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

```
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/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}
}
```

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))
}
```

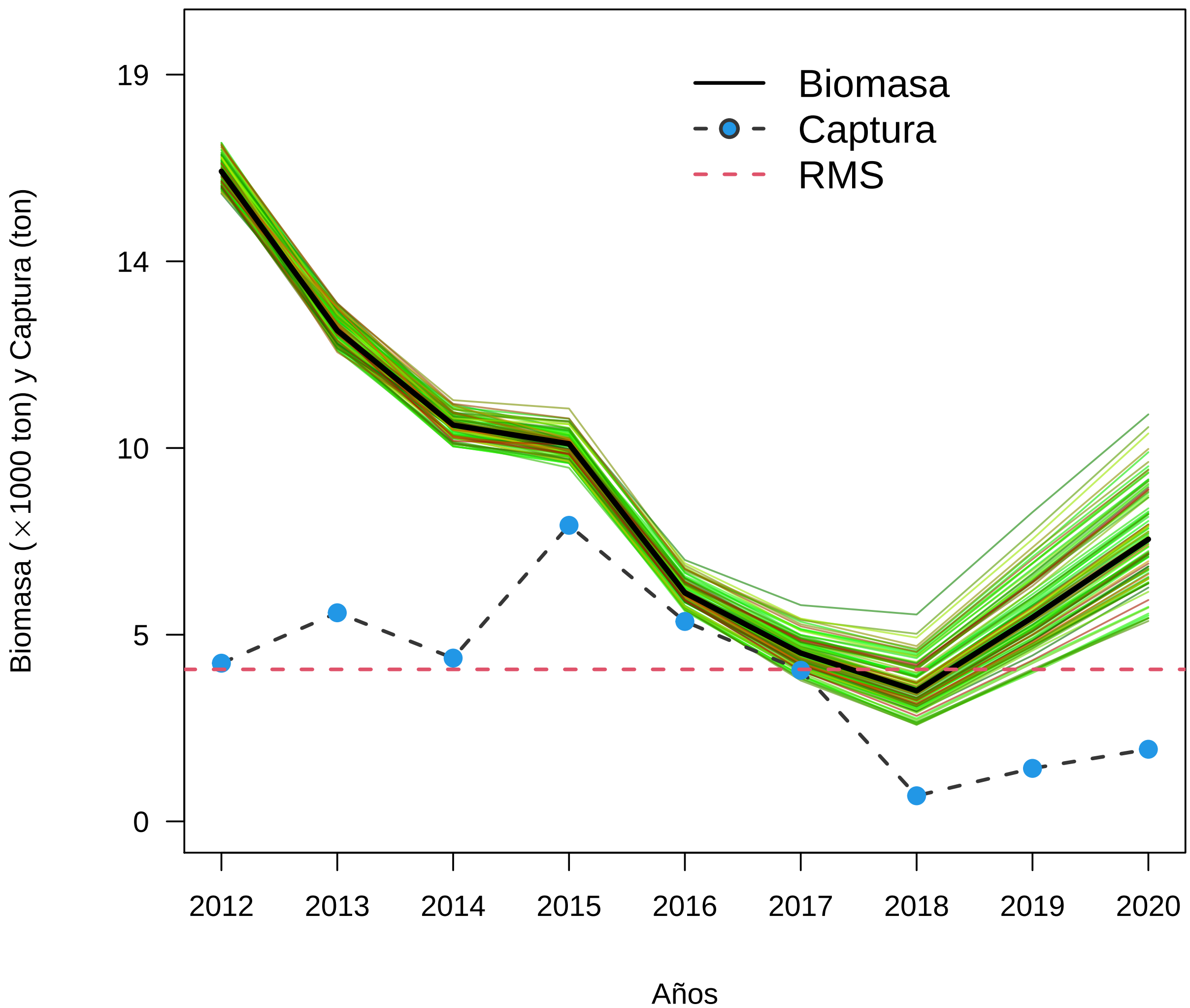
Ingresa datos de captura

```
#
########################################################################
# input catch data and r range for sautral XI stock
C=c(4033,5318,4163,7547,5097,3853,653,1352,1839)
yr=seq(2012,2020)
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$d <= 0.50,]#cutoff,assume upper depeltion=0.4
quan1     =apply(all2,2,quantile)
k25       =quan1[,1][2];k75=quan1[,1][4]
r25       =quan1[,2][2];r75=quan1[,2][4]
msy.media=quan1[,4][3]
all3      =all2[all2$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
