Método de Zhou 2013

PCOM Posterior-focused catch-only method S. Zhou, Modificado por Elson Leal y María José Zúñiga para sardina austral Aysen, CBA 2021

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

getwd()
```

```
## [1] "/Users/mariajosezunigabasualto/MJZ/CTP2022/SARDINAAUSTRAL_AYSEN/PRIMER_INFORME"
```

```r
###############################################################################################
# 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}
}
```

Simulación

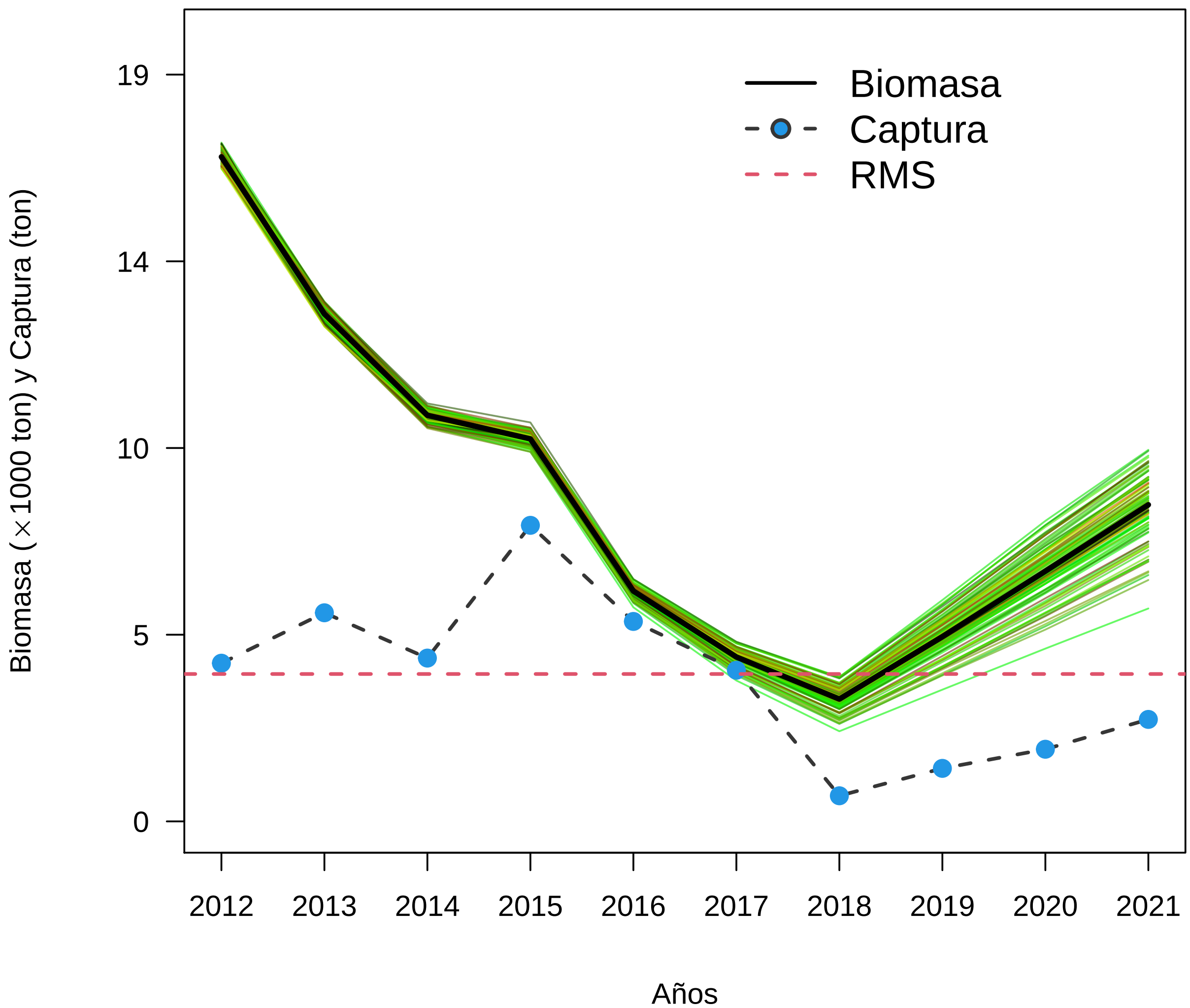
Ingresa datos de captura

