

# **Online Material**

**Supplementary data**

readme.txt

1. The folder Winbugs contains files needed to fit the Bayesian mixed model in Winbugs from freeware R
2. The folder R contains the data and the main script to compute frequentist and mixed models (models have been fitted with R.2.12.1). This script calls to WinBUGS for the Bayesian mixed model.
3. To fit the Bayesian mixed model Winbugs must be installed (model has been fitted with WinBUGS14). The R2WinBUGS package must also have been installed in R.
4. To analyse WinBUGS output, the coda package is required.
5. To fit and analyse the Frequentist mixed model, the package lme4 is required.

kmae\_R\_Script.txt

```

# Data importation
source("Data_R.txt")

#-----
# Hierarchical models
#-----

#-----
# Frequentist mixed Model
#-----

# R package needed
require(lme4)

# adding the new variable LS-square
mixdata <- cbind(mydata,LS2=mydata$LS*mydata$LS)

##### Computation of the mixed model
resmix <- lmer(LF~LS + LS2 + (1 + LS + LS2|Cohorts),data=mixdata)
summary(resmix)

# blup
blup <- ranef(resmix)
dotplot(blup)

# coefficient
coef(resmix)

# residuals
coplot(resid(resmix)~fitted(resmix)|factor(mixdata$Cohorts),show.given=F)
boxplot(resid(resmix)~factor(mixdata$Cohorts))

# Normality
qqnorm(resid(resmix))
qqline(resid(resmix),col="red",lwd=3)

##### Backcalculation at age 1+

# Simulated data from the posterior : Code for non-trivial theta_T not yet written
# samp0 <- mcmcscamp(resmix, n = 1000)

#-----
# Bayesian mixed Model
#-----

# R packages needed
# R2WinBUGS : link between R and Winbugs
require(R2WinBUGS)
# Reading and analysis of MCMC output
require(coda)

##### Call to Winbugs

```

```

# parameters of interest
parameters <- c("beta", "sigma2", "b""D""LF1.cohorts")

# Bayesian model with informative prior
apron.mcmc <- bugs(data="Data.txt", inits="Init.txt",
parameters=parameters, model.file="Model.txt",digits=3,
n.chains=3, n.iter=41000,n.thin=1,n.burnin=1000,codaPkg=T,DIC=FALSE,
bugs.directory="c:/Program Files/WinBUGS14/",summary.only=FALSE)

para <- read.bugs(apron.mcmc)

##### MCMC Analysis
summary(para)
autocorr(para)
plot(para[,10:17])
effectiveSize(para)
crosscorr(para[,42:44])
geweke.diag(para)
heidel.diag(para)

##### Residuals and model assessment

# parameters of interest
parameters <- c("sigma2", "mu")

# Bayesian model with informative prior
apron.mcmc <- bugs(data="Data.txt", inits="Init.txt",
parameters=parameters, model.file="Model.txt",digits=3,
n.chains=1, n.iter=41000,n.thin=1,n.burnin=1000,codaPkg=T,DIC=FALSE,
bugs.directory="c:/Program Files/WinBUGS14/",summary.only=FALSE)

# Intermediate calculations
res <- read.bugs(apron.mcmc)
mat <- as.matrix(res)
var <- mat[,668]
mean <- mat[,-668]
e2 <- mean*mean +var

# residuals
residuals <- LF - apply(mean,2,"mean")

# model assessment
Goodness.of.fit <- sum(residuals*residuals)
Predictive.variances <- sum(mean(var) + apply(e2,2, "mean") - (apply(mean,2,"mean"))^2)

```

```

#-----
# Figure 3
#-----

resbayes <- summary(para)[[1]]

Xgrid <- seq(0,max(mydata$LS),by=0.1)
Xgrid <- cbind( rep(1,length(Xgrid)),
               Xgrid,
               Xgrid*Xgrid)

par(mfrow=c(3,3))
for (j in 1997:2004)
{
  plot(LF~LS,data=mydata[mydata$Cohorts==j],
       main=paste("Cohort ",j),
       xlim=range(mydata$LS), ylim = range(mydata$LF))

  # Frequentist mixed model
  m.s <- as.vector(as.matrix(coef(resmix)$Cohorts[which(1997:2004 == j),]))
  lines(Xgrid[,2],Xgrid %*% m.s, lwd=2, col="blue")

  # Bayesian mixed model
  m.s <- resbayes[42:44,1] + resbayes[15:17 + 3*which(1997:2004 == j),1]
  lines(Xgrid[,2],Xgrid %*% m.s, lwd=2, col="green")

  # Frequentist fixed effects model
  m.s <- lm(LF~LS + I(LS^2),data=mydata[mydata$Cohorts==j,])$coef
  lines(Xgrid[,2],Xgrid %*% m.s, lwd=2, col="red")
}

#-----
# Posterior distribution of length size at one year, Figure 2
#-----

# L1
plot(c(8,8),c(0,4),xlim=c(5,9.5),ylim=c(0,4.2),type="l",lwd=2,xlab="Back-calculated size at one year (cm)",
     ylab="Kernel density")
palette(rainbow(8))
for (i in 10:17)
  {
    lines(density(para[,i][[1]]),col=(i-9),lwd=2)
  }
legend(5,4,1997:2004,col= c(1:8),lty=1,lwd=2)
3965