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,],
```

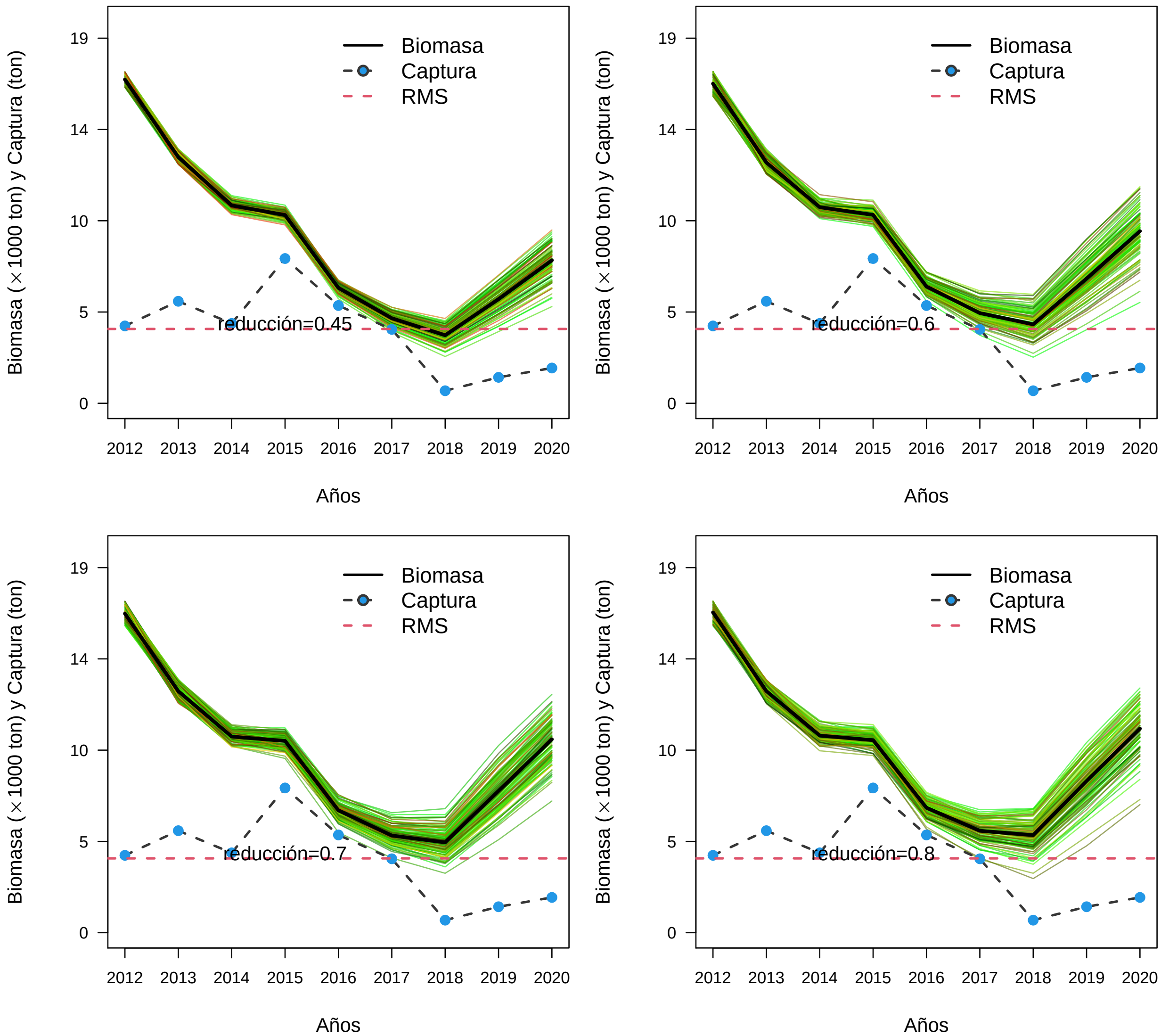
```r
                     F2Fmsy.med=apply(F2Fmsy,1,median),
                     quan1.F=apply(F2Fmsy,1,quant)[1,],
                     quan3.F=apply(F2Fmsy,1,quant)[2,])

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%	15370.15	0.8508866	3681.066	5107.767	0.3083200
25%	15989.66	0.8904154	3794.954	6434.310	0.3883941
50%	16634.15	0.9265434	3874.717	7191.507	0.4341008
75%	17304.61	0.9811221	3944.479	8048.405	0.4858257
100%	17304.61	1.0621235	4081.248	10374.774	0.6262522

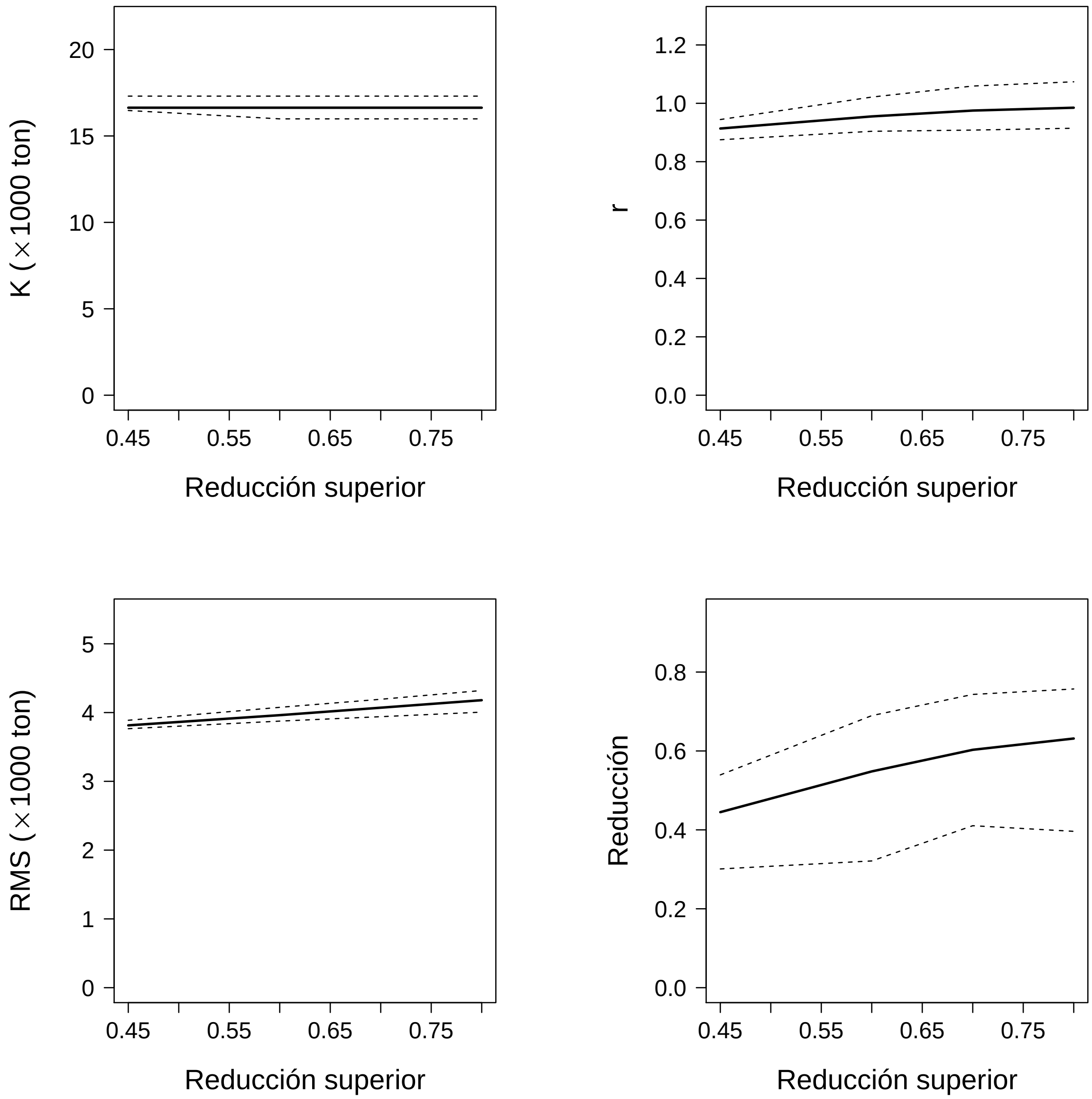
```r
Bioma <-apply(out1.backup[[6]],1,quantile)
#note: Bmsy = k/2, Blim = k/4
B.sim =data.frame(out1[6])
BF    =t(apply(B.sim,1,quantile))
BF    =cbind(BF,C/BF)
