# Método de Zhou 2013

## PCOM Posterior-focused catch-only method S. Zhou, Modificado por Elson Leal para sardina austral Aysen 2019, CBA 2020

This method requires time series of catch data only. However, some life history parameters, M, Linf, k, T_max, T_maturation, will improve the performance. Also, a rough guess of maximum depletion level D = B_end/K will be helpful. This example is for single catch series

### Modelo

```r
library(knitr) # para generar reporte Rmarkdown
library(stringr)
library(reshape)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following object is masked from 'package:reshape':
##
##     rename

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
library(ggplot2)
library(ggthemes) # para ggplot
library(patchwork) # para unir gráficos de ggplot
library(strucchange) # libreria utilizada para análisis de quiebres
```

```
## Loading required package: zoo

##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric

## Loading required package: sandwich

##
## Attaching package: 'strucchange'

## The following object is masked from 'package:stringr':
##
```

```
##     boundary
```

```
getwd()
```

```
## [1] "/Users/mariajosezunigabasualto/MJZ/CTP2021/SARDINA_AUSTRAL AYSEN/INFORME _FINAL"
```

```
##########################################################################################
# model
##########################################################################################
BDM=function(K,dep,b,C,r){  ### biomass dynamics model
 B=err.B=rep(NA,length(C))
 B[1]=b*K;b1=B[1]
 for(i in 2:length(B)){
  B[i]=max(min(B[i-1]+r*B[i-1]*(1-B[i-1]/K)-C[i-1],K),0)
#  err.B[i]=ifelse(!is.na(U[i-1]&U[i]) & B[i]>0,(B[i-1]/B[i]-U[i-1]/U[i]^2,NA)
 }
 if(all(B>C) & all(B<=K)){
  abs(B[length(B)]-dep*K)
# if(any(U>0)){((B[length(B)]-dep*K)/K)^2 +sum(err.B,na.rm=T)} else ((B[length(B)]-dep*K)/K)^2
 } else {10^5}
}
```

```
##########################################################################################
# simulation
##########################################################################################
sim1=function(k25=k25,k75=k75,r25=r25,r75=r75,yr=yr,C=C,nsim=nsim,msy=NULL){
 Bend.keep=K.keep=r.keep=dep.keep=d.keep=vector()
 nyr=length(yr)
 B=F2Fmsy=B2Bmsy=matrix(NA,nyr,nsim)
 K=r=vector()
 plot(0,0,type="n",xlim=c(min(yr),max(yr)),ylim=c(-1,round(k75,0)*1.15),
 xlab="", ylab="",yaxt="n",xaxt="n")
 for(j in 1:nsim){
   K[1]=runif(1,k25,k75)
   r[1]=runif(1,r25,r75)
   B[1,j]=K[1]
   for(i in 2:(nyr)){
     r[i]=runif(1,r25,r75)
     K[i]=runif(1,k25,k75)
     B[i,j]=B[i-1,j]+r[i]*B[i-1,j]*(1-B[i-1,j]/K[i])-C[i-1]
     F2Fmsy[i,j]=(C[i]/B[i,j])/(r[i]/2)
     B2Bmsy[i,j]=B[i,j]/(K[i]/2)
   }
   cols<-rgb(runif(1,0,j)/nsim,(nsim-runif(1,0,j))/nsim,(1)/(nsim+100),
   alpha=0.6)
   lines(yr,B[,j],col=cols)
   K.keep[j]=mean(K)
   r.keep[j]=mean(r)
   F2Fmsy[,j]=(C/B[,j])/(mean(r)/2)
   B2Bmsy[,j]=B[,j]/(mean(K)/2)
 }
 Bend.keep=B[nyr,]
 d.keep=B[nyr,]/mean(K)
 lines(yr,apply(B,1,median),lty=1,lwd=3)
 lines(yr,C,lwd=2,col="#363636",lty=2)
 points(yr,C,pch=21,col=4,bg=4,cex=1.3)
```

```
 y1<-seq(0,round(k75,0)*1.1,le=5);x1<-seq(1,length(yr),by=1)
 axis(1,at=yr[x1],labels=yr[x1],las=1)
 axis(2,at=y1,labels=format(round(y1/1000,0),3),las=2)
 legend(yr[nyr-2],max(y1)*1.05,c("Biomasa","Captura","RMS"),lty=c(1,2,2),
 col=c(1,"#363636",2),pch=c(NA,21,NA),lwd=c(2,2,2),pt.bg=c(NA,4,NA),cex=1.3)
 BC<-expression(paste('Biomasa ('%*%'1000 ton) y Captura (ton)',sep=""))
 mtext(BC,side=2,line=4.0,cex=1.3)
 mtext("Años",side=1,line=3.5,cex=1.3)
 if(is.null(msy)){} else {abline(h=msy,lty=2,col=2,lwd=2)}
 msy=K.keep*r.keep/4
 return(list(K.keep,r.keep,msy,Bend.keep,d.keep,B,r,F2Fmsy,B2Bmsy))
}
```

