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

```
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"
```

```
####################################################################################################
# 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

```
###############################################################################################
# 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,cex.axis=1)
 axis(2,at=y1,labels=format(round(y1/1000,0),3),las=2,cex.axis=1)
 legend(yr[nyr-4],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,bty="n")
 BC<-expression(paste('Biomasa ('%*%'1000 ton) y Captura (ton)',sep=""))
 mtext(BC,side=2,line=4.0,cex=1)
 mtext("Años",side=1,line=3.5,cex=1)
 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))
}
```

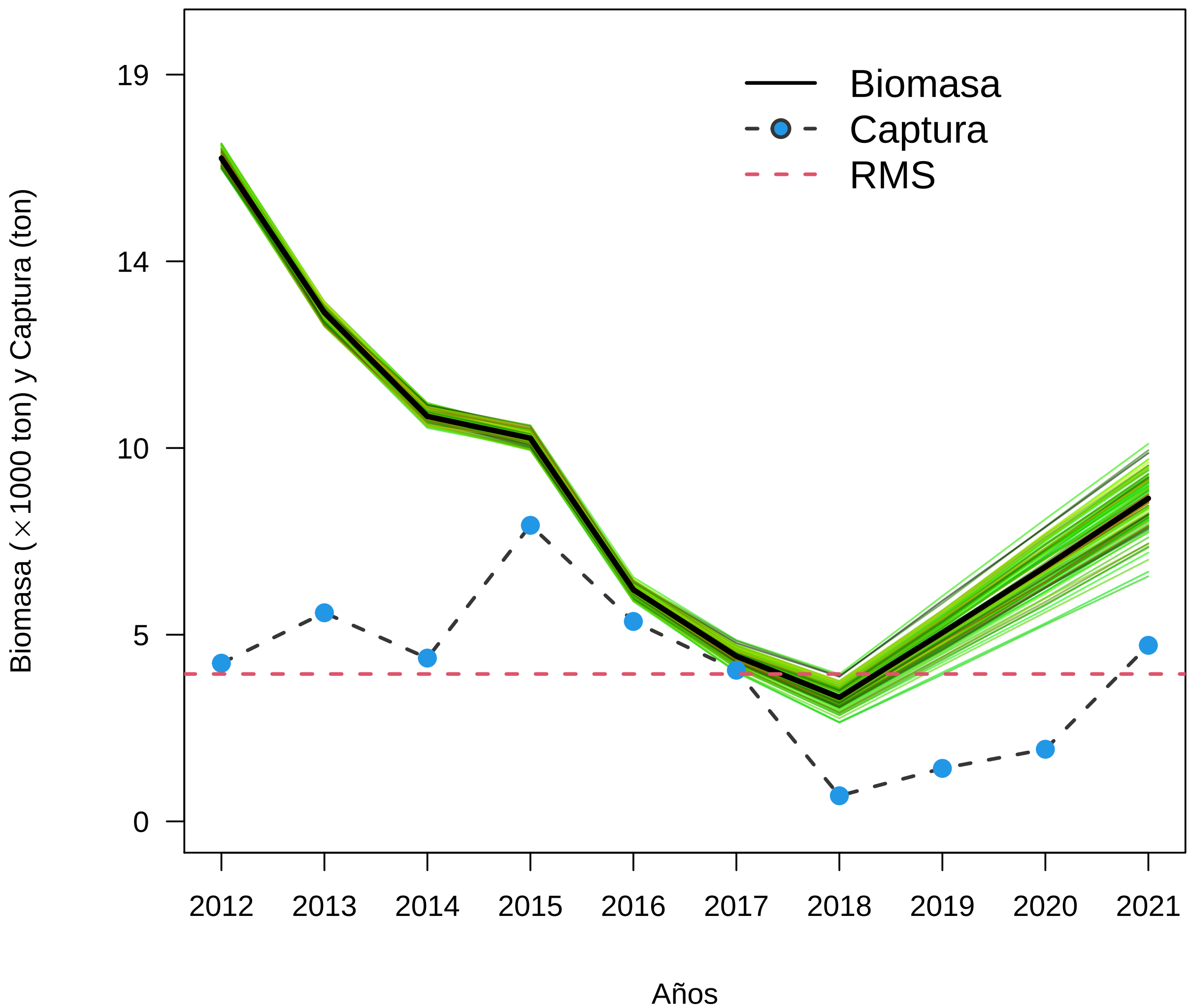
Ingresa datos de captura

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

