The long-term TP yields in the Susquehanna River at Towanda, Danville, and Marietta do not show any consistent seasonal pattern among the sites. TP yields among the tributary sites show that Lewisburg had the smallest yield during all seasons. The 2001 TP yields for Towanda, Danville, and Marietta followed the same pattern during the winter, summer, and fall months with Towanda and Danville having similar yields and Marietta slightly higher. The smallest TP yield in 2001 occurred at Lewisburg during winter, spring, and summer. Newport showed the lowest TP yield values during the fall. Conestoga had the highest TP yields for all sites during all seasons.

Long-term SS yields in the Susquehanna River generally decreased in the downstream order with the summer at Marietta as the exception. SS yields among the tributary sites were smallest at Newport in the winter and fall, and at Lewisburg during spring and summer. The 2001 seasonal SS yields did not show any consistent relationships among the sites.

COMPARISON OF THE 2001 LOADS AND YIELDS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND SUSPENDED SEDIMENT WITH THE BASELINES

Several studies, Ott and others (1991), Takita and Edwards (1993), and Takita (1998), have shown that annual loads of TN, TP, and SS change with annual fluctuations in water discharge. 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 2001 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.

Susquehanna River at Towanda, Pa.

The 5-year baselines for TN, TP, and SS for the Susquehanna River at Towanda are shown in Figure 16 with the 2001 annual yield. 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

The 2001 TN yield plotted below the 5-year baseline suggesting that the TN load decreased. The TN yield was estimated to be 4.47 lb/ac/yr at a water-discharge ratio of 0.7278 for the initial five years of monitoring, while the yield for 2001 was 3.7 lb/ac/yr at the same discharge ratio. The TP load increased in 2001. The baseline TP yield was 0.22 lb/ac/yr, compared to 0.36 lb/ac/yr for 2001. The SS yields in Figure 16 indicate that there was an increase in yields for 2001. The baseline yield was 55.3 lb/ac/yr, and the yield for 2001 was 261.96 lb/ac/yr.