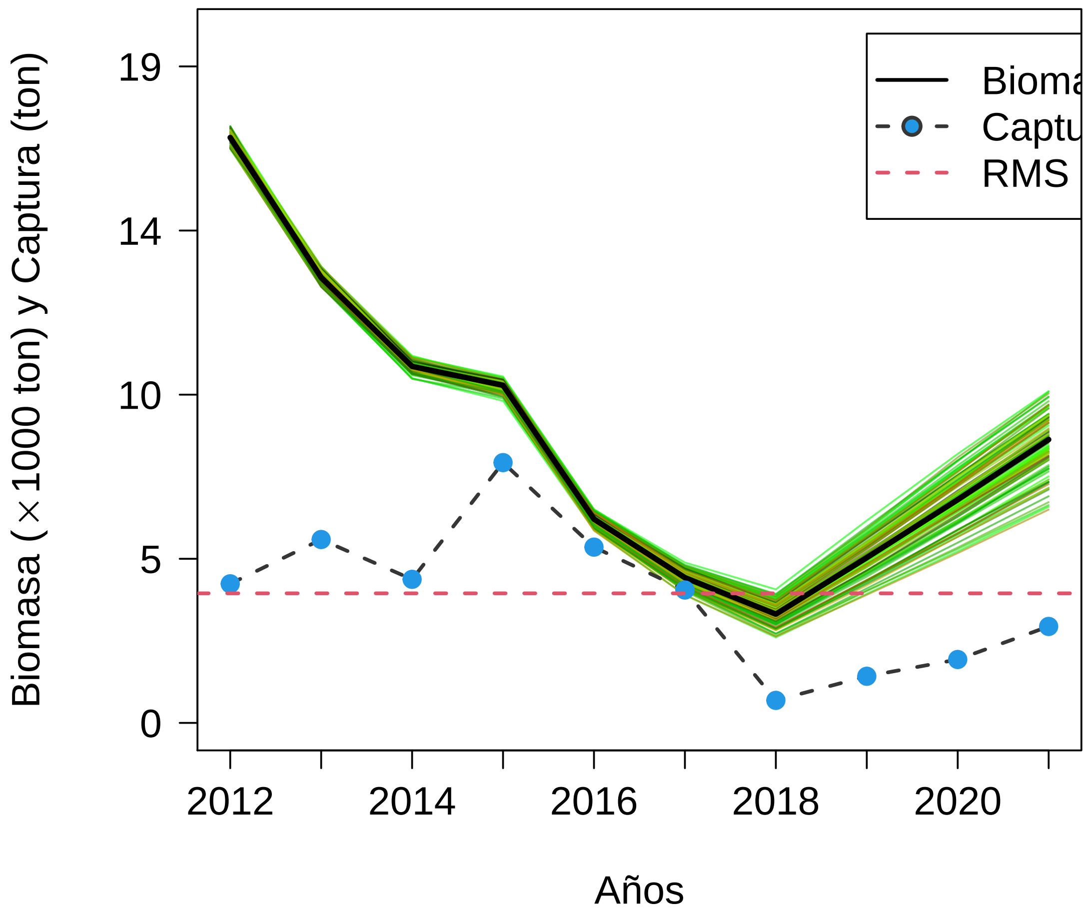
## Ingresa datos de captura

```
#
######################################################################
# input catch data and r range for sautral XI stock
C=c(4033,5318,4163,7547,5097,3853,653,1352,1839,2797)
yr=seq(2012,2021)
r.lci=0.85;r.uci=1.2
# search through K grids, with specific range for K1 follow
N1=100
K1=exp(seq(log(max(C)),log(max(C)*50),l=N1))
# genera los valores de la deplecion
dep=round(seq(0.1,0.8,0.05),2);nd=length(dep)
r1=obj1=matrix(0,N1,nd)  #matriz que almacena los output de las funciones
b=1#Si (C[1]/max(C)<0.5, (0.5+0.9)/2 (0.3+0.6)/2);b=0.5
# ciclo
for(j in 1:nd){
  for(i in 1:N1){
    out=optimize(BDM,K=K1[i],b=b,C=C,dep=dep[j],
    interval=c(r.lci-.05,r.uci+.05))
    r1[i,j]=out$min
    obj1[i,j]=out$obj
  }
}


#
#vLinf=58.95;vk=0.28;Tmax=10;Tmat=NA;T=17
#M=vector()
#M[1]=exp(1.44-0.982*log(Tmax))
#M[2]=1.65/Tmat
#M[3]=exp(1.2-0.17*log(vLinf)+log(vk))
#M[4]=1.82*vk
#M[5]=exp(-0.0152-0.279*log(vLinf)+0.6543*log(vk)+0.463*log(T))
#w=0.87 #para teleost y w=0.41 para chondrithys
#r.mean=2*mean(M,na.rm=T)*w
#r.sd=sd(M,na.rm=T)
#r.backup=r
#r[r > r.mean+2*r.sd | r < r.mean-2*r.sd]=NA
```

```
##############################
r1.backup=r1  ;# r1=r1.backup
r1[obj1 > K1*0.01]=NA
r1[r1 > r.uci | r1 < r.lci]=NA
##############################
kr=as.data.frame(cbind(K1,r1))
colnames(kr)=c('k',dep)
all=cbind(K1,stack(kr[,2:nd+1]))#antes nd+1
colnames(all)=c("k","r","ind")
all$d=as.numeric(as.character(all$ind))
all=all[,c(1,2,4)]
all=all[!is.na(all[,2]),]
all$msy=all[,1]*all[,2]/4
# estimate reference points
#cutoff=ifelse(tail(C,1)/max(C)<=0.5,0.5,0.8)
all2=all[!is.na(all$r) & all$d <= 0.5,]#cutoff,assume upper depeltion=0.4
quan1=apply(all2,2,quantile)
k25=quan1[,1][2];k75=quan1[,1][4]
r25=quan1[,2][2];r75=quan1[,2][4]
msy.media=quan1[,4][3]
all3=all2[all2$k>k25 & all2$k<k75 & all2$r>r25 & all2$r<r75,]
para=list(k25=k25,k75=k75,r25=r25,r75=r75)
```

### Figura biomasa

```
##########################################################################################
nsim=100
#GRAFICA LA BIOMASA
#name1<-paste(getwd(),"/Figuras/Fig1_Zhou2013_biomasa.png",sep="")
#png(file=name1,width=900,height=800)
#png(file=name1,width=800,height=600)
#png(filename ="bioma_shijie.png",width=600,height=500)
par(mar=c(5.2,6.2,4,4),cex.axis=1.3,cex.lab=1.3)
out1=sim1(k25=k25,k75=k75,r25=r25,r75=r75,C=C,yr=yr,nsim=nsim,msy=msy.media)
```




```
#dev.off()
```