```r
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,],
```

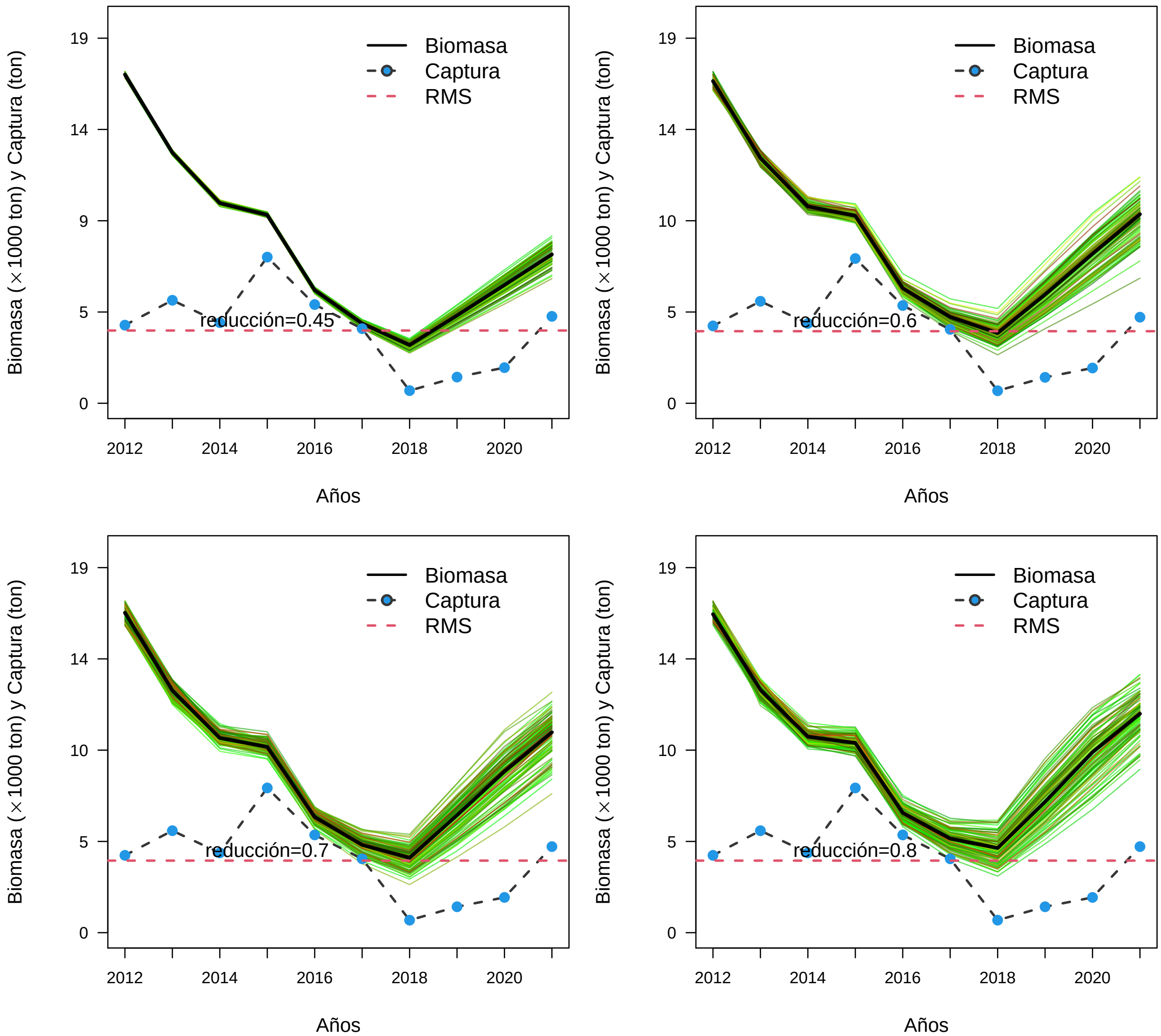
```r
                    F2Fmsy.med=apply(F2Fmsy,1,median),
                    quan1.F=apply(F2Fmsy,1,quant)[1,],
                    quan3.F=apply(F2Fmsy,1,quant)[2,])

