COMPARISON OF THE 2002 LOADS AND YIELDS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND SUSPENDED SEDIMENT WITH THE BASELINES

The annual fluctuations of nutrient and SS loads and water discharge made it difficult to determine whether the changes were related to land use, nutrient availability, or simply annual water discharge. Ott and others (1991) used the functional relationship between annual loads and annual water discharge to provide a method to reduce the variability of loadings due to discharge. This was accomplished by plotting the annual loads or yields against the water-discharge ratio. This water-discharge ratio is the ratio of the annual mean discharge to the long-term mean discharge. Data from the initial 5-year study (1985-89) were used to provide a best-fit linear regression line to be used as the baseline relationship between annual loads and water discharge. It was hypothesized that, as future loads and water-discharge ratios were plotted against the baseline, any significant deviation from the baseline would indicate that some change in the annual load had occurred, and that further evaluations to determine the reason for the change were warranted. The data collected in 2002 were compared with the 1985-89 baseline, where possible. Monitoring at some of the stations was started after 1987; therefore, a baseline was established for the 5-year period following the start of monitoring. Figures 17-22 display the baseline graphs and the 2002 yields.

Susquehanna River at Towanda, Pa.

The 5-year baselines for TN, TP, and SS for the Susquehanna River at Towanda are shown in Figure 17 with the 2002 annual yield. Actual 2002 and baseline yields are listed in Table 22 along with the discharge ratio. Best-fit lines were drawn through the initial 5-year data sets using the following equations:

Total Nitrogen (TN)

TN Yield = 0.7484 + 6.0967x $R^2 = 0.86$

Total Phosphorus (TP)

TP Yield = -0.1419 + 0.4999x $R^2 = 0.52$

Suspended Sediment (SS)

SS Yield = -612.879 + 918.165x $R^2 = 0.43$

Where x = water-discharge ratio and R2 = correlation coefficient

Table 22. Comparison of 2002 TN, TP, and SS Yields With Baseline Yields at Towanda, Pa.

Parameter	Discharge Ratio	Baseline lb/ac/yr	2002 lb/ac/yr
TN	1.028	6.5	4.6
TP	1.028	0.3975	0.35
SS	1.028	371.361	202.76

Susquehanna River at Danville, Pa.

Figure 18 shows the 5-year (1985-89) baselines for TN, TP, and SS and the 2001 yields for the Susquehanna River at Danville. Actual 2002 and baseline yields are listed in Table 23 along with the discharge ratio. The regression equations used to establish the baselines were:

Total Nitrogen (TN)

TN Yield = -0.1792 + 7.2989x $R^2 = 0.85$

Total Phosphorus (TP)

TP Yield = -0.1496 + 0.6586x $R^2 = 0.94$

Suspended Sediment (SS)

SS Yield = -471.893 + 862.484x $R^2 = 0.99$

Table 23. Comparison of 2002 TN, TP, and SS Yields With Baseline Yields at Danville, Pa.

Parameter	Discharge Ratio	Baseline lb/ac/yr	2002 lb/ac/yr
TN	1.032	7.5	5.02
TP	1.032	0.554	0.389
SS	1.032	448.24	149.26