```
#
####################################################################
# input catch data and r range for sautral XI stock
####################################################################
#C=c(4033,5318,4163,7547,5097,3853,653,1352,1839,4488)
#C=c(4033,5318,4163,7547,5097,3853,653,1352,1839,3600)
C=c(4033,5318,4163,7547,5097,3853,653,1352,1839,2600)
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
```

```r
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 <= 0.50,]#cutoff,assume upper depeltion=0.50
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
par(mar=c(5,5.5,1,1),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)
```




```
###########################################################################################
#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,],
```

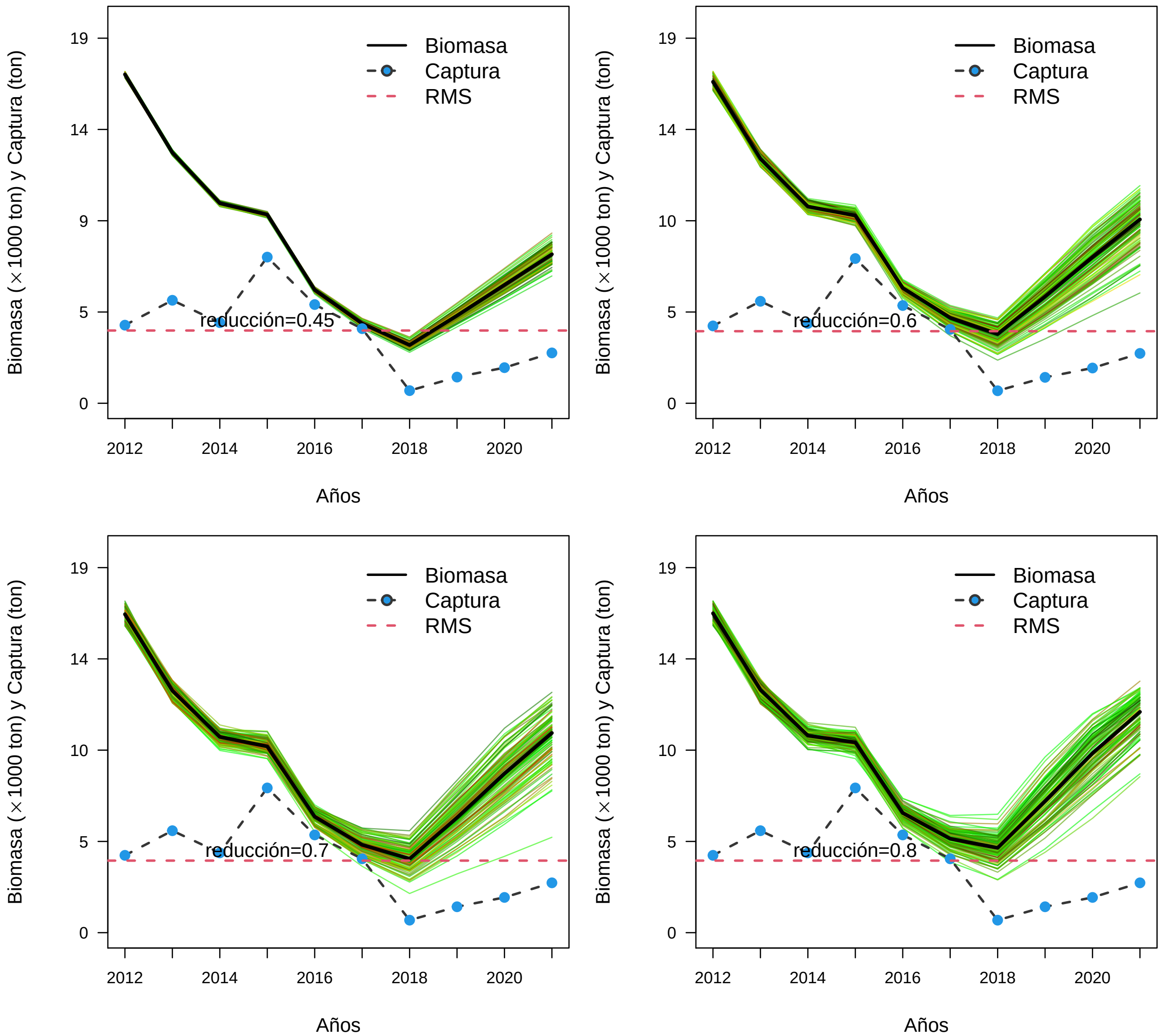
```
                    F2Fmsy.med=apply(F2Fmsy,1,median),
                    quan1.F=apply(F2Fmsy,1,quant)[1,],
                    quan3.F=apply(F2Fmsy,1,quant)[2,])

