Appendix 20. Weighted Regressions on Time, Discharge, and Season Model Evaluation and Trend Analysis Graphical Output for Suspended-Sediment Concentration during January 1, 1999, through December 31, 2019

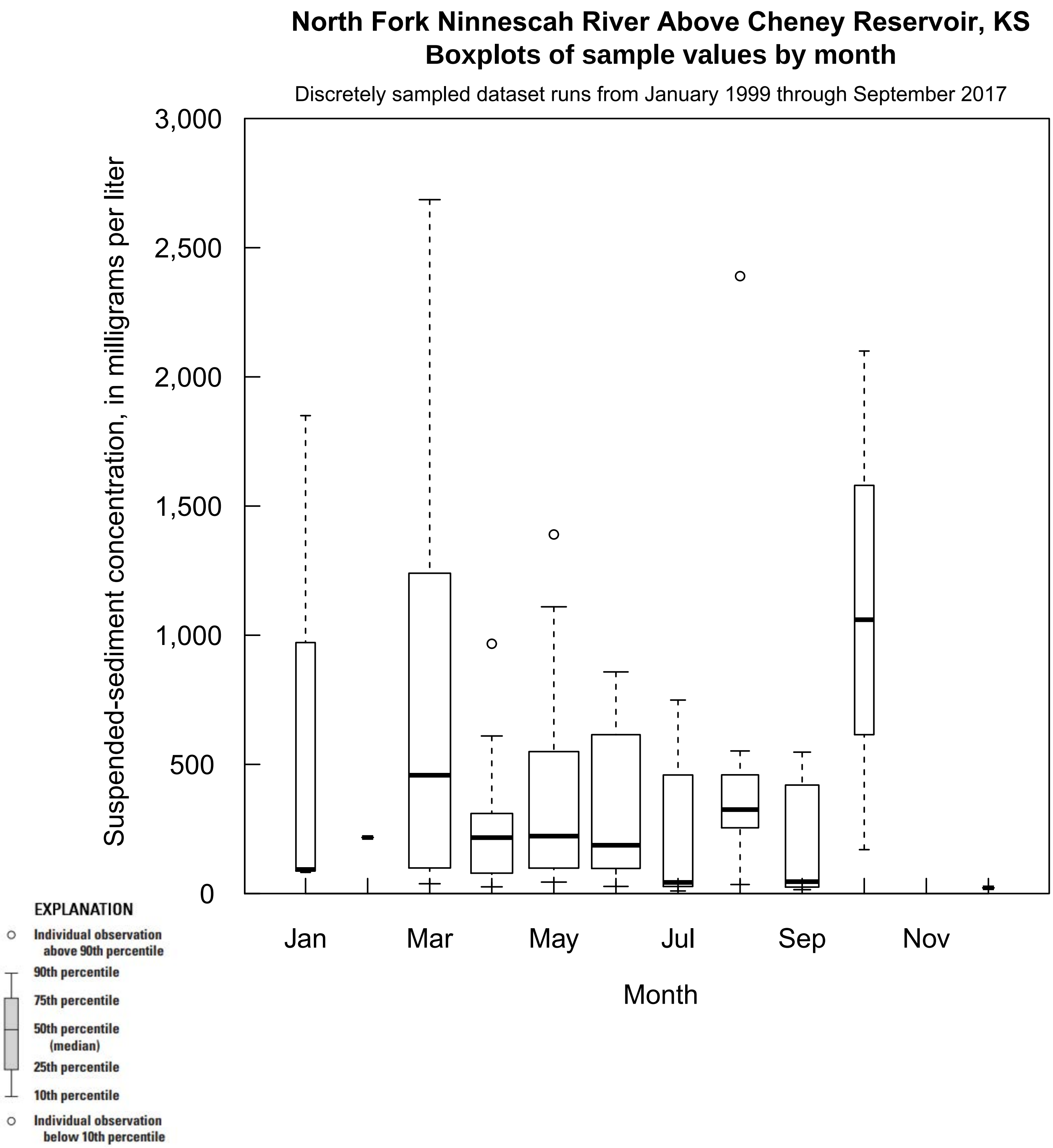
All graphics were produced using R programming language (R Core Team, 2019) and the Exploration and Graphics for RivEr Trends (EGRET) and EGRETci packages. More information on these packages and methods can be found in Hirsch and De Cicco (2015) and Hirsch and others (2015).

Functions used to produce the following outputs are included as text preceding the graphic.

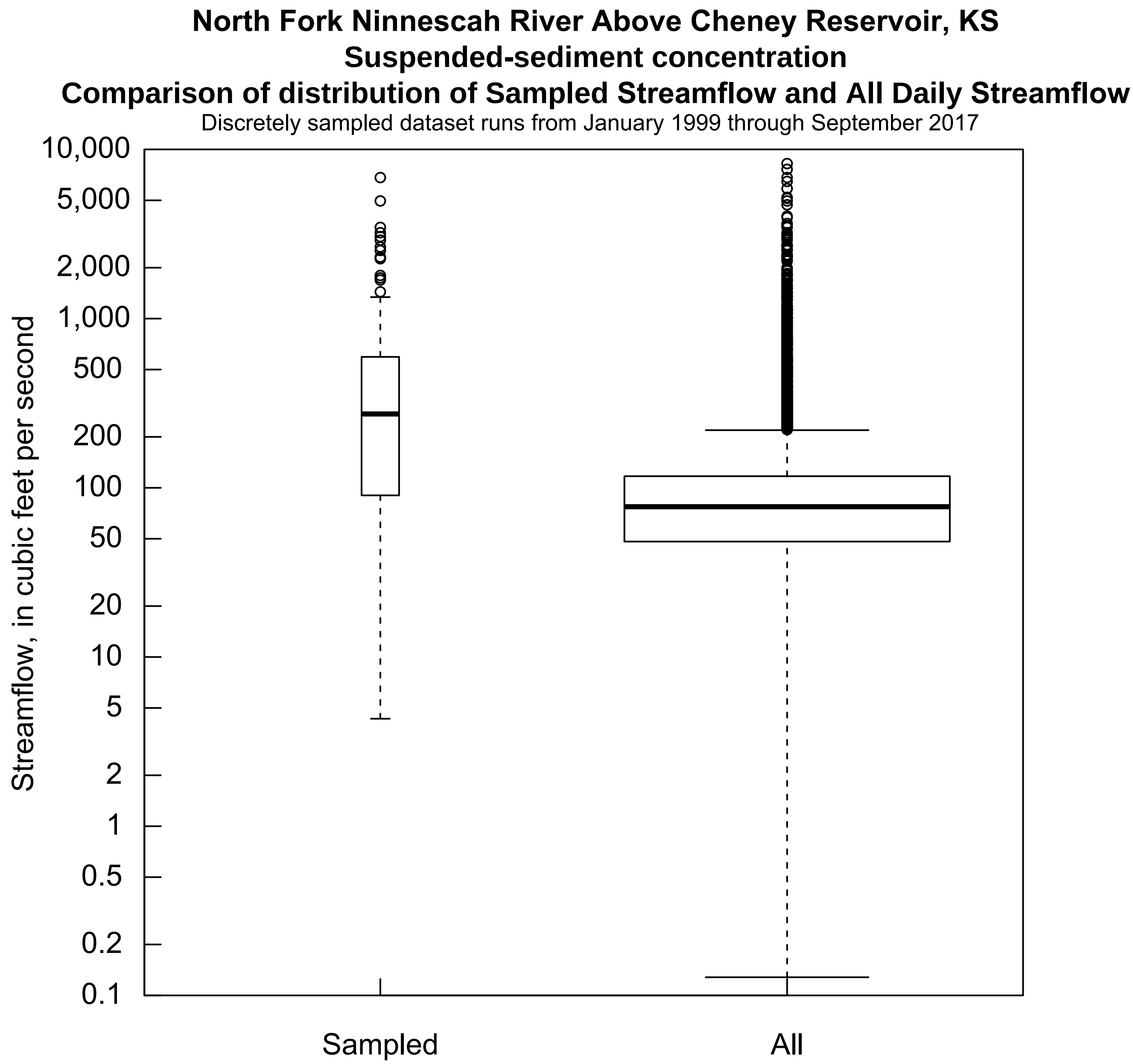
Suspended-sediment Concentration (80154)

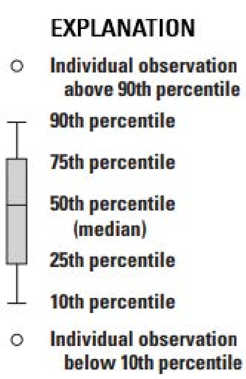
Sample Data

```
boxConcMonth(wrtds)
```