BRP   =c(quan1[3,1]/2,quan1[3,2]/2)
fs    =data.frame(cbind(BF[,c(8,3)],yr)) # F y Biomasa media
#GRAFICA BIOMASA V/S CPUE
#plot(yr,BF[,3],type="b",ylab="Biomasa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

Sensibilidad

```
#######################################################
#  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
10
14
19
2012
2013
2014
2015
2016
2017
2018
2019
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","BD","Fest","B_Bo","Brel","Frel")

kable(soli)
```

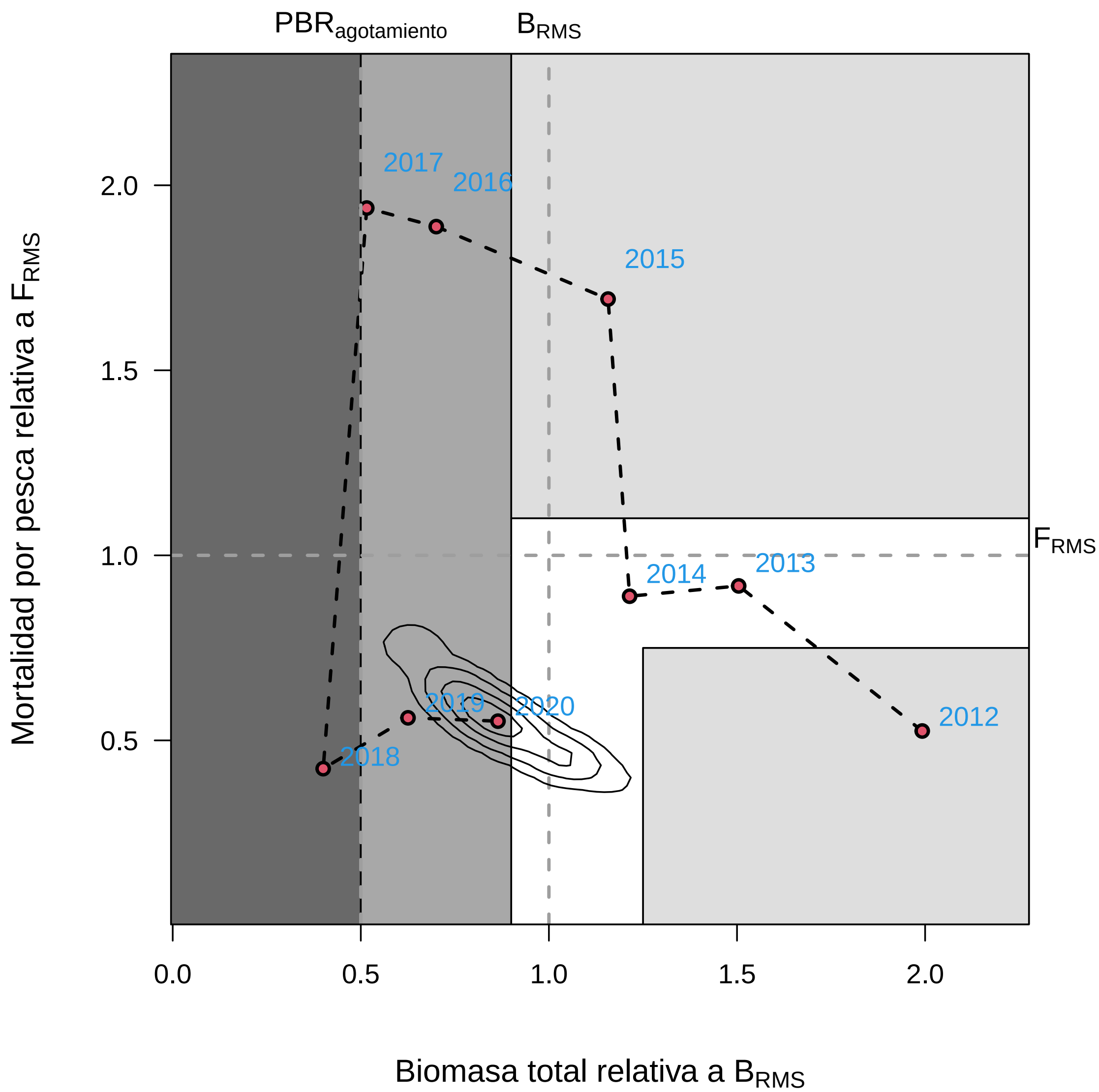
year	BD	Fest	B_Bo	Brel	Frel
2012	16570	0.24	1.00	1.99	0.53
2013	12512	0.43	0.75	1.50	0.92
2014	10101	0.41	0.61	1.21	0.89
2015	9625	0.78	0.58	1.16	1.69
2016	5826	0.87	0.35	0.70	1.89
2017	4290	0.90	0.26	0.52	1.94
2018	3327	0.20	0.20	0.40	0.42