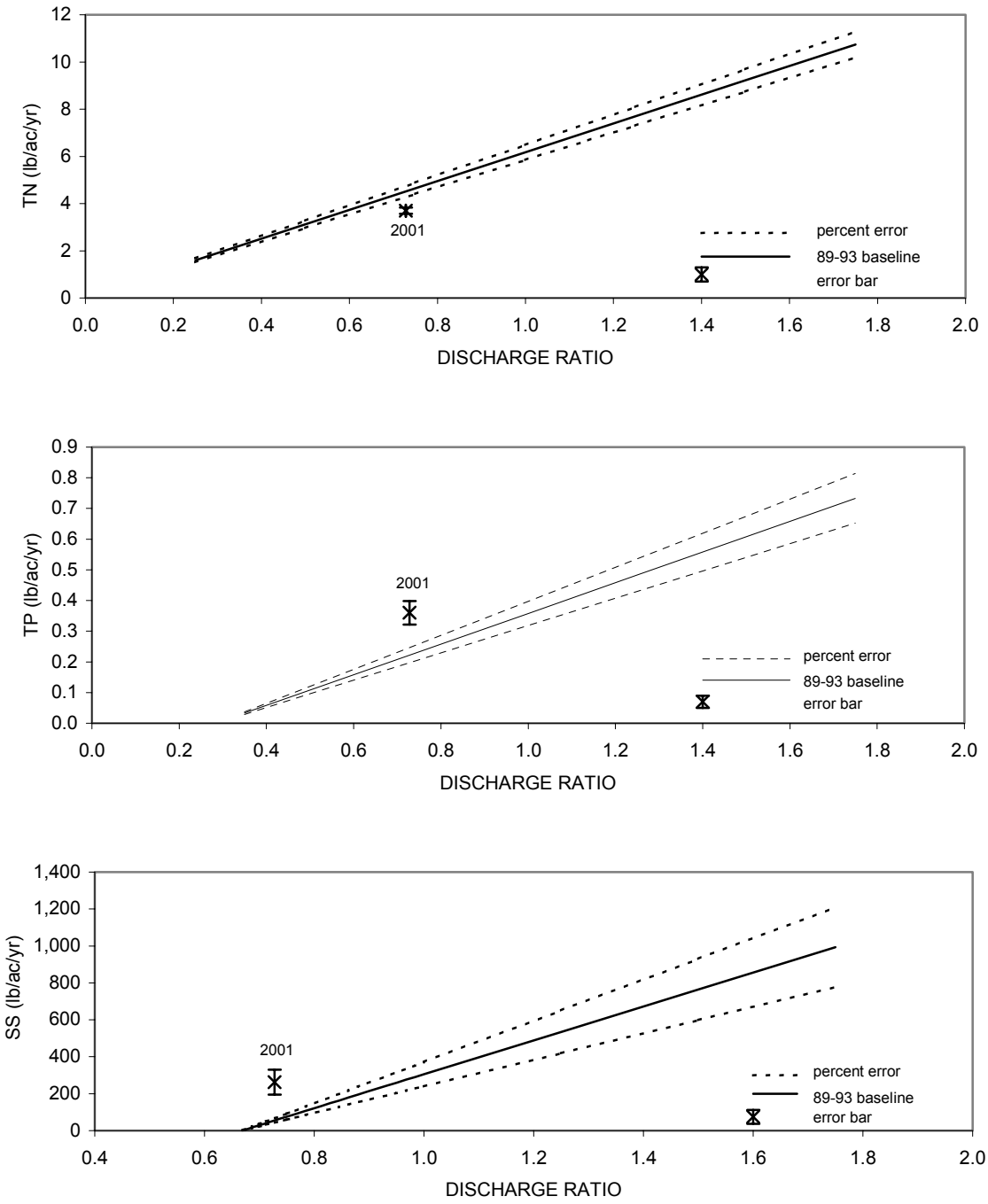


Figure 16. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Towanda, Pa., 1989-93 and 2001

Susquehanna River at Danville, Pa.

Figure 17 shows the 5-year (1985-89) baselines for TN, TP, and SS and the 2001 yields for the Susquehanna River at Danville. 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 $R^2 = 0.99$

TN yields for 2001 plotted below the baseline, indicating that there was a decrease in the loads. TP and SS for 2001 had no significant change from the baseline. The baseline TN yield was 5.13 lb/ac/yr at the water-discharge ratio of 0.7269, compared to 4.0 lb/ac/yr for 2001. The baseline yields of TP and SS were 0.33 and 155.0 lb/ac/yr compared to 0.32 and 159.72 lb/ac/yr for 2001, respectively.

West Branch Susquehanna River at Lewisburg, Pa.

The 1985-89 baselines and the 2001 yields for TN, TP, and SS are shown in Figure 18. 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 $R^2 = 0.66$

TN for 2001 plotted slightly below the baseline, indicating that the nitrogen load decreased. The baseline TN yield was 3.50 lb/ac/yr at the water-discharge ratio of 0.6244, compared to 3.01 lb/ac/yr for 2001. The TP yield was 0.20 lb/ac/yr for the baseline and 0.21 lb/ac/yr for 2001. SS data suggested that there was a decrease in 2001, but this decrease may not be significant since the margins of error overlap. The baseline yield was 62.0 lb/ac/yr, and the 2001 yield was 57.8 lb/ac/yr.

Juniata River at Newport, Pa.

The 1985-89 baselines and 2001 yields for TN, TP, and SS at Newport, shown in Figure 19, were plotted using 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 $R^2 = 0.89$

The TN yield for 2001 showed a decrease from the baseline. The TN baseline yield was 4.9 lb/ac/yr at a water-discharge ratio of 0.5805, and the 2001 yield was 3.84 lb/ac/yr. The TP and SS yields increased in 2001. TP yields were 0.22 and 0.31 lb/ac/yr for the baseline and 2001, respectively. The SS yields were 34.1 and 114.5 lb/ac/yr for the baseline and 2001, respectively.