BF2msy.end = data.frame(t(rbind(B2Bmsy[length(yr),],F2Fmsy[length(yr),])))
colnames(BF2msy.end)=c("B2Bmsy","F2Fmsy")
#kable(BF2msy.end)
#
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
######################################################################
tabla<-cbind(quan1[,c(1,2,4)],BendD[,4:5])
write.csv2(tabla,"tabla1.csv",row.names=FALSE)
kable(tabla)
```

	k	r	msy	Bend	Depletion
0%	16634.15	0.8534279	3692.060	5427.060	0.3205284
25%	16634.15	0.8614773	3726.883	7624.549	0.4503146
50%	16969.38	0.8861789	3757.632	8071.385	0.4767053
75%	17304.61	0.9106092	3786.803	8581.444	0.5068299
100%	17304.61	0.9178450	3816.893	9470.266	0.5593248

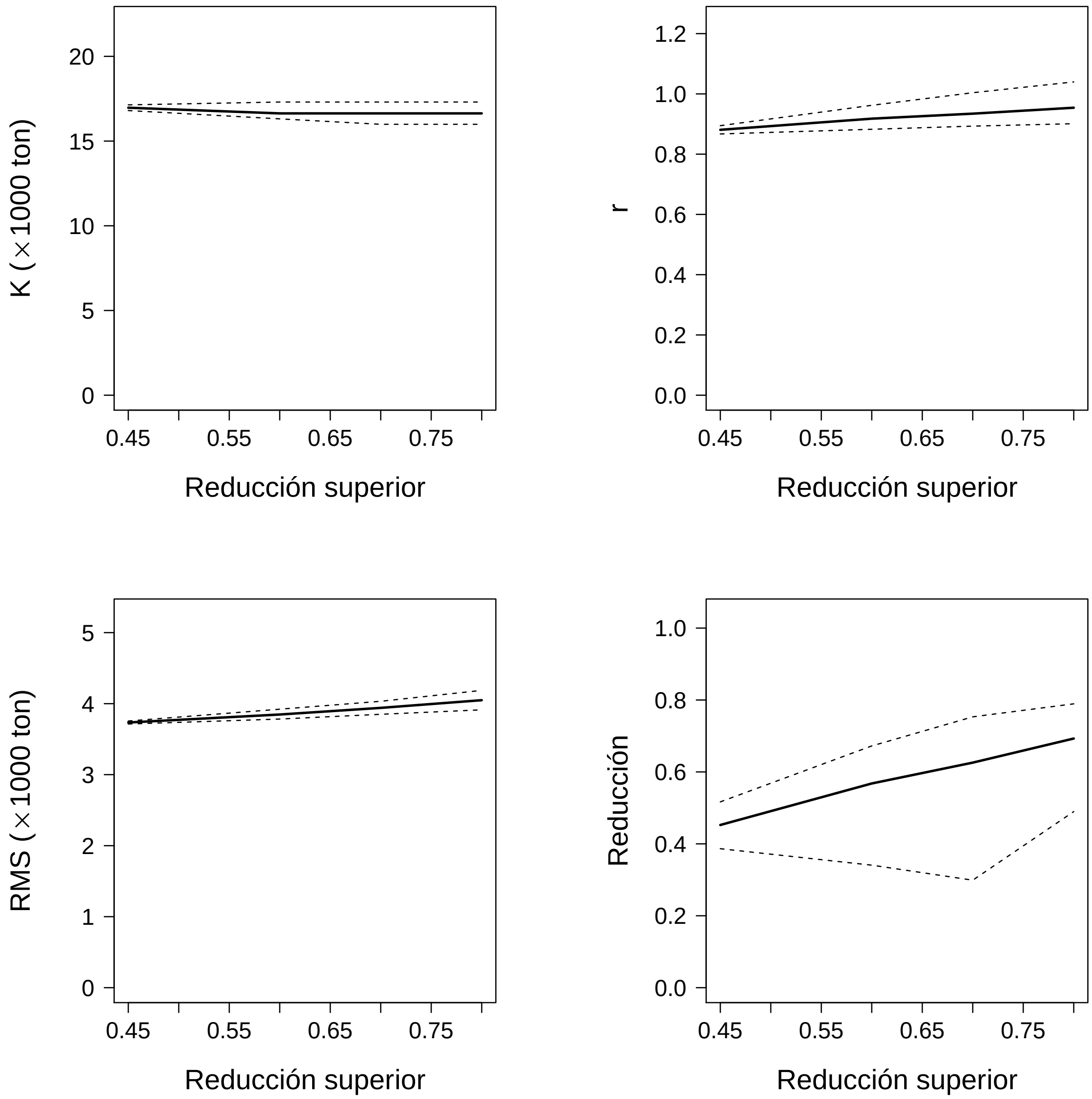
```
Bioma <-apply(out1.backup[[6]],1,quantile)
#note: Bmsy = k/2, Blim = k/4
B.sim =data.frame(out1[6])
BF    =t(apply(B.sim,1,quantile))
BF    =cbind(BF,C/BF)
BRP   =c(quan1[3,1]/2,quan1[3,2]/2)
fs    =data.frame(cbind(BF[,c(8,3)],yr)) # F y Biomasa media
#GRAFICA BIOMASA V/S CPUE
#plot(yr,BF[,3],type="b",ylab="Biomasa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