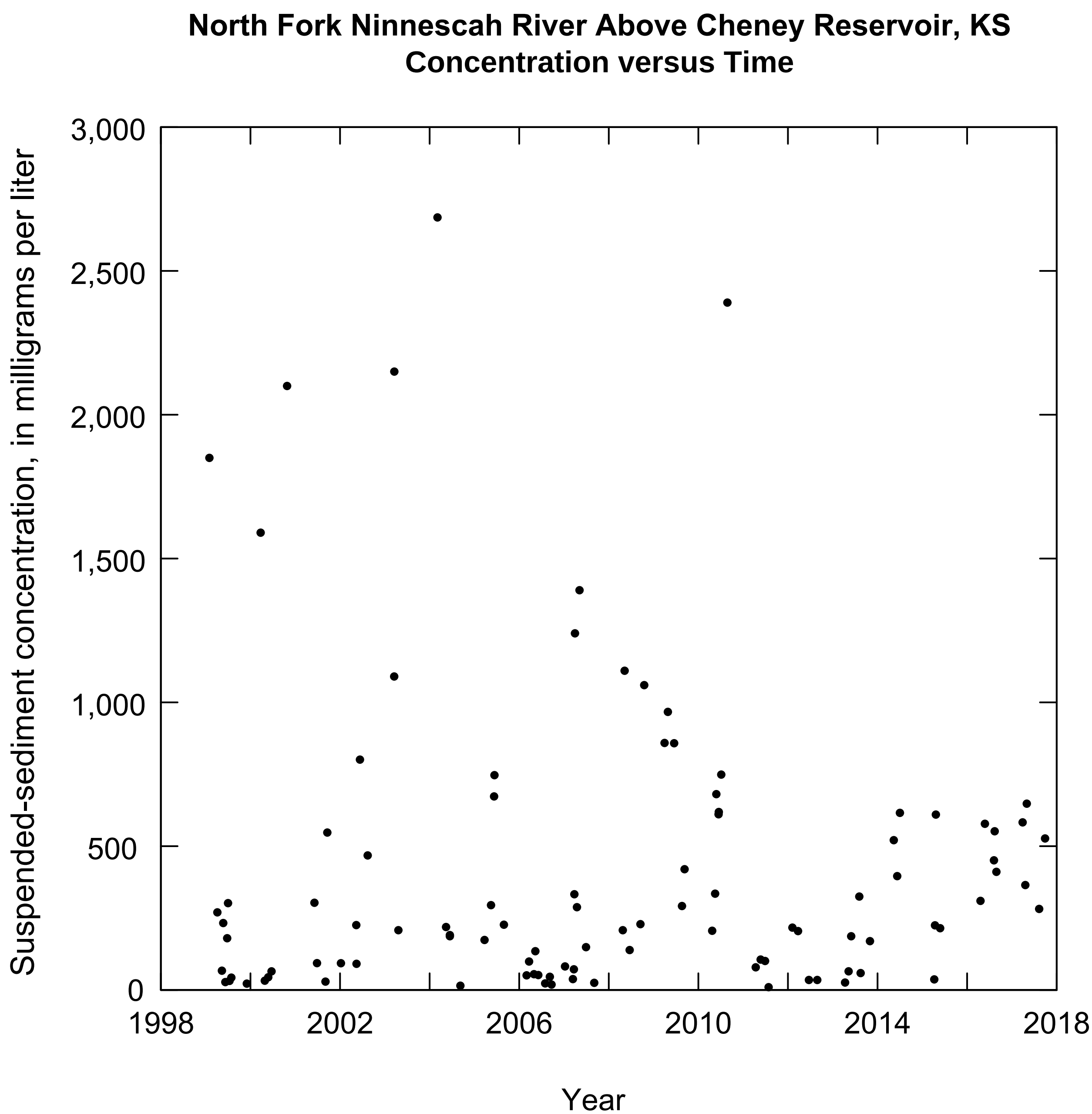


```r
boxQTwice(wrtds, qUnit=1)
```

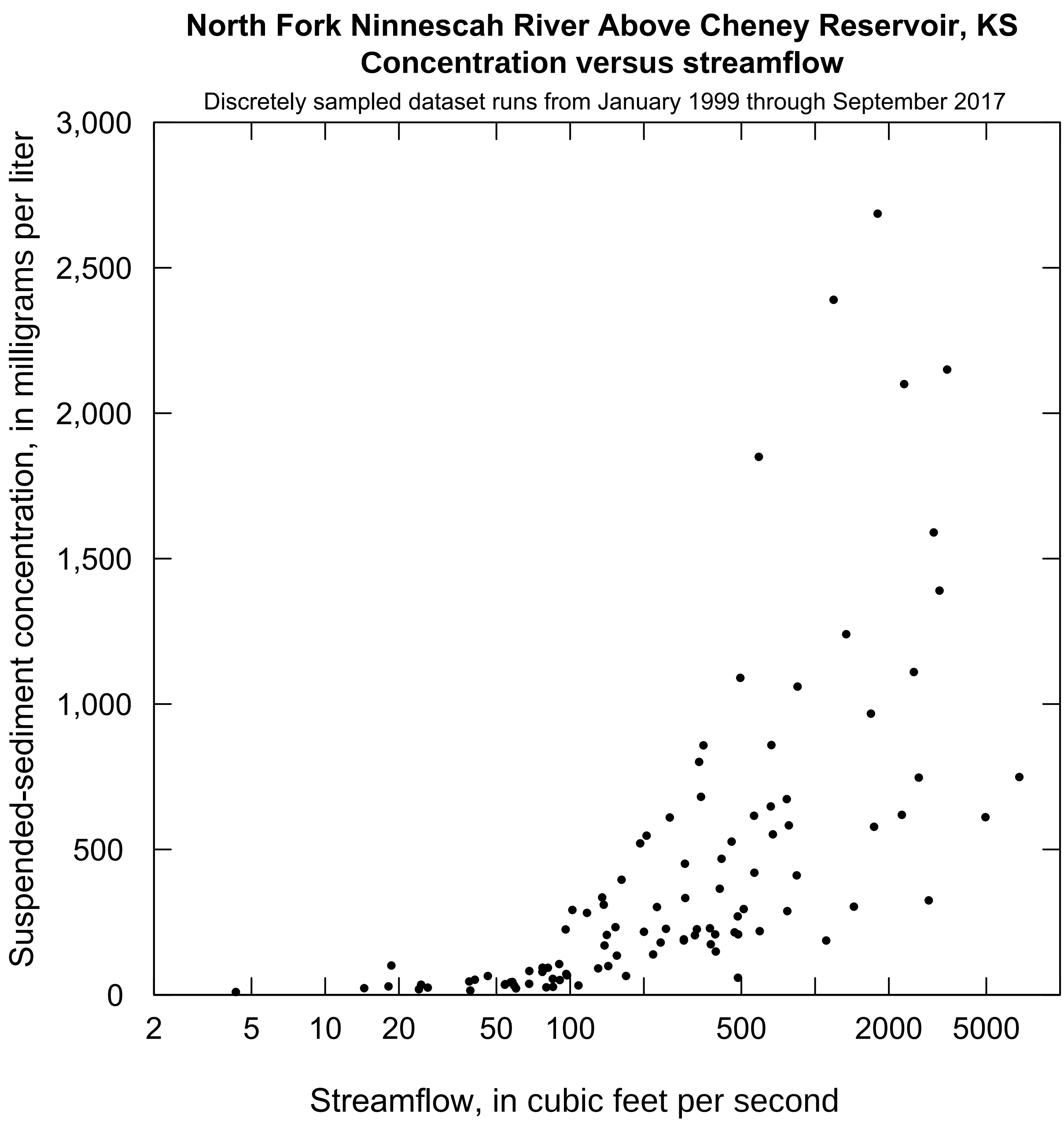




```r
plotConcTime(wrtds)
```



```r
plotConcQ(wrtds, qUnit=1)
```