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	6247.066	0.3689473
25%	16634.15	0.8614773	3726.883	7760.780	0.4583462
50%	16969.38	0.8861789	3757.632	8234.216	0.4863070
75%	17304.61	0.9106092	3786.803	8714.520	0.5146734
100%	17304.61	0.9178450	3816.893	9623.804	0.5683751

```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="")
#
```

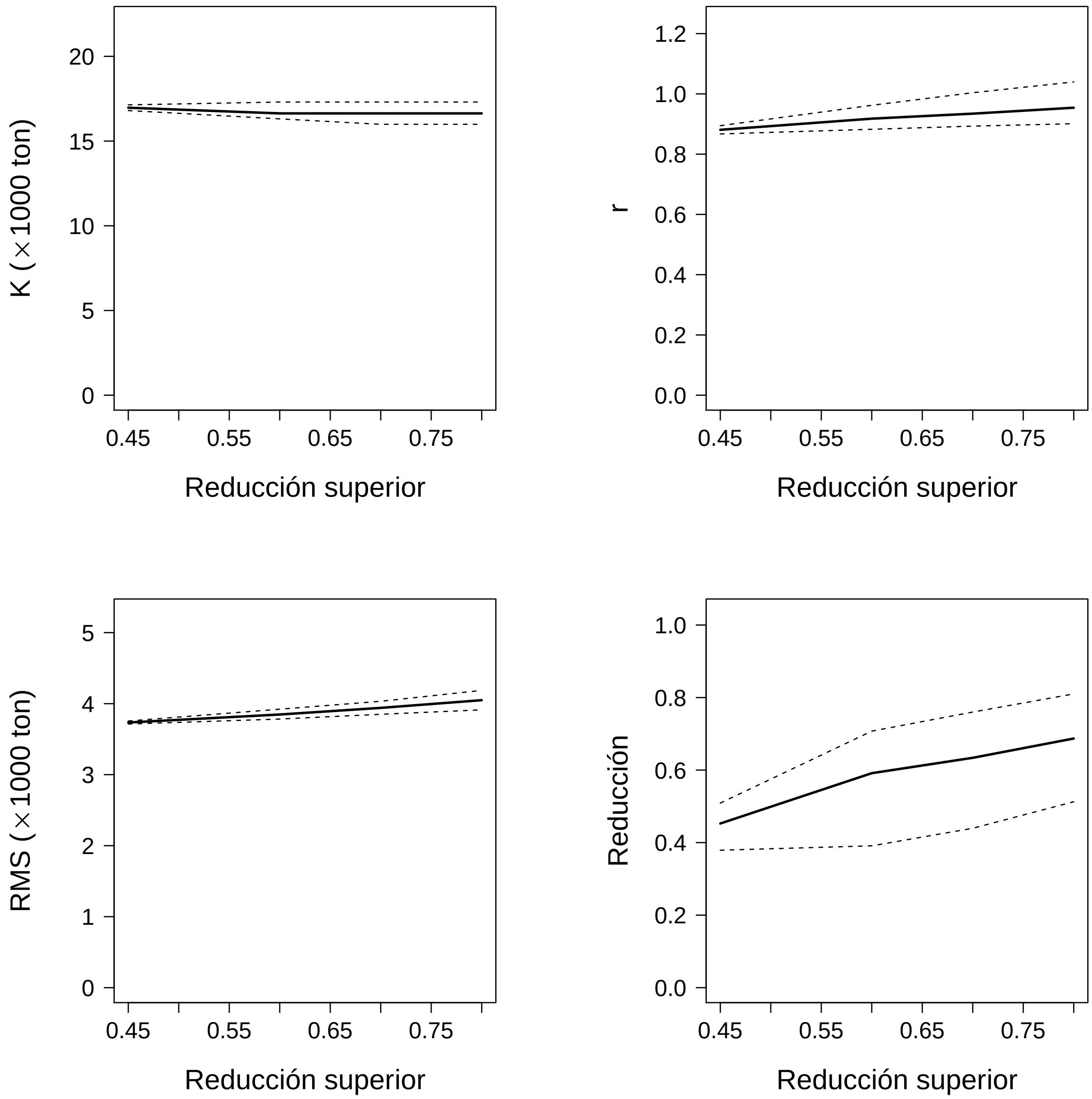
Sensibilidad

```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
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

