FIGURAS Y TABLAS PRIMER INFORME ESTATUS Y CBA 2022 SARDINA AUSTRAL LOS LAGOS

PRIMER PARTE: CORRE CÓDIGOS Y FUNCIONES

```
library(knitr) # para generar reporte Rmarkdown
library(stringr)
library(reshape)
library(dplyr)
library(ggplot2)
library(ggthemes) # para ggplot
library(patchwork) # para unir gráficos de ggplot
library(strucchange) # libreria utilizada para análisis de quiebres

dir.Fig     <-"Figuras/" # carpeta de las figuras utilizadas y generadas en este estudio
fig         <-c("pdf") # formato de figuras generadas por este código
dir.0       <-getwd() # directorio de trabajo
dir.1       <-paste(dir.0,"/codigos_admb",sep="") # carpeta de códigos ADMB
dir.2       <-paste(dir.0,"/Retrospectivobase",sep="") # carpeta de códigos ADMB
dir.3       <-paste(dir.0,"/Retrospectivoalternativo",sep="") # carpeta de códigos ADMB
dir.4       <-paste(dir.0,"/Verosimilitudalternativo",sep="") # carpeta de códigos ADMB
dir.5       <-paste(dir.0,"/Verosimilitudbase",sep="") # carpeta de códigos ADMB

dir.fun     <-paste(dir.0,"/funciones/",sep="") # carpeta de funciones utilizadas en este informe
source(paste(dir.fun,"functions.R",sep="")) # funciones para leer .dat y .rep
source(paste(dir.fun,"Fn_PBRs.R",sep="")) # funciones para leer .dat y .rep
```

```
setwd(dir.1)
#Asesoría septiembre 2021 MODELO BASE NUEVO
data.0    <- lisread(paste(dir.1,"MAT0921.dat", sep='/'));
names(data.0)<-str_trim(names(data.0), side="right")
rep0      <- reptoRlist("MAT0921.rep")
std0      <- read.table("MAT0921.std",header=T,sep="",na="NA",fill=T)
```

FUNCIÓN DE RETROSPECTIVO

FUNCIÓN DE VEROSIMILITUD

FUNCIÓN DE CBA

CÁLCULO DE TAMAÑO DE MUESTRA

```
#============================================================#
# II. COMPOSICI?N EDAD DE LAS CAPTURAS                       #
#============================================================#
years  <- data.0$Ind[,1]
nyears <- data.0$nanos
```

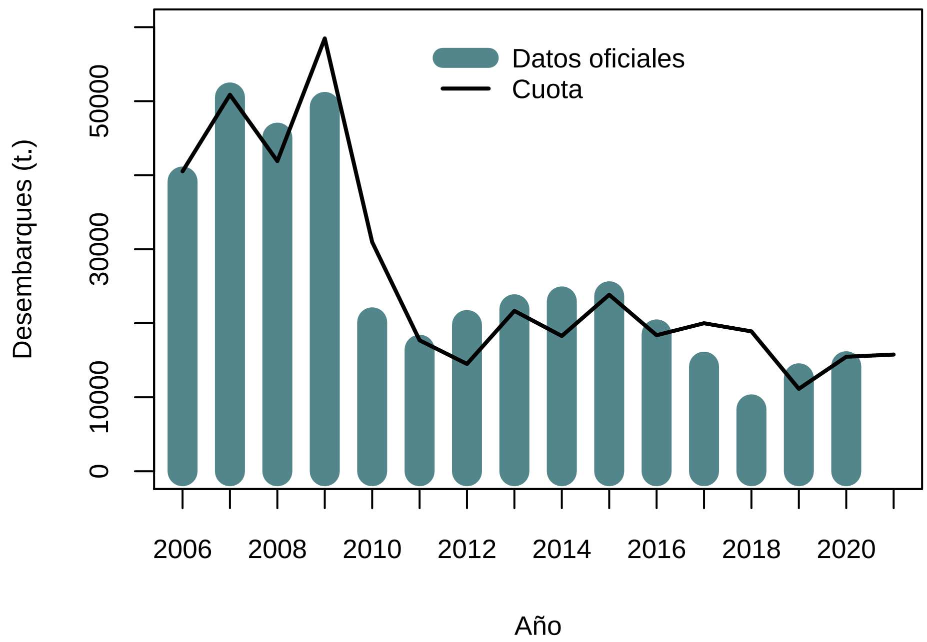
```r
age  <-seq(5.5,20,0.5)
nage<-length(age)
#Proporci?n observada
pobsF<-rep0$pf_obs
pobsR<-rep0$pobs_RECLAN

#Proporci?n predicha
ppredF<-rep0$pf_pred
ppredR<-rep0$ppred_RECLAN

#==============================================================#
# M?TODO de Francis
#==============================================================#
Nf1 <-60
Nr1 <-34
#-----------------------------------------#
#FLOTA
fanos<-years
fobs <-pobsF
fpre <-ppredF
#RECLAS
ranos<-years
robs <-pobsR[rowSums(pobsR)>0,]
rpre <-ppredR[rowSums(pobsR)>0,]
#composicion de edad Flota
Of  <- rep(0,length(fanos))
Ef  <- rep(0,length(fanos))
vf  <- rep(0,length(fanos))
vNf <- rep(0,length(fanos))
#composicion de edad crucero de verano reclas
Or  <- rep(0,length(robs[,1]))
Er  <- rep(0,length(robs[,1]))
vr  <- rep(0,length(robs[,1]))
vNr <- rep(0,length(robs[,1]))
#-----------------------------------------#
#composicion de edad Flota
for(i in 1:length(fanos)){
    Of[i]  <- sum(fobs[i,]*age)
    Ef[i]  <- sum(fpre[i,]*age)
    vf[i]  <- sum(fpre[i,]*age^2)-Ef[i]^2
    vNf[i] <- vf[i]/Nf1}
#composicion de edad crucero de verano reclas
for(i in 1:length(robs[,1])){
    Or[i]  <- sum(robs[i,]*age)
    Er[i]  <- sum(rpre[i,]*age)
    vr[i]  <- sum(rpre[i,]*age^2)-Er[i]^2
    vNr[i] <- vr[i]/Nr1}
#------------------------------------------#
wf  <- 1/var((Of-Ef)/sqrt(vNf)) #Flota
wr  <- 1/var((Or-Er)/sqrt(vNr)) #Reclas
Nf2 <- Nf1*wf                   # NM FLOTA
Nr2 <- Nr1*wr                   # NM RECLAS
```

```r
#------------------------------------------------------------------#
#NM_Fran <- data.frame(nmF=c(Nf1,Nf2),nmR=c(Nr1,Nr2));NM_Fran
#------------------------------------------------------------------#
#==================================================================#
# M?todo de Ianelli 2002
#==================================================================#
#Composici?n de edad de la FLOTA
Ofl <-ppredF[rowSums(pobsF)>0,]*(1-ppredF[rowSums(pobsF)>0,])
Efl <-(pobsF[rowSums(pobsF)>0,]-ppredF[rowSums(pobsF)>0,])^2
wfl <-rep(0,length(Ofl[,1]))
for(i in 1:length(Ofl[,1])){
    wfl[i] <-sum(Ofl[i,])/sum(Efl[i,])}

nmf_ari <-mean(wfl)                      # MEDIA ARITMETICA
nmf_geo <-exp(sum(log(wfl))/length(wfl)) # MEDIA GEOM?TRICA
nmf_arm <-1/mean(1/wfl)                  # MEDIA ARM?NICA

#------------------------------------------------------------
#Composici?n de edad Crucero de verano RECLAS
Ore <-ppredR[rowSums(pobsR)>0,]*(1-ppredR[rowSums(pobsR)>0,])
Ere <-(pobsR[rowSums(pobsR)>0,]-ppredR[rowSums(pobsR)>0,])^2
wre <-rep(0,length(Ore[,1]))
for(i in 1:length(Ore[,1])){
    wre[i] <-sum(Ore[i,])/sum(Ere[i,])}
nmr_ari <-mean(wre)                      # MEDIA ARITMETICA
nmr_geo <-exp(sum(log(wre))/length(wre)) # MEDIA GEOM?TRICA
nmr_arm <-1/mean(1/wre)                  # MEDIA ARM?NICA
#------------------------------------------------------------
#------------------------------------------------------------
NM_Ian <- data.frame(nmF=c(nmf_ari,nmf_geo,nmf_arm),nmR=c(nmr_ari,nmr_geo,nmr_arm));NM_Ian
#------------------------------------------------------------
```

SEGUNDA PARTE: GENERA GRÁFICAS Y TABLAS

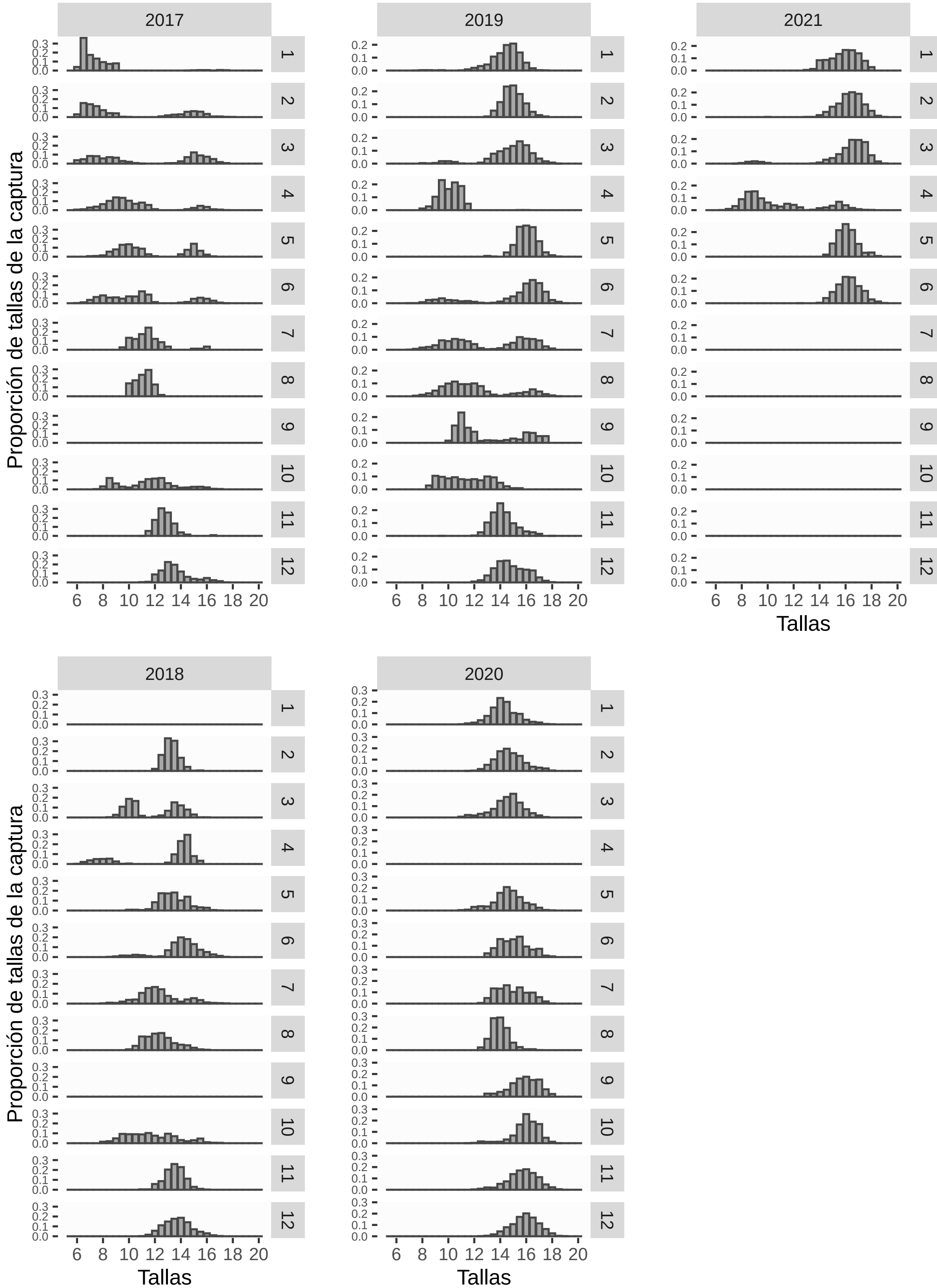
1. Antecedentes

```
year<-seq(2006,2021,1)
desemb<-c(39146,50506,45078,49225,20123,16429,19763,21888,22951,23643,18495,14134,8366,12565,14194,NA)
cuota<-c(40522,50872,41904,58481,30966,17693,14500,21670,18276,23848,18380,20000,18897,11137,15471,1576


par(mfcol=c(1,1),mar=c(4,4,1,1))
plot(year,desemb,type="h",lwd=15,ylab="Desembarques (t.)",xlab="Año",ylim=c(0,60000),xaxp=c(2000,2022,2
lines(year,cuota,type="l",lwd=2,col=1)
legend(2011,60000,c("Datos oficiales","Cuota"),lwd=c(10,2),col=c("cadetblue4",1),bty="n",cex=0.8)
```




```
datafrec<-read.table(paste(getwd(),"/Tallasmensuales.txt",sep=""),header = FALSE, sep = "")

tallas     <-seq(5.5,20,0.5)
ntallas    <-length(tallas)
etf_obs <- data.frame(datafrec[,3:32])
yearf   <- datafrec[,1]
nyearf  <-length(yearf)
month <- datafrec[,2]
nmonth <-length(month)

obs  <- as.data.frame(etf_obs) %>%
  mutate(year=yearf) %>%
  mutate(mes=month) %>%
  melt(id.vars=c('year','mes'))%>%
  mutate(talla = rep(tallas, each=nyearf))


fig0 <-   ggplot(filter(obs,year==2017)) +
```

```
        geom_bar(aes(x = talla, y = value), stat="identity", fill='gray66', color = 'gray28') +
        facet_grid(mes~year) +
        labs(x = '', y = 'Proporción de tallas de la captura')  +
        theme(panel.background = element_rect(fill ="gray99"),axis.text.y = element_text(hjust = 1, si
        theme(panel.grid=element_line(color=NA)) +
        scale_x_continuous(breaks = seq(from = 2, to = 20, by = 2))+
        scale_y_continuous(breaks = seq(from = 0, to = 0.3, by = 0.1))

fig1 <-  ggplot(filter(obs,year==2018)) +
        geom_bar(aes(x = talla, y = value), stat="identity", fill='gray66', color = 'gray28') +
        facet_grid(mes~year) +
        labs(x = 'Tallas', y = 'Proporción de tallas de la captura')  +
        theme(panel.background = element_rect(fill ="gray99"),axis.text.y = element_text(hjust = 1, si
        theme(panel.grid=element_line(color=NA)) +
        scale_x_continuous(breaks = seq(from = 2, to = 20, by = 2)) +
        scale_y_continuous(breaks = seq(from = 0, to = 0.3, by = 0.1))

fig2 <-  ggplot(filter(obs,year==2019)) +
        geom_bar(aes(x = talla, y = value), stat="identity", fill='gray66', color = 'gray28') +
        facet_grid(mes~year) +
        labs(x = '', y = '')  +
        theme(panel.background = element_rect(fill ="gray99"),axis.text.y = element_text(hjust = 1, si
        theme(panel.grid=element_line(color=NA)) +
        scale_x_continuous(breaks = seq(from = 2, to = 20, by = 2))+
        scale_y_continuous(breaks = seq(from = 0, to = 0.3, by = 0.1))

fig3 <-  ggplot(filter(obs,year==2020)) +
        geom_bar(aes(x = talla, y = value), stat="identity", fill='gray66', color = 'gray28') +
        facet_grid(mes~year) +
        labs(x = 'Tallas', y = '')  +
        theme(panel.background = element_rect(fill ="gray99"),axis.text.y = element_text(hjust = 1, si
        theme(panel.grid=element_line(color=NA)) +
        scale_x_continuous(breaks = seq(from = 2, to = 20, by = 2))+
        scale_y_continuous(breaks = seq(from = 0, to = 0.3, by = 0.1))


fig4 <-  ggplot(filter(obs,year==2021)) +
        geom_bar(aes(x = talla, y = value), stat="identity", fill='gray66', color = 'gray28') +
        facet_grid(mes~year) +
        labs(x = 'Tallas', y = '')  +
        theme(panel.background = element_rect(fill ="gray99"),axis.text.y = element_text(hjust = 1, si
        theme(panel.grid=element_line(color=NA)) +
        scale_x_continuous(breaks = seq(from = 2, to = 20, by = 2))+
        scale_y_continuous(breaks = seq(from = 0, to = 0.3, by = 0.1))

fig0+fig2+fig4+fig1+fig3
```