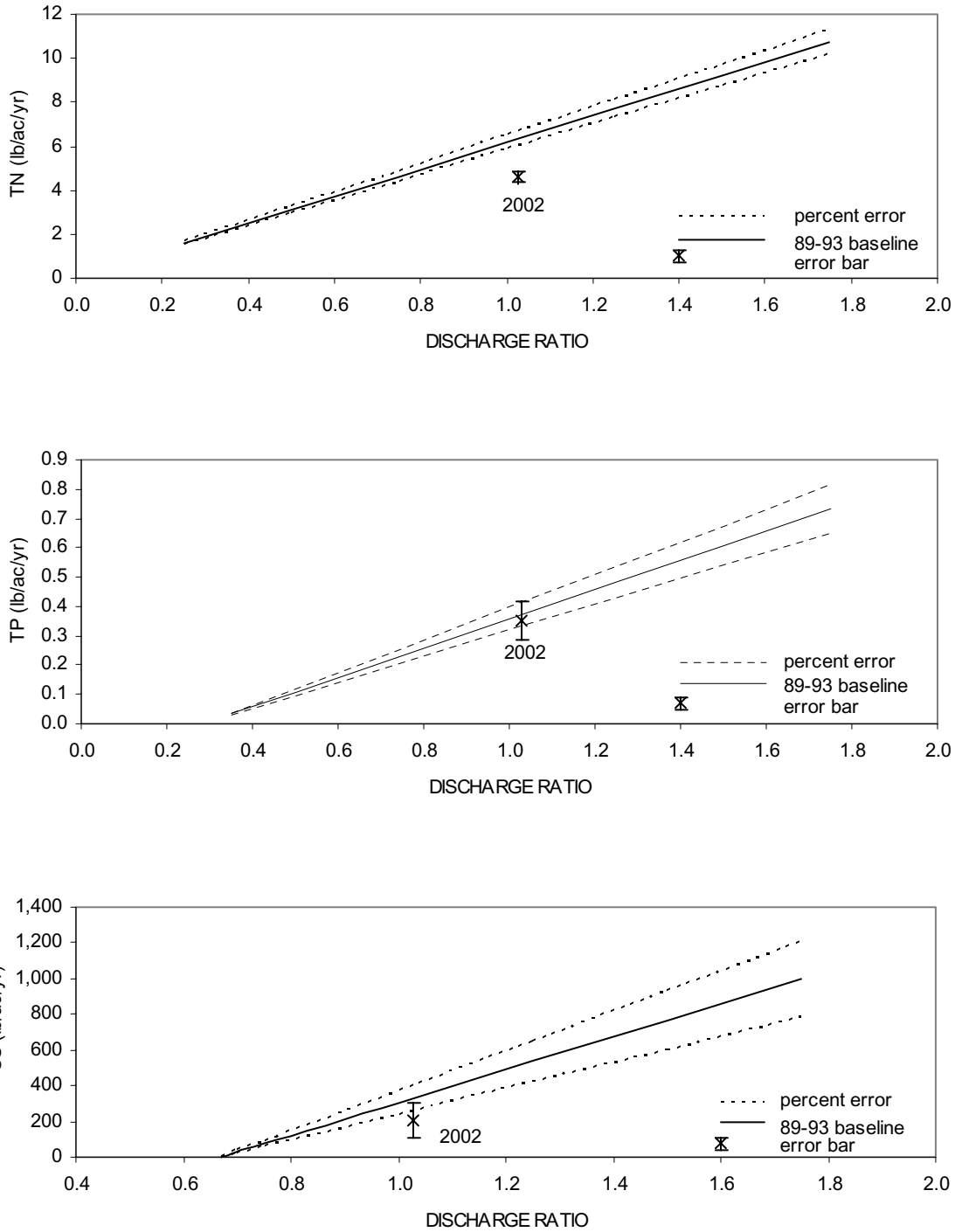

Figure 17. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Towanda, Pa., 1989-1993 and 2002