```r
##############################################################################################
# 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)
```

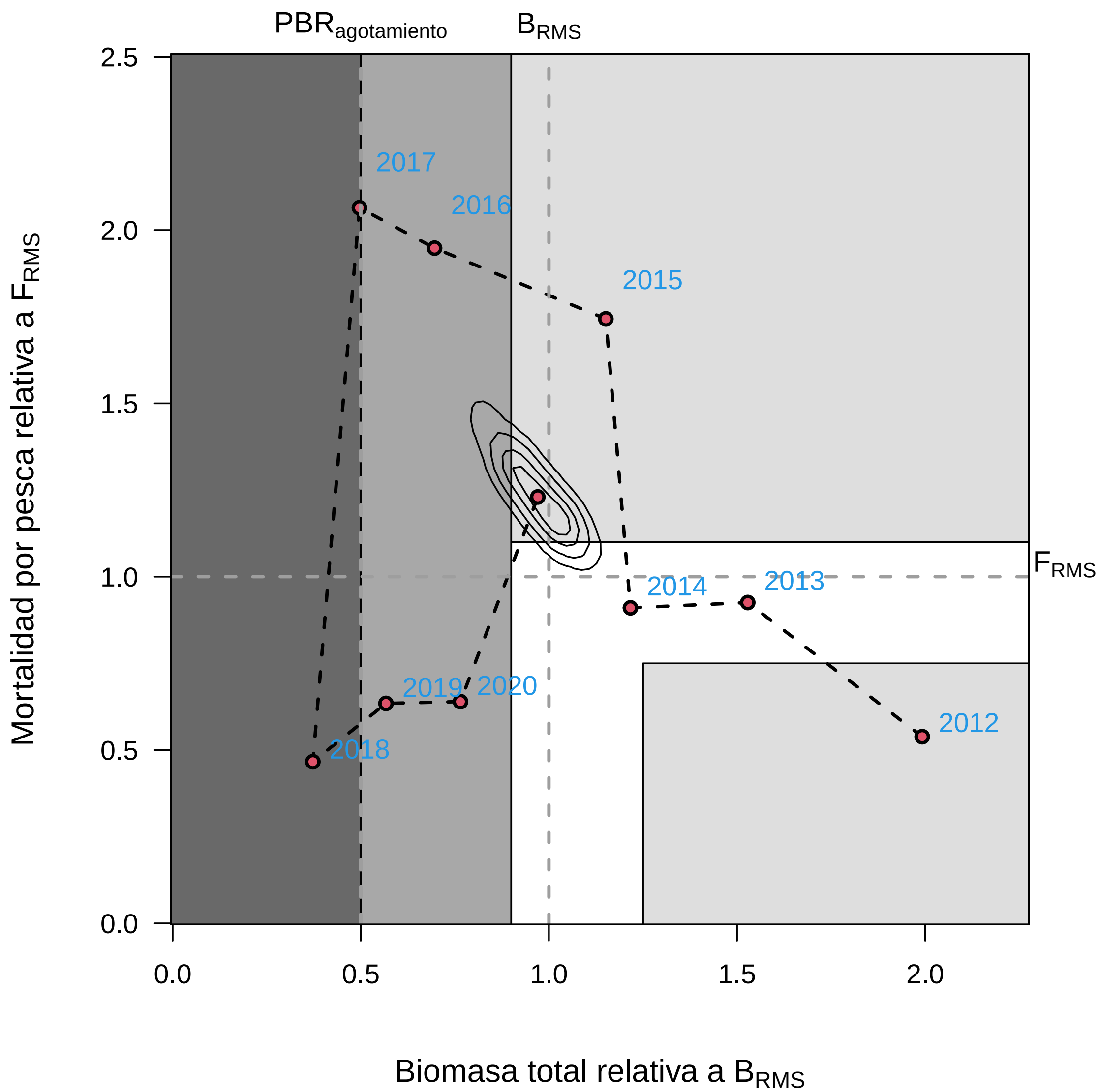
year	BT	Fest	B_Bo	Brel	Frel
2012	16903	0.24	1.00	1.99	0.54
2013	12968	0.41	0.76	1.53	0.93
2014	10323	0.40	0.61	1.22	0.91
2015	9768	0.77	0.58	1.15	1.74
2016	5906	0.86	0.35	0.70	1.95
2017	4212	0.91	0.25	0.50	2.06
2018	3161	0.21	0.19	0.37	0.47
2019	4810	0.28	0.28	0.57	0.63
2020	6489	0.28	0.38	0.76	0.64
2021	8234	0.55	0.49	0.97	1.23