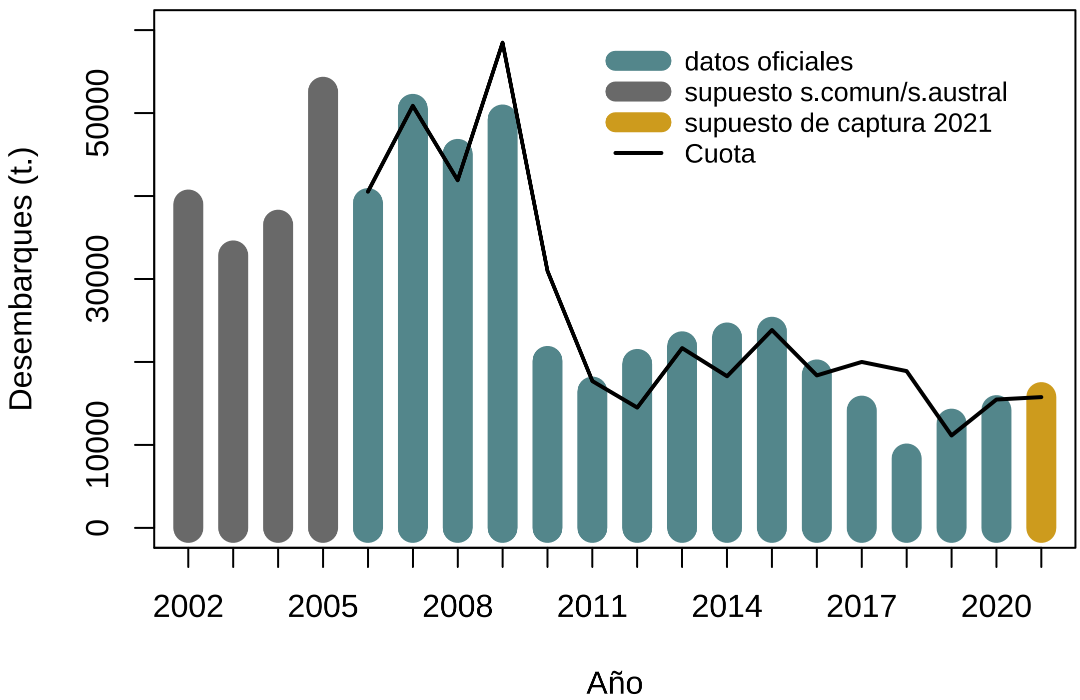

2017
2019
2021
2018
2020
Proporción de tallas de la captura
Tallas

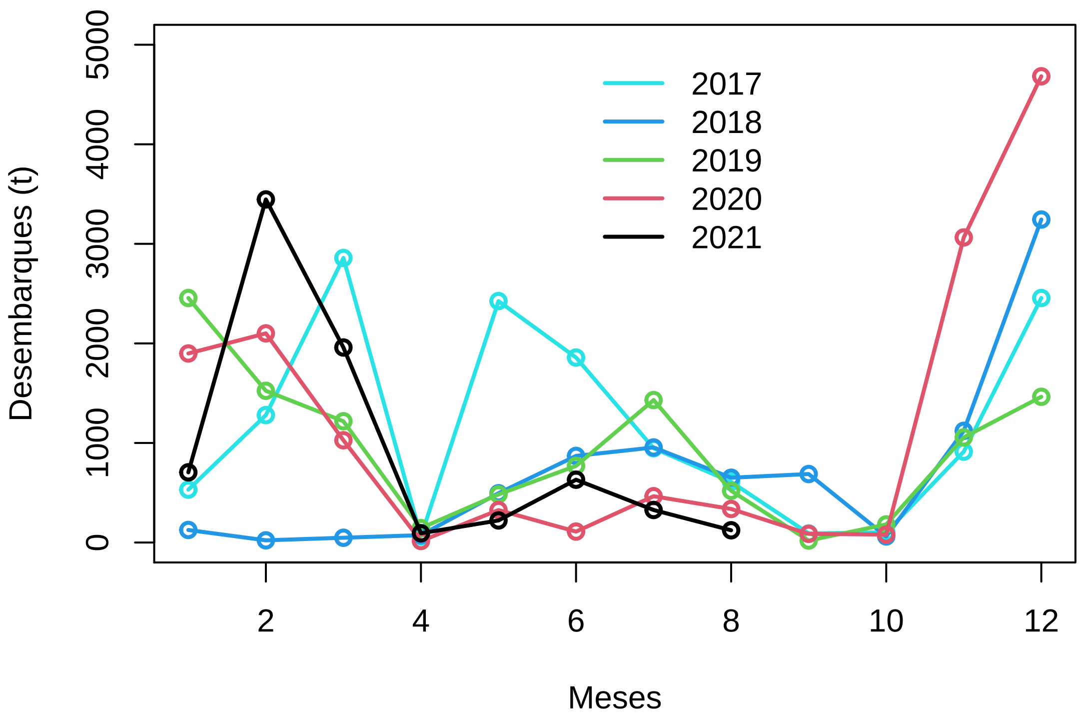
2. Metodología

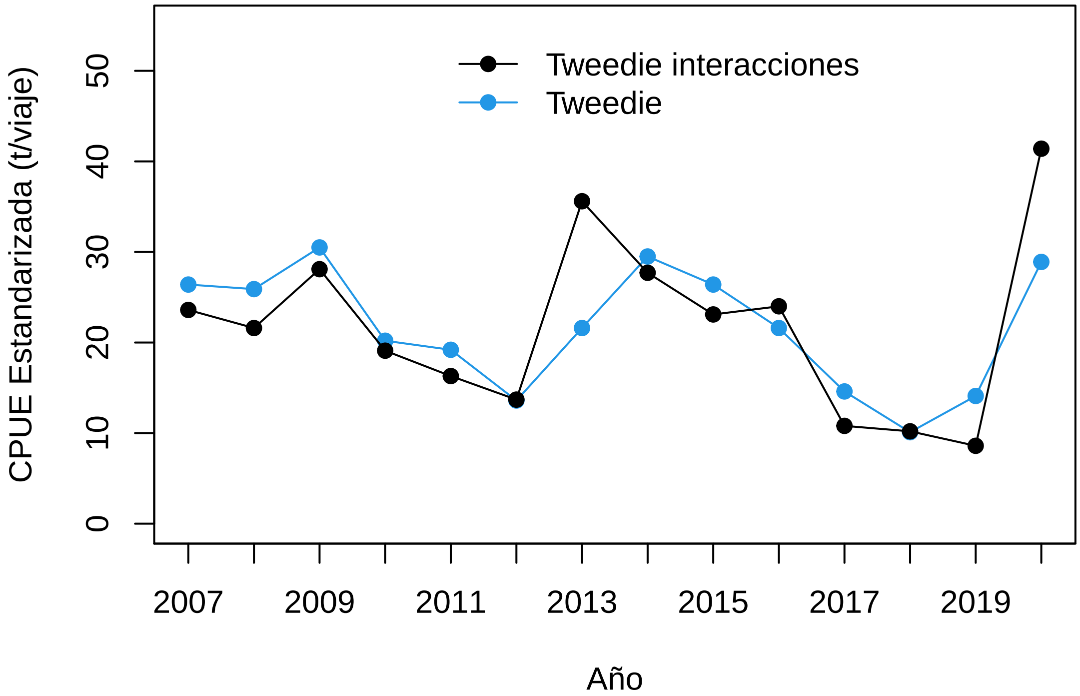
```r
dirb<-paste(dir.0,"/cba_septiembre2021",sep="")
setwd(dirb)
reps1b     <- reptoRlist("MAT0921s1.rep")
reps2b     <- reptoRlist("MAT0921s2.rep")
reps3b     <- reptoRlist("MAT0921s3.rep")



par(mfcol=c(1,1),mar=c(2,4,1,1)+0.5)

# modelo base
plot(reps1b$Years,reps1b$Reclutamiento,type="l",
     ylab="Reclutamientos",xlab="",
     main="Modelo base (Asesoría Septiembre 2020)",
     cex.axis=0.6,cex.main=0.7,cex.lab=0.7)
abline(h=c(exp(8.6053e+000),
           reps2b$Reclutamiento[11],
           reps3b$Reclutamiento[17]),col=c(1,3,2))
text(2010,c(exp(8.6053e+000),
            reps2b$Reclutamiento[11],
            reps3b$Reclutamiento[17])+1000,
            round(c(exp(8.6053e+000),
                    reps2b$Reclutamiento[11],
                    reps3b$Reclutamiento[17]),0),cex=0.7)
```

