Appendix 21. Weighted Regressions on Time, Discharge, and Season Model Evaluation and Trend Analysis Graphical Output for Nitrate plus Nitrite during January 1, 1999, through December 31, 2019

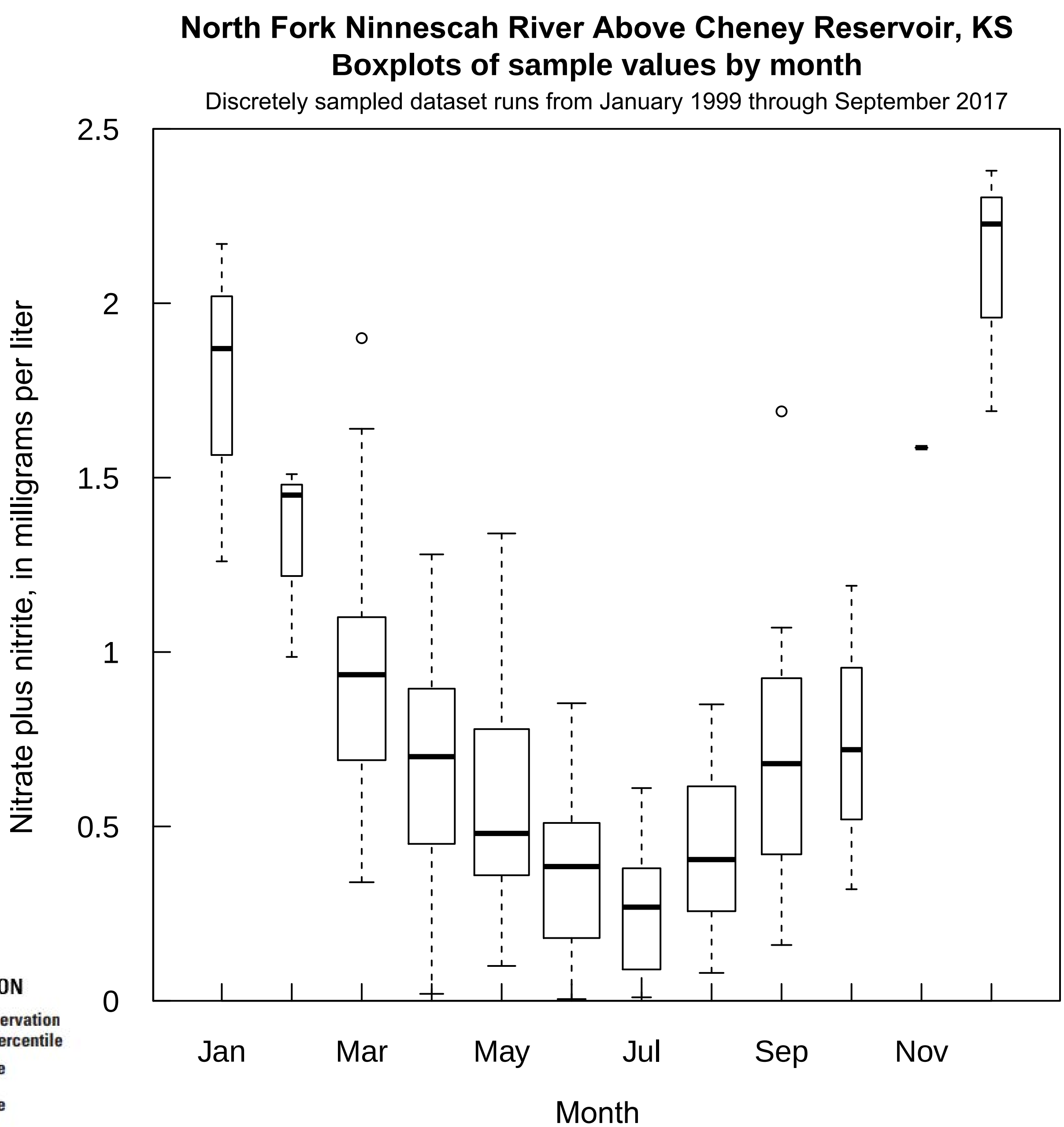
All graphics were produced using R programming language (R Core Team, 2019) and the Exploration and Graphics for RivEr Trends (EGRET) and EGRETci packages. More information on these packages and methods can be found in Hirsch and De Cicco (2015) and Hirsch and others (2015).

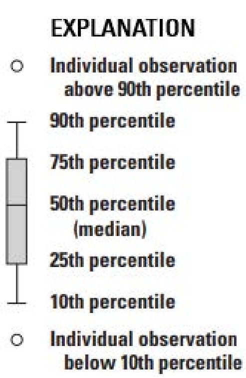
Functions used to produce the following outputs are included as text preceding the graphic.

Nitrate plus Nitrite (00631)