```

model.txt

```

model
{
for ( j in 1 : J ) {
for( i in N[j] : (N[j+1]-1) ) {
LF[i] ~dnorm( mu[i], tau.c )
mu[i] <- beta[1] + b[ j , 1 ] +(beta[2] + b[ j , 2]) * LS[i] +
(beta[3] + b[ j , 3]) * LS[i] * LS[i]
# Taille rétrocalculée à 1 an (set to 0 for fish aged 0+)
mu1[i] <- beta[1] + b[ j , 1 ] +(beta[2] + b[ j , 2]) * LS.1[i] +
(beta[3] + b[ j , 3]) * LS.1[i] * LS.1[i]
LF1[i] <- (LF[i]* mu1[i] / mu[i])*step(LS.1[i])
}
b[ j , 1 : 3] ~ dmnorm(b.m[], inv.D[ , ])
LF1.cohorts[j] <- sum(LF1[N[j] : (N[j+1]-1) ])/Nb1[j]
}
# prior
tau.c ~ dgamma(shape,rate)
sigma2 <- 1 / tau.c
beta[ 1 : 3] ~ dmnorm(m[], inv.V[ , ])
inv.D[ 1 : 3, 1 : 3] ~dwish(inv.R[ , ], d)
D[ 1 : 3, 1 : 3] <- inverse( inv.D[ 1 : 3, 1 : 3] )
}

```

Init.txt

```
list(  
  tau.c = 1,  
  beta = c(1.7, 7.4, -0.7),  
  b = structure(.Data =  
    c(0,0,0,  
      0,0,0,  
      0,0,0,  
      0,0,0,  
      0,0,0,  
      0,0,0,  
      0,0,0,  
      0,0,0),  
    .Dim=c(8,3)),  
  inv.D = structure(.Data =  
    c(1,0,0,  
      0,1,0,  
      0,0,1),  
    .Dim = c(3,3))  
)
```

Data.txt

```

list(J=8, N=c(1,119,314,368,400,478,531,649,668), Nb1=c(118 ,195, 48, 32, 58, 49, 41,19),
      shape=10,rate=0.1,
      m = c(1.7, 7.4, -0.7),
      b.m=c(0,0,0),
      inv.V = structure(.Data =
                                c(0.2,-0.3,0.1,
                                  -0.3, 0.5,-0.2,
                                  0.1,-0.2, 0.06),
                          .Dim = c(3,3)),
      inv.R = structure(.Data =
                                c(1,0,0,
                                  0, 1,0,
                                  0,0, 1),
                          .Dim = c(3,3)),
      d = 100,
      LS =
c(1.491667,1.566667,1.533333,1.808333,1.591667,1.633333,1.625,1.933333,1.991667,1.375,1.26666
7,1.241667,1.308333,1.308333,1.575,1.858333,1.666667,1.533333,1.45,1.733333,1.191667,1.441667
,1.116667,1.35,1.45,1.491667,1.458333,1.266667,1.416667,1.691667,1.733333,1.6,1.758333,1.325,1.
708333,1.716667,2.233333,1.858333,1.925,1.508333,1.508333,1.466667,1.608333,1.883333,1.84166
7,1.9,1.708333,1.5,1.537255,1.591667,2.05,1.725,1.858333,1.308333,1.691667,1.791667,1.75,1.9125,
1.683333,1.658333,1.85,1.491667,1.8,1.658333,1.833333,2.083333,2.016667,2,1.5875,1.95,1.95,1.9,2.
125,1.513725,1.725,2.054902,2.116667,1.925,1.825,2.025,2.133333,2.091667,2.508333,2.233333,2.6
25,2.391667,2,1.783333,2.0875,1.725,1.7,1.65,1.966667,2.15,1.808333,1.516667,1.85,1.533333,1.683
333,1.458333,1.625,1.566667,2.108333,1.791667,1.825,2.091667,2.141667,2.05,2.091667,2.258333,
2.325,2.383333,2.266667,2.125,2.475,1.416667,1.791667,2.066667,1.041667,1.058333,1.116667,1.1
58333,1.066667,1.191667,0.991667,1.258333,1.05,1.116667,1.016667,1.216667,1.083333,1.016667
,1.133333,1.033333,0.866667,0.933333,1.116667,1.066667,0.916667,0.816667,0.983333,1.366
667,1.1,1.133333,1.275,1.125,1.2,1.15,1.291667,1.333333,1.375,1.058333,0.991667,1.291667,1.141
667,1.116667,1.545098,1.623529,1.616667,1.019608,1.241667,1.231373,1.231373,1.275,1.333333,1.
333333,1.233333,1.241667,1.433333,1.391667,1.466667,1.225,1.316667,1.258333,1.301961,1.35833
3,1.208333,1.35,1.225,1.566667,1.583333,1.541667,1.408333,1.475,2.033333,1.35,1.241667,1.46666
7,1.4125,1.458333,1.483333,1.316667,1.258333,1.475,1.408333,1.641667,1.233333,1.725,1.6125,1.4
125,1.616667,1.375,1.25,1.591667,1.266667,1.560784,1.316667,1.35,1.45,1.241667,1.583333,1.625,1
.458824,1.55,1.933333,1.708333,2.016667,1.516667,1.616667,1.366667,1.791667,1.775,1.508333,1.
725,1.591667,1.691667,1.783333,1.233333,1.6,1.5125,1.675,1.908333,1.791667,1.683333,1.583333,
1.366667,1.516667,1.375,1.675,1.85,1.708333,1.866667,1.325,1.575,1.366667,1.341667,1.366667,1.7
66667,1.591667,1.541667,1.516667,1.216667,1.225,1.3625,1.241667,1.275,1.233333,1.483333,1.366
667,1.45,1.483333,1.566667,1.366667,1.45,1.95,1.416667,1.333333,1.641667,1.666667,1.583333,1.7
16667,1.5,2,1.841667,1.875,1.616667,1.75,1.641667,1.691667,1.775,1.75,1.858333,1.741667,1.73333
3,2.025,1.733333,1.8,1.933333,1.75,1.95,2.083333,2.008333,1.966667,1.741667,1.941667,2.033333,2
.041667,1.966667,1.633333,1.566667,1.758333,1.983333,1.7,1.4,0.75,1.666667,1.491667,1.416667,1.
8875,1.633333,1.741667,1.75,1.775,0.758333,0.866667,0.7137255,0.866667,0.883333,0.741666
7,0.991667,0.808333,1.025,0.991667,1.116667,0.783333,0.933333,0.9,0.925,0.883333,1.2833
33,1.341667,1.125,1.458333,1.308333,1.283333,1.233333,1.366667,1.508333,1.608333,1.458333,1.3
58333,1.6,1.516667,1.641667,1.491667,1.55,1.4,1.525,1.641667,1.308333,1.4,1.416667,1.716667,1.4
08333,1.425,1.508333,1.208333,1.433333,1.55,1.633333,1.441667,1.35,1.7,1.55,1.441667,1.625,1.44
1667,1.175,1.066667,1,1.075,1.108333,1.191667,1.075,1.108333,1.183333,1.041667,0.983333,1.11
6667,1.15,1.208333,1.166667,1.083333,1.408333,1.533333,1.3,1.233333,1.225,1.05,1.375,1.391667,0
.991667,1.216667,0.908333,1.191667,1.366667,1.558333,1.641667,2.633333,0.425,0.5,0.533333,
0.541667,0.458333,0.491667,0.475,0.516667,0.616667,0.425,0.608333,0.541667,0.491667,
0.575,0.458333,0.491667,0.441667,0.566667,0.608333,0.55,1.283333,1.241667,1.316667,1.10