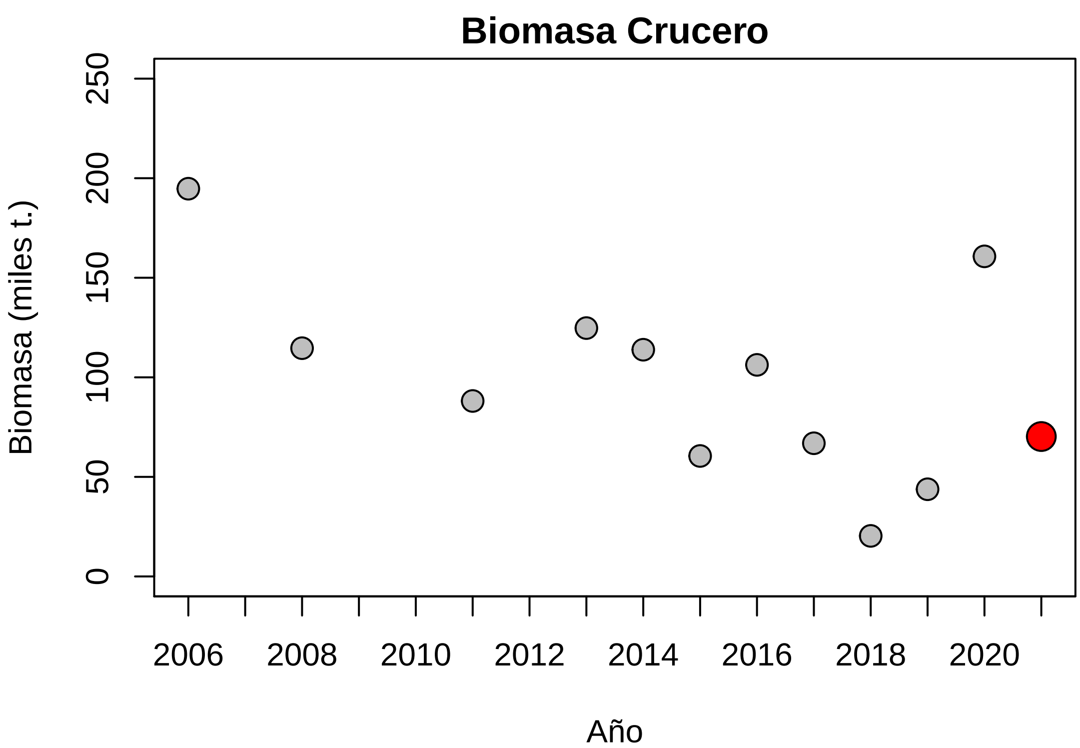
3. RESULTADOS OBJETIVO 1

3.1. Descripción de los datos de entrada al modelo de evaluación de stock





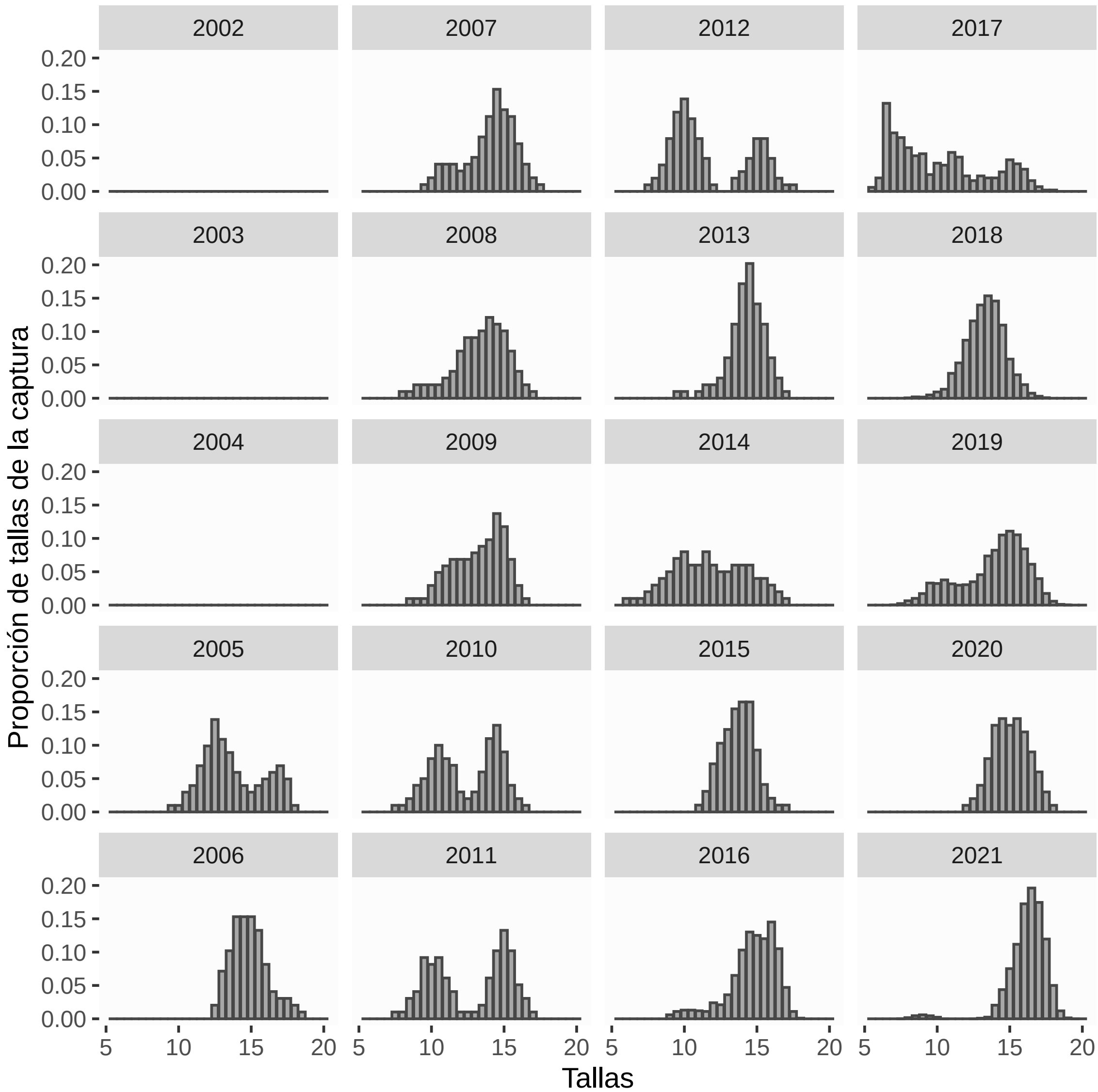




ESTRUCTURA DE TALLAS DE LA FLOTA

```
###############################################################################
# AREGLOS DE DATOS
```

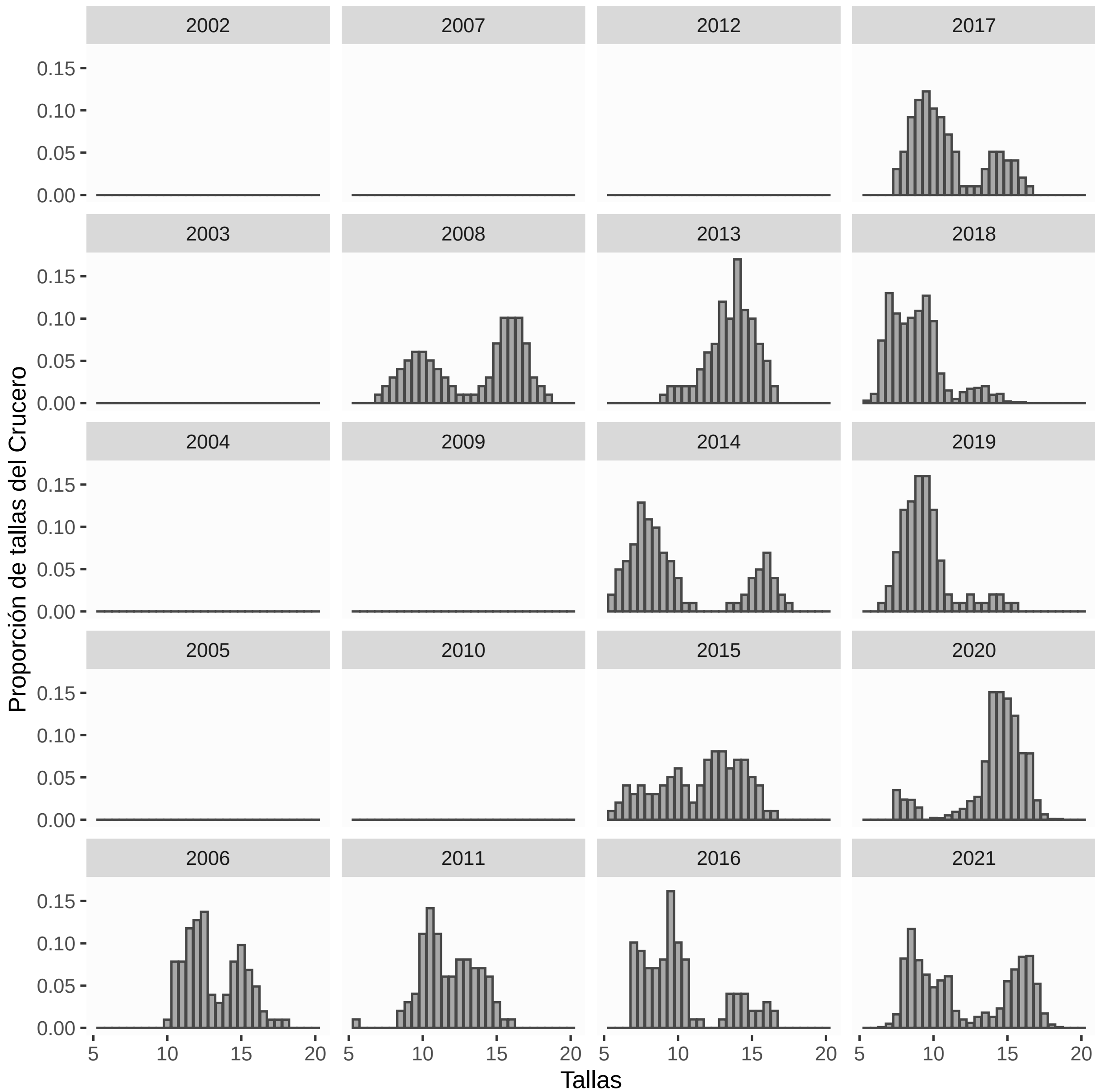
```r
#####################################################################################
age     <-seq(5.5,20,0.5)
nage    <-length(age)
etf_obs_sept <- data.frame(rep0$pf_obs)


yearf   <- rep0$YRS
nyearf  <- length(yearf)

 obs       <- as.data.frame(etf_obs_sept) %>%
                            mutate(year=yearf) %>%
                            melt(id.vars='year') %>%
                            mutate(edad = rep(age, each=nyearf)) %>%
                            mutate(type='obs')

 mat  <- rbind(obs)

#####################################################################################
# GRAFICAS
#####################################################################################
 fig1 <- ggplot(filter(mat, type=='obs')) +
        geom_bar(aes(x = edad, y = value),
                 stat="identity", fill='gray66', color = 'gray28') +
        facet_wrap(~year, dir = 'v', as.table = TRUE) +
        labs(x = 'Tallas', y = 'Proporción de tallas de la captura') +
        theme(panel.background = element_rect(fill ="gray99")) +
        theme(panel.grid=element_line(color=NA))
 fig1
```



ESTRUCTURA DE TALLAS DEL CRUCERO

```
#####################################################################################
# AREGLOS DE DATOS
#####################################################################################
age         <- seq(5.5,20,0.5)
nage        <- length(age)
etc_obs_jun <- data.frame(rep0$pobs_RECLAN)
yearc       <- rep0$YRS
nyearc      <- length(yearc)

 obs      <- as.data.frame(etc_obs_jun) %>%
                          mutate(year=yearc) %>%
                          melt(id.vars='year') %>%
                          mutate(edad = rep(age, each=nyearc)) %>%
                          mutate(type='obs')
 mat  <- rbind(obs)
```

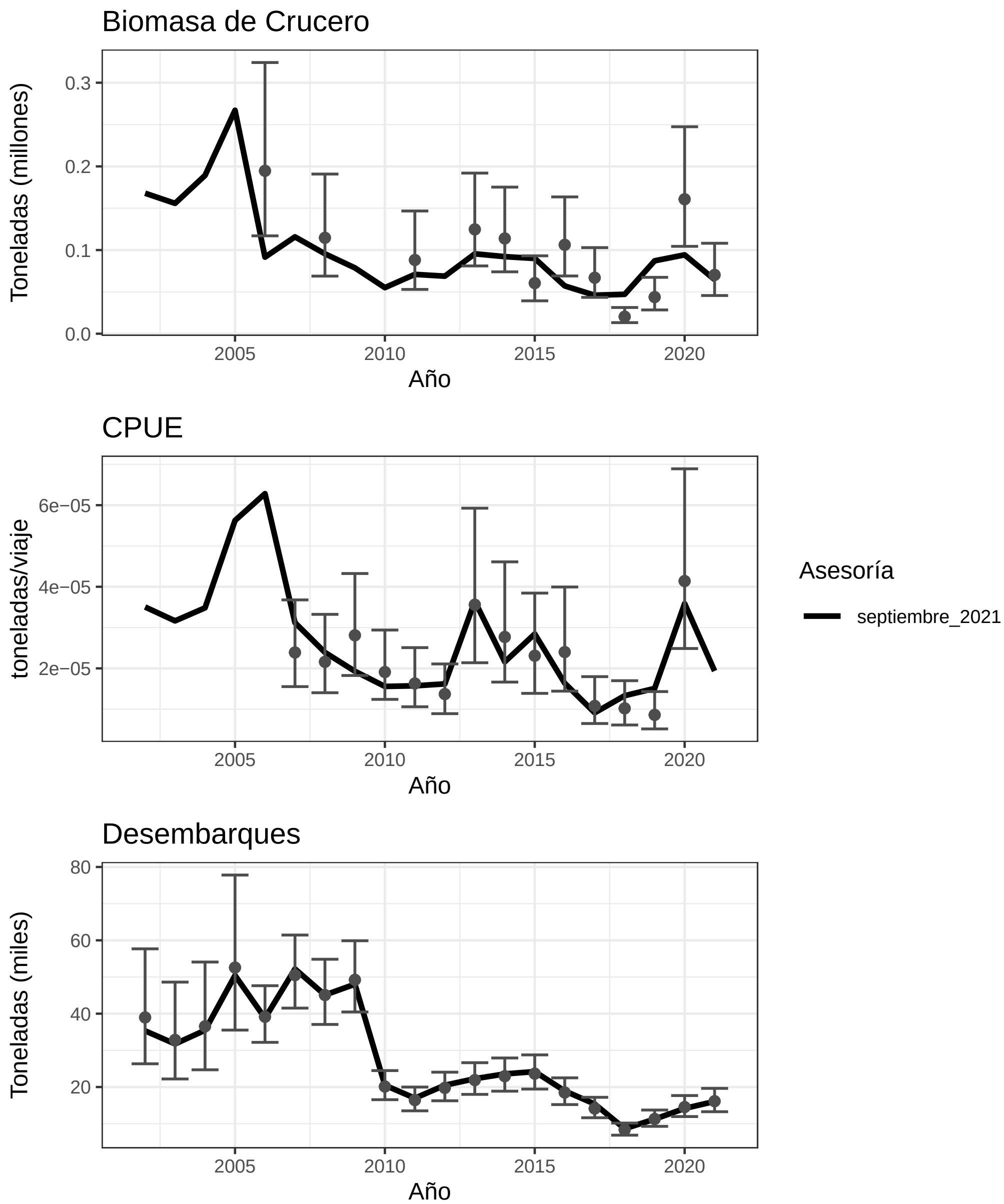
```r
################################################################################
# GRAFICAS
################################################################################
fig1 <- ggplot(filter(mat, type=='obs')) +
        geom_bar(aes(x = edad, y = value),
                 stat="identity", fill='gray66', color = 'gray28') +
        facet_wrap(~year, dir = 'v', as.table = TRUE) +
        labs(x = 'Tallas', y = 'Proporción de tallas del Crucero') +
        theme(panel.background = element_rect(fill ="gray99")) +
        theme(panel.grid=element_line(color=NA))
fig1
```



