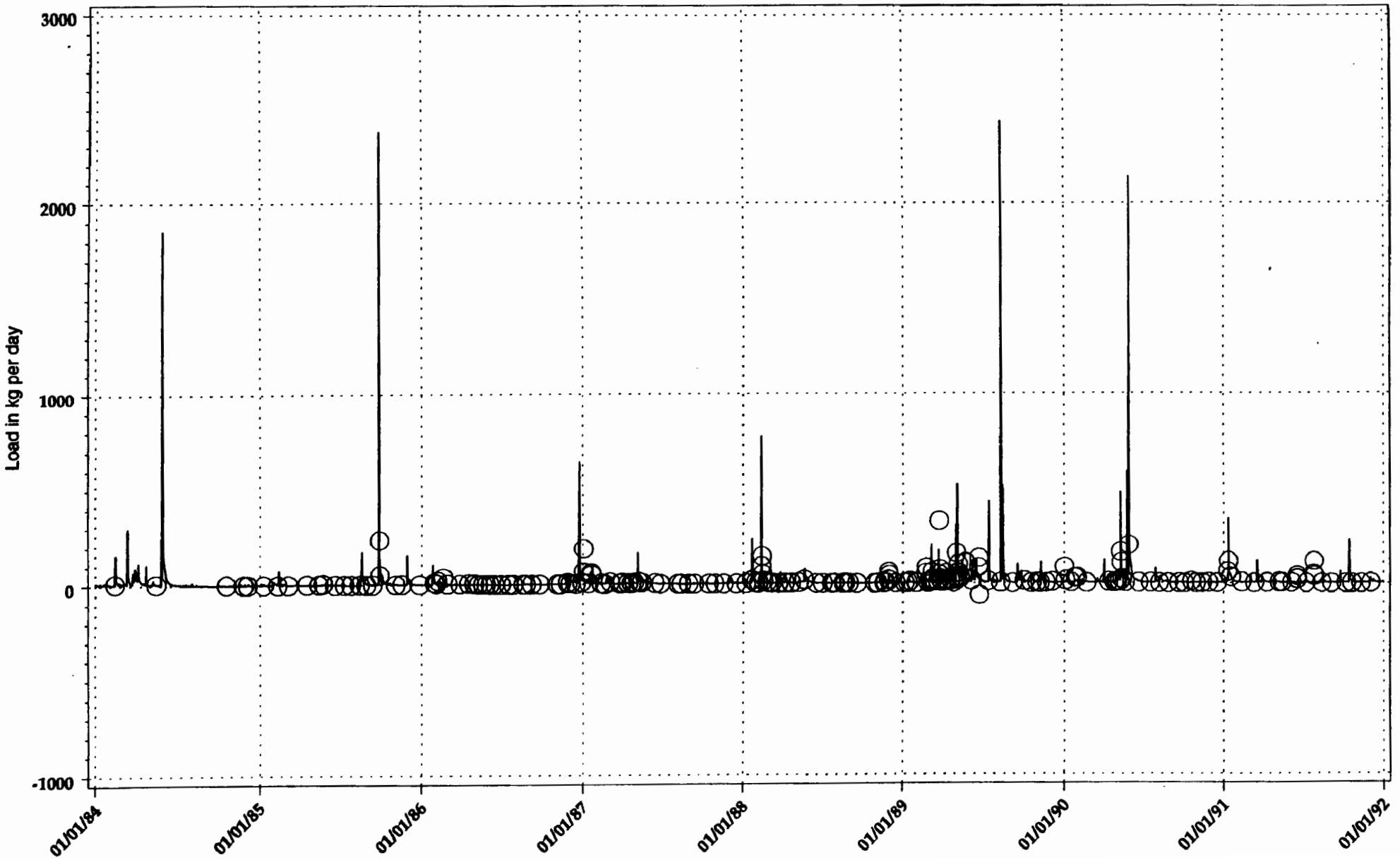


(y21_plotb.sas model3d(pwang.dt) plotowl - omtime)
(choptank.drv 23FEB98 09:32)

CHOPTANK RIVER at Segment 770

Organic and Particulate Phosphorus Observed and Simulated Load vs Time

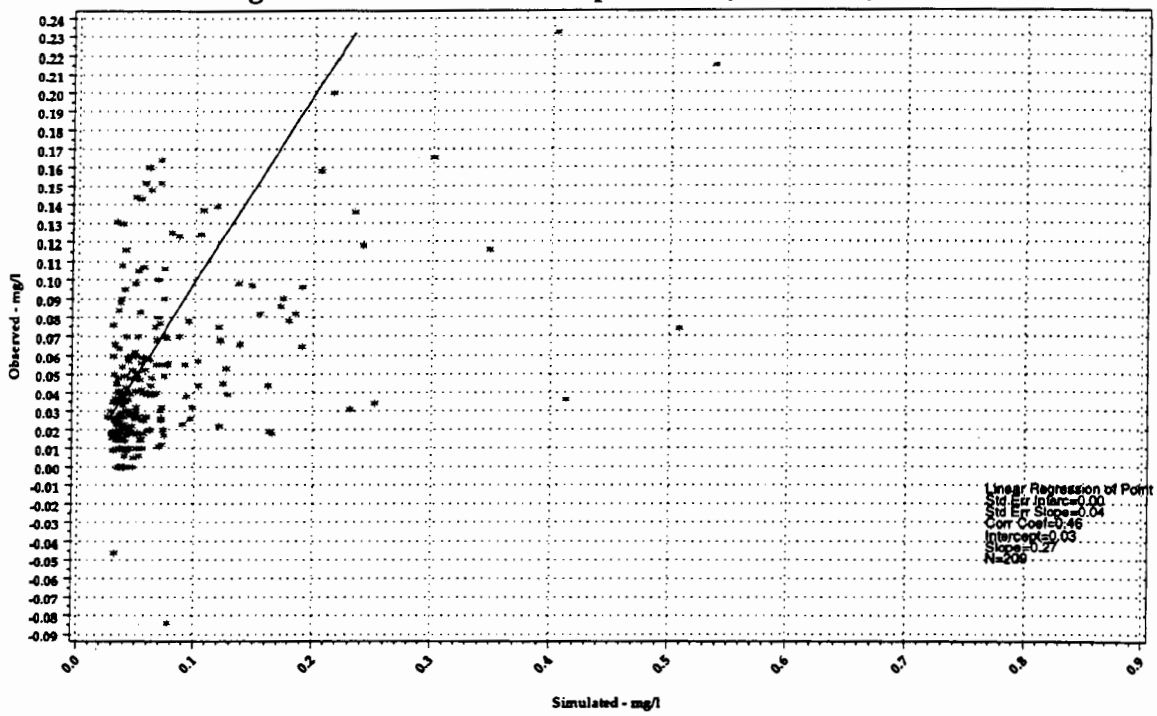
(line = simulated, O = observed)



CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

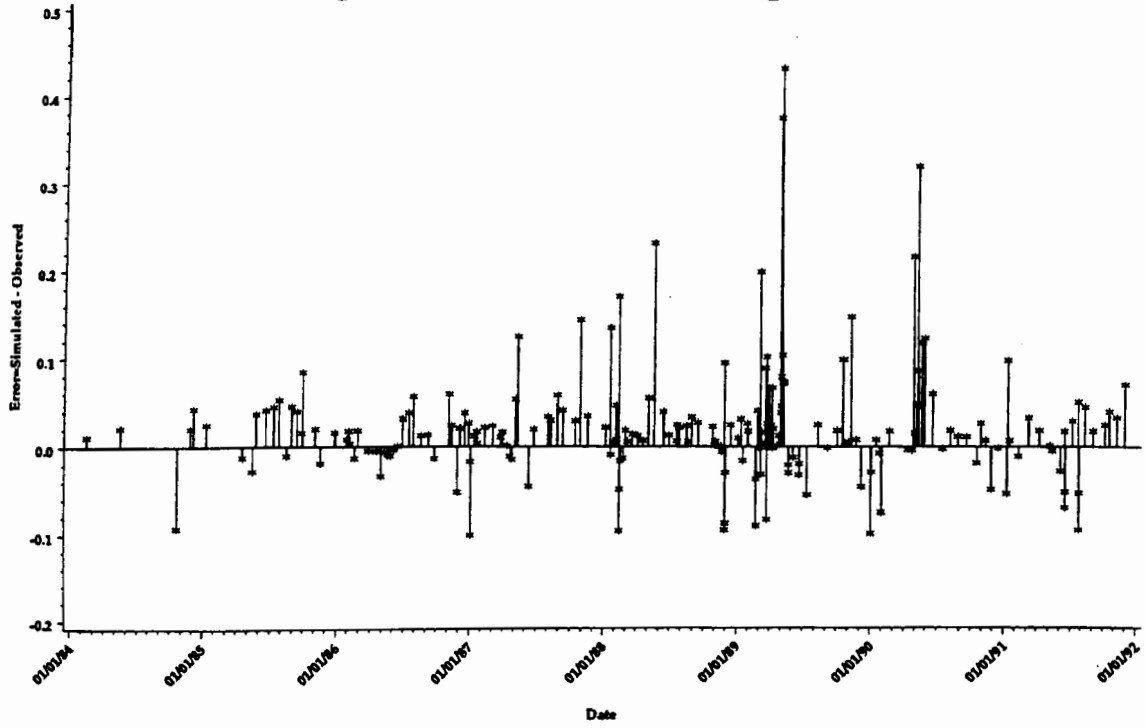
Organic and Particulate Phosphorus: 01JAN84 - 01JAN92



CHOPTANK RIVER at Segment 770

Actual Error versus Time

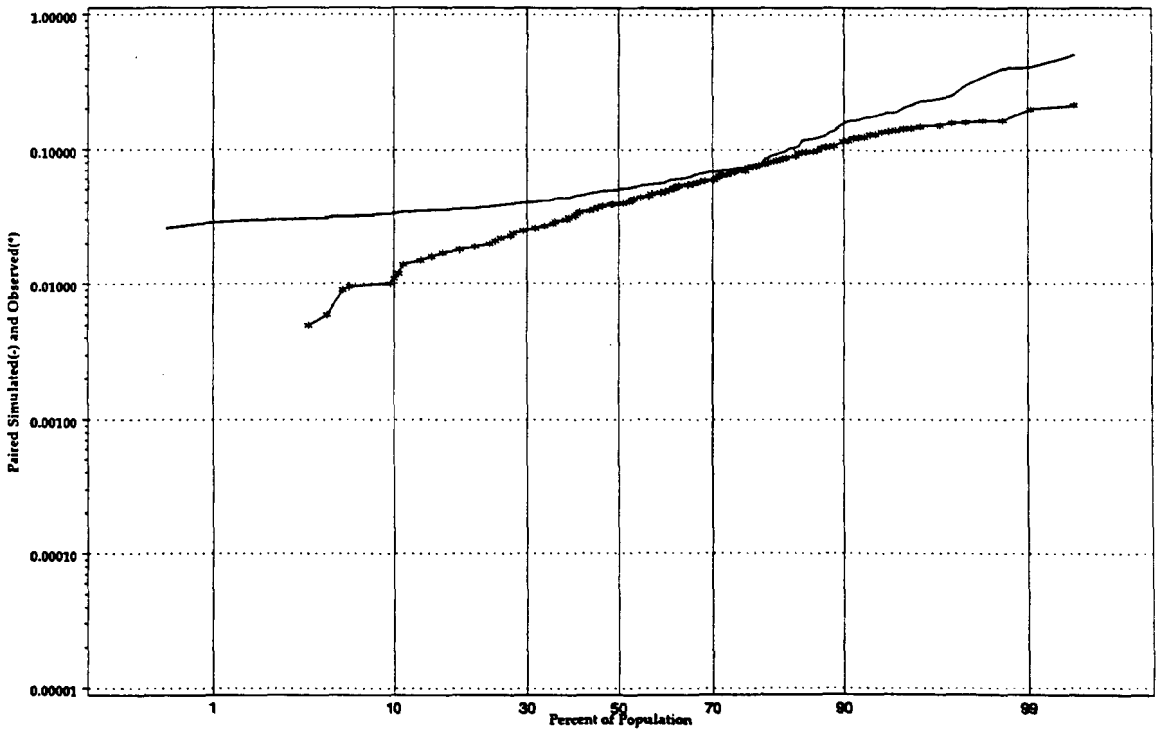
Organic and Particulate Phosphorus



CHOPTANK RIVER at Segment 770

Organic and Particulate Phosphorus

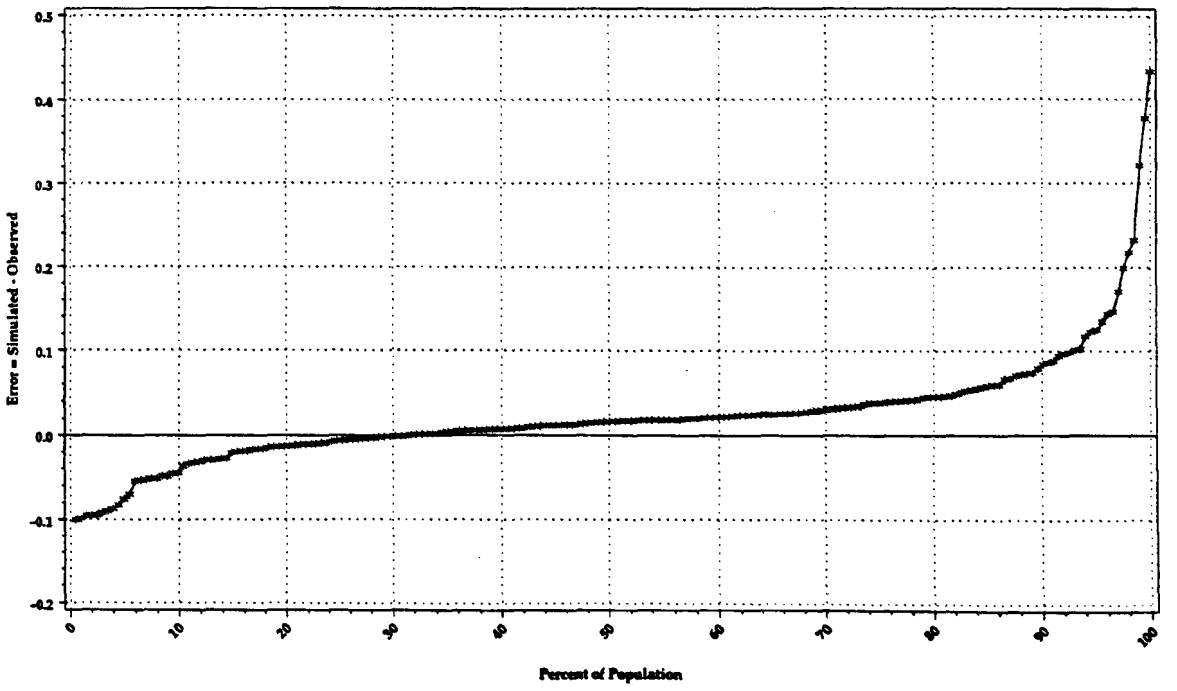
Frequency Distribution - PAIRED Simulated and Observed Data



