Introduction to the EGRETci package

By Robert M. Hirsch and Laura A. De Cicco

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1 Introduction to EGRET Confidence Intervals

2 EGRETci Workflow

```
library(EGRET)
library(EGRETci)
eList <- Choptank_eList
#Interactive function to set up trend analysis:
caseSetUp <- trendSetUp(eList)

#Non-interactive:
caseSetUp <- data.frame(nBoot=100,
                        bootBreak=39,
                        bootLength=200,
                        confStop=0.7,
                        year1=1980,
                        year2=2005,
                        yearData1=1980,
                        yearData2=2011,
                        numSamples=606)

eList <- setPA(eList)
eList <- setForBoot(eList)

eBoot <- wBT(eList,caseSetUp,
             saveOutput = TRUE, fileName = "outputText.txt")

#Save output
saveEGRETci(eList, eBoot)
```

The output in output.txt is:

```
 Choptank River    Inorganic nitrogen (nitrate and nitrite)

  Bootstrap process, for change from Water Year 1985 to Water Year 2005
                  data set runs from WaterYear 1980 to Water Year 2011
  Bootstrap block length in days 200
  bootBreak is 9  confStop is 0.7

 WRTDS estimated concentration change is   0.328  mg/L
 WRTDS estimated flux change is          0.03148  10^6 kg/yr
 value is bootstrap replicate result (deltack or deltafk in paper)
 nPos is cumulative number of positive trends
 post_p is posterior mean estimate of probability of a positive trend
 Lower and Upper are estimates of the 90\% CI values for magnitude of trend

      rep             Concentration                |              Flux
          value     nPos post_p   Lower   Upper   |     value   nPos  post_p    Lower   Upper
       1   0.267     1    0.75   0.267   0.267    |    0.02585     1    0.75  0.02585  0.02585
       2   0.295     2   0.833   0.267   0.295    |    0.02635     2   0.833  0.02585  0.02635
       3   0.318     3   0.875   0.267   0.318    |    0.03256     3   0.875  0.02585  0.03256
```

```
       4   0.233     4     0.9   0.233   0.318   |    0.02718     4     0.9  0.02585  0.03256
       5   0.373     5   0.917   0.233   0.373   |    0.03897     5   0.917  0.02585  0.03897
       6   0.309     6   0.929   0.233   0.373   |    0.03404     6   0.929  0.02585  0.03897
       7   0.354     7   0.938   0.233   0.373   |    0.03824     7   0.938  0.02585  0.03897
       8   0.293     8   0.944   0.233   0.373   |    0.02632     8   0.944  0.02585  0.03897
       9   0.415     9    0.95   0.233   0.415   |    0.04439     9    0.95  0.02585  0.04439
      10   0.421    10   0.955   0.233   0.421   |    0.04115    10   0.955  0.02585  0.04439
      11   0.374    11   0.958   0.233   0.421   |    0.03796    11   0.958  0.02585  0.04439
      12   0.362    12   0.962   0.233   0.421   |    0.03708    12   0.962  0.02585  0.04439
      13   0.309    13   0.964   0.233   0.421   |    0.03073    13   0.964  0.02585  0.04439
      14   0.353    14   0.967   0.233   0.421   |    0.03364    14   0.967  0.02585  0.04439
      15    0.18    15   0.969    0.18   0.421   |    0.01796    15   0.969  0.01796  0.04439
      16   0.312    16   0.971    0.18   0.421   |    0.02388    16   0.971  0.01796  0.04439
      17   0.401    17   0.972    0.18   0.421   |    0.04159    17   0.972  0.01796  0.04439
      18    0.34    18   0.974    0.18   0.421   |    0.03359    18   0.974  0.01796  0.04439
      19   0.285    19   0.975    0.18   0.421   |    0.03073    19   0.975  0.01796  0.04439
      20   0.291    20   0.976   0.183   0.421   |    0.02888    20   0.976  0.01826  0.04425

Should we reject Ho that Flow Normalized Concentration Trend = 0 ? Reject Ho
 best estimate is   0.328 mg/L
  Lower and Upper 90\% CIs    0.183    0.421
 also 95\% CIs    0.180    0.421
 and 50\% CIs    0.292    0.370
 approximate two-sided p-value for Conc     0.048
* Note p-value should be considered to be < stated value
 Likelihood that Flow Normalized Concentration is trending up =      0.976  is trending down =

Should we reject Ho that Flow Normalized Flux Trend = 0 ? Reject Ho
 best estimate is  0.03148 10^6 kg/year
  Lower and Upper 90\% CIs   0.0183   0.0442
 also 95\% CIs   0.0180   0.0444
 and 50\% CIs   0.0266   0.0382
 approximate two-sided p-value for Flux     0.048
* Note p-value should be considered to be < stated value
 Likelihood that Flow Normalized Flux is trending up =      0.976  is trending down=     0.0238

 Upward trend in concentration is highly likely
 Upward trend in flux is highly likely
 Downward trend in concentration is highly unlikely
 Downward trend in flux is highly unlikely
```