3.2. Ajustes del modelo a los datos de índices

```r
#####################################################################################
# AREGLOS DE DATOS
#####################################################################################

library(patchwork)

yrs   <- rep0$YRS
nyrs  <- length(yrs)
lasty <- yrs[nyrs]
cvCB   <-data.0$Ind[,8]
cvcpue <-data.0$Ind[,7]
cvdes  <-data.0$Ind[,6]

ind_obs  <- cbind(rep0$reclan,
                  rep0$cpue,
                  rep0$desemb);
ind_obs[ind_obs==0] <- NA
colnames(ind_obs) <- c('Biomasa_Crucero',
                       'CPUE',
                       'Desembarques')

ind_sept <- cbind(c(rep0$reclan_pred),
                  c(rep0$cpue_pred),
                  c(rep0$desemb_pred))

colnames(ind_sept) <- c('Biomasa_Crucero',
                        'CPUE',
                        'Desembarques')

ind     <- data.frame(ind_obs) %>%
           mutate(Asesoría='observado') %>%
           mutate (yrs= yrs) %>%
           melt(id.var=c('yrs', 'Asesoría'))

sept    <- data.frame(ind_sept) %>%
           mutate (Asesoría='septiembre_2021') %>%
           mutate (yrs= yrs)  %>%
           melt(id.var=c('yrs', 'Asesoría'))

base1 <- data.frame(rbind(ind, sept))

#####################################################################################
# GRAFICAS
#####################################################################################

f1 <- ggplot(base1 %>% filter(Asesoría!='observado', variable=='Biomasa_Crucero'),
        aes(yrs,value/1000000)) +
        geom_line(aes(colour=Asesoría), size=1) +
        scale_colour_manual(values=c('black')) +
        geom_point(data = base1 %>% filter(Asesoría=='observado',
                                            variable=='Biomasa_Crucero'),
        aes(yrs,value/1000000), shape = 19, colour = 'gray30') +
```

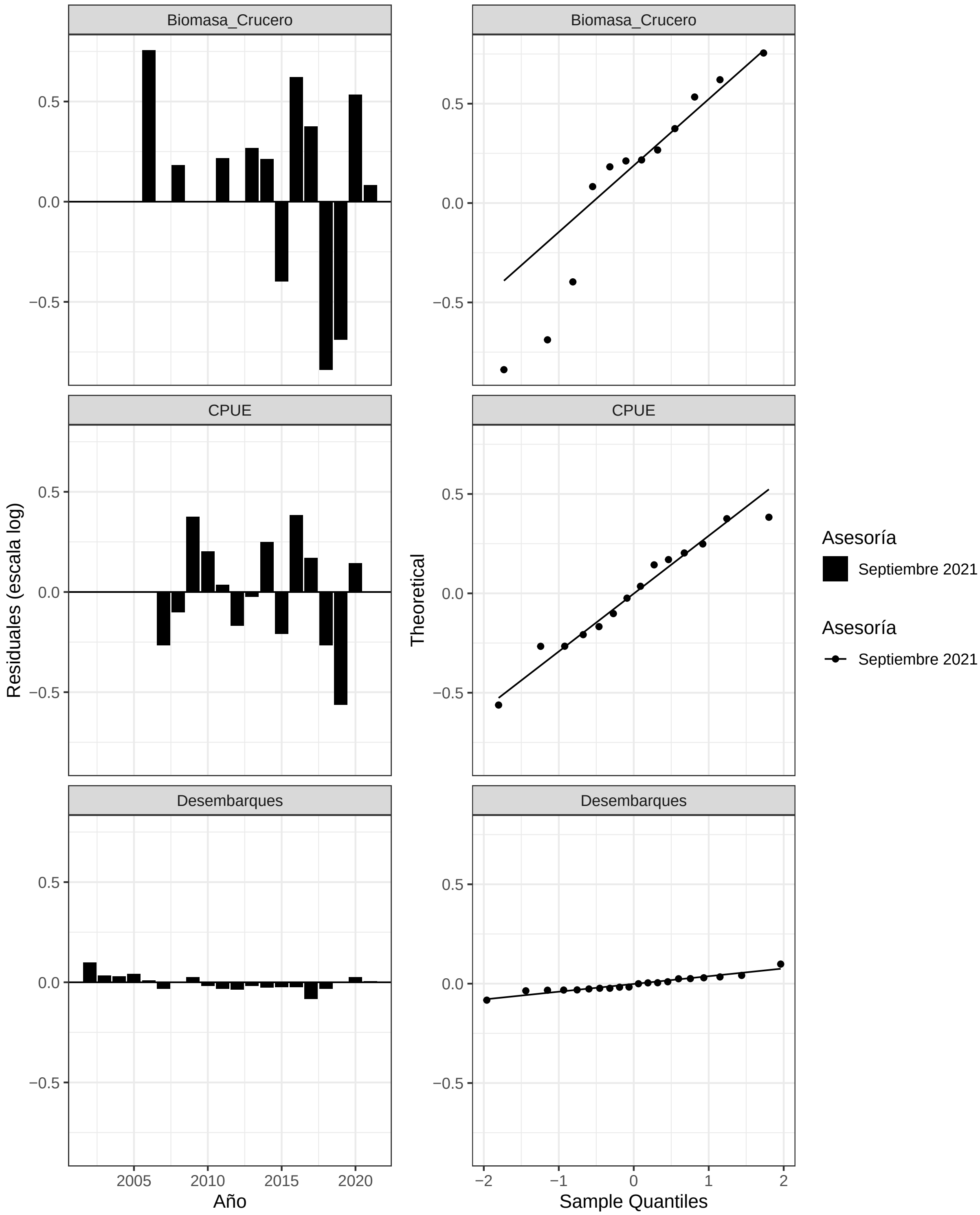
```
        geom_errorbar(data = base1 %>% filter(Asesoría=='observado',
                                              variable=='Biomasa_Crucero'),
        aes(ymin = value*exp(-1.96*cvCB)*10^-6,
            ymax = value*exp(1.96*cvCB)*10^-6), color = 'gray30') +
        scale_x_continuous(breaks = seq(from = 1985, to = 2021, by = 5)) +
        labs(title='Biomasa de Crucero', x = 'Año', y = 'Toneladas (millones)') +
        theme_bw(base_size=9)

f2 <- ggplot(base1 %>% filter(Asesoría!='observado', variable=='CPUE'),
            aes(yrs,value/1000000)) +
        geom_line(aes(colour=Asesoría), size=1) +
        scale_colour_manual(values=c('black')) +
        geom_point(data = base1 %>% filter(Asesoría=='observado',
                                           variable=='CPUE'),
        aes(yrs,value/1000000), shape = 19, colour = 'gray30') +
        geom_errorbar(data = base1 %>% filter(Asesoría=='observado',
                                              variable=='CPUE'),
        aes(ymin = value*exp(-1.96*cvcpue)*10^-6,
            ymax = value*exp(1.96*cvcpue)*10^-6), color = 'gray30') +
        scale_x_continuous(breaks = seq(from = 1985, to = 2021, by = 5)) +
        labs(title='CPUE', x = 'Año', y = 'toneladas/viaje') +
        theme_bw(base_size=9)

f3 <- ggplot(base1 %>% filter(Asesoría!='observado', variable=='Desembarques'),
        aes(yrs,value/1000)) + geom_line(aes(colour=Asesoría), size=1) +
        scale_colour_manual(values=c('black')) +
        geom_point(data = base1 %>% filter(Asesoría=='observado',
                                           variable=='Desembarques'),
        aes(yrs,value/1000), shape = 19, colour = 'gray30') +
        geom_errorbar(data = base1 %>% filter(Asesoría=='observado',
                                              variable=='Desembarques'),
        aes(ymin = value*exp(-1.96*cvdes)*10^-3,
            ymax = value*exp(1.96*cvdes)*10^-3), color = 'gray30') +
        scale_x_continuous(breaks = seq(from = 1985, to = 2021, by = 5)) +
        labs(title='Desembarques', x = 'Año', y = 'Toneladas (miles)') +
        theme_bw(base_size=9)

f1/f2/f3 + plot_layout(guides="collect")
```



Biomasa de Crucero
Toneladas (millones)
0.0
0.1
0.2
0.3
2005
2010
2015
2020
Año
CPUE
toneladas/viaje
2e−05
4e−05
6e−05
2005
2010
2015
2020
Año
Asesoría
septiembre_2021
Desembarques
Toneladas (miles)
20
40
60
80
2005
2010
2015
2020
Año

3.2. Análisis de Residuales de los índices

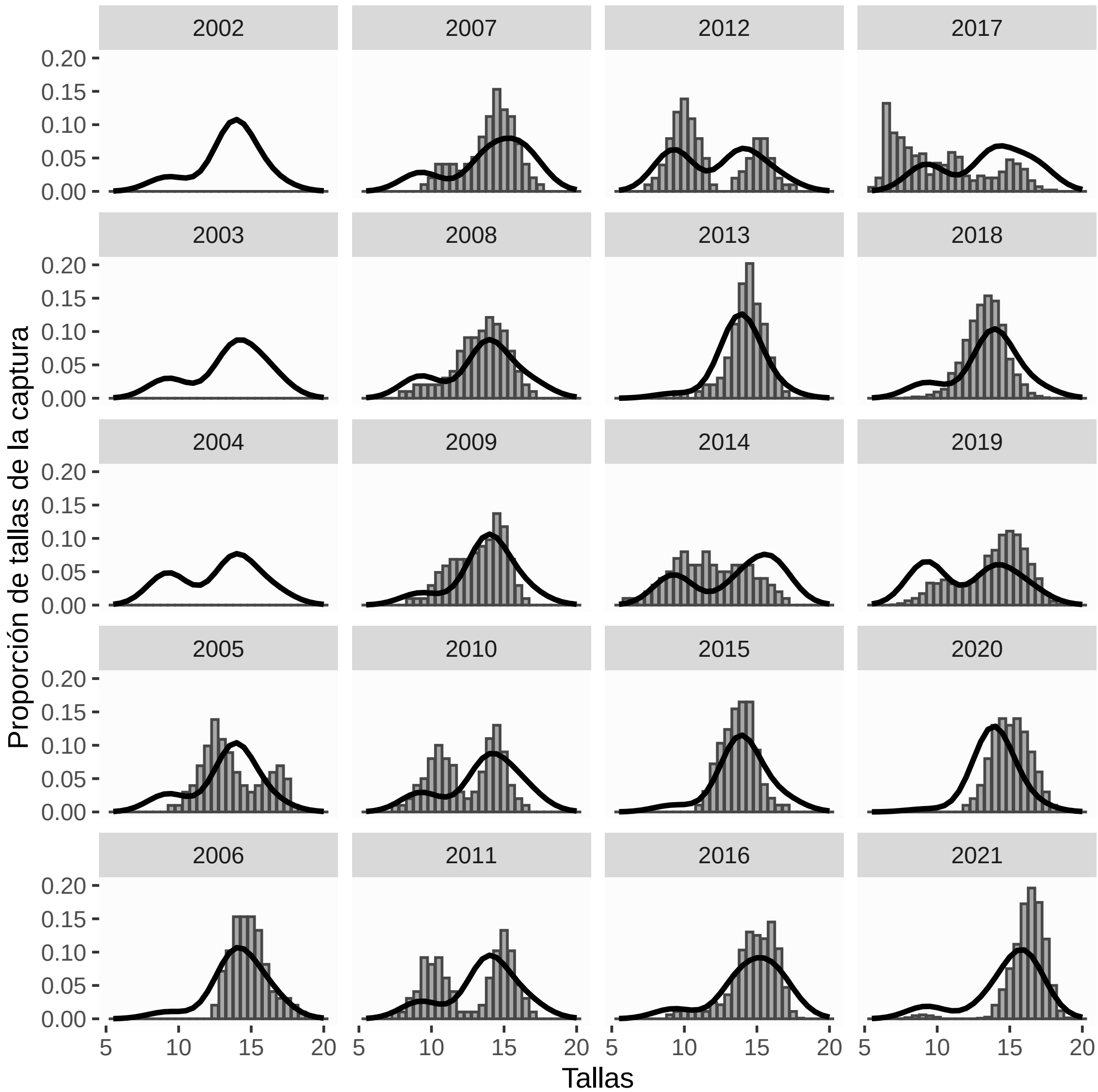
```
###########################################################################################
# AREGLOS DE DATOS
###########################################################################################

Res_matt <- data.frame(log(ind_obs) - log(ind_sept)) %>%
            mutate(yrs = yrs) %>%
            mutate(Asesoría = 'Septiembre 2021')

Res      <- rbind(Res_matt) %>%
                  melt(id.vars= c('yrs','Asesoría'))
pred     <- base1 %>%
            filter(Asesoría!='observado') %>%
            mutate (pred = log(value))

predm    <- pred$pred

Res2     <- cbind(Res,predm)

###########################################################################################
# GRAFICAS
###########################################################################################
r1 <- ggplot(Res, aes(yrs,value)) +
      geom_bar(aes(fill=Asesoría), stat='identity', position='dodge') +
      scale_fill_manual(values=c("black"))+
      geom_hline(yintercept = 0) +
      facet_wrap(. ~ variable,  ncol = 1) +
      labs(x= 'Año', y = 'Residuales (escala log)') +
      theme_bw(base_size=12)

r2 <- ggplot(Res2, aes(predm,value)) +
      geom_point(aes(colour=Asesoría), size = 1.5) +
      scale_colour_manual(values=c("black")) +
      geom_hline(yintercept = 0) +
      facet_wrap(. ~ variable, ncol = 1) +
      labs(x= 'Predicho (log)', y = 'Residuales') +
      theme_bw(base_size=12)

r3 <- ggplot(Res, aes(value, colour=Asesoría)) +
      geom_histogram(fill='white', position  = 'dodge') +
      facet_wrap(. ~ variable, ncol = 1) +
      labs(x= 'Residuales', y ='Histograma de Residuos (Frecuencia)') +
      theme_bw(base_size=12)

r4 <- ggplot(Res, aes(sample = value, colour = Asesoría)) +
      stat_qq() +
      stat_qq_line() +
      scale_colour_manual(values=c("black")) +
      facet_wrap(. ~ variable, ncol = 1) +
      labs(x= 'Sample Quantiles', y ='Theoretical') +
      theme_bw(base_size=12)

 r1+r4 + plot_layout(guides="collect")
```