CHOPTANK RIVER at Segment 770

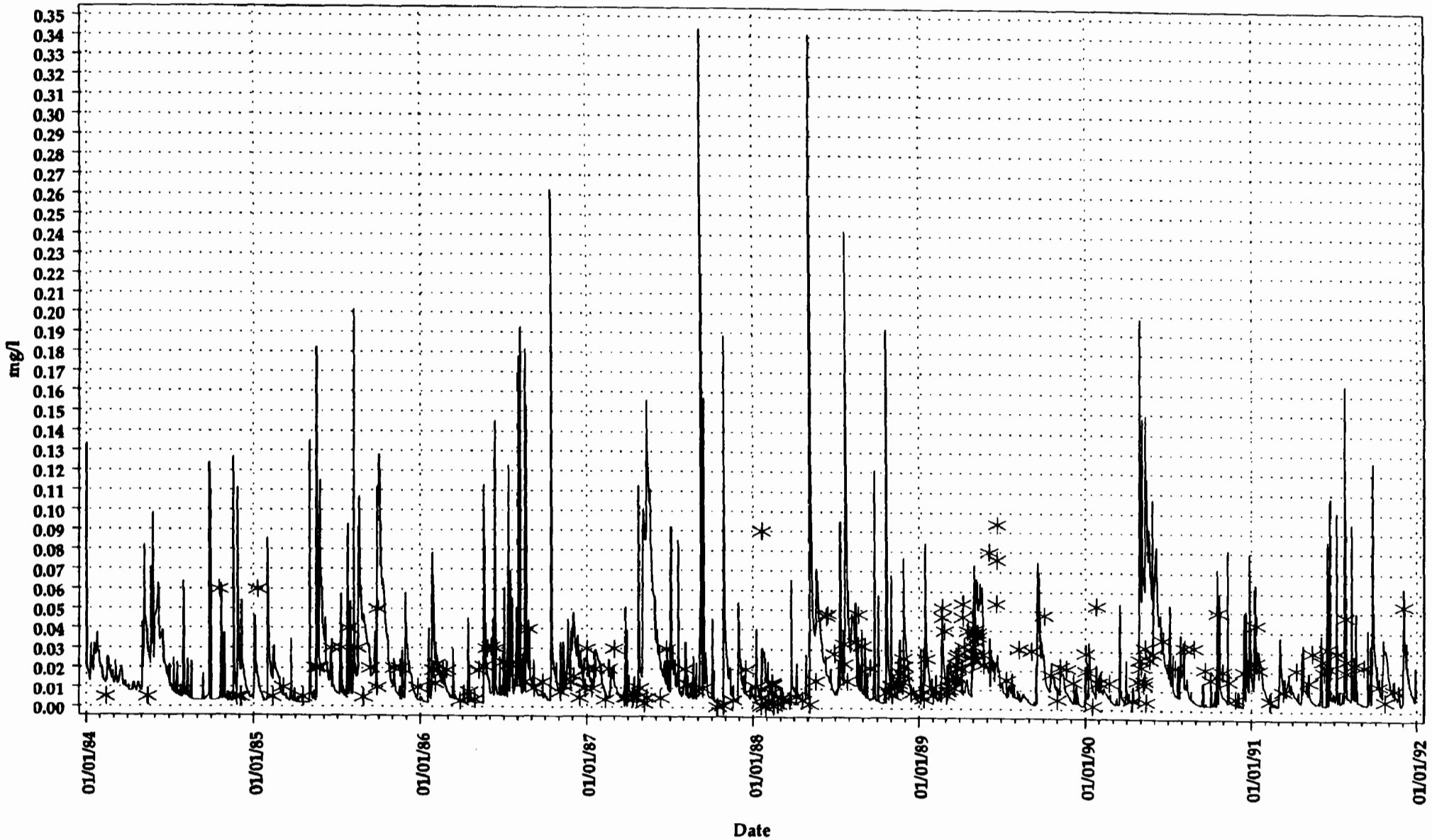
Actual error versus Percentile Sample Population
Organic and Particulate Phosphorus

Frequency Distribution - All Simulated and Observed Data



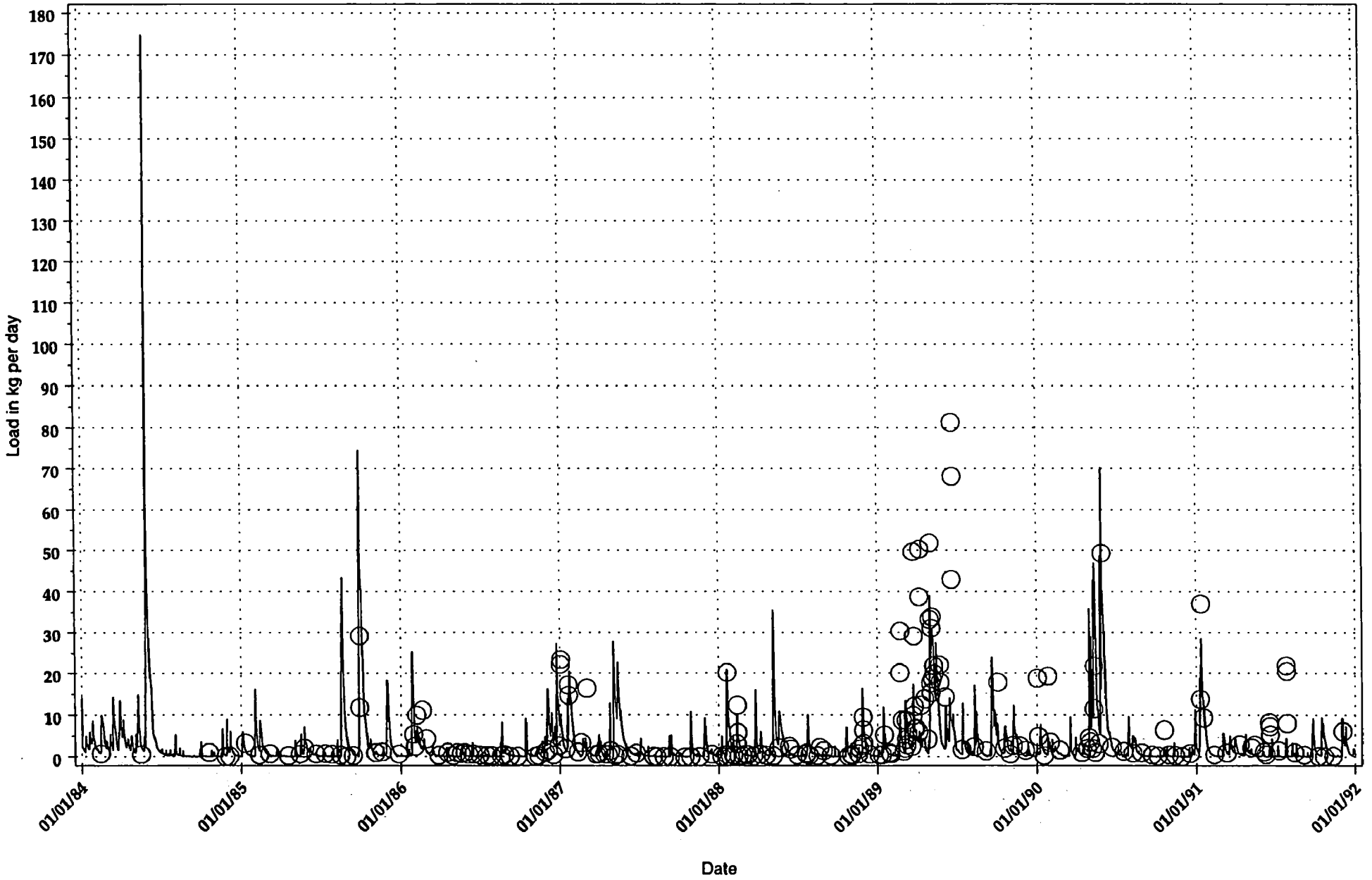
CHOPTANK RIVER at Segment 770
Observed and Simulated versus Time
Dissolved Phosphorus

(*=Observed, -=Simulated)



(y21_plotb.sas model3d\gwang.dt) plotcmt - cmdmo)
(choplark.dir 23FEB98 08:32)

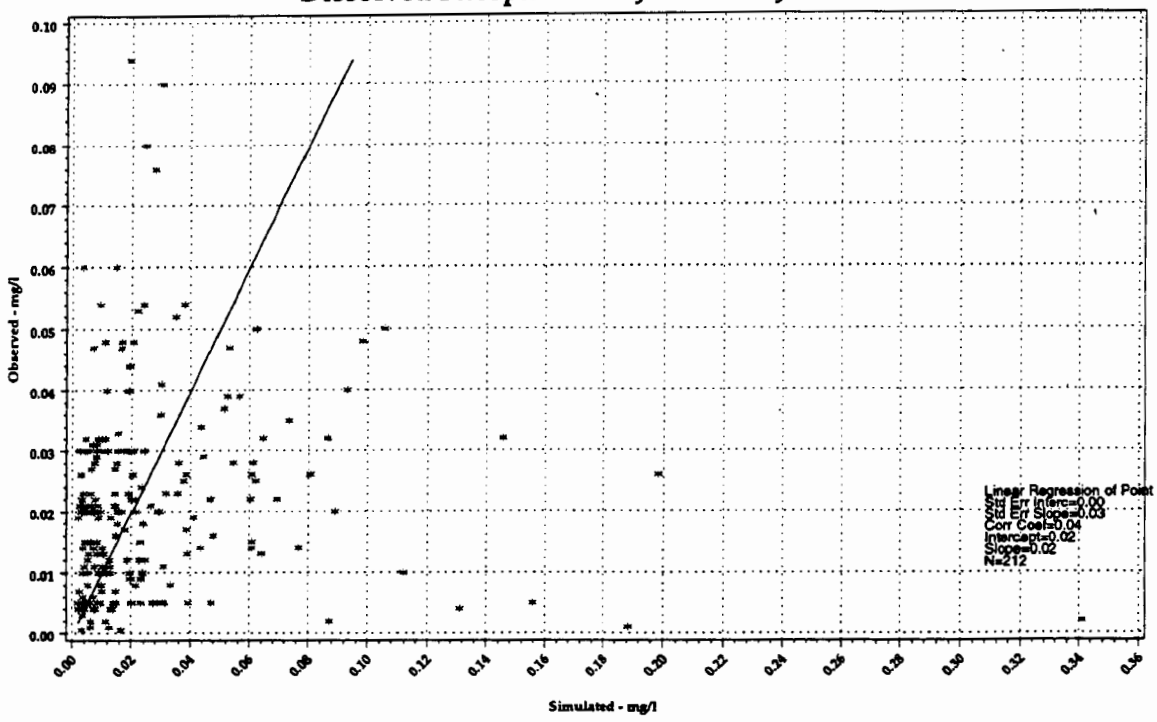
CHOPTANK RIVER at Segment 770
Dissolved Phosphorus Observed and Simulated Load vs Time
(line = simulated, O = observed)



(y21_plotb.sas model3d [pwang.dl] (kdlas)
(choptank.drv 23FEB98 08:32,proc reg,model y=x)

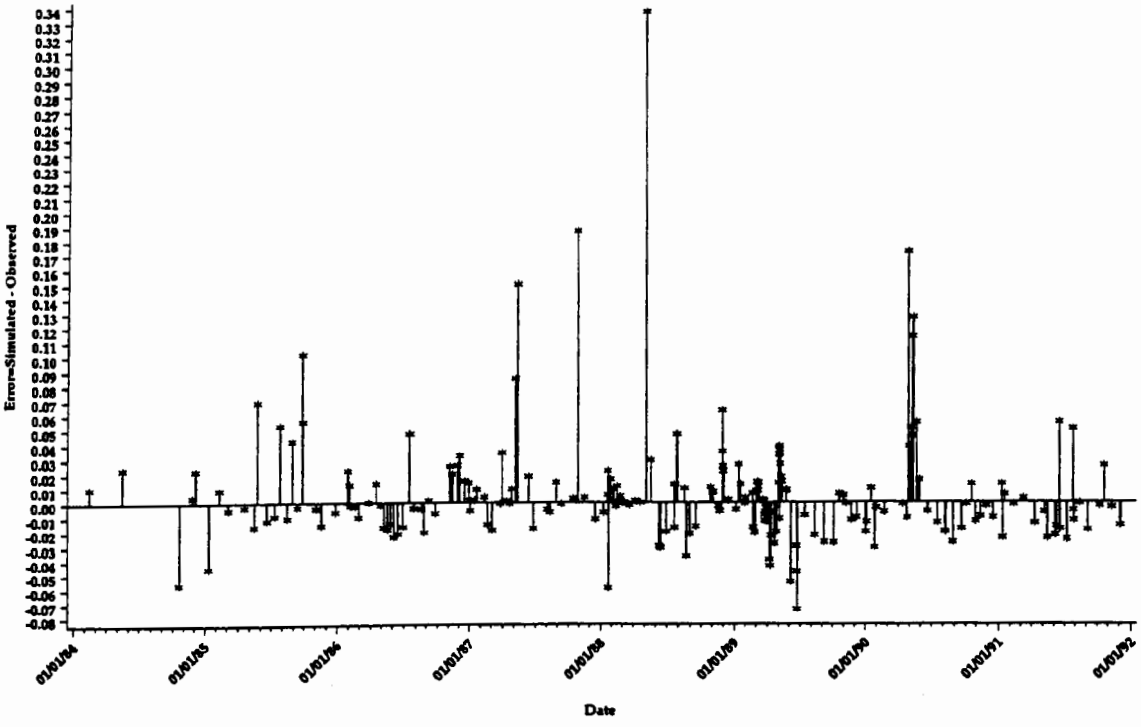
CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Dissolved Phosphorus: 01JAN84 - 01JAN92