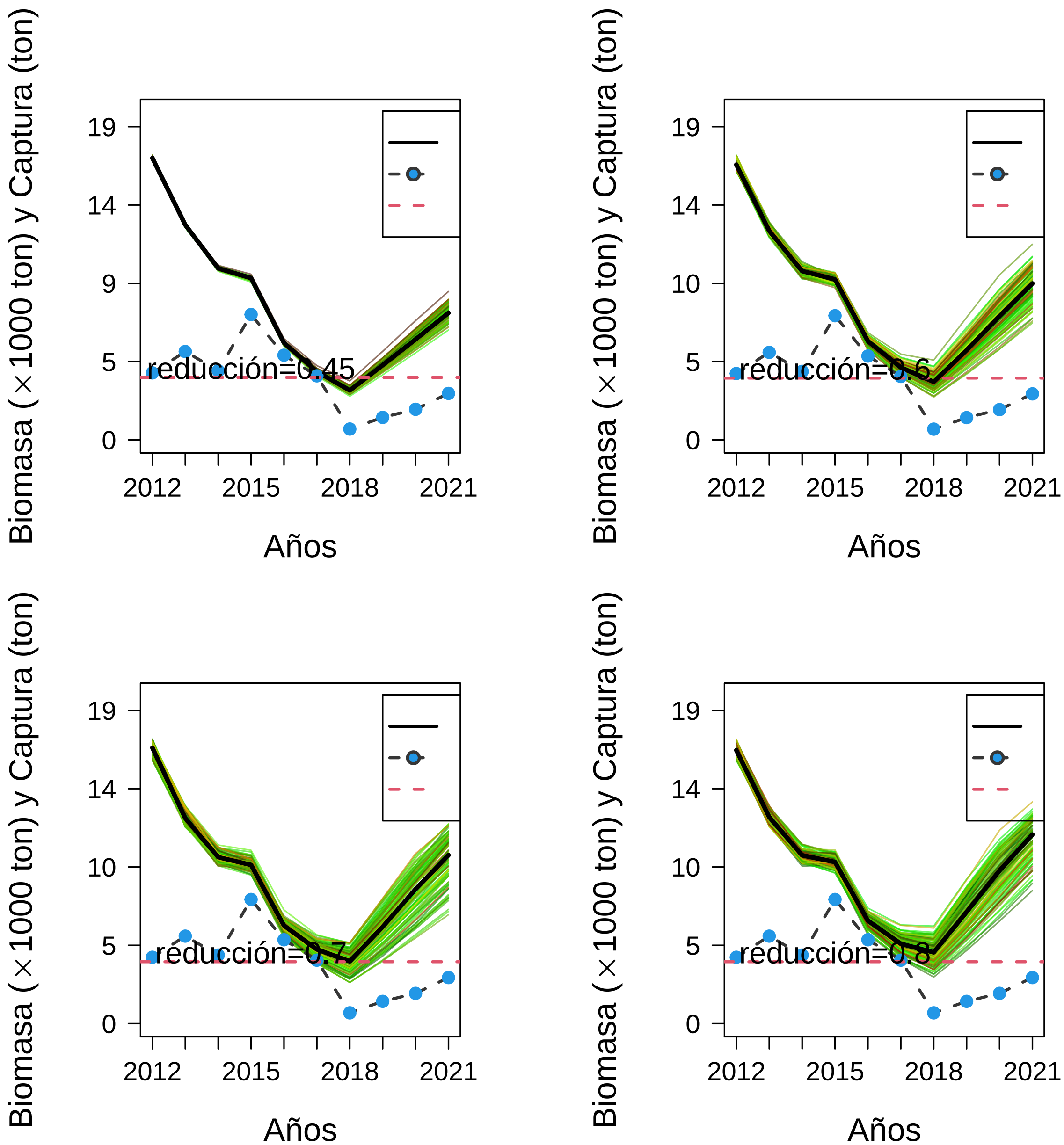
```
##########################################################################################
#EXTRAE DATOS DE INTERES PARA LA INCERTIDUMBRE
##########################################################################################
F2Fmsy=as.data.frame(out1[8]);B2Bmsy=as.data.frame(out1[9])
quant=function(x)quantile(x,c(0.2,0.8))
dat.out=data.frame(year=yr,B2Bmsy.med=apply(B2Bmsy,1,median),
quan1.B=apply(B2Bmsy,1,quant)[1,],quan3.B=apply(B2Bmsy,1,quant)[2,],
F2Fmsy.med=apply(F2Fmsy,1,median),quan1.F=apply(F2Fmsy,1,quant)[1,],
quan3.F=apply(F2Fmsy,1,quant)[2,])
BF2msy.end=data.frame(t(rbind(B2Bmsy[length(yr),],F2Fmsy[length(yr),])))
colnames(BF2msy.end)=c("B2Bmsy","F2Fmsy")
#
out1.backup=out1 #out1=out1.backup
sp=out1[1:5]
sp=as.data.frame(sp)   # summary(sp)
colnames(sp)=c("k","r","msy","Bend","Depletion")
BendD=apply(sp,2,quantile)
#FINAL RESULT
```

```r
tabla<-cbind(quan1[,c(1,2,4)],BendD[,4:5])

#library(rJava)                                              ## PROBLEMAS CON ESTO
#library(xlsx)
write.csv2(tabla,"tabla1.csv",row.names=FALSE)

print(tabla)
```

```
##              k         r      msy     Bend Depletion
## 0%   16634.15 0.8534279 3692.060 6184.365 0.3647913
## 25%  16634.15 0.8614773 3726.883 7694.024 0.4538402
## 50%  16969.38 0.8861789 3757.632 8216.055 0.4846327
## 75%  17304.61 0.9106092 3786.803 8782.574 0.5180494
## 100% 17304.61 0.9178450 3816.893 9620.252 0.5674608
```

```r
Bioma<-apply(out1.backup[[6]],1,quantile)
#note: Bmsy = k/2, Blim = k/4
B.sim=data.frame(out1[6])
BF=t(apply(B.sim,1,quantile))
BF=cbind(BF,C/BF)
BRP=c(quan1[3,1]/2,quan1[3,2]/2)
fs=data.frame(cbind(BF[,c(8,3)],yr)) # F y Biomasa media
#GRAFICA BIOMASA V/S CPUE
#plot(yr,BF[,3],type="b",ylab="Biomasa and CPUE")
#par(new=T)
#plot(yr,U,type="b",col=2,axes=F,xlab="",ylab="")
#
```

```r
#######################################################
#  sensitivity to assumed upper depletion (if needed) #
#######################################################
med.out=low.out=up.out=matrix(NA,nrow=4,ncol=6)
d.l=c(0.45,0.6,0.7,0.8)  # assumed upper depletion levels
#name2<-paste(getwd(),"/Figuras/Fig2_Zhou2013_depletion.png",sep="")
#png(file=name2,width=1400,height=1400)
layout(matrix(1:4,ncol=2,byrow=T),widths=c(1,1),heights=c(1,1))
for(i in 1:4){
  all2=all[!is.na(all$r) & all$d <= d.l[i],]
  quan1=apply(all2,2,quantile)
  k25=quan1[,1][2];k75=quan1[,1][4]
  r25=quan1[,2][2];r75=quan1[,2][4]
  msy.median=quan1[,4][3]
  nsim=100
  par(mar=c(5.5,6.9,4,4),cex.axis=1.3)
  out1=sim1(k25=k25,k75=k75,r25=r25,r75=r75,C=C,yr=yr,nsim=nsim,msy=msy.media)
  tex=paste("reducción=",d.l[i],sep="")
  text(2015,round(para$k25,0)*0.26,tex,cex=1.5,xpd=T)
  sp=out1[1:5]
  sp=as.data.frame(sp)   # summary(sp)
  colnames(sp)= c('k','r','msy','Bend','D')
  BendD=apply(sp,2,quantile)
  med.out[i,]=(c(quan1[3,],BendD[3,4:5]))
  low.out[i,]=(c(quan1[2,],BendD[1,4:5]))
  up.out[i,]=(c(quan1[4,],BendD[5,4:5]))
}
```




```
#dev.off()
#
```

```
med.out[,3]=t(d.l)
low.out[,3]=t(d.l)
up.out[,3]=t(d.l)
colnames(med.out)=c("k","r","d.upper","msy","Bend","D")
colnames(low.out)=c("k","r","d.upper","msy","Bend","D")
colnames(up.out)=c("k","r","d.upper","msy","Bend","D")
kable(med.out)
```