Biomasa_Crucero
CPUE
Desembarques
Residuales (escala log)
Theoretical
0.5
0.0
−0.5
2005
2010
2015
2020
Año
−2
−1
0
1
2
Sample Quantiles
Asesoría
Septiembre 2021
Asesoría
Septiembre 2021

3.3. Ajustes del modelo a los datos de Composiciones de tallas

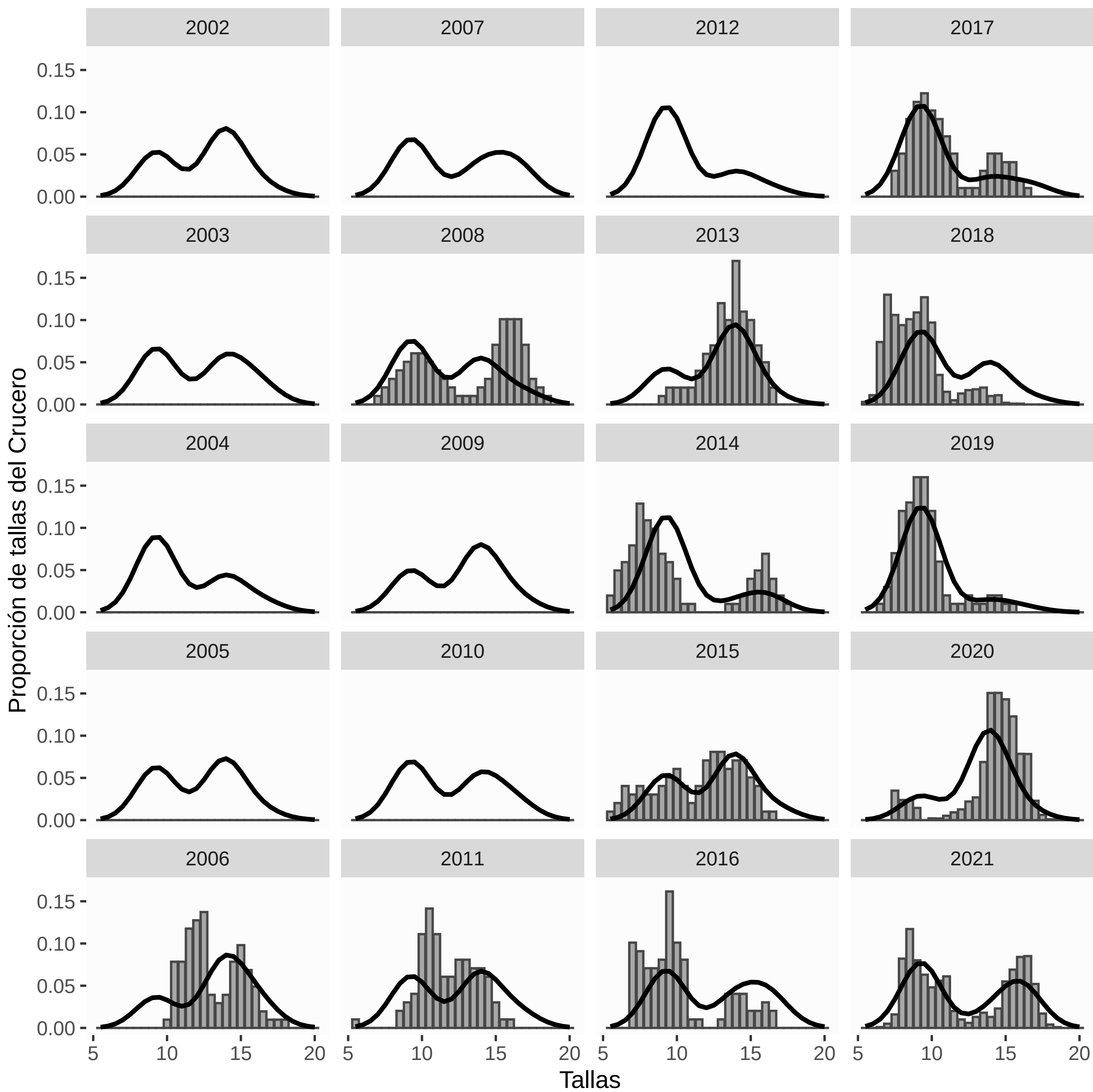
FLOTA

```
#################################################################################
# AREGLOS DE DATOS
#################################################################################
age     <-seq(5.5,20,0.5)
nage    <-length(age)

etf_obs_sept <- data.frame(rbind(rep0$pf_obs))
etf_pre_sept <- data.frame(rbind(rep0$pf_pred))

yearf   <- rep0$YRS
nyearf  <- length(yearf)

 obs       <- as.data.frame(etf_obs_sept) %>%
                           mutate(year=yearf) %>%
                           melt(id.vars='year') %>%
                           mutate(edad = rep(age, each=nyearf)) %>%
                           mutate(type='obs')


 pred_sept <- as.data.frame(etf_pre_sept) %>%
                           mutate(year=yearf) %>%
                           melt(id.vars='year') %>%
                           mutate(edad = rep(age, each=nyearf)) %>%
                           mutate(type='pred_sept')

 mat  <- rbind(obs,pred_sept)

#################################################################################
# GRAFICAS
#################################################################################
 fig1 <- ggplot(filter(mat, type=='obs')) +
        geom_bar(aes(x = edad, y = value),
                 stat="identity", fill='gray66', color = 'gray28') +
        facet_wrap(~year, dir = 'v', as.table = TRUE) +
        labs(x = 'Tallas', y = 'Proporción de tallas de la captura') +
        geom_line(data = filter(mat, type=='pred_sept'),
                  aes(x = edad, y = value), color = 'black', size = 1) +
        theme(panel.background = element_rect(fill ="gray99")) +
        theme(panel.grid=element_line(color=NA))
 fig1
```


2002
2007
2012
2017
2003
2008
2013
2018
2004
2009
2014
2019
2005
2010
2015
2020
2006
2011
2016
2021
0.20
0.15
0.10
0.05
0.00
5
10
15
20
Proporción de tallas de la captura
Tallas

CRUCERO

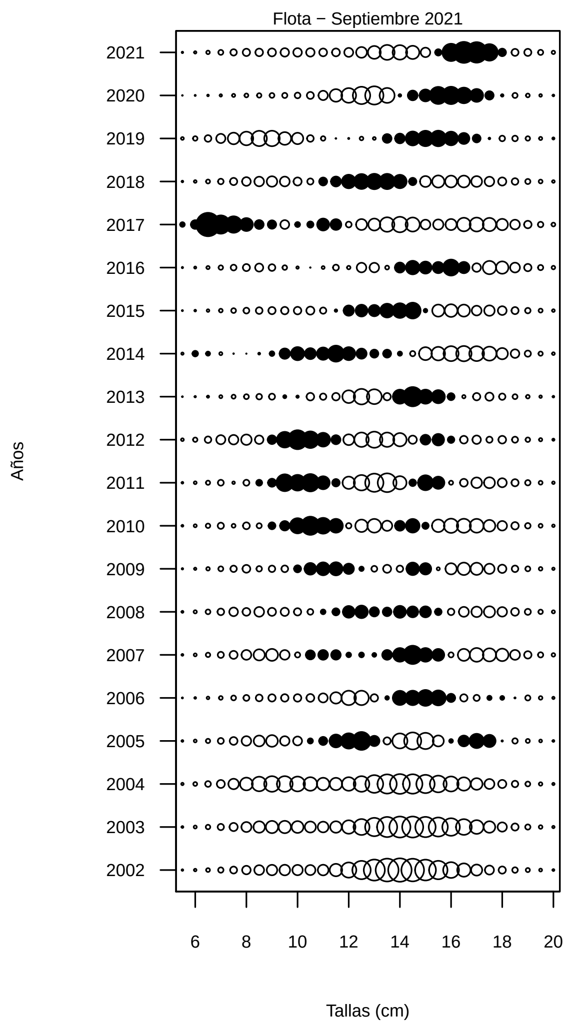
```
#######################################################################################
# AREGLOS DE DATOS
#######################################################################################
age      <-seq(5.5,20,0.5)
nage     <-length(age)

etc_obs_sept <- data.frame(rbind(rep0$pobs_RECLAN))
etc_pre_sept <- data.frame(rbind(rep0$ppred_RECLAN))

yearc    <- rep0$YRS
nyearc   <-length(yearc)

 obs       <- as.data.frame(etc_obs_sept) %>%
                          mutate(year=yearc) %>%
                          melt(id.vars='year') %>%
                          mutate(edad = rep(age, each=nyearc)) %>%
                          mutate(type='obs')

 pred_sept <- as.data.frame(etc_pre_sept) %>%
                          mutate(year=yearc) %>%
                          melt(id.vars='year') %>%
                          mutate(edad = rep(age, each=nyearf)) %>%
                          mutate(type='pred_sept')

 mat  <- rbind(obs,pred_sept)

#######################################################################################
# GRAFICAS
#######################################################################################
 fig1 <- ggplot(filter(mat, type=='obs')) +
         geom_bar(aes(x = edad, y = value),
                  stat="identity", fill='gray66', color = 'gray28') +
         facet_wrap(~year, dir = 'v', as.table = TRUE) +
         labs(x = 'Tallas', y = 'Proporción de tallas del Crucero') +
         geom_line(data = filter(mat, type=='pred_sept'),
                   aes(x = edad, y = value),color = 'black', size = 1) +
         theme(panel.background = element_rect(fill ="gray99")) +
         theme(panel.grid=element_line(color=NA))
 fig1
```


2002
2007
2012
2017
2003
2008
2013
2018
2004
2009
2014
2019
2005
2010
2015
2020
2006
2011
2016
2021
0.15
0.10
0.05
0.00
5
10
15
20
Proporción de tallas del Crucero
Tallas

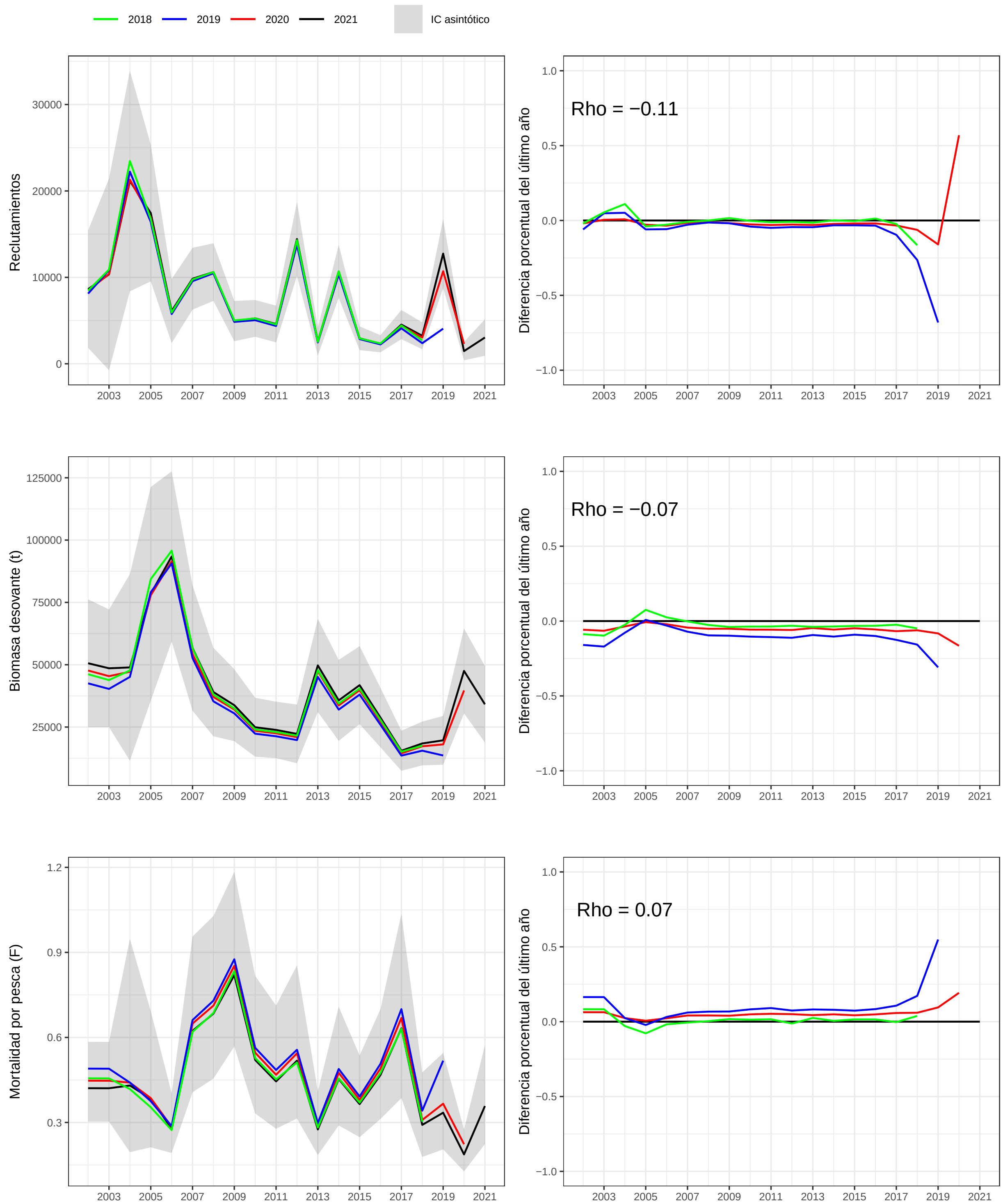
3.4. Análisis de Residuales de Composiciones de tallas

```
par(mfcol=c(1,2))
#Flota
cx<-0.7
#######################################################################################
# Residuales Flota
#######################################################################################
anos        <-rep0$YRS
obsF_alt    <-rep0$pf_obs
preF_alt    <-rep0$pf_pred
resF_alt    <-obsF_alt-preF_alt

rng <-range(resF_alt,na.rm=T)
dd  <-dim(resF_alt)
est <-matrix(NA,nrow=dd[1],ncol=dd[2])

for(j in 1:dd[1]){for(k in 1:dd[2]){val<-resF_alt[j,k]
if(val>0){est[j,k]<-val/rng[2]}
else{est[j,k]<-val/rng[1]*-1}}}

par(mar=c(5.4,6.7,2,1),cex.axis=cx,cex.lab=cx)
image(age,anos,t(est),col=0,yaxt="n",xlab="",ylab="")
ee  <-dim(est)
for(n in 1:ee[1]){for(m in 1:ee[2]){vol<-est[n,m]
if(is.na(vol)==FALSE){
    if(vol>0){points(age[m],anos[n],pch=19,cex=2*sqrt(vol),col=1)}
    if(vol<0){points(age[m],anos[n],pch=1,cex=2*sqrt(vol*-1),col=1)}
}}}
mtext("Flota - Septiembre 2021",side=3,cex=cx)
mtext("Tallas (cm)",side=1,line=3.2,cex=cx);posi<-seq(1,57,by=4)
axis(2,at=anos,labels=anos,las=2,cex=cx)
mtext("Años",side=2,line=4.7,cex=cx)
box()
#######################################################################################
# Residuales Cruceros
#######################################################################################
obsB_alt <-rep0$pobs_RECLAN
preB_alt <-rep0$ppred_RECLAN
resB_alt <-obsB_alt-preB_alt

rng <-range(resB_alt,na.rm=T)
dd  <-dim(resB_alt)
est <-matrix(NA,nrow=dd[1],ncol=dd[2])

for(j in 1:dd[1]){for(k in 1:dd[2]){val<-resB_alt[j,k]
if(val>0){est[j,k]<-val/rng[2]}
else{est[j,k]<-val/rng[1]*-1}}}

par(mar=c(5.4,6.7,2,1),cex.axis=cx,cex.lab=cx)
image(age,anos,t(est),col=0,yaxt="n",xlab="",ylab="")
ee  <-dim(est)
for(n in 1:ee[1]){for(m in 1:ee[2]){vol<-est[n,m]
if(is.na(vol)==FALSE){
```

```
    if(vol>0){points(age[m],anos[n],pch=19,cex=2*sqrt(vol),col=1)}
    if(vol<0){points(age[m],anos[n],pch=1,cex=2*sqrt(vol*-1),col=1)}
}}}
mtext("Crucero Acústico - Septiembre 2021",side=3,cex=cx)
mtext("Tallas (cm)",side=1,line=3.2,cex=cx);posi<-seq(1,57,by=4)
axis(2,at=anos,labels=anos,las=2,cex=cx)
mtext("Años",side=2,line=4.7,cex=cx)
box()
```