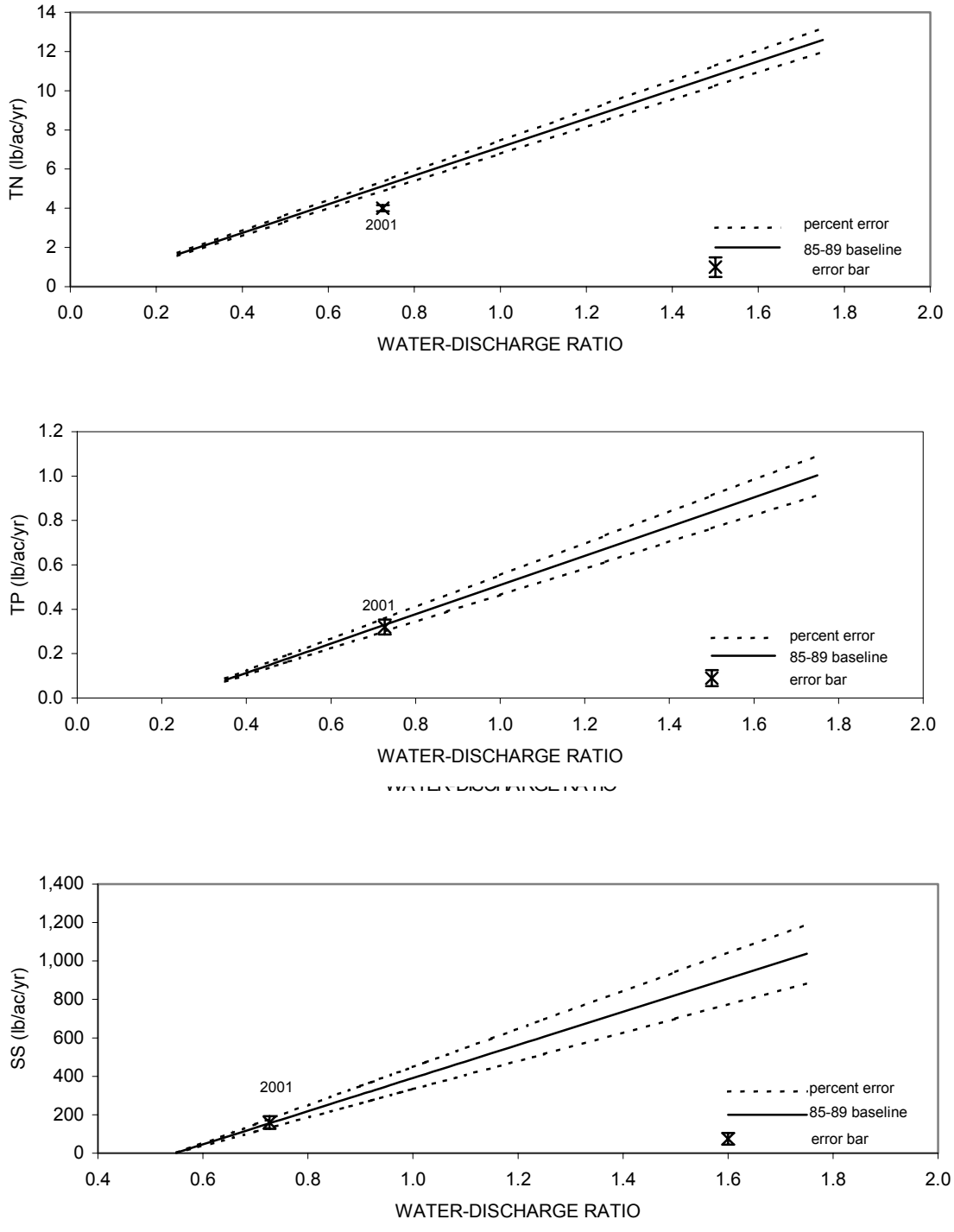


Figure 17. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Danville, Pa., 1985-89 and 2001