2019	5202	0.26	0.31	0.63	0.56
2020	7192	0.26	0.43	0.86	0.55

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

Bmrs	8317.0750007
Fmrs	0.4632717

```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)
```

```r
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()
```


PBRagotamiento
BRMS
FRMS
2017
2016
2015
2014
2013
2012
2019
2020
2018
0.0
0.5
1.0
1.5
2.0
0.5
1.0
1.5
2.0
Mortalidad por pesca relativa a FRMS
Biomasa total relativa a BRMS

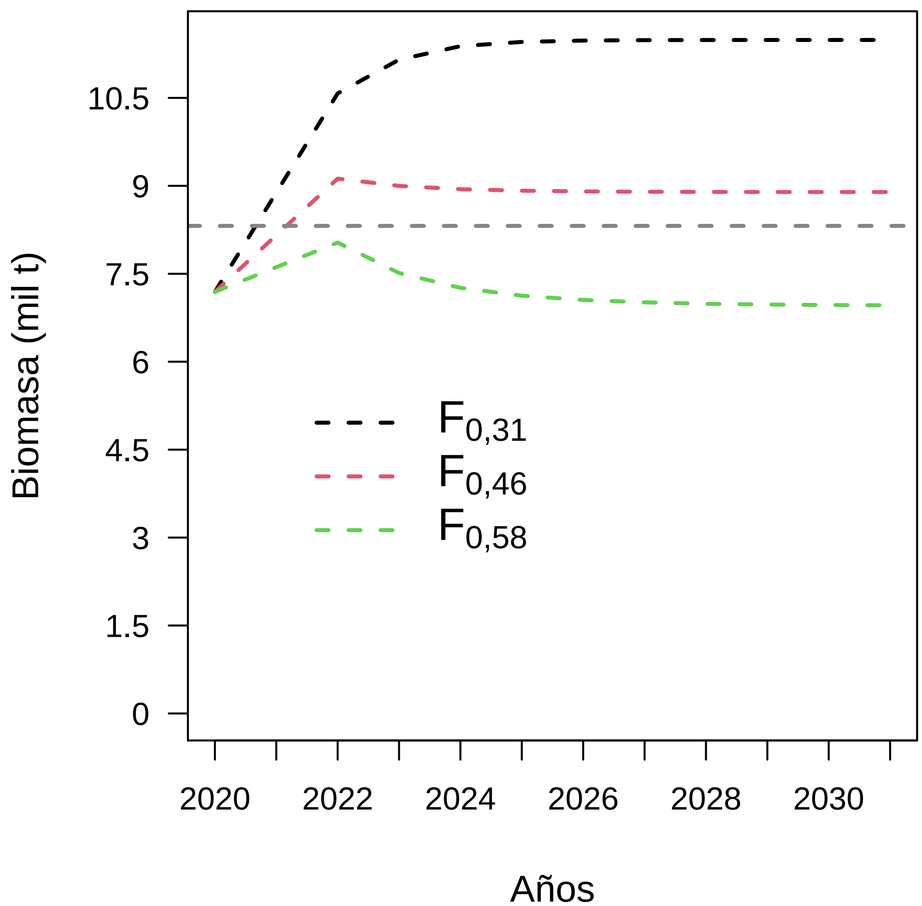
```
#dev.off()
```

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("0,31")]),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")
```

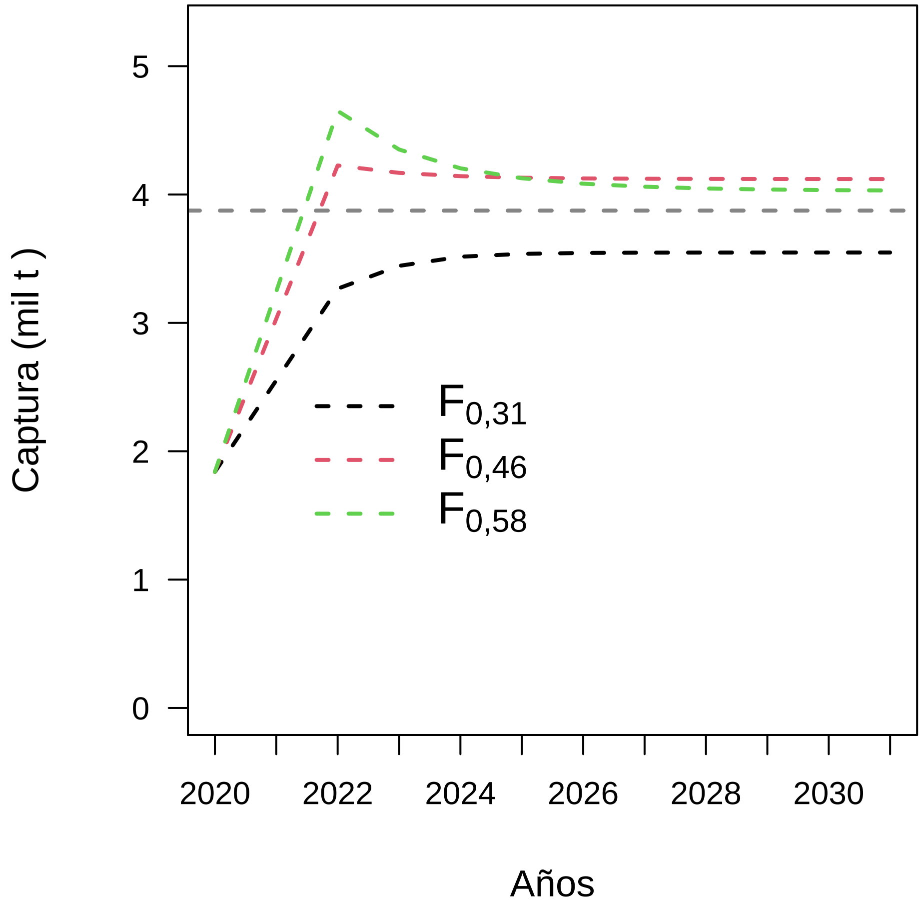



```r
xxxx
```

```
##            [,1]     [,2]     [,3]
##  [1,]  7191.507 7191.507 7191.507
```

```