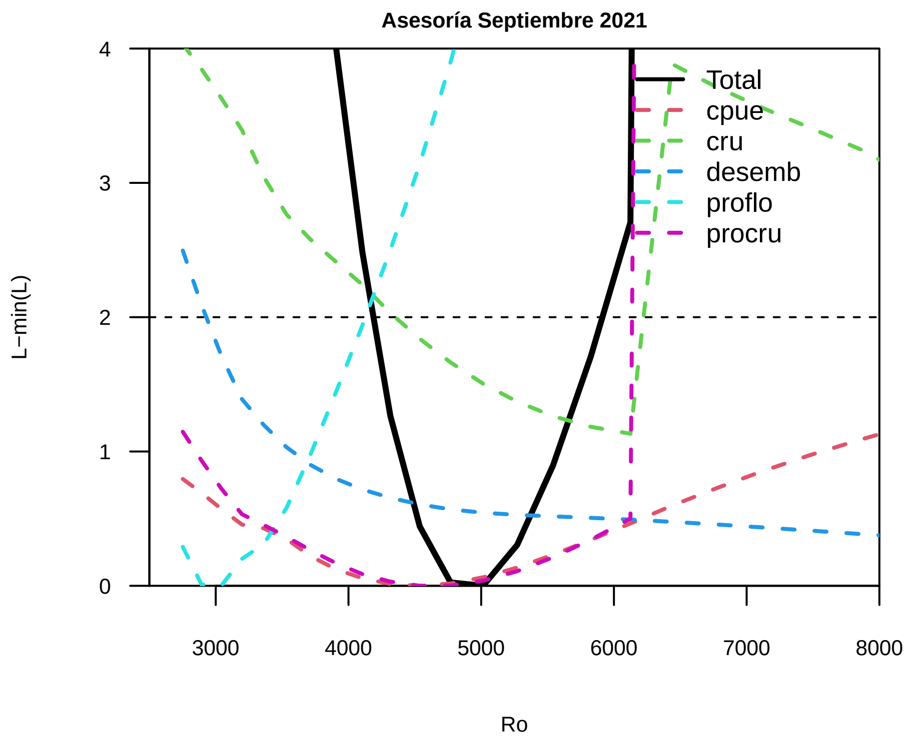


6.5. Análisis retrospectivo modelo alternativo



3.7. Perfil de verosimilitud

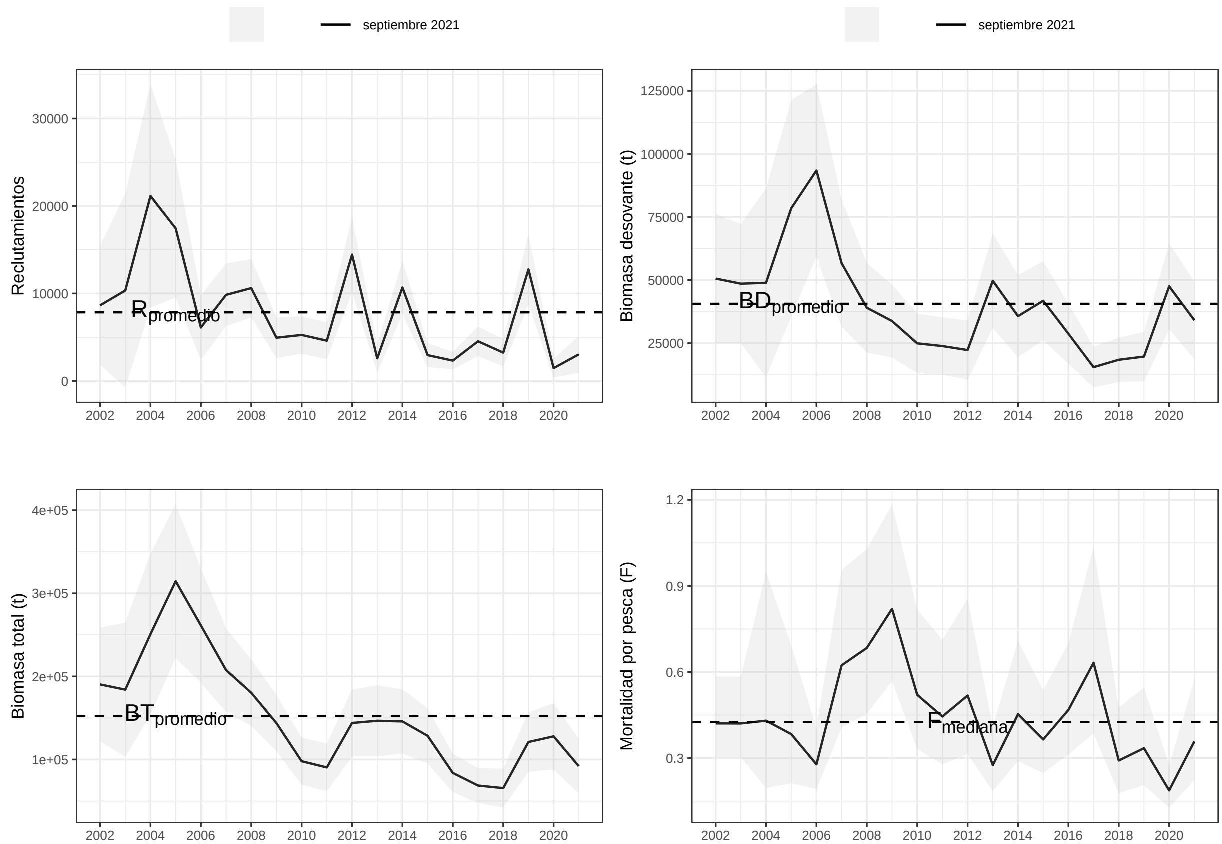
```
#######################################################################################
# AREGLOS DE DATOS
########################################################################################
admb<-"MAT0921"
dir<-paste(dir.0,"/VerosimilitudBaseN_sept",sep="")
setwd(dir)
########################################################################################
  casos <-36
  logRo    <- rep(0,casos)
  likeval  <- matrix(ncol=9,nrow=casos)
  slikeval <- matrix(ncol=10,nrow=casos)

  for(i in 1:casos){
    rep         <- reptoRlist(paste(admb,"s",i,".rep",sep=""))
    data        <- readLines(paste(admb,"s",i,".dat", sep=''),encoding="UTF-8")
    logRo[i]    <- as.numeric(data[154])
    likeval[i,] <- rep$likeval}
  #=====================================================================================
  # SEXTO PASO: ESTANDARIZAR VEROSIMILITUD
  #=====================================================================================
  like    <- data.frame(round(likeval,3),Total=apply(likeval,1,sum))
  minLik  <- apply(like,2,min)                         # busca el minimo
  for(i in 1:10){slikeval[,i]<-like[,i]-minLik[i]}    # Estandarizacin
  #=====================================================================================
  # ULTIMO PASO: GUARDAR TABLAS Y FIGURA
  #=====================================================================================
  names<-c("Ro","cpue", "cru", "desemb",    "proflo",   "procru",
           "desvRo",    "desNo",    "Lo", "","Total")
  # Tabla verosimilitud
  TLk1 <- data.frame(exp(logRo),like);
  colnames(TLk1)<-names
  # Tabla estandarizada
  TLk2 <- data.frame(exp(logRo),slikeval);
  colnames(TLk2)<-names

########################################################################################
# GRAFICAS
########################################################################################
  par(mar=c(4,4,1,1)+0.5)
  plot(TLk2$Ro,TLk2$Total,type="l",lwd=3,ylim=c(0,4),xlim=c(2500,8000),
       xaxs= "i",yaxs= "i", ylab="L-min(L)",xlab="Ro", las=1,
       main="Asesoría Septiembre 2021",cex.main=0.7,cex.axis=0.7,cex.lab=0.7)
  abline(h=2,col=1,lty=2)
   for(i in 2:6){
  lines(TLk2$Ro,TLk2[,i],col=i,lty=2,lwd=2)}
  legend(6000,4,names[c(11,2:6)],col=1:7,lty=c(1,rep(2,6)),
          lwd=2,bty="n",cex=0.8)
```


Asesoría Septiembre 2021
L−min(L)
Ro
0
1
2
3
4
3000
4000
5000
6000
7000
8000
Total
cpue
cru
desemb
proflo
procru

3.8. Sensibilidad a la actualización de datos

4. RESULTADOS OBJETIVO 2

4.1. Indicadores del stock




```r
Rt0_mean<-mean(VarPobSep$Rt0)
BT0_mean<-mean(VarPobSep$BT0)
BD0_mean<-mean(VarPobSep$BD0)

R15_18 <-mean(VarPobSep$Rt0[14:17])
BT16_18 <-mean(VarPobSep$BT0[15:17])
BT19_20 <-mean(VarPobSep$BT0[18:19])

rbind(Rt0_mean,BT0_mean,BD0_mean,R15_18,BT16_18,BT19_20)
```

```
##                 [,1]
## Rt0_mean    7846.875
## BT0_mean  152258.150
## BD0_mean   40590.900
## R15_18      3261.450
## BT16_18    72703.333
## BT19_20   124460.000
```

```
par(mfrow=c(1,2),mar=c(4,4,1,1)+0.5)

plot(data.0$Edades,rep0$Sflo_age[1,],type="l",las=1,col=4,ylim=c(0,1.1),
     ylab="Selectividad Flota",xlab="Edades",main="FLOTA")
lines(data.0$Edades,rep0$Sflo_age[9,],type="l",col=3)
lines(data.0$Edades,rep0$Sflo_age[nyears0,],type="l",col=2)
legend(4,0.3,c("sel_2002-2009","sel_2010-2012","sel_2013-2020"),
       col=c(4,3,2),lwd=c(1,1,1),cex=0.8,bty="n")


plot(data.0$Edades,rep0$Scru_age[1,],type="l",las=1,col=4,ylim=c(0,1.1),
     ylab="Selectividad Crucero",xlab="Edades",main="CRUCEROS")
lines(data.0$Edades,rep0$Scru_age[nyears0,],type="l",col=2)
legend(4,0.3,c("sel_2002-2012","sel_2013-2020"),
       col=c(4,2),lwd=c(1,1),cex=0.8,bty="n")
```