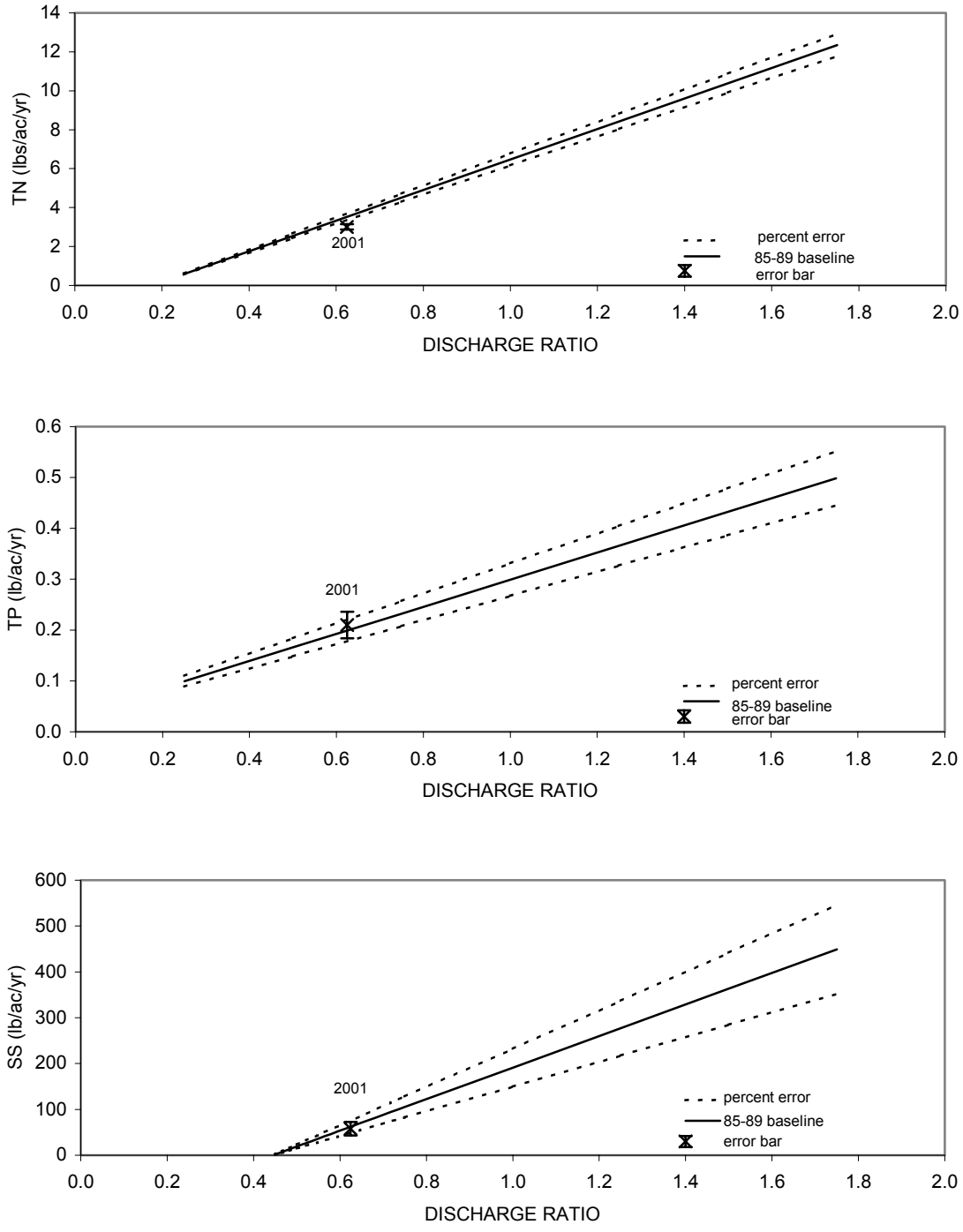


Figure 18. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, West Branch Susquehanna River at Lewisburg, Pa., 1985-89 and 2001