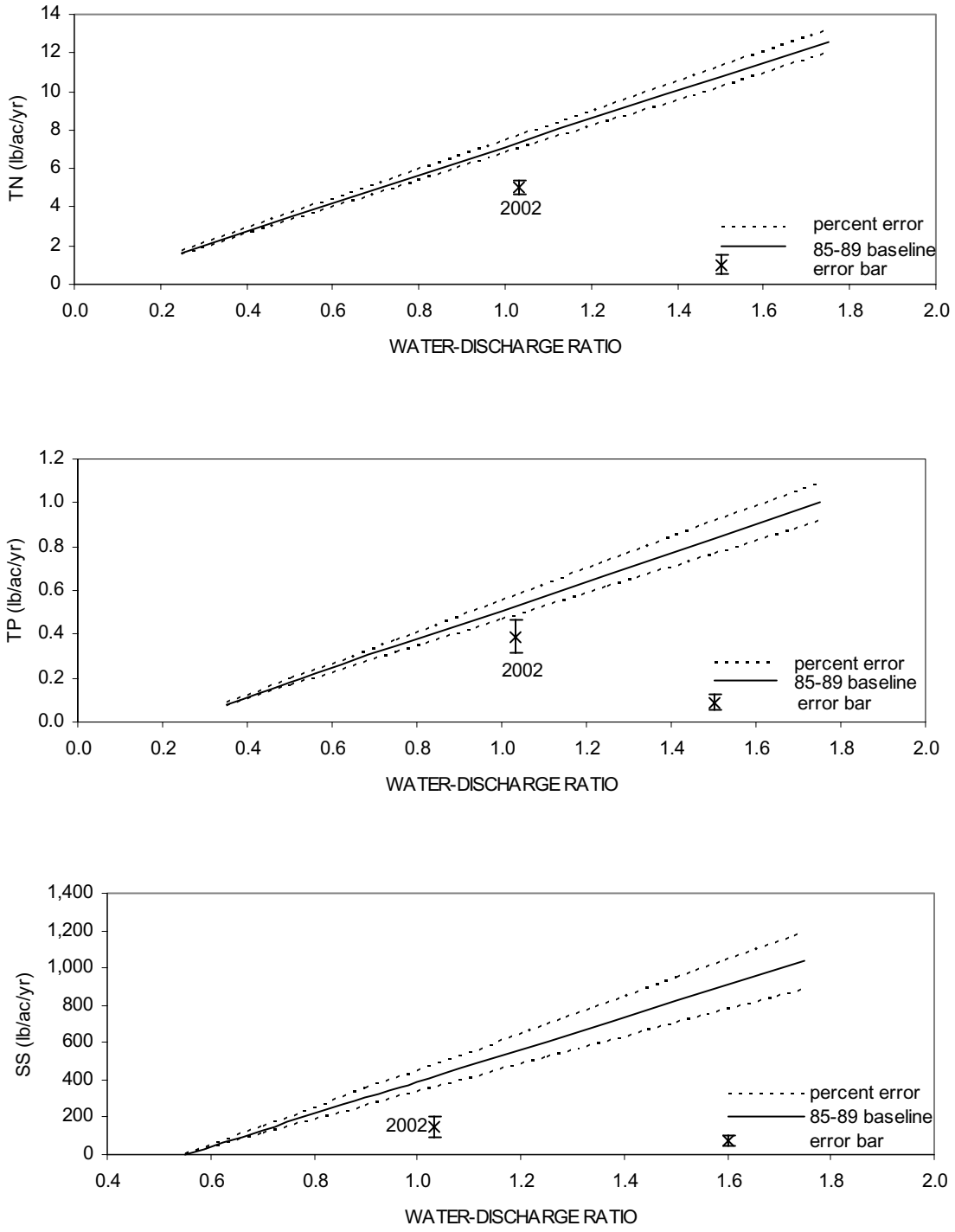

Figure 18. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Danville, Pa., 1985-1989 and 2002

West Branch Susquehanna River at Lewisburg, Pa.

The 1985-89 baselines and the 2001 yields for TN, TP, and SS are shown in Figure 19. Actual 2002 and baseline yields are listed in Table 24 along with the discharge ratio. The baselines were defined by the following equations:

Total Nitrogen (TN)

TN Yield = -1.3773 + 7.8447x $R^2 = 0.73$

Total Phosphorus (TP)

TP Yield = 0.0399 + 0.2660x $R^2 = 0.50$

Suspended Sediment (SS)

SS Yield = -152.859 + 344.025x $R^2 = 0.66$

Table 24. Comparison of 2002 TN, TP, and SS Yields With Baseline Yields at Lewisburg, Pa.

Parameter	Discharge Ratio	Baseline lb/ac/yr	2002 lb/ac/yr
TN	0.887	5.58	4.3
TP	0.887	0.27	0.22
SS	0.887	152.29	91.48

Juniata River at Newport, Pa.