| k | r | d.upper | msy | Bend | D |
|---|---|---|---|---|---|
| 16969.38 | 0.8808126 | 0.45 | 3734.416 | 7639.931 | 0.4481478 |
| 16634.15 | 0.9178450 | 0.60 | 3847.086 | 9508.414 | 0.5675254 |
| 16634.15 | 0.9344620 | 0.70 | 3940.578 | 10237.327 | 0.6151672 |
| 16634.15 | 0.9541809 | 0.80 | 4048.871 | 11491.280 | 0.6897368 |

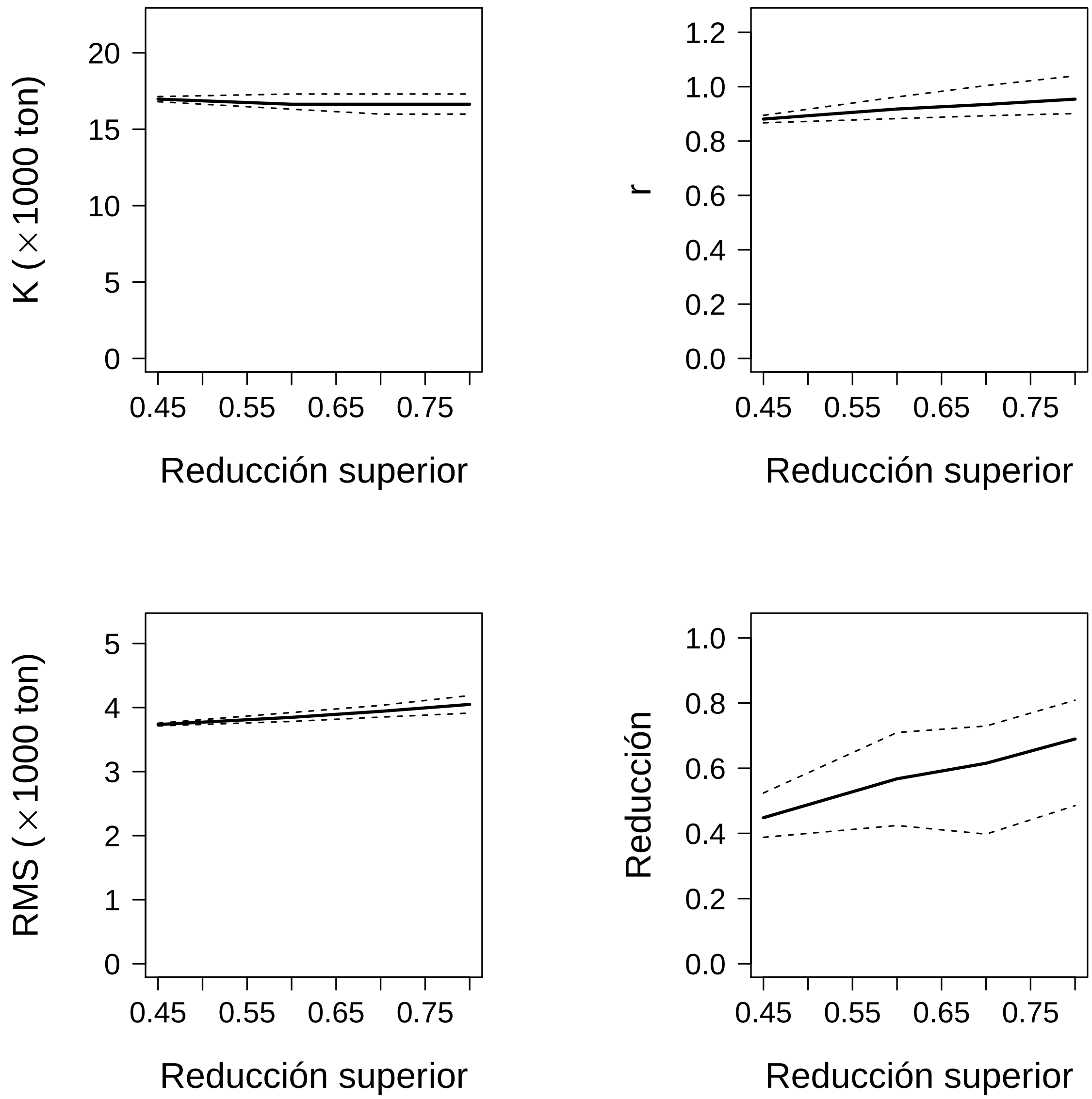
```
kable(low.out)
```

| k | r | d.upper | msy | Bend | D |
|---|---|---|---|---|---|
| 16801.77 | 0.8671203 | 0.45 | 3713.238 | 6613.459 | 0.3879364 |
| 16311.91 | 0.8826329 | 0.60 | 3783.249 | 7108.467 | 0.4242806 |
| 15989.66 | 0.8930673 | 0.70 | 3850.267 | 6619.545 | 0.3977725 |
| 15989.66 | 0.9011510 | 0.80 | 3912.928 | 8084.892 | 0.4852764 |

```
kable(up.out)
```