3 Confidence Bands

Base-R workflow for confidence bands on model results:

```
eList <- Choptank_eList

nBoot <- 100
blockLength <- 200

widthCI <- 90
ciLower <- (50-(widthCI/2))/100
ciUpper <- (50+(widthCI/2))/100
probs <- c(ciLower,ciUpper)
```

```
repAnnualResults <- vector(mode = "list", length = nBoot)
for(n in 1:nBoot){
    repAnnualResults[[n]] <- bootAnnual(eList, blockLength)
}

CIAnnualResults <- ciBands(eList, repAnnualResults, probs)
```

Taking advantage of the foreach package to do parallel computing:

```
library(foreach)
library(doParallel)
library(iterators)
library(EGRET)

eList <- Choptank_eList

nBoot <- 100
blockLength <- 200
coreOut <- 2 #Number of cores to leave out of processing tasks

widthCI <- 90
ciLower <- (50-(widthCI/2))/100
ciUpper <- (50+(widthCI/2))/100
probs <- c(ciLower,ciUpper)

nCores <- detectCores() - coreOut
cl <- makeCluster(nCores)
registerDoParallel(cl)
repAnnualResults <- foreach(n = 1:nBoot,.packages=c('EGRETci')) %dopar% {
   annualResults <- bootAnnual(eList, blockLength)
}
stopCluster(cl)

# save(repAnnualResults, file="repAnnualResults.RData")

CIAnnualResults <- ciBands(eList, repAnnualResults, probs)
```

The following concentration and flux plots can then be generated from the CIAnnualResults data.

```
#Load package data:
eList <- Choptank_eList
repAnnualResults <- repAnnualResults

CIAnnualResults <- ciBands(eList, repAnnualResults, probs=c(0.05,0.95))
plotConcHistBoot(eList, CIAnnualResults)
```

```
plotFluxHistBoot(eList, CIAnnualResults)
```