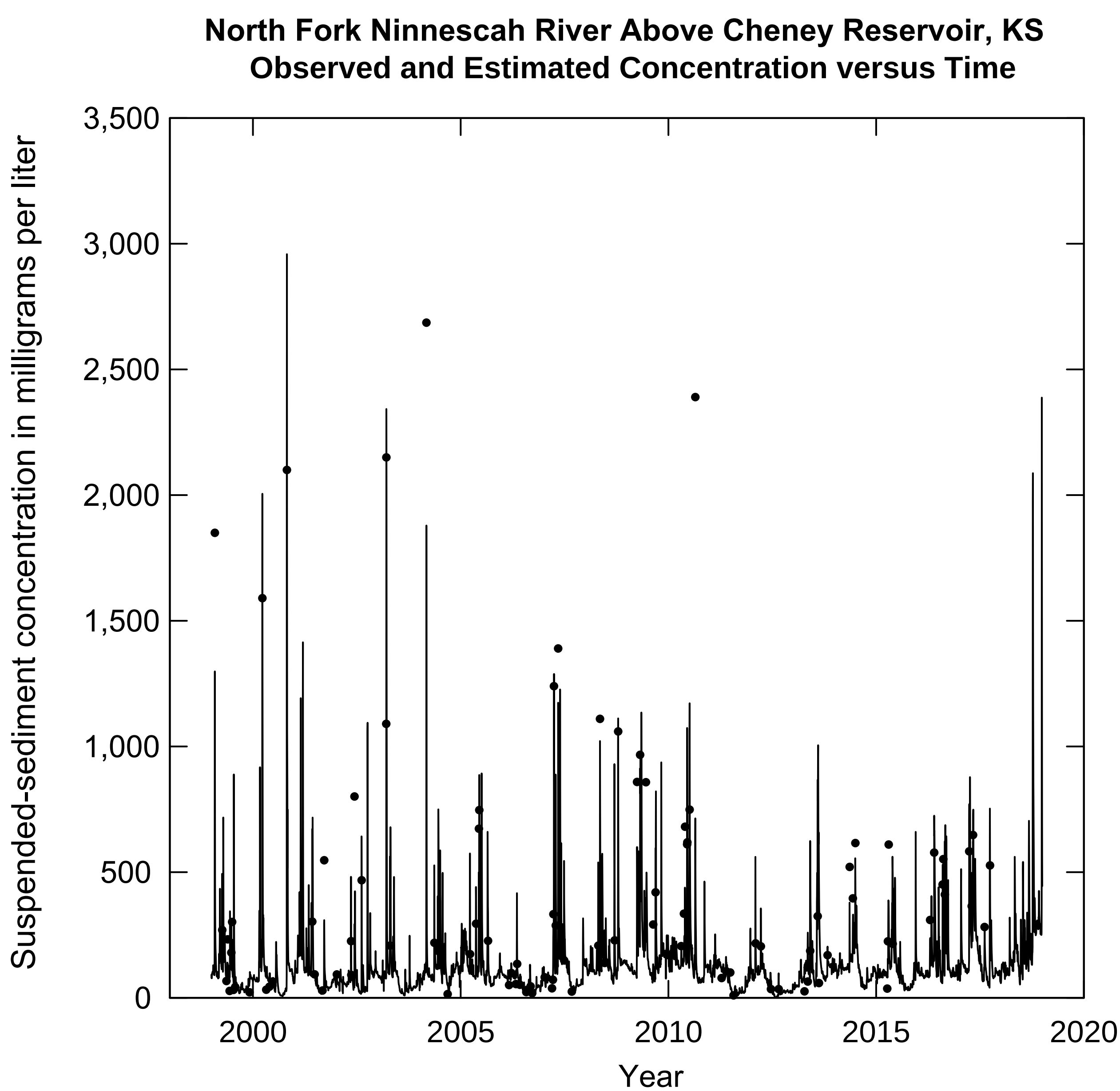
Weighted Regression on Time, Discharge, and Season Model Pesults

```
fluxBiasStat(wrtds$Sample)
```

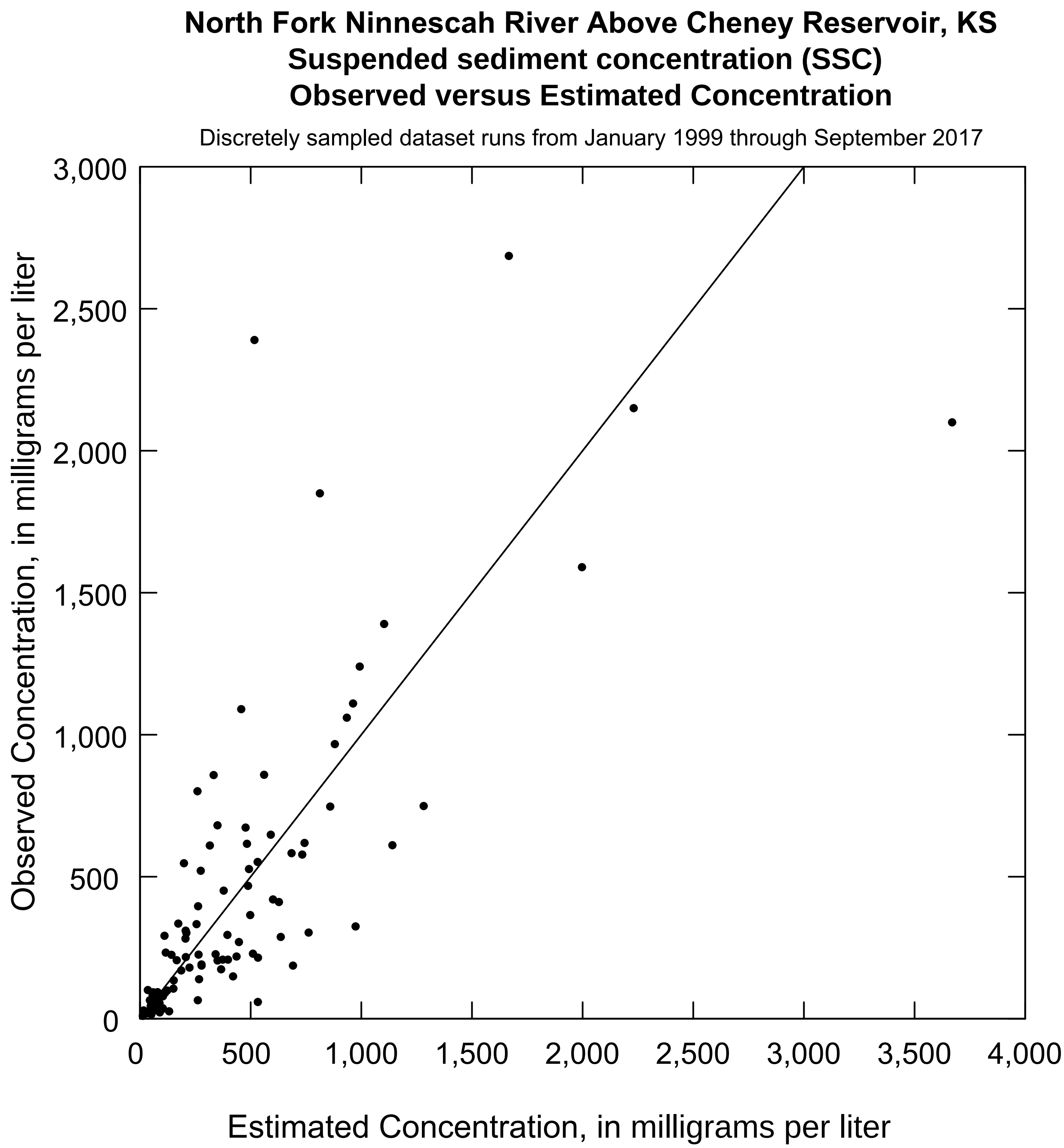
```
##             bias1
## 0.133961762659306
```

The flux bias statistic is (Mean Of Estimated Flux - Mean Of Observed Flux) / Mean Of Observed Flux. The statistic assumes all the censored values are the mean. In Hickman and Hirsch (2017) they used -0.20 to 0.20 as guidance for acceptability of the flux bias statistic.