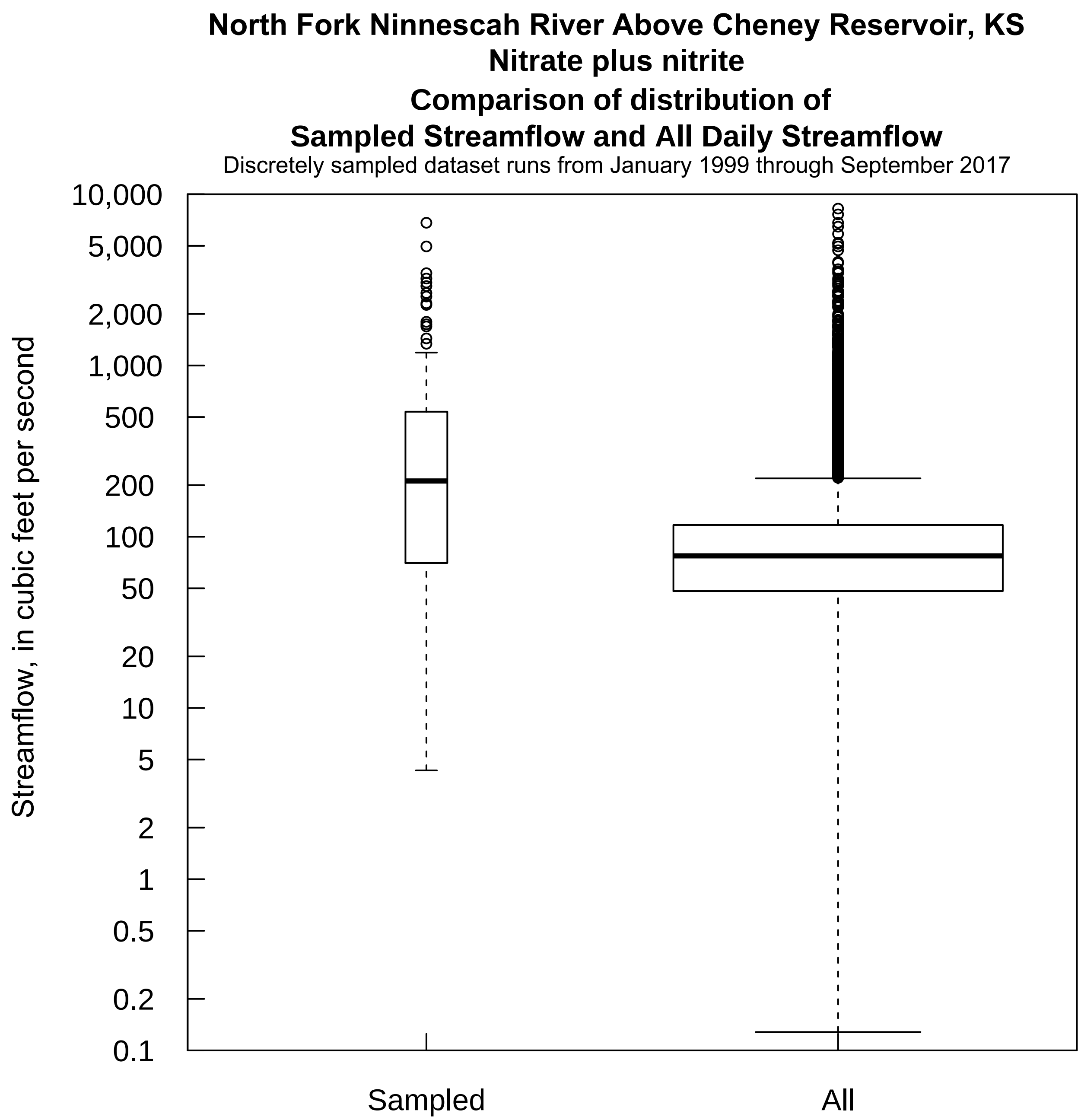
Sample Data

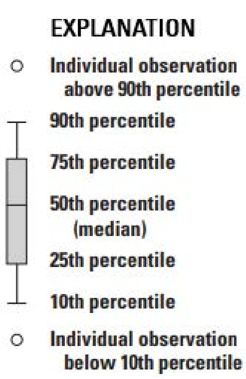
```
boxConcMonth(wrtds)
```



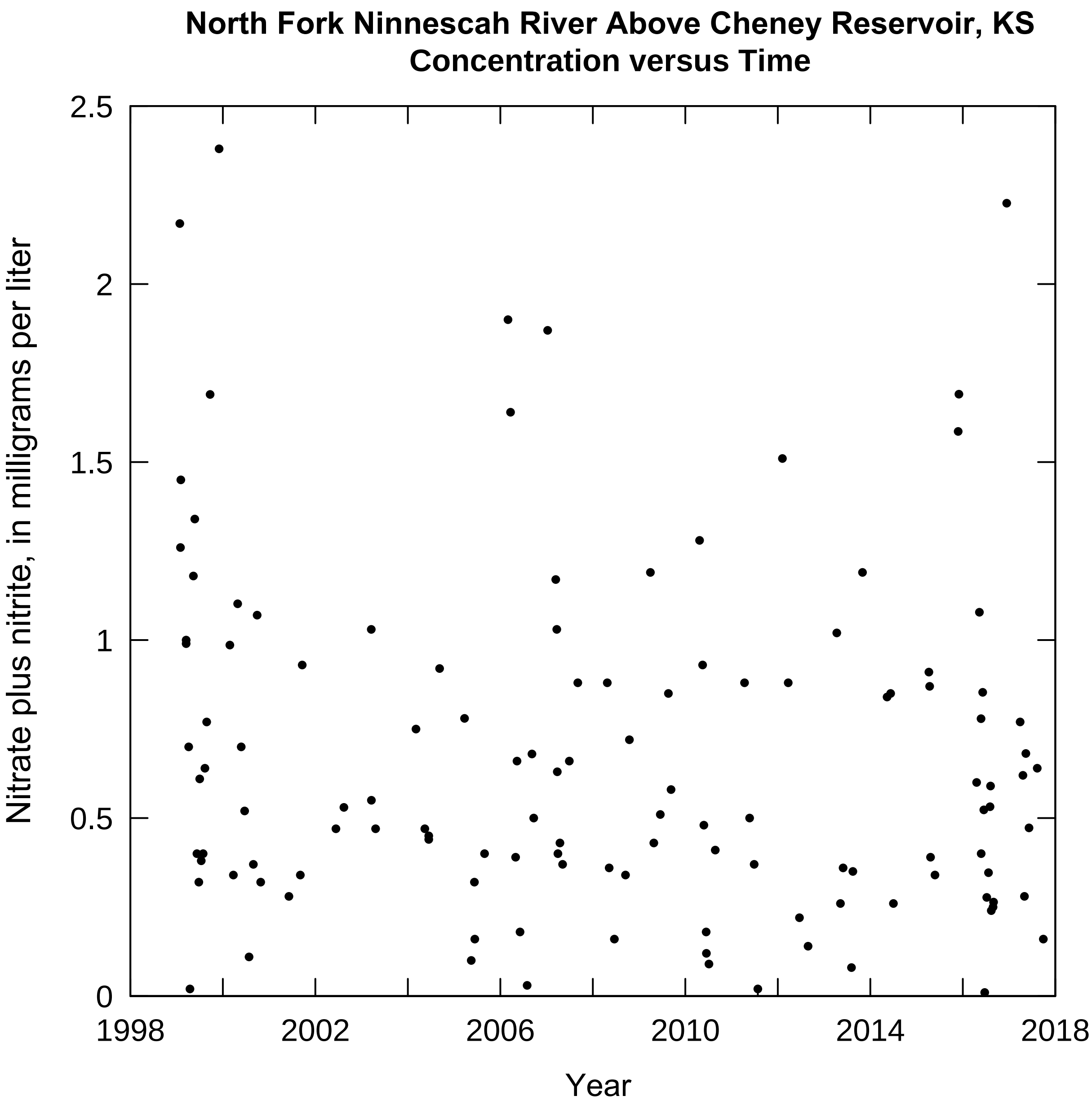


```r
boxQTwice(wrtds, qUnit=1)
```

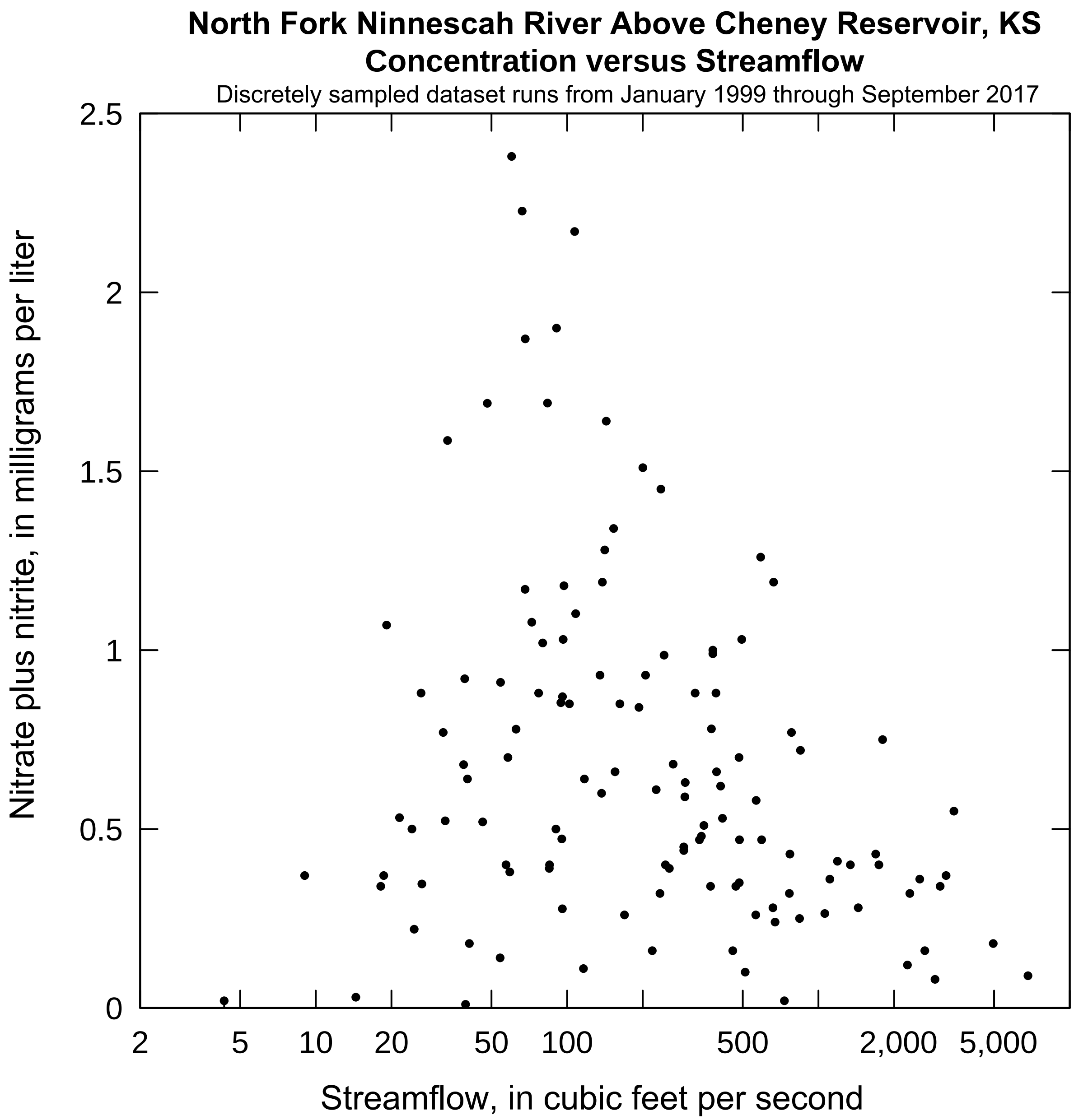




```r
plotConcTime(wrtds)
```



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