Sensibilidad

```
#######################################################
#  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
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
  ####################################################################################
  #Figura
  par(mar=c(5,5.5,1,1),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=1.2,xpd=T)
  ####################################################################################
  # Tablas
  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]))

  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)
  kable(low.out)
  kable(up.out)
  ####################################################################################
}
```


Biomasa
Captura
RMS
reducción=0.45
reducción=0.6
reducción=0.7
reducción=0.8
Biomasa (×1000 ton) y Captura (ton)
Años
0
5
9
10
14
19
2012
2014
2016
2018
2020

```
############################################################################################
# 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='',las
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='',las
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)

K       <- med.out[1,1]
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
```

```r
Z1     <-Bioma[3,]/K
#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))))
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,round(Bioma[3,],0),round(Fest,2),round(Z1,2),round(X1,2),round(Y1,2))
colnames(soli)<-c("year","BT","Fest","B_Bo","Brel","Frel")

kable(soli)
```

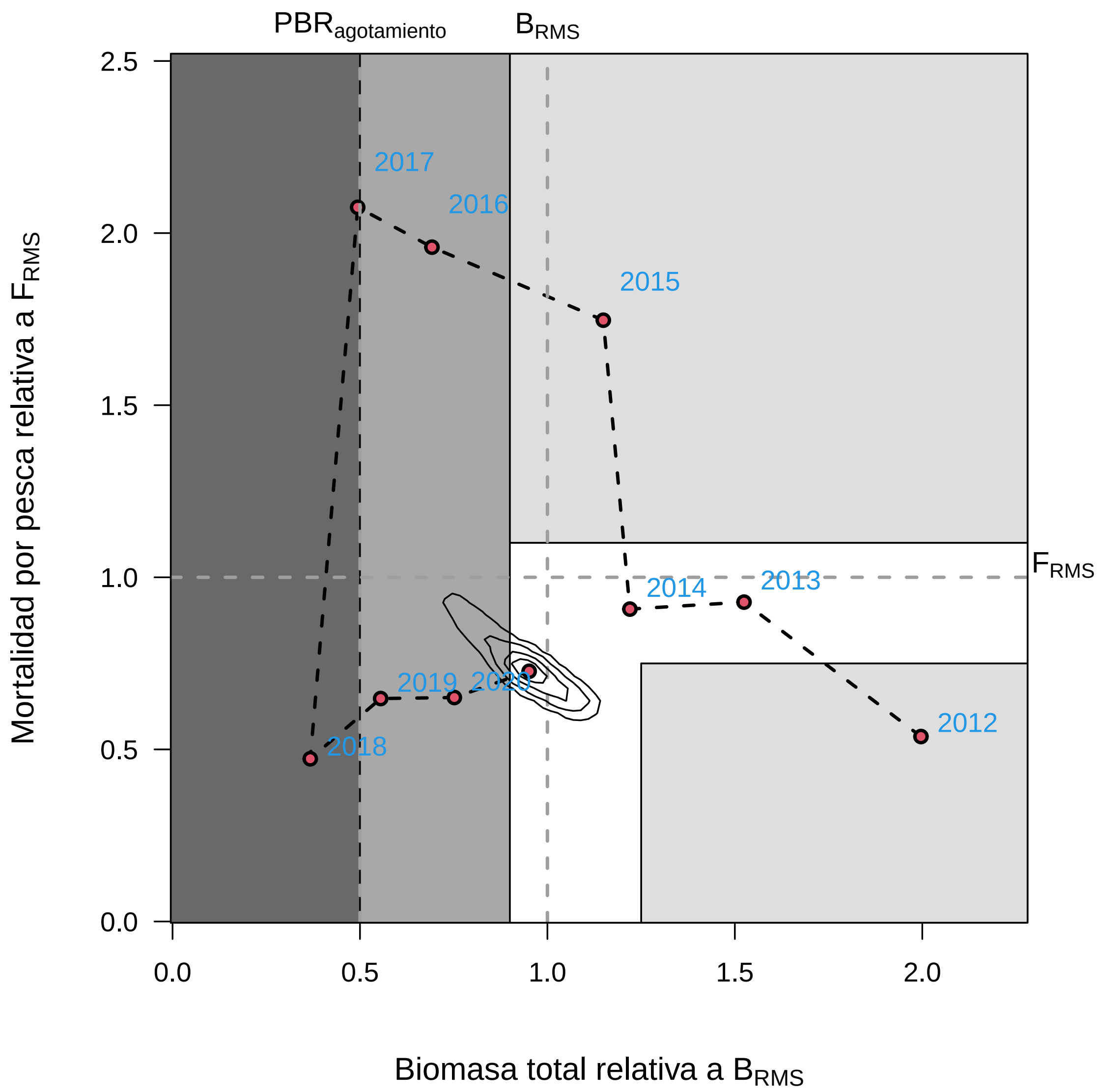
year	BT	Fest	B_Bo	Brel	Frel
2012	16939	0.24	1.00	2.00	0.54
2013	12935	0.41	0.76	1.52	0.93
2014	10351	0.40	0.61	1.22	0.91
2015	9750	0.77	0.57	1.15	1.75
2016	5872	0.87	0.35	0.69	1.96
2017	4191	0.92	0.25	0.49	2.07
2018	3117	0.21	0.18	0.37	0.47
2019	4711	0.29	0.28	0.56	0.65
2020	6378	0.29	0.38	0.75	0.65
2021	8071	0.32	0.48	0.95	0.73

```r
kable(rbind(Bmrs,Fmrs))
```