The 1985-89 baselines and 2001 yields for TN, TP, and SS at Newport, are shown in Figure 20. Actual 2002 and baseline yields are listed in Table 25 along with the discharge ratio. The baselines were defined by the following equations:

Total Nitrogen (TN)

TN Yield = -0.2937 + 8.9052x $R^2 = 0.80$

Total Phosphorus (TP)

TP Yield = -0.0892 + 0.5268x $R^2 = 0.95$

Suspended Sediment (SS)

SS Yield = -293.255 + 563.920x $R^2 = 0.89$

Table 25. Comparison of 2002 TN, TP, and SS Yields With Baseline Yields at Newport, Pa.

Parameter	Discharge Ratio	Baseline lb/ac/yr	2002 lb/ac/yr
TN	0.688	5.83	5.3
TP	0.688	0.27	0.335
SS	0.688	94.72	142.21

Susquehanna River at Marietta, Pa.

The TN, TP, and SS baseline for the 5-year period 1987-91 at Marietta and the 2001 yield are shown in Figure 21. Actual 2002 and baseline yields are listed in Table 26 along with the discharge ratio. The baselines were defined by the following equations:

Total Nitrogen (TN)

TN Yield = -0.8300 + 9.3087x $R^2 = 0.99$

Total Phosphorus (TP)

TP Yield = 0.1330 + 0.2405x $R^2 = 0.28$

Suspended Sediment (SS)

SS Yield = -97.8555 + 385.9816x $R^2 = 0.48$

Table 26. Comparison of 2002 TN, TP, and SS Yields With Baseline Yields at Marietta, Pa.

Parameter	Discharge Ratio	Baseline lb/ac/yr	2002 lb/ac/yr
TN	0.903	7.58	6.34
TP	0.903	0.35	0.468
SS	0.903	250.69	250.03