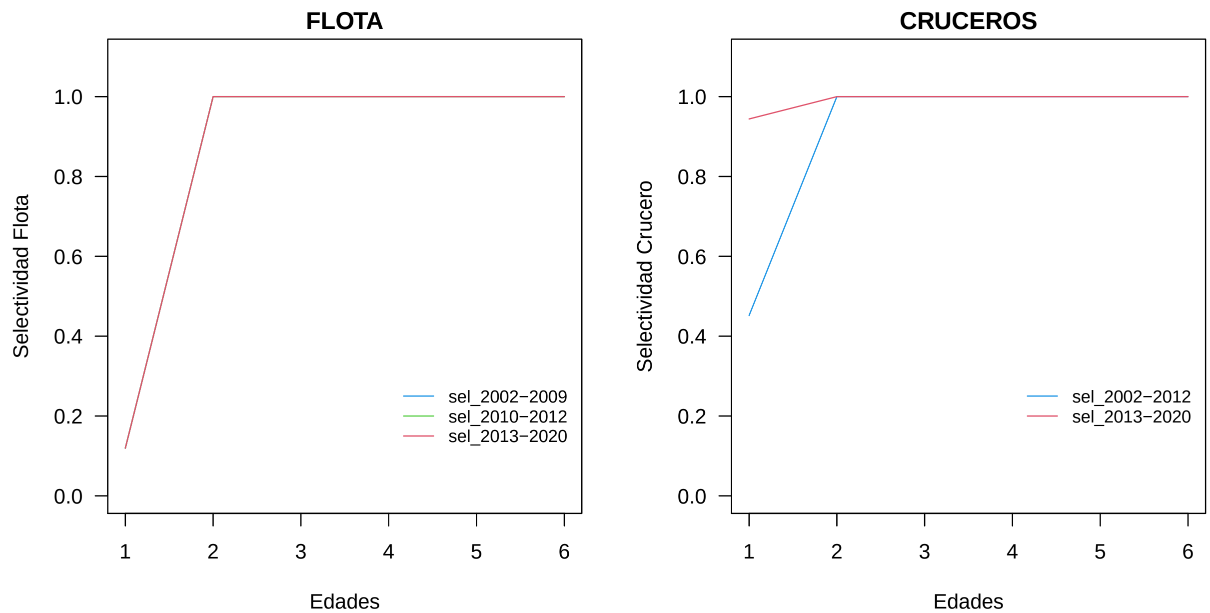


Tabla 13.
Indicadores poblacionales de sardina austral en aguas interiores de Chiloé. Tabla comparativa entre los resultados de la evaluación de septiembre (primer hito) y junio (segundo hito).

```r
VarPobl0<- cbind(anos=rep0$YRS,
                 "BD_sep"=c(BD0),
                 "BT_sep"=c(BT0),
                 "R_sep"=c(round(Rt0,0)),
                 "F_sep"=c(round(exp(Ft0),2))
                 )
kable(VarPobl0)
```

anos	BD_sep	BT_sep	R_sep	F_sep
2002	50601	190360	8640	0.42
2003	48577	184050	10340	0.42
2004	48928	250890	21144	0.43
2005	78464	314560	17443	0.38
2006	93433	261370	6109	0.28
2007	56697	207580	9841	0.62
2008	39044	180350	10611	0.68
2009	33769	143800	4942	0.82
2010	24923	97913	5256	0.52
2011	23855	90444	4602	0.44
2012	22261	143960	14439	0.52
2013	49736	146610	2583	0.28
2014	35706	145810	10685	0.45
2015	41806	128490	2952	0.36
2016	28767	83865	2322	0.47
2017	15499	68675	4535	0.63
2018	18422	65570	3237	0.29
2019	19679	121050	12751	0.33
2020	47528	127870	1465	0.19
2021	34123	91946	3040	0.36

```r
write.csv(VarPobl0, file="Tablas/TablaVarpob.csv")
```

4.2. Estados de explotación

```
#PBRs Modelo alternativo
BDo0    <- rep0$Bo
BRMS0   <- BDo0*0.55
BDlim0  <- BDo0*0.275
FRMS0   <- exp(subset(std0,name=="log_Fref")$value[3])
```

```
par(mfcol=c(1,2),mar=c(4,4,1,1)+0.5)
plot(rep0$Tallas,rep0$Selflo_talla[1,],type="l",las=1,col=4,
     ylab="Selectividad",xlab="Tallas (cm)")
lines(rep0$Tallas,rep0$Selflo_talla[9,],type="l",col=3)
lines(rep0$Tallas,rep0$Selflo_talla[nyears1,],type="l",col=2)
lines(rep0$Tallas,data.0$Madurez,lwd=2)
legend(13,0.3,c("bloque_sel1","bloque_sel2","bloque_sel3","Madurez"),
       col=c(4,3,2,1),lwd=c(1,1,1,2),cex=0.8,bty="n")

plot(PBRsb1[,1],PBRsb1[,4],type="l",ylab="%BDPR",xlab="Mortalidad por pesca (F)",lwd=1,las=1,col=4)
lines(PBRsb2[,1],PBRsb2[,4],col=3,lwd=1)
lines(PBRsb3[,1],PBRsb3[,4],col=2,lwd=1)
abline(h=0.6,col=1,lty=1)
abline(v=c(FRMSb1,FRMSb2,FRMSb3),col=c(4,3,2),lty=2)
    text(1.5,c(0.55,0.50,0.45),c("F60_sel1=0,33", "F60_sel2=0,26","F60_sel3=0,31"),cex=0.8,col=c(4,3,2))
```

```
yrs     <- rep0$YRS
nyrs    <- length(yrs)
tallas  <- seq(5,19.5,0.5)
ntallas <- length(tallas)
age     <- seq(0,4,1)
nage    <- length(age)

x  <-c(yrs,rev(yrs))
x1 <-c(yrs[1],yrs[nyrs]+1,nyrs+1/2) #xaxp
x2 <-c(yrs[1]-1,yrs[nyrs]+1) #xlim
years0    <-rep0$YRS


################################################
#modelo alternativo
################################################
Rpr0     <-subset(std0,name=="RPRrms")$value
Rpr0std  <-subset(std0,name=="RPRrms")$std
Frpr0    <-subset(std0,name=="Frpr")$value
Frpr0std <-subset(std0,name=="Frpr")$std

rpr0     <-c((Rpr0-1.96*Rpr0std),
          rev((Rpr0+1.96*Rpr0std)));
frpr0    <-c((Frpr0-1.96*Frpr0std),
          rev((Frpr0+1.96*Frpr0std)))


######################################################################################
### *MODELO BASE*
######################################################################################
# biomasa desovante vs BDrms
######################################################################################
xbs1 <- rnorm(1000, mean = Rpr0[length(years0)],
                    sd = Rpr0std[length(years0)])
```

```r
xbs  <- seq(min(xbs1),
           max(xbs1),0.005)

ybs  <- dnorm(xbs, mean = Rpr0[length(years0)],
                     sd = Rpr0std[length(years0)])

icbs <- qnorm(c(0.05,0.95,0.5),
             Rpr0[length(years0)],
             Rpr0std[length(years0)])

xxbs <- c(xbs[xbs>=icbs[1]&xbs<=icbs[2]],
      rev(xbs[xbs>=icbs[1]&xbs<=icbs[2]]))

yybs <- c(ybs[xbs>=icbs[1]&xbs<=icbs[2]],
      rep(0,length(ybs[xbs>=icbs[1]&xbs<=icbs[2]])))

#######################################################################################
# mortalidad por pesca vs Frms
#######################################################################################
xfs1 <-rnorm(1000, mean = Frpr0[length(years0)],
                     sd = Frpr0std[length(years0)])

xfs  <-seq(min(xfs1),
           max(xfs1),0.005)

yfs  <-dnorm(xfs, mean = Frpr0[length(years0)],
                    sd = Frpr0std[length(years0)])

icfs <-qnorm(c(0.05,0.95,0.5),
             Frpr0[length(years0)],
             Frpr0std[length(years0)])

xxfs <-c(xfs[xfs>=icfs[1]&xfs<=icfs[2]],
     rev(xfs[xfs>=icfs[1]&xfs<=icfs[2]]))

yyfs <-c(yfs[xfs>=icfs[1]&xfs<=icfs[2]],
     rep(0,length(yfs[xfs>=icfs[1]&xfs<=icfs[2]])))

#######################################################################################
### *Probabilidad de estar bajo BRMS*
#######################################################################################
# MALTERNATIVO
pa0<-pnorm(1,Rpr0[length(years0)],
             Rpr0std[length(years0)],
             lower.tail = TRUE,log.p = F)

#######################################################################################
### *Probabilidad de estar bajo FRMS*
#######################################################################################
# MALTERNATIVO
pb0<-1-pnorm(1,Frpr0[length(years0)],
               Frpr0std[length(years0)],
               lower.tail = TRUE,log.p = F)

#######################################################################################
### *Probabilidad de estar en zona de sobreexplotacion*
#######################################################################################
# MALTERNATIVO
```

```r
pc0<-pnorm(0.9,Rpr0[length(years0)],
               Rpr0std[length(years0)],
               lower.tail = TRUE,log.p = F)

#########################################################################################
### *Probabilidad de estar en zona de colapso*
#########################################################################################
# MALTERNATIVO
pd0<-pnorm(0.5,Rpr0[length(years0)],
               Rpr0std[length(years0)],
               lower.tail = TRUE,log.p = F)

#########################################################################################
### *Probailidad de sobrepesca*
#########################################################################################
# MALTERNATIVO
pe0<-1-pnorm(1.1,Frpr0[length(years0)],
                 Frpr0std[length(years0)],
                 lower.tail = TRUE,log.p = F)
```

```r
PBRs<-round(rbind("BD~0~"=c(BDo0)/1000,
                  "BD~RMS~"=c(BRMS0)/1000,
                  "BD~LIM~"=c(BDlim0)/1000,
                  "F~RMS~"=c(FRMS0),
                  "p(BD~2021~<BD~RMS)~"=round(c(pa0),2),
                  "p(F~2021~>F~RMS~)"=round(c(pb0),2),
                  "*p(sobreexplotación)*"=round(c(pc0),2),
                  "*p(agotado/colapsado)*"=round(c(pd0),2),
                  "*p(sobrepesca)*"=round(c(pe0),2)),3)

colnames(PBRs)<-c("Septiembre")
kable(PBRs)
```

	Septiembre
BD_0	58.529
BD_{RMS}	32.191
BD_{LIM}	16.096
F_{RMS}	0.300
$p(BD_{2021}<BD_{RMS})$	0.370
$p(F_{2021}>F_{RMS})$	0.740
p(sobreexplotación)	0.190
p(agotado/colapsado)	0.000
p(sobrepesca)	0.620

```r
write.csv(PBRs, file="Tablas/PBRs.csv")
```

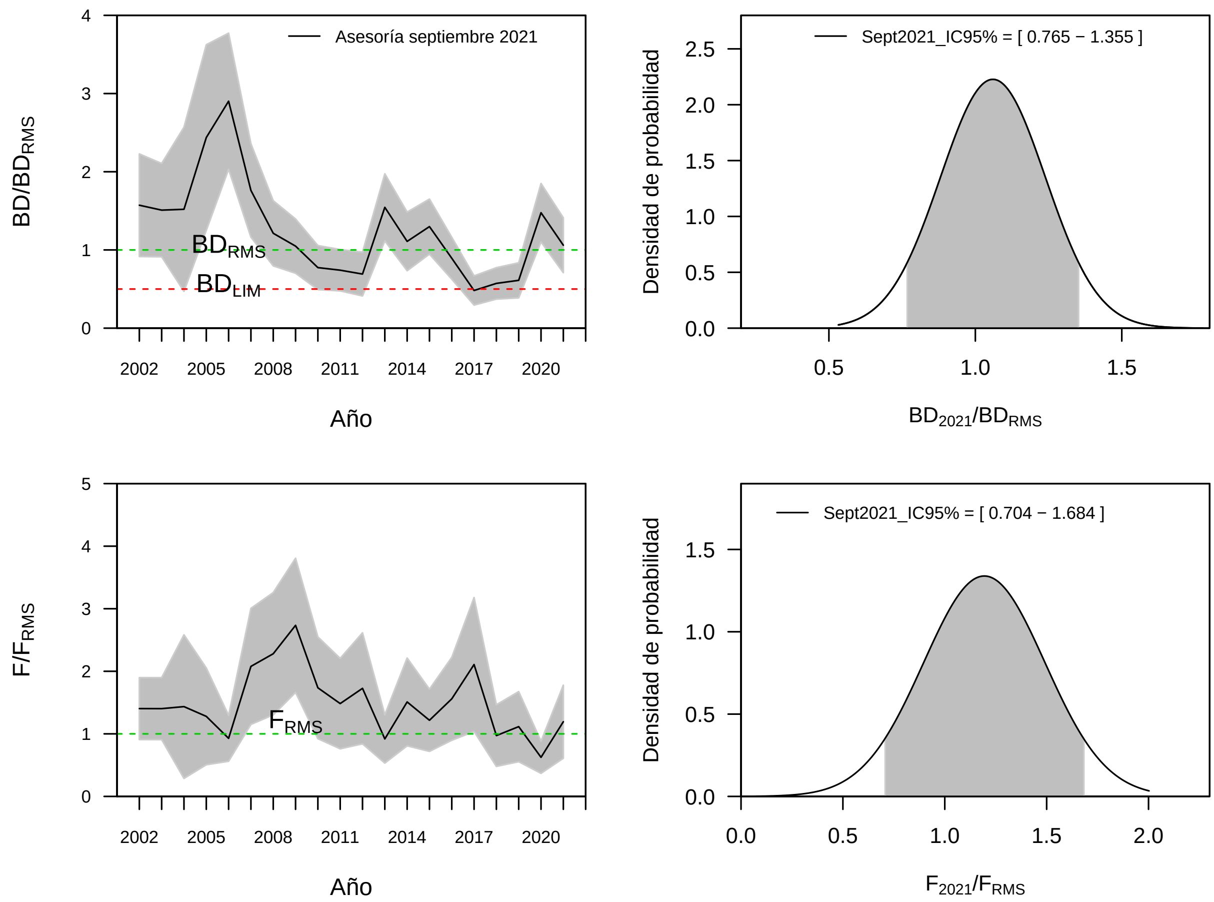


Tabla 15.