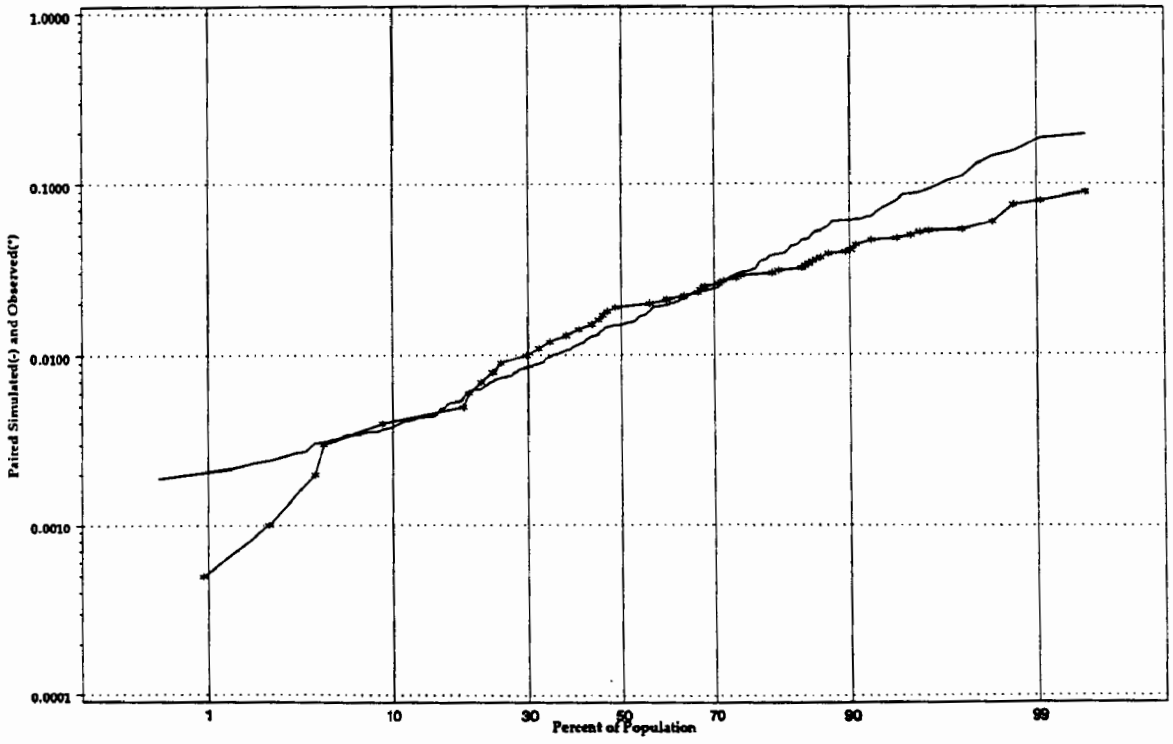


CHOPTANK RIVER at Segment 770

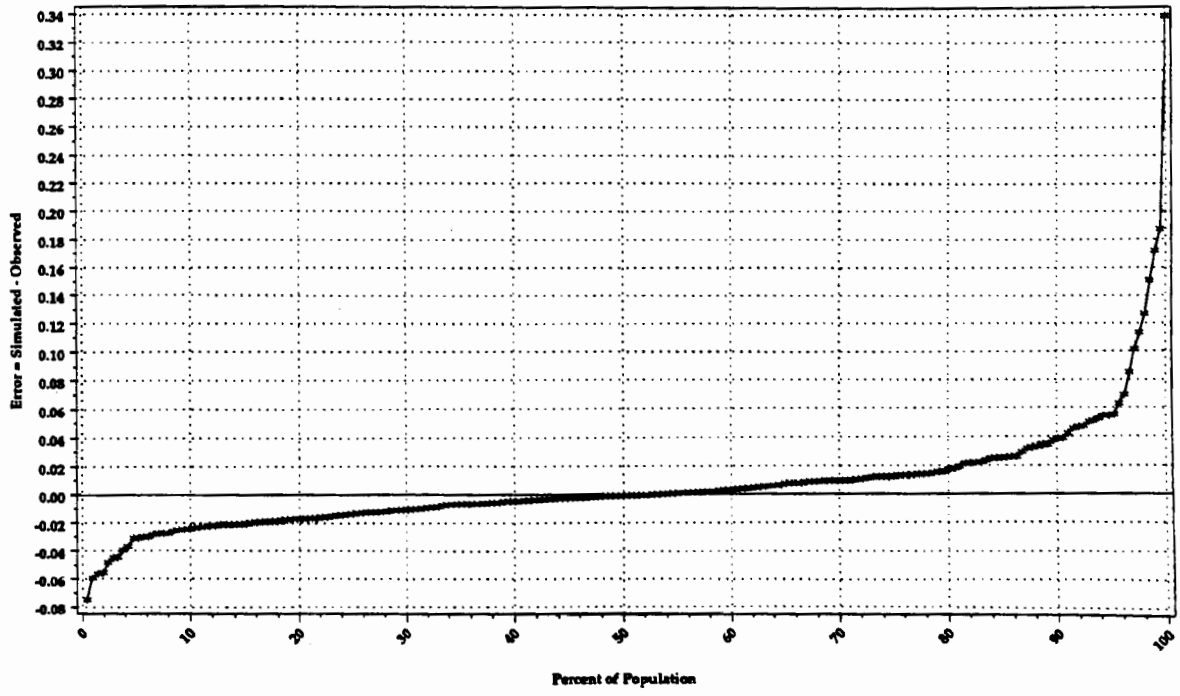
Actual Error versus Time
Dissolved Phosphorus



CHOPTANK RIVER at Segment 770
Dissolved Phosphorus
Frequency Distribution - PAIRED Simulated and Observed Data

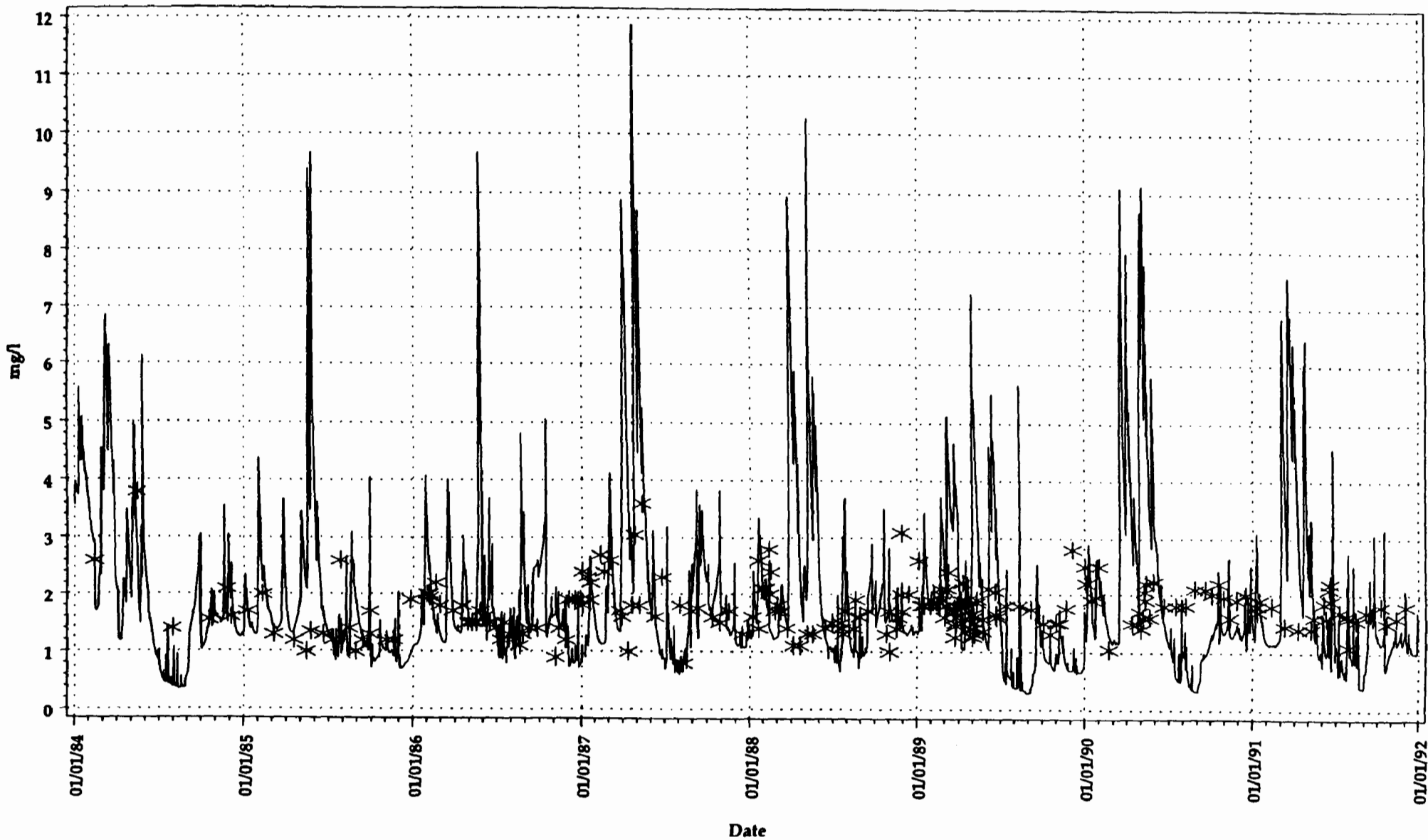


CHOPTANK RIVER at Segment 770
Actual error versus Percentile Sample Population
Dissolved Phosphorus
Frequency Distribution - All Simulated and Observed Data



Choptank River at Segment 770
Observed and Simulated versus Time
Total Nitrogen

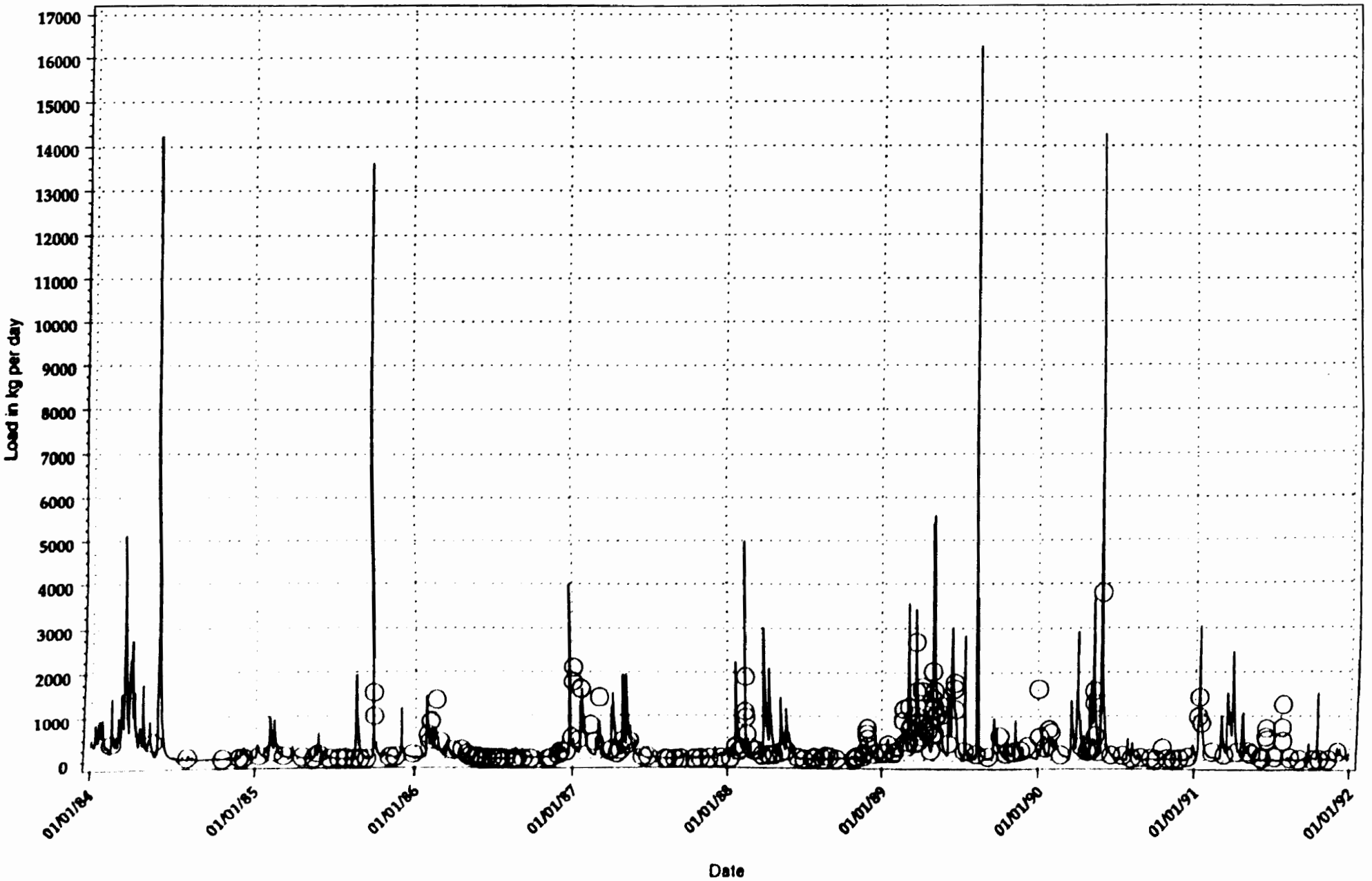
(*=Observed, -=Simulated)