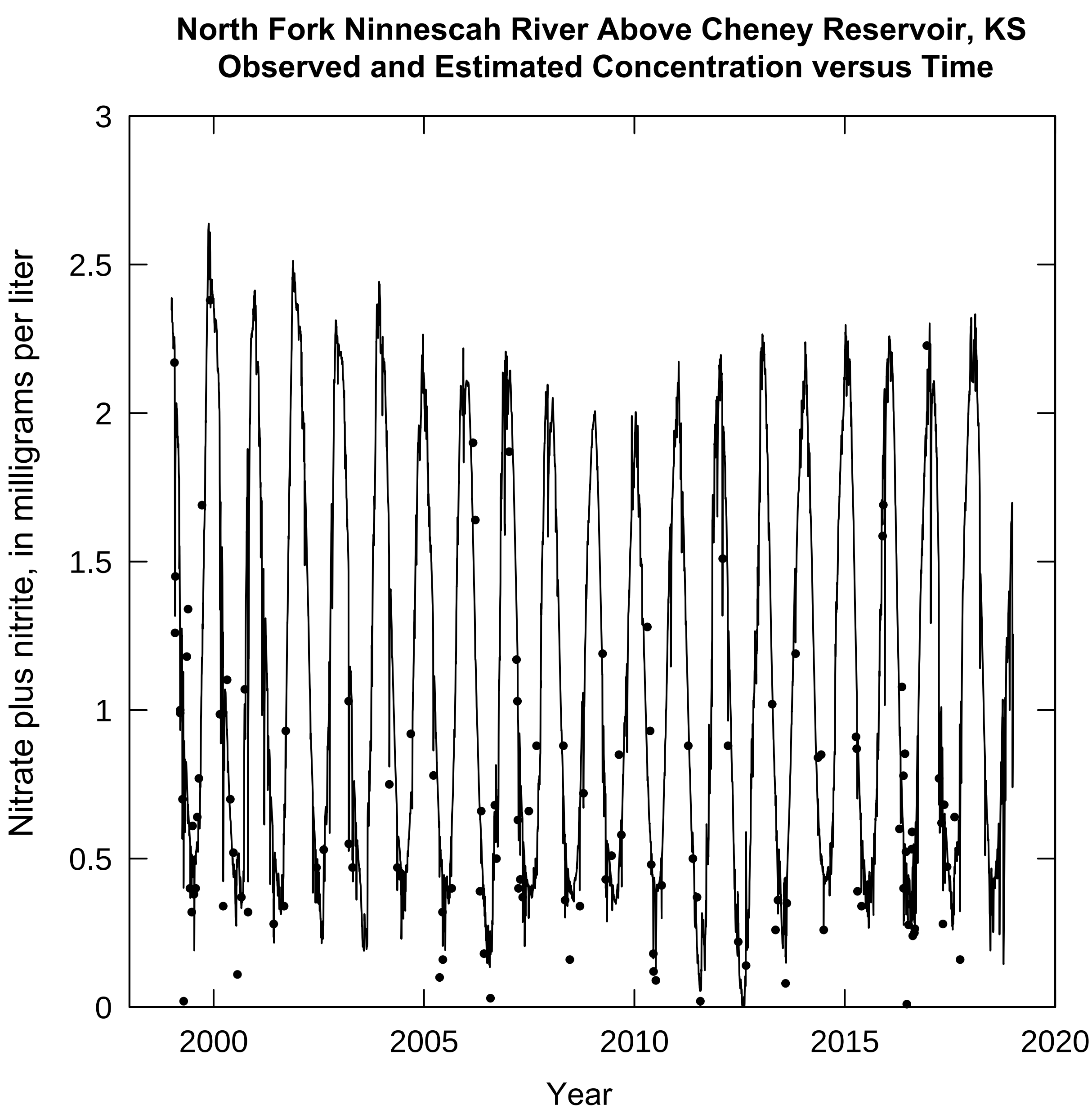
Weighted Regression on Time, Discharge, and Season Model Pesults

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

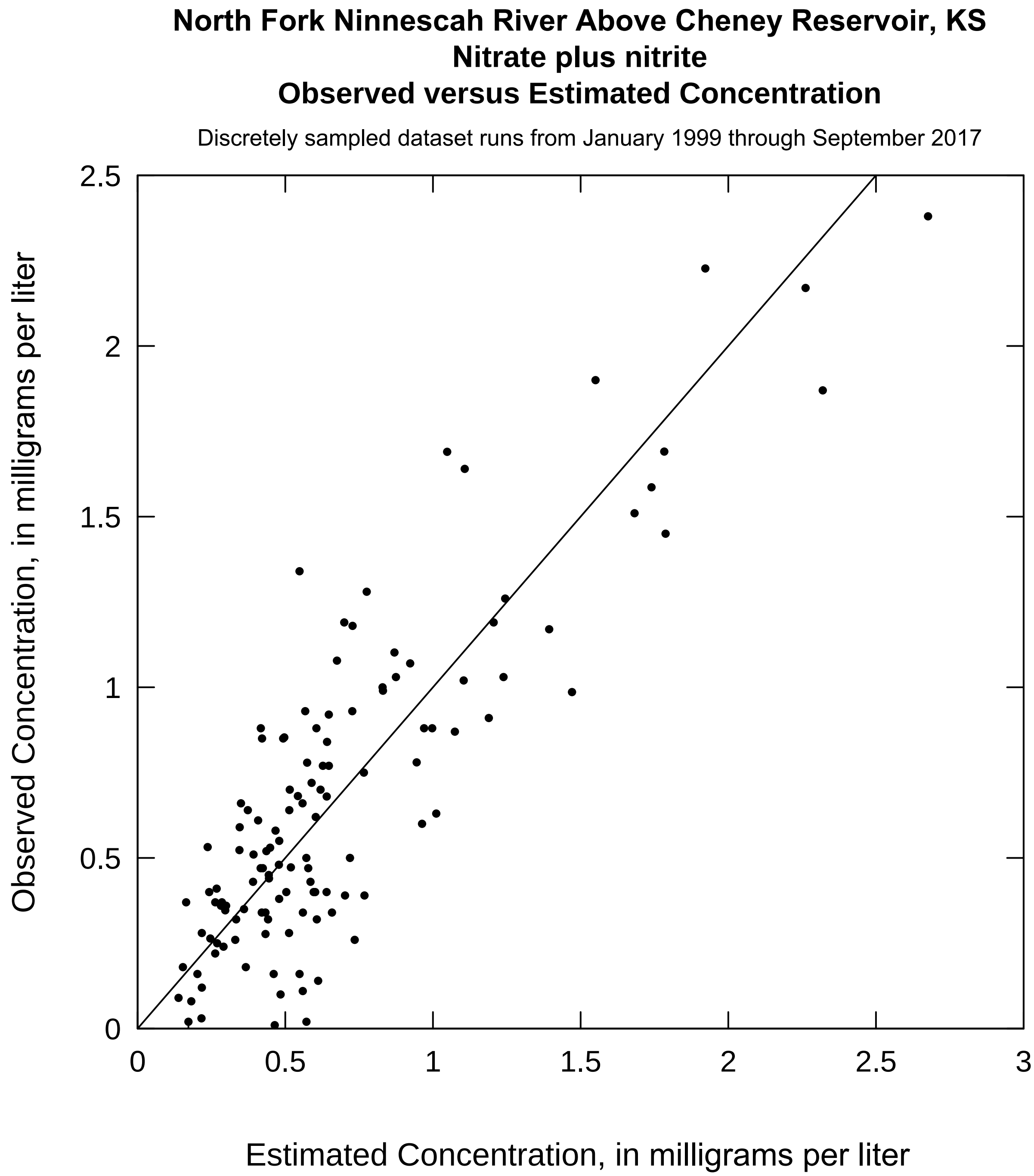
```
##              bias1
## 0.0303290254740771
```

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.