Bmrs	8484.6911038
Fmrs	0.4430894

```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,cex.lab=1)
plot(X1,Y1,col=0,xlab="",ylab="",yaxt="n",xlim=c(xmin,max(X1)*1.1),
ylim=c(0.09,max(Y1)*1.17))
```

```r
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,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=1.1,
pos=1,xpd=T)
text(1,max(Y1)*1.29,expression(B[paste("RMS")]),cex=1.1,pos=1,xpd=T)
text(max(X1)*1.19,1.11,expression(F[paste("RMS")]),cex=1.1,pos=1,xpd=T)
mtext(expression(paste("Biomasa total relativa a ",B[paste("RMS")],sep="")),
side=1,line=4.2,cex=1.2)
mtext(expression(paste("Mortalidad por pesca relativa a ",F[paste("RMS")],
sep="")),side=2,line=3.8,cex=1.2)
#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,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()
```


PBR agotamiento
B RMS
F RMS
2017
2016
2015
2014
2013
2012
2019
2020
2018
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
Mortalidad por pesca relativa a F RMS
Biomasa total relativa a B RMS

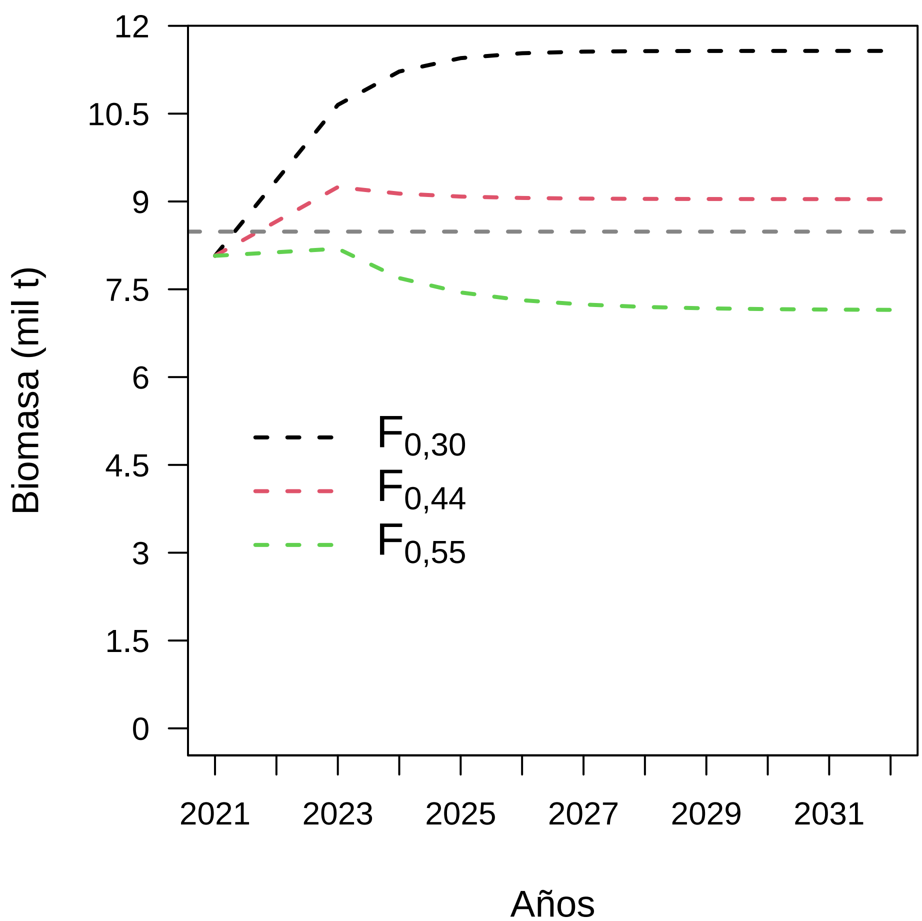
```
#dev.off()
```

Cálculo de CBA

```
#####################################################################################################
#CALCULO DE LA CBA  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(0.6666667,1.00,1.25) # pnderadores de Frms
ss      <-dim(sp)
yrs_pro <-seq(yr[yy],yr[yy]+11,by=1) # años de proyección
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

# y = Frms ponderados
# n = número de simulaciones
# m = años de proyección

for(y in 1:length(Fi)){
 for(n in 1:ss[1]){
  ki=sp$k[n] # parámetro K simulado
  ri=sp$r[n] # parámetro r simulado
  for(m in 1:(yyp-1)){ # PROYECCIÓN
   if(m==1){
     CT[y,,1]=C[yy]} # igual a la captura del último año
    else {
      CT[y,n,m]=BT[y,n,m]*Fi[y]} # captura proyectada
      BT[y,n,m+1]=BT[y,n,m]+ri*BT[y,n,m]*(1-BT[y,n,m]/ki)-CT[y,n,m] # biomasa total proyectada
   if(m==(yyp-1)){
     CT[y,n,m+1]=BT[y,n,m+1]*Fi[y]}
  }
 }
}
```