Choptank River at Segment 770

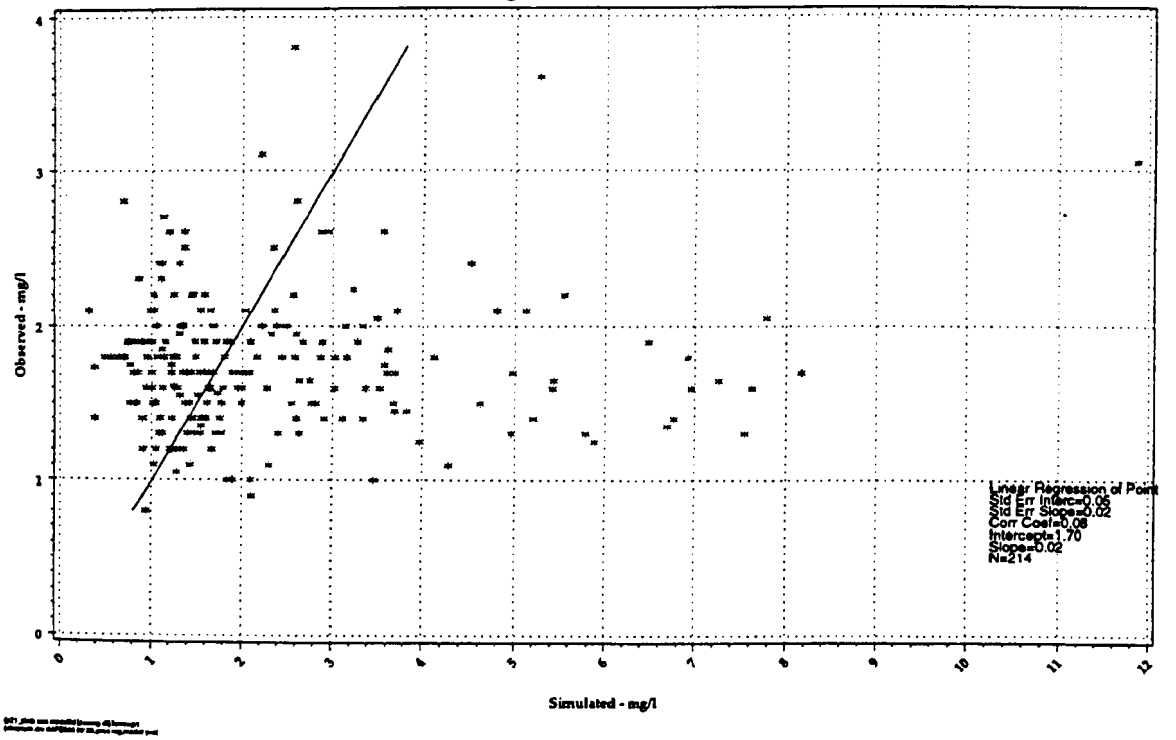
Total Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)



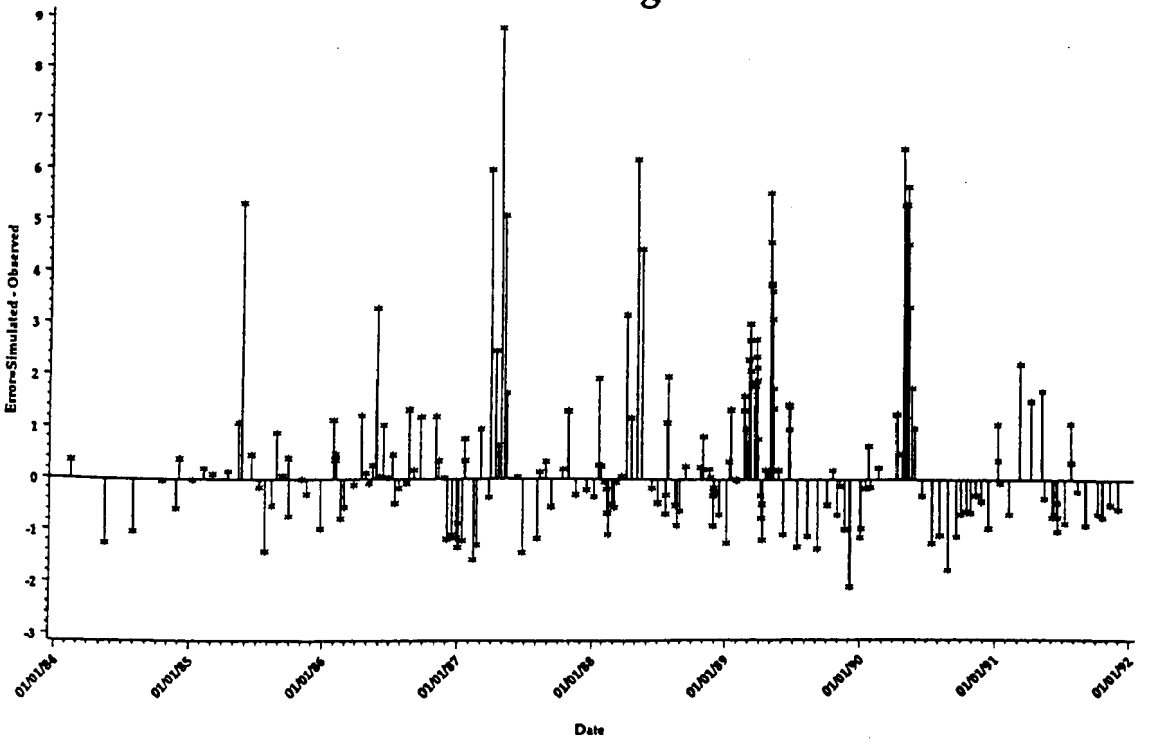
CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Nitrogen: 01JAN84 - 01JAN92

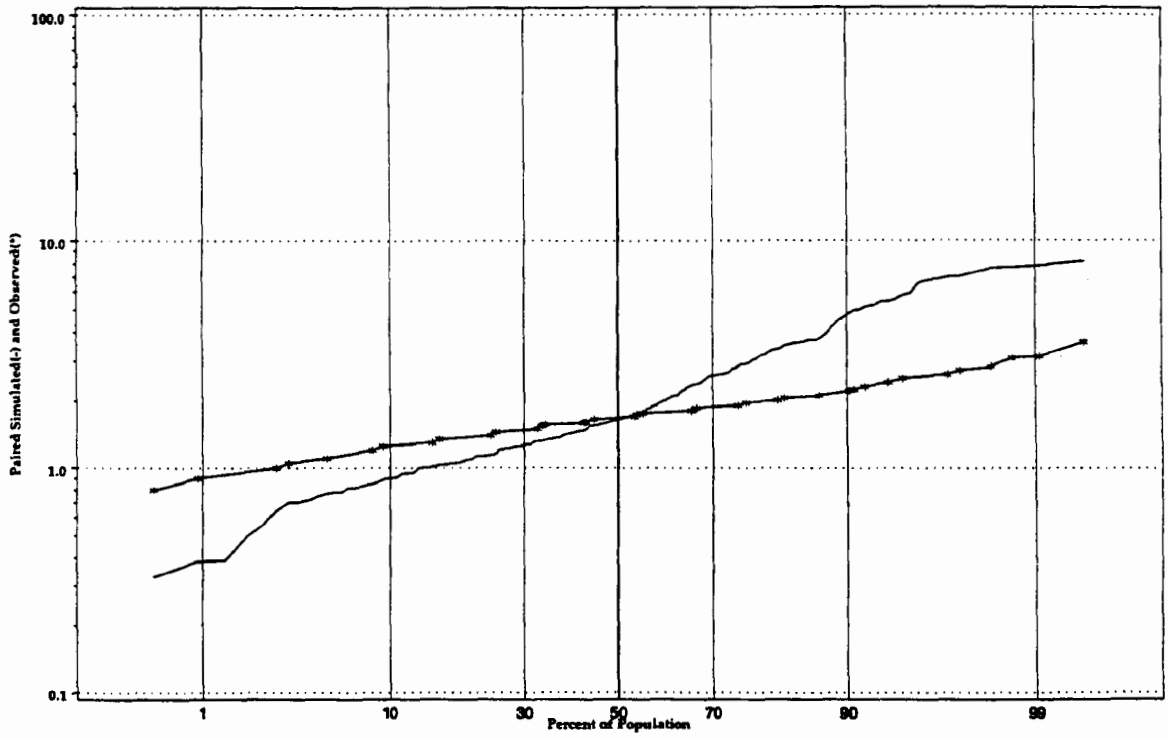


CHOPTANK RIVER at Segment 770

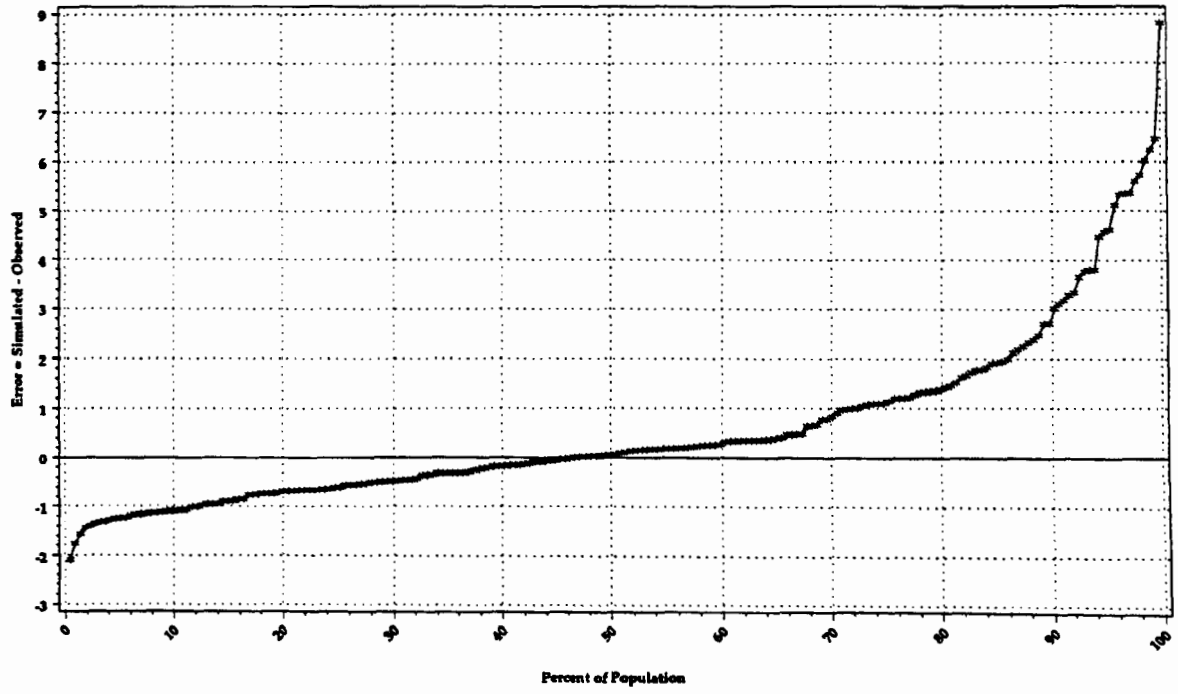
Actual Error versus Time
Total Nitrogen



CHOPTANK RIVER at Segment 770
Total Nitrogen
Frequency Distribution - PAIRED Simulated and Observed Data

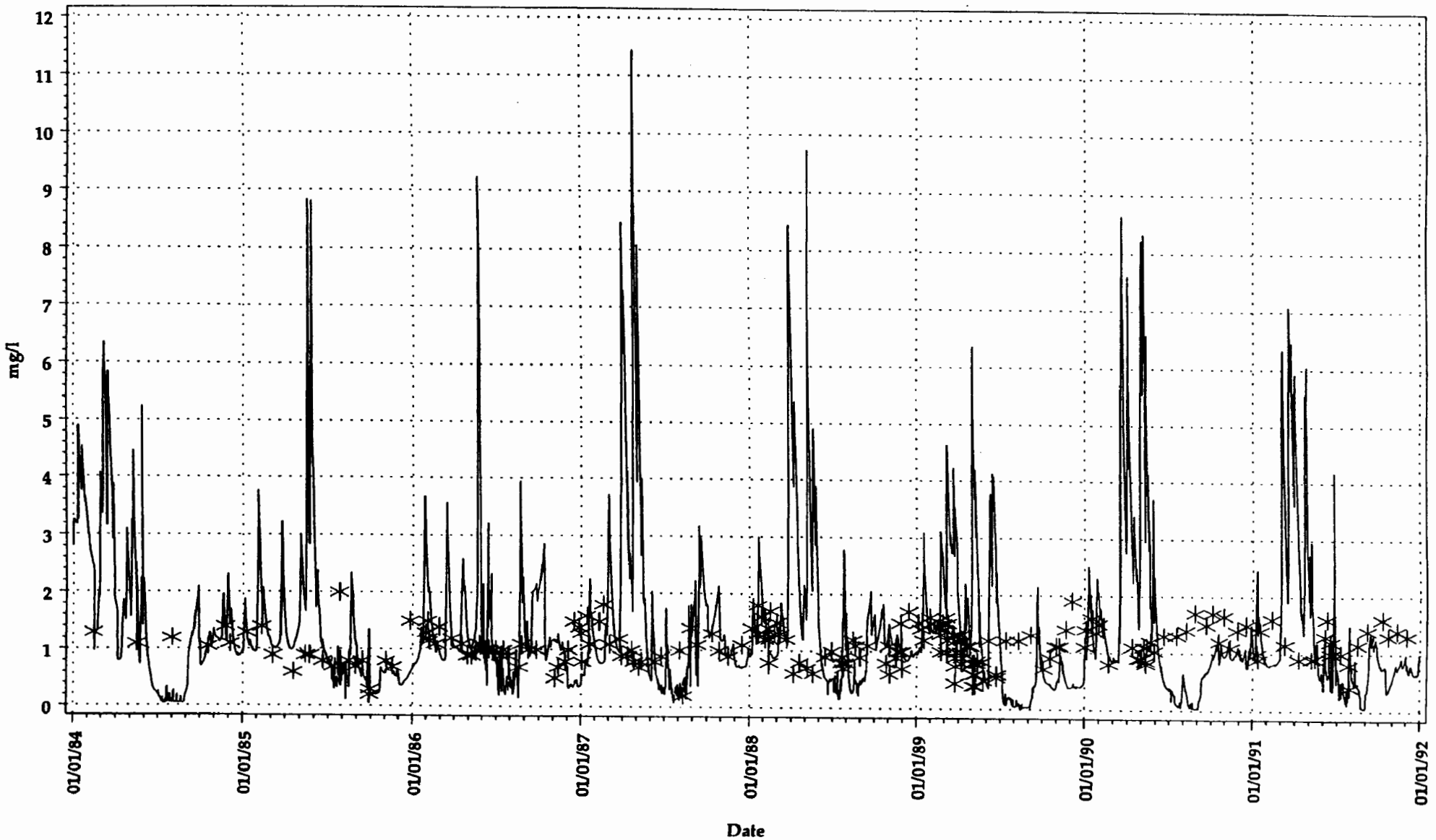


CHOPTANK RIVER at Segment 770
Actual error versus Percentile Sample Population
Total Nitrogen
Frequency Distribution - All Simulated and Observed Data