```



8333,1.241667,1.116667,1.3,1.35,1.166667,1.225,1.241667,1.291667,1.183333,1.166667,1.291667,1.366667,1.416667,1.208333,1.483333,1.433333,1.483333,1.275,1.083333,1.008333,1.383333,1.266667,1.408333,1.408333,1.358333,1.525,1.325,1.316667,1.441667,1.333333,1.408333,1.25,1.35,1.5,1.433333,1.45,1.766667,1.625,1.941667,1.366667,1.491667,1.683333,1.616667,0.96,1.84,1.891667,1.9,1.95,2.083333,2.016667,2.4,2.641667,1.9,2.075,0.683333,0.75,0.6416667,0.758333,0.85,1.041667,0.95,0.8416667,0.8666667,1.016667,0.858333,1.058333,1.325,1.233333,1.058333,1.266667,1.266667,1.233333,1.325,1.175,1.483333,1.241667,1.208333,1.325,1.416667,1.158333,1.325,1.233333,1.208333,1.2,1.25,1.225,0.75,1.366667,1.283333,1.591667,1.226667,1.653333,1.958333,1.85,1.4,1.425,1.533333,1.516667,1.383333,1.441667,1.575,1.425,1.433333,1.9,1.4,1.566667,1.475,0.608333,0.608333,0.65,0.583333,0.75,0.683333,0.633333,0.616667,0.808333,0.733333,0.7,0.7416667,0.866667,0.783333,0.583333,0.825,0.683333,0.7416667,0.766667,0.825,0.708333,0.858333,0.791667,0.758333,0.766667,0.7916667,0.75,0.708333,0.65,0.633333,0.733333,0.633333,0.608333,0.816667,0.633333,0.583333,0.633333,0.625,0.575,0.675,0.95,0.658333,0.758333,0.6416667,0.616667,0.633333,0.683333,0.583333,0.533333,0.5916667,0.7416667,0.716667,0.816667,0.8,0.65,0.775,0.725,0.783333,0.683333,0.6416667,0.675,0.775,0.8,0.8,0.816667,0.76,0.666667,0.873333,0.753333,0.793333,0.766667,0.88,0.786667,0.846667,0.74,0.873333,0.886667,1.706667,1.82,1.546667,1.486667,1.55,1.725,1.858333,1.683333,1.65,1.7,1.75,1.85,1.991667,1.908333,1.091667,1.158333,1.275,1.375,1.333333,1.291667,1.175,1.158333,1.283333,1.341667,1.275,1.25,1.025,1.108333,1.225,1.058333,1.15,1.225,1.325,1.2,2.575,2.35,1.908333,2.125,2.266667,2.216667,2.55,1.053333,1.326667,1.526667,1.62,1.486667,1.35,1.35,1.47,1.66,1.82,1.98,1.533333,1.425,1.658333,1.491667,1.925,2.058333,2.083333,2),