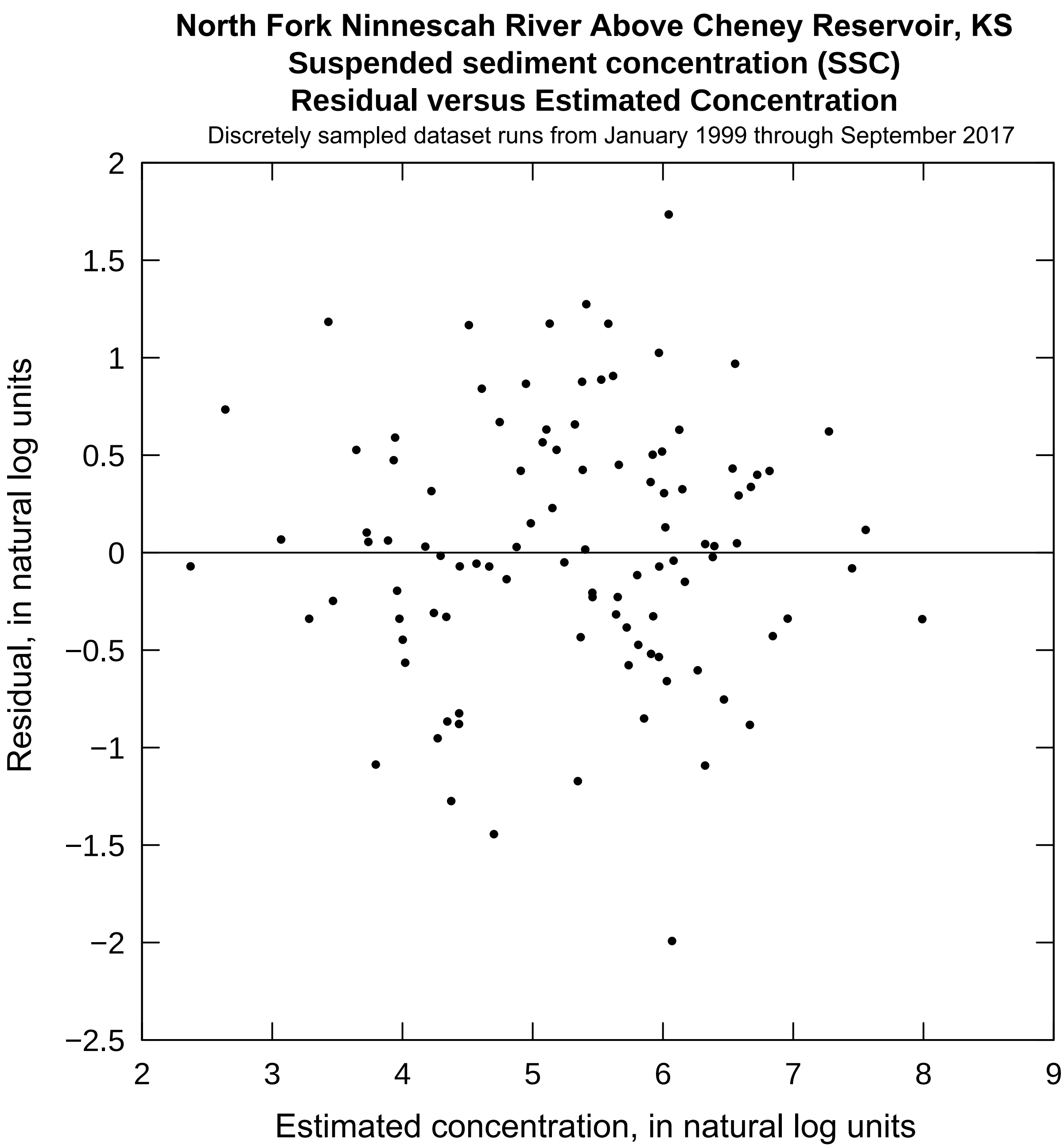
```
plotConcTimeDaily(wrtds)
```



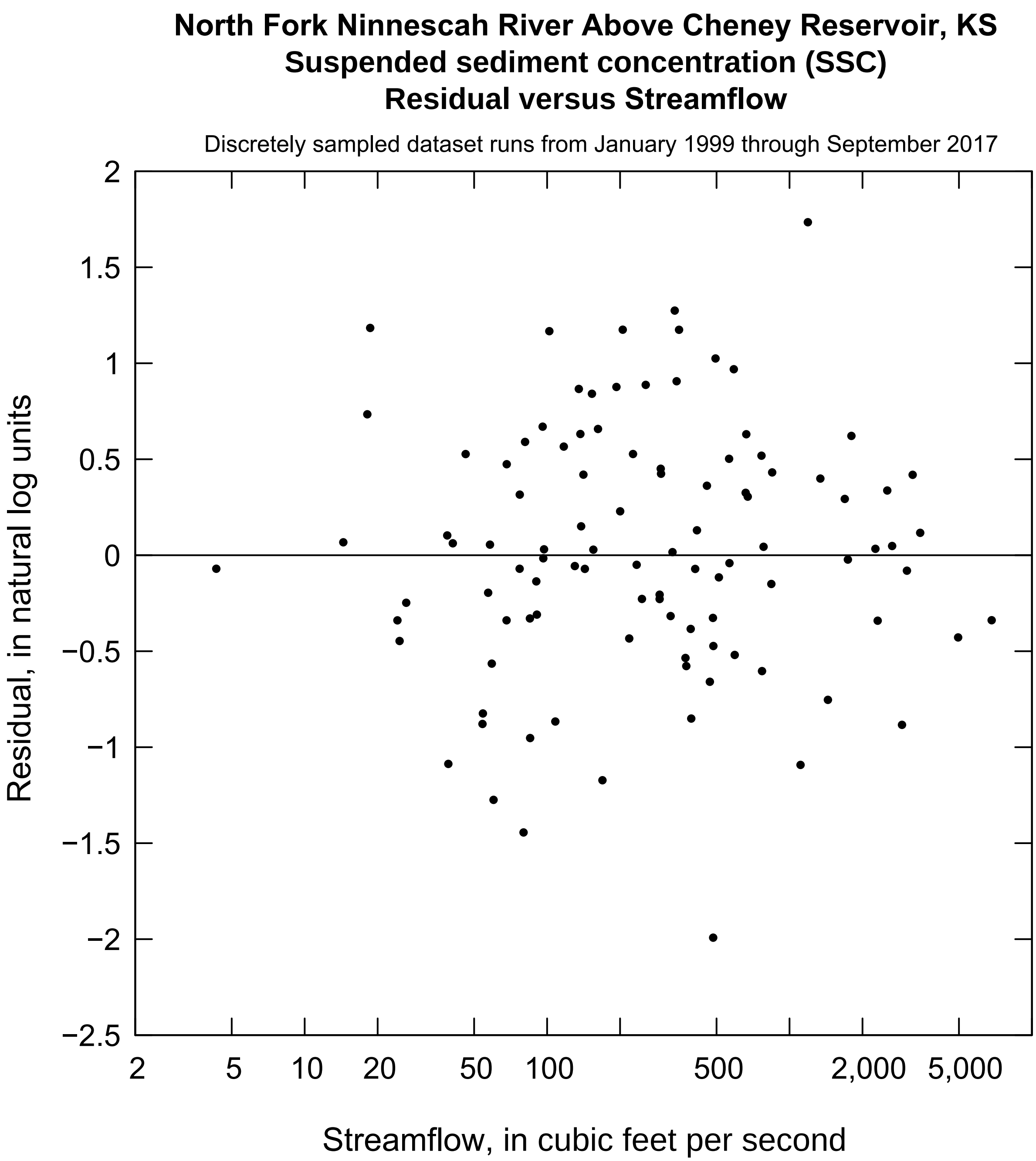
```
plotConcPred(wrtds)
```



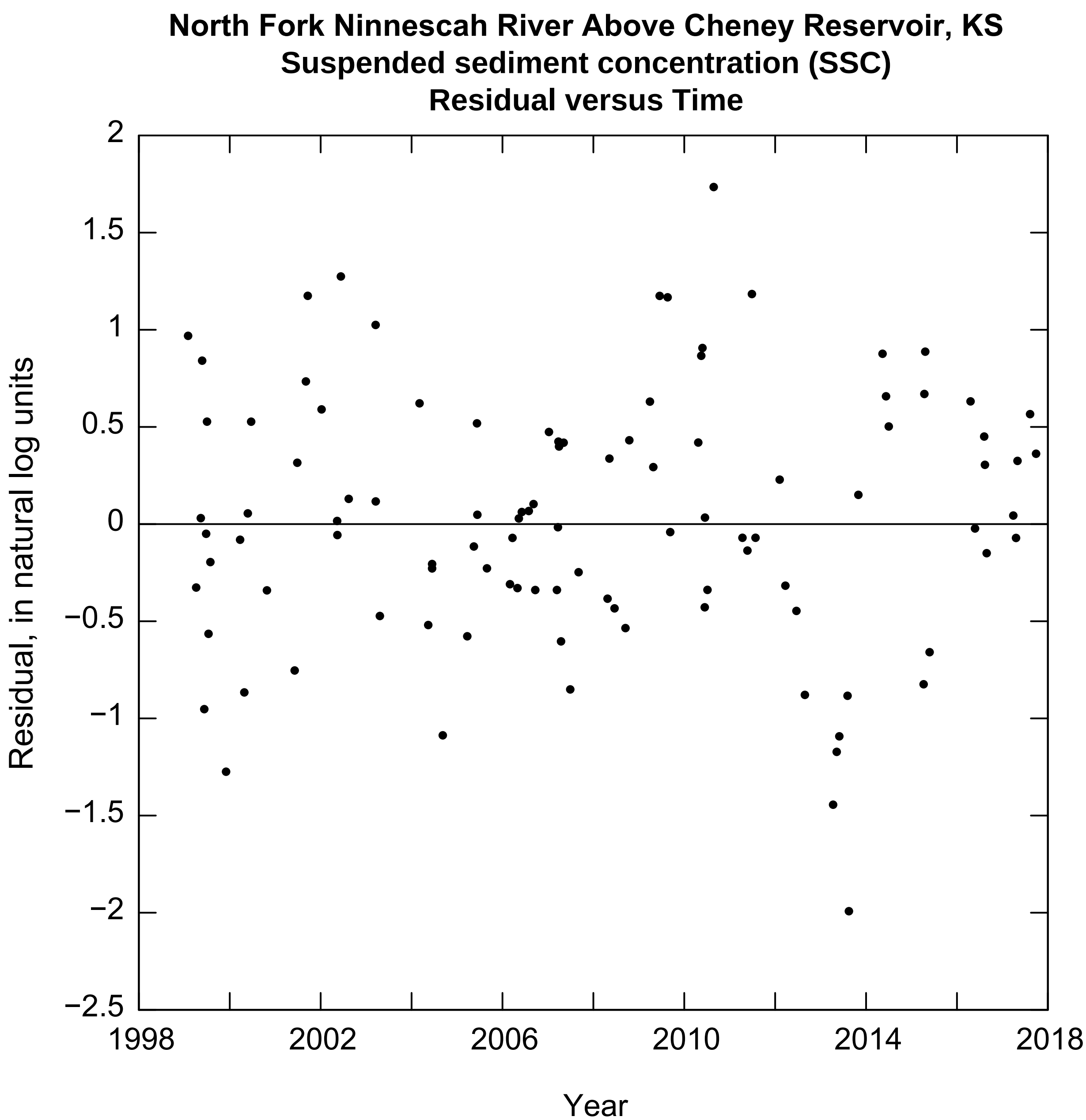
```r
plotResidPred(wzrtds)
```



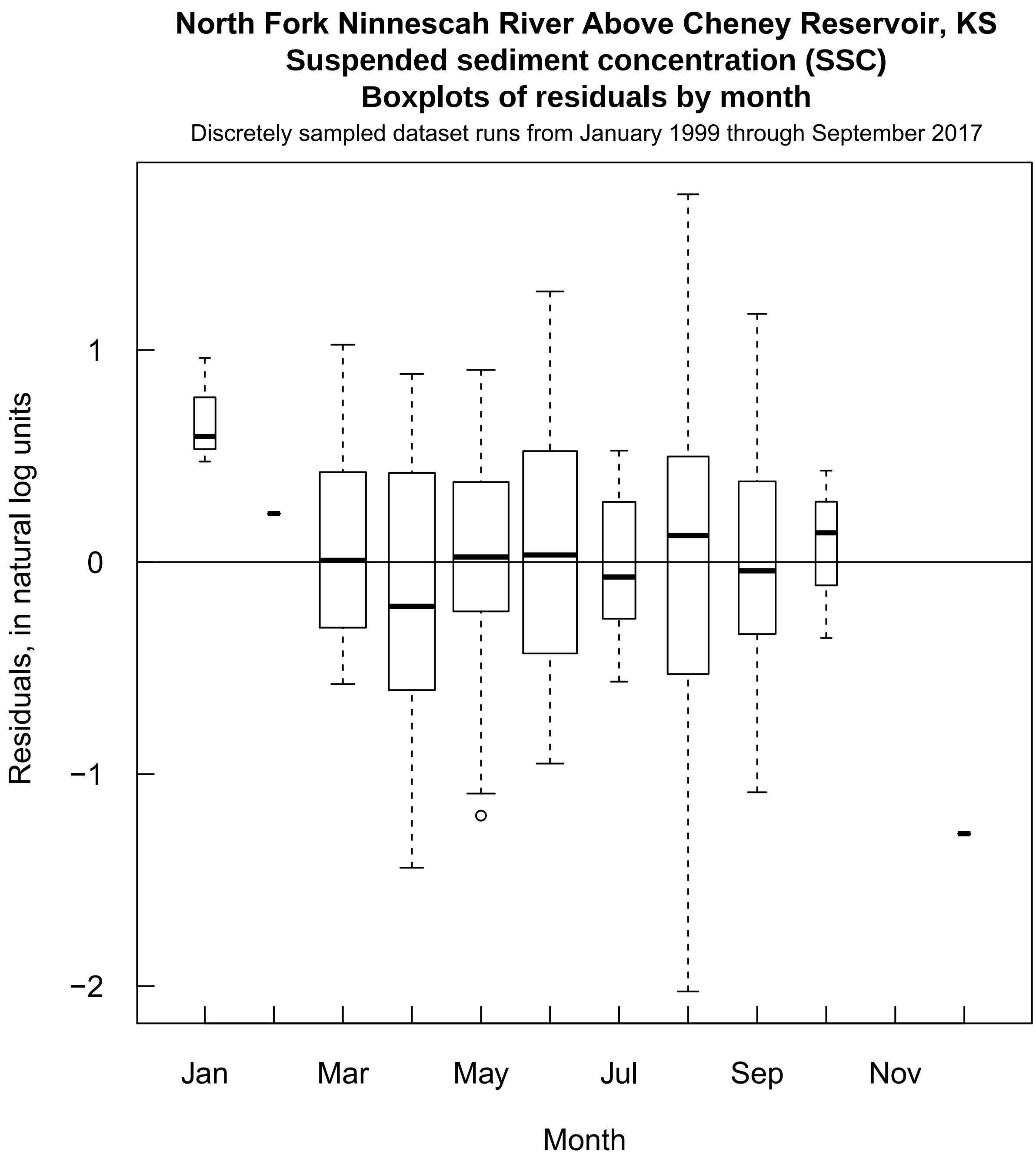
```
plotResidQ(wrtds, qUnit=1)
```

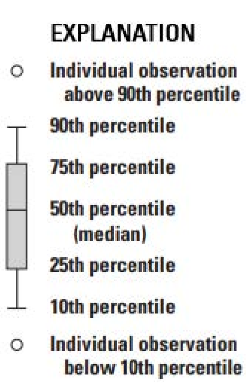


```r
plotResidTime(wrtds)