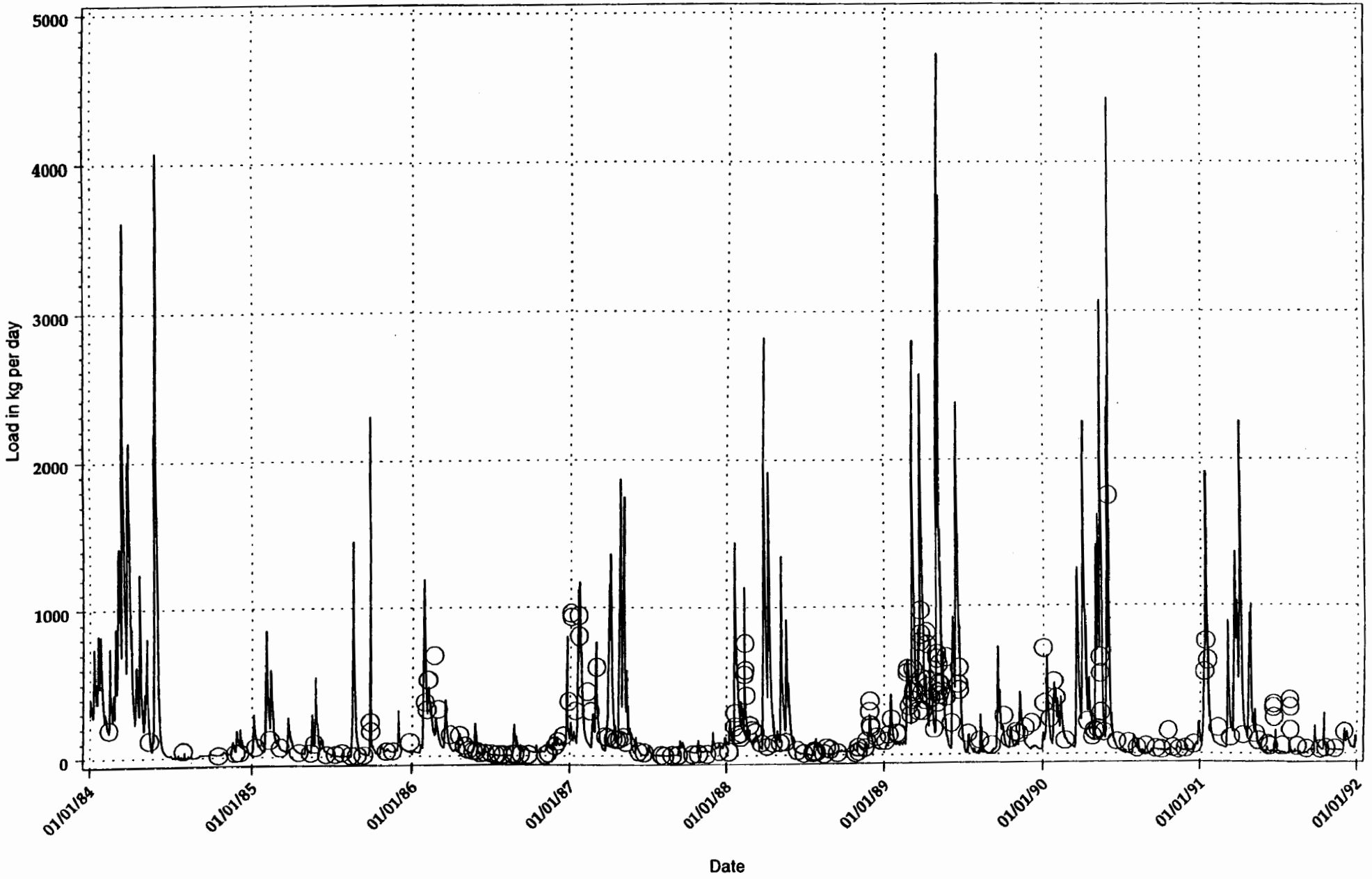


Choptank River at Segment 770
Observed and Simulated versus Time
NO3

(*=Observed, -=Simulated)



Choptank River at Segment 770
NO3 Observed and Simulated Load vs Time
(line = simulated, O = observed)

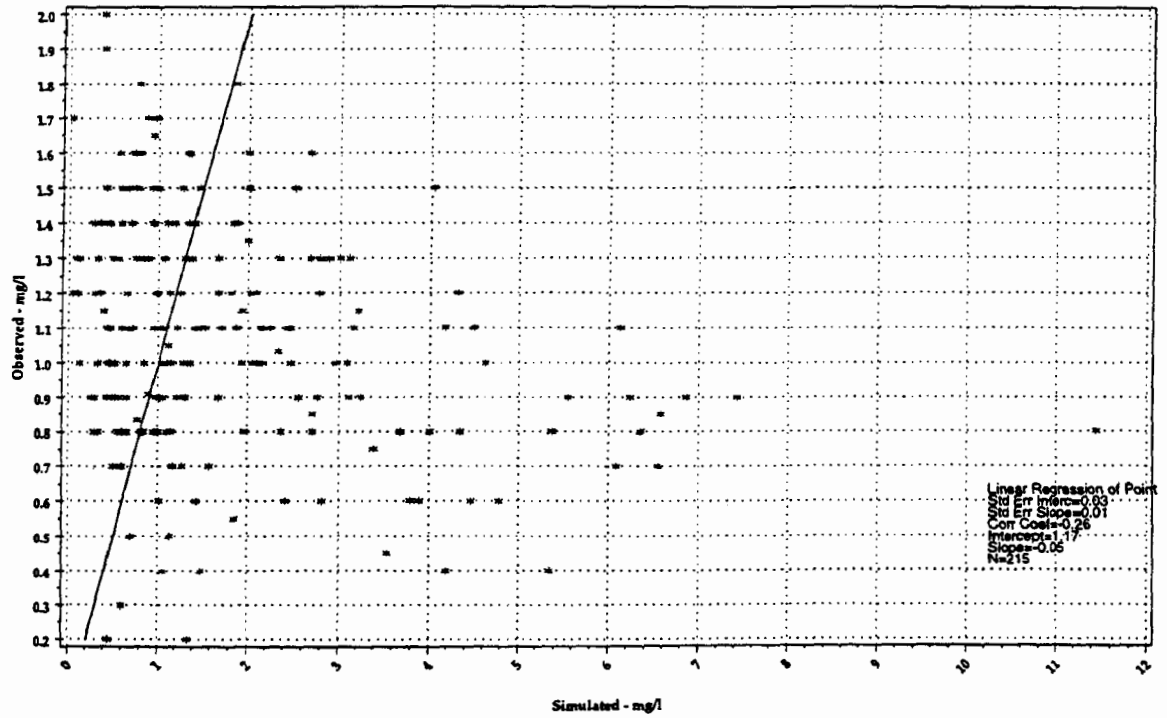


(y21_plot1.sas datastore2:[nps p3 james sas] 8dfas)
(choptank.drv 04FEB98 11:23,proc reg,model y=x)

CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

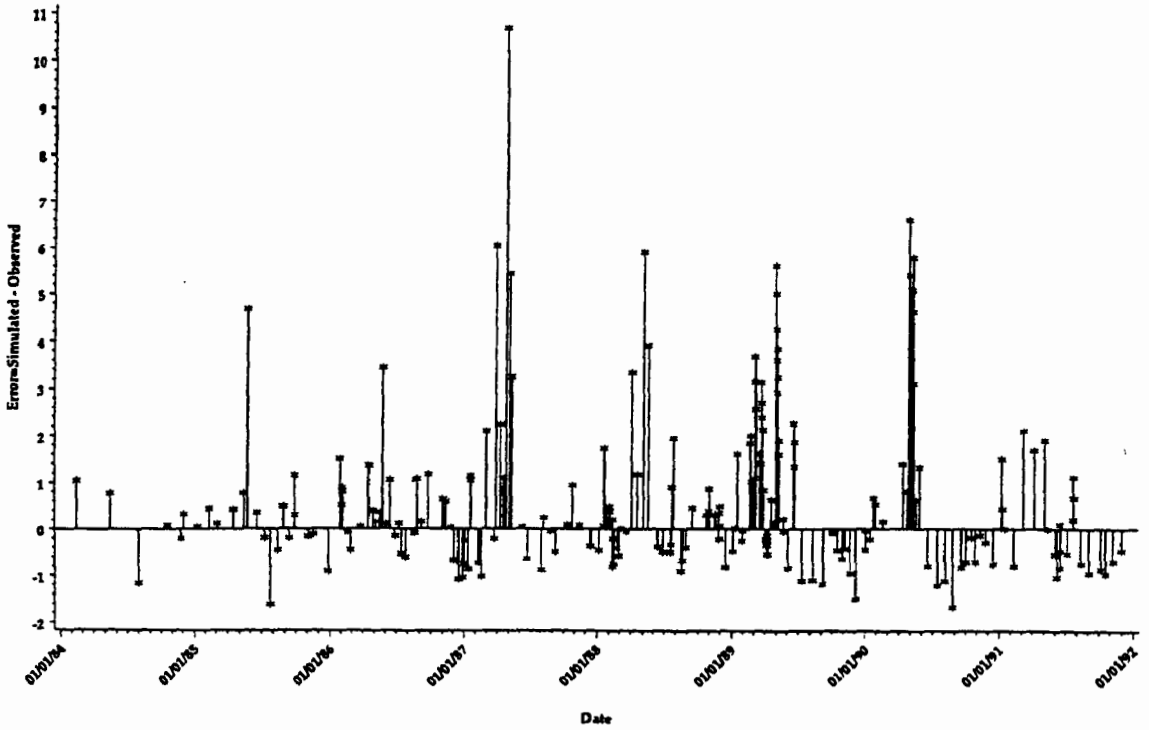
NO3: 01JAN84 - 01JAN92



CHOPTANK RIVER at Segment 770

Actual Error versus Time

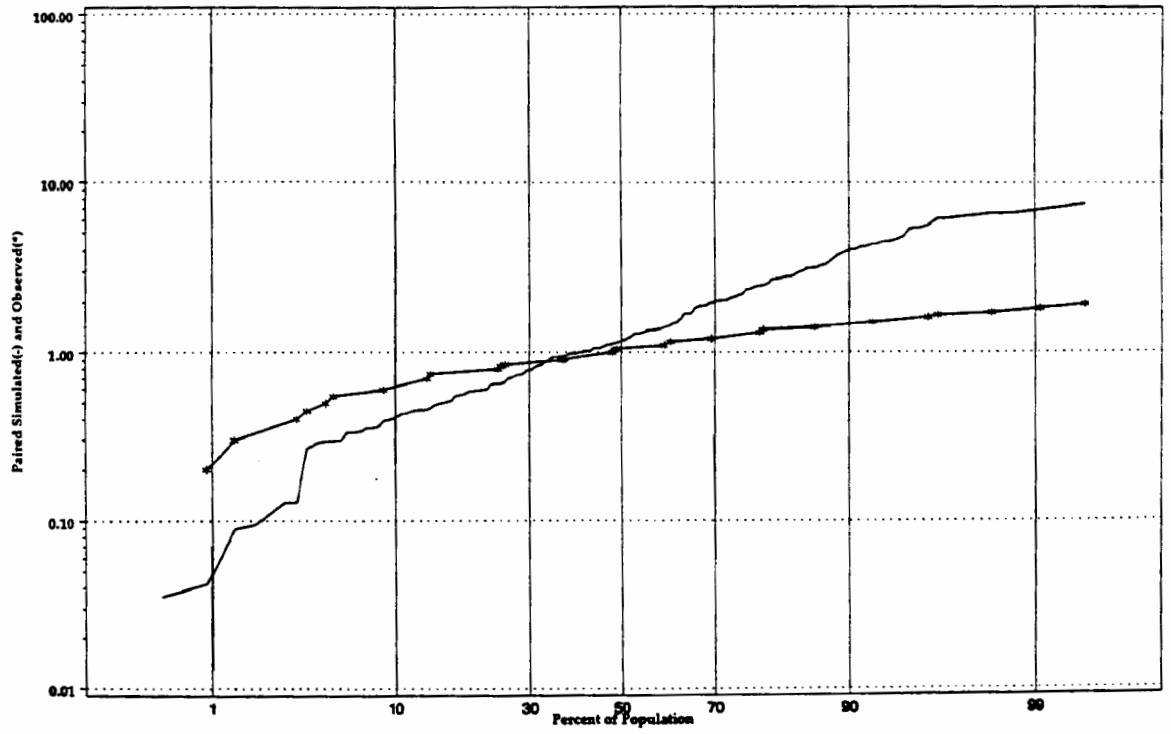
NO3



CHOPTANK RIVER at Segment 770

NO3

Frequency Distribution - PAIRED Simulated and Observed Data

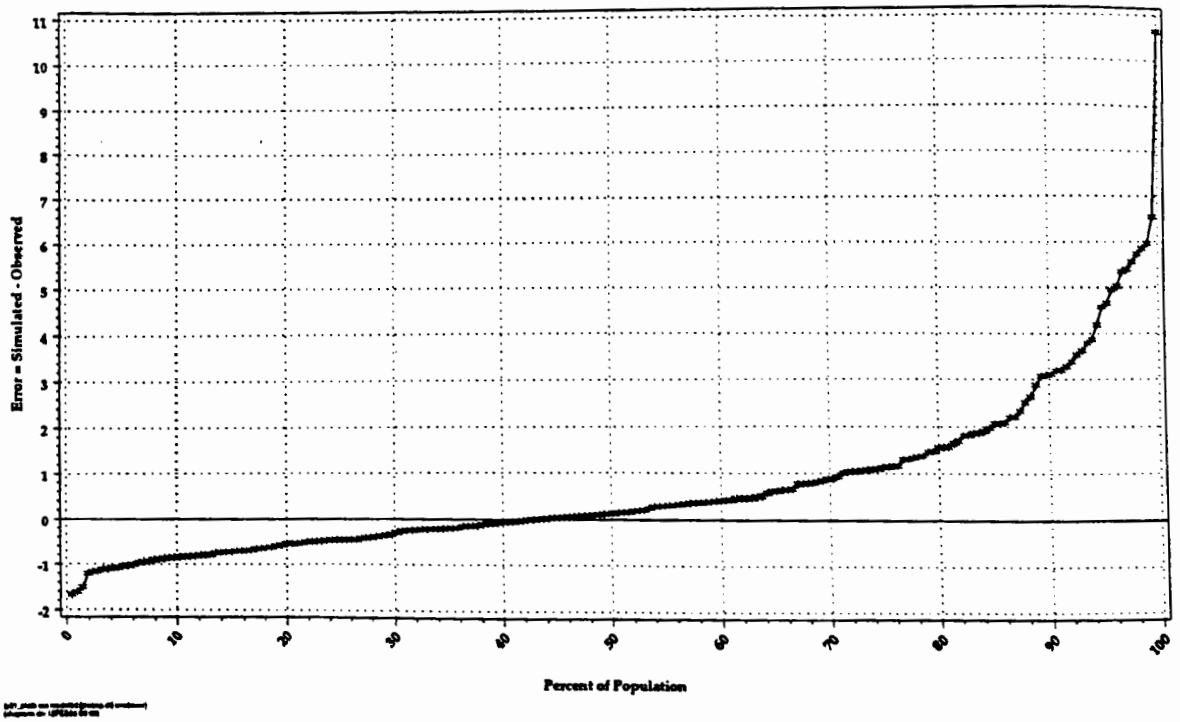


CHOPTANK RIVER at Segment 770

Actual error versus Percentile Sample Population

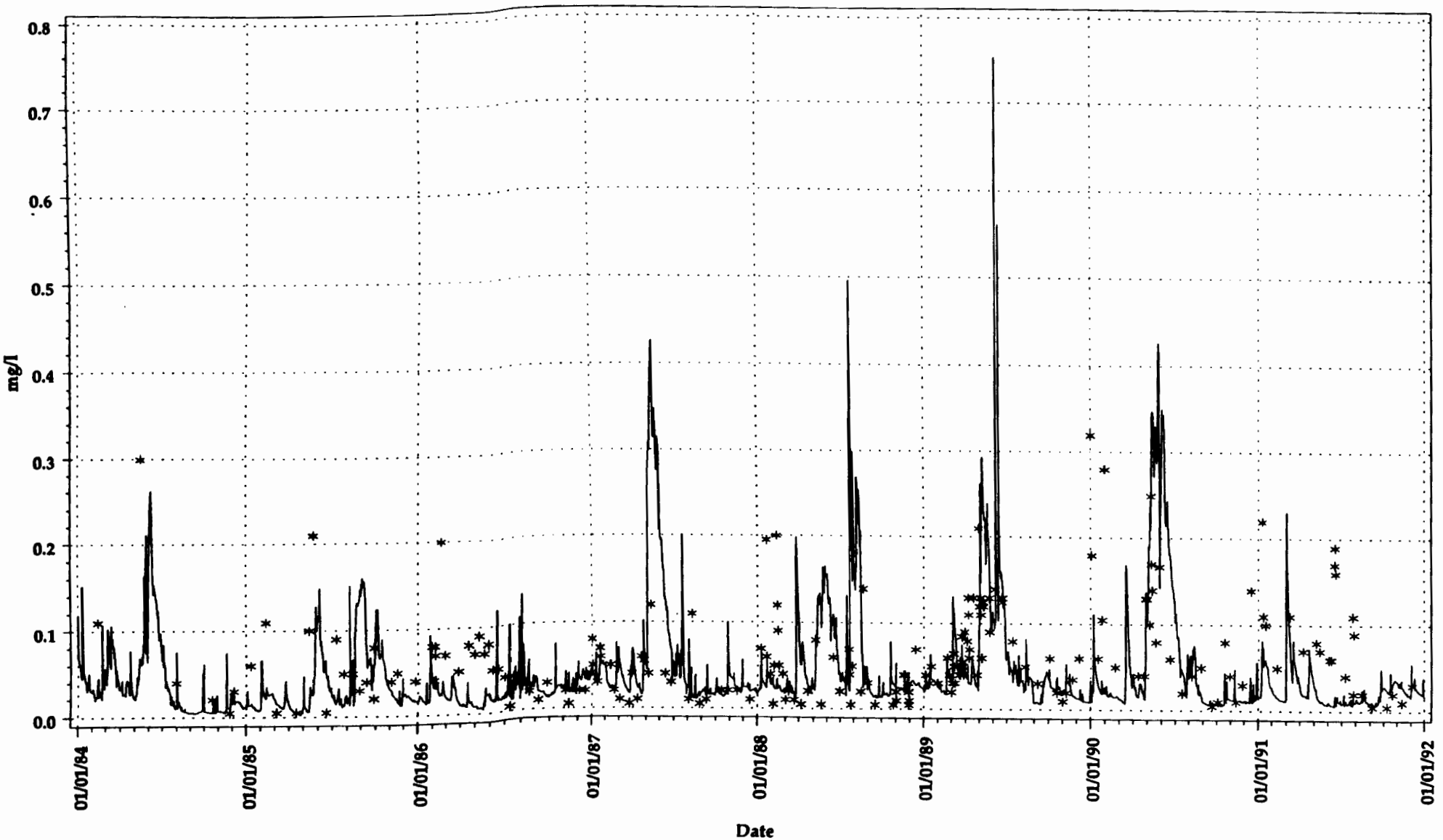
NO3

Frequency Distribution - All Simulated and Observed Data



CHOPTANK RIVER at Segment 770
Observed and Simulated versus Time
Total Ammonia

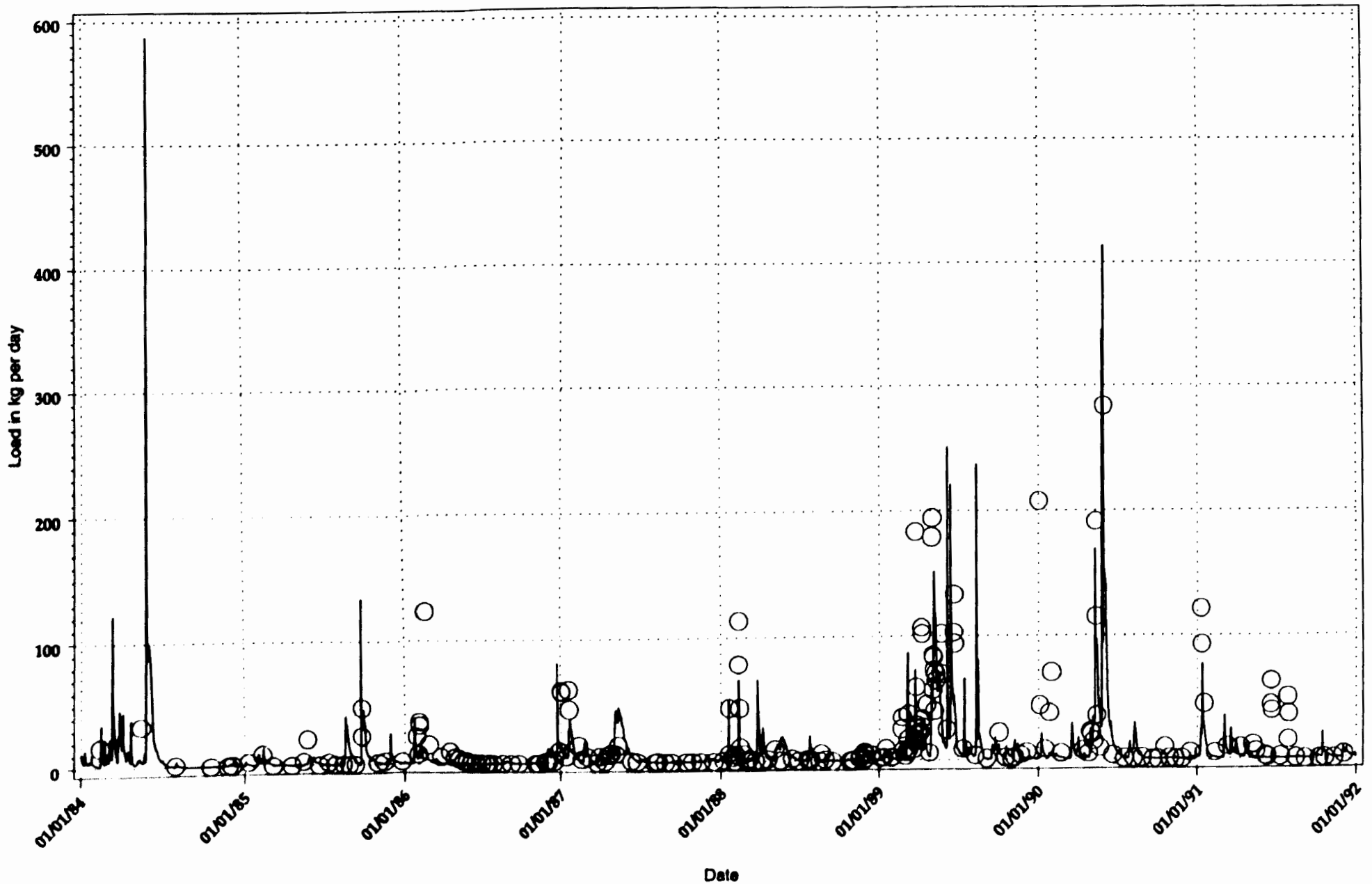
(*=Observed, -=Simulated)



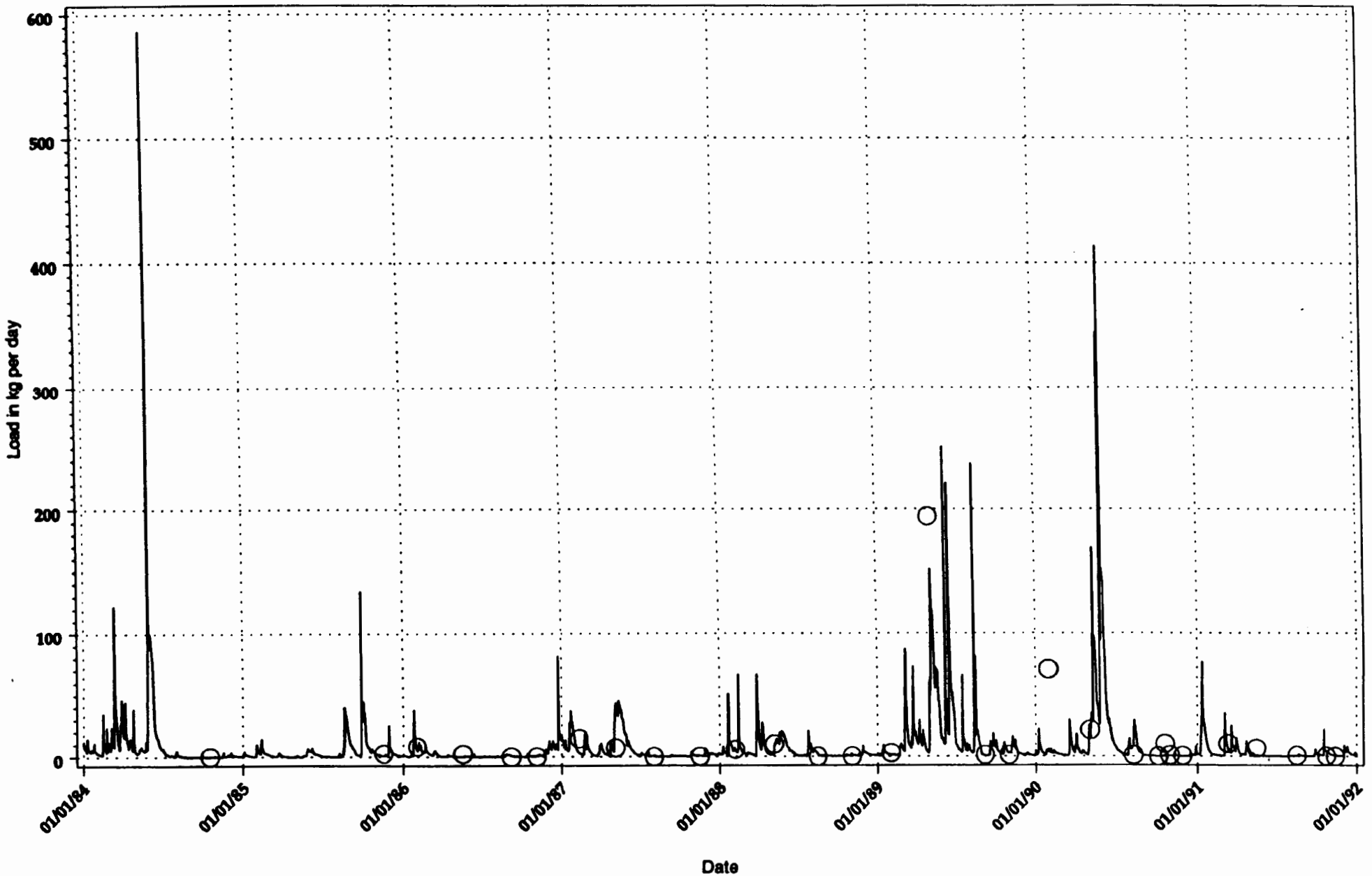
CHOPTANK RIVER at Segment 770

Total Ammonia Observed and Simulated Load vs Time

(line = simulated, O = observed)

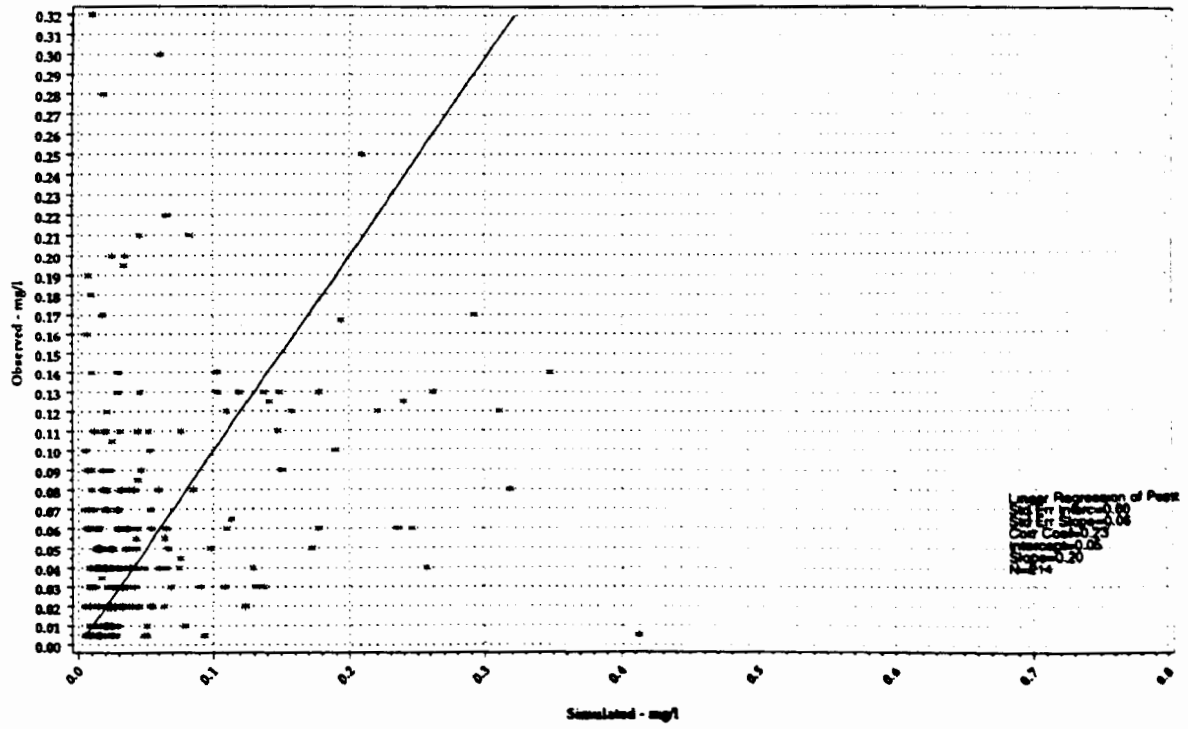


Choptank River at Segment 770
Total Ammonia Observed and Simulated Load vs Time
(line = simulated, O = observed)