| k | r | d.upper | msy | Bend | D |
|---|---|---|---|---|---|
| 17137.00 | 0.8945050 | 0.45 | 3755.595 | 8931.192 | 0.5238914 |
| 17304.61 | 0.9622123 | 0.60 | 3922.126 | 11887.888 | 0.7095483 |
| 17304.61 | 1.0039538 | 0.70 | 4033.211 | 12139.221 | 0.7294532 |
| 17304.61 | 1.0398357 | 0.80 | 4187.036 | 13474.547 | 0.8087776 |

```
##########################################################################################
# parameters as a function of assumed upper depletion level
##########################################################################################
#name3<-paste(getwd(),"/Figuras/Fig3_Zhou2013_sensitivity.png",sep="")
#png(file=name3,width=900,height=1000)
layout(matrix(1:4,ncol=2,byrow=T),widths=c(1,1),heights=c(1,1))
par(mar=c(5.6,6.7,4,4),cex.axis=1.4)

plot(med.out[,3],med.out[,1]/1000,ylim=c(0,max(med.out[,1]/1000*1.3)),type='l',lwd=2,xlab='',ylab='',la
lines(low.out[,3],low.out[,1]/1000,lty=2);lines(up.out[,3],up.out[,1]/1000,lty=2)
mtext(expression(paste('K ('%*%'1000 ton)')),side=2,line=3.8,cex=1.4)
mtext("Reducción superior",side=1,line=3.6,cex=1.4)

plot(med.out[,3],med.out[,2],ylim=c(0,max(med.out[,2]*1.3)),type='l',lwd=2,xlab='',ylab='',las=1)
mtext('r',side=2,line=3.8,cex=1.4)
mtext("Reducción superior",side=1,line=3.6,cex=1.4)
lines(low.out[,3],low.out[,2],lty=2);lines(up.out[,3],up.out[,2],lty=2)

plot(med.out[,3],med.out[,4]/1000,ylim=c(0,max(med.out[,4]/1000*1.3)),type='l',lwd=2,xlab='',ylab='',la
lines(low.out[,3],low.out[,4]/1000,lty=2);lines(up.out[,3],up.out[,4]/1000,lty=2)
mtext(expression(paste('RMS ('%*%'1000 ton)')),side=2,line=3.8,cex=1.4)
mtext("Reducción superior",side=1,line=3.6,cex=1.4)

plot(med.out[,3],med.out[,6],ylim=c(0,max(med.out[,6]*1.5)),type='l',lwd=2,xlab='',ylab='',las=1)
lines(low.out[,3],low.out[,6],lty=2);lines(up.out[,3],up.out[,6],lty=2)
mtext("Reducción",side=2,line=3.8,cex=1.4)
mtext("Reducción superior",side=1,line=3.6,cex=1.4)
```




```
#dev.off()
```

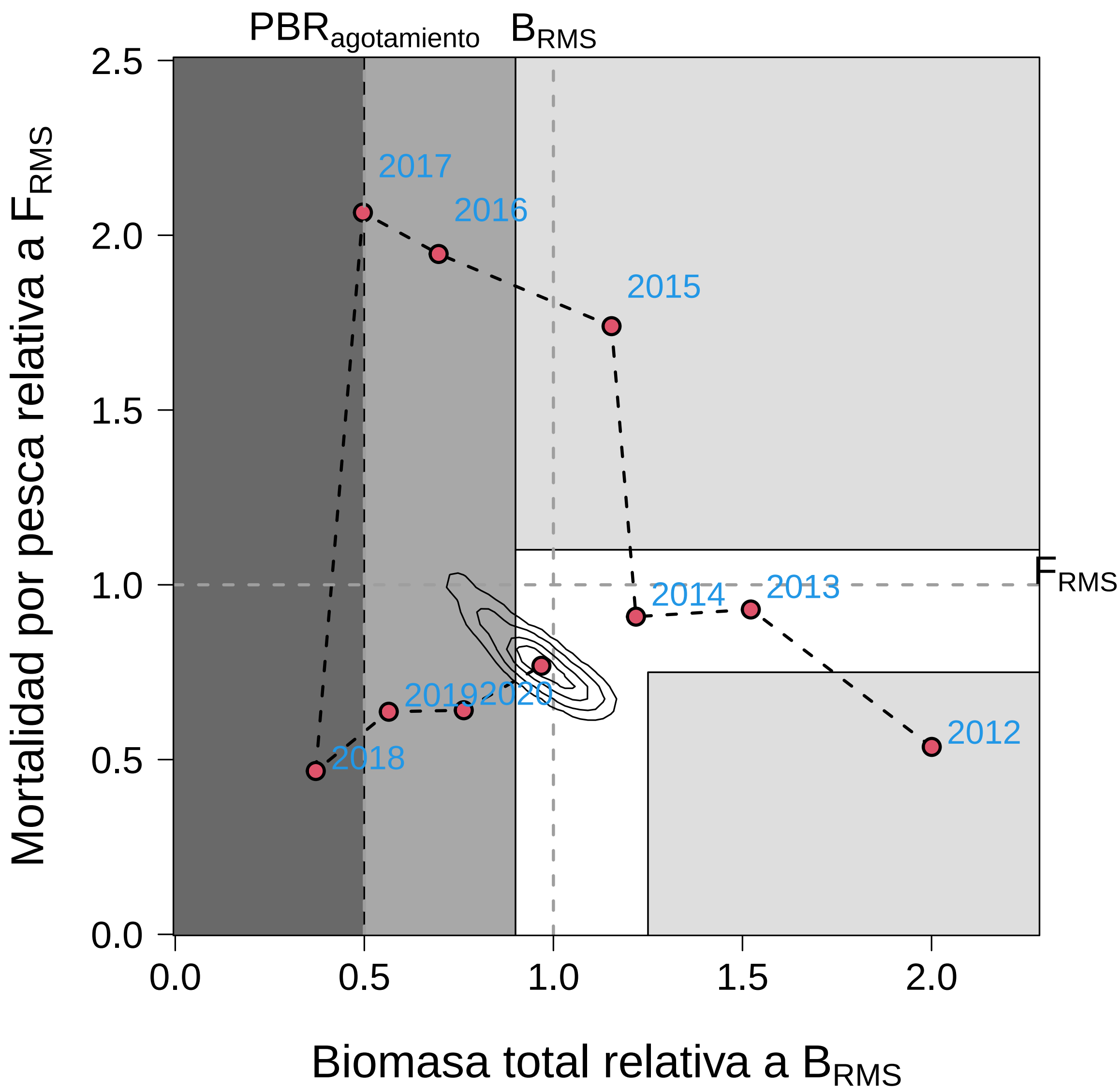
```
################################################################################################
# GRAFICA DIAGRAMA DE FASE
################################################################################################
library(MASS)
mc.dat<-BF2msy.end
Bmrs=tabla[3,1]/2 #BMRS
Fmrs=tabla[3,2]/2 #FMRS
Fest=C/Bioma[3,] #F anual
Y1<-Fest/Fmrs;X1<-Bioma[3,]/Bmrs
#h=rep(0.13,4)
z<-kde2d(mc.dat[,1],mc.dat[,2],n=100,
lims=c(range(c(0,max(X1))),range(c(0,max(Y1)*1.7))))
```

```r
est<-z$z/max(z$z);z$z<-est
#Bmrs=43590;Fmrs=0.3515;Fest=C/Bioma[3,]
#Y1<-Fest/Fmrs;X1<-Bioma[2,]/Bmrs
#
soli<-cbind(yr,Bioma[3,],Fest,X1,Y1)
colnames(soli)<-c("year","BD","Fest","Brel","Frel")

kable(soli)
```