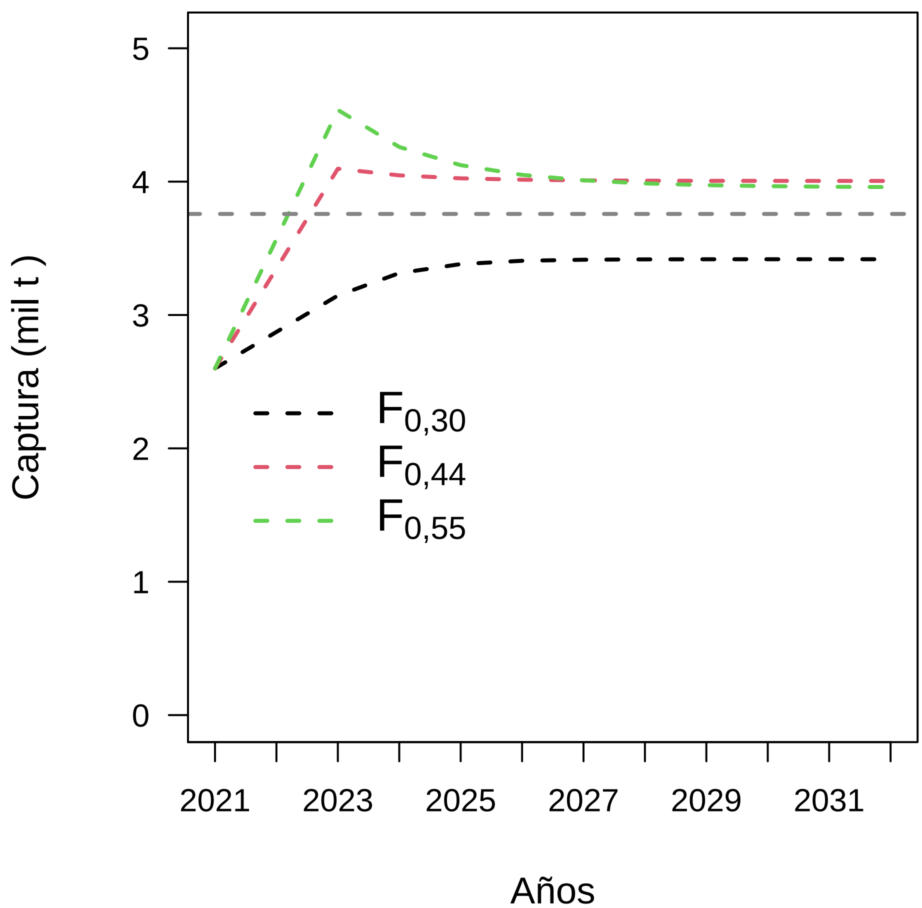
```
#####################################################################################################
# GRAFICA LA CBA 2 PARA sardina austral
#####################################################################################################
FF   <-formatC(Fi,format="f",digits=2)
BB   <-expression(paste("Biomasa (mil t)",sep=""))
Binf <-tabla[2,1]/2
Bsup <-tabla[4,1]/2
rng1 <-range(BT[,,],na.rm=T)
```

```r
ax2  <-seq(0,rng1[2]*1.15,by=1500)
cols <-"#858585"
y1   <-length(yrs_pro)
xxxx<-matrix(ncol=3,nrow=11)

par(mar=c(5,5,1,1),cex.axis=1,cex.lab=1)
plot(yrs_pro[-2],seq(0,rng1[2]*1.15,le=(y1-1)),col=0,type="o",xlab="",ylab="",yaxt="n",ylim=c(0,rng1[2]*

for(x in 1:length(Fi)){
  xxxx[,x]<-apply(BT[x,,],2,quantile)[3,-2]
 lines(yrs_pro[-2],xxxx[,x],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)
mtext(BB,side=2,line=3.5,cex=1.2)
mtext("Años",side=1,line=3.4,cex=1.2)
legend(2021,rng1[2]*0.5,c(expression(F[paste("0,30")]),expression(F[paste("0,44")]),
expression(F[paste("0,55")])),lty=c(2,2,2,2,2),lwd=c(2,2,2,2,2),cex=1.4,
col=c(1,2,3),bty="n")
```




```r
##########################################################################################
# GRAFICA LA CAPTURA
##########################################################################################
```

```r
CC   <-expression(paste("Captura (mil t )",sep=""))
MRS  <-tabla[3,3] #50%
rng2 <-range(CT[,,],na.rm=T)
ax3  <-seq(0,rng2[2]*1.15,by=1000)

xxxx<-matrix(ncol=3,nrow=11)

par(mar=c(5,5,1,1),cex.axis=1,cex.lab=1)
plot(yrs_pro[-2],seq(0,rng2[2]*1.15,le=11),col=0,type="o",xlab="",ylab="",yaxt="n",ylim=c(0,rng2[2]*0.95

for(x in 1:length(Fi)){
  xxxx[,x]<-apply(CT[x,,],2,quantile)[3,-2]
 lines(yrs_pro[-2],xxxx[,x],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=1.2)