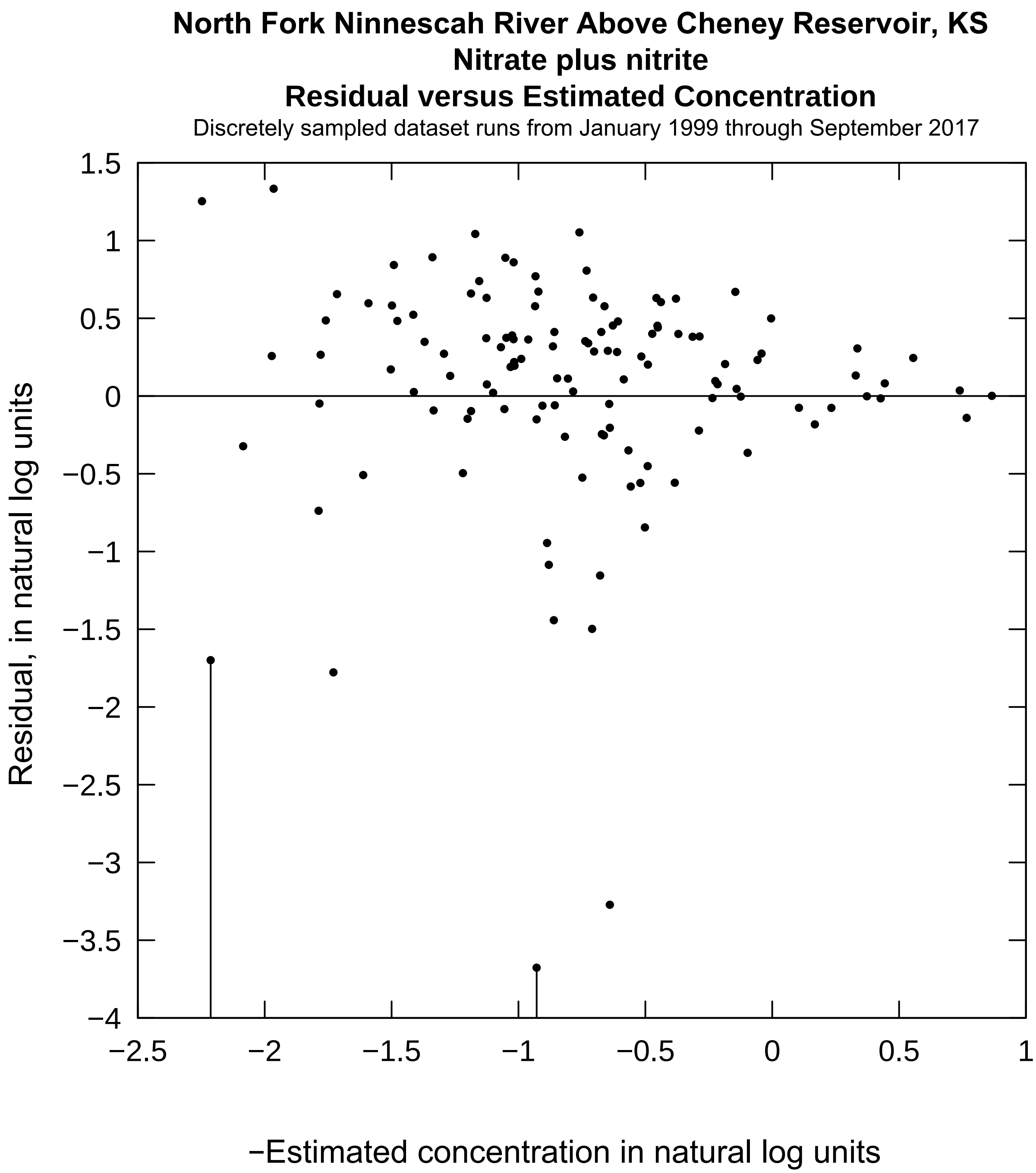
```r
plotConcTimeDaily(wrtds)
```



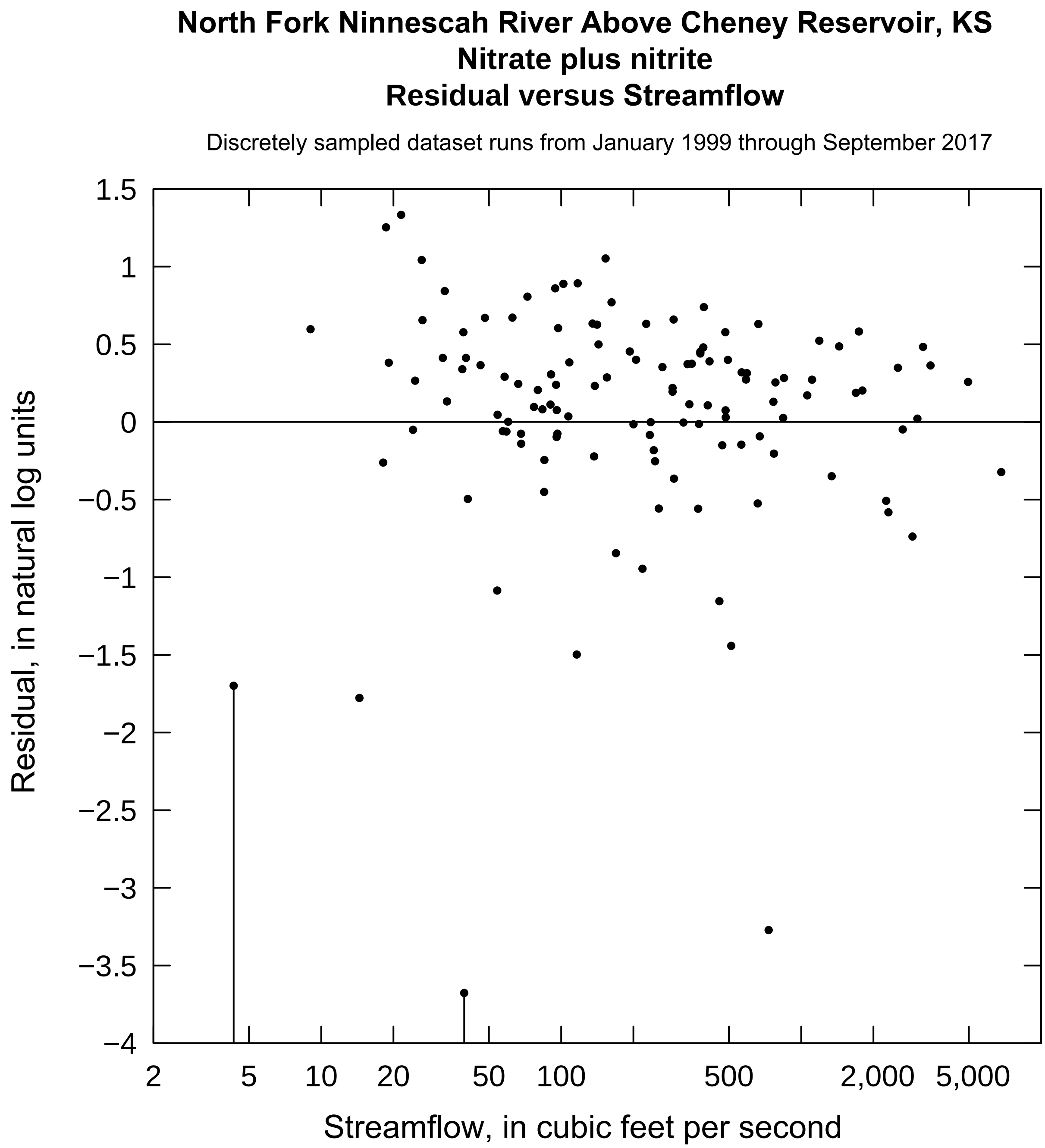
```
plotConcPred(wrtds)
```



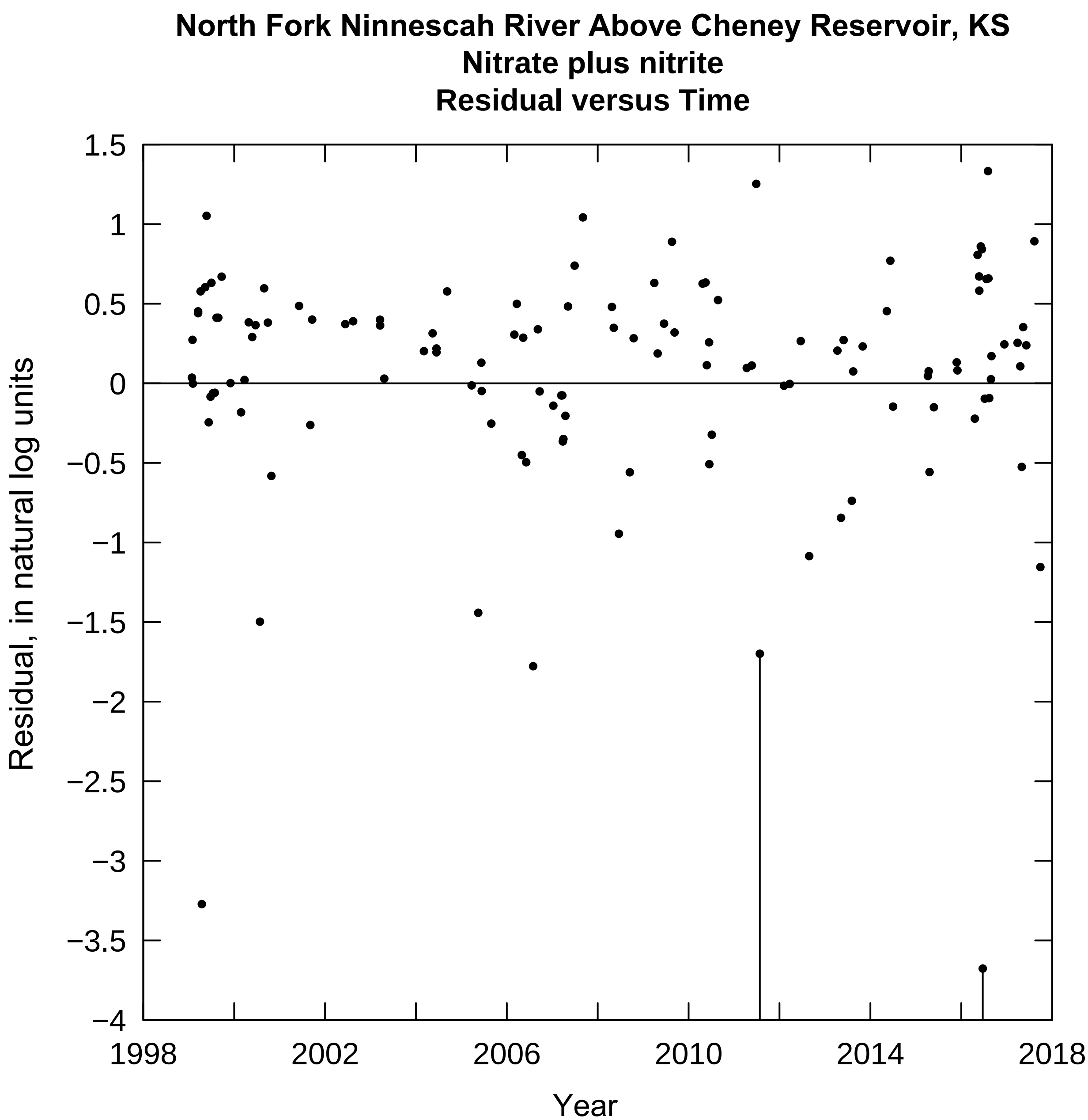
```r
plotResidPred(wzrtds)
```