LS.1 =

c(0.725,0.7916667,0.6916667,0.708333,0.625,0.575,0.625,0.8,0.9,0.5416667,0.466667,0.716667,0.616667,0.5916667,0.9,0.55,0.516667,0.758333,0.6,0.708333,0.525,0.4416667,0.6916667,0.6,0.75,0.608333,0.558333,0.625,0.5916667,0.825,0.75,0.7416667,0.7416667,0.5916667,0.666667,0.533333,0.875,0.733333,0.816667,0.516667,0.533333,0.508333,0.566667,0.833333,0.733333,0.875,0.7416667,0.583333,0.4392157,0.575,0.733333,0.675,0.558333,0.425,0.658333,0.683333,0.6,0.6625,0.775,0.508333,0.6,0.566667,0.675,0.575,0.575,0.65,0.658333,0.575,0.5125,0.625,0.6416667,0.4916667,0.816667,0.5960784,0.508333,0.6039216,0.5416667,0.8375,0.65,0.858333,0.758333,0.8,0.833333,0.75,0.7,0.65,0.608333,0.608333,0.775,0.55,0.608333,0.616667,0.808333,0.7416667,0.616667,0.7,0.716667,0.508333,0.658333,0.508333,0.5,0.491667,0.716667,0.716667,0.625,0.733333,0.666667,0.716667,0.666667,0.725,0.716667,0.825,0.733333,0.708333,0.825,0.45,0.625,0.583333,0.725,0.716667,0.775,0.7916667,0.708333,0.925,0.733333,0.833333,0.6,0.525,0.6,0.783333,0.6916667,0.616667,0.65,0.6916667,0.55,0.5416667,0.6916667,0.558333,0.55,0.5,0.525,0.8416667,0.566667,0.575,0.675,0.65,0.7,0.633333,0.75,0.6916667,0.783333,0.7,0.608333,0.766667,0.525,0.616667,0.8156863,0.8627451,0.858333,0.5019608,0.666667,0.4862745,0.572549,0.666667,0.6916667,0.675,0.825,0.666667,0.725,0.708333,0.7,0.6416667,0.708333,0.45,0.666667,0.675,0.658333,0.85,0.583333,0.883333,0.725,0.725,0.716667,0.716667,0.925,0.533333,0.566667,0.666667,0.575,0.733333,0.783333,0.733333,0.5,0.65,0.583333,0.725,0.525,0.716667,0.6625,0.6625,0.75,0.5625,0.45,0.6416667,0.5416667,0.6509804,0.5416667,0.666667,0.725,0.625,0.708333,0.683333,0.7607843,0.825,0.833333,0.666667,0.8416667,0.7,0.783333,0.708333,0.758333,0.8416667,0.758333,0.933333,0.85,0.9,0.925,0.608333,0.816667,0.6375,0.8416667,0.725,0.808333,0.6,0.858333,0.683333,0.6416667,0.733333,0.766667,0.791667,0.7,0.733333,0.608333,0.683333,0.7,0.6,0.7,0.8,0.7,0.658333,0.6416667,0.508333,0.55,0.5125,0.525,0.475,0.558333,0.633333,0.5416667,0.533333,0.566667,0.658333,0.583333,0.508333,0.708333,0.675,0.5,0.625,0.7416667,0.733333,0.633333,0.533333,0.733333,0.65,0.7416667,0.583333,0.683333,0.55,0.716667,0.783333,0.583333,0.733333,0.766667,0.658333,0.816667,0.783333,0.716667,0.558333,0.766667,0.625,0.8,0.733333,0.925,0.6916667,0.6416667,0.625,0.666667,0.625,0.583333,0.525,0.733333,0.733333,0.625,0.458333,0.2875,0.5,0.5916667,0.408333,0.6,0.516667,0.525,0.533333,0.5,-1,-1,-1,-1,-1,0.916667,0.7,0.866667,0.825,0.916667,0.5,0.5416667,0.55,0.558333,0.533333,0.75,0.883333

3,0.775,0.8583333,0.775,0.5,0.7416667,0.5333333,0.6833333,0.7833333,0.9583333,0.8,0.875,0.8833  
333,0.95,0.8166667,0.7333333,0.8,0.8416667,0.85,0.5833333,0.6083333,0.5416667,0.8083333,0.6,0.  
675,0.5833333,0.5333333,0.625,0.625,0.6,0.6,0.7416667,0.5833333,0.5583333,0.5083333,0.5416667  
,0.5333333,0.8333333,0.7916667,0.625,0.7416667,0.8166667,0.9083333,0.6916667,0.775,0.825,0.71  
66667,0.7,0.7,0.75,0.725,0.6916667,0.6583333,0.6333333,0.7833333,0.8666667,0.7833333,0.783333  
3,0.6666667,1.016667,0.5916667,0.6,0.7,0.5,0.625,0.675,0.6166667,0.45, 0.8583333, -1,-1,-1,-1,-1,-  
1,-1,-1, -1,-1,-1,-1,-1,-1,-1, -  
1,0.6833333,0.775,0.8333333,0.6333333,0.5833333,0.6083333,0.725,0.8666667,0.7,0.7583333,0.775  
,0.6916667,0.725,0.5833333,0.75,0.8,0.7333333,0.6666667,0.9416667,0.85,0.7833333,0.7833333,0.6  
166667,0.6416667,0.725,0.7333333,0.7916667,0.7583333,0.75,0.825,0.7833333,0.7916667,0.766666  
7,0.6333333,0.7,0.7833333,0.7083333,0.8666667,0.7833333,0.75,0.6083333,0.6916667,0.8166667,0.  
3916667,0.8166667,0.5916667,0.7916667,0.48,0.7,0.7,0.8,0.6666667,0.8083333,0.6833333,0.691666  
7,0.9416667,0.7416667,0.7416667,-1,-1,-1-  
1,0.675,0.8416667,0.725,0.6583333,0.7583333,0.8416667,0.6833333,0.7833333,0.625,0.5416667,0.5  
083333,0.5916667,0.55,0.5916667,0.6416667,0.575,0.675,0.6,0.5416667,0.625,0.7083333,0.5333333  
,0.65,0.5,0.6,0.55,0.6416667,0.625,0.4416667,0.6,0.7333333,0.6666667,0.5533333,0.7,0.63,0.7,0.725,  
0.5416667,0.625,0.4916667,0.525,0.525,0.5416667,0.525,0.6166667,0.8166667,0.5416667,0.558333  
3,0.525,-1,  
1,-1,  
1,  
0.6666667,0.6933333,0.7866667,0.86,0.66,0.6,0.85,0.79,0.85,0.62,0.8,0.83,0.86,0.84,0.65,0.675,0.7333  
333,0.9,0.8083333,0.7833333,0.75,0.7083333,0.75,0.8166667,0.9,0.8083333,0.6083333,0.675,0.7583  
333,0.5583333,0.6166667,0.775,0.8916667,0.7333333,1.041667,0.65,0.5083333,0.7083333,0.5,0.85,  
0.85,0.6266667,0.7266667,0.8,0.7666667,0.6933333,0.75,0.72,0.85,0.83,0.97,1.12,0.68,0.77,0.84,0.77,  
0.7,0.7083333,0.8583333,0.8083333  
),