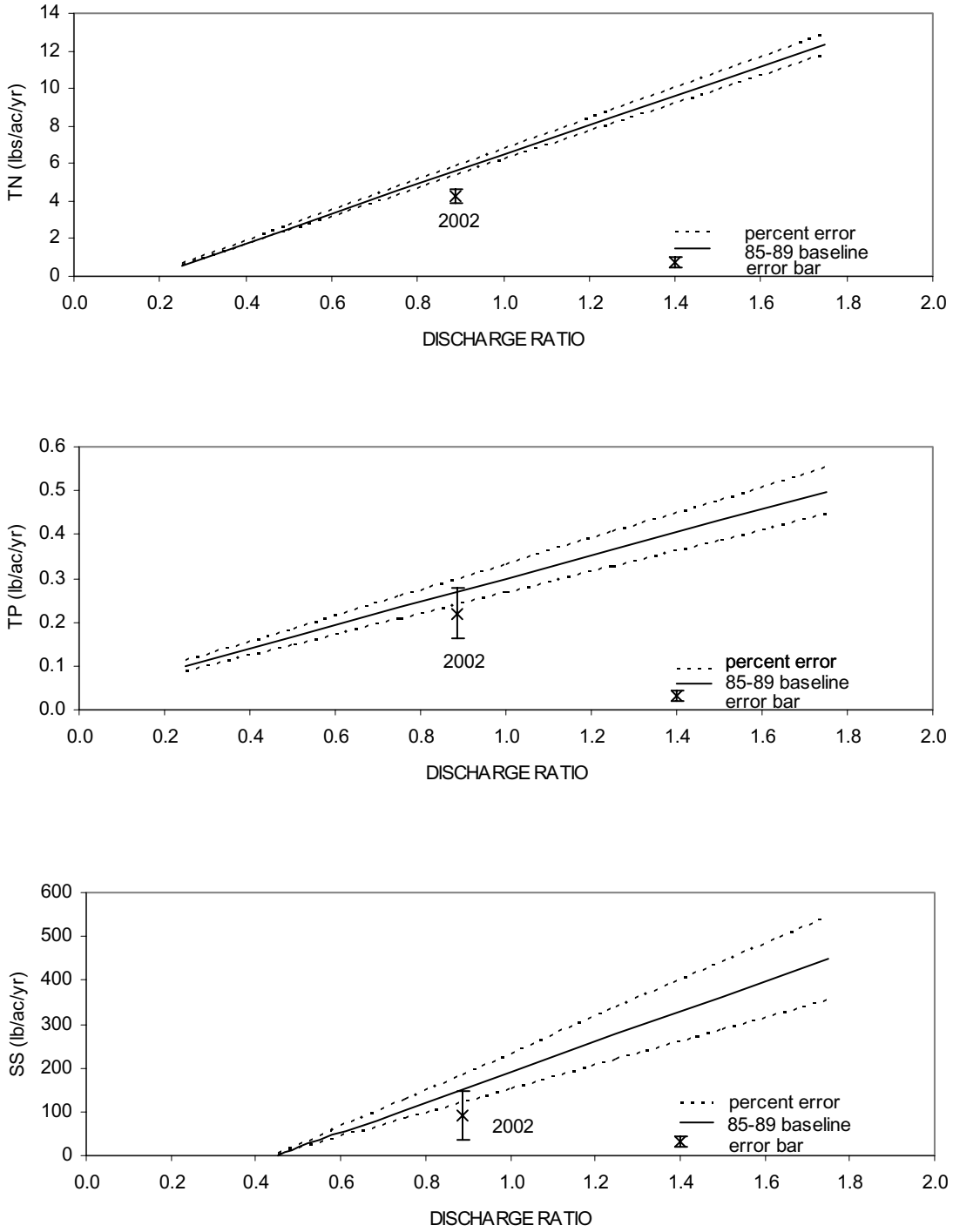

Figure 19. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, West Branch Susquehanna River at Lewisburg, Pa., 1985-1989 and 2002