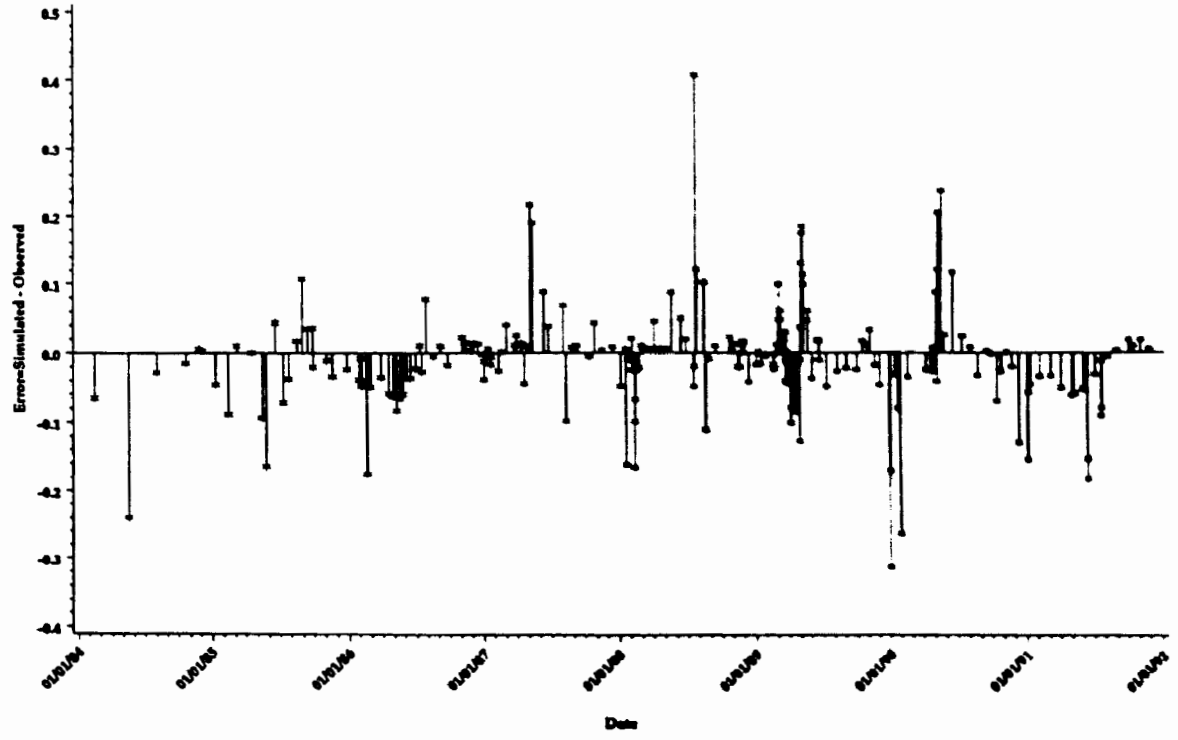
CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Total Ammonia: 01JAN84 - 01JAN92

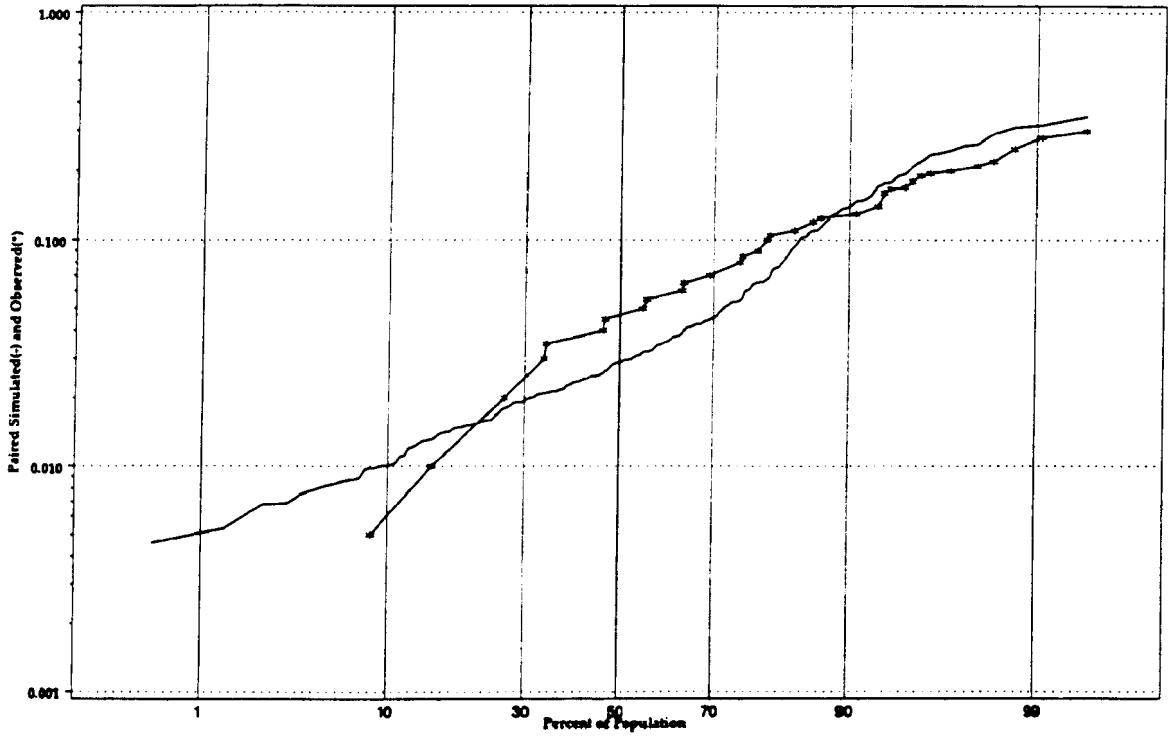


CHOPTANK RIVER at Segment 770

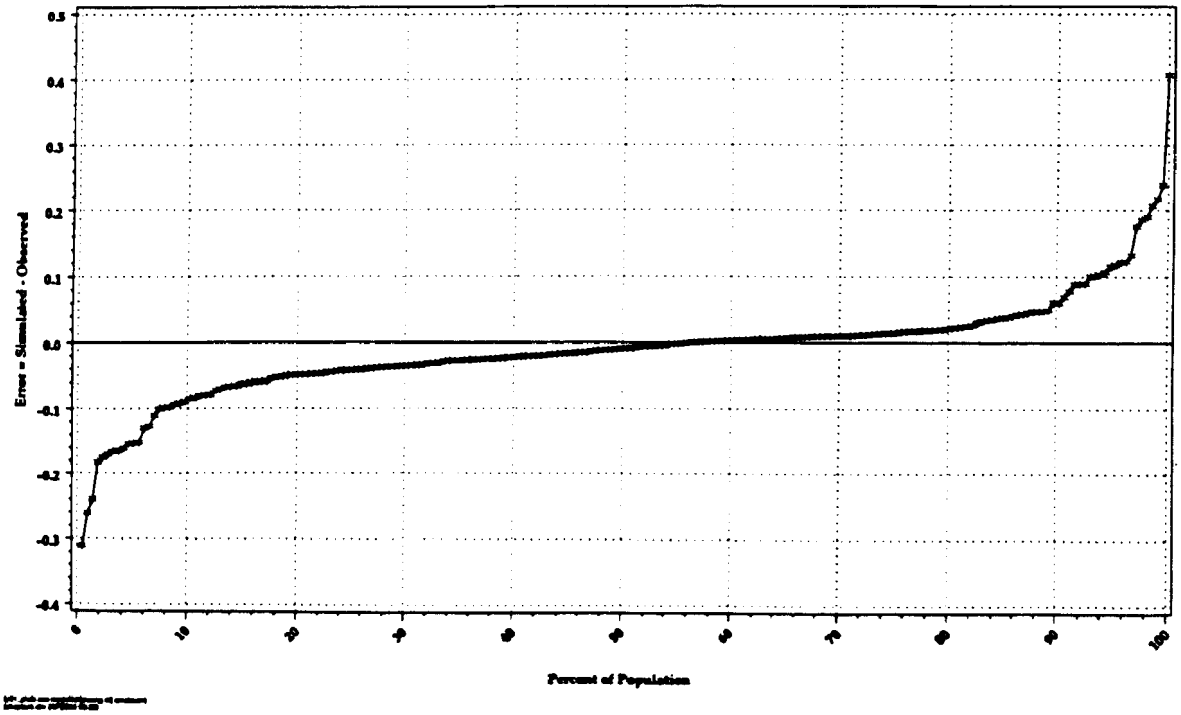
Actual Error versus Time
Total Ammonia



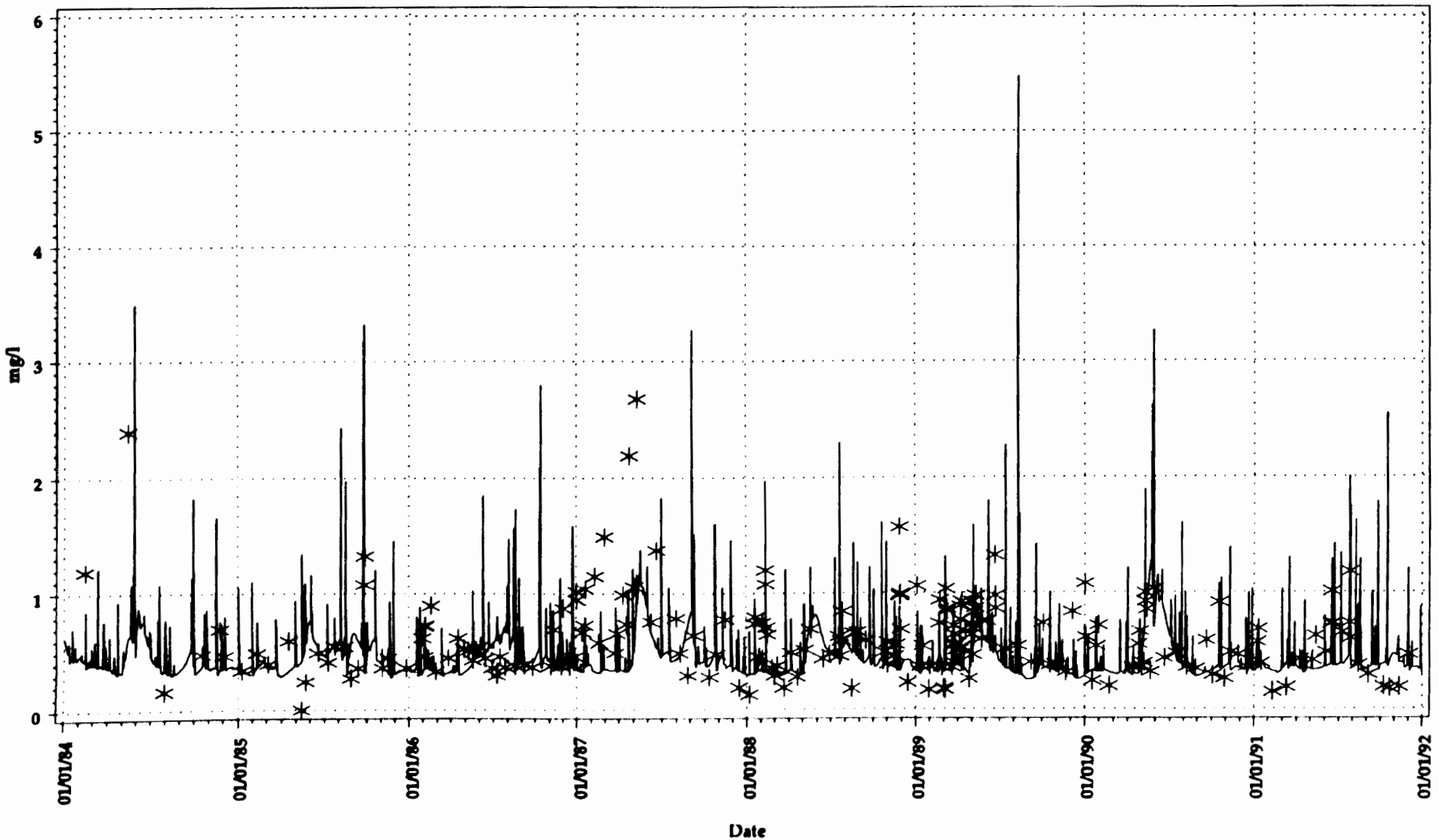
CHOPTANK RIVER at Segment 770
Total Ammonia
Frequency Distribution - PAIRED Simulated and Observed Data



CHOPTANK RIVER at Segment 770
Actual error versus Percentile Sample Population
Total Ammonia
Frequency Distribution - All Simulated and Observed Data