```

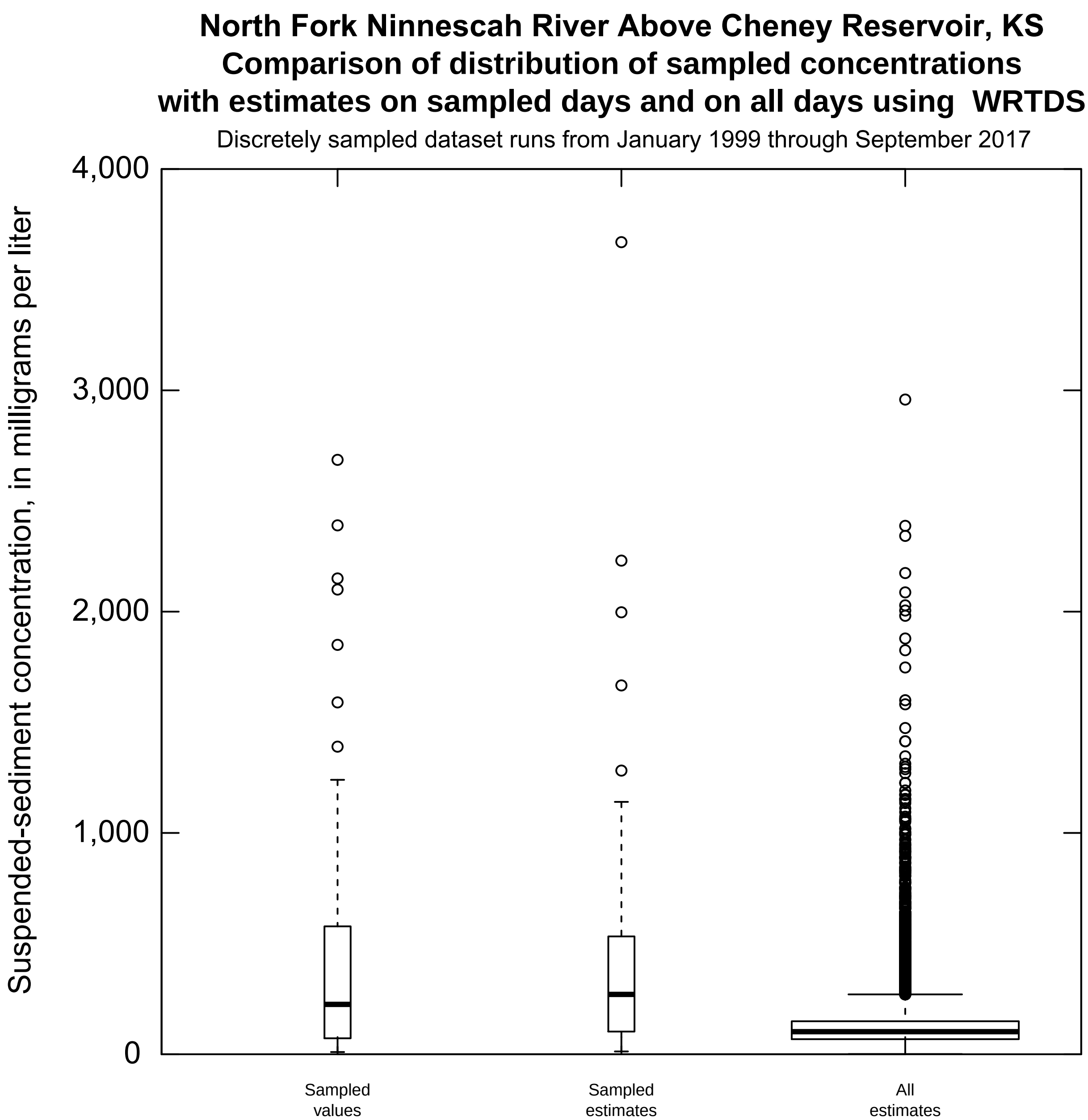


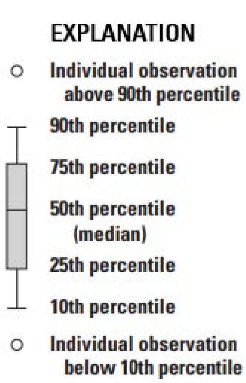
```
boxResidMonth(wrtds)
```



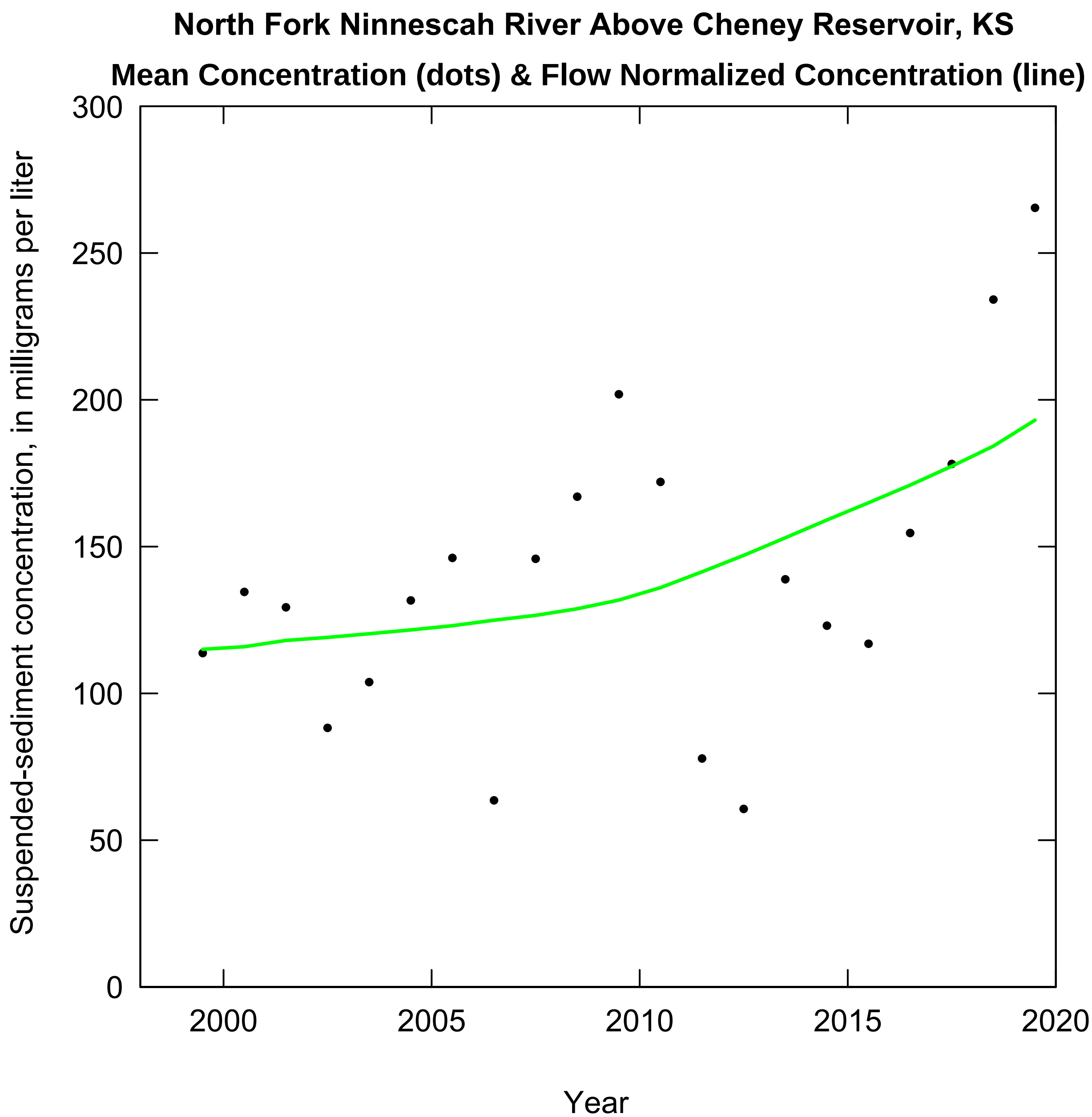


```
boxConcThree(wrtds)
```

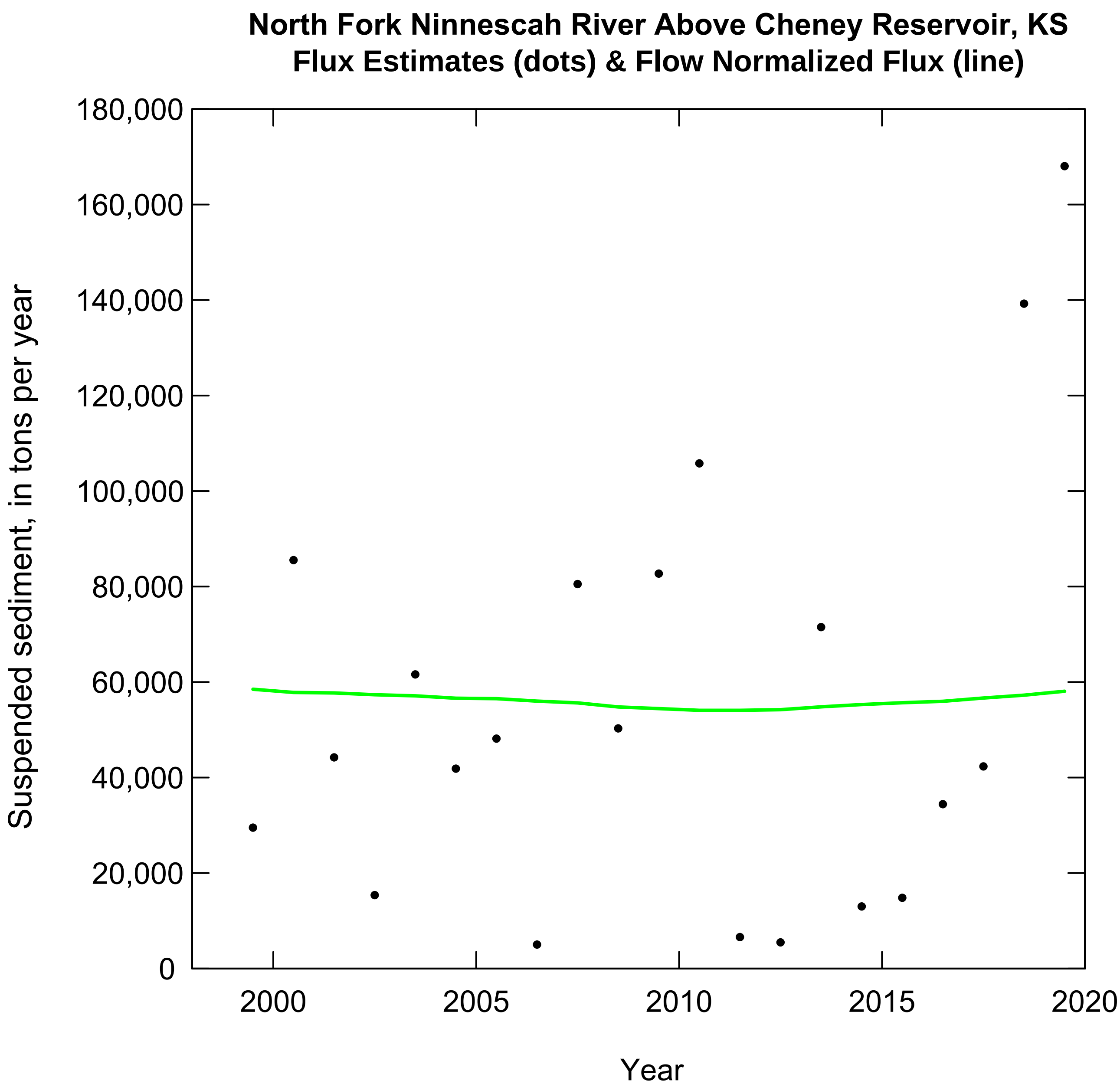




```r
plotConcHist(wrtds)
```



```r
plotFluxHist(wrtds)
```



Trend (using EGRETci)

North Fork Ninnescah River Above Cheney Reservoir, KS   Suspended-sediment concentration (SSC)

Calendar Year

Bootstrap process, for change from calendar Year 1999 to 2017
data set runs from January 1999 to September 2017
Bootstrap block length in days 200
bootBreak is 39 confStop is 0.7

Weighted Regressions on Time, Discharge and Season (WRTDS)
estimated concentration change is   63.9 milligrams per liter (mg/L)