LF =

c(10.5,10.8,10.9,11,11.5,11.8,11.8,12,12.2,10.5,10.5,10.5,10.5,10.5,10,11,11,11,11,11,11,11,11.5,11.5,1  
1.5,11.5,11.5,11.5,11.5,11.5,11.5,11.5,12,12,12.5,12.5,12.5,13,11.5,10.6,10.7,10.8,11.4,11.7,12,12,12.1,1  
2.2,12.4,12.5,12.6,12.6,12.6,11.7,11.8,11.8,11.9,12.1,12.1,12.3,12.3,12.4,12.8,13,13.3,13.3,13.8,13.9,14,  
14.3,13,13,13,13,13.5,14,14,12,11,12,12,13.5,14,12.5,13,14,14.5,12,11.5,12,12,11.5,11.5,13,11.9,12.1,1  
2.2,12.6,12.7,12.9,12.7,13,13,13.1,13,13,13,13.5,14,12.2,13.4,15,13,13,14,17,14,14.5,7.5,7.5,7.8,8.2,8.2,  
8.3,8.4,8.5,7.5,8,8,8,8,8,8,8.5,8.5,8.5,8.5,8.5,8.5,8.5,8.5,8.5,8.5,9,9,9,9,9,10,10.5,10.5,10.5,10.5,10.5,  
10.5,8.3,8.6,8.6,8.6,8.7,8.7,8.8,8.9,9.1,9.2,9.2,9.3,9.3,9.4,9.4,9.4,9.5,9.5,9.6,9.7,10.7,10.8,10.9,11,11,9.8,  
9.8,9.9,10.1,10.2,10.4,10.4,10.5,10.5,10.6,10.9,10.9,11.2,11.2,11.3,11.4,11.5,11.7,12,9.9,9.5,9.5,10,10,10,  
10,10,11,11,12,12,9,10,10,10.5,10.5,10.5,10.5,11,11,11.5,10.5,10.5,11.5,11.5,12,12,10,12,10,10.5,10.5,1  
1,12,12,12.5,10.9,5,10,10,10,10.5,10.5,11,12,10,10.2,10.5,10.6,10.6,10.7,10.7,10.9,11.4,11.6,11.6,11.7,1  
1.7,11.8,9.5,10.5,11,11.5,11.5,11.5,12,12,12,10.3,10.4,10.6,10.6,11,11.2,11.5,11.5,11.5,11.5,11.8,11.8,12  
,12,12,12,12.3,12.4,12.5,12.7,13,13,14,10.5,10.5,11,11.5,12,12,12,13,14.5,12,12.5,14,13,14.5,14,15,7,7,  
7,7.5,7,7.5,7.2,7.5,7.8,8.5,8.5,7.8,8.3,8.5,8.7,8.8,9.5,9.5,9.5,9.5,9.5,10,10,10.5,11.9,3,9.8,10,10,10.5,10.6,  
10.8,10.8,10.5,11.5,11.6,12.3,13.2,11,11,12,12.5,10,11,11.5,12.5,12,11,12.5,13,13.5,13,14,8.5,9.9,9.5,8  
,8.5,8.5,8.5,9.5,9.9,9.5,9.5,9.5,11,12,9.5,9.5,9.5,10,11,11.5,10,10.5,10.5,11,12,13,14,16.5,5.5,5.5,6.6,6,  
6,6,6,6,6,6,6,6,6,6.4,6.5,6.5,10,10,10.5,10,10,10.5,10.5,10.5,11,11,11,11,11,11,11,11,11.5,11.5,1  
1.5,11.5,11.5,9.5,9.5,10,10,10.5,10.5,10.5,10.5,10.5,10.5,10.5,10.5,10.5,11,11.5,11.5,11.5,13.5,12,1  
2.5,12,12.5,13,13.5,12.5,14,12.3,12.4,12.2,12.9,14.3,14.4,14.5,13.2,13.3,6.6,5.6,5.7,7,7,7,7,7.5,8,8.5,10,  
10.3,10.3,10.5,10.5,10.5,10.6,10.6,10.7,10.8,11.2,11.3,11.3,11.4,11.4,10,10,10.5,10,10.8,11,11,13,11.5,1  
1.5,18,11.3,9.2,9.2,9.4,9.4,9.5,9.5,9.6,9.7,9.8,12,9.3,9.3,10.3,6.5,6.5,6.5,6.5,7,7,7,7,7,7,7.2,7.2,7.2,7.2,7.  
2,7.2,7.5,7.5,7.5,8.4,6,7,7.5,7.5,6,6.5,6.5,6.5,6.5,6.5,6.5,6.5,6.5,7,7,7,7,8,6,6.5,6.5,7,7,7,7.5,7.5,7.5,7  
.5,7.5,7.5,7.5,7.5,7.5,7.5,8,8.5,7,7.5,7.5,7.5,7.5,7.5,7.5,7.5,7.5,8,8,14,14,10.5,11.5,12.2,12.5,12.5,  
12.5,12.9,13.3,13.4,14,14.5,14.5,8.2,8.6,8.7,9.9,1.9,6.7,8.7,9.8,8.3,8.6,8.8,8.8,5.8,7.8,8.9,9.5,13.8,14,  
14.5,15.5,16,14,14.5,9.5,10,12.5,12.5,13.9,9,10.5,10.8,11.4,11.8,12,12.3,12.5,13,13,11.7,12,12.3,13.5))

Data\_R.txt

# Z. Asper data for KMAE 2013

# Fish scale (LS) and fork length (LF) size are in the same order

# Observations are ordered by cohorts from 1997 to 2004

# Starting position of each cohorts in the size vectors

N=c(1,119,314,368,400,478,531,649,668)