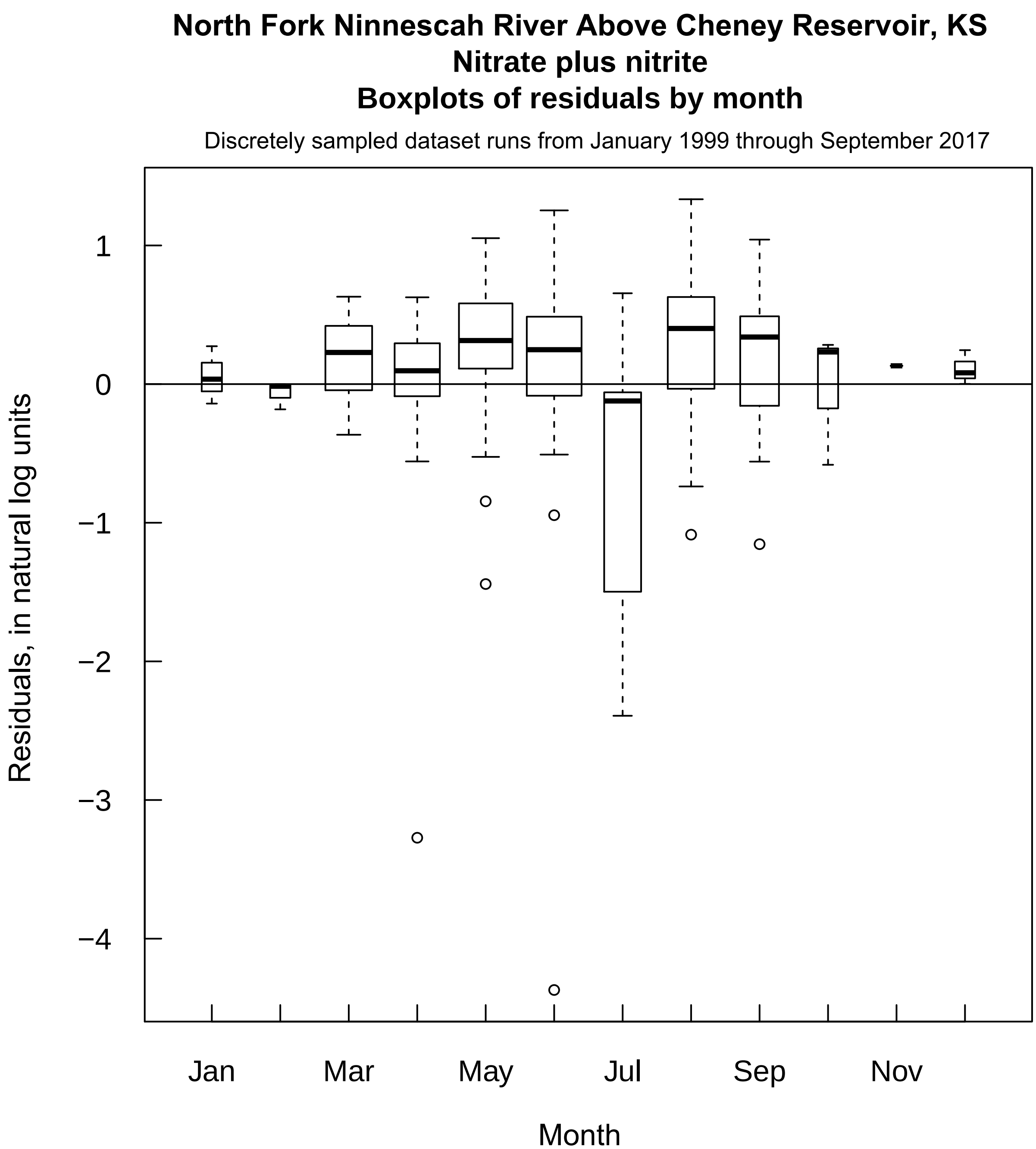
```r
plotResidQ(wrtds, qUnit=1)
```

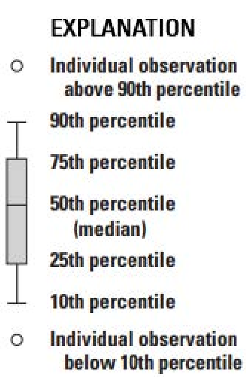


```r
plotResidTime(wrtds)
```

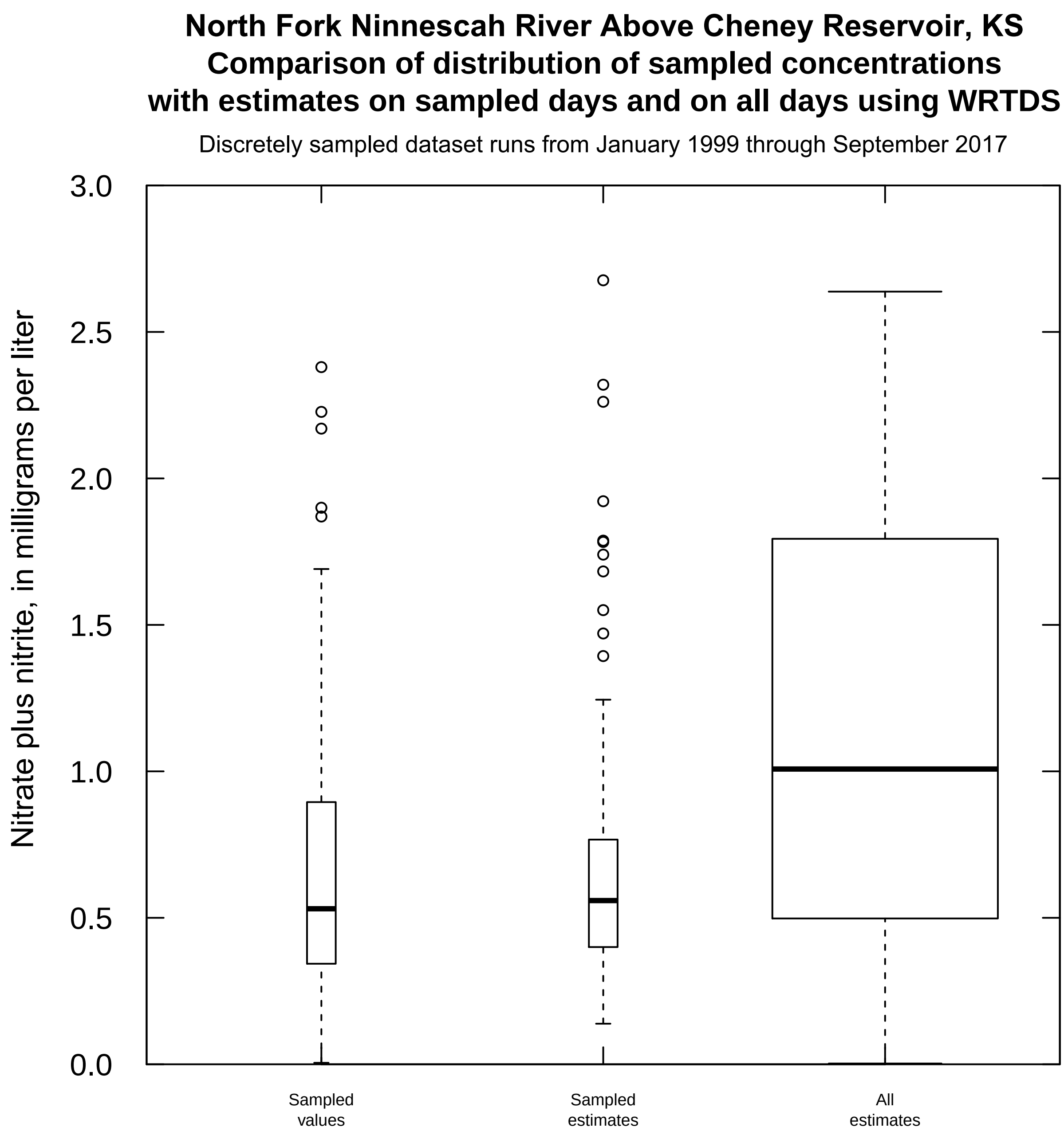


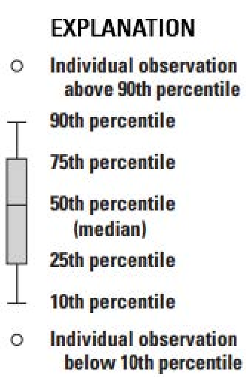