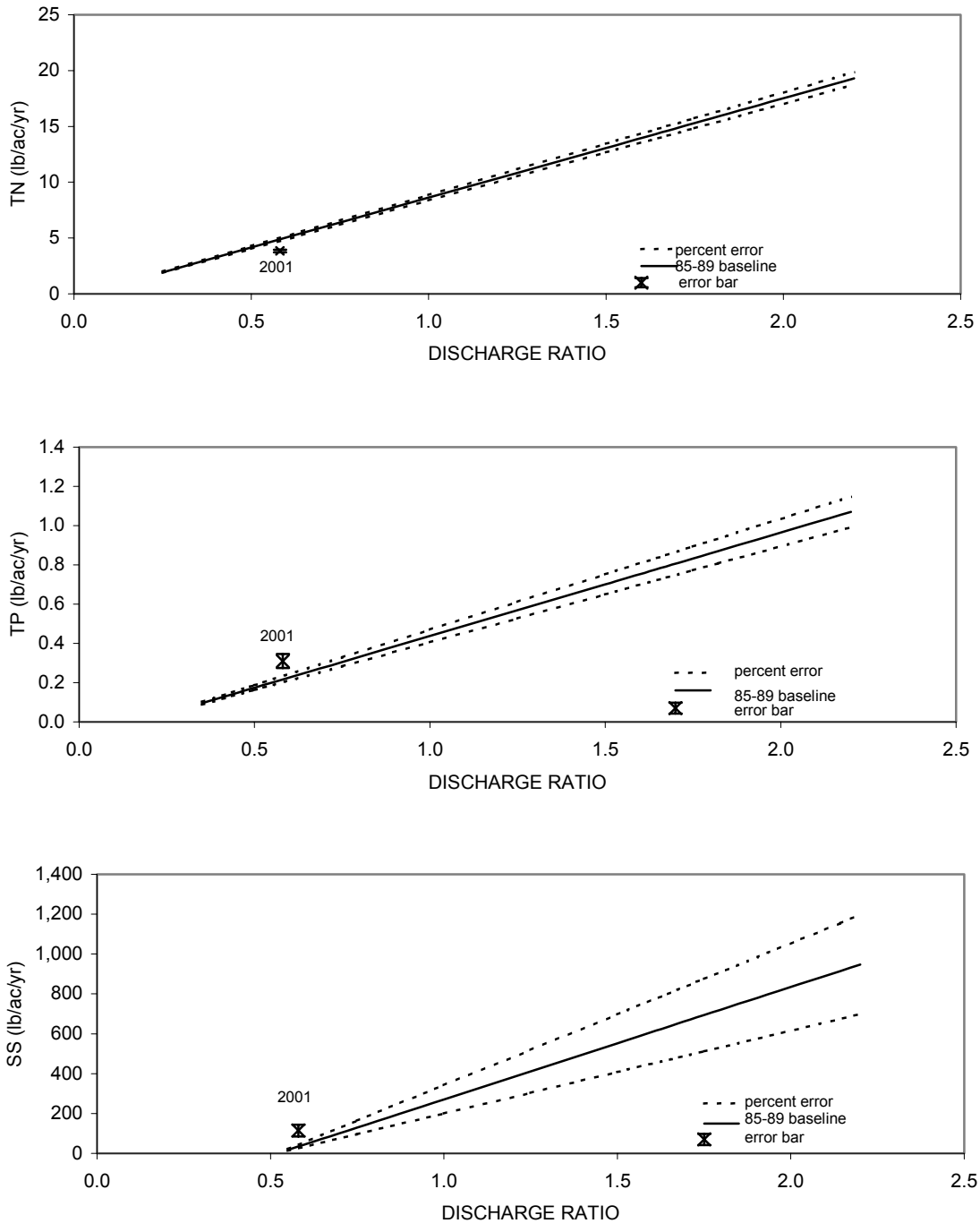


Figure 19. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Juniata River at Newport, Pa., 1985-89 and 2001