Variación interanual de F respecto de FRMS (F/F RMS), BD respecto de BDRMS (BD/BD RMS), y de las tasas de explotación referidos a la biomasa total (Y/BT) en la pesquería de sardina austral. Comparación entre las Estimaciones de la evaluación de stock actual (sept 2018) y anterior (jun 2018).

```
VarPobl0<- cbind(anos=rep0$YRS,
                 "F/F~RMS~**S**"=c(round(exp(Ft0)/FRMS0,3)),
                 "BD/BD~RMS~**S**"=c(round(BD0/BRMS0,3)),
                 "Y/BT_**S**"=c(round(rep0$desemb_pred/BT0,3)))
kable(VarPobl0)
```

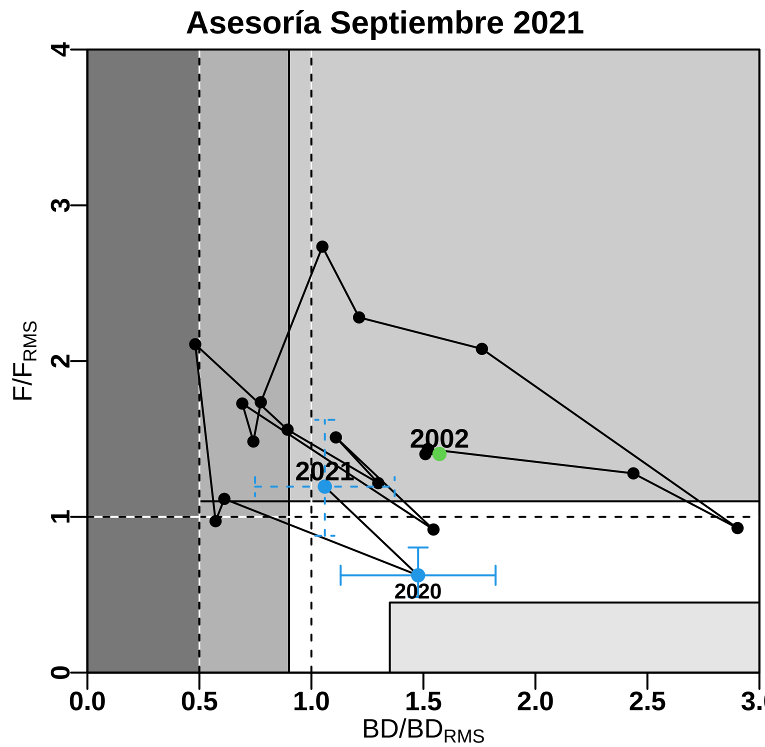
anos	F/F_{RMS}**S**	BD/BD_{RMS}**S**	Y/BT_**S**
2002	1.403	1.572	0.186
2003	1.403	1.509	0.172
2004	1.435	1.520	0.141
2005	1.279	2.437	0.160
2006	0.928	2.902	0.148
2007	2.078	1.761	0.251
2008	2.280	1.213	0.250
2009	2.734	1.049	0.334
2010	1.736	0.774	0.209
2011	1.484	0.741	0.187
2012	1.727	0.692	0.142
2013	0.919	1.545	0.152
2014	1.510	1.109	0.162
2015	1.217	1.299	0.188

anos	F/F_{RMS}**S**	BD/BD_{RMS}**S**	Y/BT_**S**
2016	1.560	0.894	0.226
2017	2.108	0.481	0.224
2018	0.972	0.572	0.132
2019	1.115	0.611	0.093
2020	0.625	1.476	0.111
2021	1.194	1.060	0.175

```r
write.csv(VarPobl0, file="Tablas/Estatus.csv")
```

Diagramas de Fase

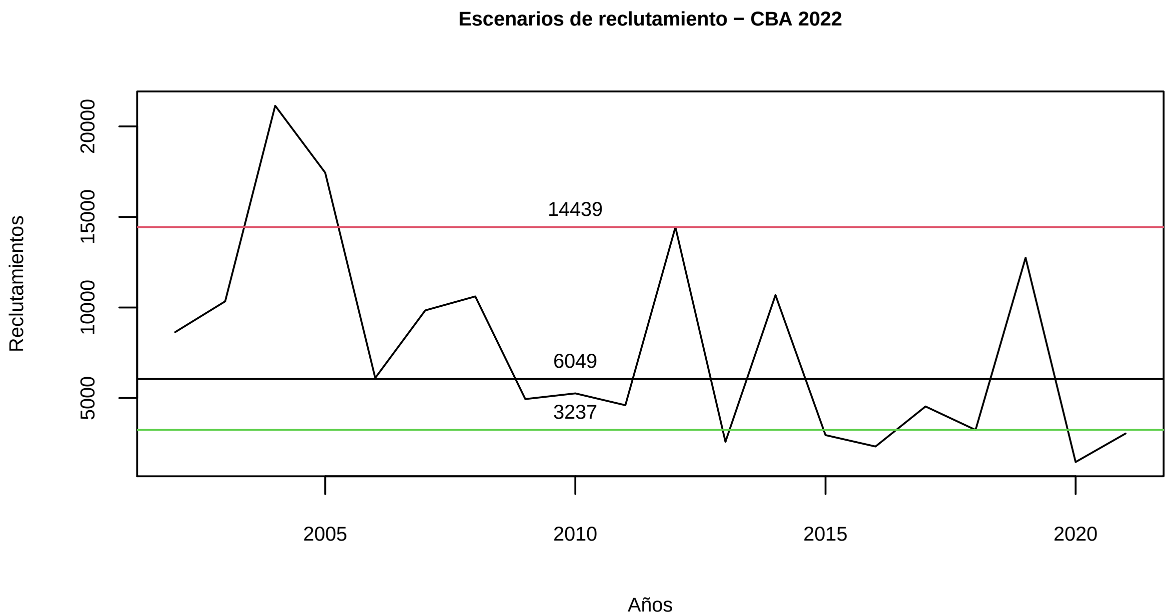
```r
source(paste(getwd(),"/funciones/Fn_DiagramaFase.R",sep=""))
name0<-"Asesoría Septiembre 2021"

years0<-rep0$YRS
SSBt0         <- subset(std0,name=="BD")$value
SSBt0std      <- subset(std0,name=="BD")$std
Ft0           <- subset(std0,name=="log_F")$value
Ft0std        <- subset(std0,name=="log_F")$std
BDo0    <- rep0$Bo
BRMS0   <- BDo0*0.55
FRMS0   <- exp(subset(std0,name=="log_Fref")$value[3])

DiagramaFase(name0,FRMS0,BRMS0,SSBt0,SSBt0std,Ft0,Ft0std,years0)
#cruz del año previo
lastB0    <- SSBt0[nyears0-1]/BRMS0
lastB    <- SSBt0[nyears0-1]
lastF    <- exp(Ft0[nyears0-1])/FRMS0
# Calculate confidence intervals
Qmult    <- -qnorm((1-(80/100))/2.0)
sbSE     <- SSBt0std[nyears0-1]
sb95     <- c(lastB-Qmult*sbSE,lastB+Qmult*sbSE)
B95      <- sb95/BRMS0
FvSE     <- Ft0std[nyears0-1]
F95      <- c(lastF*exp(-Qmult*FvSE),lastF*exp(Qmult*FvSE))

arrows(x0=B95[1],
       y0=lastF,
       x1=B95[2],
       y1=lastF,
       length=0.05,angle=90,col=4,lwd=1,code=3)
arrows(x0=lastB0,
       y0=F95[1],
       x1=lastB0,
       y1=F95[2],
       length=0.05,angle=90,col=4,lwd=1,code=3)

points(lastB0,lastF,pch=19,col=4)
text(lastB0,lastF-0.1,years0[nyears0-1],cex=0.8)
```


Asesoría Septiembre 2021
F/F_RMS
BD/BD_RMS
0
1
2
3
4
0.0
0.5
1.0
1.5
2.0
2.5
2002
2021
2020

5. RESULTADOS OBJETIVO 3

"Determinar niveles de Captura Biológicamente Aceptable (CBA) que lleven y/o mantenga la pesquería en torno al Rendimiento Máximo Sostenible (RMS), a partir de un análisis de riesgo en condiciones de incertidumbre de no alcanzar los objetivos de conservación y sostenibilidad conforme lo establece la LGPA y contenidos en el Plan de Manejo y/o en el Programa de Recuperación respectivo, según corresponda."

1. Escenarios de reclutamiento para proyección

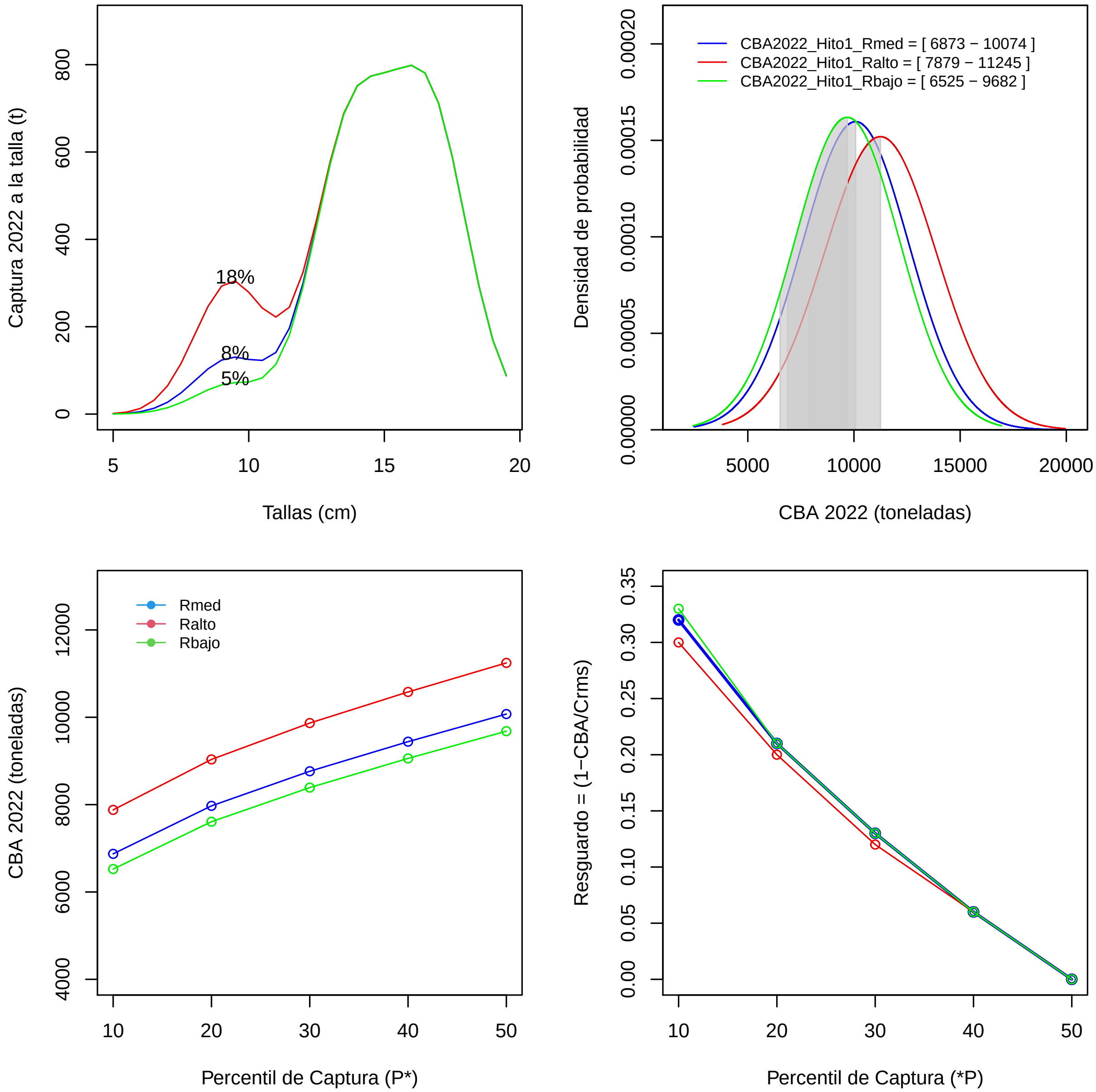


2. Tablas de decisión CBA para cada escenario de reclutamiento, percentil de captura y resguardo

percentil	CBA_Rmed	CBA_Ralto	CBA_Rbajo
10	6873	7879	6525
20	7972	9035	7609
30	8764	9868	8390
40	9441	10580	9058
50	10074	11245	9682

percentil	Resguardo_Rmed	Resguardo_Ralto	Resguardo_Rbajo
10	0.32	0.30	0.33
20	0.21	0.20	0.21
30	0.13	0.12	0.13
40	0.06	0.06	0.06
50	0.00	0.00	0.00

percentil	Aporte_Rmed	Aporte_Ralto	Aporte_Rbajo
10	0.11	0.22	0.06
20	0.10	0.20	0.05
30	0.09	0.19	0.05
40	0.09	0.19	0.05
50	0.08	0.18	0.05



Captura 2022 a la talla (t)
0
200
400
600
800
18%
8%
5%
5
10
15
20
Tallas (cm)
Densidad de probabilidad
0.00000
0.00005
0.00010
0.00015
0.00020
CBA2022_Hito1_Rmed = [6873 − 10074]
CBA2022_Hito1_Ralto = [7879 − 11245]
CBA2022_Hito1_Rbajo = [6525 − 9682]
5000
10000
15000
20000
CBA 2022 (toneladas)
CBA 2022 (toneladas)
4000
6000
8000
10000
12000
Rmed
Ralto
Rbajo
10
20
30
40
50
Percentil de Captura (P*)
Resguardo = (1−CBA/Crms)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
10
20
30
40
50
Percentil de Captura (*P)