```r
boxResidMonth(wrtds)
```



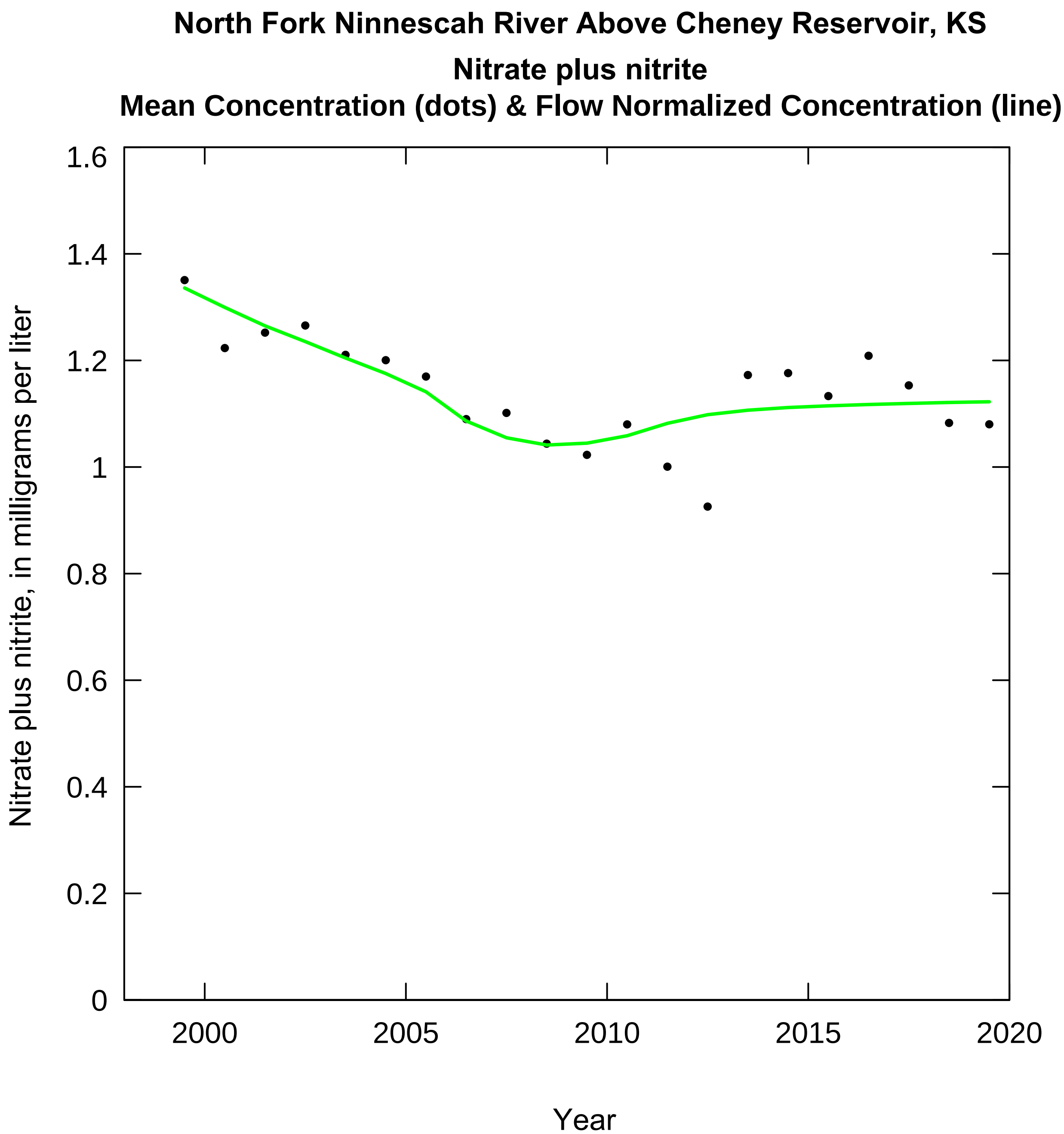


```
boxConcThree(wrtds)
```

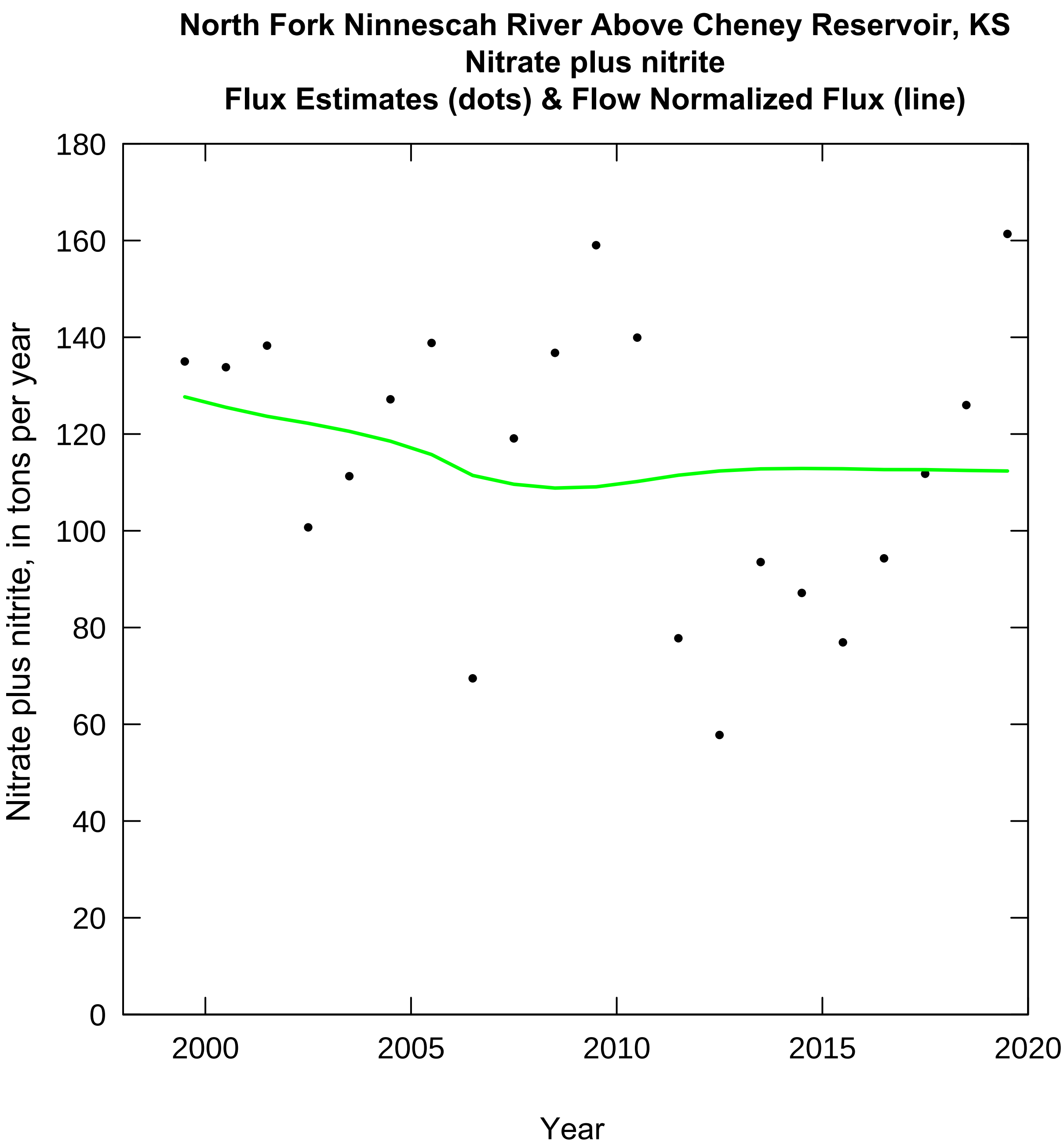




```r
plotConcHist(wrtds)
```



```r
plotFluxHist(wrtds)
```