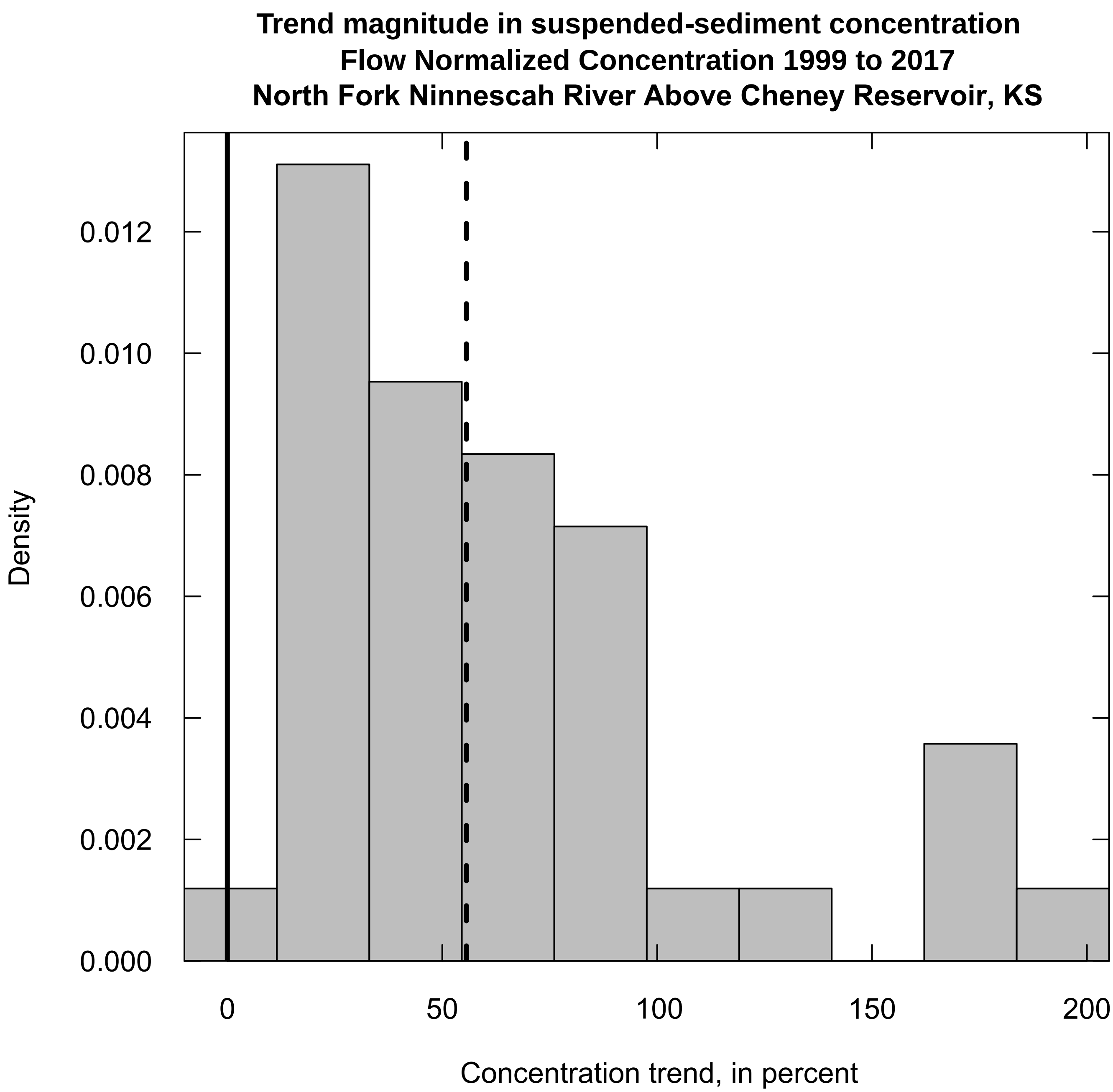
WRTDS estimated flux change is   -2.073 10^6 kilograms per year (kg/yr)

Should we reject Ho that Flow Normalized Concentration Trend = 0 ? Reject Ho
best estimate is   63.9 mg/L
Lower and Upper 90% CIs   26.5   150.6
also 95% CIs   19.7   157.4
and 50% CIs   44.1   88.8
approximate two-sided p-value for Conc   0.05
* Note p-value should be considered to be < stated value
Likelihood that Flow Normalized Concentration is trending up = 0.988 is trending down =   0.0125

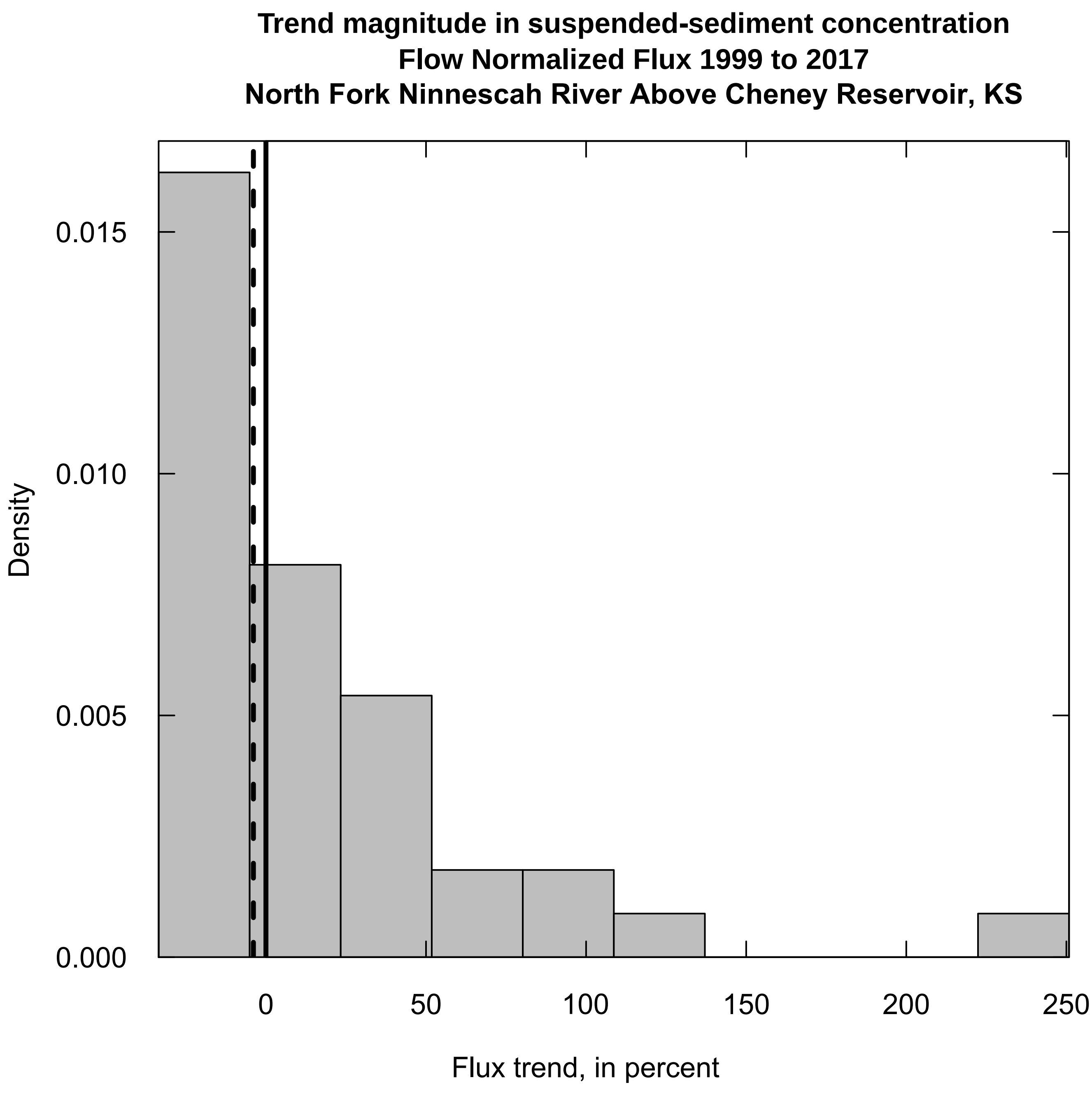
Should we reject Ho that Flow Normalized Flux Trend = 0 ? Do Not Reject Ho
best estimate is   -2.073 10^6 kg/yr
Lower and Upper 90% CIs -21.515   44.920
also 95% CIs -21.734   79.929
and 50% CIs   -8.852   16.406
approximate two-sided p-value for Flux   0.95
Likelihood that Flow Normalized Flux is trending up = 0.463 is trending down= 0.537

Upward trend in concentration is highly likely
Upward trend in flux is about as likely as not
Downward trend in concentration is highly unlikely
Downward trend in flux is about as likely as not

```
par(mar=c(5,6,5,0))
par(mfrow=c(2,1))
plotHistogramTrend(wrtds, eBoot, caseSetUp, flux=FALSE)
plotHistogramTrend(wrtds, eBoot, caseSetUp, flux=TRUE)
```