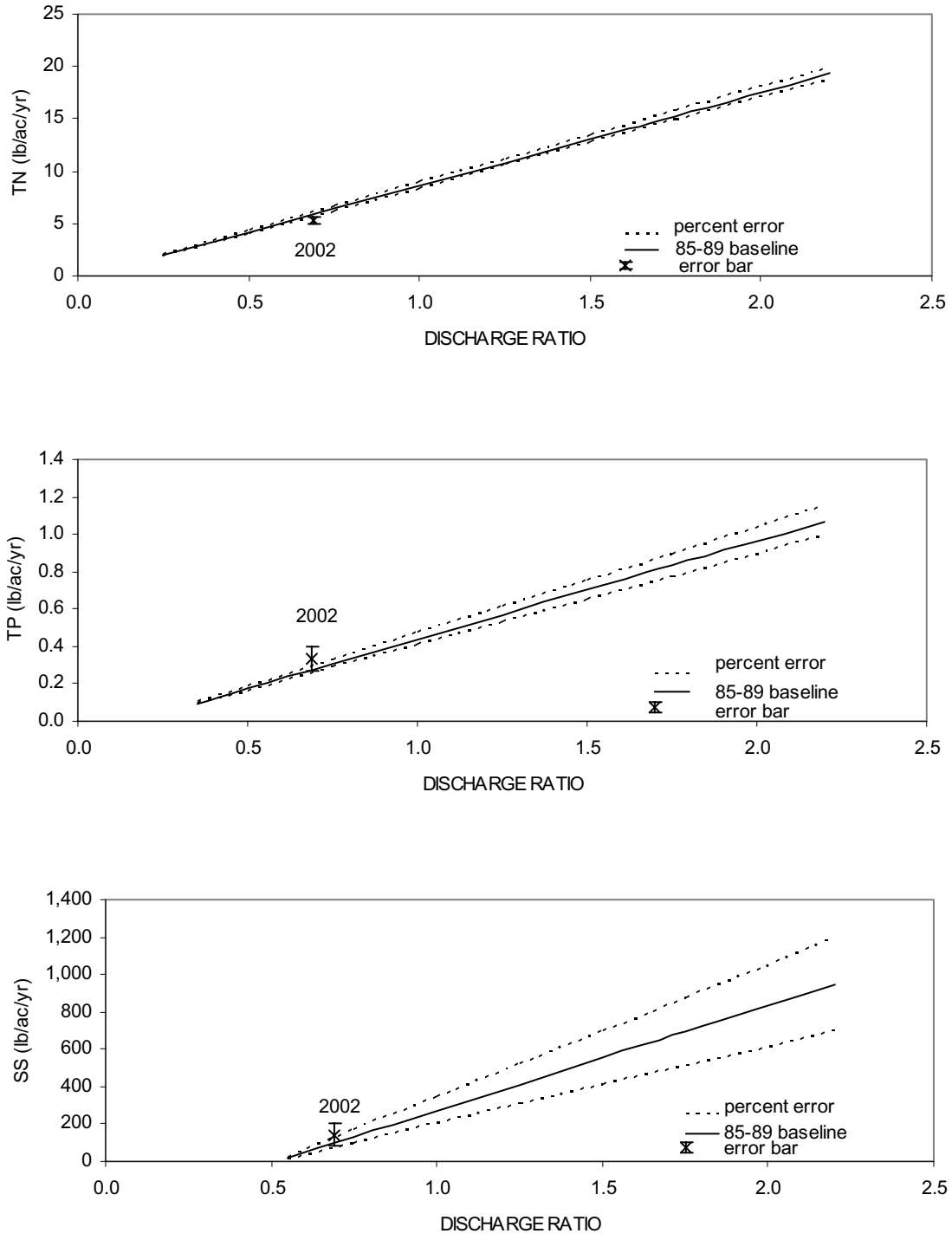

Figure 20. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Juniata River at Newport, Pa., 1985-1989 and 2002