Trend (using EGRETci)

North Fork Ninnescah River Above Cheney Reservoir, KS   Nitrate plus nitrite

Calendar Year

Bootstrap process, for change from calendar year 1999 to 2017
dataset 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 -0.222 milligrams per liter (mg/L)

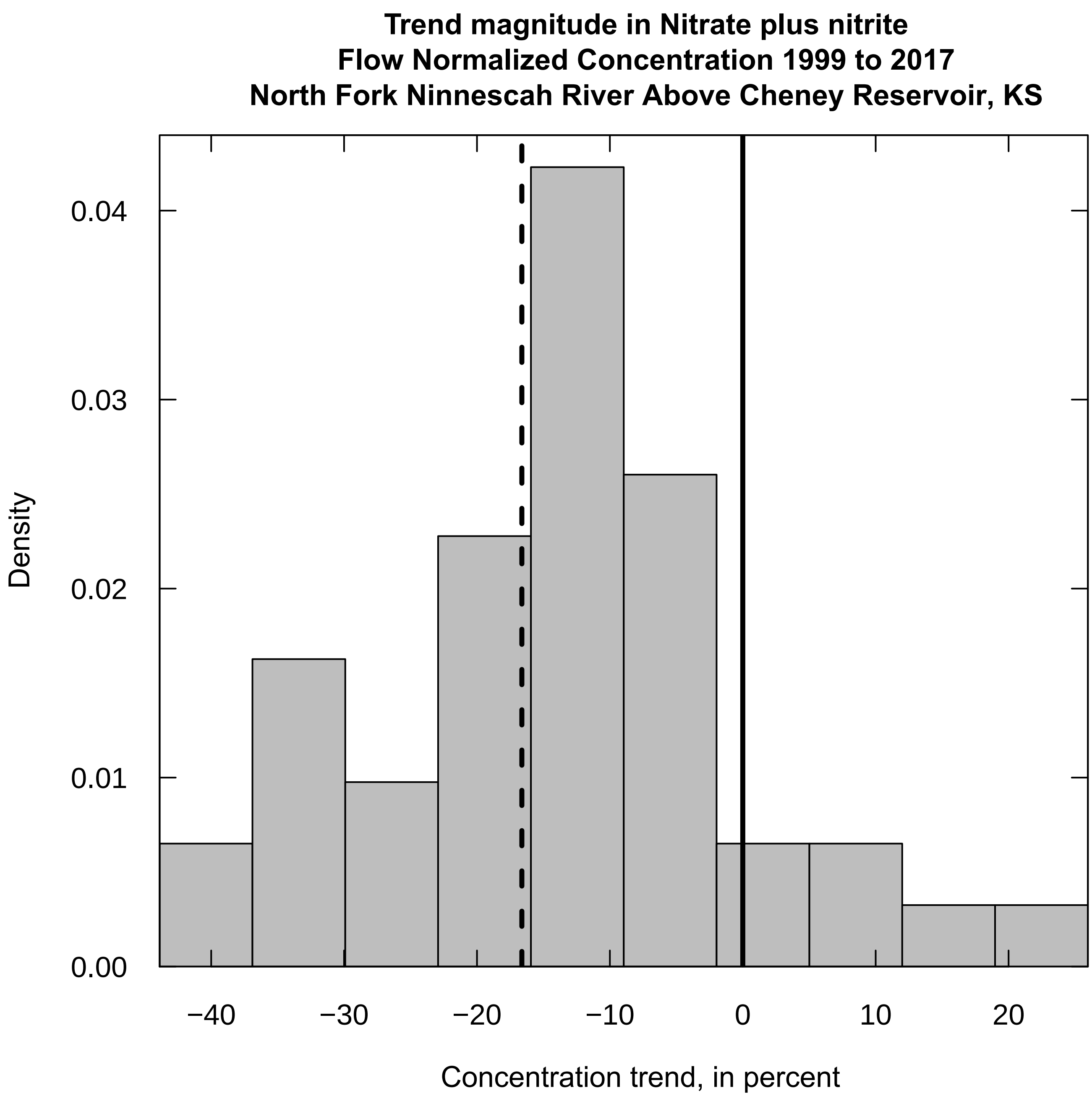
WRTDS estimated flux change is   -0.01449 10^6 killograms per year (kg/yr)

Should we reject Ho that Flow Normalized Concentration Trend = 0 ? Do Not Reject Ho
best estimate is -0.222mg/L
Lower and Upper 90% CIs -0.6478   0.1941
also 95% CIs -0.6891   0.4962
and 50% CIs -0.2877 -0.0879
approximate two-sided p-value for Conc   0.3
Likelihood that Flow Normalized Concentration is trending up =   0.144 is trending down = 0.856

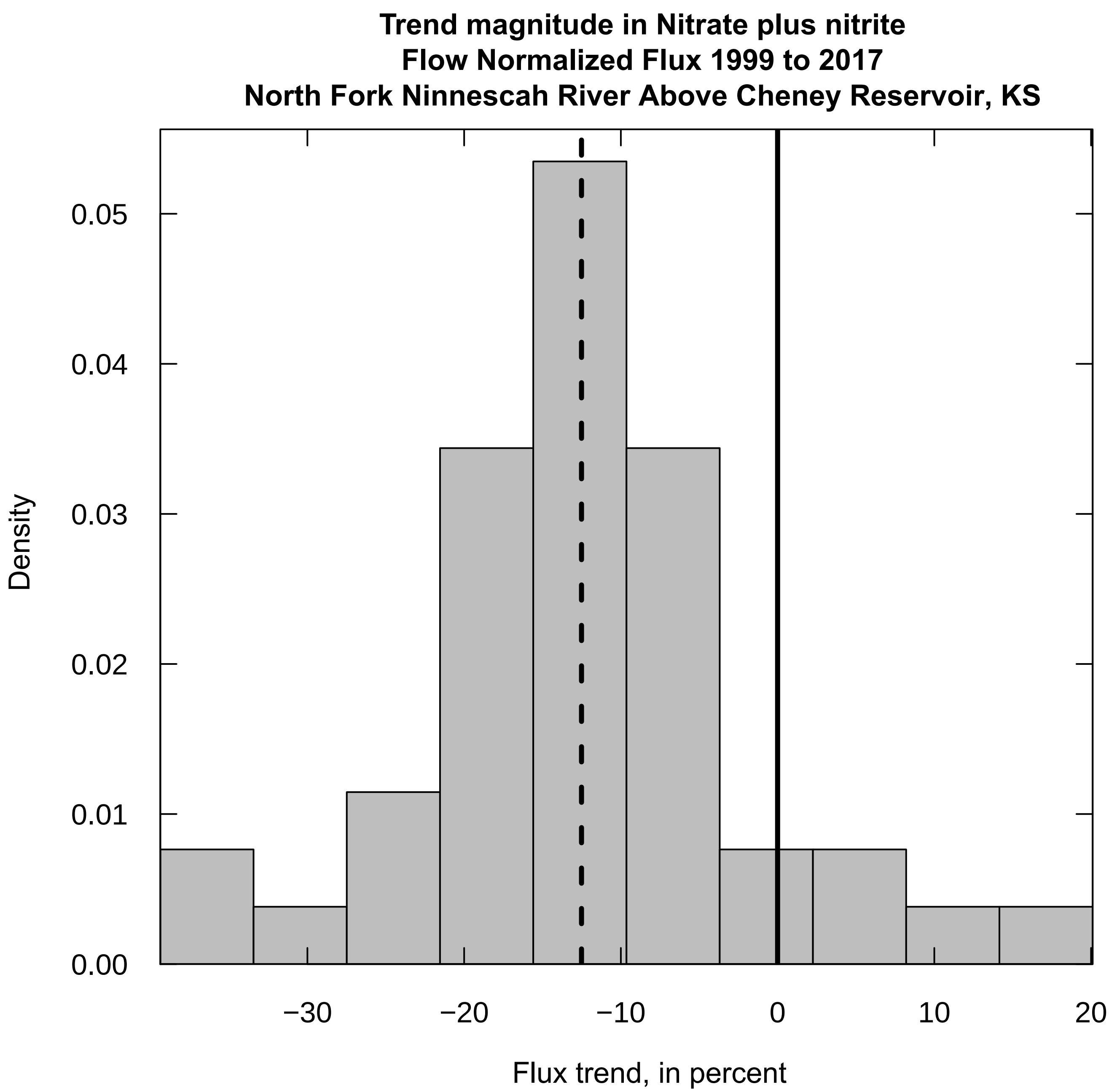
Should we reject Ho that Flow Normalized Flux Trend = 0 ? Do Not Reject Ho
best estimate is -0.01449 10^6 kg/yr
Lower and Upper 90% CIs -0.047984 0.022316
also 95% CIs -0.058528 0.032973
and 50% CIs -0.021204 -0.007829
approximate two-sided p-value for Flux   0.21
Likelihood that Flow Normalized Flux is trending up = 0.1 is trending down= 0.9