##  [2,] 10575.768 9122.320 8032.233
##  [3,] 11151.719 8998.621 7513.555
##  [4,] 11382.324 8942.773 7260.045
##  [5,] 11454.522 8916.961 7126.259
##  [6,] 11477.821 8904.907 7053.288
##  [7,] 11485.114 8899.250 7012.498
##  [8,] 11487.385 8896.590 6988.577
##  [9,] 11488.091 8895.337 6974.762
## [10,] 11488.311 8894.747 6966.752
## [11,] 11488.379 8894.469 6962.097
```

```
#################################################################################################
# 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("0,31")]),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")
```




```
xxxx
```

```
##            [,1]     [,2]     [,3]
##  [1,] 1839.000 1839.000 1839.000
##  [2,] 3266.303 4226.113 4651.383
##  [3,] 3444.184 4168.807 4351.022
##  [4,] 3515.406 4142.934 4204.217
##  [5,] 3537.704 4130.976 4126.743
##  [6,] 3544.900 4125.392 4084.486
##  [7,] 3547.153 4122.771 4060.865
##  [8,] 3547.854 4121.538 4047.013
##  [9,] 3548.072 4120.958 4039.013
## [10,] 3548.140 4120.685 4034.374
## [11,] 3548.161 4120.556 4031.678
```

```
###############################################################################################
# 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)
```

```r
cat("\n")
```

```r
print(ct)
```

```
##           10%      20%      30%      40%      50%
## 0.31 2884.787 2894.161 2898.599 2902.964 2907.884
## 0.46 4327.180 4341.242 4347.898 4354.446 4361.825
## 0.58 5408.975 5426.552 5434.872 5443.057 5452.282
```

```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%	4300.291
25%	4344.147
50%	4361.825
75%	4385.608
97.5%	4421.512

```r
#
#FIN
```