mtext("Años",side=1,line=3.4,cex=1.2)
legend(2021,rng2[2]*0.5,c(expression(F[paste("0,30")]),expression(F[paste("0,44")]),
expression(F[paste("0,55")])),lty=c(2,2,2,2,2),lwd=c(2,2,2,2,2),cex=1.4,
col=c(1,2,3),bty="n")
```



```
#####################################################################################
# TABLA DE RESULTADOS CAPTURA 2021
#####################################################################################
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")
```

```
print(ct)
```

```
##           10%      20%      30%      40%      50%
## 0.30 2786.160 2792.219 2798.004 2802.863 2807.559
## 0.44 4179.239 4188.329 4197.005 4204.294 4211.338
## 0.55 5224.049 5235.411 5246.257 5255.368 5264.172
```

```
#####################################################################################
# TABLA DE RESULTADOS biomasa 2021
#####################################################################################
bt<-matrix(NA,length(Fi),5)
for(i in 1:length(Fi)){
 bt[i,]<-as.numeric(quantile(BT[i,,2],probs=c(.1,.2,.3,.4,.5)))  # CT[i,,2] (el 2 representa 1 año de p
}
colnames(bt)<-c("10%","20%","30%","40%","50%")
rownames(bt)<-formatC(Fi,format="f",digits=2)
cat("\n")
print(bt)


year<-seq(2012,2021)
bioHil<-c(NA,17712,12394,11186,6911,5161,4212,6108,7933,8592)

par(mar=c(5,5,1,1),cex.axis=1,cex.lab=1)
plot(year,c(soli[,2],bt[2,5]),type="o",pch=19,ylim=c(0,20000), xaxp=c(2012,2022,10),ylab="Biomasa total
lines(year,bioHil,type="o",col=2,pch=19)
legend(2017,16000,c("Hilborn y Mangel 1997","Zhou 2013"),
       bty="n",lwd=1,pch=19,col=c(2,1), title="Método de estimación")
```

```
#####################################################################################
# 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%	4162.952
25%	4191.870
50%	4211.338
75%	4223.640
97.5%	4254.486

```
#
#FIN
```