Upward trend in concentration is unlikely
Upward trend in flux is very unlikely
Downward trend in concentration is likely
Downward trend in flux is likely

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

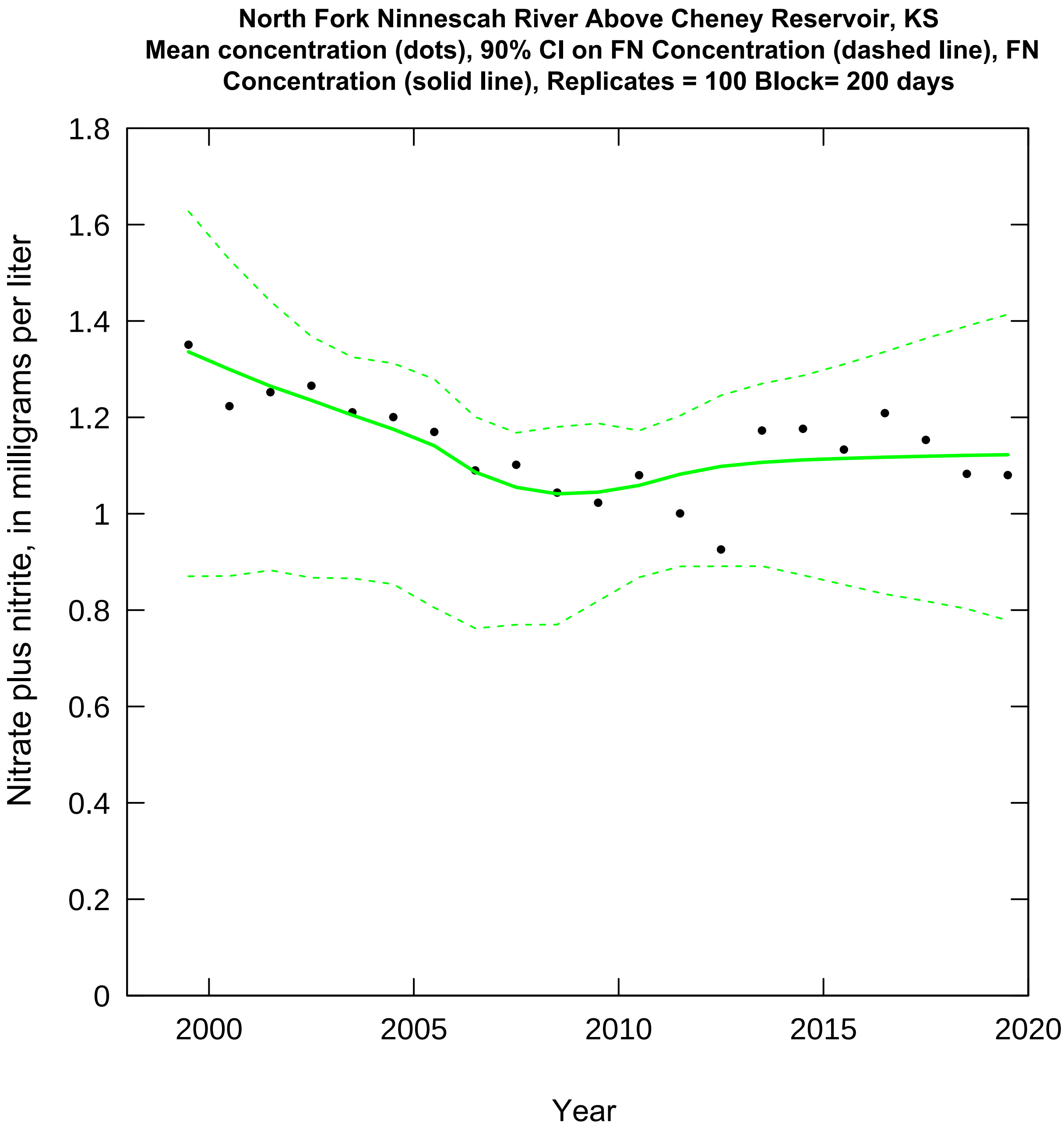


solid line = zero line (no trend)
dashed line = WRTDS trend estimate



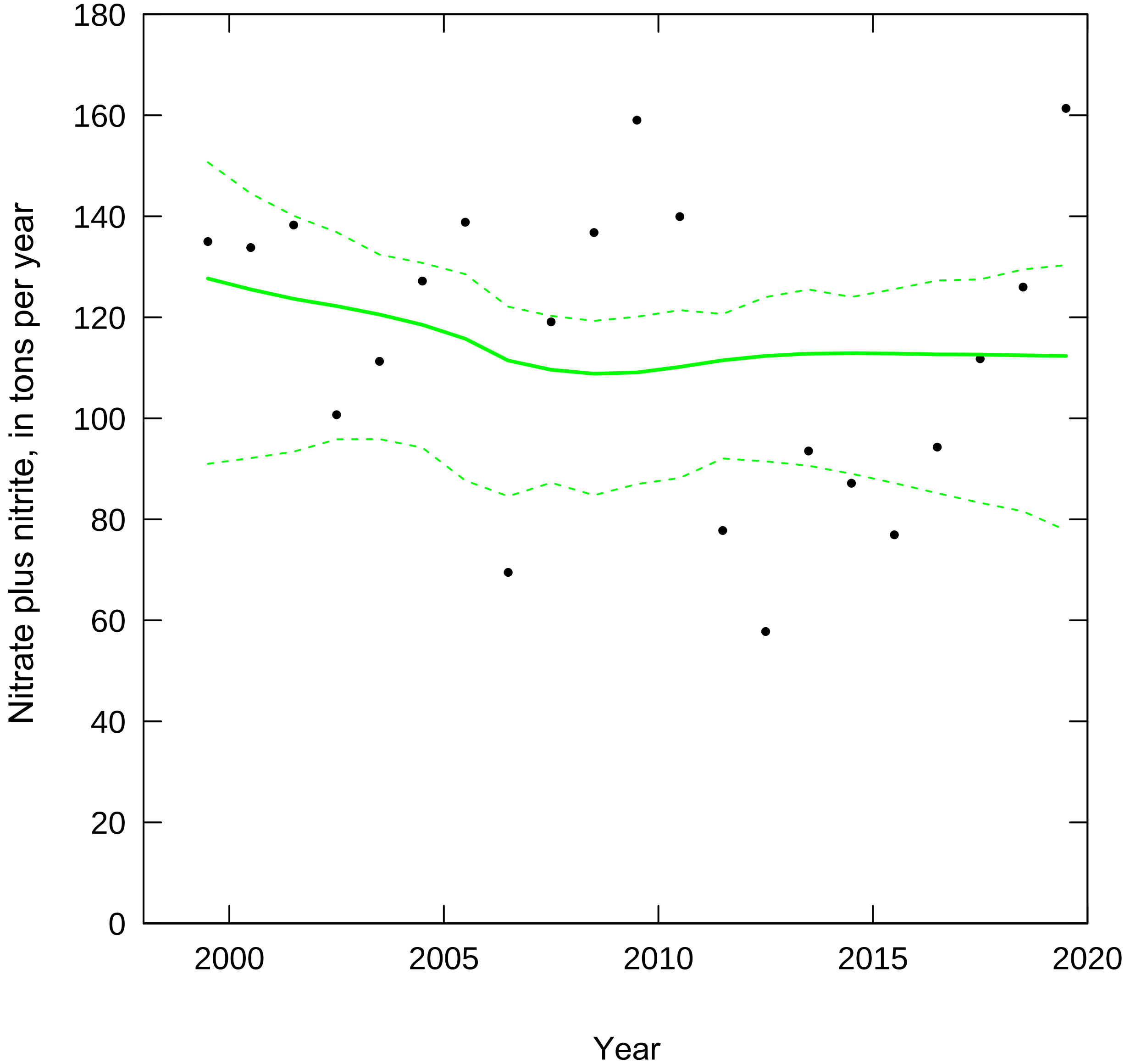
solid line = zero line (no trend)
dashed line = WRTDS trend estimate

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



FN = Flow Normalized
CI = Confidence Interval

North Fork Ninnescah River Above Cheney Reservoir, KS
Mean Flux (dots), FN Flux (solid line), 90% CI on FN Flux (dashed line), Replicates = 100 , Block= 200 days



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.]

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