| year | BD | Fest | Brel | Frel |
|---|---:|---:|---:|---:|
| 2012 | 16973.734 | 0.2376024 | 2.0005129 | 0.5362403 |
| 2013 | 12914.123 | 0.4117972 | 1.5220499 | 0.9293772 |
| 2014 | 10337.422 | 0.4027116 | 1.2183616 | 0.9088721 |
| 2015 | 9789.457 | 0.7709315 | 1.1537788 | 1.7399003 |
| 2016 | 5909.892 | 0.8624523 | 0.6965359 | 1.9464519 |
| 2017 | 4211.110 | 0.9149606 | 0.4963186 | 2.0649569 |
| 2018 | 3153.544 | 0.2070686 | 0.3716746 | 0.4673291 |
| 2019 | 4791.072 | 0.2821915 | 0.5646725 | 0.6368727 |
| 2020 | 6473.296 | 0.2840902 | 0.7629383 | 0.6411577 |
| 2021 | 8216.055 | 0.3404310 | 0.9683387 | 0.7683122 |

```r
#library(rJava)                                          ## PROBLEMAS CON ESTO
#library(xlsx)
write.csv2(soli,"tabla2.csv",row.names=FALSE)
#DEFINE LAS AREAS DE LOS POLIGONOS
cols<-c("#696969","#A8A8A8","#DEDEDE")
ini<-c(-0.09);xmax<-max(X1)*1.35;ymax<-max(Y1)*1.22;xmin<-(0.08)
pol1<-matrix(c(0.9,ini,0.9,1.1,xmax,1.1,xmax,0.75,1.25,0.75,1.25,ini),
ncol=2,byrow=T)
pol2<-matrix(c(1.25,ini,1.25,0.75,xmax,0.75,xmax,ini),ncol=2,byrow=T)
pol3<-matrix(c(xmax,1.1,xmax,ymax,0.9,ymax,0.9,1.1),ncol=2,byrow=T)
pol4<-matrix(c(0.5,ini,0.9,ini,0.9,ymax,0.5,ymax),ncol=2,byrow=T)
pol5<-matrix(c(-0.07,ini,0.5,ini,0.5,ymax,-0.07,ymax),ncol=2,byrow=T)

#name4<-paste(getwd(),"/Figuras/Fig4_Zhou2013_fase.png",sep="")
#png(file=name4,width=1200,height=1000)
par(mar=c(6.1,6.5,4.8,4.8),cex.axis=1.5,cex.lab=1.5)
plot(X1,Y1,col=0,xlab="",ylab="",yaxt="n",xlim=c(xmin,max(X1)*1.1),
ylim=c(0.09,max(Y1)*1.17))
axis(2,las=1)
polygon(pol5,col=cols[1],border=1);polygon(pol4,col=cols[2],border=1)
polygon(pol3,col=cols[3],border=1);polygon(pol2,col=cols[3],border=1)
polygon(pol1,col="white",border="black")
#points(mc.dat[,1],mc.dat[,2],pch=21,bg="#B5B5B5",cex=0.9,col=1)
lines(X1,Y1,lty=2,col=1,lwd=2)
lines(X1,Y1,type="p",bg=2,pch=21,cex=1.5,lwd=2)
abline(v=1,lty=2,col=8,lwd=2);abline(h=1,lty=2,col=8,lwd=2)
abline(v=0.5,lty=2,col=8,lwd=2)
contour(z,drawlabels=FALSE,levels=c(0.1,0.25,0.5,0.75),add=TRUE)
text(0.5,max(Y1)*1.29,expression(PBR[paste("agotamiento")]),cex=1.6,
pos=1,xpd=T)
text(1,max(Y1)*1.29,expression(B[paste("RMS")]),cex=1.6,pos=1,xpd=T)
```

```
text(max(X1)*1.19,1.11,expression(F[paste("RMS")]),cex=1.6,pos=1,xpd=T)
mtext(expression(paste("Biomasa total relativa a ",B[paste("RMS")],sep="")),
side=1,line=4.2,cex=1.8)
mtext(expression(paste("Mortalidad por pesca relativa a ",F[paste("RMS")],
sep="")),side=2,line=3.8,cex=1.8)
#a2<-which(yr%in%seq(2015,1994,by=-2)==TRUE)
a2<-c(1,2,3,4,5,6,7,8,9)
text(X1[a2],Y1[a2]*1.06,yr[a2],cex=1.3,pos=4,col=4)
#text(1.10,0.83,"Plena Explotación",cex=1.6,pos=4,col=1,lwd=2)
#text(1.56,0.31,"Sub Explotación",cex=1.6,pos=4,col=1,lwd=2)
#text(1.33,1.51,"Sobrepesca",cex=1.6,pos=4,col=1,lwd=2)
#text(0.58,0.67,"Sobre",cex=1.6,pos=4,col=1,lwd=2)
#text(0.52,0.51,"Explotación",cex=1.6,pos=4,col=1,lwd=2)
#text(0.68,1.18,"Sobre-explotación y Sobrepesca",cex=1.6,pos=4,lwd=2,srt=90)
#text(0.23,1.18,"Colapso y/o Agotamiento",cex=1.6,pos=4,lwd=2,srt=90)
box()
```