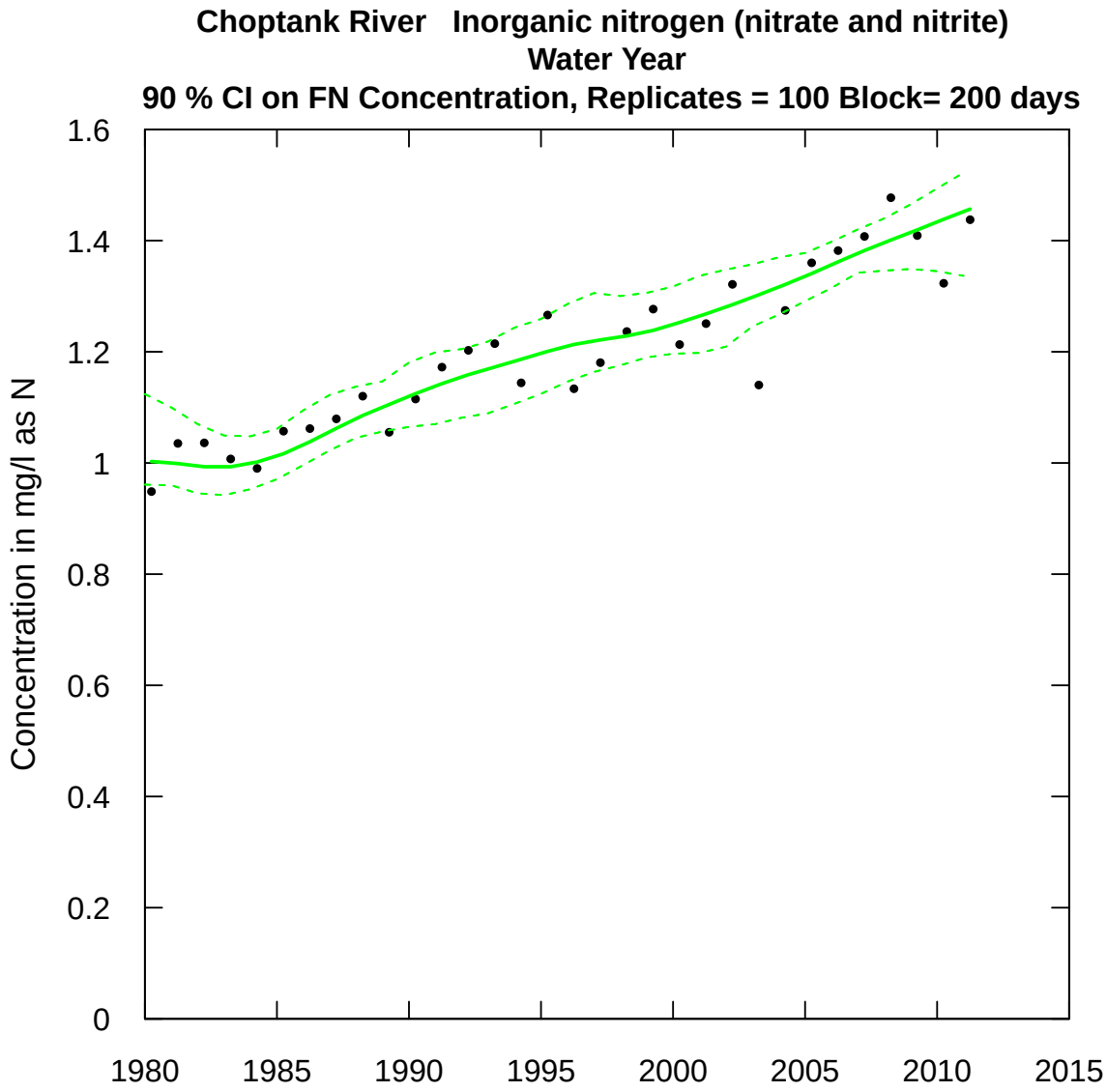

Figure 1. plotConcHistBoot

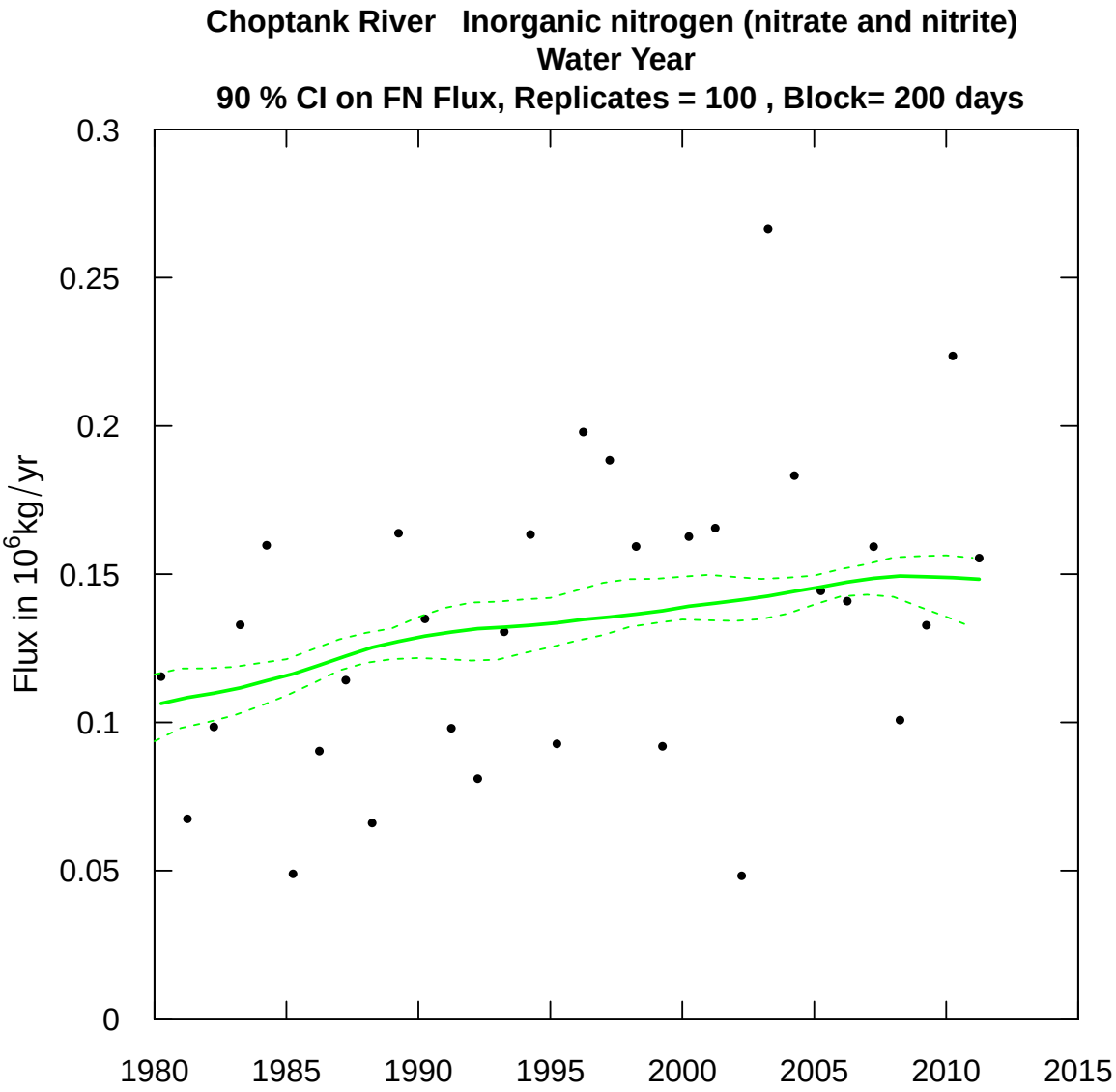

Figure 2. plotFluxHistBoot