# Numbers of fish per cohort

Nb= c(118,314-119,368-314,400-368,478-400,531-478,649-531,668-649)

# Scale length at capture

LS =

c(1.491667,1.566667,1.533333,1.808333,1.591667,1.633333,1.625,1.933333,1.991667,1.375,1.266667,1.241667,1.308333,1.308333,1.575,1.858333,1.666667,1.533333,1.45,1.733333,1.191667,1.441667,1.116667,1.35,1.45,1.491667,1.458333,1.266667,1.416667,1.691667,1.733333,1.6,1.758333,1.325,1.708333,1.716667,2.233333,1.858333,1.925,1.508333,1.508333,1.466667,1.608333,1.883333,1.841667,1.9,1.708333,1.5,1.537255,1.591667,2.05,1.725,1.858333,1.308333,1.691667,1.791667,1.75,1.9125,1.683333,1.658333,1.85,1.491667,1.8,1.658333,1.833333,2.083333,2.016667,2.15875,1.95,1.95,1.9,2.125,1.513725,1.725,2.054902,2.116667,1.925,1.825,2.025,2.133333,2.091667,2.508333,2.233333,2.625,2.391667,2.178333,2.0875,1.725,1.7,1.65,1.966667,2.15,1.808333,1.516667,1.85,1.533333,1.683333,1.458333,1.625,1.566667,2.108333,1.791667,1.825,2.091667,2.141667,2.05,2.091667,2.258333,2.325,2.383333,2.266667,2.125,2.475,1.416667,1.791667,2.066667,1.041667,1.058333,1.116667,1.158333,1.066667,1.191667,0.9916667,1.258333,1.05,1.116667,1.016667,1.216667,1.083333,1.016667,1.133333,1.033333,0.866667,0.933333,1.116667,1.066667,0.916667,0.816667,0.983333,1.366667,1.1,1.133333,1.275,1.125,1.2,1.15,1.291667,1.333333,1.375,1.058333,0.991667,1.291667,1.141667,1.116667,1.545098,1.623529,1.616667,1.019608,1.241667,1.231373,1.231373,1.275,1.333333,1.333333,1.233333,1.241667,1.433333,1.391667,1.466667,1.225,1.316667,1.258333,1.301961,1.358333,1.208333,1.35,1.225,1.566667,1.583333,1.541667,1.408333,1.475,2.033333,1.35,1.241667,1.466667,1.4125,1.458333,1.483333,1.316667,1.258333,1.475,1.408333,1.641667,1.233333,1.725,1.6125,1.4125,1.616667,1.375,1.25,1.591667,1.266667,1.560784,1.316667,1.35,1.45,1.241667,1.583333,1.625,1.458824,1.55,1.933333,1.708333,2.016667,1.516667,1.616667,1.366667,1.791667,1.775,1.508333,1.725,1.591667,1.691667,1.783333,1.233333,1.6,1.5125,1.675,1.908333,1.791667,1.683333,1.583333,1.366667,1.516667,1.375,1.675,1.85,1.708333,1.866667,1.325,1.575,1.366667,1.341667,1.366667,1.766667,1.591667,1.541667,1.516667,1.216667,1.225,1.3625,1.241667,1.275,1.233333,1.483333,1.366667,1.45,1.483333,1.566667,1.366667,1.45,1.95,1.416667,1.333333,1.641667,1.666667,1.583333,1.716667,1.5,2,1.841667,1.875,1.616667,1.75,1.641667,1.691667,1.775,1.75,1.858333,1.741667,1.733333,2.025,1.733333,1.8,1.933333,1.75,1.95,2.083333,2.008333,1.966667,1.741667,1.941667,2.033333,2.041667,1.966667,1.633333,1.566667,1.758333,1.983333,1.7,1.4,0.75,1.666667,1.491667,1.416667,1.8875,1.633333,1.741667,1.75,1.775,0.758333,0.866667,0.7137255,0.866667,0.883333,0.741667,0.991667,0.808333,1.025,0.991667,1.116667,0.783333,0.933333,0.9,0.925,0.883333,1.283333,1.341667,1.125,1.458333,1.308333,1.283333,1.233333,1.366667,1.508333,1.608333,1.458333,1.358333,1.6,1.516667,1.641667,1.491667,1.55,1.4,1.525,1.641667,1.308333,1.4,1.416667,1.716667,1.408333,1.425,1.508333,1.208333,1.433333,1.55,1.633333,1.441667,1.35,1.7,1.55,1.441667,1.625,1.441667,1.175,1.066667,1,1.075,1.108333,1.191667,1.075,1.108333,1.183333,1.041667,0.983333,1.116667,1.15,1.208333,1.166667,1.083333,1.408333,1.533333,1.3,1.233333,1.225,1.05,1.375,1.391667,0.991667,1.216667,0.908333,1.191667,1.366667,1.558333,1.641667,2.633333,0.425,0.5,0.533333,0.541667,0.458333,0.491667,0.475,0.516667,0.616667,0.425,0.608333,0.541667,0.491667,0.575,0.458333,0.491667,0.441667,0.566667,0.608333,0.55,1.283333,1.241667,1.316667,1.108333,1.241667,1.116667,1.3,1.35,1.166667,1.225,1.241667,1.291667,1.183333,1.166667,1.291667,1.366667,1.416667,1.208333,1.483333,1.433333,1.483333,1.275,1.083333,1.008333,1.383333,1.266667,1.408333,1.408333,1.358333,1.525,1.325,1.316667,1.441667,1.333333,1.408333,1.25,1.35,1.5,1.43