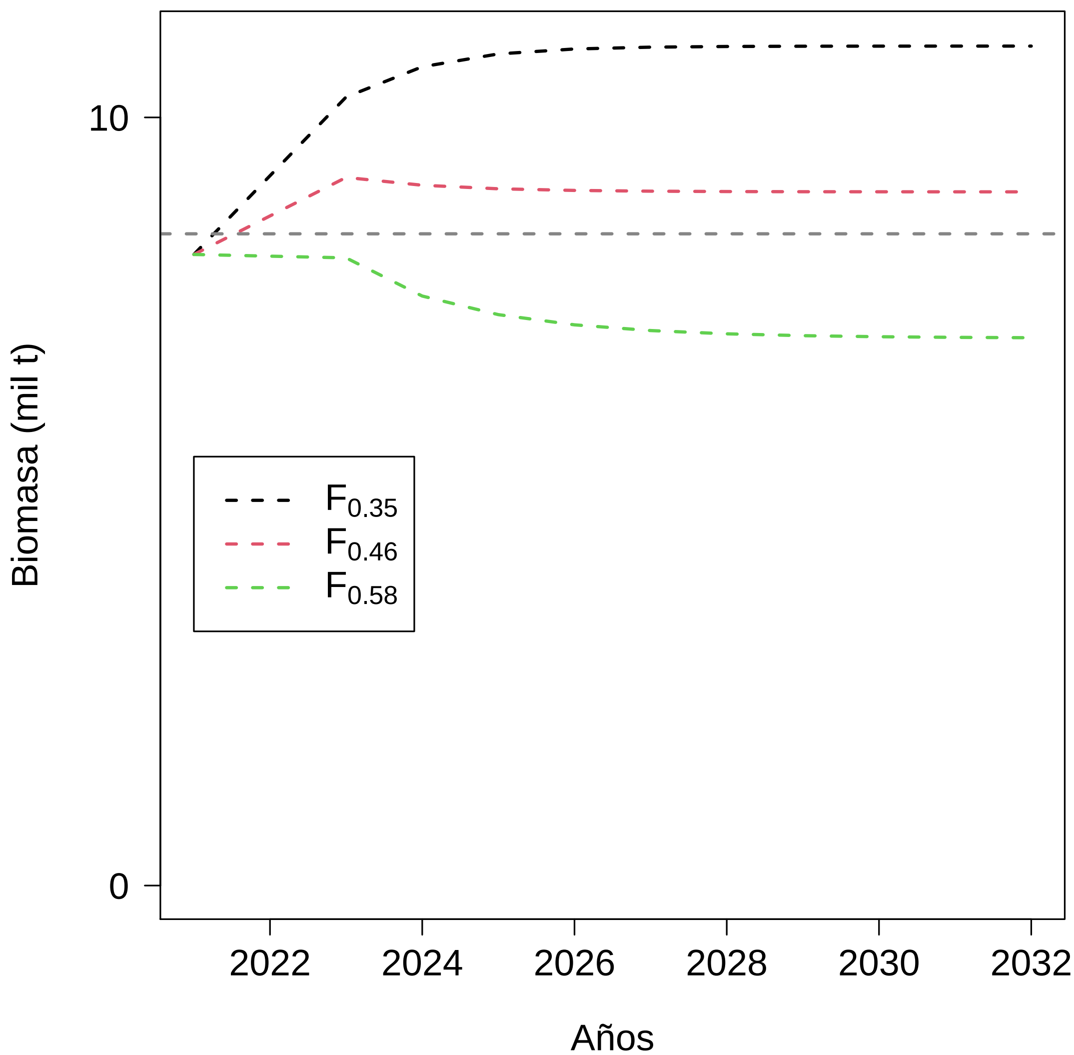

```
#dev.off()
```

### Cálculo de CBA

```
############################################################################################
#CALCULO DE LA CBA 2020 PARA SARDINA AUSTRAL XI
############################################################################################
mata<-out1.backup[1:5];mm<-length(mata);mato<-vector()
for(p in 1:mm){mato<-cbind(mato,mata[[p]])}
mate<-as.data.frame(mato)
colnames(mate)<-c("k","r","msy","Bend","Depletion")
yy<-length(yr);prob=c(0.75,1.00,1.25)
ss<-dim(sp);yrs_pro<-seq(yr[yy],yr[yy]+11,by=1);yyp<-length(yrs_pro)
```

```
BT=CT=array(NA,c(length(prob),ss[1],length(yrs_pro)))
BT[,,1]<-Bioma[3,yy];CT[,,1]<-C[yy]
Fi=Fmrs*prob
for(y in 1:length(Fi)){
 for(n in 1:ss[1]){
  ki=sp$k[n];ri=sp$r[n]
  for(m in 1:(yyp-1)){
   if(m==1){CT[y,,1]=C[yy]} else {CT[y,n,m]=BT[y,n,m]*Fi[y]}
   BT[y,n,m+1]=BT[y,n,m]+ri*BT[y,n,m]*(1-BT[y,n,m]/ki)-CT[y,n,m]
   if(m==(yyp-1)){CT[y,n,m+1]=BT[y,n,m+1]*Fi[y]}
  }
 }
}
```