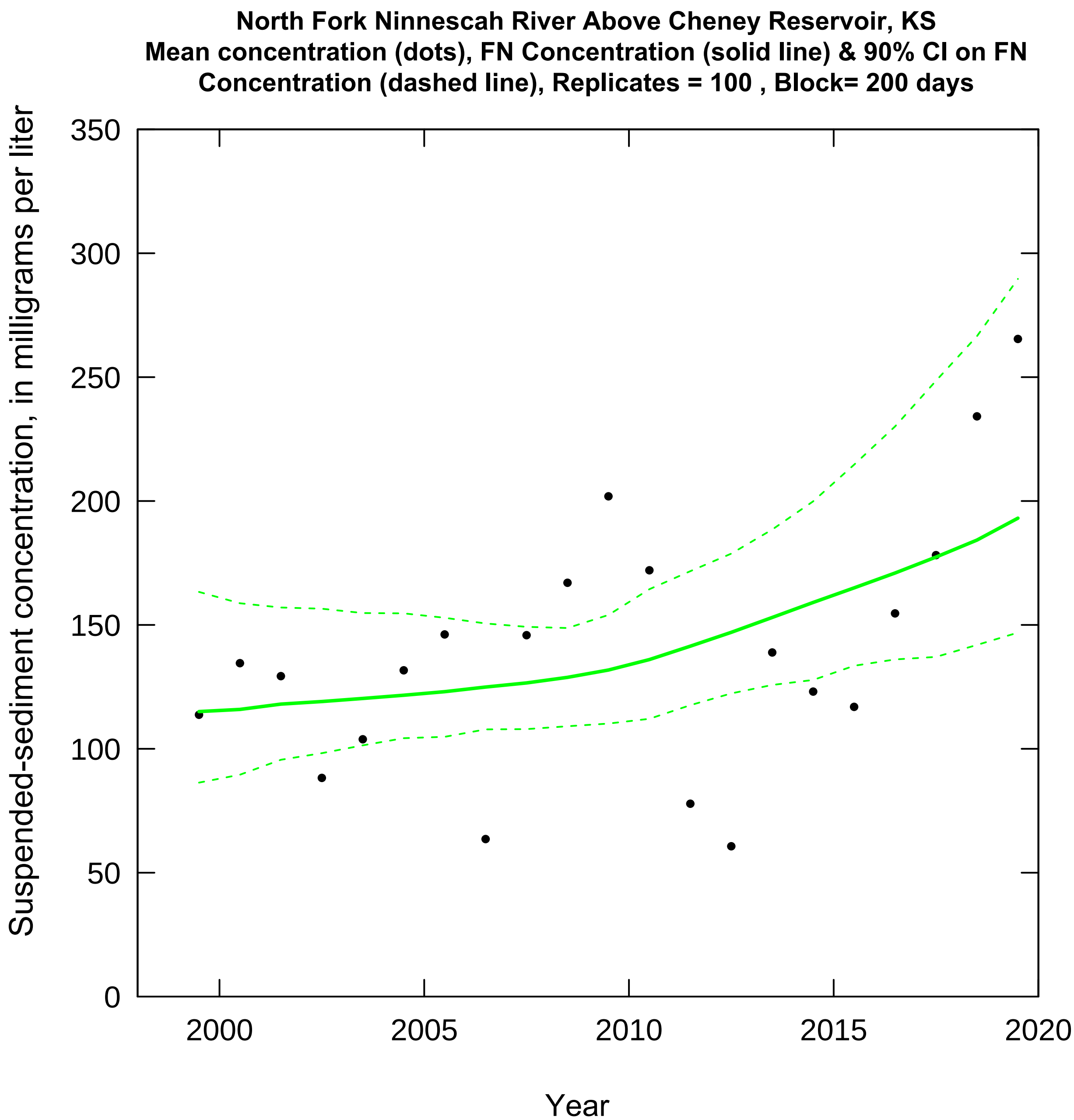


solid line = zero line (no trend)
dashed line = WRTDS trend estimate

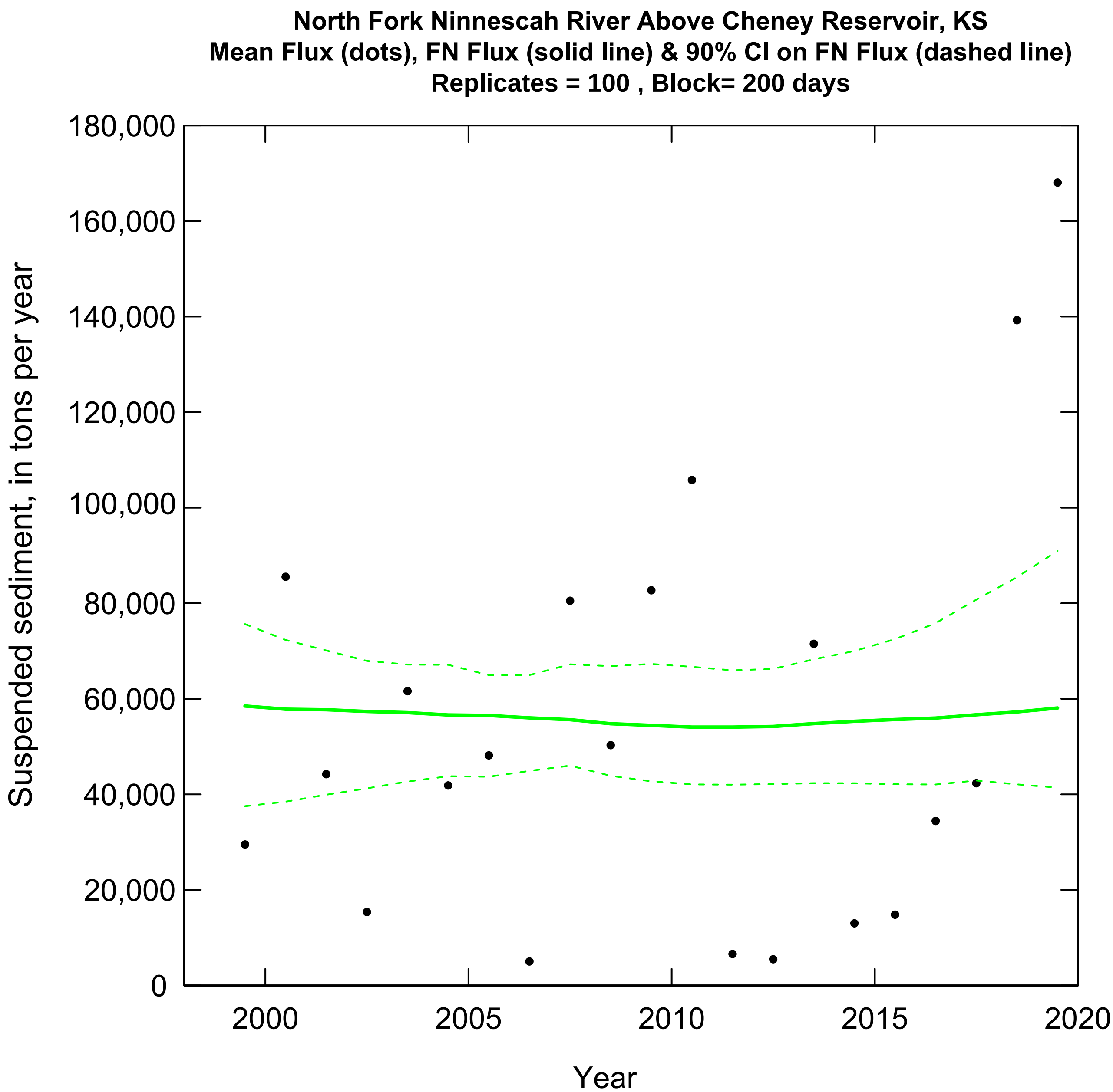


solid line = zero line (no trend)
dashed line = WRTDS trend estimate

```r
par(mfrow=c(2,1))
plotConcHistBoot(wrtds, CIAnnualResults)
plotFluxHistBoot(wrtds, CIAnnualResults)
```



FN = Flow Normalized
CI = Confidence Interval



FN = Flow Normalized
CI = Confidence Interval

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

References Cited

Hickman, R.E., and Hirsch, R.M., 2017, Trends in the quality of water in New Jersey streams, water years 1971–2011: U.S. Geological Survey Scientific Investigations Report 2016–5176, 58 p., accessed July 2020 at https://doi.org/10.3133/sir20165176.

Hirsch, R.M., Archfield, S.A., and De Cicco, L.A., 2015, A bootstrap method for estimating uncertainty of water quality trends: Environmental Modelling & Software, v. 73, p. 148–166. [Also available at https://doi.org/10.1016/j.envsoft.2015.07.017.]

Hirsch, R.M., and De Cicco, L.A., 2015, User guide to Exploration and Graphics for RivEr Trends (EGRET) and dataRetrieval—R packages for hydrologic data (ver. 2.0, February 2015): U.S. Geological Survey Techniques and Methods, book 4, chap. A10, 93 p., accessed July 2020 at https://doi.org/10.3133/tm4A10.

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