3333,1.45,1.766667,1.625,1.941667,1.366667,1.491667,1.683333,1.616667,0.96,1.84,1.891667,1.9,1.95,2.083333,2.016667,2.4,2.641667,1.9,2.075,0.683333,0.75,0.6416667,0.7583333,0.85,1.041667,0.95,0.8416667,0.8666667,1.016667,0.8583333,1.058333,1.325,1.233333,1.058333,1.266667,1.266667,1.233333,1.325,1.175,1.483333,1.241667,1.208333,1.325,1.416667,1.158333,1.325,1.233333,1.208333,1.2,1.25,1.225,0.75,1.366667,1.283333,1.591667,1.226667,1.653333,1.958333,1.85,1.4,1.425,1.533333,1.516667,1.383333,1.441667,1.575,1.425,1.433333,1.9,1.4,1.566667,1.475,0.6083333,0.6083333,0.65,0.5833333,0.75,0.6833333,0.6333333,0.6166667,0.8083333,0.7333333,0.7,0.7416667,0.8666667,0.7833333,0.5833333,0.825,0.6833333,0.7416667,0.7666667,0.825,0.7083333,0.8583333,0.7916667,0.7583333,0.7666667,0.7916667,0.75,0.7083333,0.65,0.6333333,0.7333333,0.6333333,0.6083333,0.8166667,0.6333333,0.5833333,0.6333333,0.625,0.575,0.675,0.95,0.6583333,0.7583333,0.6416667,0.6166667,0.6333333,0.6833333,0.5833333,0.5333333,0.5916667,0.7416667,0.7166667,0.8166667,0.8,0.65,0.775,0.725,0.7833333,0.6833333,0.6416667,0.675,0.775,0.8,0.8,0.8166667,0.76,0.6666667,0.8733333,0.7533333,0.7933333,0.7666667,0.88,0.7866667,0.8466667,0.74,0.8733333,0.8866667,1.706667,1.82,1.546667,1.486667,1.55,1.725,1.858333,1.683333,1.65,1.7,1.75,1.85,1.991667,1.908333,1.091667,1.158333,1.275,1.375,1.333333,1.291667,1.175,1.158333,1.283333,1.341667,1.275,1.25,1.025,1.108333,1.225,1.058333,1.15,1.225,1.325,1.2,2.575,2.35,1.908333,2.125,2.266667,2.216667,2.55,1.053333,1.326667,1.526667,1.62,1.486667,1.35,1.35,1.47,1.66,1.82,1.98,1.533333,1.425,1.658333,1.491667,1.925,2.058333,2.083333,2 )

# Scale length at one year old

LS1 <- c( 0.725,0.7916667,0.6916667,0.7083333,0.625,0.575,0.625,0.8,0.9,0.5416667,0.4666667,0.7166667,0.6166667, 0.5916667,0.9,0.55,0.5166667,0.7583333,0.6,0.7083333,0.525,0.4416667,0.6916667,0.6,0.75,0.6083333, 0.5583333,0.625,0.5916667,0.825,0.75,0.7416667,0.7416667,0.5916667,0.6666667,0.5333333,0.875, 0.7333333,0.8166667,0.5166667,0.5333333,0.5083333,0.5666667,0.8333333,0.7333333,0.875,0.7416667, 0.5833333,0.4392157,0.575,0.7333333,0.675,0.5583333,0.425,0.6583333,0.6833333,0.6,0.6625,0.775, 0.5083333,0.6,0.5666667,0.675,0.575,0.575,0.65,0.6583333,0.575,0.5125,0.625,0.6416667,0.4916667, 0.8166667,0.5960784,0.5083333,0.6039216,0.5416667,0.8375,0.65,0.8583333,0.7583333,0.8,0.8333333, 0.75,0.7,0.65,0.6083333,0.6083333,0.775,0.55,0.6083333,0.6166667,0.8083333,0.7416667,0.6166667, 0.7166667,0.5083333,0.6583333,0.5083333,0.5,0.4916667,0.7166667,0.7166667,0.625,0.7333333,0.6666667, 0.7166667,0.6666667,0.725,0.7166667,0.825,0.7333333,0.7083333,0.825,0.45,0.625,0.5833333,0.725,0.7166667, 0.775,0.7916667,0.7083333,0.925,0.7333333,0.8333333,0.6,0.525,0.6,0.7833333,0.6916667,0.6166667, 0.65, 0.6916667,0.55,0.5416667,0.6916667,0.5583333,0.55,0.5,0.525,0.8416667,0.5666667,0.575,0.675,0.65, 0.6333333,0.75,0.6916667,0.7833333,0.7,0.6083333,0.7666667,0.525,0.6166667,0.8156863,0.8627451,0.8583333, 0.5019608,0.6666667,0.4862745,0.572549,0.6666667,0.6916667,0.675,0.825,0.6666667,0.725,0.7083333,0.7, 0.6416667,0.7083333,0.45,0.6666667,0.675,0.6583333,0.85,0.5833333,0.8833333,0.725,0.725,0.7166667, 0.7166667,0.925,0.5333333,0.5666667,0.6666667,0.575,0.7333333,0.7833333,0.7333333,0.5,0.65,0.5833333,



```

0.85,0.79,0.85,0.62,0.8,0.83,0.86,0.84,0.65,0.675,0.7333333,0.9,0.8083333,0.7833333,0.75,0.7083333,
0.75,
0.8166667,0.9,0.8083333,0.6083333,0.675,0.7583333,0.5583333,0.6166667,0.775,0.8916667,0.7333
333,1.041667,
0.65,0.5083333,0.7083333,0.5,0.85,0.85,0.6266667,0.7266667,0.8,0.7666667,0.6933333,0.75,0.72,0.8
5,0.83,
0.97,1.12,0.68,0.77,0.84,0.77,0.7,0.7083333,0.8583333,0.8083333
)