```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))
```

```
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$_{RMS}$
2.5
2.0
1.5
1.0
0.5
0.0
2017
2016
2015
2014
2013
2012
2019
2020
2018
F$_{RMS}$
0.0
0.5
1.0
1.5
2.0
Mortalidad por pesca relativa a F$_{RMS}$
Biomasa total relativa a B$_{RMS}$

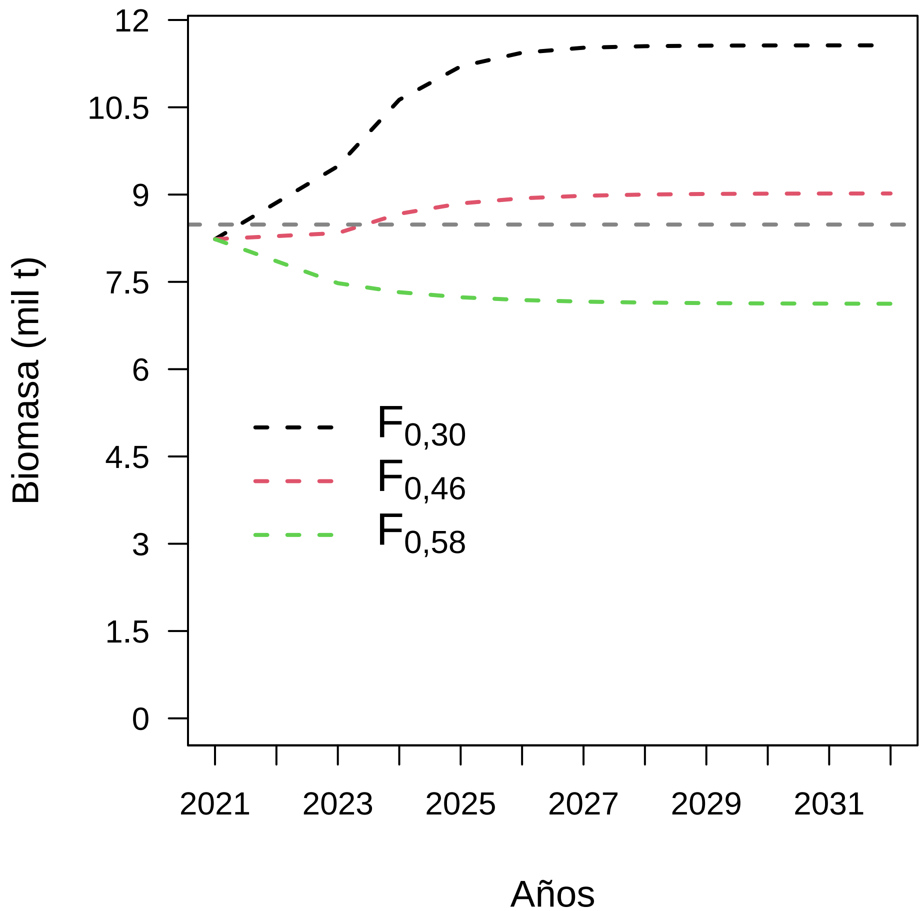
```
#dev.off()
```

Cálculo de CBA

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

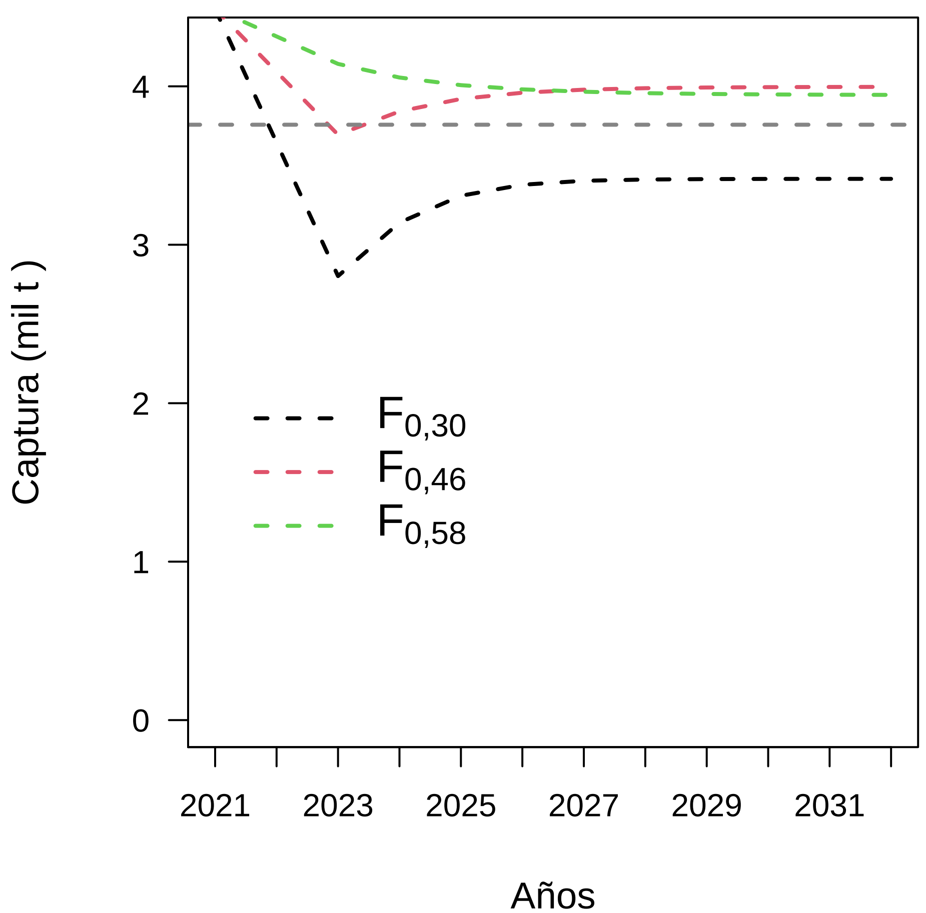
```r
##################################################################################################
# GRAFICA LA CBA 2 PARA sardina austral
##################################################################################################
FF   <-formatC(Fi,format="f",digits=2)
BB   <-expression(paste("Biomasa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

```
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("0,46")]),
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),bty="n")
```




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

```
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("0,46")]),
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),bty="n")
```



```r
##########################################################################################
# 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")
```

```r
print(ct)
```

```
##          10%      20%      30%      40%      50%
## 0.30 2277.035 2282.162 2288.156 2293.619 2295.858
## 0.44 3415.552 3423.243 3432.234 3440.429 3443.786
## 0.55 4269.440 4279.054 4290.293 4300.536 4304.733
```

```r
##########################################################################################
# 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")
```

```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%	3392.999
25%	3427.983
50%	3443.786
75%	3458.664
97.5%	3497.313

```
#
#FIN
```