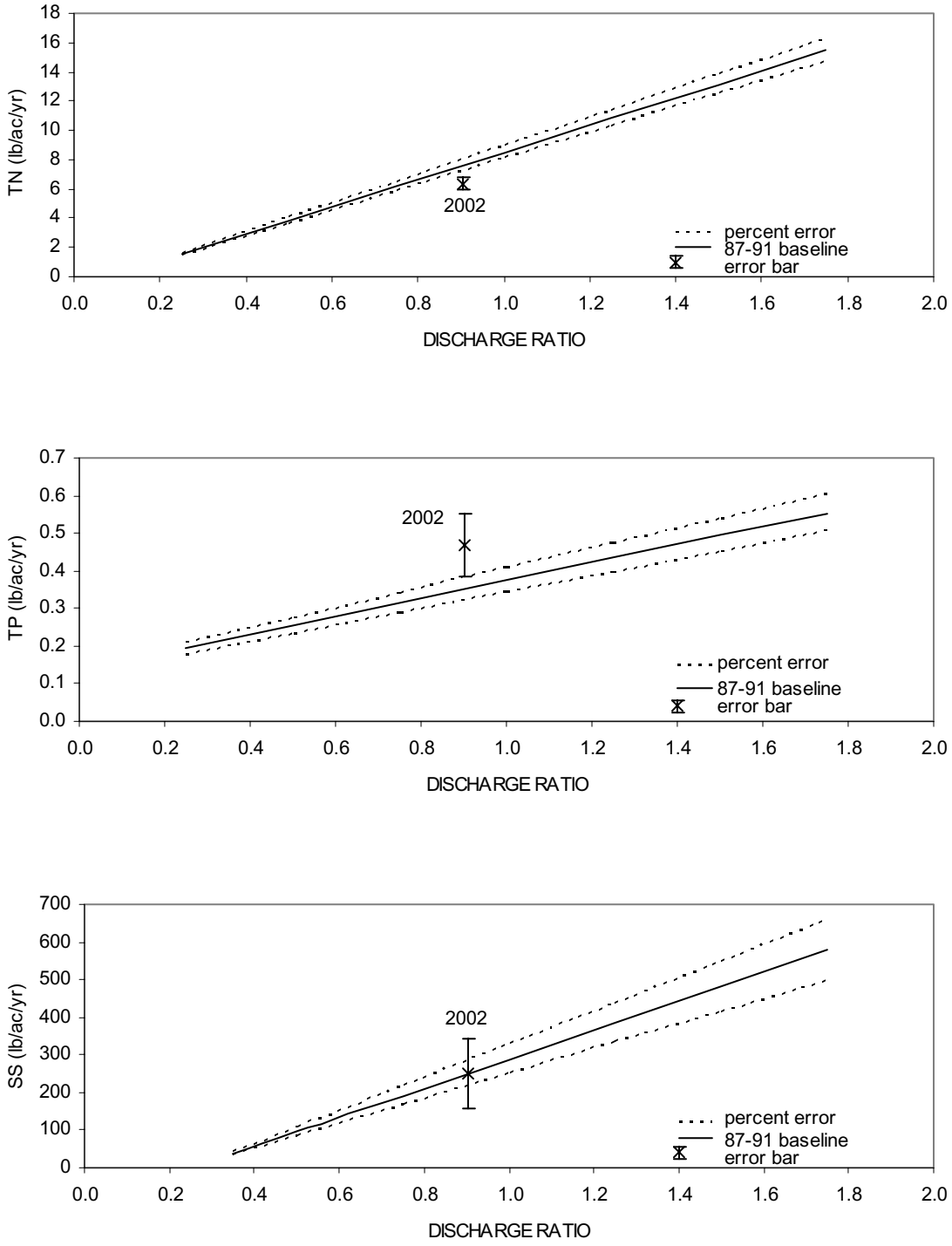

Figure 21. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Marietta, Pa., 1987-1991 and 2002

Conestoga River at Conestoga, Pa.

Figure 22 shows the TN, TP, and SS baselines. Actual 2002 and baseline yields are listed in Table 27 along with the discharge ratio. The baselines were defined by the following equations:

Total Nitrogen (TN)

TN Yield = 2.3343 + 35.3217x $R^2 = 0.97$

Total Phosphorus (TP)

TP Yield = -1.4013 + 3.3216x $R^2 = 0.92$

Suspended Sediment (SS)

SS Yield = -617.301 + 1978.075x $R^2 = 0.72$

Table 27. Comparison of 2002 TN, TP, and SS Yields With Baseline Yields at Conestoga, Pa.

Parameter	Discharge Ratio	Baseline lb/ac/yr	2002 lb/ac/yr
TN	0.57	22.47	17.03
TP	0.57	0.49	1.436
SS	0.57	510.2	509.76

DISCHARGE, NUTRIENT, AND SUSPENDED-SEDIMENT TRENDS

Trend analyses of water quality and flow data collected at the six monitoring sites were completed for the period January 1985 through December 2002. Trends were estimated using linear regression techniques and the USGS estimator model (Cohn and others, 1989). These tests were used to estimate the direction and magnitude of trends for discharge, SS, TOC, and several forms of nitrogen and phosphorus. Results were reported for monthly mean discharge (FLOW), monthly load (LOAD), flow-weighted concentration (FWC), and flow-adjusted concentration (FAC).

Trends in FLOW indicate the natural changes in hydrology. Changes in flow and the cumulative sources of flow (baseflow and over land runoff) affect the observed concentrations and the estimated loads of nutrients and SS.

The LOAD represents the amount of a given constituent transported past a given point over a set duration of time. Trends in LOAD indicate the flux of constituents through the system or rates of output. When loads are expressed as yields (load per unit area), the rates of output among watersheds can be compared. The FWC is the result of the LOAD divided by the monthly flow. Trends in FWC indicate changes in stream quality over the period being investigated.

The FWC is an average monthly concentration, rather than a single observed concentration, and is more representative of monthly stream quality conditions. This is the concentration that affects the biological processes of the stream. The FAC is the concentration after the effects of flow are removed from the concentration time series. Trends in FAC indicate that changes have occurred in the processes that deliver constituents to the stream system. After the effects of flow are removed, this is the concentration that relates to the effects of nutrient-reduction activities and other actions taking place in the watershed. A description of the methodology is included in Langland and others (1999).

Trends in FLOW, LOAD, FWC, and FAC represent four diverse approaches to evaluating stream quality. While each trend will not reveal the specific cause of water quality changes, the combined information can improve understanding of the causes influencing water quality trends.