```

# Fork length

LF =

```

c(10.5,10.8,10.9,11,11.5,11.8,11.8,12,12.2,10.5,10.5,10.5,10.5,10.5,10,11,11,11,11,11,11,11,11.5,11.5,1
1.5,11.5,11.5,11.5,11.5,11.5,11.5,11.5,11.5,12,12,12.5,12.5,12.5,13,11.5,10.6,10.7,10.8,11.4,11.7,12,12,12.1,1
2.2,12.4,12.5,12.6,12.6,12.6,11.7,11.8,11.8,11.9,12.1,12.1,12.3,12.3,12.4,12.8,13,13.3,13.3,13.3,13.8,13.9,14,
14.3,13,13,13,13,13.5,14,14,12,11,12,12,13.5,14,12.5,13,14,14.5,12,11.5,12,12,11.5,11.5,13,11.9,12.1,1
2.2,12.6,12.7,12.9,12.7,13,13,13.1,13,13,13.5,14,12.2,13.4,15,13,13,14,17,14,14.5,7.5,7.5,7.8,8.2,8.2,
8.3,8.4,8.5,7.5,8.8,8.8,8.8,8.8,8.5,8.5,8.5,8.5,8.5,8.5,8.5,8.5,8.5,8.5,8.5,8.5,9.9,9.9,9.9,9.9,10,10.5,10.5,10.5,10.5,
10.5,8.3,8.6,8.6,8.6,8.7,8.7,8.8,8.9,9.9,1.9,2.9,2.9,3.9,3.9,4.9,4.9,4.9,5.9,5.9,5.9,6.9,7.0,7.0,10.8,10.9,11,11,9.8,
9.8,9.9,10.1,10.2,10.4,10.4,10.5,10.5,10.6,10.9,10.9,11.2,11.2,11.3,11.4,11.5,11.7,12.9,9.9,9.5,9.5,10,10,10,
10,10,11,11,12,12.9,10,10,10.5,10.5,10.5,10.5,11,11,11.5,10.5,10.5,11.5,11.5,12,12,10,12,10,10.5,10.5,1
1,12,12,12.5,10,9.5,10,10,10,10.5,10.5,11,12,10,10.2,10.5,10.6,10.6,10.7,10.7,10.9,11.4,11.6,11.6,11.7,1
1.7,11.8,9.5,10.5,11,11.5,11.5,11.5,12,12,12,10.3,10.4,10.6,10.6,11,11.2,11.5,11.5,11.5,11.5,11.8,11.8,12
,12,12,12.3,12.4,12.5,12.7,13,13,14,10.5,10.5,11,11.5,12,12,13,14.5,12,12.5,14,13,14.5,14,15,7,7,
7,7.5,7.5,7.2,7.5,7.8,8.5,8.5,7.8,8.3,8.5,8.7,8.8,9.9,9.5,9.5,9.5,9.5,10,10,10.5,11.9,3.9,8,10,10,10.5,10.6,
10.8,10.8,10.5,11.5,11.6,12.3,13.2,11,11,12,12.5,10,11,11.5,12.5,12,11,12.5,13,13.5,13,14,8.8,5.9,9.9,9.5,8
,8.5,8.5,8.5,9.9,9.9,9.5,9.5,9.5,11,12.9,5.9,9.5,10,11,11.5,10,10.5,10.5,11,12,13,14,16.5,5.5,5.5,6.6,6,
6,6,6,6,6,6,6,6,6,6.4,6.5,6.5,10,10,10.5,10,10,10.5,10.5,10.5,11,11,11,11,11,11,11,11,11.5,11.5,1
1.5,11.5,11.5,9.5,9.5,10,10,10.5,10.5,10.5,10.5,10.5,10.5,10.5,10.5,10.5,10.5,11,11.5,11.5,11.5,13.5,12,1
2.5,12,12.5,13,13.5,12.5,14,12.3,12.4,12.2,12.9,14.3,14.4,14.5,13.2,13.3,6.6,6.5,6.5,7.7,7.7,7.5,8.8,8.5,10,
10.3,10.3,10.5,10.5,10.5,10.6,10.6,10.7,10.8,11.2,11.3,11.3,11.4,11.4,10,10,10.5,10,10.8,11,11,13,11.5,1
1.5,18,11.3,9.2,9.2,9.4,9.4,9.5,9.5,9.6,9.7,9.8,12.9,3.9,3.9,10.3,6.5,6.5,6.5,6.5,7.7,7.7,7.7,7.7,7.2,7.2,7.2,7.2,7.
2,7.2,7.5,7.5,7.5,8.4,6.7,7.5,7.5,6.6,6.5,6.5,6.5,6.5,6.5,6.5,6.5,7.7,7.7,7.8,6.6,6.5,6.5,7.7,7.7,7.5,7.5,7.5,7
.5,7.5,7.5,7.5,7.5,7.5,8.8,8.5,7.7,7.5,7.5,7.5,7.5,7.5,7.5,7.5,7.5,8.8,14,14,10.5,11.5,12.2,12.5,12.5,
12.5,12.9,13.3,13.4,14,14.5,14.5,8.2,8.6,8.7,9.9,1.9,6.7,8.7,9.8,8.3,8.6,8.8,8.5,8.7,8.7,8.8,9.9,9.5,13.8,14,
14.5,15.5,16,14,14.5,9.5,10,12.5,12.5,13.9,9,10.5,10.8,11.4,11.8,12,12.3,12.5,13,13,11.7,12,12.3,13.5)

```

# Final data frame

```

mydata <- data.frame(LS=LS, LS1=LS1, LF=LF, Cohorts= rep(1997:2004, Nb),pop=rep("Durance",667))

```