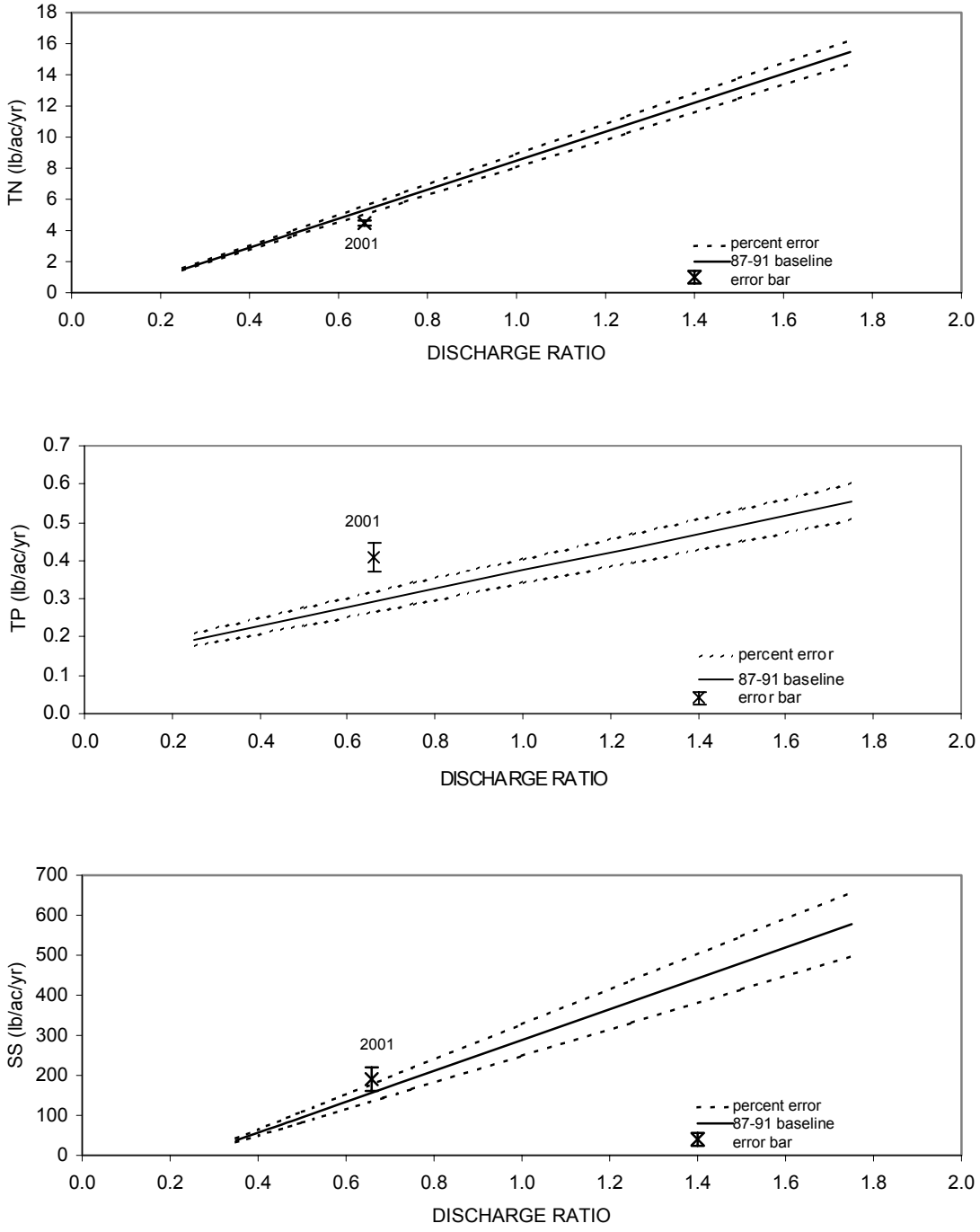


Figure 20. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Susquehanna River at Marietta, Pa., 1985-89 and 2001

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 20. The baselines were plotted using 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 $R^2 = 0.48$

The TN yield for 2001 plotted below the baseline, indicating that there was a decrease in the load. The TN baseline yield was 5.32 lb/ac/yr at a water-discharge ratio of 0.6582, and the 2001 yield was 4.48. The TP data showed increases in the 2001 loads. The TP baseline yield was 0.29 lb/ac/yr, compared to 0.41 lb/ac/yr for 2001. The SS baseline yield was 156.2 lb/ac/yr, compared to 190.66 lb/ac/yr in 2001.

Conestoga River at Conestoga, Pa.

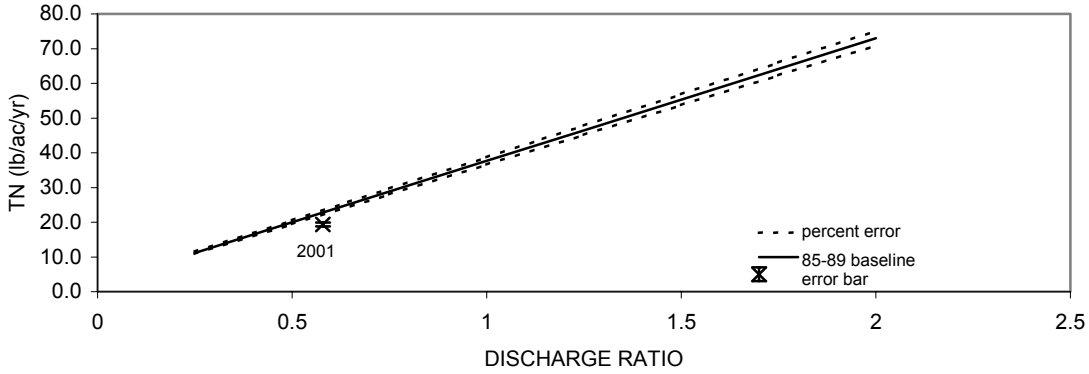
Figure 21 shows the TN, TP, and SS baselines. These baselines were plotted using the following equations:

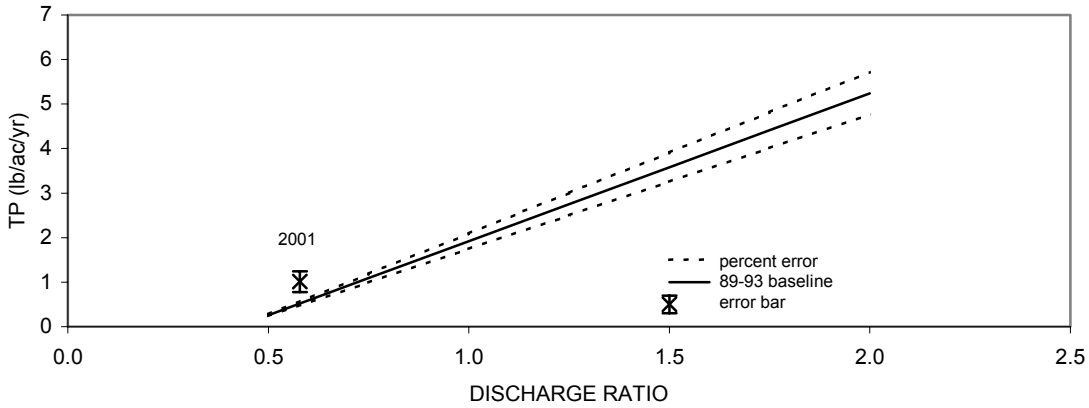
Total Nitrogen (TN)
TN Yield = 2.3343 + 35.3217x $R^2 = 0.97$

Total Phosphorus (TP)
TP Yield = -1.4013 + 3.3216x $R^2 = 0.92$

Suspended Sediment (SS)
SS Yield = -617.301 + 1978.075x $R^2 = 0.72$

The 2001 TN yield showed a decrease from the baseline yields. The baseline and 2001 yields of TN were 22.78 and 19.38 lb/ac/yr, respectively, at a water-discharge ratio of 0.5789. The TP yield increased in 2001. The baseline yield was 0.55 lb/ac/yr, and the 2001 yield was 1.01 lb/ac/yr. The baseline and 2001 yields of SS were 527.762 and 286.09 lb/ac/yr, respectively. This may not indicate an increase in SS transport as the error bars overlap.





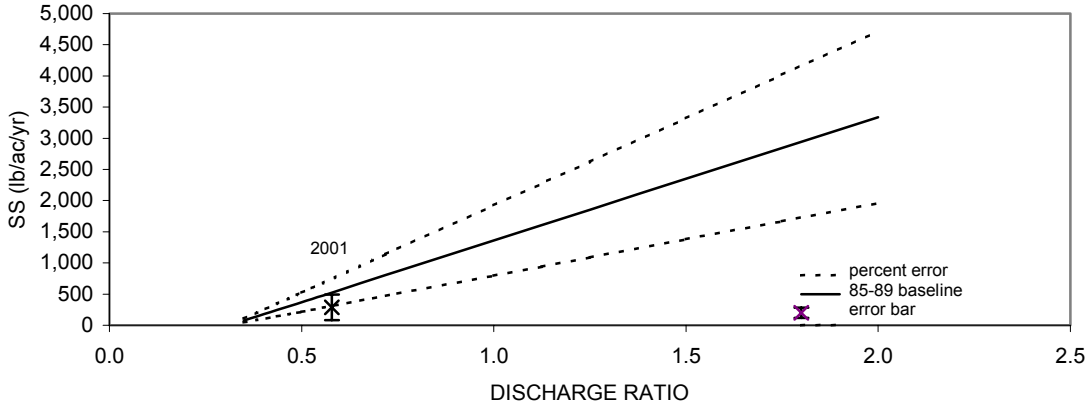


Figure 21. Total Nitrogen (TN), Total Phosphorus (TP), and Suspended-Sediment (SS) Yields, Conestoga River at Conestoga, Pa., 1985-89 and 2001