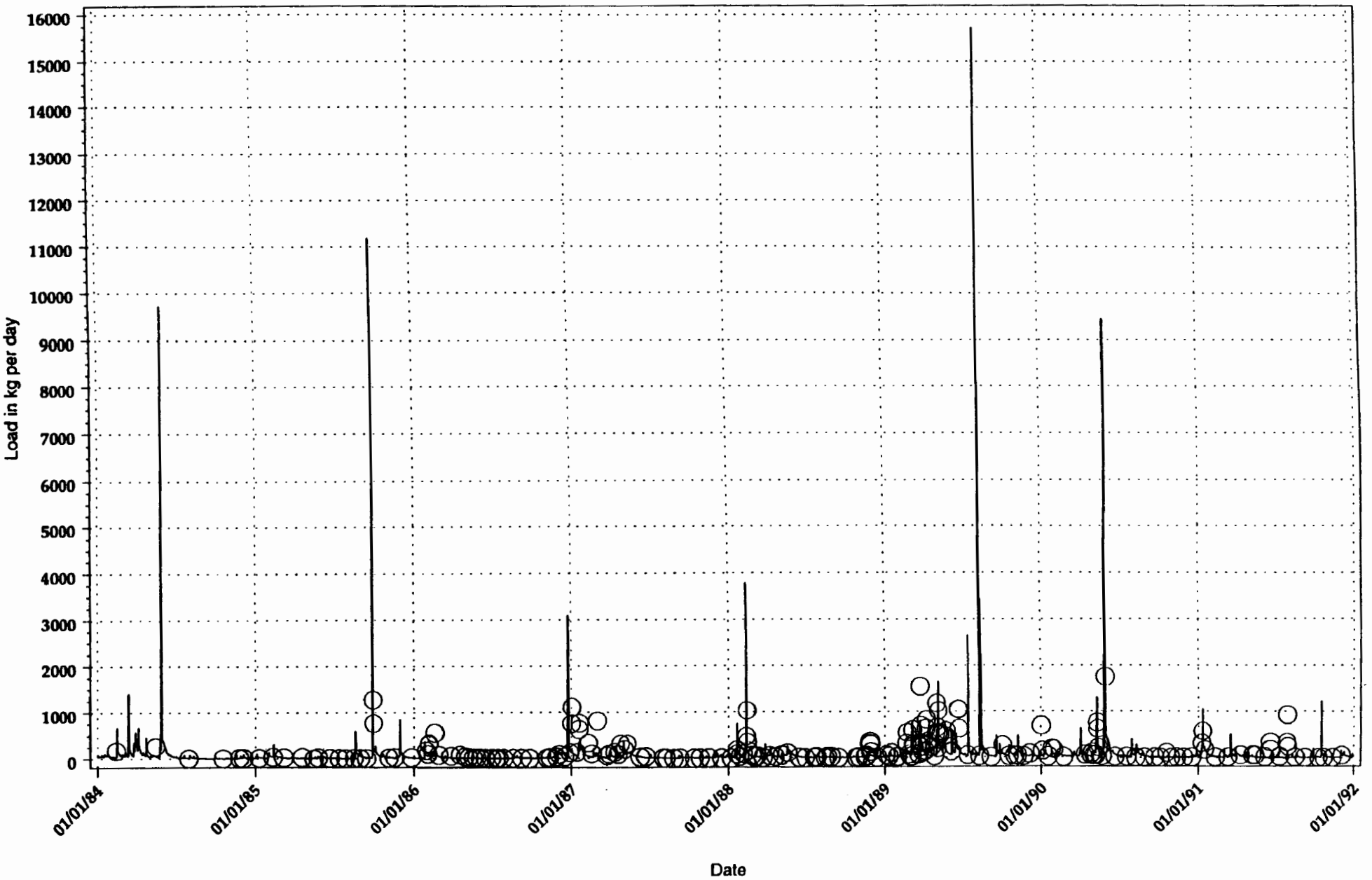
CHOPTANK RIVER at Segment 770
Observed and Simulated versus Time
Organic Nitrogen
(*=Observed, -=Simulated)



CHOPTANK RIVER at Segment 770

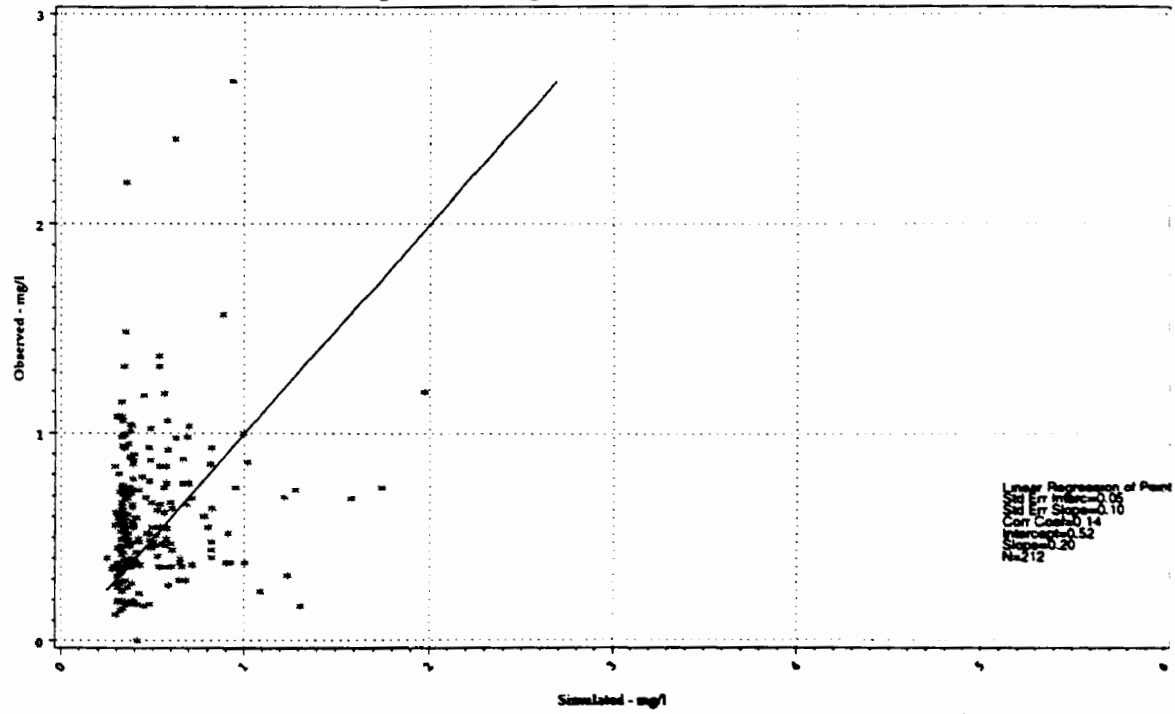
Organic Nitrogen Observed and Simulated Load vs Time

(line = simulated, O = observed)



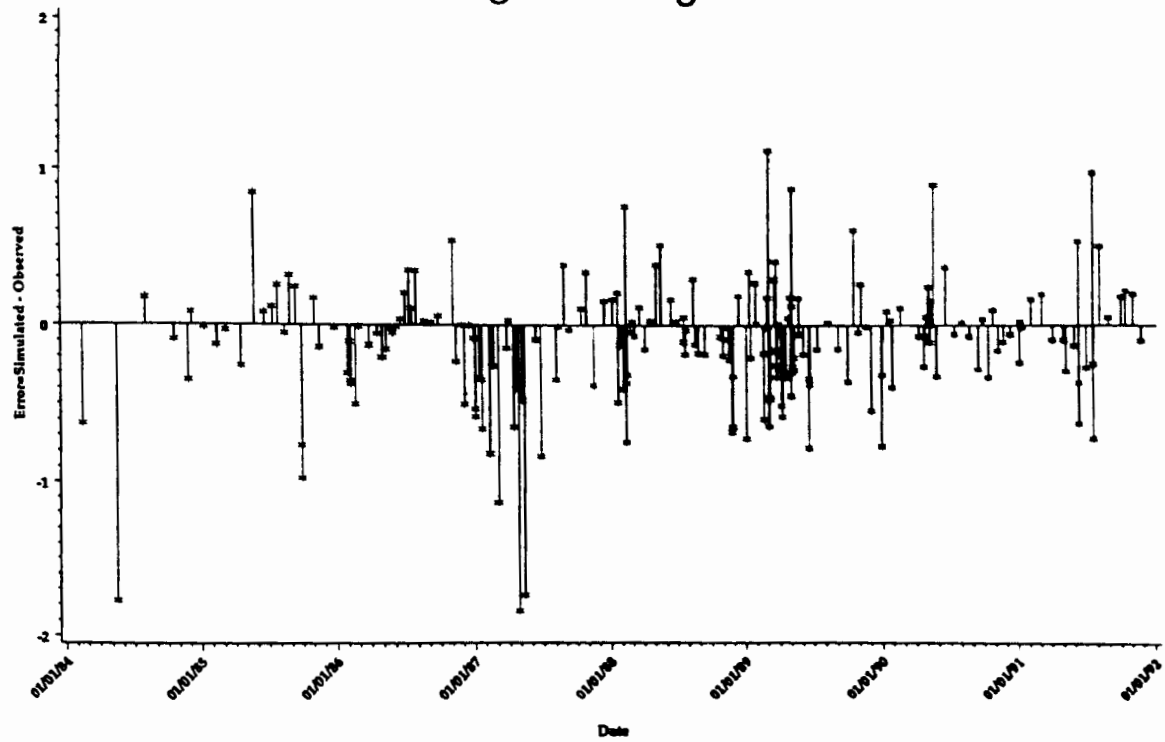
CHOPTANK RIVER at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line
Organic Nitrogen: 01JAN84 - 01JAN92



CHOPTANK RIVER at Segment 770

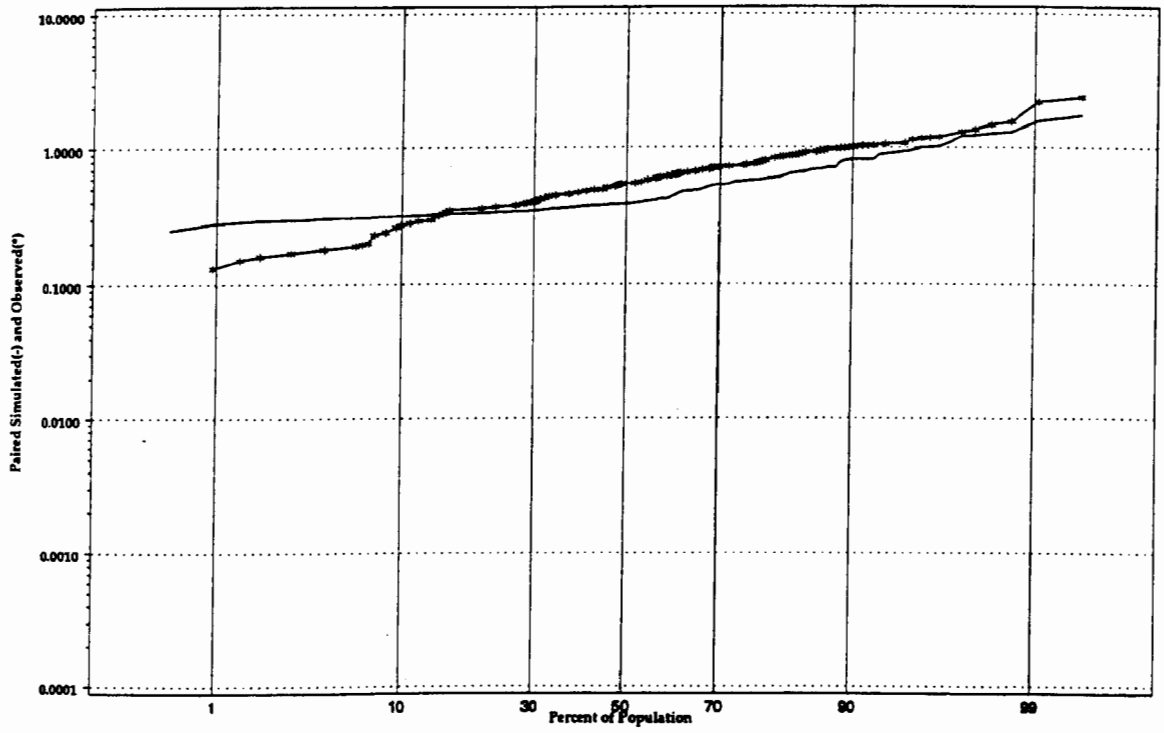
Actual Error versus Time
Organic Nitrogen



CHOPTANK RIVER at Segment 770

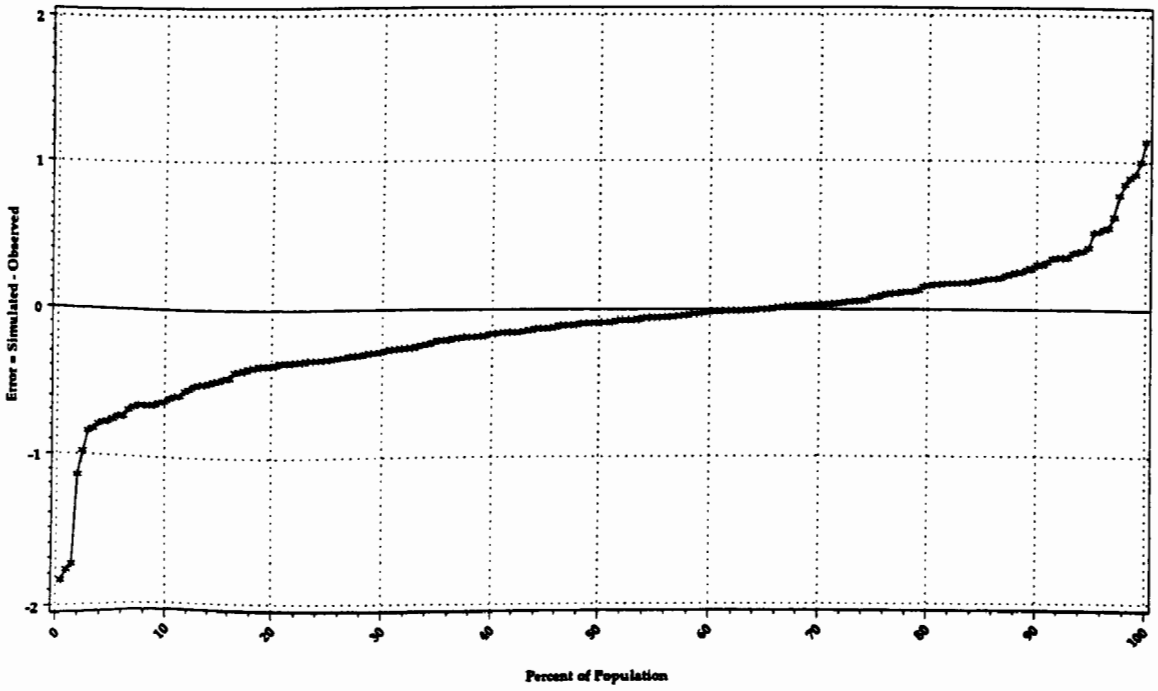
Organic Nitrogen

Frequency Distribution - PAIRED Simulated and Observed Data



CHOPTANK RIVER at Segment 770

Actual error versus Percentile Sample Population

Organic Nitrogen

Frequency Distribution - All Simulated and Observed Data