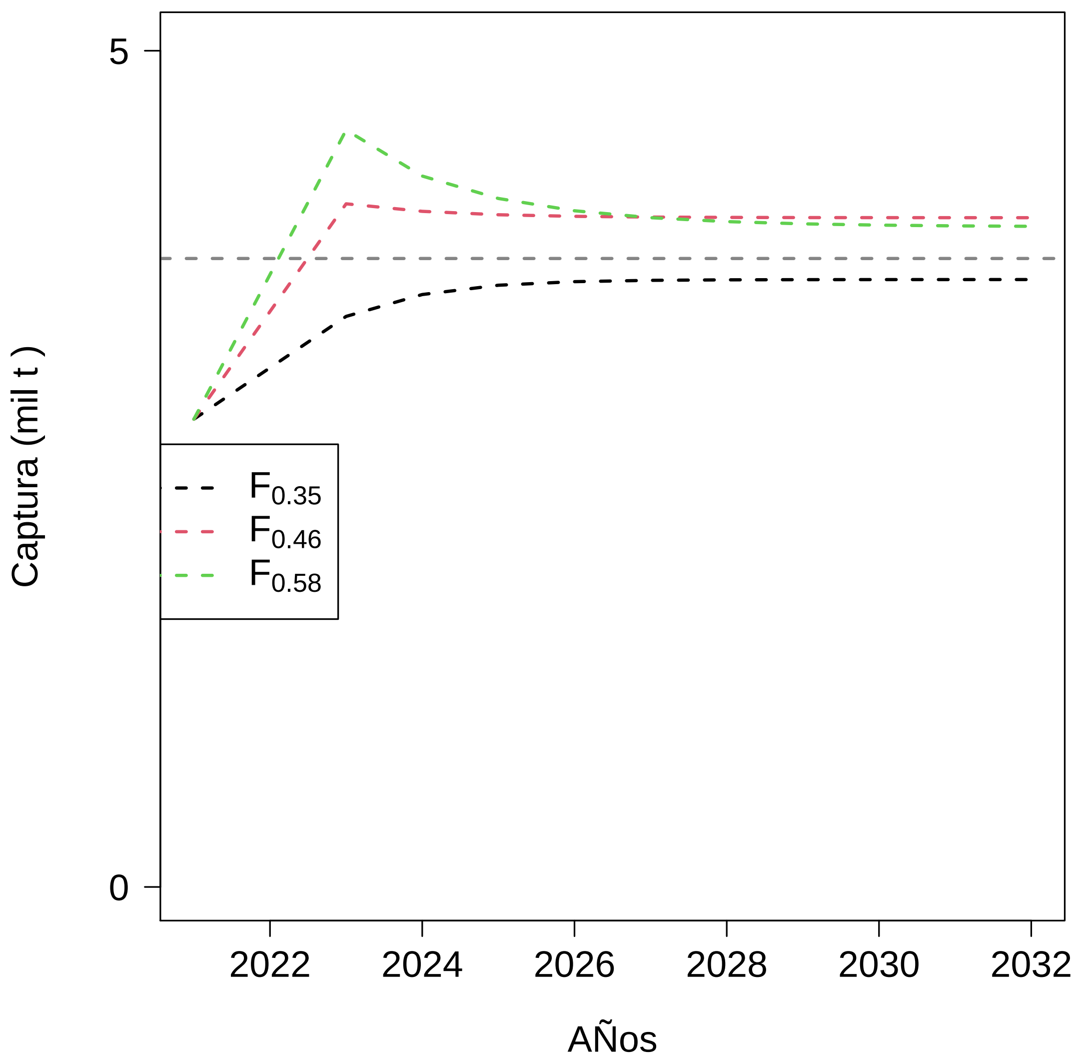
```
################################################################################################
# GRAFICA LA CBA 2020 PARA sardina austral
################################################################################################
FF<-formatC(Fi,format="f",digits=2)
BB<-expression(paste("Biomasa (mil t)",sep=""))
Binf<-tabla[2,1]/2;Bsup<-tabla[4,1]/2
rng1<-range(BT[,,],na.rm=T)
ax2<-seq(0,rng1[2]*1.15,by=10000);cols<-"#858585";y1<-length(yrs_pro)

#name5<-paste(getwd(),"/Figuras/Fig5_Zhou2013_Proyeccion_B.png",sep="")
#png(file=name5,width=900,height=800)
#x11(width=8,height=7)
par(mar=c(6.1,6.2,4.8,4.8),cex.axis=1.4,cex.lab=1.4)
plot(yrs_pro[-2],seq(0,rng1[2]*1.15,le=(y1-1)),col=0,type="l",xlab="",ylab="",yaxt="n",ylim=c(0,rng1[2]
for(x in 1:length(Fi)){
 lines(yrs_pro[-2],apply(BT[x,,],2,quantile)[3,-2],col=x,lty=2,lwd=2)
}
abline(h=Bmrs,lty=2,lwd=2,col=cols)
axis(2,at=ax2,labels=ax2/1000,las=1,cex=1.4)
mtext(BB,side=2,line=3.5,cex=1.4)
mtext("Años",side=1,line=3.4,cex=1.4)
legend(2021,rng1[2]*0.5,c(expression(F[paste("0.35")]),expression(F[paste("0.46")]),
expression(F[paste("0.58")])),lty=c(2,2,2,2,2),lwd=c(2,2,2,2,2),cex=1.4,
col=c(1,2,3))
```




```
#dev.off()
```

```
####################################################################################################
# GRAFICA LA CAPTURA
####################################################################################################
CC<-expression(paste("Captura (mil t )",sep=""))
MRS=tabla[3,3]
rng2<-range(CT[,,],na.rm=T)
ax3<-seq(0,rng2[2]*1.15,by=5000)

#name6<-paste(getwd(),"/Figuras/Fig6_Zhou2013_capturas.png",sep="")
#png(file=name6,width=900,height=800)

#x11(width=8,height=7)
```

```r
par(mar=c(6.1,6.2,4.8,4.8),cex.axis=1.4,cex.lab=1.4)
plot(yrs_pro[-2],seq(0,rng2[2]*1.15,le=11),col=0,type="l",xlab="",ylab="",yaxt="n",ylim=c(0,rng2[2]*0.95
for(x in 1:length(Fi)){
 lines(yrs_pro[-2],apply(CT[x,,],2,quantile)[3,-2],col=x,lty=2,lwd=2)
}
abline(h=MRS,lty=2,lwd=2,col=cols)
axis(2,at=ax3,labels=sprintf("%0.0f",ax3/1000),las=1,cex=1.4)
mtext(CC,side=2,line=3.5,cex=1.4)
mtext("AÑos",side=1,line=3.4,cex=1.4)
legend(2020,rng2[2]*0.5,c(expression(F[paste("0.35")]),expression(F[paste("0.46")]),
expression(F[paste("0.58")])),lty=c(2,2,2,2,2),lwd=c(2,2,2,2,2),cex=1.4,
col=c(1,2,3))
```



```r
#dev.off()
```

```r
##########################################################################################
# TABLA DE RESULTADOS
##########################################################################################
ct<-matrix(NA,length(Fi),5)
for(i in 1:length(Fi)){
 ct[i,]<-as.numeric(quantile(CT[i,,2],probs=c(.1,.2,.3,.4,.5)))  # CT[i,,2] (el 2 representa 1 año de p
}
colnames(ct)<-c("10%","20%","30%","40%","50%")
rownames(ct)<-formatC(Fi,format="f",digits=2)
cat("\n")
```

```r
print(ct)
```

```
##           10%      20%      30%      40%      50%
## 0.33 3114.226 3123.352 3129.292 3135.562 3140.357
## 0.44 4152.301 4164.469 4172.389 4180.749 4187.143
## 0.55 5190.376 5205.586 5215.486 5225.936 5233.929
```

```r
##########################################################################################
# RANGO CBA PARA PBR Al MRS (2) y EL 2021(2)
##########################################################################################
rango<-quantile(CT[2,,2],prob=c(0.025,0.25,0.50,0.75,0.975))

kable(rango)
```

| | x |
|---|---|
| 2.5% | 4142.343 |
| 25% | 4168.543 |
| 50% | 4187.143 |
| 75% | 4206.894 |
| 97.5% | 4225.940 |

```r
#
#FIN
```